MPRF File Copy

National Aeronautics and Space Administration

BUDGET ESTIMATES

FISCAL YEAR 1963

GENERAL DATA AND SUMMARY

RESEARCH, DEVELOPMENT AND OPERATION

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

FISCAL YEAR 1963 ESTIMATES

RESEARCH, DEVELOPMENT AND OPERATION

TABLE OF CONTENTS

ITEM	PAGE NO.
Summary schedules	
Appropriation summaries	S-1
Identification of programs with activities	S-3
Summary of Research, Development and Operation programs	A 1-1
Fund requirements - summary distribution	A 2-1
Fund requirements - institutional support	A 3-1
Summary distribution of personnel services	A 4-1
Summary by object classification	A 5-1
Personal services and benefits	A 6-1
Organization and staffing charts	
NASA organization chart	A 7-1
Personnel staffing charts:	
NASA headquarters	A 7-2
Western Operations Office	A 7-3
Langley Research Center	A 7-4
Ames Research Center	A 7-5
Lewis Research Center	A 7-6
Flight Research Center	A 7-7
Goddard Space Flight Center	A 7-8
Manned Spacecraft Center	A 7-9
George C. Marshall Space Flight Center	A 7-10
Wallops Station	A 7-11
Space Nuclear Propulsion Office (Cleveland)	A 7-12
Object classification	
Travel and transportation of persons	A 8-1
Transportation of things	A 9-1
Rent, communications and utilities	A 10-1
Printing and reproduction	A 11-1
Other services	A 12-1
Supplies and materials	A 13-1
Equipment	A 14-1
Insurance claims and indemnities	A 15-1

...

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

FISCAL YEAR 1963 ESTIMATES

RESEARCH, DEVELOPMENT AND OPERATION

TABLE OF CONTENTS

ITEM	PAGE NO.
Justification by research and development program	
Mercury	RDO 1-1
Advanced manned space flight	RDO 2-1
Saturn C-1	RDO 3-1
Advanced Saturn	RDO 4-1
Nova	RDO 5-1
Meteorological satellites	RDO 6-1
Communications satellites	RDO 7-1
Sounding rockets	RDO 8-1
Scientific satellites	RDO 9-1
Lunar and planetary exploration	RDO 10-1
Scout	RDO 11-1
Delta	RDO 12-1
Centaur	RDO 13-1
Spacecraft technology	RDO 14-1
Launch vehicle technology	RDO 15-1
Launch operations development	RDO 16-1
Electric propulsion	RDO 17-1
Liquid propulsion	RDO 18-1
Solid propulsion	RDO 19-1
Space power technology	RDO 20-1
Nuclear systems technology	RDO 21-1
Aircraft and missile technology	RDO 22-1
Tracking and data acquisition	RDO 23-1

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

FISCAL YEAR 1963 ESTIMATES

APPROPRIATION SUMMARY

	1961	1962	1962 Supplemental	1963
SALARIES AND EXPENSES	$(170,760,000)	$(206,750,000)	$ -	$ -
RESEARCH AND DEVELOPMENT	(670,453,000)	(1,220,000,000)	(85,000,000)	-
RESEARCH, DEVELOPMENT AND OPERATION	841,213,000	1,426,750,000	85,000,000	2,968,278,000
CONSTRUCTION OF FACILITIES	122,787,000	245,000,000	71,000,000	818,998,000
TOTAL	$ 964,000,000	$1,671,750,000	$156,000,000	$3,787,276,000

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

FISCAL YEAR 1963 ESTIMATES

APPROPRIATION SUMMARY

	Salaries and Expenses	Research and Development	Research, Development and Operation	Construction of Facilities	Total
FISCAL YEAR 1961					
Independent Offices Appropriation Act, 74 Stat.436..	($170,760,000)	($ 621,453,000)	$ 792,213,000	$122,787,000	$ 915,000,000
Third Supplemental Appropriation Act, 75 Stat.25...	---	(49,000,000)	49,000,000	---	49,000,000
Appropriation Transfers, 74 Stat. 436.....	(- 3,942,000)	(+ 1,502,000)	- 2,440,000	+ 2,440,000	---
Total.....	($166,818,000)	($ 671,955,000)	$ 838,773,000	$125,227,000	$ 964,000,000
FISCAL YEAR 1962					
Independent Offices Appropriation Act, 75 Stat.355..	($206,750,000)	($1,220,000,000)	$1,426,750,000	$245,000,000	$1,671,750,000
Supplemental Appropriation Act, 75 Stat. 742.....	(+ 10,000,000)	(- 10,000,000)	---	---	---
Appropriation Transfers, 75 Stat. 355.....	---	(- 24,356,000)	- 24,356,000	+ 24,356,000	---
Anticipated:					
Supplemental Appropriation.	---	(85,000,000)	85,000,000	71,000,000	156,000,000
Appropriation Transfers....	---	(+ 22,261,000)	+ 22,261,000	- 22,261,000	---
Total.....	($216,750,000)	($1,292,905,000)	$1,509,655,000	$318,095,000	$1,827,750,000
FISCAL YEAR 1963					
Regular Estimates.....	---	---	$2,968,278,000	$818,998,000	$3,787,276,000

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

FISCAL YEAR 1963 ESTIMATES

IDENTIFICATION OF RESEARCH, DEVELOPMENT AND OPERATION PROGRAMS WITH PRESIDENT'S BUDGET ACTIVITIES

BUDGET ACTIVITY	RESEARCH, DEVELOPMENT AND OPERATION PROGRAMS
1. Manned Space Flight	
a. Spacecraft Development and Operations	Mercury Advanced Manned Space Flight
b. Launch Vehicle Development	Saturn C-1 Advanced Saturn NOVA
2. Space Applications	
a. Meteorology	Meteorological Satellites
b. Communications	Communications Satellites
3. Unmanned Investigations in Space	
a. Spacecraft Development and Operations	Sounding Rockets Scientific Satellites Lunar and Planetary Exploration
b. Launch Vehicle Development	Scout Delta Centaur
4. Space Technology	
a. Launch Vehicles and Spacecraft	Spacecraft Technology Launch Vehicle Technology Launch Operations Development
b. Propulsion and Space Power	Electric Propulsion Liquid Propulsion Solid Propulsion Space Power Technology Nuclear Systems Technology
5. Aircraft and Missile Technology	Aircraft and Missile Technology
6. Supporting Operations	Tracking and Data Acquisition

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

FISCAL YEAR 1963 ESTIMATES

SUMMARY OF RESEARCH, DEVELOPMENT AND OPERATION PROGRAMS

Program	1961	1962	1962 Supplemental	1963
Mercury	$124,330,000	$ 68,278,000	---	$ 13,259,000
Advanced Manned Space Flight	6,266,000	147,241,500	---	863,628,000
Saturn C-1	173,908,000	282,193,000	---	249,237,000
Advanced Saturn	623,000	27,762,000	50,000,000	335,172,000
Nova	297,000	6,322,000	---	163,574,000
Meteorological Satellites	19,610,000	54,310,000	---	51,185,000
Communications Satellites	33,833,000	48,477,000	---	85,377,000
Sounding Rockets	12,330,000	14,261,000	---	19,157,000
Scientific Satellites	54,398,000	117,618,000	---	175,165,000
Lunar and Planetary Exploration	91,019,000	169,964,000	---	273,560,000
Scout	9,652,000	8,206,000	---	8,947,000
Delta	10,479,000	2,927,000	---	268,000
Centaur	64,673,000	65,840,000	9,000,000	66,664,000
Spacecraft Technology	27,126,000	37,145,000	---	54,084,000
Launch Vehicle Technology	13,851,000	23,080,000	---	31,690,000
Launch Operations Development	100,000	1,789,000	---	21,486,000
Electric Propulsion	7,164,000	17,581,000	---	30,647,000
Liquid Propulsion	72,726,000	103,901,000	26,000,000	163,102,000
Solid Propulsion	1,899,000	4,297,000	---	7,944,000
Space Power Technology	8,913,000	14,644,000	---	20,172,000
Nuclear Systems Technology	25,050,000	50,234,500	---	122,962,000
Aircraft and Missile Technology	37,857,000	41,479,000	---	52,588,000
Tracking and Data Acquisition	44,330,000	94,844,000	---	158,410,000
Total	$840,434,000	$1,402,394,000	$85,000,000	$2,968,278,000

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

FISCAL YEAR 1963 ESTIMATES

SUMMARY DISTRIBUTION OF FUND REQUIREMENTS

RESEARCH, DEVELOPMENT AND OPERATION

PROGRAMS	FISCAL YEAR 1961				FISCAL YEAR 1962				FISCAL YEAR
	Research & Development Program Requirements	Institutional Support	Personnel Services	Total	Research & Development Program Requirements	Institutional Support	Personnel Services	Total	Research & Development Program Requirements	Institutional Support	Pers Serv
Mercury	$109,851,000	$ 4,804,991	$ 9,674,009	$124,330,000	$ 54,433,000	$ 7,042,942	$ 6,802,058	$ 68,278,000	$ 3,500,000	$ 4,880,170	$ 4,8
Advanced Manned Space Flight	5,265,000	351,263	649,737	6,266,000	122,162,000	12,509,826	12,569,674	147,241,500	800,933,000	27,442,823	35,2
Saturn C-1	119,085,000	16,325,221	38,497,779	173,908,000	201,789,000	31,455,567	48,948,433	282,193,000	170,000,000	33,001,367	46,2
Advanced Saturn	-	290,367	332,633	623,000	21,500,000	3,972,623	2,289,377	27,762,000	314,443,000	10,694,076	10,0
Nova	-	144,909	152,091	297,000	2,300,000	2,674,275	1,347,725	6,322,000	155,000,000	5,763,536	2,81
Meteorological Satellites	17,595,000	817,491	1,197,509	19,610,000	50,816,000	1,782,802	1,711,198	54,310,000	45,894,000	2,737,632	2,5
Communications Satellites	31,206,000	1,031,803	1,595,197	33,833,000	43,823,000	1,919,944	2,734,056	48,477,000	79,624,000	2,542,427	3,21
Sounding Rockets	8,250,000	1,716,746	2,363,254	12,330,000	9,800,000	2,132,299	2,328,701	14,261,000	13,571,000	2,786,242	2,7
Scientific Satellites	35,468,000	8,170,236	10,759,764	54,398,000	96,568,000	10,941,769	10,108,231	117,618,000	145,532,000	15,424,301	14,2
Lunar and Planetary Exploration	85,797,000	2,086,559	3,135,441	91,019,000	163,768,000	2,739,809	3,456,191	169,964,000	263,433,000	4,696,230	5,4
Scout	5,950,000	1,461,042	2,240,958	9,652,000	3,950,000	1,846,008	2,409,992	8,206,000	4,200,000	2,373,874	2,37
Delta	9,575,000	439,185	464,815	10,479,000	2,755,000	51,731	120,269	2,927,000	-	101,410	16
Centaur	62,575,000	1,162,830	935,170	64,673,000	62,600,000	1,437,511	1,802,489	65,840,000	60,000,000	3,052,496	3,61
Spacecraft Technology	9,149,000	6,584,528	11,392,472	27,126,000	17,796,000	7,365,626	11,983,374	37,145,000	28,828,000	10,724,494	14,53
Launch Vehicle Technology	9,047,000	1,946,862	2,857,138	13,851,000	14,523,000	3,456,227	5,100,773	23,080,000	20,060,000	4,728,341	6,90
Launch Operations Development	100,000	-	-	100,000	1,656,000	69,941	63,059	1,789,000	20,177,000	637,994	67
Electric Propulsion	3,391,000	1,362,360	2,410,640	7,164,000	12,121,000	1,918,616	3,541,384	17,581,000	21,218,000	3,977,264	5,45
Liquid Propulsion	58,981,000	4,661,693	9,083,307	72,726,000	90,226,000	5,163,812	8,511,188	103,901,000	147,421,000	6,271,339	9,40
Solid Propulsion	1,372,000	186,419	340,581	1,899,000	3,424,000	401,980	471,020	4,297,000	6,019,000	990,846	93
Space Power Technology	4,725,000	1,441,030	2,746,970	8,913,000	7,175,000	3,159,188	4,309,812	14,644,000	10,638,000	3,695,313	5,83
Nuclear Systems Technology	13,494,000	3,650,180	7,905,820	25,050,000	34,266,000	6,927,783	9,040,717	50,234,500	103,028,000	7,354,084	12,57
Aircraft and Missile Technology	980,000	14,399,269	22,477,731	37,857,000	1,860,000	16,288,347	23,330,653	41,479,000	4,905,000	20,730,508	26,95
Tracking and Data Acquisition	29,651,000	6,443,016	8,235,984	44,330,000	70,884,000	11,680,374	12,279,626	94,844,000	121,871,000	19,060,233	17,47
TOTAL	$621,507,000	$79,478,000	$139,449,000	$840,434,000	$1,090,195,000	$136,939,000	$175,260,000	$1,402,394,000	$2,540,295,000	$193,667,000	$234,31

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

FISCAL YEAR 1963 ESTIMATES

SUMMARY DISTRIBUTION OF FUND REQUIREMENTS

RESEARCH, DEVELOPMENT AND OPERATION

	FISCAL YEAR 1961				FISCAL YEAR 1962				FISCAL YEAR 1963			
	Research & Development Program Requirements	Institutional Support	Personnel Services	Total	Research & Development Program Requirements	Institutional Support	Personnel Services	Total	Research & Development Program Requirements	Institutional Support	Personnel Services	Total
	$109,851,000	$ 4,804,991	$ 9,674,009	$124,330,000	$ 54,433,000	$ 7,042,942	$ 6,802,058	$ 68,278,000	$ 3,500,000	$ 4,880,170	$ 4,878,830	$ 13,259,000
light	5,265,000	351,263	649,737	6,266,000	122,162,000	12,509,826	12,569,674	147,241,500	800,933,000	27,442,823	35,252,177	863,628,000
	119,085,000	16,325,221	38,497,779	173,908,000	201,789,000	31,455,567	48,948,433	282,193,000	170,000,000	33,001,367	46,235,633	249,237,000
	-	290,367	332,633	623,000	21,500,000	3,972,623	2,289,377	27,762,000	314,443,000	10,694,076	10,034,924	335,172,000
	-	144,909	152,091	297,000	2,300,000	2,674,275	1,347,725	6,322,000	155,000,000	5,763,536	2,810,464	163,574,000
es	17,595,000	817,491	1,197,509	19,610,000	50,816,000	1,782,802	1,711,198	54,310,000	45,894,000	2,737,632	2,553,368	51,185,000
es	31,206,000	1,031,803	1,595,197	33,833,000	43,823,000	1,919,944	2,734,056	48,477,000	79,624,000	2,542,427	3,210,573	85,377,000
	8,250,000	1,716,746	2,363,254	12,330,000	9,800,000	2,132,299	2,328,701	14,261,000	13,571,000	2,786,242	2,799,758	19,157,000
	35,468,000	8,170,236	10,759,764	54,398,000	96,568,000	10,941,769	10,108,231	117,618,000	145,532,000	15,424,301	14,208,699	175,165,000
loration	85,797,000	2,086,559	3,135,441	91,019,000	163,768,000	2,739,809	3,456,191	169,964,000	263,433,000	4,696,230	5,430,770	273,560,000
	5,950,000	1,461,042	2,240,958	9,652,000	3,950,000	1,846,008	2,409,992	8,206,000	4,200,000	2,373,874	2,373,126	8,947,000
	9,575,000	439,185	464,815	10,479,000	2,755,000	51,731	120,269	2,927,000	-	101,410	166,590	268,000
	62,575,000	1,162,830	935,170	64,673,000	62,600,000	1,437,511	1,802,489	65,840,000	60,000,000	3,052,496	3,611,504	66,664,000
	9,149,000	6,584,528	11,392,472	27,126,000	17,796,000	7,365,626	11,983,374	37,145,000	28,828,000	10,724,494	14,531,506	54,084,000
gy	9,047,000	1,946,862	2,857,138	13,851,000	14,523,000	3,456,227	5,100,773	23,080,000	20,060,000	4,728,341	6,901,659	31,690,000
opment	100,000	-	-	100,000	1,656,000	69,941	63,059	1,789,000	20,177,000	637,994	671,006	21,486,000
	3,391,000	1,362,360	2,410,640	7,164,000	12,121,000	1,918,616	3,541,384	17,581,000	21,218,000	3,977,264	5,451,736	30,647,000
	58,981,000	4,661,693	9,083,307	72,726,000	90,226,000	5,163,812	8,511,188	103,901,000	147,421,000	6,271,339	9,409,661	163,102,000
	1,372,000	186,419	340,581	1,899,000	3,424,000	401,980	471,020	4,297,000	6,019,000	990,846	934,154	7,944,000
	4,725,000	1,441,030	2,746,970	8,913,000	7,175,000	3,159,188	4,309,812	14,644,000	10,638,000	3,695,313	5,838,687	20,172,000
ogy	13,494,000	3,650,180	7,905,820	25,050,000	34,266,000	6,927,783	9,040,717	50,234,500	103,028,000	7,354,084	12,579,916	122,962,000
chnology	980,000	14,399,269	22,477,731	37,857,000	1,860,000	16,288,347	23,330,653	41,479,000	4,905,000	20,730,508	26,952,492	52,588,000
sition	29,651,000	6,443,016	8,235,984	44,330,000	70,884,000	11,680,374	12,279,626	94,844,000	121,871,000	19,060,233	17,478,767	158,410,000
	$621,507,000	$79,478,000	$139,449,000	$840,434,000	$1,090,195,000	$136,939,000	$175,260,000	$1,402,394,000	$2,540,295,000	$193,667,000	$234,316,000	$2,968,278,000

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

FISCAL YEAR 1963 ESTIMATES

SUMMARY DISTRIBUTION OF FUND REQUIREMENTS FOR INSTITUTIONAL SUPPORT

RESEARCH, DEVELOPMENT AND OPERATION

	TOTAL			HEADQUARTERS			WESTERN OPERATIONS OFFICE			LANGLEY RESEARCH CENTER		
	1961	1962	1963	1961	1962	1963	1961	1962	1963	1961	1962	1963
Mercury	$ 4,804,991	$ 7,042,942	$ 4,880,170	$ 244,792	$ 126,595	$ 240,159	$ -	$ -	$ -	$ 280,714	$ 370,471	$ 41
Advanced Manned Space Flight	351,263	12,509,826	27,442,823	142,742	3,222,079	7,151,132	-	28,790	53,136	104,768	666,047	1,480
Saturn C-1	16,325,221	31,455,567	33,001,367	955,169	779,419	1,446,551	34,998	75,537	90,928	231,289	294,577	636
Advanced Saturn	290,367	3,972,623	10,694,076	236,843	3,464,459	7,272,915	-	-	-	-	-	
Nova	144,909	2,674,275	5,763,536	139,742	2,337,689	4,899,537	5,167	6,958	5,448	-	-	
Meteorological Satellites	817,491	1,782,802	2,737,632	362,354	564,689	1,112,812	-	-	-	-	-	
Communications Satellites	1,031,803	1,919,944	2,542,427	495,096	730,622	1,422,291	7,167	12,916	11,896	349,893	294,577	337
Sounding Rockets	1,716,746	2,132,299	2,786,242	148,332	112,784	211,290	-	-	-	228,289	242,551	285
Scientific Satellites	8,170,236	10,941,769	15,424,301	961,911	1,473,676	2,932,987	17,500	23,832	30,792	770,964	813,836	379
Lunar and Planetary Exploration	2,086,559	2,739,809	4,696,230	719,119	1,433,297	2,773,480	12,333	39,706	50,360	69,179	110,341	171
Scout	1,461,042	1,846,008	2,373,874	122,101	110,041	169,913	7,167	-	-	730,416	810,836	635
Delta	439,185	51,731	101,410	418,225	-	-	17,500	35,748	49,688	-	-	
Centaur	1,162,830	1,437,511	3,052,496	185,972	135,338	207,290	6,167	-	-	105,768	36,447	42
Spacecraft Technology	6,584,528	7,365,626	10,724,494	969,320	1,466,946	2,963,624	7,167	5,958	6,448	1,679,287	1,847,354	2,542
Launch Vehicle Technology	1,946,862	3,456,227	4,728,341	127,101	217,527	512,261	-	4,479	2,224	228,289	370,471	845
Launch Operations Development	-	69,941	637,994	-	-	-	-	-	-	-	-	
Electric Propulsion	1,362,360	1,918,616	3,977,264	82,871	434,054	934,551	-	9,437	11,672	33,589	35,447	41
Liquid Propulsion	4,661,693	5,163,812	6,271,339	227,972	273,122	607,638	7,167	5,958	7,448	-	-	
Solid Propulsion	186,419	401,980	990,846	41,230	244,824	512,261	20,500	24,832	33,792	104,768	110,341	171
Space Power Technology	1,441,030	3,159,188	3,695,313	431,225	574,541	1,264,464	5,167	8,437	9,672	175,947	184,235	210
Nuclear Systems Technology	3,650,180	6,927,783	7,354,084	64,691	514,473	1,402,349	12,333	43,706	50,136	-	-	
Aircraft and Missile Technology	14,399,269	16,288,347	20,730,508	717,967	809,514	1,647,972	80,500	139,748	153,912	4,659,554	5,287,350	7,040
Tracking and Data Acquisition	6,443,016	11,680,374	19,060,233	472,225	920,811	1,618,523	7,167	6,958	8,448	1,682,286	1,669,119	2,115
TOTAL	$79,478,000	$136,939,000	$193,667,000	$8,267,000	$19,946,500	$41,304,000	$248,000	$473,000	$576,000	$11,435,000	$13,144,000	$16,979

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

FISCAL YEAR 1963 ESTIMATES

SUMMARY DISTRIBUTION OF FUND REQUIREMENTS FOR INSTITUTIONAL SUPPORT

RESEARCH, DEVELOPMENT AND OPERATION

	TOTAL			HEADQUARTERS			WESTERN OPERATIONS OFFICE			LANGLEY RESEARCH CENTER		
	1961	1962	1963	1961	1962	1963	1961	1962	1963	1961	1962	1963
	$ 4,804,991	$ 7,042,942	$ 4,880,170	$ 244,792	$ 126,595	$ 240,159	$ -	$ -	$ -	$ 280,714	$ 370,471	$ 41,685
Flight	351,263	12,509,826	27,442,823	142,742	3,222,079	7,151,132	-	28,790	53,136	104,768	666,047	1,480,975
	16,325,221	31,455,567	33,001,367	955,169	779,419	1,446,551	34,998	75,537	90,928	231,289	294,577	636,275
	290,367	3,972,623	10,694,076	236,843	3,464,459	7,272,915	-	-	-	-	-	-
	144,909	2,674,275	5,763,536	139,742	2,337,689	4,899,537	5,167	6,958	5,448	-	-	-
tes	817,491	1,782,802	2,737,632	362,354	564,689	1,112,812	-	-	-	-	-	-
tes	1,031,803	1,919,944	2,542,427	495,096	730,622	1,422,291	7,167	12,916	11,896	349,893	294,577	337,480
	1,716,746	2,132,299	2,786,242	148,332	112,784	211,290	-	-	-	228,289	242,551	285,952
	8,170,236	10,941,769	15,424,301	961,911	1,473,676	2,932,987	17,500	23,832	30,792	770,964	813,836	379,165
cploration	2,086,559	2,739,809	4,696,230	719,119	1,433,297	2,773,480	12,333	39,706	50,360	69,179	110,341	171,740
	1,461,042	1,846,008	2,373,874	122,101	110,041	169,913	7,167	-	-	730,416	810,836	635,275
	439,185	51,731	101,410	418,225	-	-	17,500	35,748	49,688	-	-	-
	1,162,830	1,437,511	3,052,496	185,972	135,338	207,290	6,167	-	-	105,768	36,447	42,685
	6,584,528	7,365,626	10,724,494	969,320	1,466,946	2,963,624	7,167	5,958	6,448	1,679,287	1,847,354	2,542,100
logy	1,946,862	3,456,227	4,728,341	127,101	217,527	512,261	-	4,479	2,224	228,289	370,471	845,700
elopment	-	69,941	637,994	-	-	-	-	-	-	-	-	-
	1,362,360	1,918,616	3,977,264	82,871	434,054	934,551	-	9,437	11,672	33,589	35,447	41,685
	4,661,693	5,163,812	6,271,339	227,972	273,122	607,638	7,167	5,958	7,448	-	-	-
	186,419	401,980	990,846	41,230	244,824	512,261	20,500	24,832	33,792	104,768	110,341	171,740
r	1,441,030	3,159,188	3,695,313	431,225	574,541	1,264,464	5,167	8,437	9,672	175,947	184,235	210,425
ology	3,650,180	6,927,783	7,354,084	64,691	514,473	1,402,349	12,333	43,706	50,136	-	-	-
Technology	14,399,269	16,288,347	20,730,508	717,967	809,514	1,647,972	80,500	139,748	153,912	4,659,554	5,287,350	7,040,867
uisition	6,443,016	11,680,374	19,060,233	472,225	920,811	1,618,523	7,167	6,958	8,448	1,682,286	1,669,119	2,115,251
	$79,478,000	$136,939,000	$193,667,000	$8,267,000	$19,946,500	$41,304,000	$248,000	$473,000	$576,000	$11,435,000	$13,144,000	$16,979,000

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

FISCAL YEAR 1963 ESTIMATES

SUMMARY DISTRIBUTION OF FUND REQUIREMENTS FOR INSTITUTIONAL SUPPORT

RESEARCH, DEVELOPMENT AND OPERATION

(Continued)

	AMES RESEARCH CENTER			LEWIS RESEARCH CENTER			FLIGHT RESEARCH CENTER			GODDARD SPACE FLIGHT CEN		
	1961	1962	1963	1961	1962	1963	1961	1962	1963	1961	1962	
Mercury	$ 21,979	$ 15,413	$ -	$ -	$ -	$ -	$ -	$ 165,069	$459,800	$ -	$ -	$
Advanced Manned Space Flight	37,299	462,110	1,350,268	-	780,610	1,643,264	27,000	82,034	746,127	-	-	
Saturn C-1	-	-	-	16,606	-	-	-	-	-	-	-	
Advanced Saturn	-	-	-	-	-	188,947	-	-	-	-	-	
Nova	-	-	-	-	-	188,947	-	-	-	-	-	
Meteorological Satellites	109,895	59,797	-	-	-	-	-	-	-	265,178	727,727	
Communications Satellites	-	-	-	-	-	-	-	-	-	128,806	778,939	
Sounding Rockets	-	-	-	-	-	-	-	-	-	509,177	449,515	
Scientific Satellites	255,090	273,013	372,005	-	-	-	-	-	-	4,547,263	8,193,606	10,
Lunar and Planetary Exploration	547,479	668,473	975,263	-	-	-	-	-	-	345,193	97,636	
Scout	-	-	-	-	-	-	-	-	-	-	-	
Delta	-	-	-	-	-	-	-	-	-	-	-	
Centaur	-	-	-	20,606	79,061	78,965	-	-	-	-	-	
Spacecraft Technology	3,857,738	3,859,892	4,989,427	48,175	185,476	222,895	-	-	-	-	-	
Launch Vehicle Technology	-	-	-	38,853	191,146	560,842	-	-	-	-	-	
Launch Operations Development	-	-	-	-	-	-	-	-	-	-	-	
Electric Propulsion	-	-	-	987,995	1,284,805	2,935,995	-	-	-	-	-	
Liquid Propulsion	-	-	-	4,132,649	4,521,104	4,609,235	-	-	-	-	-	
Solid Propulsion	-	-	-	-	-	-	-	-	-	-	-	
Space Power Technology	-	-	-	821,646	2,276,884	2,137,370	-	-	-	7,045	115,091	
Nuclear Systems Technology	-	-	-	3,439,473	5,981,433	5,006,563	-	-	-	-	-	
Aircraft and Missile Technology	2,513,520	2,598,302	3,728,037	2,044,997	1,490,481	2,016,977	1,428,000	2,563,897	3,505,073	-	-	
Tracking and Data Acquisition	-	-	-	-	-	-	-	-	-	4,281,338	9,083,486	15,
TOTAL	$7,343,000	$7,937,000	$11,415,000	$11,551,000	$16,791,000	$19,590,000	$1,455,000	$2,811,000	$4,711,000	$10,084,000	$19,446,000	$27,

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

FISCAL YEAR 1963 ESTIMATES

SUMMARY DISTRIBUTION OF FUND REQUIREMENTS FOR INSTITUTIONAL SUPPORT

RESEARCH, DEVELOPMENT AND OPERATION

(Continued)

	AMES RESEARCH CENTER			LEWIS RESEARCH CENTER			FLIGHT RESEARCH CENTER			GODDARD SPACE FLIGHT CENTER		
	1961	1962	1963	1961	1962	1963	1961	1962	1963	1961	1962	1963
	$ 21,979	$ 15,413	$ -	$ -	$ -	$ -	$ -	$ 165,069	$459,800	$ -	$ -	$ -
Flight	37,299	462,110	1,350,268	-	780,610	1,643,264	27,000	82,034	746,127	-	-	-
	-	-	-	16,606	-	-	-	-	-	-	-	-
	-	-	-	-	-	188,947	-	-	-	-	-	-
	-	-	-	-	-	188,947	-	-	-	-	-	-
ites	109,895	59,797	-	-	-	-	-	-	-	265,178	727,727	995,225
ites	-	-	-	-	-	-	-	-	-	128,806	778,939	428,222
	-	-	-	-	-	-	-	-	-	509,177	449,515	362,909
	255,090	273,013	372,005	-	-	-	-	-	-	4,547,263	8,193,606	10,623,973
xploration	547,479	668,473	975,263	-	-	-	-	-	-	345,193	97,636	49,278
	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	20,606	79,061	78,965	-	-	-	-	-	-
	3,857,738	3,859,892	4,989,427	48,175	185,476	222,895	-	-	-	-	-	-
logy	-	-	-	38,853	191,146	560,842	-	-	-	-	-	-
elopment	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	987,995	1,284,805	2,935,995	-	-	-	-	-	-
	-	-	-	4,132,649	4,521,104	4,609,235	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-
y	-	-	-	821,646	2,276,884	2,137,370	-	-	-	7,045	115,091	73,382
ology	-	-	-	3,439,473	5,981,433	5,006,563	-	-	-	-	-	-
Technology	2,513,520	2,598,302	3,728,037	2,044,997	1,490,481	2,016,977	1,428,000	2,563,897	3,505,073	-	-	-
isition	-	-	-	-	-	-	-	-	-	4,281,338	9,083,486	15,318,011
	$7,343,000	$7,937,000	$11,415,000	$11,551,000	$16,791,000	$19,590,000	$1,455,000	$2,811,000	$4,711,000	$10,084,000	$19,446,000	$27,851,000

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

FISCAL YEAR 1963 ESTIMATES

SUMMARY DISTRIBUTION OF FUND REQUIREMENTS FOR INSTITUTIONAL SUPPORT

RESEARCH, DEVELOPMENT AND OPERATION

(Continued)

	MANNED SPACECRAFT CENTER			MARSHALL SPACE FLIGHT CENTER			WALLOPS STATION			SPACE NUCLEAR PROPUL OFFICE (CLEVELAND		
	1961	1962	1963	1961	1962	1963	1961	1962	1963	1961	1962	
Mercury	$2,739,006	$6,176,622	$3,939,473	$ 1,168,825	$ 188,772	$ 199,053	$ 349,675	$ -	$ -	$ -	$ -	
Advanced Manned Space Flight	9,994	6,781,378	12,717,527	29,460	211,823	1,897,734	-	274,955	402,660	-	-	
Saturn C-1	-	-	-	15,087,159	30,306,034	30,827,613	-	-	-	-	-	
Advanced Saturn	-	-	-	53,524	508,164	3,232,214	-	-	-	-	-	
Nova	-	-	-	-	329,628	669,604	-	-	-	-	-	
Meteorological Satellites	-	-	-	50,841	102,890	157,527	29,223	327,699	472,068	-	-	
Communications Satellites	-	-	-	50,841	102,890	342,538	-	-	-	-	-	
Sounding Rockets	-	-	-	-	-	-	830,948	1,327,449	1,926,091	-	-	
Scientific Satellites	-	-	-	1,617,508	163,806	1,085,379	-	-	-	-	-	
Lunar and Planetary Exploration	-	-	-	334,810	298,704	545,189	58,446	91,652	130,920	-	-	
Scout	-	-	-	54,381	54,941	308,095	546,977	870,190	1,260,591	-	-	
Delta	-	-	-	3,460	15,983	51,722	-	-	-	-	-	
Centaur	-	-	-	844,317	1,186,665	2,723,556	-	-	-	-	-	
Spacecraft Technology	-	-	-	22,841	-	-	-	-	-	-	-	
Launch Vehicle Technology	-	-	-	1,552,619	2,672,604	2,807,314	-	-	-	-	-	
Launch Operations Development	-	-	-	-	69,941	637,994	-	-	-	-	-	
Electric Propulsion	-	-	-	257,905	154,873	53,361	-	-	-	-	-	
Liquid Propulsion	-	-	-	293,905	363,628	1,047,018	-	-	-	-	-	
Solid Propulsion	-	-	-	19,921	21,983	273,053	-	-	-	-	-	
Space Power Technology	-	-	-	-	-	-	-	-	-	-	-	
Nuclear Systems Technology	-	-	-	133,683	345,671	714,036	-	-	-	-	42,500	
Aircraft and Missile Technology	-	-	-	1,890,000	1,705,000	179,000	1,064,731	1,694,055	2,458,670	-	-	
Tracking and Data Acquisition	-	-	-	-	-	-	-	-	-	-	-	
TOTAL	$2,749,000	$12,958,000	$16,657,000	$23,466,000	$38,804,000	$47,752,000	$2,880,000	$4,586,000	$6,651,000	$ -	$ 42,500	$

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

FISCAL YEAR 1963 ESTIMATES

SUMMARY DISTRIBUTION OF FUND REQUIREMENTS FOR INSTITUTIONAL SUPPORT

RESEARCH, DEVELOPMENT AND OPERATION

(Continued)

	MANNED SPACECRAFT CENTER			MARSHALL SPACE FLIGHT CENTER			WALLOPS STATION			SPACE NUCLEAR PROPULSION OFFICE (CLEVELAND)		
	1961	1962	1963	1961	1962	1963	1961	1962	1963	1961	1962	1963
	$2,739,006	$6,176,622	$3,939,473	$ 1,168,825	$ 188,772	$ 199,053	$ 349,675	$ -	$ -	$ -	$ -	$ -
e Flight	9,994	6,781,378	12,717,527	29,460	211,823	1,897,734	-	274,955	402,660	-	-	-
	-	-	-	15,087,159	30,306,034	30,827,613	-	-	-	-	-	-
	-	-	-	53,524	508,164	3,232,214	-	-	-	-	-	-
	-	-	-	-	329,628	669,604	-	-	-	-	-	-
lites	-	-	-	50,841	102,890	157,527	29,223	327,699	472,068	-	-	-
lites	-	-	-	50,841	102,890	342,538	-	-	-	-	-	-
	-	-	-	-	-	-	830,948	1,327,449	1,926,091	-	-	-
s	-	-	-	1,617,508	163,806	1,085,379	-	-	-	-	-	-
Exploration	-	-	-	334,810	298,704	545,189	58,446	91,652	130,920	-	-	-
	-	-	-	54,381	54,941	308,095	546,977	870,190	1,260,591	-	-	-
	-	-	-	3,460	15,983	51,722	-	-	-	-	-	-
	-	-	-	844,317	1,186,665	2,723,556	-	-	-	-	-	-
y	-	-	-	22,841	-	-	-	-	-	-	-	-
ology	-	-	-	1,552,619	2,672,604	2,807,314	-	-	-	-	-	-
velopment	-	-	-	-	69,941	637,994	-	-	-	-	-	-
	-	-	-	257,905	154,873	53,361	-	-	-	-	-	-
	-	-	-	293,905	363,628	1,047,018	-	-	-	-	-	-
	-	-	-	19,921	21,983	273,053	-	-	-	-	-	-
gy	-	-	-	-	-	-	-	-	-	-	-	-
nology	-	-	-	133,683	345,671	714,036	-	-	-	-	42,500	181,000
Technology	-	-	-	1,890,000	1,705,000	179,000	1,064,731	1,694,055	2,458,670	-	-	-
quisition	-	-	-	-	-	-	-	-	-	-	-	-
	$2,749,000	$12,958,000	$16,657,000	$23,466,000	$38,804,000	$47,752,000	$2,880,000	$4,586,000	$6,651,000	$ -	$ 42,500	$ 181,000

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

FISCAL YEAR 1963 ESTIMATES

SUMMARY DISTRIBUTION OF PERSONNEL SERVICES

RESEARCH, DEVELOPMENT AND OPERATION

	TOTAL			HEADQUARTERS			WESTERN OPERATIONS OFFICE			LANGLEY RESEARCH CENTER		
	1961	1962	1963	1961	1962	1963	1961	1962	1963	1961	1962	1963
	$9,674,009	$6,802,058	$4,878,830	$ 182,208	$ 31,405	$ 72,841	$ -	$ -	$ -	$ 643,286	$ 785,529	$ 84,315
Personnel	1195	961	561	19	4	7	-	-	-	80	100	10
Flight	649,737	12,569,674	35,252,177	134,258	1,562,421	2,278,868	-	85,210	150,864	241,232	1,413,953	2,951,025
Personnel	78	1708	4056	14	199	219	-	10	14	30	180	350
	38,497,779	48,948,433	46,235,633	728,831	180,581	447,449	107,002	187,463	237,072	530,711	628,423	1,264,725
Personnel	4502	5448	4967	76	23	43	12	22	22	66	80	150
	332,633	2,289,377	10,034,924	230,157	1,397,541	2,310,085	-	-	-	-	-	-
Personnel	36	277	1055	24	178	222	-	-	-	-	-	-
	152,091	1,347,725	2,810,464	134,258	934,311	1,550,463	17,833	17,042	21,552	-	-	-
Personnel	16	165	288	14	119	149	2	2	2	-	-	-
tes	1,197,509	1,711,198	2,553,368	335,646	353,311	697,188	-	-	-	-	-	-
Personnel	147	217	268	35	45	67	-	-	-	-	-	-
tes	1,595,197	2,734,056	3,210,573	469,904	455,378	915,709	17,833	34,084	43,104	804,107	628,423	674,520
Personnel	191	346	339	49	58	88	2	4	4	100	80	80
	2,363,254	2,328,701	2,799,758	124,668	94,216	197,710	-	-	-	530,711	518,449	548,048
Personnel	310	303	322	13	12	19	-	-	-	66	66	65
	10,759,764	10,108,231	14,208,699	863,089	1,303,324	2,539,013	53,500	68,168	86,208	1,769,036	1,728,164	758,835
Personnel	1341	1281	1495	90	166	244	6	8	8	220	220	90
ploration	3,135,441	3,456,191	5,430,770	680,881	1,177,703	2,372,520	35,667	119,294	161,640	160,821	235,659	337,260
Personnel	379	428	580	71	150	228	4	14	15	20	30	40
	2,240,958	2,409,992	2,373,126	95,899	54,959	156,087	17,833	-	-	1,680,584	1,728,164	1,264,725
Personnel	282	310	280	10	7	15	2	-	-	209	220	150
	464,815	120,269	166,590	402,775	-	-	53,500	102,252	129,312	-	-	-
Personnel	49	14	16	42	-	-	6	12	12	-	-	-
	935,170	1,802,489	3,611,504	163,028	70,662	197,710	17,833	-	-	241,232	78,553	84,315
Personnel	109	207	389	17	9	19	2	-	-	30	10	10
	11,392,472	11,983,374	14,531,506	872,680	895,054	1,394,376	17,833	17,042	21,552	3,859,713	3,927,646	5,058,900
Personnel	1385	1497	1697	91	114	134	2	2	2	480	500	600
›gy	2,857,138	5,100,773	6,901,659	95,899	133,473	249,739	-	8,521	10,776	530,711	785,529	1,686,300
Personnel	337	592	769	10	17	24	-	1	1	66	100	200

NATIONAL AERONAUTICS AND SPACE AD

FISCAL YEAR 1963 ESTIMA

SUMMARY DISTRIBUTION OF PERSONNE

RESEARCH, DEVELOPMENT AND OPE

		TOTAL			HEADQUARTERS		
		1961	1962	1963	1961	1962	1963
Mercury		$9,674,009	$6,802,058	$4,878,830	$ 182,208	$ 31,405	$ 72,841
	Personnel	1195	961	561	19	4	7
Advanced Manned Space Flight		649,737	12,569,674	35,252,177	134,258	1,562,421	2,278,868
	Personnel	78	1708	4056	14	199	219
Saturn C-1		38,497,779	48,948,433	46,235,633	728,831	180,581	447,449
	Personnel	4502	5448	4967	76	23	43
Advanced Saturn		332,633	2,289,377	10,034,924	230,157	1,397,541	2,310,085
	Personnel	36	277	1055	24	178	222
Nova		152,091	1,347,725	2,810,464	134,258	934,311	1,550,463
	Personnel	16	165	288	14	119	149
Meteorological Satellites		1,197,509	1,711,198	2,553,368	335,646	353,311	697,188
	Personnel	147	217	268	35	45	67
Communications Satellites		1,595,197	2,734,056	3,210,573	469,904	455,378	915,709
	Personnel	191	346	339	49	58	88
Sounding Rockets		2,363,254	2,328,701	2,799,758	124,668	94,216	197,710
	Personnel	310	303	322	13	12	19
Scientific Satellites		10,759,764	10,108,231	14,208,699	863,089	1,303,324	2,539,013
	Personnel	1341	1281	1495	90	166	244
Lunar and Planetary Exploration		3,135,441	3,456,191	5,430,770	680,881	1,177,703	2,372,520
	Personnel	379	428	580	71	150	228
Scout		2,240,958	2,409,992	2,373,126	95,899	54,959	156,087
	Personnel	282	310	280	10	7	15
Delta		464,815	120,269	166,590	402,775	-	-
	Personnel	49	14	16	42	-	-
Centaur		935,170	1,802,489	3,611,504	163,028	70,662	197,710
	Personnel	109	207	389	17	9	19
Spacecraft Technology		11,392,472	11,983,374	14,531,506	872,680	895,054	1,394,376
	Personnel	1385	1497	1697	91	114	134
Launch Vehicle Technology		2,857,138	5,100,773	6,901,659	95,899	133,473	249,739
	Personnel	337	592	769	10	17	24
Launch Operations Development		-	63,059	671,006	-	-	-
	Personnel	-	7	72	-	-	-
Electric Propulsion		2,410,640	3,541,384	5,451,736	67,129	266,946	447,449
	Personnel	278	458	633	7	34	43
Liquid Propulsion		9,083,307	8,511,188	9,409,661	163,028	164,878	291,362
	Personnel	1045	1102	1092	17	21	28
Solid Propulsion		340,581	471,020	934,154	28,770	149,176	249,739
	Personnel	41	59	100	3	19	24
Space Power Technology		2,746,970	4,309,812	5,838,687	402,775	345,459	603,536
	Personnel	316	559	673	42	44	58
Nuclear Systems Technology		7,905,820	9,040,717	12,579,916	86,309	447,527	811,651
	Personnel	910	1170	1447	9	57	78
Aircraft and Missiles Technology		22,477,731	23,330,653	26,952,492	537,033	502,486	770,029
	Personnel	2744	2907	3158	56	64	74
Tracking and Data Acquisition		8,235,984	12,279,626	17,478,767	402,775	518,189	1,217,476
	Personnel	1053	1564	1887	42	66	117
Total		139,449,000	175,260,000	234,316,000	7,202,000	11,039,000	19,771,000
	Personnel	16744	21580	26144	751	1406	1900
Reimbursements		4,104,000	3,044,000	1,317,000	-	-	-
	Personnel	333	300	129	-	-	-
GRAND TOTAL		$143,553,000	$178,304,000	$235,633,000	$7,202,000	$11,039,000	$19,771,000
	Personnel	17077	21880	26273	751	1406	1900

Communications Satellites		1,595,197	2,734,056	3,210,573	469,904	455,378	915,709	17,833	34,084	43,104	804,107	628
	Personnel	191	346	339	49	58	88	2	4	4	100	
Sounding Rockets		2,363,254	2,328,701	2,799,758	124,668	94,216	197,710	-	-	-	530,711	518
	Personnel	310	303	322	13	12	19	-	-	-	66	
Scientific Satellites		10,759,764	10,108,231	14,208,699	863,089	1,303,324	2,539,013	53,500	68,168	86,208	1,769,036	1,728
	Personnel	1341	1281	1495	90	166	244	6	8	8	220	
Lunar and Planetary Exploration		3,135,441	3,456,191	5,430,770	680,881	1,177,703	2,372,520	35,667	119,294	161,640	160,821	235
	Personnel	379	428	580	71	150	228	4	14	15	20	
Scout		2,240,958	2,409,992	2,373,126	95,899	54,959	156,087	17,833	-	-	1,680,584	1,728
	Personnel	282	310	280	10	7	15	2	-	-	209	
Delta		464,815	120,269	166,590	402,775	-	-	53,500	102,252	129,312	-	
	Personnel	49	14	16	42	-	-	6	12	12	-	
Centaur		935,170	1,802,489	3,611,504	163,028	70,662	197,710	17,833	-	-	241,232	78
	Personnel	109	207	389	17	9	19	2	-	-	30	
Spacecraft Technology		11,392,472	11,983,374	14,531,506	872,680	895,054	1,394,376	17,833	17,042	21,552	3,859,713	3,927
	Personnel	1385	1497	1697	91	114	134	2	2	2	480	
Launch Vehicle Technology		2,857,138	5,100,773	6,901,659	95,899	133,473	249,739	-	8,521	10,776	530,711	785
	Personnel	337	592	769	10	17	24	-	1	1	66	
Launch Operations Development		-	63,059	671,006	-	-	-	-	-	-	-	
	Personnel	-	7	72	-	-	-	-	-	-	-	
Electric Propulsion		2,410,640	3,541,384	5,451,736	67,129	266,946	447,449	-	25,563	32,328	80,411	76
	Personnel	278	458	633	7	34	43	-	3	3	10	
Liquid Propulsion		9,083,307	8,511,188	9,409,661	163,028	164,878	291,362	17,833	17,042	21,552	-	
	Personnel	1045	1102	1092	17	21	28	2	2	2	-	
Solid Propulsion		340,581	471,020	934,154	28,770	149,176	249,739	53,500	68,168	86,208	241,232	235
	Personnel	41	59	100	3	19	24	6	8	8	30	
Space Power Technology		2,746,970	4,309,812	5,838,687	402,775	345,459	603,536	17,833	25,563	32,328	402,053	392
	Personnel	316	559	673	42	44	58	2	3	3	50	
Nuclear Systems Technology		7,905,820	9,040,717	12,579,916	86,309	447,527	811,651	35,667	119,294	150,864	-	
	Personnel	910	1170	1447	9	57	78	4	14	14	-	
Aircraft and Missiles Technology		22,477,731	23,330,653	26,952,492	537,033	502,486	770,029	53,500	102,252	140,088	10,855,446	11,798
	Personnel	2744	2907	3158	56	64	74	6	12	13	1350	
Tracking and Data Acquisition		8,235,984	12,279,626	17,478,767	402,775	518,189	1,217,476	17,833	17,042	21,552	3,859,714	3,531
	Personnel	1053	1564	1887	42	66	117	2	2	2	480	
Total		139,449,000	175,260,000	234,316,000	7,202,000	11,039,000	19,771,000	535,000	1,014,000	1,347,000	26,431,000	28,49
	Personnel	16744	21580	26144	751	1406	1900	60	119	125	3287	
Reimbursements		4,104,000	3,044,000	1,317,000	-	-	-	-	-	-	-	
	Personnel	333	300	129	-	-	-	-	-	-	-	
GRAND TOTAL		$143,553,000	$178,304,000	$235,633,000	$7,202,000	$11,039,000	$19,771,000	$535,000	$1,014,000	$1,347,000	$26,431,000	$28,49
	Personnel	17077	21880	26273	751	1406	1900	60	119	125	3287	

Communications Satellites	-	-	-	-	-	-	-	-	-	269,194	1,499,061
Personnel	-	-	-	-	-	-	-	-	-	36	19
Sounding Rockets	-	-	-	-	-	-	-	-	-	1,061,823	855,485
Personnel	-	-	-	-	-	-	-	-	-	142	10
Scientific Satellites	571,910	553,987	669,995	-	-	-	-	-	-	4,598,737	6,247,394
Personnel	70	68	80	-	-	-	-	-	-	615	79
Lunar and Planetary Exploration	1,225,521	1,360,527	1,758,737	-	-	-	-	-	-	732,807	188,364
Personnel	150	167	210	-	-	-	-	-	-	98	2
Scout	-	-	-	-	-	-	-	-	-	-	-
Personnel	-	-	-	-	-	-	-	-	-	-	-
Delta	-	-	-	-	-	-	-	-	-	-	-
Personnel	-	-	-	-	-	-	-	-	-	-	-
Centaur	-	-	-	43,394	229,939	254,035	-	-	-	-	-
Personnel	-	-	-	5	30	30	-	-	-	-	-
Spacecraft Technology	6,495,262	6,607,108	7,294,573	112,825	536,524	762,105	-	-	-	-	-
Personnel	795	811	871	13	70	90	-	-	-	-	-
Launch Vehicle Technology	-	-	-	104,147	551,854	1,143,158	-	-	-	-	-
Personnel	-	-	-	12	72	135	-	-	-	-	-
Launch Operations Development	-	-	-	-	-	-	-	-	-	-	-
Personnel	-	-	-	-	-	-	-	-	-	-	-
Electric Propulsion	-	-	-	2,135,005	3,035,195	4,869,005	-	-	-	-	-
Personnel	-	-	-	246	396	575	-	-	-	-	-
Liquid Propulsion	-	-	-	8,774,351	7,932,896	7,959,765	-	-	-	-	-
Personnel	-	-	-	1011	1035	940	-	-	-	-	-
Solid Propulsion	-	-	-	-	-	-	-	-	-	-	-
Personnel	-	-	-	-	-	-	-	-	-	-	-
Space Power Technology	-	-	-	1,909,354	3,334,116	4,572,630	-	-	-	14,955	211,909
Personnel	-	-	-	220	435	540	-	-	-	2	2
Nuclear Systems Technology	-	-	-	7,715,527	7,917,567	10,415,437	-	-	-	-	-
Personnel	-	-	-	889	1033	1230	-	-	-	-	-
Aircraft and Missiles Technology	3,480,480	4,032,698	5,024,963	3,081,003	1,816,519	2,100,023	3,650,000	3,980,103	3,675,927	-	-
Personnel	426	495	600	355	237	248	438	449	405	-	-
Tracking and Data Acquisition	-	-	-	-	-	-	-	-	-	3,955,662	8,209,514
Personnel	-	-	-	-	-	-	-	-	-	529	104
Total	12,149,000	13,646,000	17,177,000	23,919,000	27,654,000	38,173,000	3,675,000	4,379,000	4,992,000	11,194,000	18,130,000
Personnel	1487	1675	2051	2756	3608	4508	441	494	550	1497	231
Reimbursements	-	-	-	-	-	-	-	-	-	-	544,000
Personnel	-	-	-	-	-	-	-	-	-	-	8
GRAND TOTAL	$12,149,000	$13,646,000	$17,177,000	$23,919,000	$27,654,000	$38,173,000	$3,675,000	$4,379,000	$4,992,000	$11,194,000	$18,674,000
Personnel	1487	1675	2051	2756	3608	4508	441	494	550	1497	239

AERONAUTICS AND SPACE ADMINISTRATION

FISCAL YEAR 1963 ESTIMATES

DISTRIBUTION OF PERSONNEL SERVICES

ARCH, DEVELOPMENT AND OPERATION

(Continued)

RESEARCH CENTER		FLIGHT RESEARCH CENTER			GODDARD SPACE FLIGHT CENTER		
1962	1963	1961	1962	1963	1961	1962	1963
-	$ -	$ -	$ 265,931	$499,200	$ -	$ -	$ -
-	-	-	30	55	-	-	-
2,299,390	5,334,736	25,000	132,966	816,873	-	-	-
300	630	3	15	90	-	-	-
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
-	381,053	-	-	-	-	-	-
-	45	-	-	-	-	-	-
-	381,053	-	-	-	-	-	-
-	45	-	-	-	-	-	-
-	-	-	-	-	560,822	918,273	1,488,775
-	-	-	-	-	75	117	157
-	-	-	-	-	269,194	1,499,061	1,213,778
-	-	-	-	-	36	191	128
-	-	-	-	-	1,061,823	855,485	1,043,091
-	-	-	-	-	142	109	110
-	-	-	-	-	4,598,737	6,247,394	8,999,027
-	-	-	-	-	615	796	949
-	-	-	-	-	732,807	188,364	151,722
-	-	-	-	-	98	24	16
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
229,939	254,035	-	-	-	-	-	-
30	30	-	-	-	-	-	-
536,524	762,105	-	-	-	-	-	-
70	90	-	-	-	-	-	-
551,854	1,143,158	-	-	-	-	-	-
72	135	-	-	-	-	-	-
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
3,035,195	4,869,005	-	-	-	-	-	-
396	575	-	-	-	-	-	-
7,932,896	7,959,765	-	-	-	-	-	-
1035	940	-	-	-	-	-	-
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
3,334,116	4,572,630	-	-	-	14,955	211,909	208,618
435	540	-	-	-	2	27	22
7,917,567	10,415,437	-	-	-	-	-	-
1033	1230	-	-	-	-	-	-
1,816,519	2,100,023	3,650,000	3,980,103	3,675,927	-	-	-
237	248	438	449	405	-	-	-
-	-	-	-	-	3,955,662	8,209,514	12,023,989
-	-	-	-	-	529	1046	1268
7,654,000	38,173,000	3,675,000	4,379,000	4,992,000	11,194,000	18,130,000	25,129,000
3608	4508	441	494	550	1497	2310	2650
-	-	-	-	-	-	544,000	1,020,000
-	-	-	-	-	-	84	99
7,654,000	$38,173,000	$3,675,000	$4,379,000	$4,992,000	$11,194,000	$18,674,000	$26,149,000
3608	4508	441	494	550	1497	2394	2749

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

FISCAL YEAR 1963 ESTIMATES

SUMMARY DISTRIBUTION OF PERSONNEL SERVICES

RESEARCH, DEVELOPMENT AND OPERATION

(Continued)

	AMES RESEARCH CENTER			LEWIS RESEARCH CENTER			FLIGHT RESEARCH CENTER			GODDARD SPACE FLIGHT CENTER		
	1961	1962	1963	1961	1962	1963	1961	1962	1963	1961	1962	1963
	$ 49,021	$ 32,587	$ -	$ -	$ -	$ -	$ -	$ 265,931	$499,200	$ -	$ -	$ -
Personnel	6	4	-	-	-	-	-	30	55	-	-	-
e Flight	81,701	936,890	2,428,732	-	2,299,390	5,334,736	25,000	132,966	816,873	-	-	-
Personnel	10	115	290	-	300	630	3	15	90	-	-	-
	-	-	-	43,394	-	-	-	-	-	-	-	-
Personnel	-	-	-	5	-	-	-	-	-	-	-	-
	-	-	-	-	-	381,053	-	-	-	-	-	-
Personnel	-	-	-	-	-	45	-	-	-	-	-	-
lites	245,105	122,203	-	-	-	-	-	-	-	560,822	918,273	1,488,775
Personnel	30	15	-	-	-	-	-	-	-	75	117	157
lites	-	-	-	-	-	-	-	-	-	269,194	1,499,061	1,213,778
Personnel	-	-	-	-	-	-	-	-	-	36	191	128
	-	-	-	-	-	-	-	-	-	1,061,823	855,485	1,043,091
Personnel	-	-	-	-	-	-	-	-	-	142	109	110
s	571,910	553,987	669,995	-	-	-	-	-	-	4,598,737	6,247,394	8,999,027
Personnel	70	68	80	-	-	-	-	-	-	615	796	949
Exploration	1,225,521	1,360,527	1,758,737	-	-	-	-	-	-	732,807	188,364	151,722
Personnel	150	167	210	-	-	-	-	-	-	98	24	16
	-	-	-	-	-	-	-	-	-	-	-	-
Personnel	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-
Personnel	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	43,394	229,939	254,035	-	-	-	-	-	-
Personnel	-	-	-	5	30	30	-	-	-	-	-	-
gy	6,495,262	6,607,108	7,294,573	112,825	536,524	762,105	-	-	-	-	-	-
Personnel	795	811	871	13	70	90	-	-	-	-	-	-

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

FISCAL YEAR 1963 ESTIMATES

SUMMARY DISTRIBUTION OF PERSONNEL SERVICES

RESEARCH, DEVELOPMENT AND OPERATION

(Continued)

	MANNED SPACECRAFT CENTER			MARSHALL SPACE FLIGHT CENTER			WALLOPS STATION			SPACE NUCLEAR PROPULSION OFFICE (CLEVELAND)		
	1961	1962	1963	1961	1962	1963	1961	1962	1963	1961	1962	1963
Personnel	$6,240,994 785	$5,443,378 796	$3,961,527 461	$2,297,175 269	$ 243,228 27	$ 260,947 28	$ 261,325 36	$ - -	$ - -	$ - -	$ - -	$ - -
Flight Personnel	159,006 20	5,771,622 844	19,240,473 2239	8,540 1	189,177 21	1,845,266 198	- -	178,045 24	205,340 26	- -	- -	- -
Personnel	- -	- -	- -	37,087,841 4343	47,951,966 5323	44,286,387 4752	- -	- -	- -	- -	- -	- -
Personnel	- -	- -	- -	102,476 12	891,836 99	7,343,786 788	- -	- -	- -	- -	- -	- -
Personnel	- -	- -	- -	- -	396,372 44	857,396 92	- -	- -	- -	- -	- -	- -
ites Personnel	- -	- -	- -	34,159 4	117,110 13	130,473 14	21,777 3	200,301 27	236,932 30	- -	- -	- -
ites Personnel	- -	- -	- -	34,159 4	117,110 13	363,462 39	- -	- -	- -	- -	- -	- -
Personnel	- -	- -	- -	- -	- -	- -	646,052 89	860,551 116	1,010,909 128	- -	- -	- -
Personnel	- -	- -	- -	2,903,492 340	207,194 23	1,155,621 124	- -	- -	- -	- -	- -	- -
xploration Personnel	- -	- -	- -	256,190 30	315,296 35	577,811 62	43,554 6	59,348 8	71,080 9	- -	- -	- -
Personnel	- -	- -	- -	25,619 3	63,059 7	288,905 31	421,023 58	563,810 76	663,409 84	- -	- -	- -
Personnel	- -	- -	- -	8,540 1	18,017 2	37,278 4	- -	- -	- -	- -	- -	- -
Personnel	- -	- -	- -	469,683 55	1,423,335 158	3,075,444 330	- -	- -	- -	- -	- -	- -
Personnel	- -	- -	- -	34,159 4	- -	- -	- -	- -	- -	- -	- -	- -

NATIONAL AERONAUTICS AND SPACE A

FISCAL YEAR 1963 ESTIM

SUMMARY DISTRIBUTION OF PERSONN

RESEARCH, DEVELOPMENT AND OP

(Continued)

		MANNED SPACECRAFT CENTER			MARSHALL SPACE FLIGHT CENTER		
		1961	1962	1963	1961	1962	1963
Mercury		$6,240,994	$5,443,378	$3,961,527	$2,297,175	$ 243,228	$ 260,947
	Personnel	785	796	461	269	27	28
Advanced Manned Space Flight		159,006	5,771,622	19,240,473	8,540	189,177	1,845,266
	Personnel	20	844	2239	1	21	198
Saturn C-1		-	-	-	37,087,841	47,951,966	44,286,387
	Personnel	-	-	-	4343	5323	4752
Advanced Saturn		-	-	-	102,476	891,836	7,343,786
	Personnel	-	-	-	12	99	788
Nova		-	-	-	-	396,372	857,396
	Personnel	-	-	-	-	44	92
Meteorological Satellites		-	-	-	34,159	117,110	130,473
	Personnel	-	-	-	4	13	14
Communications Satellites		-	-	-	34,159	117,110	363,462
	Personnel	-	-	-	4	13	39
Sounding Rockets		-	-	-	-	-	-
	Personnel	-	-	-	-	-	-
Scientific Satellites		-	-	-	2,903,492	207,194	1,155,621
	Personnel	-	-	-	340	23	124
Lunar and Planetary Exploration		-	-	-	256,190	315,296	577,811
	Personnel	-	-	-	30	35	62
Scout		-	-	-	25,619	63,059	288,905
	Personnel	-	-	-	3	7	31
Delta		-	-	-	8,540	18,017	37,278
	Personnel	-	-	-	1	2	4
Centaur		-	-	-	469,683	1,423,335	3,075,444
	Personnel	-	-	-	55	158	330
Spacecraft Technology		-	-	-	34,159	-	-
	Personnel	-	-	-	4	-	-
Launch Vehicle Technology		-	-	-	2,126,381	3,621,396	3,811,686
	Personnel	-	-	-	249	402	409
Launch Operations Development		-	-	-	-	63,059	671,006
	Personnel	-	-	-	-	7	72
Electric Propulsion		-	-	-	128,095	135,127	18,639
	Personnel	-	-	-	15	15	2
Liquid Propulsion		-	-	-	128,095	396,372	1,136,982
	Personnel	-	-	-	15	44	122
Solid Propulsion		-	-	-	17,079	18,017	260,947
	Personnel	-	-	-	2	2	28
Space Power Technology		-	-	-	-	-	-
	Personnel	-	-	-	-	-	-
Nuclear Systems Technology		-	-	-	68,317	351,329	698,964
	Personnel	-	-	-	8	39	75
Aircraft and Missiles Technology		-	-	-	-	-	-
	Personnel	-	-	-	-	-	-
Tracking and Data Acquisition		-	-	-	-	-	-
	Personnel	-	-	-	-	-	-
Total		$6,400,000	11,215,000	23,202,000	45,730,000	56,519,000	66,821,000
	Personnel	805	1640	2700	5355	6274	7170
Reimbursements		-	-	-	4,104,000	2,500,000	297,000
	Personnel	-	-	-	333	216	30
GRAND TOTAL		$6,400,000	$11,215,000	$23,202,000	$49,834,000	$59,019,000	$67,118,000
	Personnel	805	1640	2700	5688	6490	7200

Communications Satellites		-	-	-	34,159	117,110	363,462	-	-	-	-	-	-
	Personnel	-	-	-	4	13	39	-	-	-	-	-	
Sounding Rockets		-	-	-	-	-	-	646,052	860,551	1,010,909	-	-	
	Personnel	-	-	-	-	-	-	89	116	128	-	-	
Scientific Satellites		-	-	-	2,903,492	207,194	1,155,621	-	-	-	-	-	
	Personnel	-	-	-	340	23	124	-	-	-	-	-	
Lunar and Planetary Exploration		-	-	-	256,190	315,296	577,811	43,554	59,348	71,080	-	-	
	Personnel	-	-	-	30	35	62	6	8	9	-	-	
Scout		-	-	-	25,619	63,059	288,905	421,023	563,810	663,409	-	-	
	Personnel	-	-	-	3	7	31	58	76	84	-	-	
Delta		-	-	-	8,540	18,017	37,278	-	-	-	-	-	
	Personnel	-	-	-	1	2	4	-	-	-	-	-	
Centaur		-	-	-	469,683	1,423,335	3,075,444	-	-	-	-	-	
	Personnel	-	-	-	55	158	330	-	-	-	-	-	
Spacecraft Technology		-	-	-	34,159	-	-	-	-	-	-	-	
	Personnel	-	-	-	4	-	-	-	-	-	-	-	
Launch Vehicle Technology		-	-	-	2,126,381	3,621,396	3,811,686	-	-	-	-	-	
	Personnel	-	-	-	249	402	409	-	-	-	-	-	
Launch Operations Development		-	-	-	-	63,059	671,006	-	-	-	-	-	
	Personnel	-	-	-	-	7	72	-	-	-	-	-	
Electric Propulsion		-	-	-	128,095	135,127	18,639	-	-	-	-	-	
	Personnel	-	-	-	15	15	2	-	-	-	-	-	
Liquid Propulsion		-	-	-	128,095	396,372	1,136,982	-	-	-	-	-	
	Personnel	-	-	-	15	44	122	-	-	-	-	-	
Solid Propulsion		-	-	-	17,079	18,017	260,947	-	-	-	-	-	
	Personnel	-	-	-	2	2	28	-	-	-	-	-	
Space Power Technology		-	-	-	-	-	-	-	-	-	-	-	
	Personnel	-	-	-	-	-	-	-	-	-	-	-	
Nuclear Systems Technology		-	-	-	68,317	351,329	698,964	-	-	-	-	205,00	
	Personnel	-	-	-	8	39	75	-	-	-	-	-	
Aircraft and Missiles Technology		-	-	-	-	-	-	820,269	1,097,945	1,287,330	-	-	
	Personnel	-	-	-	-	-	-	113	148	163	-	-	
Tracking and Data Acquisition		-	-	-	-	-	-	-	-	-	-	-	
	Personnel	-	-	-	-	-	-	-	-	-	-	-	
Total		$6,400,000	11,215,000	23,202,000	45,730,000	56,519,000	66,821,000	2,214,000	2,960,000	3,475,000	-	205,00	
	Personnel	805	1640	2700	5355	6274	7170	305	399	440	-		
Reimbursements		-	-	-	4,104,000	2,500,000	297,000	-	-	-	-	-	
	Personnel	-	-	-	333	216	30	-	-	-	-	-	
GRAND TOTAL		$6,400,000	$11,215,000	$23,202,000	$49,834,000	$59,019,000	$67,118,000	$2,214,000	$2,960,000	$3,475,000	-	205,00	
	Personnel	805	1640	2700	5688	6490	7200	305	399	440	-		

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

FISCAL YEAR 1963 ESTIMATES

RESERACH, DEVELOPMENT, AND OPERATION

SUMMARY BY OBJECT CLASSIFICATION OF
PERSONNEL SERVICES AND INSTITUTIONAL SUPPORT

	1961	1962	1963
End of year employment	17,077	21,880	26,273
11 Personnel compensation.....	$134,277,705	$166,713,000	$220,311,000
12 Personnel benefits.....	9,275,518	11,591,000	15,322,000
21 Travel and transportation of persons.....	5,450,394	9,441,000	16,505,000
Regular travel.....	(5,260,051)	(9,171,000)	(16,024,000)
Local transportation.....	(38,245)	(78,000)	(111,000)
Rental of passenger motor vehicles.....	(152,098)	(192,000)	(370,000)
22 Transportation of things.....	2,100,461	4,786,000	6,070,000
23 Rent, communications and utilities.....	22,378,074	30,921,000	46,433,000
Rent.....	(12,380,413)	(18,963,000)	(32,101,000)
Communications.....	(2,359,667)	(4,004,000)	(5,080,000)
Utilities.....	(7,637,994)	(7,954,000)	(9,252,000)
24 Printing and reproduction....	779,691	2,077,000	3,321,000
25 Other services.....	21,158,402	45,773,500	67,693,000
26 Supplies and materials.....	15,816,000	22,004,000	27,648,000
31 Equipment.....	13,052,000	24,406,000	27,486,000
42 Insurance claims and indemnities.....	8,753	110,000	116,000
Unvouchered.....	10,000	17,500	35,000
Total obligations.....	224,306,998	317,840,000	430,940,000
Unobligated balance lapsing.....	847,628	---	---
Anticipated reimbursements.....	- 6,227,626	- 5,641,000	- 2,957,000
TOTAL	$218,927,000	$312,199,000	$427,983,000

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

FISCAL YEAR 1963 ESTIMATES

10 PERSONAL SERVICES AND BENEFITS

	TOTAL			HEADQUARTERS			WESTERN OPERATIONS OFFICE		
	1961	1962	1963	1961	1962	1963	1961	1962	1963
Number of employees	17,077	21,880	26,273	751	1,406	1,900	60	119	125
Personnel compensation:									
Permanent positions	$122,071,672	$153,493,600	$202,060,000	$6,442,241	$9,790,000	$17,706,000	$432,399	$822,000	$1,126,000
Temporary employment	537,273	965,400	1,015,000	-	-	-	-	-	-
Intermittent employment	88,235	265,000	450,000	52,833	175,000	300,000	-	-	-
Other compensation:									
Regular pay above 52-week base	498,171	-	-	27,246	-	-	2,211	-	-
Overtime and holiday pay	10,598,912	11,356,000	15,874,000	179,986	279,000	400,000	9,830	33,000	35,000
Nightwork differential	171,145	215,000	282,000	-	-	-	-	-	-
Additional pay for service abroad	4,032	6,000	10,000	-	-	-	-	-	-
Reimbursable details	308,265	412,000	620,000	39,220	96,000	100,000	58,000	98,000	100,000
Total, personnel compensation	134,277,705	166,713,000	220,311,000	6,741,526	10,340,000	18,506,000	502,440	953,000	1,261,000
Personnel benefits:									
Uniform allowances	9,404	7,300	5,000	128	200	-	-	-	-
Living and quarters allowances	16,121	21,000	26,000	4,194	6,000	6,000	-	-	-
Life insurance and health program	1,339,445	1,659,500	2,134,000	53,520	75,800	110,000	3,870	8,000	12,000
Retirement contributions	7,839,620	9,788,200	12,989,000	400,988	614,000	1,132,000	27,449	52,000	73,000
FICA taxes	59,684	63,000	74,000	1,976	2,000	3,000	215	1,000	1,000
Incentive awards	11,244	52,000	81,500	-	1,000	1,500	-	-	-
Accident compensation	-	-	12,500	-	-	12,500	-	-	-
Total, personnel benefits	9,275,518	11,591,000	15,322,000	460,806	699,000	1,265,000	31,534	61,000	86,000
Total personal services and benefits	$143,553,223	$178,304,000	$235,633,000	$7,202,332	$11,039,000	$19,771,000	$533,974	$1,014,000	$1,347,000

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

FISCAL YEAR 1963 ESTIMATES

10 PERSONAL SERVICES AND BENEFITS

	LANGLEY RESEARCH CENTER			AMES RESEARCH CENTER			LEWIS RESEARCH CENTER		
	1961	1962	1963	1961	1962	1963	1961	1962	1963
Number of employees	3,287	3,628	4,000	1,487	1,675	2,051	2,756	3,608	4,508
Personnel compensation:									
Permanent positions	$23,755,225	$25,635,000	$29,912,000	$11,152,993	$12,585,000	$15,796,000	$21,312,616	$24,837,000	$34,618,000
Temporary employment	89,703	208,000	208,000	-	-	-	-	-	-
Intermittent employment	-	-	-	-	-	-	-	-	-
Other compensation:									
Regular pay above 52-week base	94,947	-	-	44,046	-	-	83,631	-	-
Overtime and holiday pay	629,193	655,000	1,276,000	46,679	50,000	100,000	849,034	850,000	880,000
Nightwork differential	38,443	42,000	42,000	60,113	65,000	95,000	51,456	55,000	70,000
Additional pay for service abroad	-	-	-	-	-	-	-	-	-
Reimbursable details	-	-	-	5,858	-	-	-	-	-
Total, personnel compensation	24,607,511	26,540,000	31,438,000	11,309,689	12,700,000	15,991,000	22,296,737	25,742,000	35,568,000
Personnel benefits:									
Uniform allowances	946	1,000	1,000	840	1,000	1,000	5,357	2,000	-
Living and quarters allowances	-	-	-	-	-	-	-	-	-
Life insurance and health program	271,705	292,000	342,000	119,698	135,000	170,000	235,207	270,000	340,000
Retirement contributions	1,548,840	1,664,000	1,943,000	716,564	806,000	1,010,000	1,378,149	1,633,000	2,255,000
FICA taxes	1,225	1,000	1,000	2,896	3,000	4,000	2,792	5,000	8,000
Incentive awards	90	1,000	1,000	179	1,000	1,000	915	2,000	2,000
Accident compensation	-	-	-	-	-	-	-	-	-
Total, personnel benefits	1,822,806	1,959,000	2,288,000	840,177	946,000	1,186,000	1,622,420	1,912,000	2,605,000
Total personal services and benefits	$26,430,317	$28,499,000	33,726,000	$12,149,866	$13,646,000	$17,177,000	$23,919,157	$27,654,000	$38,173,000

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

FISCAL YEAR 1963 ESTIMATES

10 PERSONAL SERVICES AND BENEFITS

	FLIGHT RESEARCH CENTER			GODDARD SPACE FLIGHT CENTER			MANNED SPACECRAFT CENTER		
	1961	1962	1963	1961	1962	1963	1961	1962	1963
Number of employees	441	494	550	1,497	2,394	2,749	805	1,640	2,700
Personnel compensation:									
Permanent positions	$3,089,362	$3,607,000	$4,063,000	$9,191,224	$16,066,000	$21,103,000	$5,050,111	$9,346,000	$19,310,000
Temporary employment	20,390	15,400	-	91,168	110,000	175,000	-	-	-
Intermittent employment	-	-	-	14,239	15,000	30,000	-	-	-
Other compensation:									
Regular pay above 52-week base	12,704	-	-	50,595	-	-	22,464	-	-
Overtime and holiday pay	320,699	467,000	595,000	1,125,081	1,254,000	3,194,000	740,777	942,000	2,000,000
Nightwork differential	359	13,000	25,000	7,212	8,000	15,000	4,730	20,000	20,000
Additional pay for service abroad	-	-	-	4,032	6,000	10,000	-	-	-
Reimbursable details	-	-	-	-	-	-	205,187	218,000	420,000
Total, personnel compensation	3,443,514	4,102,400	4,683,000	10,483,551	17,459,000	24,527,000	6,023,269	10,526,000	21,750,000
Personnel benefits:									
Uniform allowances	100	100	-	-	-	-	33	1,000	1,000
Living and quarters allowances	-	-	-	11,927	15,000	20,000	-	-	-
Life insurance and health program	32,440	38,500	43,000	92,959	173,000	245,000	52,320	93,000	201,000
Retirement contributions	196,101	234,000	262,000	591,729	1,020,000	1,350,000	320,100	584,000	1,237,000
FICA taxes	2,899	3,000	3,000	13,957	6,000	6,000	4,876	9,000	10,000
Incentive awards	360	1,000	1,000	-	1,000	1,000	-	2,000	3,000
Accident compensation	-	-	-	-	-	-	-	-	-
Total, personnel benefits	231,900	276,600	309,000	710,572	1,215,000	1,622,000	377,329	689,000	1,452,000
Total personal services and benefits	$3,675,414	$4,379,000	$4,992,000	$11,194,123	$18,674,000	$26,149,000	$6,400,598	$11,215,000	$23,202,000

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

FISCAL YEAR 1963 ESTIMATES

10 PERSONAL SERVICES AND BENEFITS

	MARSHALL SPACE FLIGHT CENTER			WALLOPS STATION			SPACE NUCLEAR PROPULSION OFFICE (CLEVE)		
	1961	1962	1963	1961	1962	1963	1961	1962	1963
Number of employees	5,688	6,490	7,200	305	399	400	-	27	50
Personnel compensation:									
Permanent positions	$39,853,626	$48,170,600	$55,156,000	$1,791,875	$2,448,000	$2,806,000	-	$187,000	$464,000
Temporary employment	336,012	632,000	632,000	-	-	-	-	-	-
Intermittent employment	21,163	75,000	120,000	-	-	-	-	-	-
Other compensation:									
Regular pay above 52-week base	153,252	-	-	7,075	-	-	-	-	-
Overtime and holiday pay	6,426,916	6,510,000	6,951,000	270,717	315,000	440,000	-	1,000	3,000
Nightwork differential	3,726	5,000	5,000	5,106	7,000	10,000	-	-	-
Additional pay for service abroad	-	-	-	-	-	-	-	-	-
Reimbursable details	-	-	-	-	-	-	-	-	-
Total, personnel compensation	46,794,695	55,392,600	62,864,000	2,074,773	2,770,000	3,256,000	-	188,000	467,000
Personnel benefits:									
Uniform allowances	-	-	-	2,000	2,000	2,000	-	-	-
Living and quarters allowances	-	-	-	-	-	-	-	-	-
Life insurance and health program	454,508	538,000	625,000	23,218	33,000	41,000	-	3,200	5,000
Retirement contributions	2,549,035	3,016,400	3,524,000	110,665	152,000	173,000	-	12,800	30,000
FICA taxes	26,108	30,000	35,000	2,740	3,000	3,000	-	-	-
Incentive awards	9,700	42,000	70,000	-	-	-	-	1,000	1,000
Accident compensation	-	-	-	-	-	-	-	-	-
Total, personnel benefits	3,039,351	3,626,400	4,254,000	138,623	190,000	219,000	-	17,000	36,000
Total personal services and benefits	$49,834,046	$59,019,000	$67,118,000	$2,213,396	$2,960,000	$3,475,000	-	$205,000	$503,000

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

FISCAL YEAR 1963 ESTIMATES

10 PERSONAL SERVICES AND BENEFITS

Summary analysis by types of compensation	1961	1962	1963
End of year employment.....	17,077	21,880	26,273
Position lapses.....	-1,127	-2,550	-1,201
Average number of positions..	15,950	19,330	25,072
Net cost of positions.....	$122,697,180	$154,724,000	$203,525,000
Other compensation.....	11,580,525	11,989,000	16,786,000
Personnel benefits.....	9,275,518	11,591,000	15,322,000
Total.....	$143,553,223	$178,304,000	$235,633,000

STAFFING REQUIREMENTS

The estimates submitted for the fiscal year 1963 support a proposed end of year staffing level of 26,273 employees, an increase of 4,393 over the anticipated level for the current fiscal year.

The expansion and acceleration of program activity, particularly in the advanced program for the manned exploration of space, materially contributes to the increased staffing level proposed for the budget year. Some of the factors supporting the requested personnel growth are as follows:

(1) Aggressive proposed launch and spacecraft and launch vehicle development schedules;
(2) Expansion of launching capabilities; especially at the Atlantic Missile Range;
(3) Administration of expanded engine and stage static test sites and at new production facilities;
(4) Expansion and increased activity at tracking sites; and
(5) Expansion of the capability to monitor and conduct effectively advanced research, technical development, development and flight programs.

Referring to the summary charts (pages A4-1, A4-2, and A4-3), it will be seen that over half of the requested increase is directly related to the manned space flight program, including the development of large multi-stage vehicles and propulsion systems. Other program areas

requiring significant personnel increases include meteorological satellites, scientific satellites, unmanned lunar and planetary exploration, the Centaur launch vehicle, spacecraft and launch vehicle technology, electric, nuclear and solid propulsion systems, nuclear and non-nuclear auxiliary power units, research on advanced aircraft in conjunction with other Government agencies, and tracking and data acquisition. A distribution, by location, of the proposed staffing increase requested for the budget year is as follows:

NASA Headquarters	494
Western Operations Office	6
Langley Research Center	372
Ames Research Center	376
Lewis Research Center	900
Flight Research Center	56
Goddard Space Flight Center	355
Manned Spacecraft Center	1,060
Marshall Space Flight Center	710
Wallops Station	41
Space Nuclear Propulsion Office	23
Total	4,393

NASA Headquarters

The increase requested for operation of the NASA Headquarters is summarized as follows:

Office of the Administrator	33
Office of Advanced Research and Technology	40
Office of Applications	20
Office of Manned Space Flight	245
Office of Space Sciences	11
Office of Tracking and Data Acquisition	5
Office of Technical Information and Education	8
Office of Administration	132
Total	494

The staff increases requested for the Office of the Administrator and the five program offices, totaling 354, are required to provide an adequate staffing level to plan, coordinate, and direct the technical and general aspects of the NASA program. The effective control, evaluation, coordination and appraisal of the agency's operations can only be attained through detailed review of program requirements and progress on a continuing basis. The requested personnel will provide management with the capability essential to coordinate properly NASA's effort with related work in other Government agencies, the scientific community, and industry. A very large portion of the requested increase is to support the manned lunar landing program. The increase requested for

the Office of Technical Information and Education will allow better dissemination of knowledge gained in the space program to interested technical people and the general public.

The increase requested for the Office of Administration is required to provide technical and clerical assistance for personnel administration in areas concerning classification, recruiting, and manpower evaluation and development; to provide technical assistance in procurement matters relating to contract negotiation and administration; to improve and strengthen the budgetary and fiscal functions; and to provide technical personnel necessary to perform the audit activities of the agency. In other areas, minor increases are requested for administrative support services and security operations.

Langley Research Center

The mission of the Langley Research Center is essentially to provide basic technical information in support of the development of advanced types of manned vehicles with considerable emphasis on the behavior and integrity of materials and structures. Studies and experiments, directed toward the structural and operational problems associated with the supersonic transport, will be expanded during the budget year. Considerable effort will also be expended on problems involving lunar and planetary landings and take-offs, satellite rendezvous, and reentry flight. A total of 372 additional employees is requested for fiscal year 1963. See summary charts (pages A4-1 through A4-3) for detailed personnel breaks by program.

Ames Research Center

The research capability of the Ames Research Center is primarily directed in support of the space missions of the agency. Studies will be continued, however, on the supersonic transport and other advanced aircraft of interest both to the military and commercial operators. Intensified effort relating to the manned lunar mission will be expended on problems dealing with vehicle integration, navigational guidance and control, human behavior under space environmental conditions, life support systems, biomedicine and spacecraft reentry. A total of 376 additional employees is requested for the fiscal year 1963. See summary charts (pages A4-1 through A4-3) for detailed personnel breaks by program.

Lewis Research Center

The work of the Lewis Research Center, including the operation of facilities at the Plum Brook site, supports experimental and developmental projects associated with propulsion systems, fuels, and the effect of nuclear radiation and temperature on materials. The problems of lunar spacecraft propulsion and auxiliary power systems, propellant handling

in space environment, and the large liquid rocket engine projects will receive the greatest attention. The Center also conducts fundamental research in advanced propulsion concepts, auxiliary power generation systems, and energy conversion devices. Studies and experiments on nuclear propulsion and radiation, in conjunction with the Atomic Energy Commission, will be expanded during the budget year. Research will also be accelerated on propulsion systems for the supersonic transport. A total of 900 additional employees is required for the fiscal year 1963. See summary charts (pages A4-1 through A4-3) for detailed personnel breaks by program.

Flight Research Center

The basic mission of the Flight Research Center is the conduct of full-scale flight operations to evaluate manned aircraft, including research on problems associated with aircraft design and construction. Work at this Center is primarily in support of the X-15 flight research program, the joint Air Force-NASA Dynasoar project, and, in the budget year, the supersonic transport project. Studies will also be undertaken on recovery techniques of reentry-type vehicles, crew functions and life support systems, and guidance and control problems associated with manned lunar systems. A total of 56 additional employees is requested for the fiscal year 1963. See summary charts (pages A4-1 through A4-3) for detailed personnel breaks by program.

Goddard Space Flight Center

The Goddard Space Flight Center is assigned the responsibility for the development of unmanned earth orbiting spacecraft. This includes development of sounding rockets, scientific satellites, and applications satellites designed to provide operational weather and communications systems. In addition, the Center is responsible for the operation and maintenance of the world-wide satellite tracking networks. A total of 355 additional employees is requested for the fiscal year 1963 for the project management of large systems contracts undertaken by industrial contractors; management of the development of new and advanced tracking systems and equipment; preflight testing and evaluation of spacecraft under simulated flight conditions; business administration area to negotiate and administer contracts required by the accelerated space programs; and for the operational meteorological satellite program under the sponsorship of the United States Weather Bureau. See summary charts (pages A4-1 through A4-3) for detailed personnel breaks by program.

Manned Spacecraft Center

The Manned Spacecraft Center is assigned responsibility for the direction of the agency's manned space flight program and the development of all manned spacecraft. This Center will serve to direct and

manage the programs relating to manned extended earth orbital, circumlunar, and lunar landing missions. During the fiscal year 1963, major emphasis will be directed to orbital rendezvous technology, development and environmental full-scale testing of spacecraft and support systems, development and miniaturization of instrumentation, and for the training of flight crews, flight controllers, and supporting ground personnel.

The substantial increase of 1,060 people requested for this Center will be enough in fiscal year 1963 to undertake all phases of the program to insure a successful lunar landing as soon as practicable. In addition to providing for the management and technical direction of the manned flight program, the requested staffing level includes personnel to staff the facilities currently under construction, as well as the supporting shop and administrative areas.

Marshall Space Flight Center

The Marshall Space Flight Center is assigned responsibility for the development of launch vehicles and associated propulsion systems to meet the NASA space mission requirements, and for the supervision of launch operations at the Atlantic and Pacific Missile Ranges in support of NASA sponsored programs. At the present time, the Marshall Space Flight Center is charged with management responsibility for the Saturn, Nova, and Centaur vehicle development programs; the procurement and launch of operational Agena-B vehicles; and the development of the 1,500,000-pound thrust F-1 engine, the 200,000-pound thrust J-2 engine, and the 1,000,000-pound thrust M-1 engine.

The planned expansion and acceleration of program activity in the fiscal year 1963 will require additional staffing at this Center in support of the Nova and Advanced Saturn launch vehicle and the M-1 engine development programs, operation of expanding vehicle launching areas at the Atlantic Missile Range, and for the administration and maintenance of industrial and engine and stage static test sites at the Michoud Plant and the Mississippi Test Facility respectively. In addition, administrative personnel, primarily in the area of contract negotiation and administration, will be required. Total staffing needs will be met in part by the gradual phasing out of the weapons systems work currently being performed for the Department of Defense. A net total of 710 additional employees is requested for the fiscal year 1963. See summary charts (pages A4-1 through A4-3) for detailed personnel breaks by program.

Wallops Station

The Wallops Station serves as a small launch facility for the sounding rocket program, the solid propellant Scout vehicle, and other programs relating to reentry physics and flight testing of spacecraft components. In addition, this Station also serves as

a readout facility for the meteorological satellite program. An additional 41 employees is requested for the fiscal year 1963 in support of increased activity in tracking and data acquisition, range planning and control, and to strengthen the general management function of the Station.

Other Offices

Six additional employees are required for the Western Operations Office to meet the increasing workload in connection with the management and monitoring of contracts with development contractors located on the West Coast.

Twenty-three additional employees are required for the Space Nuclear Propulsion Office at Cleveland for the administrative and technical direction of the nuclear systems technology program, and to administer the design and construction of the National Nuclear Rocket Development Facility in Nevada authorized in the fiscal year 1962.

FUNDING REQUIREMENTS

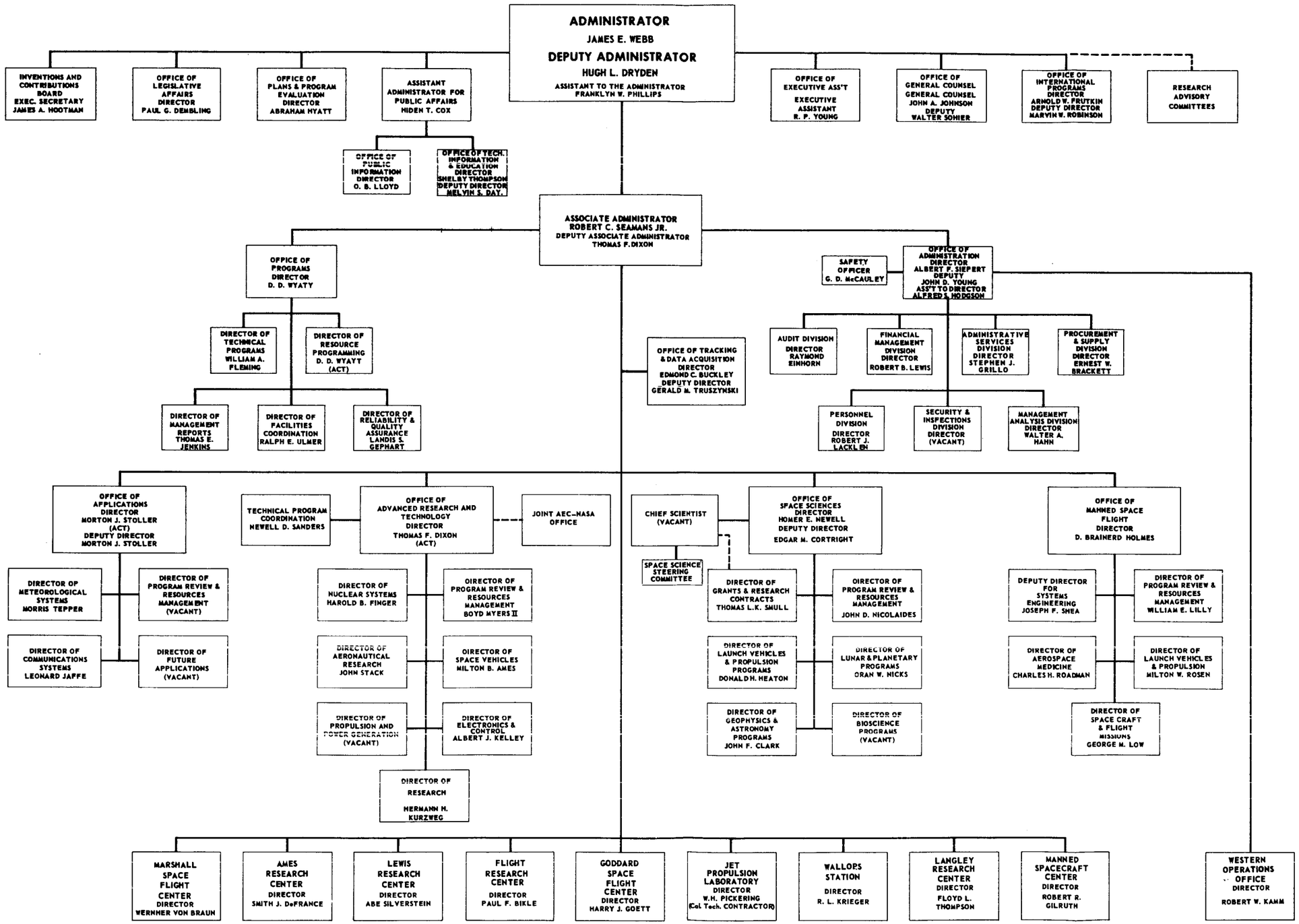
The funding levels proposed for the fiscal year 1963 are required to finance the staffing level authorized for the end of the current fiscal year on a full-year basis; the additional within-grade salary advancements due in the budget year; and the 4,393 additional employees requested. The position lapse rate for new positions is estimated at approximately 25 per cent. A lapse rate of 50 percent has been used for the within-grade salary advancements becoming due in the fiscal year 1963.

Funding requirements for personnel compensation, other compensation and personnel benefits are set forth on pages A6-1, 2, 3 and 4 preceding.

The major portion of the increase requested for overtime and holiday pay is for operational requirements in connection with the logistic and preflight checkouts on vehicles, spacecraft, and instrumentation before launchings. Further, the phasing of workloads on program components must be geared to meet urgent program deadlines and schedules particularly in those areas where operations are interrelated with contractor activity.

Funding requirements for the insurance and health program, retirement contribution, and other personnel benefits are commensurate with the proposed staffing level requested for the fiscal year 1963.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION



NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

PROPOSED PERSONNEL STAFFING CHART
FISCAL YEAR 1963
NASA HEADQUARTERS

OFFICE OF ADMINISTRATOR

1	Excepted Administrator	$22,500
1	Exec. Deputy Administrator	21,500
1	Exec. Asst. to the Admin.	17,000
5	Other GS Personnel	32,535
1	WB Personnel	4,680
9		$98,215

AERONAUTICS & ASTRONAUTICS COORDINATING BOARD

1	Exc. Secretary to the Board	$16,000
1	Other GS Personnel	5,820
2		$21,820

OFFICE OF LEGISLATIVE AFFAIRS

1	Exc. Dir. Off. of Legis. Aff.	$ 18,000
2	GS-15 Asst. Director	28,780
3	GS-15 Legis. Liaison Officer	44,960
1	GS-14 Legis. Asst.	12,730
17	Other GS Personnel	124,635
1	WB Personnel	4,780
25		$234,865

INVENTIONS & CONTRIBUTIONS BOARD

1	GS-15 Secretary to the Board	$14,380
4	Other GS Personnel	27,470
5		$41,850

OFFICE OF PLANS & PROGRAM EVAL.

1	Exc. Dir. of Prog. Planning and Evaluation	$ 20,000
2	Exc. Associate Dir.	38,000
2	Exc. Senior Staff Scientist	35,000
7	GS-15 Staff Scientist	102,285
1	GS-14 Staff Scientist	13,510
7	Other GS Personnel	51,396
20		$260,191

OFFICE OF EXECUTIVE ASSISTANT

1	GS-15 Exec. Asst. to the Administrator	$ 13,730
1	GS-14 Aeronautics Res. Sci.	12,470
1	GS-14 Mgt. Analyst	12,210
1	GS-14 Aerospace Tech.	12,210
1	GS-14 Chief, Corr. & Rpt. Br.	12,210
21	Other GS Personnel	149,767
26		$212,597

OFFICE OF GENERAL COUNSEL

1	Exc. Gen. Counsel	$ 20,500
1	Exc. Dep. Gen. Counsel	18,000
1	Exc. Asst. Gen. Counsel for Patent Matters	17,500
2	Exc. Asst. Gen. Counsel	32,000
5	GS-15 Attorney-Advisor	71,575
7	GS-14 Attorney-Advisor	86,170
25	Other GS Personnel	164,284
42		$410,529

OFFICE OF INTERNATIONAL PROG.

1	Exc. Dir. of Int. Prog.	$ 17,000
1	Exc. Dep. Dir.	15,500
1	Exc. Dir., European Lia. Ofcr.	15,500
1	GS-15 Chief, Coop. Prog.	13,730
1	GS-15 Chief, Oper. Support	15,030
1	GS-15 Chief, Inter. Org.	13,730
1	GS-15 Scientific & Tech. Adv.	14,380
1	GS-14 Sr. Coop. Prog. Offcr.	12,210
1	GS-14 Sr. Oper. Supp. Offcr.	12,210
1	GS-14 Sr. Pers. Exch. Offcr.	12,210
1[illegible]	Other GS Personnel	73,818
2[illegible]		$215,318

OFFICE OF ADMIN.

1	Exc. Dir. of Admin.	$ 19,000
1	Exc. Dep. Dir.	18,500
2	Exc. Asst. to Dir.	32,500
1	GS-15 Safety Officer	14,705
1	GS-15 Staff Asst.	15,030
1	GS-14 Program Analyst	12,480
5	Other GS Personnel	32,113
12		$144,328

OFFICE OF THE ASSOCIATE ADMIN.

1	Exc. Assoc. Admin.	$ 21,000
1	Exc. Dep. Assoc. Admin.	21,000
1	Exc. Tech. Asst.	19,000
7	Other GS Personnel	48,284
10		$109,284

OFFICE OF PROGRAMS

1	Exc. Dir.	$ 19,000
1	Other GS Personnel	6,050
2		$ 25,050

DIR. OF RESOURCE PROGRAMMING

1	Exc. Dir.	$ 15,500
1	GS-15 Sup. Programm. Specialist	13,730
1	GS-15 Programm. Spec.	13,730
1	GS-14 Program Res. Spec.	12,210
8	Other GS Personnel	55,092
12		$110,262

DIR. OF FACILITIES COORD.

1	Exc. Dir.	$ 16,500
1	GS-15 Facil. Spec.	13,730
3	GS-14 " "	37,410
7	Other GS Personnel	39,087
12		$106,727

DIR. OF REL. & QUAL. ASSURANCE

1	Exc. Dir.	$ 17,500
1	Exc. Dep. Dir.	15,500
11	GS-15 Aerospace Tech.	151,030
1	GS-14 Aerospace Tech.	12,470
1	GS-14 Mgt. Analyst	12,210
5	Other GS Personnel	24,320
20		$233,030

DIR. OF TECH. PROGRAMS

1	Exc. Dir.	$ 18,000
2	Exc. Tech. Programs Off.	31,000
3	GS-15 Aerospace Technol.	41,190
4	Other GS Personnel	19,177
10		$109,367

DIR. OF MGT. REPORTS

1	Exc. Dir.	$ 16,000
2	Exc. Chief Analyst	31,000
4	GS-15 Aerospace Tech.	54,920
2	GS-15 Program Mgt. Anal.	27,460
2	GS-14 Aerospace Tech.	24,940
13	Other GS Personnel	88,066
24		$242,386

ADMIN. SERVICES DIVISION

1	GS-15 Dir. Admin. Serv.	$ 14,705
1	GS-15 Asst. Dir.	14,380
3	GS-14 Automatic Data Prog. Specialist - Proced. Analyst	36,890
83	Other GS Personnel	490,287
19	WB Personnel	90,658
107		$646,920

SECURITY & INSPECTIONS DIVISION

1	Exc. Dir., Sec. & Inspec.	$ 16,500
1	Exc. Dir. of Inspec.	16,500
1	GS-15 Dir. of Sec.	15,030
1	GS-15 Chief, Pers. & Ind. Sec.	13,730
1	GS-15 Chief, Hdqrs. Sec. Oper.	13,730
2	GS-15 Inspector	27,750
1	GS-14 Chief, Sec. Classif.	12,210
2	GS-14 Inspector	25,460
1	GS-14 Asst. Chief Hdqrs. Sec. Operations	12,210
1	GS-14 Asst. to Dir. of Sec. & Inspections	12,470
1	GS-14 Chief, Physical Sec. Br.	12,210
39	Other GS Personnel	276,324
52		$454,124

MGT. ANALYSIS DIVISION

1	Exc. Dir., Mgt. Analysis	$ 17,500
1	GS-15 Ind. Engineer	15,030
3	GS-15 Mgt. Analyst	43,140
5	GS-14 Mgt. Analyst	62,350
5	Other GS Personnel	30,768
15		$168,788

PERSONNEL DIV.

1	Exc. Dir. of Personnel	$ 17,000
1	GS-15 Chief, Classif. & Compensation	14,380
1	GS-15 Chief, Employee Relations & Reg.	13,730
1	GS-15 Hdqrs. Pers. Offcr.	13,730
1	GS-15 Chief, Recruitment & Examining Programs	13,730
1	GS-15 Chief, Training Prog	13,730
1	GS-15 Asst. for Prog. Coord. & Evaluation	13,730
1	GS-15 Scientist for Manpower Resources	13,730
1	GS-14 Dep. Chief, Classif. & Compensation	12,730
1	GS-14 Examination & Qualif Officer	12,470
1	GS-14 Exc. Develop. Offcr.	12,210
1	GS-14 College Recruit. & Advertising Offcr.	12,470
1	GS-14 Professional Recruit Offcr.	12,470
1	GS-14 Dep. Chief, Train. Programs	12,210
1	GS-14 Chief, Hdqrs. Place. & Employee Relations	12,210
1	GS-14 Chief, Hdqrs. Class. & Wage	12,210
1	GS-14 Hdqrs. Dep. Pers. Ofcr	12,210
62	Other GS Personnel	430,662
79		$655,612

STENOGRAPHIC & TYPING POOL

15	Other GS Personnel	$ 66,208

AUDIT DIVISION

1	Exc. Dir. of Audits	$ 17,000
1	Exc. Dep. Dir.	16,000
7	GS-15 Sup. Auditor	97,410
13	GS-14 Sup. Auditor	160,730
38	Other GS Personnel	328,141
60		$619,281

PROCUREMENT & SUPPLY DIVISION

1	Exc. Dir. Procurement & Supply Div.	$ 18,500
1	Exc. Asst. Dir.	16,500
1	Exc. Chief, Procurement Review Office	16,500
1	GS-15 Contract Specialist	15,030
3	GS-15 Procurement Officer	43,140
2	GS-15 Sup. Contract Spec.	29,385
1	GS-15 Sup. Ind. Spec.	13,730
1	GS-15 Sup. Trans. Spec.	13,730
5	GS-14 Contract Spec.	74,340
1	GS-14 Electric Rate Spec.	12,990
3	GS-14 Industrial Spec.	37,150
5	GS-14 Procurement Spec.	61,050
2	GS-14 Production Officer	24,680
1	GS-14 Program Analyst	12,470
4	GS-14 Sup. Contract Spec.	49,350
1	GS-14 Sup. Prop. Mgt. Officer	12,470
2	GS-14 Trans. Spec.	24,940
[illegible]	Other GS Personnel	564,195
1[illegible]		$1,038,860

FINANCIAL MANAGEMENT DIVISION

1	Exc. Dir.	$ 17,000
1	Exc. Chief, Acctg. Sys. Div.	16,000
1	GS-15 Budget Officer	13,730
1	GS-15 Fiscal Officer	14,705
1	GS-15 Hdqrs. Bud. Officer	13,730
1	GS-15 Chief, Cen. Acc. & Rpt.	13,730
4	GS-15 Accountants	54,920
1	GS-15 Asst. to Dir., Fin. Mgt.	13,730
10	GS-14 Accountants	122,060
2	GS-14 Budget Analyst	24,420
1	GS-14 Dep. Cen. Off. Acc. & Reports	12,210
[illegible]	Other GS Personnel	443,453
95		$759,688

OFF. OF TRACKING & DATA ACQUIS.

1	Exc. Dir.	$ 19,000
1	Exc. Dep. Dir.	18,000
1	Exc. Dir. of Network Oper. & Facil.	16,000
1	Exc. Chief, Commun. & Freq.	16,000
1	Exc. Dir. of Program Support & Adv. Systems	16,000
1	Exc. Chief, Program Support	15,500
1	Exc. Chief, Adv. Systems	15,500
1	GS-15 Senior Scientific Rep.	15,030
1	GS-15 Dir. of Nat'l. Rge. Supp.	13,730
1	GS-15 Chief, Network Oper.	13,730
1	GS-15 Chief, Facil. & Station Implementation	13,730
1	GS-15 Head, Range Require. Planning	13,730
1	GS-15 Flight Mission Require. Offcr.	13,730
1	GS-15 Operational Liaison Offcr.	13,730
1	GS-15 Head, Manned Space Flt. Data Sys.	13,730
1	GS-15 Head, Lunar & Planet. Data Sys.	13,730
1	GS-15 Head, Scientific Satell. Sys.	14,055
1	GS-15 Head, Application Satell. Daya Sys.	13,730
1	GS-15 Head, Deep Space Instr. Facil.	13,730
1	GS-15 Head, Manned Space Fl.	13,730
1	GS-15 Head, Satell. Network	13,730
1	GS-15 Head, Facil. Engineer.	13,730
1	GS-15 Head, Interagency Rel.	13,730
1	GS-15 Facil. Engineer, Offcr	13,730
7	GS-15 Staff Scientist	96,435
1	GS-14 Chief, Program Coor.	12,210
10	Other GS Personnel	53,430
42		$513,110

OFF. OF ADV. RESEARCH & TECH.

1	Exc. Dir., Off. Adv. Res. & Tech.	$ 21,000
1	Exc. Dep. Dir.	19,000
1	Exc. Tech. Asst. to the Dir.	17,500
3	Other GS Personnel	17,319
6		$ 74,819

TECHNICAL PROGRAM COORD.

1	Exc. Dir.	$ 19,000
5	GS-15 Aerospace Tech.	69,300
3	Other GS Personnel	16,475
9		$104,775

JOINT AEC-NASA OFFICE

2	Exc. Chief of Office	$ 31,000
1	GS-15 Aerospace Tech.	13,730
1	GS-15 Facilities Officer	14,055
1	GS-15 Admin. Officer	14,055
2	GS-14 Aerospace Tech.	24,420
4	Other GS Personnel	24,696
11		$121,956

DIRECTOR OF RESEARCH

1	Exc. Dir	$ 19,000
2	Exc. Chief of Program	32,000
2	GS-15 Chief of Program	29,735
7	GS-15 Aerospace Tech	97,085
4	GS-14 Aerospace Tech.	49,640
6	Other GS Personnel	31,369
22		$258,829

DIR. OF AERONAUTICAL RESEARCH

1	Exc. Dir	$ 19,000
3	Exc. Chief of Program	48,500
2	GS-15 Chief of Program	29,735
7	GS-15 Aerospace Tech.	96,760
4	GS-14 Aerospace Tech.	49,640
8	Other GS Personnel	53,239
25		$296,874

DIR. OF PROGRAM REV. & RES. MGT.

1	Exc. Dir.	$ 17,500
3	GS-15 Chief of Group	44,115
2	GS-14 Aerospace Tech.	24,960
15	Other GS Personnel	100,923
21		$187,498

DIR. OF ELECTRONICS & CONTROL

1	Dir.	$ 16,500
1	Exc. Chief of Program	16,000
3	GS-15 Chief of Program	44,440
9	GS-15 Aerospace Tech.	124,870
6	GS-14 Aerospace Tech.	74,300
10	Other GS Personnel	60,432
30		$336,542

DIR. OF SPACE VEHICLES

1	Exc. Dir.	$ 19,000
2	Exc. Asst. Dir. of Sp. Veh.	36,000
2	Exc. Chief of Program	32,500
3	GS-15 Chief of Program	43,790
8	GS-15 Aerospace Tech.	110,490
6	GS-14 Aerospace Tech.	75,080
11	Other GS Personnel	63,569
33		$380,429

DIR. OF PROPULSION & POWER GEN.

1	Exc. Dir.	$ 19,000
1	Exc. Chief of Program	16,000
3	GS-15 Chief of Program	43,790
8	GS-15 Aerospace Tech.	110,490
5	GS-14 Aerospace Tech.	62,350
8	Other GS Personnel	46,781
26		$298,411

DIR. OF NUCLEAR SYSTEMS

1	Exc. Dir.	$ 18,500
1	Exc. Dep. Dir.	18,000
2	Exc. Asst. Dir.	35,500
2	Exc. Chief of Program	32,500
4	GS-15 Chief of Program	58,820
9	GS-15 Aerospace Tech.	125,845
6	GS-14 Aerospace Tech.	75,080
13	Other GS Personnel	83,957
38		$448,202

DIR. OF AEROSPACE MEDICINE

1	Exc. Dir.	$ 19,000
1	Exc. Dep. Dir.	18,000
1	Exc. Asst. Dir.	17,000
1	Exc. Staff Sci.	17,000
1	GS-15 Aerospace Tech., Life Sci. & Sys.	14,055
2	GS-15 Aerospace Tech., Flight Physiology	28,110
1	GS-15 Aerospace Tech., Radiology	14,055
1	GS-15 Aerospace Tech., Behavioral Studies	13,730
2	GS-15 Aerospace Tech., Environment Control	27,460
2	GS-14 Aerospace Tech., Life Sciences & Systems	24,420
2	GS-14 Aerospace Tech., Flight Physiology	24,680
38	Other GS Personnel	247,870
53		$485,180

OFFICE OF MANNED SPACE FLIGHT

1	Exc. Dir., Manned Space Flight Program	$ 21,000
1	Exc. Staff Scientist	18,000
2	Other GS Personnel	11,482
4		$ 50,482

DIR. OF PROG. REVIEW & RESOURCES MGT.

1	Exc. Dir.	$ 16,500
2	Exc. Asst. Dir.	32,000
1	Exc. Chief of Program	15,500
1	GS-15 Prog. Planning Spec.	14,055
3	GS-15 Resources Programming Specialist	41,515
1	GS-15 Engineer, Facilities	14,055
5	GS-14 Prog. Planning Spec.	61,050
3	GS-14 Resources Programming Specialist	36,630
5	GS-14 Engineer, Facilities	61,310
44	Other GS Personnel	333,292
66		$625,907

DIR. OF LAUNCH VEHICLES & PROP.

1	Exc. Dir.	$ 19,000
3	Exc. Asst. Dir.	52,500
8	Exc. Chief of Program	131,500
1	Exc. Staff Scientist	17,500
37	GS-15 Aerospace Tech., Proj. Mgt.	509,960
4	GS-15 Aerospace Tech., Tech. Mgt.	55,245
17	GS-14 Aerospace Tech. Proj. Mgt.	208,870
4	GS-14 Aerospace Tech., Tech. Mgt.	49,100
41	Other GS Personnel	230,444
116		$1,274,119

DEP. DIR. FOR SYSTEMS ENGINEERING

1	Exc. Dep. Dir.	$ 20,000
5	Exc. Asst. Dir.	85,000
8	Exc. Chief of Program	148,500
34	GS-15 Aerospace Tech., Proj. Mgt.	469,745
5	GS-15 Aerospace Tech., Tech. Mgt.	68,975
33	GS-14 Aerospace Tech., Proj. Mgt.	405,530
3	GS-14 Aerospace Tech., Tech. Mgt.	36,630
43	Other GS Personnel	294,929
133		$1,529,309

DIR. OF SPACECRAFT & FLIGHT MISS.

1	Exc. Dir.	$ 19,000
3	Exc. Asst. Dir.	49,500
5	Exc. Chief of Program	80,000
1	Exc. Staff Sci.	17,000
20	GS-15 Aerospace Tech.	276,225
25	GS-14 Asst. Proj. Mgt.	306,550
33	Other GS Personnel	222,780
88		$971,055

OFFICE OF SPACE SCIENCES

1	Exc. Dir., Off. of Space Sciences	$21,000
1	Exc. Dep. Dir.	19,000
3	Other GS Personnel	17,044
5		$57,044

DIR. OF LUNAR & PLANETARY PROG.

1	Exc. Dir.	$ 18,000
1	Exc. Chf., Lunar & Planetary Sciences	17,500
1	Exc. Asst. Chf. Lunar & Planetary Sciences	16,500
1	Exc. Chf., Lunar & Planetary Flight Systems	16,500
1	Exc. Head, Lunar Flight Sys.	16,000
1	Exc. Staff Engr., Lunar Flight Systems	15,500
1	Exc. Head, Planetary & Interplanetary Flight Systems	16,000
1	Exc. Head, Lunar & Planetary Technology	15,500
1	GS-15 Exec. Asst., Lunar & Planetary Programs	13,730
1	GS-15 Head, Planetary Sciences	14,055
1	GS-15 Head, Interplanetary Sciences	14,055
1	GS-15 Head, Lunar & Planetary Scientific Instruments	14,380
2	GS-15 Staff Engineer	27,460
2	GS-15 Staff Scientist	27,460
1	GS-14 Head, Lunar Sciences	12,730
4	GS-14 Staff Scientists	48,840
11	Other GS Personnel	53,081
32		$357,291

DIRECTOR OF BIOSCIENCE PROGRAMS

1	Exc. Dir.	$18,000
1	Exc. Chf., Exbiology Prog.	17,500
1	GS-15 Chf., Environmental Biology Program	13,730
1	GS-15 Staff Scientist, Exbiology Program	13,730
1	GS-14 Staff Scientist, Environmental Biology Prog.	12,730
3	Other GS Personnel	15,725
8		$91,415

DIR. OF PROG. REVIEW & RESOURCES MGT.

1	Exc. Dir.	$ 17,500
1	Exc. Prog. Review Officer	17,500
1	GS-14 Admin. Officer	12,730
1	GS-14 Resources Mgt. Officer	12,210
1	GS-14 Prog. Review Asst.	12,210
9	Other GS Personnel	53,955
14		$126,105

DIR. OF GRANTS & RESEARCH CONTRACTS

1	Exc. Dir.	$ 17,500
1	Exc. Chf. of Admin.	16,500
1	GS-15 Chf. of Prog.	13,730
5	GS-15 Prog. Admin.	68,650
3	GS-15 Instr. Liaison Officer	41,840
1	GS-14 Head, Mgt. Operations	12,210
1	GS-14 Admin. Officer	12,210
26	Other GS Personnel	157,292
38		$339,932

CHIEF SCIENTIST

1	Exc. Chief Scientist	$19,000
1	GS-15 Scientific Asst.	13,730
2	Other GS Personnel	13,305
4		$51,035

DIR. OF LAUNCH VEHICLES & PROP. PROG.

1	Exc. Dir.	$ 19,000
1	Exc. Dep. Dir.	17,500
1	Exc. Chf., Small Veh. Prog.	16,000
1	Exc. Chf., Launch Operations	15,500
1	GS-15 Chf., Centaur Program	13,730
1	GS-15 Head, Centaur Systems	13,730
1	GS-15 Head, Centaur Prop.	13,730
1	GS-15 Head, Centaur Launch Operations & Facilities	13,730
1	GS-15 Chf., Agena Program	13,730
1	GS-15 Head, JPL & STG Agena Missions	13,730
1	GS-15 Head, GSFC Agena Missions	13,730
1	GS-15 Head, Agena Launch Operations & Facilities	13,730
1	GS-15 Head, Scout Program	13,730
1	GS-15 Head, Sounding Rocket Program	13,730
1	GS-15 Head, Launch Oper. & Fac. for Small Veh. Prog.	13,730
1	GS-15 Chf., Advanced Projects	13,730
1	GS-15 Staff Eng. Studies & Systems Analysis	13,730
1	GS-15 Staff Engr., Guidance Control & Elec. Systems	13,730
1	GS-15 Staff Engr., Performance & Flight Dynamics	13,730
1	GS-15 Staff Engr., Prop. Sys.	13,730
1	GS-15 Exec. Asst., Launch Operations	13,730
[illegible]	Other GS Personnel	55,496
3[illegible]		$356,906

DIR. OF GEOPHYSICS & ASTRONOMY PROG.

1	Exc. Dir.	$ 18,000
1	Exc. Chf., Astronomy & Solar Physics	16,000
1	Exc. Head, Solar Physics	16,500
1	Exc. Chf., Physics	16,500
1	Exc. Head, Plasma Physics	16,500
1	Exc. Chf., Chemistry	16,500
1	Exc. Head, Aeronomy	15,500
1	Exc. Chf., Flight Systems	16,000
1	GS-15 Scientific Asst., Geophysics & Astronomy Prog.	14,380
1	GS-15 Asst. Chf., Astronomy & Solar Physics	13,730
1	GS-15 Staff Scientist For Ionospheres	14,055
1	GS-15 Head, Magnetodynamics	13,730
1	GS-15 Staff Scientist for Instrumentation	13,730
1	GS-15 Staff Scientist for Photochemistry	13,730
1	GS-15 Asst. Chf., Flight Sys.	13,730
3	GS-15 Project Officers	42,165
1	GS-14 Exec. Asst. Geophysics & Astronomy Programs	12,730
1	GS-14 Staff Engr., Instrum.	12,210
1	GS-14 Proj. Off. for Solar Obser.	12,730
26	Other GS Personnel	87,404
36		$395,824

GPO 923574

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

PROPOSED PERSONNEL STAFFING CHART
FISCAL YEAR 1963
NASA HEADQUARTERS

OFFICE OF ADMINISTRATOR

1 Excepted Administrator	$22,500
1 Exc. Deputy Administrator	21,500
1 Exc. Asst. to the Admin.	17,000
5 Other GS Personnel	32,535
1 WB Personnel	4,680
9	$98,215

AERONAUTICS & ASTRONAUTICS COORDINATING BOARD

1 Exc. Secretary to the Board	$16,000
1 Other GS Personnel	5,820
2	$21,820

OFFICE OF ASSISTANT ADMIN. FOR PUBLIC AFFAIRS

1 Exc. Asst. Admin. for Pub. Aff	$ 20,000
1 Exc. Deputy Asst. Admin. for Pub. Affairs	19,000
1 Exc. Director, Office of Program Development	16,000
1 GS-15 Deputy Director, Office of Program Development	13,730
1 GS-14 Administrative Officer	12,210
1 GS-14 Staff Officer	12,210
5 Other GS Personnel	27,335
11	$120,485

OFFICE OF LEGISLATIVE AFFAIRS

1 Exc. Dir., Off. of Legis. Aff.	$ 19,000
2 GS-15 Asst. Director	28,760
3 GS-15 Legis. Liaison Officer	44,960
1 GS-14 Legis. Asst.	12,730
17 Other GS Personnel	124,635
1 WB Personnel	4,780
25	$234,865

INVENTIONS & CONTRIBUTIONS BOARD

1 GS-15 Secretary to the Board	$14,380
4 Other GS Personnel	27,470
5	$41,850

OFFICE OF PLANS & PROGRAM EVAL.

1 Exc. Dir. of Prog. Planning and Evaluation	$ 20,000
2 Exc. Associate Dir.	38,000
2 Exc. Senior Staff Scientist	35,000
7 GS-15 Staff Scientist	102,285
1 GS-14 Staff Scientist	13,510
7 Other GS Personnel	51,396
20	$260,191

OFFICE OF EXECUTIVE ASSISTANT

1 GS-15 Exec. Asst. to the Administrator	$ 13,730
1 GS-14 Aeronautics Res. Sci.	12,470
1 GS-14 Mgt. Analyst	12,210
1 GS-14 Aerospace Tech.	12,210
1 GS-14 Chief, Corr. & Rpt. Br.	12,210
21 Other GS Personnel	149,767
26	$212,597

OFFICE OF GENERAL COUNSEL

1 Exc. Gen. Counsel	$ 20,500
1 Exc. Dep. Gen. Counsel	18,000
1 Exc. Asst. Gen. Counsel for Patent Matters	17,500
2 Exc. Asst. Gen. Counsel	32,000
5 GS-15 Attorney-Advisor	71,575
7 GS-14 Attorney-Advisor	86,770
25 Other GS Personnel	164,184
42	$410,529

OFFICE OF PUBLIC INFORMATION

1 Exc. Dir.	$ 17,500
1 GS-15 Dep. Dir.	14,705
1 GS-15 Assoc. Dir.	13,730
1 GS-15 Chief, News Div.	13,730
2 GS-14 Info. Spec.	24,420
23 Other GS Personnel	175,119
29	$259,204

OFF. OF TECH. INFOR. & EDUCATION

1 Exc. Dir.	$ 18,000
1 Exc. Dep. Dir.	16,500
1 GS-15 Dir., Ed. Prog. Div.	15,030
1 GS-15 Dir., Tech. Info. Div.	15,030
1 GS-15 Dir., Spec. Proj. Div.	15,030
1 GS-15 NASA Historian	14,055
1 GS-15 Chief, Reports Staff	13,730
1 GS-15 Asst. Dir., Ed. Prog. Div.	13,730
1 GS-15 Chief, Ed. Serv. Br.	13,730
1 GS-15 Chief, Ed. Audio-Visual Br.	13,730
1 GS-15 Dep. Dir., Tech. Info. Div.	13,730
1 GS-15 Chief, Tech. Serv. Br.	13,730
1 GS-15 Chief, Tech. Pub. Br.	14,380
1 GS-15 Chief, Proj. Info. Br.	13,730
1 GS-15 Chief, Lib. Prog. Br.	13,730
1 GS-15 Chief, Contract Oper. Br.	13,730
1 GS-15 Asst. Dir., Spec. Proj. Div.	13,730
1 GS-15 Chief, Exhibit Design & Production Br.	15,030
1 GS-15 Chief, Exhibits Mgt. Br.	13,730
1 GS-14 Spec. Asst. to the Dir.	12,210
1 GS-14 Asst. Historian	12,210
4 GS-14 Info. Spec. (Rpts.)	48,840
2 GS-14 Ed. Spec.	24,410
1 GS-14 Motion Picture Spec.	12,210
1 GS-14 Writer-Editor (Educ.)	12,210
1 GS-14 Document Spec. (Tech.)	12,210
3 GS-14 Tech. Info. Spec.	36,630
1 GS-14 Tech. Info. Spec. (Lib. Sci)	12,210
3 GS-14 Exhibits Spec.	36,630
78 Other GS Personnel	502,685
115	$996,535

OFFICE OF PROGRAMS

1 Exc. Dir.	$ 19,000
1 Other GS Personnel	6,050
2	$ 25,050

OFFICE OF THE ASSOCIATE ADMIN.

1 Exc. Assoc. Admin.	$ 21,000
1 Exc. Dep. Assoc. Admin.	21,000
1 Exc. Tech. Asst.	19,000
7 Other GS Personnel	48,284
10	$109,284

OFFICE OF ADMIN.

1 Exc. Dir. of Admin.	$ 19,000
1 Exc. Dep. Dir.	18,500
2 Exc. Asst. to Dir.	32,500
1 GS-15 Safety Officer	14,705
1 GS-15 Staff Asst.	15,030
1 GS-14 Program Analyst	12,480
5 Other GS Personnel	32,113
12	$144,328

DIR. OF RESOURCE PROGRAMMING

1 Exc. Dir.	$ 15,500
1 GS-15 Sup. Programm. Specialist	13,730
1 GS-15 Programm. Spec.	13,730
1 GS-14 Program Res. Spec.	12,210
8 Other GS Personnel	55,092
12	$110,262

DIR. OF FACILITIES COORD.

1 Exc. Dir.	$ 16,500
1 GS-15 Facil. Spec.	13,730
3 GS-14 " "	37,410
7 Other GS Personnel	39,087
12	$106,727

DIR. OF REL. & QUAL. ASSURANCE

1 Exc. Dir.	$ 17,500
1 Exc. Dep. Dir.	15,500
11 GS-15 Aerospace Tech.	151,030
1 GS-14 Aerospace Tech.	12,470
1 GS-14 Mgt. Analyst	12,210
5 Other GS Personnel	24,320
20	$233,030

DIR. OF TECH. PROGRAMS

1 Exc. Dir.	$ 18,000
2 Exc. Tech. Programs Off.	31,000
3 GS-15 Aerospace Technol.	41,190
4 Other GS Personnel	19,177
10	$109,367

DIR. OF MGT. REPORTS

1 Exc. Dir.	$ 16,000
2 Exc. Chief Analyst	31,000
4 GS-15 Aerospace Tech.	54,920
2 GS-15 Program Mgt. Anal.	27,460
2 GS-14 Aerospace Tech.	24,940
13 Other GS Personnel	88,066
24	$242,386

ADMIN. SERVICES DIVISION

1 GS-15 Dir. Admin. Serv.	$ 14,705
1 GS-15 Asst. Dir.	14,380
3 GS-14 Automatic Data Prog. Specialist - Proced. Analyst	36,890
83 Other GS Personnel	190,287
19 WB Personnel	90,658
107	$346,920

SECURITY & INSPECTIONS DIVISION

1 Exc. Dir., Sec. & Inspec.	$ 16,500
1 Exc. Dir. of Inspec.	16,500
1 GS-15 Dir. of Sec.	15,030
1 GS-15 Chief, Pers. & Ind. Sec.	13,730
1 GS-15 Chief, Hdqrs. Sec. Oper.	13,730
2 GS-15 Inspector	27,750
1 GS-14 Chief, Sec. Classif.	12,210
2 GS-14 Inspector	25,460
1 GS-14 Asst. Chief Hdqrs. Sec. Operations	12,210
1 GS-14 Asst. to Dir. of Sec. & Inspections	12,470
1 GS-14 Chief, Physical Sec. Br.	12,210
39 Other GS Personnel	276,324
52	$454,124

MGT. ANALYSIS DIVISION

1 Exc. Dir., Mgt. Analysis	$ 17,500
1 GS-15 Ind. Engineer	15,030
3 GS-15 Mgt. Analyst	43,140
5 GS-14 Mgt. Analyst	62,350
5 Other GS Personnel	30,768
15	$168,788

PERSONNEL DIV.

1 Exc. Dir. of Personnel	$ 17,500
1 GS-15 Chief, Classif. & Compensation	14,380
1 GS-15 Chief, Employee Relations & Reg.	13,730
1 GS-15 Hdqrs. Pers. Offcr.	13,730
1 GS-15 Chief, Recruitment & Examining Programs	13,730
1 GS-15 Chief, Training Prog.	13,730
1 GS-15 Asst. for Prog. Coord. & Evaluation	13,730
1 GS-15 Scientist for Manpower Resources	13,730
1 GS-14 Dep. Chief, Classif. & Compensation	12,730
1 GS-14 Examination & Qualif. Officer	12,470
1 GS-14 Exec. Develop. Offcr.	12,210
1 GS-14 College Recruit. & Advertising Offcr.	12,470
1 GS-14 Professional Recruit. Offcr.	12,470
1 GS-14 Dep. Chief, Train. Programs	12,210
1 GS-14 Chief, Hdqrs. Place. & Employee Relations	12,210
1 GS-14 Chief, Hdqrs. Class. & Wage	12,210
1 GS-14 Hdqrs. Dep. Pers. Offcr.	12,210
62 Other GS Personnel	430,662
79	$655,612

STENOGRAPHIC & TYPING POOL

15 Other GS Personnel	$ 66,208

AUDIT DIVISION

1 Exc. Dir. of Audits	$ 17,000
1 Exc. Dep. Dir.	16,000
7 GS-15 Sup. Auditor	97,410
13 GS-14 Sup. Auditor	160,730
38 Other GS Personnel	328,141
60	$619,281

OFF. OF TRACKING & DATA ACQUIS.

1 Exc. Dir.	$ 19,000
1 Exc. Dep. Dir.	18,000
1 Exc. Dir. of Network Oper. & Facil	16,000
1 Exc. Chief, Commun. & Freq.	16,000
1 Exc. Dir. of Program Support & Adv. Systems	16,000
1 Exc. Chief, Program Support	15,500
1 Exc. Chief, Adv. Systems	15,500
1 GS-15 Senior Scientific Rep.	15,030
1 GS-15 Dir. of Natl. Rge. Supp.	13,730
1 GS-15 Chief, Network Oper.	13,730
1 GS-15 Chief, Facil. & Station Implementation	13,730
1 GS-15 Head, Range Require. Planning	13,730
1 GS-15 Flight Mission Require. Offcr.	13,730
1 GS-15 Operational Liaison Offcr.	13,730
1 GS-15 Head, Manned Space Flt. Data Sys.	13,730
1 GS-15 Head, Lunar & Planet. Data Sys.	13,730
1 GS-15 Head, Scientific Satell. Sys.	14,055
1 GS-15 Head, Application Satell. Data Sys.	13,730
1 GS-15 Head, Deep Space Instr. Facil.	13,730
1 GS-15 Head, Manned Space Fl.	13,730
1 GS-15 Head, Satell. Network	13,730
1 GS-15 Head, Facil. Engineer.	13,730
1 GS-15 Head, Interagency Rel.	13,730
1 GS-15 Facil. Engineer. Offcr.	13,730
7 GS-15 Staff Scientist	96,435
1 GS-14 Chief, Program Coor.	12,210
10 Other GS Personnel	53,430
42	$513,110

DIR. OF PROG. REVIEW & RESOURCES MGT.

1 Exc. Dir.	$ 16,500
2 Exc. Asst. Dir.	32,000
1 Exc. Chief of Program	15,500
1 GS-15 Prog. Planning Spec.	14,055
3 GS-15 Resources Programming Specialist	41,515
1 GS-15 Engineer, Facilities	14,055
5 GS-14 Prog. Planning Spec.	61,050
3 GS-14 Resources Programming Specialist	36,630
5 GS-14 Engineer, Facilities	61,310
44 Other GS Personnel	353,292
66	$625,907

DIR. OF LAUNCH VEHICLES & PROP.

1 Exc. Dir.	$ 19,000
3 Exc. Asst. Dir.	52,500
8 Exc. Chief of Program	131,500
1 Exc. Staff Scientist	17,500
37 GS-15 Aerospace Tech., Proj. Mgt.	509,960
4 GS-15 Aerospace Tech., Tech. Mgt.	55,245
17 GS-14 Aerospace Tech. Proj. Mgt.	208,870
4 GS-14 Aerospace Tech., Tech. Mgt.	49,100
41 Other GS Personnel	230,444
116	$1,274,119

DEP. DIR. FOR SYSTEMS ENGINEERING

1 Exc. Dep. Dir.	$ 20,000
5 Exc. Asst. Dir.	85,000
9 Exc. Chief of Program	148,500
34 GS-15 Aerospace Tech., Proj. Mgt.	489,745
5 GS-15 Aerospace Tech., Tech Mgt.	68,975
33 GS-14 Aerospace Tech., Proj. Mgt.	405,530
3 GS-14 Aerospace Tech., Tech Mgt.	36,630
43 Other GS Personnel	294,929
133	$1,529,309

DIR. OF SPACECRAFT & FLIGHT MISS.

1 Exc. Dir.	$ 19,000
3 Exc. Asst. Dir.	49,500
5 Exc. Chief of Program	80,000
1 Exc. Staff Sci.	17,000
20 GS-15 Aerospace Tech.	276,225
25 GS-14 Asst. Proj. Mgt.	306,550
33 Other GS Personnel	222,780
88	$971,055

OFFICE OF APPLICATIONS

1 Exc. Dir.	$ 21,000
1 Exc. Dep. Dir.	19,000
1 GS-15 Tech. Asst.	14,055
1 GS-15 Asst. For Admin.	13,730
3 Other GS Personnel	17,205
7	$ 84,990

OFF. OF ADV. RESEARCH & TECH.

1 Exc. Dir., Off. Adv. Res. & Tech.	$ 21,000
1 Exc. Dep. Dir.	19,000
1 Exc. Tech. Asst. to the Dir.	17,500
3 Other GS Personnel	17,359
6	$ 74,859

OFFICE OF MANNED SPACE FLIGHT

1 Exc. Dir., Manned Space Flight Program	$ 21,000
1 Exc. Staff Scientist	18,000
2 Other GS Personnel	11,482
4	$ 50,482

OFFICE OF SPACE SCIENCES

1 Exc. Dir., Off. of Space Sciences	$21,000
1 Exc. Dep. Dir.	19,000
3 Other GS Personnel	17,044
5	$57,044

DIR. OF METEROLOGICAL SYSTEMS

1 Exc. Dir.	$ 16,500
1 Exc. Chief of Met. Satell. Development	16,000
1 Exc. Chief of Operational Met. Satell.	16,000
1 GS-15 Chief Met. Sys. Eng	14,380
2 GS-15 Staff Sci.-Met.	27,460
2 GS-15 Staff Eng	27,460
1 GS-15 Chief of Met. Scund.	13,730
1 GS-14 Exec. Asst	12,210
6 Other GS Personnel	28,290
16	$172,030

TECHNICAL PROGRAM COORD.

1 Exc. Dir.	$ 19,000
5 GS-15 Aerospace Tech.	69,300
3 Other GS Personnel	16,475
9	$104,775

JOINT AEC-NASA OFFICE

2 Exc. Chief of Office	$ 31,000
1 GS-15 Aerospace Tech.	13,730
1 GS-15 Facilities Officer	14,055
1 GS-15 Admin. Officer	14,055
2 GS-14 Aerospace Tech.	24,420
4 Other GS Personnel	24,696
11	$121,956

DIR. OF LUNAR & PLANETARY PROG.

1 Exc. Dir.	$ 18,000
1 Exc. Chf., Lunar & Planetary Sciences	17,500
1 Exc. Asst. Chf., Lunar & Planetary Sciences	16,500
1 Exc. Chf., Lunar & Planetary Flight Systems	16,500
1 Exc. Head, Lunar Flight Sys.	16,000
1 Exc. Staff Engr., Lunar Flight Systems	15,500
1 Exc. Head, Planetary & Interplanetary Flight Systems	16,000
1 Exc. Head, Lunar & Planetary Technology	15,500
1 GS-15 Exec. Asst., Lunar & Planetary Programs	13,730
1 GS-15 Head, Planetary Sciences	14,055
1 GS-15 Head, Interplanetary Sciences	14,055
1 GS-15 Head, Lunar & Planetary Scientific Instruments	14,380
2 GS-15 Staff Engineer	27,460
2 GS-15 Staff Scientist	27,460
1 GS-14 Head, Lunar Sciences	12,730
4 GS-14 Staff Scientist	48,840
11 Other GS Personnel	53,081
32	$357,291

DIR. OF FUTURE APPLICATIONS

1 Exc. Dir.	$ 16,500
1 GS-15 Chief, Fut. Satel. App.	13,730
1 GS-15 Chief, Ind. App.	13,730
1 GS-15 Staff Eng.	13,730
3 GS-14 App. Analyst	36,630
1 GS-14 Exec. Asst.	12,210
5 Other GS Personnel	23,905
13	$130,435

DIRECTOR OF RESEARCH

1 Exc. Dir.	$ 19,000
2 Exc. Chief of Program	32,000
2 GS-15 Chief of Program	29,735
7 GS-15 Aerospace Tech.	97,085
4 GS-14 Aerospace Tech.	49,640
6 Other GS Personnel	31,369
22	$258,829

DIR. OF AERONAUTICAL RESEARCH

1 Exc. Dir.	$ 19,000
3 Exc. Chief of Program	48,500
2 GS-15 Chief of Program	29,735
7 GS-15 Aerospace Tech.	96,760
4 GS-14 Aerospace Tech.	49,640
8 Other GS Personnel	53,239
25	$296,874

DIRECTOR OF BIOSCIENCE PROGRAMS

1 Exc. Dir.	$18,000
1 Exc. Chf., Exbiology Prog.	17,500
1 GS-15 Chf., Environmental Biology Program	13,730
1 GS-15 Staff Scientist, Exbiology Program	13,730
1 GS-14 Staff Scientist, Environmental Biology Prog.	12,730
3 Other GS Personnel	15,725
8	$91,415

DIR. OF PROGRAM REV. & RESOURCES

1 Exc. Dir.	$ 16,000
1 GS-15 Asst., Prog. Coord.	13,730
1 GS-15 Asst., Res. Mgt.	13,730
1 GS-14 Res. Mgt. Asst.	12,210
3 Other GS Personnel	15,115
7	$ 70,785

DIR. OF PROGRAM REV. & RES. MGT.

1 Exc. Dir.	$ 17,500
3 GS-15 Chief of Group	44,115
2 GS-14 Aerospace Tech.	24,960
15 Other GS Personnel	100,923
21	$187,498

DIR. OF ELECTRONICS & CONTROL

1 Dir.	$ 16,500
1 Exc. Chief of Program	16,000
3 GS-15 Chief of Program	44,440
9 GS-15 Aerospace Tech.	124,870
6 GS-14 Aerospace Tech.	74,300
10 Other GS Personnel	60,432
30	$336,542

DIR. OF PROG. REVIEW & RESOURCES MGT.

1 Exc. Dir.	$ 17,500
1 Exc. Prog. Review Officer	17,500
1 GS-14 Admin. Officer	12,730
1 GS-14 Resources Mgt. Officer	12,210
1 GS-14 Prog. Review Asst.	12,210
9 Other GS Personnel	53,955
14	$126,105

DIR. OF COMMUNICATIONS SYSTEMS

1 Exc. Dir.	$ 17,000
1 Exc. Asst., Telecomm. Coord.	16,000
1 GS-15 Chief, Comm. Satell. Dev.	13,730
1 GS-15 Chief, Adv. Comm. Sys.	13,730
1 GS-15 Chief, Comm. Satell. Oper.	13,730
4 GS-15 Staff Eng.	54,920
1 GS-14 Exec. Asst	12,210
7 Other GS Personnel	32,610
17	$173,930

DIR. OF SPACE VEHICLES

1 Exc. Dir.	$ 19,000
2 Exc. Asst. Dir. of Sp. Veh.	36,000
2 Exc. Chief of Program	32,500
3 GS-15 Chief of Program	43,790
8 GS-15 Aerospace Tech.	110,490
6 GS-14 Aerospace Tech.	75,080
11 Other GS Personnel	63,569
33	$380,429

DIR. OF PROPULSION & POWER GEN.

1 Exc. Dir.	$ 19,000
1 Exc. Chief of Program	16,000
3 GS-15 Chief of Program	43,790
8 GS-15 Aerospace Tech.	110,490
5 GS-14 Aerospace Tech.	62,350
8 Other GS Personnel	46,781
26	$298,411

DIR. OF GRANTS & RESEARCH CONTRACTS

1 Exc. Dir.	$ 17,500
1 Exc. Chf. of Admin.	16,500
1 GS-15 Chf. of Prog.	13,730
5 GS-15 Prog. Admin.	68,650
3 GS-15 Inst. Liaison Officer	41,840
1 GS-14 Head, Mgt. Operations	12,210
1 GS-14 Admin. Officer	12,210
26 Other GS Personnel	157,292
38	$339,932

DIR. OF NUCLEAR SYSTEMS

1 Exc. Dir.	$ 18,500
1 Exc. Dep. Dir.	18,000
2 Exc. Asst. Dir.	35,500
2 Exc. Chief of Program	32,500
4 GS-15 Chief of Program	58,820
9 GS-15 Aerospace Tech.	125,845
6 GS-14 Aerospace Tech.	75,080
13 Other GS Personnel	83,957
38	$448,202

DIR. OF AEROSPACE MEDICINE

1 Exc. Dir.	$ 19,000
1 Exc. Dep. Dir.	18,000
1 Exc. Asst. Dir.	17,000
1 Exc. Staff Sci.	17,000
1 GS-15 Aerospace Tech., Life Sci. & Sys.	14,055
2 GS-15 Aerospace Tech., Flight Physiology	28,110
1 GS-15 Aerospace Tech., Radiology	14,055
1 GS-15 Aerospace Tech., Behavioral Studies	13,730
2 GS-15 Aerospace Tech., Environment Control	27,460
2 GS-14 Aerospace Tech., Life Sciences & Systems	24,420
2 GS-14 Aerospace Tech., Flight Physiology	24,680
38 Other GS Personnel	247,870
53	$465,180

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Proposed Personnel Staffing Chart
Fiscal Year 1963

WESTERN OPERATIONS OFFICE

OFFICE OF THE DIRECTOR

1	Excepted Director	$19,011
1	Excepted Deputy Director	16,516
2	GS personnel	11,039
4		$46,566

LEGAL OFFICE

1	GS-15 Chief counsel	$14,394
1	GS-15 Patent counsel	14,061
1	GS-14 Attorney advisor	12,750
1	GS-14 Patent attorney	12,750
5	Other GS personnel	31,788
9		$85,743

TECHNICAL DIVISION

1	GS-15 Chief of division	14,706
3	GS-15 Aerospace technologist	43,805
21	GS-14 Aerospace technologist	275,324
10	Other GS personnel	66,962
35		$400,797

PUBLIC INFORMATION DIVISION

1	GS-14 Public information specialist	$12,750
3	Other GS personnel	19,864
4		$32,614

SECURITY DIVISION

4	GS personnel	$29,329

FINANCIAL MANAGEMENT DIVISION

9	GS personnel	$55,864

CONTRACT MANAGEMENT DIVISION

1	Excepted Procurement Officer	$15,517
2	GS-14 Contract specialist	25,500
40	Other GS personnel	370,532
43		$411,549

EDUCATIONAL PROGRAMS DIVISION

1	GS-14 Educational Specialist	$12,750

ADMINISTRATIVE SERVICES DIVISION

16	GS personnel	$81,847

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Proposed personnel staffing chart

F.Y. 1963

LANGLEY RESEARCH CENTER

OFFICE OF DIRECTOR

1	Excepted	Director, Langley Research Center	$ 21,008
1	Excepted	Associate Director, Langley Research Center	19,011
1	Excepted	Technical Assistant to Director	17,514
1	Excepted	Research Assistant for Cooperative Projects	16,016
1	GS-15	Executive Assistant and Program Control Officer	15,309
1	GS-14	Executive Assistant to Associate Director	13,520
3		All other GS employees	19,240
9		Total	$121,618

(Budget Office)

		Budget Officer	$14,061
			31,512
			$45,573

RESEARCH STAFF SCIENTIST

1	Excepted	Research Staff Scientist	$18,013

SCOUT PROJECT GROUP

1	GS-15	Head, Scout Project Group	$ 14,394
4	GS-14	Aerospace Technologist	50,460
18		All other GS employees	150,593
23		Total	$215,447

FLIGHT REENTRY PROGRAM OFFICE

1	Excepted	Manager, Flight Reentry Program Office	$ 16,516
1	Excepted	Asst. Manager, Flight Reentry Program Office	16,016
2	GS-15	Aerospace Technologist	29,412
2	GS-14	Aerospace Technologist	24,460
14		All other GS employees	109,713
20		Total	$196,117

RESEARCH STAFF

*1	GS-15	Executive Assistant and Program Control Officer	
3		All other GS employees	$35,048
3		Total	$35,048

*Position not included in totals as this is a multiple function position and is included under Office of Director.

RESEARCH REPORTS DIVISION

1	GS-14	Chief of Division	$ 12,480
56		All other GS employees	355,061
57		Total	$367,541

...NT DIRECTOR

	...epted	Assistant Director, Langley Research Center	$18,512

...YSICS DIVISION

	...xcepted	Chief of Division	$ 18,013
	...xcepted	Assistant Chief of Division	17,015
	...xcepted	Head, Magnetoplasmadynamics Branch	16,016
	...S-15	Assistant Chief of Division	15,038
	...S-15	Division Executive	14,394
	...S-15	Head, Continuous Flow Hypersonic Tunnel Branch	14,394
	...S-15	Head, Internal Aerodynamics Branch	15,038
	...S-15	Head, Reentry Physics Branch	14,394
	...S-15	Assistant Head, Internal Aerodynamics Branch	14,394
	...S-15	Head, Hypersonic Aerodynamics Section	14,394
	...S-15	Head, 20-Inch Hypersonic Tunnel Section	14,706
	...S-15	Head, Helium Tunnels Section	14,061
	...S-15	Head, High-Temperature Fluid Mechanics Section	14,061
	...S-15	Head, Magnetohydrodynamics Section	14,706
	...S-15	Head, Plasma Applications Section	14,706
	...S-15	Head, Plasma Physics Section	14,706
	...S-15	Aerospace Technologist	13,749
	...S-14	Assistant Head, Continuous Flow Hypersonic Tunnel Branch	13,000
	...S-14	Aerospace Technologist	113,400
		All other GS employees	1,442,751
		Total	$1,822,936

...LE RESEARCH DIVISION

	...cepted	Chief of Division	$ 17,015
	...cepted	Assistant Chief of Division	16,516
	...-15	Head, 8-Foot Tunnels Branch	15,038
	...-15	Head, Full-Scale Analysis Branch	15,038
	...-15	Head, General Aerodynamics Branch	14,706
	...-15	Head, Large-Scale Compressible Flow Branch	15,038
	...-15	Head, 7- by 10-Foot Tunnels Branch	15,309
	...-15	Head, Unitary Plan Wind Tunnel Branch	15,038
	...-15	Head, Components Section	15,038
	...-15	Aerospace Technologist	86,987
	...-14	Head, 16-Foot Transonic Tunnel Section	14,040
	...-14	Head, Supersonics Section	13,520
	...-14	Aerospace Technologist	210,370
		All other GS employees	1,653,841
		Total	$2,117,494

...CAL MECHANICS DIVISION

	...epted	Chief of Division	$ 18,013
	...15	Assistant to Chief of Division	29,412
	...15	Head, Astromechanics Branch	15,038
	...15	Head, Mathematical Physics Branch	14,061
	...15	Assistant Head, Astromechanics Branch	14,706
	...15	Aerospace Technologist	30,535
	...14	Division Executive	13,790
	...14	Head, Astronautical Systems Section	12,750
	...14	Head, Mission Analysis Section	13,000

ASSISTANT DIRECTOR

1	Excepted	Assistant Director, Langley Research Center	$18,512

APPLIED MATERIALS AND PHYSICS DIVISION

1	Excepted	Chief of Division	$ 16,016
2	Excepted	Assistant Chief of Division	33,032
1	Excepted	Assistant to Chief of Division	16,516
1	Excepted	Head, High-Temperature Materials Branch	16,516
1	GS-15	Head, Spacecraft and Missile Dynamics Branch	15,038
1	GS-15	Head, Vehicle Performance Branch	14,706
1	GS-15	Assistant Head, High-Temperature Materials Branch	15,038
1	GS-15	Head, Systems Application Section	14,061
2	GS-15	Aerospace Technologist	27,498
1	GS-14	Head, Systems Analysis Section	13,520
1	GS-14	Head, Heat Transfer Section	13,000
1	GS-14	Head, Reentry Performance Section	13,000
1	GS-14	Head, Vehicle Systems Section	12,480
13	GS-14	Aerospace Technologist	165,130
180		All other GS employees	1,473,253
7		All WB employees	47,340
215		Total	$1,906,144

DYNAMIC LOADS DIVISION

1	Excepted	Chief of Division	$ 18,013
1	Excepted	Associate Chief of Division	17,015
1	Excepted	Assistant Chief of Division	16,016
1	GS-15	Head, Acoustics Branch	15,038
1	GS-15	Head, Landing and Impact Branch	15,038
1	GS-15	Head, Structural Dynamics Branch	14,706
1	GS-15	Head, Vehicles Dynamics Branch	14,706
1	GS-15	Assistant Head, Vibration and Flutter Branch	15,038
1	GS-15	Head, Aeroelasticity and Flutter Section	14,706
1	GS-15	Head, Analysis Section	15,038
1	GS-15	Head, Vibration and Dynamics Section	14,061
2	GS-15	Aerospace Technologist	29,058
1	GS-14	Assistant Head, Structural Dynamics Branch	13,520
1	GS-14	Assistant Head, Vehicle Dynamics Branch	13,520
11	GS-14	Aerospace Technologist	139,150
182		All other GS employees	1,543,437
208		Total	$1,908,060

STRUCTURES RESEARCH DIVISION

1	Excepted	Chief of Division	$ 18,013
1	Excepted	Assistant Chief of Division	16,516
1	Excepted	Assistant Chief of Division	16,016
1	GS-15	Special Assistant to Chief of Division	15,038
1	GS-15	Head, Aero-Thermal Facility Branch	14,061
1	GS-15	Head, 8-Foot High Temperature Structures Tunnel Branch	14,061
1	GS-15	Head, Entry Structures Branch	14,706
1	GS-15	Head, Fatigue Branch	14,706
1	GS-15	Head, Space Structures Branch	15,038
1	GS-15	Head, Structural Materials Branch	14,061
1	GS-15	Assistant Head, Fatigue Branch	14,394
1	GS-15	Head, Thermal Protection Section	14,706
4	GS-15	Aerospace Technologist	57,241
1	GS-14	Assistant Head, Structural Materials Branch	12,480
1	GS-14	Assistant Head, Aero-Thermal Facility Branch	13,000
1	GS-14	Head, Structural Mechanics Branch	12,750
1	GS-14	Head, Erectable Structures Section	12,230
1	GS-14	Head, Impacting Structures Section	13,520

ASSISTANT DIRECTOR

1	Excepted	Assistant Director, Langley Research Center	$19,011
2		All other GS employees	23,358
3		Total	$42,369

AERO-SPACE MECHANICS DIVISION

1	Excepted	Chief of Division	$ 17,015
1	Excepted	Associate Chief of Division	17,015
1	Excepted	Head, Guidance and Control Branch	17,015
1	Excepted	Head, Operations Branch	16,016
1	GS-15	Technical Assistant to Chief of Division	15,038
1	GS-15	Head, Airworthiness Branch	14,706
1	GS-15	Head, Dynamic Stability Branch	15,038
1	GS-15	Head, Flight Mechanics Branch	15,038
1	GS-15	Head, Recovery Systems Branch	15,038
1	GS-15	Head, VTOL Branch	15,038
1	GS-15	Assistant Head, Airworthiness Branch	14,061
1	GS-15	Assistant Head, Guidance and Control Branch	14,706
1	GS-15	Head, VTOL Section	15,038
1	GS-15	Head, Pilots Section	15,038
1	GS-15	Aerospace Technologist, Research Piloting	15,038
1	GS-14	Assistant Head, Flight Mechanics Branch	12,750
1	GS-14	Head, Reentry Vehicle Dynamics Section	13,520
1	GS-14	Head, Control and Simulation Section	13,000
1	GS-14	Head, Systems Analysis Section	12,480
2	GS-14	Aerospace Technologist	26,000
10	GS-14	Aerospace Technologist	128,710
141		All other GS employees	1,141,183
33		All WB employees	247,291
205		Total	$1,825,772

INSTRUMENT RESEARCH DIVISION

1	Excepted	Chief of Division	$ 17,514
2	Excepted	Assistant Chief of Division	32,532
1	Excepted	Head, Measurements Research Branch	16,016
1	GS-15	Head, Ground Facilities Instrumentation Branch	14,706
1	GS-15	Head, Instrument Standards and Systems Integration Branch	14,706
1	GS-15	Assistant Head, Navigation and Communications Research Branch	14,706
1	GS-15	Head, Reliability and Quality Control Section	14,706
2	GS-15	Aerospace Technologist	27,498
1	GS-14	Head, Tracking Systems Section	12,480
1	GS-14	Head, Telemeter Instrumentation Section	13,000
1	GS-14	Head, Vehicle Instrumentation Section	12,750
1	GS-14	Head, Instrument Physics Research Section	13,520
1	GS-14	Head, Telemeter Techniques Research Section	13,000
1	GS-14	Head, Automatic Control Section	13,000
1	GS-14	Head, Communications Research Section	13,000
1	GS-14	Head, Navigation and Guidance Research Section	12,480
9	GS-14	Aerospace Technologist	112,880
226		All other GS employees	1,913,392
156		All WB employees	1,120,587
409		Total	$3,402,473

ANALYSIS AND COMPUTATION DIVISION

1	Excepted	Chief of Division	$ 16,516

OFFICE OF CHIEF, TECHNICAL SERVICES

1	Excepted	Chief of Technical Services	$16,516
1	GS-15	Assistant Chief of Technical Services	15,309
1	GS-14	Assistant to Chief of Technical Services	12,750
2		All other GS employees	14,685
5		Total	$59,260

SAFETY OFFICE

3		All other GS employees	$19,324

PLANNING OFFICE

1	GS-13	Head, Planning Section	$ 11,939
13		All other GS employees	84,700
4		All WB employees	28,953
18		Total	$125,592

ELECTRICAL DIVISION

1	GS-15	Chief of Division	$ 15,038
1	GS-15	Assistant Chief of Division	14,706
1	GS-15	Head, Electrical Engineering Branch	14,706
1	GS-15	Aerospace Technologist, Electrical Systems	13,749
1	GS-14	Head, Electrical Distribution Section	13,520
1	GS-14	Head, Electrical Equipment and Control Section	13,520
1	GS-14	Aerospace Technologist, Electrical Systems	12,480
44		All other GS employees	342,996
188		All WB employees	1,191,099
239		Total	$1,631,814

ENGINEERING DIVISION

1	Excepted	Chief of Division	$ 16,516
1	GS-15	Associate Chief of Division	15,558
1	GS-15	Assistant Chief of Division	14,706
1	GS-15	Technical Assistant to Division Chief	14,706
1	GS-15	Head, Engineering Projects Analysis Staff	14,394
1	GS-15	Head, Research Models and Vehicles Branch	14,706
1	GS-15	Head, Systems Engineering Branch	14,394
1	GS-15	Aerospace Technologist	13,749
1	GS-14	Aerospace Technologist, Technical Management	13,000
1	GS-14	Head, Research Facilities Branch	13,520
1	GS-14	Assistant Head, Research Facilities Branch	12,480
1	GS-14	Head, Plant Engineering Section	12,750
1	GS-14	Head, Research Equipment Design Section	12,480
1	GS-14	Head, Dynamics Vehicle Section	13,000
1	GS-14	Head, Research Models and Payloads Section	13,520
1	GS-14	Head, Systems Control Section	13,520
1	GS-14	Head, Dynamics Analysis Staff	13,520
2	GS-14	Aerospace Technologist, Technical Assistant	27,040
4	GS-14	Aerospace Technologist	49,920
246		All other GS employees	2,062,550
269		Total	$2,376,029

MECHANICAL SERVICE DIVISION

1	GS-15	Chief of Division	$ 14,706
1	GS-15	Assistant Chief of Division	14,061

OFFICE OF CHIEF OF ADMINISTRATIVE SERVICES

1	Excepted	Chief of Administrative Services and Administrative Management Officer	$15,517
1		All other GS employees	5,824
2		Total	$21,341

OFFICE OF CHIEF COUNSEL

1	GS-15	Attorney Advisor	$14,394
1		All other GS employees	4,680
2		Total	$19,074

OFFICE OF PATENT COUNSEL

1	GS-13	Patent Advisor	$11,170
2		All other GS employees	10,650
3		Total	$21,820

SECURITY OFFICE

1	GS-13	Security Officer	$11,170
11		All other GS employees	58,659
12		Total	$69,829

FISCAL DIVISION

1	GS-14	Chief of Division	$ 13,000
76		All other GS employees	384,820
77		Total	$397,820

OFFICE SERVICES DIVISION

1	GS-13	Chief of Division	$ 11,170
52		All other GS employees	250,830
11		All WB employees	43,826
64		Total	$305,826

PERSONNEL DIVISION

1	GS-15	Chief of Division and Personnel Officer	$ 14,394
1	GS-14	Assistant Chief of Division and Assistant Personnel Officer	13,000
1	GS-14	Head, Employee Services Section	12,480
1	GS-14	Head, Training Section	12,480
41		All other GS employees	249,209
45		Total	$301,563

NATIONAL AERONAUTICS AND SP

Proposed personnel st

F.Y. 1963

LANGLEY RESEARCH

OFFICE OF DIRECTOR

1	Excepted	Director, Langley Research Cent	
1	Excepted	Associate Director, Langley Res	
1	Excepted	Technical Assistant to Director	
1	Excepted	Research Assistant for Cooperat	
1	GS-15	Executive Assistant and Program	
1	GS-14	Executive Assistant to Associat	
2		All other GS employees	
9		Total	

BUDGET OFFICE

1	GS-15	Program Management Specialist and Budget Officer	$14,061
4		All other GS employees	31,512
5		Total	$45,573

RESEARCH STAFF SCIENTIST

1	Excepted	Research Staff Scientist	$18,013

SCOUT PROJECT GROUP

1	GS-15	Head, Scout Project Group	$ 14,394
4	GS-14	Aerospace Technologist	50,460
18		All other GS employees	150,593
23		Total	$215,447

ASSISTANT DIRECTOR

1	Excepted	Assistant Director, Langley Research Center	$18,512

ASSISTANT DIRECTOR

1	Excepted	Assistant Director, Langley Research Center	$18,512

ASSISTANT DIRECTOR

1	Excepted	Assistant Director, Langley Res	
2		All other GS employees	
3		Total	

AERO-PHYSICS DIVISION

1	Excepted	Chief of Division	$ 18,013
1	Excepted	Assistant Chief of Division	17,015
1	Excepted	Head, Magnetoplasmadynamics Branch	16,016
1	GS-15	Assistant Chief of Division	15,038
1	GS-15	Division Executive	14,394
1	GS-15	Head, Continuous Flow Hypersonic Tunnel Branch	14,394
1	GS-15	Head, Internal Aerodynamics Branch	15,038
1	GS-15	Head, Reentry Physics Branch	14,394
1	GS-15	Assistant Head, Internal Aerodynamics Branch	14,394
1	GS-15	Head, Hypersonic Aerodynamics Section	14,394
1	GS-15	Head, 20-Inch Hypersonic Tunnel Section	14,706
1	GS-15	Head, Helium Tunnels Section	14,061
1	GS-15	Head, High-Temperature Fluid Mechanics Section	14,061
1	GS-15	Head, Magnetohydrodynamics Section	14,706
1	GS-15	Head, Plasma Applications Section	14,706
1	GS-15	Head, Plasma Physics Section	14,706
1	GS-15	Aerospace Technologist	13,749
1	GS-14	Assistant Head, Continuous Flow Hypersonic Tunnel Branch	13,000
9	GS-14	Aerospace Technologist	113,400
181		All other GS employees	1,442,751
208		Total	$1,822,936

FULL-SCALE RESEARCH DIVISION

1	Excepted	Chief of Division	$ 17,015
1	Excepted	Assistant Chief of Division	16,516
1	GS-15	Head, 8-Foot Tunnels Branch	15,038
1	GS-15	Head, Full-Scale Analysis Branch	15,038
1	GS-15	Head, General Aerodynamics Branch	14,706
1	GS-15	Head, Large-Scale Compressible Flow Branch	15,038
1	GS-15	Head, 7- by 10-Foot Tunnels Branch	15,309
1	GS-15	Head, Unitary Plan Wind Tunnel Branch	15,038
1	GS-15	Head, Components Section	15,038
6	GS-15	Aerospace Technologist	86,987
1	GS-14	Head, 16-Foot Transonic Tunnel Section	14,040
1	GS-14	Head, Supersonics Section	13,520
16	GS-14	Aerospace Technologist	210,370
202		All other GS employees	1,653,841
235		Total	$2,117,494

THEORETICAL MECHANICS DIVISION

1	Excepted	Chief of Division	$ 18,013
2	GS-15	Assistant to Chief of Division	29,412
1	GS-15	Head, Astromechanics Branch	15,038
1	GS-15	Head, Mathematical Physics Branch	14,061
1	GS-15	Assistant Head, Astromechanics Branch	14,706
2	GS-15	Aerospace Technologist	30,535
1	GS-14	Division Executive	13,790
1	GS-14	Head, Astronautical Systems Section	12,750
1	GS-14	Head, Mission Analysis Section	13,000
1	GS-14	Head, Rendezvous Analysis Section	13,520
1	GS-14	Head, Systems Simulation Section	12,750
4	GS-14	Aerospace Technologist	52,270
47		All other GS employees	388,964
64		Total	$628,809

APPLIED MATERIALS AND PHYSICS DIVISION

1	Excepted	Chief of Division	$ 16,016
2	Excepted	Assistant Chief of Division	33,032
1	Excepted	Assistant to Chief of Division	16,516
1	Excepted	Head, High-Temperature Materials Branch	16,516
1	GS-15	Head, Spacecraft and Missile Dynamics Branch	15,038
1	GS-15	Head, Vehicle Performance Branch	14,706
1	GS-15	Assistant Head, High-Temperature Materials Branch	15,038
1	GS-15	Head, Systems Application Section	14,061
2	GS-15	Aerospace Technologist	27,488
1	GS-14	Head, Systems Analysis Section	13,520
1	GS-14	Head, Heat Transfer Section	13,000
1	GS-14	Head, Reentry Performance Section	13,000
1	GS-14	Head, Vehicle Systems Section	12,480
13	GS-14	Aerospace Technologist	165,130
180		All other GS employees	1,473,253
7		All WB employees	47,340
215		Total	$1,906,144

DYNAMIC LOADS DIVISION

1	Excepted	Chief of Division	$ 18,013
1	Excepted	Associate Chief of Division	17,015
1	Excepted	Assistant Chief of Division	16,016
1	GS-15	Head, Acoustics Branch	15,038
1	GS-15	Head, Landing and Impact Branch	15,038
1	GS-15	Head, Structural Dynamics Branch	14,706
1	GS-15	Head, Vehicles Dynamics Branch	14,706
1	GS-15	Assistant Head, Vibration and Flutter Branch	15,038
1	GS-15	Head, Aeroelasticity and Flutter Section	14,706
1	GS-15	Head, Analysis Section	15,038
1	GS-15	Head, Vibration and Dynamics Section	14,061
2	GS-15	Aerospace Technologist	29,058
1	GS-14	Assistant Head, Structural Dynamics Branch	13,520
1	GS-14	Assistant Head, Vehicle Dynamics Branch	13,520
11	GS-14	Aerospace Technologist	139,150
182		All other GS employees	1,543,437
208		Total	$1,908,060

STRUCTURES RESEARCH DIVISION

1	Excepted	Chief of Division	$ 18,013
1	Excepted	Assistant Chief of Division	16,516
1	Excepted	Assistant Chief of Division	16,016
1	GS-15	Special Assistant to Chief of Division	15,038
1	GS-15	Head, Aero-Thermal Facility Branch	14,061
1	GS-15	Head, 8-Foot High Temperature Structures Tunnel Branch	14,061
1	GS-15	Head, Entry Structures Branch	14,706
1	GS-15	Head, Fatigue Branch	14,706
1	GS-15	Head, Space Structures Branch	15,038
1	GS-15	Head, Structural Materials Branch	14,061
1	GS-15	Assistant Head, Fatigue Branch	14,394
1	GS-15	Head, Thermal Protection Section	14,706
4	GS-15	Aerospace Technologist	57,241
1	GS-14	Assistant Head, Structural Materials Branch	12,480
1	GS-14	Assistant Head, Aero-Thermal Facility Branch	13,000
1	GS-14	Head, Structural Mechanics Branch	12,750
1	GS-14	Head, Erectable Structures Section	12,250
1	GS-14	Head, Impacting Structures Section	13,520
1	GS-14	Head, Protective Structures Section	12,750
1	GS-14	Head, Structural Analysis Section	12,750
1	GS-14	Head, Structural Strength Section	13,000
1	GS-14	Head, Structural Heat Transfer Section	12,480
1	GS-14	Head, Thermal Structural Dynamics Section	12,480
1	GS-14	Head, Research Techniques Section	12,480
9	GS-14	Aerospace Technologist	113,690
181		All other GS employees	1,501,947
217		Total	$1,994,114

AERO-SPACE MECHANICS DIVISION

1	Excepted	Chief of Division
1	Excepted	Associate Chief of Division
1	Excepted	Head, Guidance and Control B
1	Excepted	Head, Operations Branch
1	GS-15	Technical Assistant to Chief
1	GS-15	Head, Airworthiness Branch
1	GS-15	Head, Dynamic Stability Bran
1	GS-15	Head, Flight Mechanics Branc
1	GS-15	Head, Recovery Systems Branc
1	GS-15	Head, VTOL Branch
1	GS-15	Assistant Head, Airworthines
1	GS-15	Assistant Head, Guidance and
1	GS-15	Head, VTOL Section
1	GS-15	Head, Pilots Section
1	GS-15	Aerospace Technologist, Rese
1	GS-14	Assistant Head, Flight Mecha
1	GS-14	Head, Reentry Vehicle Dynami
1	GS-14	Head, Control and Simulation
1	GS-14	Head, Systems Analysis Secti
2	GS-14	Aerospace Technologist
10	GS-14	Aerospace Technologist
141		All other GS employees
32		All WB employees
205		Total

INSTRUMENT RESEARCH DIVISION

1	Excepted	Chief of Division
2	Excepted	Assistant Chief of Division
1	Excepted	Head, Measurements Research
1	GS-15	Head, Ground Facilities Inst
1	GS-15	Head, Instrument Standards Integration Branch
1	GS-15	Assistant Head, Navigation Research Branch
1	GS-15	Head, Reliability and Quali
2	GS-15	Aerospace Technologist
1	GS-14	Head, Tracking Systems Sect
1	GS-14	Head, Telemeter Instrumenta
1	GS-14	Head, Vehicle Instrumentati
1	GS-14	Head, Instrument Physics Re
1	GS-14	Head, Telemeter Techniques
1	GS-14	Head, Automatic Control Sec
1	GS-14	Head, Communications Resear
1	GS-14	Head, Navigation and Guidan
9	GS-14	Aerospace Technologist
226		All other GS employees
156		All WB employees
409		Total

ANALYSIS AND COMPUTATION DIVISION

1	Excepted	Chief of Division
1	GS-15	Assistant Chief of Divisi
1	GS-14	Head, Data Systems Branch
1	GS-14	Head, Read-Out Equipment
126		All other GS employees
12		All WB employees
142		Total

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Proposed personnel staffing chart

F.Y. 1963

LANGLEY RESEARCH CENTER

OFFICE OF DIRECTOR

1	Excepted	Director, Langley Research Center	$ 21,008
1	Excepted	Associate Director, Langley Research Center	19,011
1	Excepted	Technical Assistant to Director	17,514
1	Excepted	Research Assistant for Cooperative Projects	16,016
1	GS-15	Executive Assistant and Program Control Officer	15,309
1	GS-14	Executive Assistant to Associate Director	13,520
3		All other GS employees	19,240
9		Total	$121,618

Officer	$14,061
	31,512
	$45,573

RESEARCH STAFF SCIENTIST

1	Excepted	Research Staff Scientist	$18,013

SCOUT PROJECT GROUP

1	GS-15	Head, Scout Project Group	$ 14,394
4	GS-14	Aerospace Technologist	50,460
18		All other GS employees	150,593
23		Total	$215,447

FLIGHT REENTRY PROGRAM OFFICE

1	Excepted	Manager, Flight Reentry Program Office	$ 16,516
1	Excepted	Asst. Manager, Flight Reentry Program Office	16,016
2	GS-15	Aerospace Technologist	29,412
2	GS-14	Aerospace Technologist	24,460
14		All other GS employees	109,713
20		Total	$196,117

RESEARCH STAFF

*1	GS-15	Executive Assistant and Program Control Officer	
3		All other GS employees	$35,048
3		Total	$35,048

*Position not included in totals as this is a multiple function position and is included under Office of Director.

RESEARCH REPORTS DIVISION

1	GS-14	Chief of Division	$ 12,480
56		All other GS employees	355,061
57		Total	$367,541

...CTOR

Assistant Director, Langley Research Center	$18,512

ASSISTANT DIRECTOR

1	Excepted	Assistant Director, Langley Research Center	$18,512

ASSISTANT DIRECTOR

1	Excepted	Assistant Director, Langley Research Center	$19,011
2		All other GS employees	23,358
3		Total	$42,369

OFFICE OF CHIEF, TECHNICAL SERVICES

1	Excepted	Chief of Technical Services	$16,516
1	GS-15	Assistant Chief of Technical Services	15,309
1	GS-14	Assistant to Chief of Technical Services	12,750
2		All other GS employees	14,685
5		Total	$59,260

OFFICE OF CHIEF OF ADMINISTRATIVE SERVICES

1	Excepted	Chief of Administrative Services and Administrative Management Officer	$15,517
1		All other GS employees	5,824
2		Total	$21,341

...VISION

Chief of Division	$ 18,013
Assistant Chief of Division	17,015
Head, Magnetoplasmadynamics Branch	16,016
Assistant Chief of Division	15,038
Division Executive	14,394
Head, Continuous Flow Hypersonic Tunnel Branch	14,394
Head, Internal Aerodynamics Branch	15,038
Head, Reentry Physics Branch	14,394
Assistant Head, Internal Aerodynamics Branch	14,394
Head, Hypersonic Aerodynamics Section	14,394
Head, 20-Inch Hypersonic Tunnel Section	14,706
Head, Helium Tunnels Section	14,061
Head, High-Temperature Fluid Mechanics Section	14,061
Head, Magnetohydrodynamics Section	14,706
Head, Plasma Applications Section	14,706
Head, Plasma Physics Section	14,706
Aerospace Technologist	13,749
Assistant Head, Continuous Flow Hypersonic Tunnel Branch	13,000
Aerospace Technologist	113,400
All other GS employees	1,442,751
Total	$1,822,936

APPLIED MATERIALS AND PHYSICS DIVISION

1	Excepted	Chief of Division	$ 16,016
2	Excepted	Assistant Chief of Division	33,032
1	Excepted	Assistant to Chief of Division	16,516
1	Excepted	Head, High-Temperature Materials Branch	16,516
1	GS-15	Head, Spacecraft and Missile Dynamics Branch	15,038
1	GS-15	Head, Vehicle Performance Branch	14,706
1	GS-15	Assistant Head, High-Temperature Materials Branch	15,038
1	GS-15	Head, Systems Application Section	14,061
2	GS-15	Aerospace Technologist	27,498
1	GS-14	Head, Systems Analysis Section	13,520
1	GS-14	Head, Heat Transfer Section	13,000
1	GS-14	Head, Reentry Performance Section	13,000
1	GS-14	Head, Vehicle Systems Section	12,480
13	GS-14	Aerospace Technologist	165,130
180		All other GS employees	1,473,253
7		All WB employees	47,340
215		Total	$1,906,144

AERO-SPACE MECHANICS DIVISION

1	Excepted	Chief of Division	$ 17,015
1	Excepted	Associate Chief of Division	17,015
1	Excepted	Head, Guidance and Control Branch	17,015
1	Excepted	Head, Operations Branch	16,016
1	GS-15	Technical Assistant to Chief of Division	15,038
1	GS-15	Head, Airworthiness Branch	14,706
1	GS-15	Head, Dynamic Stability Branch	15,038
1	GS-15	Head, Flight Mechanics Branch	15,038
1	GS-15	Head, Recovery Systems Branch	15,038
1	GS-15	Head, VTOL Branch	15,038
1	GS-15	Assistant Head, Airworthiness Branch	14,061
1	GS-15	Assistant Head, Guidance and Control Branch	14,706
1	GS-15	Head, VTOL Section	15,038
1	GS-15	Head, Pilots Section	15,038
1	GS-15	Aerospace Technologist, Research Piloting	15,038
1	GS-14	Assistant Head, Flight Mechanics Branch	12,750
1	GS-14	Head, Reentry Vehicle Dynamics Section	13,520
1	GS-14	Head, Control and Simulation Section	13,000
1	GS-14	Head, Systems Analysis Section	12,480
2	GS-14	Aerospace Technologist	26,000
10	GS-14	Aerospace Technologist	128,710
141		All other GS employees	1,141,183
33		All WB employees	247,291
205		Total	$1,825,772

SAFETY OFFICE

3		All other GS employees	$19,324

PLANNING OFFICE

1	GS-13	Head, Planning Section	$ 11,939
13		All other GS employees	84,700
4		All WB employees	28,953
18		Total	$125,592

ELECTRICAL DIVISION

1	GS-15	Chief of Division	$ 15,038
1	GS-15	Assistant Chief of Division	14,706
1	GS-15	Head, Electrical Engineering Branch	14,706
1	GS-15	Aerospace Technologist, Electrical Systems	13,749
1	GS-14	Head, Electrical Distribution Section	13,520
1	GS-14	Head, Electrical Equipment and Control Section	13,520
1	GS-14	Aerospace Technologist, Electrical Systems	12,480
44		All other GS employees	342,996
188		All WB employees	1,191,099
239		Total	$1,631,814

OFFICE OF CHIEF COUNSEL

1	GS-15	Attorney Advisor	$14,394
1		All other GS employees	4,680
2		Total	$19,074

OFFICE OF PATENT COUNSEL

1	GS-13	Patent Advisor	$11,170
2		All other GS employees	10,650
3		Total	$21,820

SECURITY OFFICE

1	GS-13	Security Officer	$11,170
11		All other GS employees	58,659
12		Total	$69,829

DYNAMIC LOADS DIVISION

1	Excepted	Chief of Division	$ 18,013
1	Excepted	Associate Chief of Division	17,015
1	Excepted	Assistant Chief of Division	16,016
1	GS-15	Head, Acoustics Branch	15,038
1	GS-15	Head, Landing and Impact Branch	15,038
1	GS-15	Head, Structural Dynamics Branch	14,706
1	GS-15	Head, Vehicles Dynamics Branch	14,706
1	GS-15	Assistant Head, Vibration and Flutter Branch	15,038
1	GS-15	Head, Aeroelasticity and Flutter Section	14,706
1	GS-15	Head, Analysis Section	15,038
1	GS-15	Head, Vibration and Dynamics Section	14,061
2	GS-15	Aerospace Technologist	29,058
1	GS-14	Assistant Head, Structural Dynamics Branch	13,520
1	GS-14	Assistant Head, Vehicle Dynamics Branch	13,520
11	GS-14	Aerospace Technologist	139,150
182		All other GS employees	1,543,437
208		Total	$1,908,060

...CH DIVISION

Chief of Division	$ 17,015
Assistant Chief of Division	16,516
Head, 8-Foot Tunnels Branch	15,038
Head, Full-Scale Analysis Branch	15,038
Head, General Aerodynamics Branch	14,706
Head, Large-Scale Compressible Flow Branch	15,038
Head, 7- by 10-Foot Tunnels Branch	15,309
Head, Unitary Plan Wind Tunnel Branch	15,038
Head, Components Section	15,038
Aerospace Technologist	86,987
Head, 16-Foot Transonic Tunnel Section	14,040
Head, Supersonics Section	13,520
Aerospace Technologist	210,370
All other GS employees	1,653,841
Total	$2,117,494

INSTRUMENT RESEARCH DIVISION

1	Excepted	Chief of Division	$ 17,514
2	Excepted	Assistant Chief of Division	32,532
1	Excepted	Head, Measurements Research Branch	16,016
1	GS-15	Head, Ground Facilities Instrumentation Branch	14,706
1	GS-15	Head, Instrument Standards and Systems Integration Branch	14,706
1	GS-15	Assistant Head, Navigation and Communications Research Branch	14,706
1	GS-15	Head, Reliability and Quality Control Section	14,706
2	GS-15	Aerospace Technologist	27,498
1	GS-14	Head, Tracking Systems Section	12,480
1	GS-14	Head, Telemeter Instrumentation Section	13,000
1	GS-14	Head, Vehicle Instrumentation Section	12,750
1	GS-14	Head, Instrument Physics Research Section	13,520
1	GS-14	Head, Telemeter Techniques Research Section	13,000
1	GS-14	Head, Automatic Control Section	13,000
1	GS-14	Head, Communications Research Section	13,000
1	GS-14	Head, Navigation and Guidance Research Section	12,480
9	GS-14	Aerospace Technologist	112,880
226		All other GS employees	1,913,392
156		All WB employees	1,120,587
409		Total	$3,402,473

ENGINEERING DIVISION

1	Excepted	Chief of Division	$ 16,516
1	GS-15	Associate Chief of Division	15,558
1	GS-15	Assistant Chief of Division	14,706
1	GS-15	Technical Assistant to Division Chief	14,706
1	GS-15	Head, Engineering Projects Analysis Staff	14,394
1	GS-15	Head, Research Models and Vehicles Branch	14,706
1	GS-15	Head, Systems Engineering Branch	14,394
1	GS-15	Aerospace Technologist	13,749
1	GS-14	Aerospace Technologist, Technical Management	13,000
1	GS-14	Head, Research Facilities Branch	13,520
1	GS-14	Assistant Head, Research Facilities Branch	12,480
1	GS-14	Head, Plant Engineering Section	12,750
1	GS-14	Head, Research Equipment Design Section	12,480
1	GS-14	Head, Dynamics Vehicle Section	13,000
1	GS-14	Head, Research Models and Payloads Section	13,520
1	GS-14	Head, Systems Control Section	13,520
1	GS-14	Head, Dynamics Analysis Staff	13,520
2	GS-14	Aerospace Technologist, Technical Assistant	27,040
4	GS-14	Aerospace Technologist	49,920
246		All other GS employees	2,062,550
269		Total	$2,376,029

FISCAL DIVISION

1	GS-14	Chief of Division	$ 13,000
76		All other GS employees	384,820
77		Total	$397,820

OFFICE SERVICES DIVISION

1	GS-13	Chief of Division	$ 11,170
52		All other GS employees	250,830
11		All WB employees	43,826
64		Total	$305,826

STRUCTURES RESEARCH DIVISION

1	Excepted	Chief of Division	$ 18,013
1	Excepted	Assistant Chief of Division	16,516
1	Excepted	Assistant Chief of Division	16,016
1	GS-15	Special Assistant to Chief of Division	15,038
1	GS-15	Head, Aero-Thermal Facility Branch	14,061
1	GS-15	Head, 8-Foot High Temperature Structures Tunnel Branch	14,061
1	GS-15	Head, Entry Structures Branch	14,706
1	GS-15	Head, Fatigue Branch	14,706
1	GS-15	Head, Space Structures Branch	15,038
1	GS-15	Head, Structural Materials Branch	14,061
1	GS-15	Assistant Head, Fatigue Branch	14,394
1	GS-15	Head, Thermal Protection Section	14,706
4	GS-15	Aerospace Technologist	57,241
1	GS-14	Assistant Head, Structural Materials Branch	12,480
1	GS-14	Assistant Head, Aero-Thermal Facility Branch	13,000
1	GS-14	Head, Structural Mechanics Branch	12,750
1	GS-14	Head, Erectable Structures Section	12,230
1	GS-14	Head, Impacting Structures Section	13,520
1	GS-14	Head, Protective Structures Section	12,750
1	GS-14	Head, Structural Analysis Section	

...ICS DIVISION

Chief of Division	$ 18,013
Assistant to Chief of Division	29,412
Head, Astromechanics Branch	15,038
Head, Mathematical Physics Branch	14,061
Assistant Head, Astromechanics Branch	14,706
Aerospace Technologist	30,535
Division Executive	13,790
Head, Astronautical Systems Section	12,750
Head, Mission Analysis Section	13,000
Head, Rendezvous Analysis Section	13,520
Head, Systems Simulation Section	12,750
Aerospace Technologist	

ANALYSIS AND COMPUTATION DIVISION

1	Excepted	Chief of Division	$ 16,516
1	GS-15	Assistant Chief of Division	14,706

MECHANICAL SERVICE DIVISION

1	GS-15	Chief of Division	$ 14,706
1	GS-15	Assistant Chief of Division	14,061
7		All other GS employees	34,175

PERSONNEL DIVISION

1	GS-15	Chief of Division and Personnel Officer	$ 14,394
1	GS-14	Assistant Chief of Division and Assistant Personnel Officer	13,000
1	GS-14	Head, Employee Services Section	12,480
1	GS-14	Head, Training Section	12,480
41		All other GS employees	249,209
45		Total	$301,563

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
PROPOSED PERSONNEL STAFFING CHART
FISCAL YEAR 1963
AMES RESEARCH CENTER

Office of the Director

1	Excepted	Director	$ 21,006
1	Excepted	Associate Director	19,011
1	Excepted	Technical Assistant to Director	16,016
2	GS-15	Technical Assistant to Director	30,347
1	GS-15	Executive Assistant and Budget Officer	15,038
1	GS-14	Public Information Officer	12,480
7	All other GS personnel		47,406
14			$161,304

Office of Assistant Director

1	Excepted	Assistant Director	$19,011
1	GS-15	Technical Assistant	14,706
1	All other GS personnel		5,658
3			$39,375

Vehicle-Environment Division

1	Excepted	Chief of Division	$ 18,013
1	Excepted	Assistant Chief of Division	16,016
1	GS-15	Chief, Physics Branch	14,061
1	GS-15	Chief, Entry Simulation Branch	15,038
1	GS-15	Chief, Structural Dynamics branch	15,038
1	GS-15	Chief, 3.5 Foot Hypersonic Wind Tunnel Branch	15,038
1	GS-15	Chief, Hypervelocity Ballistic Range Branch	15,038
10	GS-15	Aerospace Technologist	144,499
16	GS-14	Aerospace Techologist	206,980
114	All other GS personnel		949,777
50	All other Wage Board personnel		353,608
197			$1,763,106

Aero-Thermodynamics Division

1	Excepted	Chief of Division	$ 18,013
1	Excepted	Assistant Chief of Division	16,016
2	Excepted	Research Scientists	35,028
1	Excepted	Chief, Supersonic Free-Flight Wind Tunnel Branch	16,516
1	Excepted	Chief, Heat Transfer Branch	16,516
1	Excepted	Chief, Theorectical Branch	16,516
1	GS-15	Chief, Fluid Mechanics Branch	15,038
1	GS-15	Chief, Trisonic Aerodynamics Branch	15,038
14	GS-15	Aerospace Technologist	204,984
17	GS-14	Aerospace Technologist	243,900
145	All other GS personnel		1,157,765
92	All other Wage Board personnel		388,246
239			$2,123,676

Office of Assistant Director

1	Excepted	Assistant Director	$18,512
2	GS-15	Technical Assistant	29,100
1	All other GS personnel		5,824
4			$53,436

Full Scale and Systems Research Division

1	Excepted	Chief of Division	$ 17,514
1	Excepted	Assistant Chief of Division	15,517
1	GS-15	Chief, 40- by 80-Foot Wind Tunnel Branch	15,038
1	GS-15	Chief, Flight and Systems Simulation Branch	14,394
1	GS-15	Chief, Operations Branch	15,309
1	GS-15	Chief, Analog and Flight Simulator Branch	14,394
1	GS-15	Chief, Guidance and Control Branch	15,038
1	GS-15	Chief, Guidance Systems Components Branch	15,038
2	GS-15	AST and Pilot	30,076
10	GS-15	Aerospace Technologist	145,812
1	GS-14	AST and Pilot	12,230
18	GS-14	Aerospace Technologist	233,000
108	All other GS personnel		930,504
20	All other Wage Board personnel		147,689
167			$1,621,553

Unitary Plan Wind Tunnel Division

1	Excepted	Chief of Division	$ 16,016
1	GS-15	Assistant Chief of Division	15,038
1	GS-15	Chief, 8- by 7-Foot Supersonic Wind Tunnel Branch	15,038
1	GS-15	Chief, 9- by 7-Foot Supersonic Wind Tunnel Branch	15,038
1	GS-15	Chief, 11 Foot Transonic Wind Tunnel Branch	15,038
3	GS-15	Aerospace Technologist	43,805
6	GS-14	Aerospace Technologist	77,480
75	All other GS personnel		593,225
45	All other Wage Board personnel		326,401
134			$1,117,079

Instrumentation Division

1	Excepted	Chief of Division	$ 16,516
1	Excepted	Assistant Chief of Division	16,516
1	GS-15	Chief, Measurement Research Branch	14,706
1	GS-15	Chief, Instrument Systems Development Branch	13,749
[illegible]	[illegible]	Chief, Electronic Analog Computing Branch	[illegible]
2	GS-15	Aerospace Technologist	30,076
10	GS-14	Aerospace Technologist	130,020
130	All other GS personnel		998,786
150	All other Wage Board personnel		1,112,607
297			$2,348,016

Office of Assistant Director for Life Sciences

1	Excepted	Assistant Director for Life Sciences	$18,013
1	Excepted	Deputy Assistant Director	17,015
1	GS-15	Chief, Professional Support Group	14,394
5	All other GS personnel		29,286
8			$78,708

Exobiology Division

1	Excepted	Chief of Division	$ 17,015
1	GS-15	Chief, Life Synthesis Branch	13,749
1	GS-15	Chief, Cellular Biology Branch	13,749
2	GS-15	Aerospace Technologist	27,498
5	GS-14	Aerospace Technologist	63,460
15	All other GS personnel		124,971
25			$260,442

Environmental Biology Division

1	Excepted	Chief of Division	$ 17,015
1	Excepted	Chief, Radiobiology Branch	15,517
1	GS-15	Chief, Microbiology, Zoology, and Botany Branch	13,749
1	GS-15	Chief, Experimental Pathology Branch	13,749
1	GS-15	Chief, Physiology Branch	13,749
4	GS-15	Aerospace Technologist	54,996
10	GS-14	Aerospace Technologist	126,920
41	All other GS personnel		341,587
60			$597,282

Biotechnology Division

1	Excepted	Chief of Division	$ 17,015
1	Excepted	Assistant Chief of Division	16,016
1	Excepted	Staff Scientist, Neurophysiology	18,013
1	GS-15	Chief, Human Performance Requirements Branch	13,749
1	GS-15	Chief, Engineering Psychology Branch	13,749
1	GS-15	Chief, Human Systems Engineering Branch	14,706
3	GS-15	Aerospace Technologist	41,247
9	GS-14	Aerospace Technologist	114,690
40	All other GS personnel		333,255
58			$582,440

Office of Assistant Director for Administration

1	Excepted	Assistant Director for Administration	$15,517
1	All other GS personnel		5,824
2			$21,341

Administrative Services Division

1	GS-11	Chief of Division	$ 8,861
45	All other GS personnel		208,847
10	All other Wage Board personnel		49,281
56			$266,989

Fiscal Division

1	GS-14	Chief of Division and Fiscal Officer	$ 13,000
57	All other GS personnel		295,445
58			$308,445

Personnel Division

1	GS-14	Chief of Division and Personnel Officer	$ 13,520
41	All other GS personnel		225,205
42			$238,725

Procurement and Supply Division

1	GS-13	Chief of Division, Procurement and Supply Officer	$ 14,061
1	GS-14	Assistant Procurement and Supply Officer	12,480
50	All other GS personnel		266,561
20	All other Wage Board personnel		145,926
72			$438,028

Technical Services Division

1	GS-15	Chief of Division	$ 15,038
1	GS-15	Assistant Chief of Division	14,706
1	GS-14	Assistant Chief of Division	13,520
2	All other GS personnel		8,653
396	All other Wage Board personnel		2,876,482
401			$2,928,399

1	Excepted	[illegible]	[illegible]
1	GS-15	[illegible]	[illegible]
1	GS-15	[illegible]	[illegible]
1	GS-15	[illegible]	[illegible]
2	GS-15	[illegible]	[illegible]
19	GS-14	[illegible]	[illegible]
109	All other	[illegible]	[illegible]
75	All other	[illegible]	[illegible]
209			

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
PROPOSED PERSONNEL STAFFING CHART
FISCAL YEAR 1963
AMES RESEARCH CENTER

Office of the Director

1	Excepted	Director	$ 21,008
1	Excepted	Associate Director	19,011
1	Excepted	Technical Assistant to Director	16,016
2	GS-15	Technical Assistant to Director	30,347
1	GS-15	Executive Assistant and Budget Officer	15,038
1	GS-14	Public Information Officer	12,480
7	All other GS personnel		47,404
14			$161,304

Office of Assistant Director

1	Excepted	Assistant Director	$18,512
2	GS-15	Technical Assistant	29,100
1	All other GS personnel		5,824
4			$53,436

Office of Assistant Director for Life Sciences

1	Excepted	Assistant Director for Life Sciences	$18,013
1	Excepted	Deputy Assistant Director	17,015
1	GS-15	Chief, Professional Support Group	14,394
5	All other GS personnel		29,286
8			$78,708

Office of Assistant Director for Administration

1	Excepted	Assistant Director for Administration	$15,517
1	All other GS personnel		5,824
2			$21,341

Full Scale and Systems Research Division

1	Excepted	Chief of Division	$ 17,514
1	Excepted	Assistant Chief of Division	15,517
1	GS-15	Chief, 40- by 80-Foot Wind Tunnel Branch	15,038
1	GS-15	Chief, Flight and Systems Simulation Branch	14,394
1	GS-15	Chief, Operations Branch	15,309
1	GS-15	Chief, Analog and Flight Simulator Branch	14,394
1	GS-15	Chief, Guidance and Control Branch	15,038
1	GS-15	Chief, Guidance Systems Components Branch	15,038
2	GS-15	AST and Pilot	30,076
10	GS-15	Aerospace Technologist	145,812
1	GS-14	AST and Pilot	12,230
18	GS-14	Aerospace Technologist	233,000
108	All other GS personnel		930,504
20	All other Wage Board personnel		147,689
167			$1,621,553

Unitary Plan Wind Tunnel Division

1	Excepted	Chief of Division	$ 16,016
1	GS-15	Assistant Chief of Division	15,038
1	GS-15	Chief, 8- by 7-Foot Supersonic Wind Tunnel Branch	15,038
1	GS-15	Chief, 9- by 7-Foot Supersonic Wind Tunnel Branch	15,038
1	GS-15	Chief, 11 Foot Transonic Wind Tunnel Branch	15,038
3	GS-15	Aerospace Technologist	43,805
6	GS-14	Aerospace Technologist	77,480
75	All other GS personnel		593,225
45	All other Wage Board personnel		326,401
134			$1,117,079

Instrumentation Division

1	Excepted	Chief of Division	$ 16,516
1	Excepted	Assistant Chief of Division	16,516
1	GS-15	Chief, Measurement Research Branch	14,706
1	GS-15	Chief, Instrument Systems Development Branch	13,749
1	GS-15	Chief, Electronic Machine Computing Branch	15,038
2	GS-15	Aerospace Technologist	30,076
10	GS-14	Aerospace Technologist	130,020
130	All other GS personnel		998,786
150	All other Wage Board personnel		1,112,809
297			$2,348,016

Exobiology Division

1	Excepted	Chief of Division	$ 17,015
1	GS-15	Chief, Life Synthesis Branch	13,749
1	GS-15	Chief, Cellular Biology Branch	13,749
2	GS-15	Aerospace Technologist	27,498
5	GS-14	Aerospace Technologist	63,460
15	All other GS personnel		124,971
25			$260,442

Environmental Biology Division

1	Excepted	Chief of Division	$ 17,015
1	Excepted	Chief, Radiobiology Branch	15,517
1	GS-15	Chief, Microbiology, Zoology, and Botany Branch	13,749
1	GS-15	Chief, Experimental Pathology Branch	13,749
1	GS-15	Chief, Physiology Branch	13,749
4	GS-15	Aerospace Technologist	54,996
10	GS-14	Aerospace Technologist	126,920
41	All other GS personnel		341,587
60			$597,282

Biotechnology Division

1	Excepted	Chief of Division	$ 17,015
1	Excepted	Assistant Chief of Division	16,016
1	Excepted	Staff Scientist, Neurophysiology	18,013
1	GS-15	Chief, Human Performance Requirements Branch	13,749
1	GS-15	Chief, Engineering Psychology Branch	13,749
1	GS-15	Chief, Human Systems Engineering Branch	14,706
3	GS-15	Aerospace Technologist	41,247
9	GS-14	Aerospace Technologist	114,690
40	All other GS personnel		333,255
58			$582,440

Administrative Services Division

1	GS-11	Chief of Division	$ 8,861
45	All other GS personnel		208,847
10	All other Wage Board personnel		49,281
56			$266,989

Fiscal Division

1	GS-14	Chief of Division and Fiscal Officer	$ 13,000
57	All other GS personnel		295,445
58			$308,445

Personnel Division

1	GS-14	Chief of Division and Personnel Officer	$ 13,520
41	All other GS personnel		225,205
42			$238,725

Procurement and Supply Division

1	GS-15	Chief of Division, Procurement and Supply Officer	$ 14,061
1	GS-14	Assistant Procurement and Supply Officer	12,480
56	All other GS personnel		266,561
22	All other Wage Board personnel		144,926
77			$438,028

Technical Services Division

1	GS-15	Chief of Division	$ 15,038
1	GS-15	Assistant Chief of Division	14,706
1	GS-14	Assistant Chief of Division	13,520
2	All other GS personnel		8,653
396	All other Wage Board personnel		2,876,482
401			$2,928,399

Research Facilities and Equipment Division

1	Excepted	Chief of Division	$ 15,517
1	GS-15	Chief, Research Facilities Electrical Engineering Branch	15,038
1	GS-15	Chief, Research Equipment Engineering Branch	15,038
1	GS-15	Chief, Research Facilities Engineering Branch	15,038
2	GS-15	Aerospace Technologists	30,076
19	GS-14	Aerospace Technologists	245,980
109	All other GS personnel		847,586
75	All other Wage Board personnel		540,332
209			$1,724,656

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
PROPOSED PERSONNEL STAFFING CHART
FISCAL YEAR 1963
LEWIS RESEARCH CENTER

OFFICE OF THE DIRECTOR

1	Excepted	Director	$ 21,000
1	Excepted	Deputy Director	19,000
1	GS-15	Assistant to the Director	14,380
3	All other GS Personnel		18,280
6			$ 72,660

BUDGET OFFICE

1	Excepted	Budget Officer	$ 16,000
1	GS-14	Assistant Budget Officer	12,990
4	All other GS Personnel		41,775
6			$ 70,765

OFFICE OF ASSOCIATE DIRECTOR FOR RESEARCH

1	Excepted	Associate Director	$ 19,000
1			$ 19,000

OFFICE OF RESEARCH PLANS AND PROGRAMS

1	Excepted	Chief, Office of Research Plans and Programs	$16,500
1	GS-15	Chief, Flight Mechanics Section	15,030
1	GS-15	Head, Flight Systems Section	15,030
1	GS-15	Assistant Chief, Mission Analysis Branch	13,730
1	GS-14	Chief, Propulsion Section	13,510
24	All other GS Personnel		206,980
29			$280,780

CHEMISTRY AND ENERGY CONVERSION DIVISION

1	Excepted	Chief, Division	$18,000
1	Excepted	Chief, Physical Chemistry Branch	16,000
1	Excepted	Chief, Rocket Fundamentals Branch	16,000
1	GS-15	Technical Consultant	15,030
1	GS-15	Head, Rocket Cooling Section	15,030
1	GS-15	Head, Propellant Chemistry Section	15,030
1	GS-15	Head, Rocket Combustion Section	15,030
1	GS-15	Chief, Rocket Heat Transfer Branch	15,030
1	GS-15	Chief, Direct Energy Conversion Branch	15,030
1	GS-15	Head, Gas Dynamics Section	14,705
1	GS-15	Head, Reaction Kinetics Section	14,705
3	GS-15	Aerospace Research Scientists	45,090
1	GS-14	Head, Direct Energy Conversion Section A	13,510
1	GS-14	Head, Analytical Chemistry Section	13,510
1	GS-14	Head, Research Operations Section	12,990
1	GS-14	Head, Thermodynamics Section	12,990
1	GS-14	Head, Cryogenic Heat Transfer Section	12,990
1	GS-14	Head, Direct Energy Conversion Section B	12,990
10	GS-14	Aerospace Research Scientists	127,300
105	All other GS Personnel		865,635
135			$1,286,595

ELECTROMAGNETIC PROPULSION DIVISION

1	Excepted	Chief, Division	$18,000
1	Excepted	Assistant Chief, Division	16,000
1	GS-15	Chief Electromagnetics Branch	15,030
1	GS-15	Head, Theoretical Analysis Section	15,030
1	GS-15	Chief, Electrostatic Propulsion Branch	14,705
1	GS-15	Aerospace Research Scientists	14,705
1	GS-15	Chief, Plasma Physics Branch	14,380
1	GS-15	Chief, Research Installations Branch	14,380
1	GS-15	Head, Electrostatic Propulsion System Section	13,730
1	GS-15	Head, Electrostatic Propulsion Component Section	13,730
1	GS-15	Head, Space Environment Section	13,730
1	GS-14	Head, Magnetics Section	13,250
1	GS-14	Head, Electrothermal Section	12,990
1	GS-14	Head, Research Facilities Section	12,990
1	GS-14	Head, Electronics Section	12,210
1	GS-14	Head, High-Temperature Plasma Section	12,210
1	GS-14	Head, Plasma Flow Section	12,210
13	GS-14	Aerospace Research Scientists	166,010
85	All other GS Personnel		739,295
115			$1,144,585

NUCLEAR REACTOR DIVISION

1	Excepted	Chief, Division	$18,000
1	Excepted	Head, Reactor Experimental Projects Panel	16,000
1	Excepted	Chief, Propulsion Concepts Branch	16,000
1	Excepted	Chief, Reactor Physics Branch	16,000
1	GS-15	Chief, Heat Transfer Branch	15,030
1	GS-15	Head, Reactor Components Section	14,705
1	GS-15	Chief, Radiation Physicis Branch	14,055
1	GS-14	Head, Concepts Analysis Section	12,990
1	GS-14	Head, Theoretical Physics Section	12,990
1	GS-14	Head, Reactor Analysis Section	12,470
1	GS-14	Head, Experimental Reactor Physics Section	12,470
1	GS-14	Head, Nuclear Physics Section	12,210
1	GS-14	Head, General Physics Section	12,210
10	GS-14	Aerospace Research Scientists	129,640
73	All other GS Personnel		648,400
96			963,170

FLUID SYSTEMS COMPONENTS DIVISION

1	Excepted	Chief, Division	$18,000
1	Excepted	Assistant Chief, Division	16,500
1	Excepted	Chief, Flow Processes Branch	16,000
1	Excepted	Chief, Turbopump Branch	16,000
1	GS-15	Chief, Research Installations Branch	15,030
1	GS-15	Head, Lubrication Section	15,030
1	GS-15	Chief, Flow Physics Branch	14,705
1	GS-15	Head, Pump Section	14,705
1	GS-15	Head, Flow Physics Section A	14,380
1	GS-15	Head, Turbodrive Section	14,380
1	GS-15	Aerospace Research Scientist	14,380
1	GS-15	Head, Flow Physics Section B	14,055
1	GS-15	Head, Cryogenics and Condenser Section	14,055
1	GS-15	Chief, Lubrication and Wear Branch	14,055
1	GS-15	Head, Bearings Section	14,055
1	GS-14	Head, Space Radiator Section	12,210
21	GS-14	Aerospace Research Scientists	267,850
103	All other GS Personnel		926,375
140			$1,431,765

INSTRUMENT AND COMPUTING DIVISION

1	Excepted	Chief, Division	$17,500
1	Excepted	Chief, Mechanized Computation and Analyses Branch	16,000
1	Excepted	Chief, Instrument Research Branch	16,000
1	GS-15	Assistant Chief, Division	15,030
1	GS-15	Chief, Instrument Systems Research Branch	14,705
1	GS-15	Aerospace Research Scientist	14,380
1	GS-15	Head, Instrument Research Section B	14,055
1	GS-15	Chief, Automatic Data Processing Branch	14,055
1	GS-15	Chief, Machine Computing Branch	14,055
1	GS-15	Chief, Data Systems Branch	13,730
1	GS-14	Head, Measurement Systems Components Section	13,510
1	GS-14	Head, Optical Section	12,470
1	GS-14	Head, Instrumentation Section	12,210
1	GS-14	Head, Test Operations Control Section	12,210
1	GS-14	Head, Advanced Systems Section	12,210
1	GS-14	Head, Instrument Research Section A	12,210
4	GS-14	Aerospace Research Scientists	51,440
178	All other GS Personnel		1,326,360
88	All other Wage Board Personnel		589,414
286			$2,191,544

MATERIALS AND STRUCTURES DIVISION

1	Excepted	Chief, Division	$18,000
1	Excepted	Assistant Chief, Division	17,000
1	Excepted	Chief, Strength of Materials Branch	16,000
1	Excepted	Chief, Structures Branch	16,000
1	Excepted	Chief, Chemical Physics Branch	16,000
1	GS-15	Chief, Alloys and Composite Materials Branch	14,705
1	GS-15	Head, Powerplant Structures Section	14,380
1	GS-15	Head, Alloys Section	14,380
1	GS-15	Head, Structure Protection Section	14,055
1	GS-15	Head, Refractory Metals Section	14,055
1	GS-15	Chief, Refractory Materials Branch	14,055
1	GS-15	Chief, Liquid Metals Branch	13,730
2	GS-15	Aerospace Research Scientists	28,760
1	GS-14	Head, Chemical and Metallurgical Laboratory Sec.	12,990
1	GS-14	Head, High Temperature Chemistry Section	12,990
1	GS-14	Head, Solid State Physics Section	12,210
1	GS-14	Head, Composite Materials Section	12,210
1	GS-14	Head, Refractory Compounds Section	12,210
20	GS-14	Aerospace Research Scientists	253,560
118	All other GS Personnel		1,043,515
157			$1,570,805

OFFICE OF ASSOCIATE DIRECTOR FOR DEVELOPMENT

1	Excepted	Associate Director	$19,000
1	Excepted	Deputy Associate Director	18,500
1	Excepted	Technical Consultant	17,000
1	GS-15	Assistant to the Associate Director	15,030
3	All other GS Personnel		14,540
7			$84,070

OFFICE OF DEVELOPMENT PLANS AND PROGRAMS

1	Excepted	Chief of Plans and Programs	$18,000
1	GS-15	Assistant Chief, Plans and Programs	15,030
3	GS-15	Aerospace Engineers	45,090
6	GS-14	Aerospace Engineers	81,060
9	All other GS Personnel		97,695
20			$256,875

ADVANCED DEVELOPMENT AND EVALUATION DIVISION

1	Excepted	Division Chief	$18,000
1	Excepted	Assistant Division Chief	17,000
1	Excepted	Technical Consultant	16,500
1	Excepted	Chief, Power Generation Branch	16,500
1	Excepted	Chief, Nuclear Propulsion Branch	16,500
1	Excepted	Chief, Flight Programs Branch	16,500
1	Excepted	Chief, Systems Dynamics & Controls Branch	16,500
1	Excepted	Chief, Chemical Propulsion Branch	16,000
1	GS-15	Staff Assistant to Division Chief	15,290
1	GS-15	Assistant Chief, Nuclear Propulsion Branch	15,030
1	GS-15	Assistant Chief, Flight Programs Branch	15,030
1	GS-15	Chief of Flight Operations Branch	15,030
1	GS-15	Technical Consultant to Division Chief	15,030
1	GS-15	Chief, Aerospace Operating Problems Branch	15,030
1	GS-15	Head, Liquid Metal Systems Section	15,030
1	GS-15	Head, Liquid Metal Mechanical Problems Section	15,030
1	GS-15	Head, Nuclear Rocket Heat Transfer Section	15,030
1	GS-15	Head, Nuclear Rocket Propulsion Systems Section	15,030
1	GS-15	Head, Nuclear Rocket Mechanical Problems Section	15,030
1	GS-15	Head, Flight Programs Fluid Systems Section	15,030
1	GS-15	Head, Flight Programs Power Systems Section	15,030
1	GS-15	Head, Flight Programs Space-Electric Flight Sect.	15,030
1	GS-15	Head, Aerospace Systems Problem Section	15,030
1	GS-15	Head, Aerospace Mechanical Problems Section	15,030
1	GS-15	Head, High Energy Chemical Propulsion Section	15,030
1	GS-15	Head, Chemical Propulsion Operating Problems Sect.	15,030
1	GS-15	Head, Mechanical Problems Section	15,030
1	GS-15	Head, Power Generation Control Section	15,030
1	GS-15	Head, Nuclear Rocket Control Section	15,030
1	GS-15	Head, Chemical Rocket Control Section	15,030
4	GS-15	Aerospace Engineers	60,120
1	GS-14	Head, Power Generation Electrical Systems Sect.	13,510
51	GS-14	Aerospace Engineers	622,710
144	All other GS Personnel		1,486,350
230			$2,646,610

OFFICE OF RELIABILITY AND QUALITY ASSURANCE

1	Excepted	Chief of Reliability & Quality Assurance	$17,000
1	GS-15	Assistant Chief, Reliability & Quality Assurance	15,030
9	GS-15	Aerospace Engineers	135,270
17	GS-14	Aerospace Engineers	229,670
42	All other GS Personnel		376,110
70			$773,080

OFFICE OF PROJECT MANAGEMENT

1	Excepted	Chief, Office of Project Management	$18,000
1	Excepted	Assistant Chief, Office of Project Management	17,500
1	Excepted	Assistant Chief, Propulsion	17,000
1	Excepted	Assistant Chief, Power	17,000
1	Excepted	Chief, Apollo Propulsion	17,000
1	Excepted	Chief, Apollo Power	17,000
1	Excepted	Chief, Launch Vehicle Propulsion	17,000
1	Excepted	Assistant Chief, Apollo Propulsion	16,500
1	Excepted	Chief, Electric Propulsion	16,500
1	Excepted	Chief, Space Electric Propulsion	16,500
1	GS-15	Assistant to Chief, Power	15,030
1	GS-15	Assistant Chief, Components	15,030
1	GS-15	Assistant Chief, Systems	15,030
1	GS-15	Assistant Chief, Apollo Power	15,030
1	GS-15	Assistant Chief, Energy Sources	15,030
1	GS-15	Assistant Chief, Power Systems	15,030
1	GS-15	Assistant Chief, Launch Vehicle Propulsion	15,030
1	GS-15	Assistant Chief, Electric Propulsion	15,030
1	GS-15	Assistant Chief, Space Electric Propulsion	15,030
55	GS-15	Aerospace Engineers	755,150
1	GS-14	Assistant to Chief, Apollo Propulsion	13,510
1	GS-14	Assistant to Chief, Apollo Power	13,510
1	GS-14	Assistant to Chief, Launch Vehicle Propulsion	13,510
1	GS-14	Assistant to Chief, Electric Propulsion	13,510
1	GS-14	Assistant to Chief, Space Electric Propulsion	13,510
102	GS-14	Aerospace Engineers	1,245,420
253	All other GS Personnel		2,31[illegible]
440			$4,[illegible]2,735

SYSTEMS ENGINEERING AND REQUIREMENTS DIVISION

1	Excepted	Chief, Systems Engineering & Requirements Div.	$17,500
1	Excepted	Asst. Chief, Systems Engineering & Requirements Div.	17,000
1	Excepted	Chief, Systems Engineering Branch	16,500
1	Excepted	Chief, Preliminary Design Branch	16,500
1	GS-15	Chief, Applications Analysis Branch	15,030
1	GS-15	Hd., Chemical Propulsion Applications Analysis Sect.	15,030
1	GS-15	Asst. Chief, Systems Engineering Branch	15,030
1	GS-15	Head, Nuclear Systems Engineering Section	15,030
1	GS-15	Head, Shielding Analysis Section	15,030
1	GS-15	Head, Chemical Systems Engineering Section	15,030
1	GS-15	Assistant Chief, Preliminary Design Branch	15,030
1	GS-15	Head, Nuclear Systems Preliminary Design Section	15,030
1	GS-15	Head, Chemical Systems Preliminary Design Section	15,030
[illegible]	GS-15	Aerospace Engineers	[illegible]
1	GS-14	Assistant Chief, Applications Analysis Branch	13,510
1	GS-14	Hd., Nuclear Propulsion Applications Analysis Sect.	13,510
27	GS-14	Aerospace Engineers	328,070
85	All other GS Personnel		761,195
133			$1,403,025

PLUMBROOK STATION

1	Excepted	Director	$16,500
1	GS-15	Deputy Director	15,290
2	All other GS Personnel		13,785
4			$45,575

ADMINISTRATIVE DIVISION

1	GS-14	Chief, Division	$ 12,210
24	All other GS Personnel		128,520
25			$140,730

PROPULSION DIVISION

1	GS-15	Chief, Division	$14,055
1	GS-14	Chief, Turbopump Branch	13,510
1	GS-14	Chief, Rocket Systems Branch	13,510
1	GS-14	Chief, Operations Branch	13,510
36	All other GS Personnel		326,935
40			$381,520

REACTOR DIVISION

1	Excepted	Chief Division	$16,000
1	GS-15	Chief, Reactor Operations Branch	15,030
1	GS-15	Chief, Reactor Engineering Branch	15,030
1	GS-14	Head, Reactor Physics Section	13,510
1	GS-14	Head, Instrument and Controls Section	13,510
1	GS-14	Head, Processing Engineering Section	13,510
1	GS-14	Head, Hot Laboratory Section	13,510
1	GS-14	Head, Experimental Equipment Section	13,510
3	GS-14	Nuclear Projects Engineer	40,530
95	All other GS Personnel		850,725
106			$1,004,865

OFFICE OF ASSISTANT DIRECTOR FOR ADMINISTRATION

1	Excepted	Assistant Director	$ 17,000
2	All other GS Personnel		10,[illegible]
3			$ 27,[illegible]

STAFF ASSISTANTS

1	GS-14	Chief Counsel	$ 12,470
1	GS-14	Public Information Officer	12,210
1	GS-14	Patent Advisory Counsel	12,210
16	All other GS Personnel		116,420
19			$153,310

PERSONNEL DIVISION

1	GS-15	Chief, Division	$ 13,730
53	All other GS Personnel		300,700
54			$314,430

ACCOUNTING AND AUDITING DIVISION

1	GS-14	Chief Division	$ 12,210
81	All other GS Personnel		413,120
82			$425,330

TECHNICAL PUBLICATIONS DIVISION

1	GS-14	Chief, Division	$ 12,210
106	All other GS Personnel		602,430
31	All other Wage Board Personnel		168,800
138			$783,440

PROCUREMENT AND SUPPLY DIVISION

1	GS-15	Chief Division	$ 14,055
1	GS-14	Asst Chief for Research Procurement	12,210
1	GS-14	Asst Chief for Development Procurement	12,210
115	All other GS Personnel		730,105
39	All other Wage Board Personnel		204,510
157			$973,090

ADMINISTRATIVE SERVICES DIVISION

24	All other GS Personnel		[illegible]
2	All other Wage Board Personnel		[illegible]
26			$124,[illegible]

ENGINEERING DESIGN DIVISION

1	GS-15	Chief, Division	$15,290
1	GS-15	Assistant Chief, Division	15,030
1	GS-15	Chief, Electrical Engineering Branch	15,030
1	GS-15	Head, Equipment Engineering Section A	14,055
1	GS-15	Head, Machine Design Section A	14,055
1	GS-15	Head, Equipment Engineering Section C	13,730
1	GS-15	Chief, Mechanical Engineering Branch	13,720
1	GS-14	Head, Equipment Engineering Section A	13,510
1	GS-14	Head, Machine Design Section B	13,510
1	GS-14	Head, Research Engineering Section	12,990
1	GS-14	Head, Electrical Engineering Section	12,210
159	All other GS Personnel		[illegible]
4	All other Wage Board Personnel		16,327
174			$1,345,[illegible]

FACILITIES SERVICES DIVISION

1	WB-20	Chief, Division	$ 12,750
319	All other Wage Board Personnel		1,943,986
320			$1,956,736

1	Excepted	Chi[illegible]	
1	Excepted	Ass[illegible]	
1	GS-14	Eng[illegible]	
1	GS-14	Saf[illegible]	
7	All other GS		
11			

6	All o[illegible]		
8	All o[illegible]		
14			

1	WB-20		
3	All o[illegible]		
387	All o[illegible]		
391			

1	GS-14		
40	All o[illegible]		
122	All o[illegible]		
163			

1	GS-15		
1	GS-14		
20	All o[illegible]		
235	All o[illegible]		
257			

1	GS-13		
1	GS-14		
32	All o[illegible]		
466	All o[illegible]		
500			

1	Excep[illegible]		
1	GS-15		
1	GS-15		
1	GS-15		
1	GS-15		
1	GS-14		
1	GS-14		
1	GS-14		
1	GS-14		
1	GS-14		
1	GS-14		
1	GS-14		
1	GS-14		
110	All o[illegible]		
1	All o[illegible]		
124			

1			
1			
1			
1			
1			
25			
30			

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
PROPOSED PERSONNEL STAFFING CHART
FISCAL YEAR 1963
LEWIS RESEARCH CENTER

OFFICE OF THE DIRECTOR

1	Excepted	Director	$ 21,000
1	Excepted	Deputy Director	19,000
1	GS-15	Assistant to the Director	[illegible]
3	All other GS Personnel		16,280
6			$ 72,[illegible]

BUDGET OFFICE

1	Excepted	Budget Officer	$ 16,000
1	GS-14	Assistant Budget Officer	12,990
4	All other GS Personnel		41,775
6			$ 70,765

OFFICE OF ASSOCIATE DIRECTOR FOR RESEARCH

1	Excepted	Associate Director	$ 19,000
1			$ 19,000

…D PROGRAMS

…s and Programs	$16,500
…n	15,030
	15,030
…sis Branch	13,730
	13,510
	206,980
	$280,780

…ON DIVISION

	$18,000
…ch	16,000
…anch	16,000
	15,030
	15,030
…tion	15,030
…on	15,030
…anch	15,030
…on Branch	15,030
	14,705
…on	14,705
	45,090
… Section A	13,510
…tion	13,510
…ion	12,990
	12,990
… Section	12,990
… Section B	12,990
	127,300
	865,635
	$1,256,595

… DIVISION

	$18,000
	16,000
	[illegible],030
…tion	[illegible],030
…on Branch	14,705
	14,705
	14,380
… Branch	14,380
… System Section	13,730
… Component Section	13,730
…on	13,730
	13,250
	12,990
…tion	12,990
	12,210
… Section	12,210
	12,210
	[illegible]
	739,295
	$1,144,585

…SION

	$18,000
…ojects Panel	16,000
…anch	16,000
	16,000
	15,030
…ion	14,705
…nch	14,055
…on	12,990
…tion	12,990
…n	12,470
…ysics Section	12,470
	12,210
	12,210
	[illegible]
	640,400
	[illegible],170

FLUID SYSTEMS COMPONENTS DIVISION

1	Excepted	Chief, Division	$18,000
1	Excepted	Assistant Chief, Division	16,500
1	Excepted	Chief, Flow Processes Branch	16,000
1	Excepted	Chief, Turbopump Branch	16,000
1	GS-15	Chief, Research Installations Branch	15,030
1	GS-15	Head, Lubrication Section	15,030
1	GS-15	Chief, Flow Physics Branch	14,705
1	GS-15	Head, Pump Section	14,705
1	GS-15	Head, Flow Physics Section A	14,380
1	GS-15	Head, Turbodrive Section	14,380
1	GS-15	Aerospace Research Scientist	14,380
1	GS-15	Head, Flow Physics Section B	14,055
1	GS-15	Head, Cryogenics and Condenser Section	14,055
1	GS-15	Chief, Lubrication and Wear Branch	14,055
1	GS-15	Head, Bearings Section	14,055
1	GS-14	Head, Space Radiator Section	12,210
21	GS-14	Aerospace Research Scientists	267,850
103	All other GS Personnel		926,375
140			$1,431,765

INSTRUMENT AND COMPUTING DIVISION

1	Excepted	Chief, Division	$17,500
1	Excepted	Chief, Mechanized Computation and Analyses Branch	16,000
1	Excepted	Chief, Instrument Research Branch	16,000
1	GS-15	Assistant Chief, Division	15,030
1	GS-15	Chief, Instrument Systems Research Branch	14,705
1	GS-15	Aerospace Research Scientist	14,380
1	GS-15	Head, Instrument Research Section B	14,055
1	GS-15	Chief, Automatic Data Processing Branch	14,055
1	GS-15	Chief, Machine Computing Branch	14,055
1	GS-15	Chief, Data Systems Branch	13,730
1	GS-14	Head, Measurement Systems Components Section	13,510
1	GS-14	Head, Optical Section	12,470
1	GS-14	Head, Instrumentation Section	12,210
1	GS-14	Head, Test Operations Control Section	12,210
1	GS-14	Head, Advanced Systems Section	12,210
1	GS-14	Head, Instrument Research Section A	12,210
4	GS-14	Aerospace Research Scientists	51,440
179	All other GS Personnel		1,326,360
88	All other Wage Board Personnel		589,414
286			$2,191,544

MATERIALS AND STRUCTURES DIVISION

1	Excepted	Chief, Division	$18,000
1	Excepted	Assistant Chief, Division	17,000
1	Excepted	Chief, Strength of Materials Branch	16,000
1	Excepted	Chief, Structures Branch	16,000
1	Excepted	Chief, Chemical Physics Branch	16,000
1	GS-15	Chief, Alloys and Composite Materials Branch	14,705
1	GS-15	Head, Powerplant Structures Section	14,380
1	GS-15	Head, Alloys Section	14,380
1	GS-15	Head, Structure Protection Section	14,055
1	GS-15	Head, Refractory Metals Section	14,055
1	GS-15	Chief, Refractory Materials Branch	14,055
1	GS-15	Chief, Liquid Metals Branch	13,730
2	GS-15	Aerospace Research Scientists	28,760
1	GS-14	Head, Chemical and Metallurgical Laboratory Sec.	12,990
1	GS-14	Head, High Temperature Chemistry Section	12,990
1	GS-14	Head, Solid State Physics Section	12,210
1	GS-14	Head, Composite Materials Section	12,210
1	GS-14	Head, Refractory Compounds Section	12,210
20	GS-14	Aerospace Research Scientists	253,560
118	All other GS Personnel		1,043,515
157			$1,570,805

OFFICE OF ASSOCIATE DIRECTOR FOR DEVELOPMENT

1	Excepted	Associate Director	$19,000
1	Excepted	Deputy Associate Director	18,500
1	Excepted	Technical Consultant	17,000
1	GS-15	Assistant to the Associate Director	15,030
3	All other GS Personnel		[illegible],540
7			$[illegible],070

OFFICE OF DEVELOPMENT PLANS AND PROGRAMS

1	Excepted	Chief of Plans and Programs	$18,000
1	GS-15	Assistant Chief, Plans and Programs	15,030
3	GS-15	Aerospace Engineers	45,090
6	GS-14	Aerospace Engineers	81,060
9	All other GS Personnel		97,695
20			$256,875

ADVANCED DEVELOPMENT AND EVALUATION DIVISION

1	Excepted	Division Chief	$18,000
1	Excepted	Assistant Division Chief	17,000
1	Excepted	Technical Consultant	16,500
1	Excepted	Chief, Power Generation Branch	16,500
1	Excepted	Chief, Nuclear Propulsion Branch	16,500
1	Excepted	Chief, Flight Programs Branch	16,500
1	Excepted	Chief, Systems Dynamics & Controls Branch	16,500
1	Excepted	Chief, Chemical Propulsion Branch	16,000
1	GS-15	Staff Assistant to Division Chief	15,290
1	GS-15	Assistant Chief, Nuclear Propulsion Branch	15,030
1	GS-15	Assistant Chief, Flight Programs Branch	15,030
1	GS-15	Chief of Flight Operations Branch	15,030
1	GS-15	Technical Consultant to Division Chief	15,030
1	GS-15	Chief, Aerospace Operating Problems Branch	15,030
1	GS-15	Head, Liquid Metal Systems Section	15,030
1	GS-15	Head, Liquid Metal Mechanical Problems Section	15,030
1	GS-15	Head, Nuclear Rocket Heat Transfer Section	15,030
1	GS-15	Head, Nuclear Rocket Propulsion Systems Section	15,030
1	GS-15	Head, Nuclear Rocket Mechanical Problems Section	15,030
1	GS-15	Head, Flight Programs Fluid Systems Section	15,030
1	GS-15	Head, Flight Programs Power Systems Section	15,030
1	GS-15	Head, Flight Programs Space-Electric Flight Sect.	15,030
1	GS-15	Head, Aerospace Systems Problem Section	15,030
1	GS-15	Head, Aerospace Mechanical Problems Section	15,030
1	GS-15	Head, High Energy Chemical Propulsion Section	15,030
1	GS-15	Head, Chemical Propulsion Operating Problems Sect.	15,030
1	GS-15	Head, Mechanical Problems Section	15,030
1	GS-15	Head, Power Generation Control Section	15,030
1	GS-15	Head, Nuclear Rocket Control Section	15,030
1	GS-15	Head, Chemical Rocket Control Section	15,030
4	GS-15	Aerospace Engineers	60,120
1	GS-14	Head, Power Generation Electrical Systems Sect.	13,510
51	GS-14	Aerospace Engineers	622,710
144	All other GS Personnel		1,480,350
230			$2,646,610

OFFICE OF RELIABILITY AND QUALITY ASSURANCE

1	Excepted	Chief of Reliability & Quality Assurance	$17,000
1	GS-15	Assistant Chief, Reliability & Quality Assurance	15,030
9	GS-15	Aerospace Engineers	135,270
17	GS-14	Aerospace Engineers	229,670
42	All other GS Personnel		376,110
70			$773,080

OFFICE OF PROJECT MANAGEMENT

1	Excepted	Chief, Office of Project Management	$18,000
1	Excepted	Assistant Chief, Office of Project Management	17,500
1	Excepted	Assistant Chief, Propulsion	17,000
1	Excepted	Assistant Chief, Power	17,000
1	Excepted	Chief, Apollo Propulsion	17,000
1	Excepted	Chief, Apollo Power	17,000
1	Excepted	Chief, Launch Vehicle Propulsion	17,000
1	Excepted	Assistant Chief, Apollo Propulsion	16,500
1	Excepted	Chief, Electric Propulsion	16,500
1	Excepted	Chief, Space Electric Propulsion	16,500
1	GS-15	Assistant to Chief, Power	15,030
1	GS-15	Assistant Chief, Components	15,030
1	GS-15	Assistant Chief, Systems	15,030
1	GS-15	Assistant Chief, Apollo Power	15,030
1	GS-15	Assistant Chief, Energy Sources	15,030
1	GS-15	Assistant Chief, Power Systems	15,030
1	GS-15	Assistant Chief, Launch Vehicle Propulsion	15,030
1	GS-15	Assistant Chief, Electric Propulsion	15,030
1	GS-15	Assistant Chief, Space Electric Propulsion	15,030
55	GS-15	Aerospace Engineers	755,150
1	GS-14	Assistant to Chief, Apollo Propulsion	13,510
1	GS-14	Assistant to Chief, Apollo Power	13,510
1	GS-14	Assistant to Chief, Launch Vehicle Propulsion	13,510
1	GS-14	Assistant to Chief, Electric Propulsion	13,510
1	GS-14	Assistant to Chief, Space Electric Propulsion	13,510
102	GS-14	Aerospace Engineers	1,2[illegible],420
259	All other GS Personnel		2,310,315
440			$[illegible]

SYSTEMS ENGINEERING AND REQUIREMENTS DIVISION

1	Excepted	Chief, Systems Engineering & Requirements Div.	$17,500
1	Excepted	Asst. Chief, Systems Engineering & Requirements Div.	17,000
1	Excepted	Chief, Systems Engineering Branch	16,500
1	Excepted	Chief, Preliminary Design Branch	16,500
1	GS-15	Chief, Applications Analysis Branch	15,030
1	GS-15	Hd., Chemical Propulsion Applications Analysis Sect.	15,030
1	GS-15	Asst. Chief, Systems Engineering Branch	15,030
1	GS-15	Head, Nuclear Systems Engineering Section	15,030
1	GS-15	Head, Shielding Analysis Section	15,030
1	GS-15	Head, Chemical Systems Engineering Section	15,030
1	GS-15	Assistant Chief, Preliminary Design Branch	15,030
1	GS-15	Head, Nuclear Systems Preliminary Design Section	15,030
1	GS-15	Head, Chemical Systems Preliminary Design Section	15,030
[illegible]	GS-15	Aerospace Engineers	[illegible],350
1	GS-14	Assistant Chief, Applications Analysis Branch	13,510
1	GS-14	Hd., Nuclear Propulsion Applications Analysis Sect.	13,510
27	GS-14	Aerospace Engineers	[illegible]
85	All other GS Personnel		701,1[illegible]
133			$1,403,025

PLUMBROOK STATION

1	Excepted	Director	$16,500
1	GS-15	Deputy Director	15,230
2	All other GS Personnel		13,735
4			$45,575

ADMINISTRATIVE DIVISION

1	GS-14	Chief, Division	$ 12,210
24	All other GS Personnel		128,520
25			$140,730

PROPULSION DIVISION

1	GS-15	Chief, Division	$14,055
1	GS-14	Chief, Turbopump Branch	13,510
1	GS-14	Chief, Rocket Systems Branch	13,510
1	GS-14	Chief, Operations Branch	13,510
36	All other GS Personnel		326,935
40			$381,520

REACTOR DIVISION

1	Excepted	Chief Division	$1[illegible],000
1	GS-15	Chief, Reactor Operations Branch	15,030
1	GS-15	Chief, Reactor Engineering Branch	15,030
1	GS-14	Head, Reactor Physics Section	13,510
1	GS-14	Head, Instrument and Controls Section	13,510
1	GS-14	Head, Processing Engineering Section	13,510
1	GS-14	Head, Hot Laboratory Section	[illegible]
1	GS-14	Head, Experimental Equipment Section	13,510
3	GS-14	Nuclear Projects Engineer	40,530
95	All other GS Personnel		850,725
106			$1,00[illegible],565

OFFICE OF ASSISTANT DIRECTOR FOR ADMINISTRATION

1	Excepted	Assistant Director	$ 17,000
2	All other GS Personnel		[illegible]
3			$ [illegible]

STAFF ASSISTANTS

1	GS-14	Chief Counsel	$ 12,470
1	GS-14	Public Information Officer	12,210
1	GS-14	Patent Advisory Counsel	12,210
16	All other GS Personnel		116,[illegible]20
19			$153,310

PERSONNEL DIVISION

1	GS-15	Chief, Division	$ 13,730
53	All other GS Personnel		300,700
54			$314,430

ACCOUNTING AND AUDITING DIVISION

1	GS-14	Chief Division	$ 12,210
81	All other GS Personnel		413,120
82			$425,330

TECHNICAL PUBLICATIONS DIVISION

1	GS-14	Chief, Division	$ 12,210
106	All other GS Personnel		602,430
31	All other Wage Board Personnel		168,800
138			$783,440

PROCUREMENT AND SUPPLY DIVISION

1	GS-15	Chief Division	$ 14,055
1	GS-14	Asst Chief for Research Procurement	12,210
1	GS-14	Asst Chief for Development Procurement	12,210
115	All other GS Personnel		730,105
39	All other Wage Board Personnel		204,510
157			$973,090

ADMINISTRATIVE SERVICES DIVISION

23	All other GS Personnel		$115,[illegible]50
2	All other Wage Board Personnel		[illegible],930
25			$124,480

ENGINEERING DESIGN DIVISION

1	GS-15	Chief, Division	$15,[illegible]
1	GS-15	Assistant Chief, Division	15,030
1	GS-15	Chief, Electrical Engineering Branch	15,030
1	GS-15	Head, Equipment Engineering Section A	14,055
1	GS-15	Head, Machine Design Section A	14,055
1	GS-15	Head, Equipment Engineering Section C	13,730
1	GS-15	Chief, Mechanical Engineering Branch	13,720
1	GS-14	Head, Equipment Engineering Section A	13,510
1	GS-14	Head, Machine Design Section B	13,510
1	GS-14	Head, Research Engineering Section	12,990
1	GS-14	Head, Electrical Engineering Section	12,210
159	All other GS Personnel		1,170,440
4	All other Wage Board Personnel		16,327
174			$[illegible]

OFFICE OF CHIEF OF TECHNICAL SERVICES

1	Excepted	Chief, Technical Services	$17,000
1	Excepted	Assistant Chief, Technical Services	15,500
1	GS-14	Engineering Planning Officer	14,030
1	GS-14	Safety Officer	13,510
7	All other GS Personnel		17,275
11			$77,315

SERVICE SCHEDULING OFFICE

6	All other GS Personnel		$41,105
8	All other Wage Board Personnel		60,736
14			$101,841

TEST INSTALLATIONS DIVISION

1	WB-20	Chief, Division	$12,750
3	All other GS Personnel		17,310
387	All other Wage Board Personnel		2,427,277
391			$2,457,337

PLANT SERVICES DIVISION

1	GS-14	Chief, Division	$12,470
40	All other GS Personnel		228,365
122	All other Wage Board Personnel		692,340
163			$933,175

FABRICATION DIVISION

1	GS-15	Chief, Division	$15,030
1	GS-14	Chief, Metallurgical Branch	12,470
20	All other GS Personnel		145,485
235	All other Wage Board Personnel		1,628,203
257			$1,801,188

FACILITIES OPERATIONS DIVISION

1	GS-15	Chief, Division	$14,705
1	GS-14	Chief, Engineering and Dispatch Branch	12,990
32	All other GS Personnel		257,850
466	All other Wage Board Personnel		3,084,403
500			$3,369,948

FACILITIES ENGINEERING DIVISION

1	Excepted	Chief, Division	$18,000
1	GS-15	Chief, Mechanical Design Branch	14,380
1	GS-15	Head, Mechanical Design Section A	14,055
1	GS-15	Chief, Electrical Design Branch	14,055
1	GS-15	Chief, Architectural-Structural Design Branch	14,055
1	GS-14	Administrative Officer	13,250
1	GS-14	Head, Mechanical Design Section A	13,510
1	GS-14	Head, Architectural Design Section	13,510
1	GS-14	Head, Structural Design Section	13,510
1	GS-14	Head, Mechanical Design Section A	12,[illegible]
1	GS-14	Head, Electrical Design Section A	12,470
1	GS-14	Head, Electrical Design Section B	12,470
1	GS-14	Chief, Construction Branch	12,470
110	All other GS Personnel		919,195
1	All other Wage Board Personnel		7,717
124			$1,103,637

FACILITIES SERVICES DIVISION

1	WB-20	Chief, Division	$ 12,750
319	All other Wage Board Personnel		1,843,986
320			$1,856,736

ENGINEERING DIVISION

1	GS-15	Chief, Division	$ 13,730
1	GS-14	Chief, Electrical Engineering Branch	12,210
1	GS-14	Chief, Mechanical Engineering Branch	12,210
1	GS-14	Chief, Civil Engineering Branch	12,210
1	GS-14	Chief, Construction Engineering Branch	12,210
25	All other GS Personnel		189,000
30			$251,570

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
PROPOSED PERSONNEL STAFFING CHART
FISCAL YEAR 1963
FLIGHT RESEARCH CENTER

OFFICE OF THE DIRECTOR

1	Excepted Director	$19,000
1	Excepted Associate Director	17,500
1	Other GS personnel	6,180
3		$42,680

PROGRAMS OFFICE

1	Excepted Chief, FRC Prog. Ofc.	$16,000
1	GS-14 AST, Fluid & Flt. Mech.	12,210
2	Other GS personnel	11,605
4		$39,815

PROJECT MANAGEMENT OFFICE

3	GS-15 AST, Project Management	$41,840
3		$41,840

RESEARCH DIVISION

1	Excepted Chief, Research Div.	$16,500
1	Excepted Asst. Chief, Res. Div.	16,000
2	GS-15 AST, Fluid & Flt. Mech.	29,410
1	GS-15 AST, Contr. & Guid. Sys.	15,030
1	GS-15 AST, Struc. Mech.	14,055
5	GS-14 AST, Contr. & Guid. Sys.	64,690
4	GS-14 AST, Fluid & Flt. Mech.	48,840
1	GS-14 AST, Flight Systems	12,990
96	Other GS personnel	719,875
112		$ 937,390

FLIGHT OPERATIONS DIVISION

3	Excepted Aero. Res. Pilots	$48,500
1	GS-15 AST, Flight Systems	15,290
2	GS-15 AST, Research Piloting	29,085
1	GS-15 AST, Flt. Veh. Exp. Tech.	14,055
1	GS-14 AST, Research Piloting	12,210
3	GS-14 AST, Flt. Veh. Exp. Tech.	37,150
17	Other GS personnel	120,640
141	Wage Board personnel	984,000
169		$1,260,930

DATA SYSTEMS DIVISION

3	GS-15 AST, Meas. & Instr. Sys.	$42,815
1	GS-14 AST, Meas. & Instr. Sys.	12,470
1	GS-14 AST, Radio Freq. Sys.	12,470
1	GS-14 AST, Data Systems	12,210
76	Other GS personnel	580,000
93	Wage Board personnel	648,000
175		$1,307,965

ADMINISTRATIVE DIVISION

1	GS-15 Administrative Mgt. Off.	$13,730
1	GS-14 Ass't. Admin. Mgt. Off.	12,210
56	Other GS personnel	363,000
26	Wage Board personnel	162,107
84		$551,047

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

PROPOSED PERSONNEL STAFFING CHART
FISCAL YEAR 1963

GODDARD SPACE FLIGHT CENTER

OFFICE OF THE DIRECTOR

1	Director	21,000
1	Associate Director	19,000
1	GS-15 Assistant to the Director	15,030
12	Other GS Personnel	82,130
15		137,160

OFFICE OF THE ASSISTANT DIRECTOR FOR ADMINISTRATION

1	Assistant Director For Administration	17,000
1	Deputy Assistant Director For Administration	15,500
1	GS-15 Technical Management Assistant	13,730
1	GS-15 Attorney-Advisor	13,730
1	GS-14 Information Officer	12,210
1	GS-14 Attorney-Advisor	12,210
2	GS-14 Management Analyst	24,680
1	GS-14 Space Flight Program Coordinator	12,210
73	Other GS Personnel	500,430
82		621,700

FINANCIAL MANAGEMENT DIVISION

1	GS-15 Financial Management Officer	13,730
1	GS-14 Assistant Financial Management Officer	12,470
1	GS-14 Budget Officer	12,210
85	Other GS Personnel	624,325
88		662,735

ORGANIZATION AND PERSONNEL DIVISION

1	GS-15 Personnel Officer	13,730
1	GS-14 Assistant Personnel Officer	12,210
57	Other GS Personnel	395,470
59		421,410

PROCUREMENT AND SUPPLY DIVISION

1	Procurement and Supply Officer	16,500
1	GS-15 Assistant Procurement and Supply Officer	13,730
1	GS-14 Procurement Analyst (Contracts)	12,210
4	GS-14 Supervisory Contract Specialist	48,840
1	GS-14 Procurement Specialist	12,210
220	Other GS Personnel	1,389,750
26	Wage Board Personnel	162,618
254		1,655,858

TECHNICAL INFORMATION DIVISION

39	Other GS Personnel	263,230
18	Wage Board Personnel	124,335
57		387,565

MANAGEMENT SERVICES DIVISION

1	GS-14 Chief, Management Services Division	12,210
49	Other GS Personnel	327,610
10	Wage Board Personnel	53,762
60		393,582

OFFICE OF TECHNICAL SERVICES

1	Chief of Technical Services	17,000
5	Other GS Personnel	33,025
6		50,025

FACILITIES ENGINEERING DIVISION

1	Chief, Facilities Engineering Division	16,500
1	GS-14 Design Construction Engineer	12,210
40	Other GS Personnel	327,910
123	Wage Board Personnel	852,946
165		1,209,566

TEST AND EVALUATION DIVISION

1	Chief, Test and Evaluation Division	15,500
2	GS-15 Aerospace Tech, Flight Systems	27,785
2	GS-14 Aerospace Tech, Materials and Structures	25,460
7	GS-14 Aerospace Tech, Flight Systems	86,510
5	GS-14 Aerospace Tech, Measurement and Instrumentation	61,050
2	GS-14 Aerospace Tech, Experimental Facilities and Equipment	24,420
162	Other GS Personnel	1,263,645
181		1,504,370

FABRICATION DIVISION

1	GS-15 Aerospace Tech, Flight Systems	13,730
12	Other GS Personnel	82,210
127	Wage Board Personnel	898,462
140		994,402

OFFICE OF THE ASSISTANT DIRECTOR (SPACE SCIENCE AND SATELLITE APPLICATIONS)

1	Assistant Director—Space Science & Sat. Applications	19,000
1	Head, Systems Review Group	17,000
1	GS-15 Aerospace Tech, Space Sciences	13,730
1	GS-15 Aerospace Tech, Technical Management	13,730
6	Other GS Personnel	38,955
10		102,415

SPACE SCIENCES DIVISION

1	Chief, Space Sciences Division	18,000
1	Associate Chief, Space Sciences Division	16,500
1	Aerospace Scientist, Astrophysics	16,500
1	Aerospace Scientist, Research Instrumentation	15,500
1	Aerospace Scientist, Ionosphere	15,500
1	Head, Fields and Particles Branch	15,500
1	Head, Planetary Ionospheres Branch	15,500
8	GS-15 Aerospace Tech, Space Sciences	110,545
1	GS-15 Aerospace Tech, Flight Systems	14,705
16	GS-14 Aerospace Tech, Space Sciences	197,440
5	GS-14 Aerospace Tech, Flight Systems	62,090
2	GS-14 Aerospace Tech, Measurement and Instrumentation	24,420
2	GS-14 Aerospace Tech, Experimental Facilities and Equipment	24,420
1	GS-14 Aero Research Scientist	12,210
158	Other GS Personnel	1,235,045
200		1,793,875

SPACECRAFT SYSTEMS AND PROJECTS DIVISION

1	Chief, Spacecraft Systems and Projects Division	18,000
1	Staff Scientist, Communications	17,000
1	Head, Communications Branch	16,500
1	Head, Spacecraft Systems Branch	16,500
1	Associate Chief, Spacecraft Systems and Projects Division	16,000
1	Head, Advanced Projects Group	15,500
17	GS-15 Aerospace Tech, Flight Systems	233,915
5	GS-14 Aerospace Tech, Fluid and Flight Mechanics	61,570
4	GS-14 Aerospace Tech, Materials and Structures	49,880
1	GS-14 Aerospace Tech, Propulsion and Power	12,210
18	GS-14 Aerospace Tech, Flight Systems	222,900
8	GS-14 Aerospace Tech, Measurement and Instrumentation	100,280
1	GS-14 Aerospace Tech, Data Systems	12,210
216	Other GS Personnel	1,736,890
276		2,529,355

THEORETICAL DIVISION

1	Chief, Theoretical Division	18,000
1	Deputy Chief, Theoretical Division	17,000
1	Assistant Chief, Theoretical Division	16,000
2	GS-15 Aerospace Tech, Space Sciences	27,460
1	GS-15 Aerospace Tech, Fluid and Flight Mechanics	13,730
1	GS-15 Aerospace Tech, Data Systems	13,730
6	GS-14 Aerospace Tech, Space Sciences	74,300
1	GS-14 Aerospace Tech, Data Systems	12,210
86	Other GS Personnel	683,610
100		876,040

SPACECRAFT TECHNOLOGY DIVISION

1	Chief, Spacecraft Technology Division	17,000
1	GS-15 Aerospace Tech, Fluid and Flight Mechanics	13,730
1	GS-15 Aerospace Tech, Materials and Structures	13,730
1	GS-15 Aerospace Tech, Flight Systems	13,730
7	GS-15 Aerospace Tech, Measurement and Instrumentation	97,410
6	GS-14 Aerospace Tech, Materials and Structures	73,780
1	GS-14 Aerospace Tech, Propulsion and Power	12,210
4	GS-14 Aerospace Tech, Flight Systems	48,840
15	GS-14 Aerospace Tech, Measurement and Instrumentation	186,270
173	Other GS Personnel	1,385,050
6	Wage Board Personnel	34,723
216		1,896,473

AERONOMY AND METEOROLOGY DIVISION

1	Chief, Aeronomy and Meteorology Division	17,000
1	Project Manager (NIMBUS)	17,000
1	Head, Planetary Atmospheres Branch	16,500
1	Aerospace Scientist	15,500
3	GS-15 Aerospace Tech, Space Sciences	41,190
6	GS-15 Aerospace Tech, Flight Systems	82,935
4	GS-15 Aeraspace Tech, Measurement and Instrumentation	54,920
13	GS-14 Aerospace Tech, Space Sciences	161,330
3	GS-14 Aerospace Tech, Flight Systems	36,630
6	GS-14 Aerospace Tech, Measurement and Instrumentation	73,260
165	Other GS Personnel	1,331,250
204		1,847,515

OFFICE OF THE ASSISTANT DIRECTOR (TRACKING AND DATA SYSTEMS)

1	Assistant Director, Tracking and Data Systems	[illegible]
1	Deputy Assistant Director For Operations	[illegible]
1	GS-15 Aerospace Tech, Technical Management	[illegible]
1	GS-15 Aerospace Tech, Measurement & Instrumentation	[illegible]
16	Other GS Personnel	11[illegible]
20		17[illegible]

TRACKING SYSTEMS DIVISION

1	Chief, Tracking Systems Division	17,000
4	GS-15 Aerospace Tech, Measurement and Instrumentation	54,920
3	GS-14 Aerospace Tech, Materials & Structures	36,890
10	GS-14 Aerospace Tech, Measurement and Instrumentation	124,180
95	Other GS Personnel	701,680
113		934,670

DATA SYSTEMS DIVISION

1	Chief, Data Systems Division	16,500
1	Staff Scientist, Data Systems	16,500
1	Machine Programming Mathematician	16,000
2	GS-15 Aerospace Tech, Data Systems	27,785
5	GS-14 Aerospace Tech, Fluid & Flight Mechanics	62,610
3	GS-14 Aerospace Tech, Data Systems	37,930
1	GS-14 Supervisory Machine Programming Mathematician	12,730
158	Other GS Personnel	1,127,340
172		1,317,395

OPERATIONS AND SUPPORT DIVISION

9	GS-15 Aerospace Tech, Measurement and Instrumentation	126,495
4	GS-14 Aerospace Tech, Measurement and Instrumentation	49,360
1	GS-14 Aerospace Tech, Experimental Facilities and Equipment	12,210
98	Other GS Personnel	744,800
112		932,865

MANNED SP[illegible]

8	GS-15 Aerospace [illegible] Instrumentation	[illegible]
4	GS-14 Aerospace [illegible] Instrumentation	[illegible]
64	Other GS Person[illegible]	[illegible]
76		[illegible]

SPACE [illegible]

1	Chief, Space D[illegible]	[illegible]
1	GS-15 Aerospa[illegible] Instrumentati[illegible]	[illegible]
2	GS-15 Aerospa[illegible]	[illegible]
2	GS-14 Aerospa[illegible] Instrumentati[illegible]	[illegible]
2	GS-14 Aerospa[illegible]	[illegible]
135	Other GS Pers[illegible]	[illegible]
143		[illegible]

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

PROPOSED PERSONNEL STAFFING CHART
FISCAL YEAR 1963

GODDARD SPACE FLIGHT CENTER

OFFICE OF THE DIRECTOR

1	Director	21,000
1	Associate Director	19,000
1	GS-15 Assistant to the Director	15,030
12	Other GS Personnel	82,130
15		137,160

ISTANT DIRECTOR FOR STRATION

	nistation	17,000
	or Administration	15,500
	t Assistant	13,730
		13,730
		12,210
		12,210
		24,680
	Coordinator	12,210
		500,430
		621,700

ORGANIZATION AND PERSONNEL DIVISION

1	GS-15 Personnel Officer	13,730
1	GS-14 Assistant Personnel Officer	12,210
57	Other GS Personnel	395,470
59		421,410

TECHNICAL INFORMATION DIVISION

39	Other GS Personnel	263,230
18	Wage Board Personnel	124,335
57		387,565

OFFICE OF TECHNICAL SERVICES

1	Chief of Technical Services	17,000
5	Other GS Personnel	33,025
6		50,025

FACILITIES ENGINEERING DIVISION

1	Chief, Facilities Engineering Division	16,500
1	GS-14 Design Construction Engineer	12,210
40	Other GS Personnel	327,910
123	Wage Board Personnel	852,946
165		1,209,566

TEST AND EVALUATION DIVISION

1	Chief, Test and Evaluation Division	15,500
2	GS-15 Aerospace Tech, Flight Systems	27,785
2	GS-14 Aerospace Tech, Materials and Structures	25,460
7	GS-14 Aerospace Tech, Flight Systems	86,510
5	GS-14 Aerospace Tech, Measurement and Instrumentation	61,050
2	GS-14 Aerospace Tech, Experimental Facilities and Equipment	24,420
162	Other GS Personnel	1,263,645
181		1,504,370

FABRICATION DIVISION

1	GS-15 Aerospace Tech, Flight Systems	13,730
12	Other GS Personnel	82,210
127	Wage Board Personnel	898,462
140		994,402

OFFICE OF THE ASSISTANT DIRECTOR (SPACE SCIENCE AND SATELLITE APPLICATIONS)

1	Assistant Director—Space Science & Sat. Applications	19,000
1	Head, Systems Review Group	17,000
1	GS-15 Aerospace Tech, Space Sciences	13,730
1	GS-15 Aerospace Tech, Technical Management	13,730
6	Other GS Personnel	38,955
10		102,415

SPACE SCIENCES DIVISION

1	Chief, Space Sciences Division	18,000
1	Associate Chief, Space Sciences Division	16,500
1	Aerospace Scientist, Astrophysics	16,500
1	Aerospace Scientist, Research Instrumentation	15,500
1	Aerospace Scientist, Ionosphere	15,500
1	Head, Fields and Particles Branch	15,500
1	Head, Planetary Ionospheres Branch	15,500
8	GS-15 Aerospace Tech, Space Sciences	110,545
1	GS-15 Aerospace Tech, Flight Systems	14,705
16	GS-14 Aerospace Tech, Space Sciences	197,440
5	GS-14 Aerospace Tech, Flight Systems	62,090
2	GS-14 Aerospace Tech, Measurement and Instrumentation	24,420
2	GS-14 Aerospace Tech, Experimental Facilities and Equipment	24,420
1	GS-14 Aero Research Scientist	12,210
158	Other GS Personnel	1,235,045
200		1,793,875

THEORETICAL DIVISION

1	Chief, Theoretical Division	18,000
1	Deputy Chief, Theoretical Division	17,000
1	Assistant Chief, Theoretical Division	16,000
2	GS-15 Aerospace Tech, Space Sciences	27,460
1	GS-15 Aerospace Tech, Fluid and Flight Mechanics	13,730
1	GS-15 Aerospace Tech, Data Systems	13,730
6	GS-14 Aerospace Tech, Space Sciences	74,300
1	GS-14 Aerospace Tech, Data Systems	12,210
86	Other GS Personnel	683,610
100		876,040

SPACECRAFT SYSTEMS AND PROJECTS DIVISION

1	Chief, Spacecraft Systems and Projects Division	18,000
1	Staff Scientist, Communications	17,000
1	Head, Communications Branch	16,500
1	Head, Spacecraft Systems Branch	16,500
1	Associate Chief, Spacecraft Systems and Projects Division	16,000
1	Head, Advanced Projects Group	15,500
17	GS-15 Aerospace Tech, Flight Systems	233,915
5	GS-14 Aerospace Tech, Fluid and Flight Mechanics	61,570
4	GS-14 Aerospace Tech, Materials and Structures	49,880
1	GS-14 Aerospace Tech, Propulsion and Power	12,210
18	GS-14 Aerospace Tech, Flight Systems	222,900
8	GS-14 Aerospace Tech, Measurement and Instrumentation	100,280
1	GS-14 Aerospace Tech, Data Systems	12,210
216	Other GS Personnel	1,736,890
276		2,529,355

SPACECRAFT TECHNOLOGY DIVISION

1	Chief, Spacecraft Technology Division	17,000
1	GS-15 Aerospace Tech, Fluid and Flight Mechanics	13,730
1	GS-15 Aerospace Tech, Materials and Structures	13,730
1	GS-15 Aerospace Tech, Flight Systems	13,730
7	GS-15 Aerospace Tech, Measurement and Instrumentation	97,410
6	GS-14 Aerospace Tech, Materials and Structures	73,780
1	GS-14 Aerospace Tech, Propulsion and Power	12,210
4	GS-14 Aerospace Tech, Flight Systems	48,840
15	GS-14 Aerospace Tech, Measurement and Instrumentation	186,270
173	Other GS Personnel	1,385,050
6	Wage Board Personnel	34,723
216		1,886,473

AERONOMY AND METEOROLOGY DIVISION

1	Chief, Aeronomy and Meteorology Division	17,000
1	Project Manager (NIMBUS)	17,000
1	Head, Planetary Atmospheres Branch	16,500
1	Aerospace Scientist	15,500
3	GS-15 Aerospace Tech, Space Sciences	41,190
6	GS-15 Aerospace Tech, Flight Systems	82,935
4	GS-15 Aerospace Tech, Measurement and Instrumentation	54,920
13	GS-14 Aerospace Tech, Space Sciences	161,330
3	GS-14 Aerospace Tech, Flight Systems	36,630
6	GS-14 Aerospace Tech, Measurement and Instrumentation	73,260
165	Other GS Personnel	1,331,250
204		1,847,515

OFFICE OF THE ASSISTANT DIRECTOR (TRACKING AND DATA SYSTEMS)

1	Assistant Director, Tracking and Data Systems	18,500
1	Deputy Assistant Director For Operations	18,000
1	GS-15 Aerospace Tech, Technical Management	14,055
1	GS-15 Aerospace Tech, Measurement & Instrumentation	13,730
16	Other GS Personnel	110,400
20		174,685

TRACKING SYSTEMS DIVISION

1	Chief, Tracking Systems Division	17,000
4	GS-15 Aerospace Tech, Measurement and Instrumentation	54,920
3	GS-14 Aerospace Tech, Materials & Structures	36,890
10	GS-14 Aerospace Tech, Measurement and Instrumentation	124,180
95	Other GS Personnel	701,680
113		934,670

DATA SYSTEMS DIVISION

1	Chief, Data Systems Division	16,500
1	Staff Scientist, Data Systems	16,500
1	Machine Programming Mathematician	16,000
2	GS-15 Aerospace Tech, Data Systems	27,785
5	GS-14 Aerospace Tech, Fluid & Flight Mechanics	62,610
3	GS-14 Aerospace Tech, Data Systems	37,930
1	GS-14 Supervisory Machine Programming Mathematician	12,730
158	Other GS Personnel	1,127,340
172		1,317,395

OPERATIONS AND SUPPORT DIVISION

9	GS-15 Aerospace Tech, Measurement and Instrumentation	126,495
4	GS-14 Aerospace Tech, Measurement and Instrumentation	49,360
1	GS-14 Aerospace Tech, Experimental Facilities and Equipment	12,210
98	Other GS Personnel	744,800
112		932,865

MANNED SPACE FLIGHT SUPPORT DIVISION

8	GS-15 Aerospace Tech, Measurement and Instrumentation	111,465
4	GS-14 Aerospace Tech, Measurement and Instrumentation	49,360
64	Other GS Personnel	453,440
76		614,265

SPACE DATA ACQUISITION DIVISION

1	Chief, Space Data Acquisition Division	16,500
1	GS-15 Aerospace Tech, Measurement and Instrumentation	13,730
2	GS-15 Aerospace Tech, Data Systems	27,460
2	GS-14 Aerospace Tech, Measurement and Instrumentation	24,420
2	GS-14 Aerospace Tech, Data Systems	24,420
135	Other GS Personnel	906,750
143		1,013,280

ASSISTANT DIRECTOR FOR RESEARCH & DEVELOPMENT

1	Excepted	Asst. Director for R & D	$18,013
1	GS-15	Asst. to the Asst. Dir. for R & D	13,749
1	All Other GS Personnel		4,846
3			$36,608

SPACECRAFT RESEARCH DIVISION

1	Excepted	Chief	$18,013
1	Excepted	Deputy Chief	17,514
1	GS-15	Chief, Systems Integ. Br.	13,749
1	GS-15	Chief, Spacecraft Integ. Br.	13,749
1	GS-15	Chief, Eng. Design & Eval.	13,749
1	GS-15	Chief, Mech. Systems Design	13,749
1	GS-15	Chief, Elec. Systems Design	13,749
1	GS-15	Chief, Special Instrumentation	13,749
1	GS-15	Chief, Flight Dynamics	13,749
1	GS-15	Chief, Structures	13,749
1	GS-15	Asst. to Chief (Technical)	13,749
1	GS-15	Asst. to Chief (Operations)	13,749
1	GS-15	Research Coordinator	13,749
29	GS-14	Aerospace Technologists	354,670
208	All Other GS Personnel		1,534,832
250			$2,076,268

LIFE SYSTEMS DIVISION

1	Excepted	Chief	$18,013
1	GS-15	Deputy Chief	13,749
1	GS-15	Chief, Aerospace Med.	13,749
1	GS-15	Chief, Spec. Equip. Dev.	13,749
7	GS-14	Aerospace Technologists	85,610
69	All Other GS Personnel		509,151
80			$654,021

DEVELOPMENT, TEST, & EVALUATION DIVISION

1	Excepted	Chief	$18,013
1	Excepted	Deputy Chief	17,514
1	GS-15	Asst. to Chief	13,749
1	GS-15	Chief Research Eng.	13,749
1	GS-15	Materials Engineer	13,749
1	GS-15	Chief, Mech. Eng.	13,749
1	GS-15	Chief, Elec. Systems	13,749
1	GS-15	Test Coordinator	13,749
1	GS-15	Planning Officer	13,749
22	GS-14	Aerospace Tech.	269,060
149	All Other GS Personnel		1,099,471
180			$1,500,301

SPACE PHYSICS DIVISION

1	Excepted	Chief	$18,013
1	GS-15	Deputy Chief	13,749
2	GS-15	Branch Chiefs	27,498
2	GS-15	Research Physicists	27,498
9	GS-14	Aerospace Technologists	110,070
35	All Other GS Personnel		258,265
50			$455,093

ASSISTANT DIRECTOR FOR OPERATIONS

1	Excepted	Asst. Director for Oper.	$18,512
1	GS-15	Asst. to Asst. Dir. for Operations	13,749
1	All Other GS Personnel		4,846
3			$37,107

AEROSPACE MEDICAL OPERATIONS OFFICE

1	GS-14 Chief	12,230
14	All Other GS Personnel	103,306
15		$115,536

PREFLIGHT OPERATIONS DIVISION

1	Excepted	Chief	$17,015
1	Excepted	Deputy Chief	16,016
1	GS-15	Asst. to Chief	13,749
1	GS-15	Chief, AMR Project Off.	13,749
1	GS-15	Chief, Instrumentation Br.	13,749
1	GS-15	Chief, Spacecraft Systems Br.	13,749
1	GS-15	Chief, Launch Coord. Off., Apollo	13,749
1	GS-15	Chief, Preflight Planning	13,749
1	GS-15	Asst. Chief, Instrumentation Br.	13,749
1	GS-15	Asst. Chief, Spacecraft Systems Br.	13,749
1	GS-15	Chief, Technical Services Br.	13,749
20	GS-14	Aerospace Technologists	244,600
74	All Other GS Personnel		546,046
145	Wage Board		911,035
250			$1,858,453

FLIGHT OPERATIONS DIVISION

1	Excepted	Chief	$18,013
1	Excepted	Deputy Chief	17,514
1	GS-15	Chief, Operations Coord.	13,749
1	GS-15	Chief, Network Coord.	13,749
1	GS-15	Chief, Mission Analysis Br.	13,749
1	GS-15	Chief, Traj. Analysis Br.	13,749
1	GS-15	Chief, Spacecraft Oper. Br.	13,749
2	GS-15	Flight Control Br.	27,498
1	GS-15	Chief, Recovery Br.	13,749
1	GS-15	Chief, Training & Simulator Br.	13,749
1	GS-15	Chief, Spacecraft Systems Br.	13,749
1	GS-15	Chief, Flight Control Facil. Sec.	13,749
1	GS-15	Chief, Training Aids Sec.	13,749
20	GS-14	Aerospace Technologists	244,600
191	All Other GS Personnel		1,409,389
225			$1,854,504

ASTRONAUTS & TRAINING DIVISION

1	Excepted	Chief	$18,013
1	GS-15	Deputy Chief	13,749
2	GS-15	Branch Chiefs	27,498
4	GS-14	Aerospace Technologists	48,920
47	All Other GS Personnel		346,813
55			$454,993

ASSISTANT DIRECTOR FOR ENGINEERING SUPPORT

1	Excepted	Asst. Director for Eng. Support	$18,512
1	GS-15	Asst. to the Asst. Dir. for Eng. Support	13,749
1	All Other GS Personnel		4,846
3			$37,107

INSTRUMENTATION AND DATA SYSTEMS DIVISION

1	Excepted	Chief	$18,013
1	GS-15	Deputy Chief	13,749
1	GS-15	Chief, Instrumentation Br.	13,749
1	GS-15	Chief, Data Systems Br.	13,749
1	GS-15	Asst. Chief, Instrumen. Br.	13,749
1	GS-15	Asst. Chief, Data Systems Br.	13,749
6	GS-14	Aerospace Technologists	73,380
153	All Other GS Personnel		1,128,987
165			$1,289,125

DATA COMPUTATION & REDUCTION DIVISION

1	Excepted	Chief	$18,013
1	GS-15	Deputy Chief	13,749
1	GS-15	Chief, Data Computation Br.	13,749
1	GS-15	Chief, Data Reduction Br.	13,749
1	GS-15	Deputy Chief, Data Comp. Br.	13,749
1	GS-15	Deputy Chief, Data Reduc. Br.	13,749
2	GS-14	Programers	24,460
77	All Other GS Personnel		568,183
85			$679,401

SHOP SERVICES DIVISION

1	GS-15 Chief		$13,749
1	GS-14 Deputy Chief		12,230
8	All Other GS Personnel		59,032
230	Wage Board		1,445,090
240			$1,530,101

ENGINEERING DESIGN DIVISION

1	GS-15	Chief	$13,749
1	GS-15	Deputy Chief	13,749
2	GS-15	Branch Chiefs	27,498
2	GS-14	Assistant Branch Chiefs	24,460
44	All Other GS Personnel		324,676
50			$404,132

ASSISTANT DIRECTOR FOR ADMINISTRATION

1	Excepted	Asst. Director for Admin.	$17,015
1	Excepted	Deputy Asst. Director for Admin.	15,517
3	All other GS Personnel		13,249
5			$45,781

MANAGEMENT SERVICES DIVISION

1	Excepted	Chief	$15,517
1	GS-15	Deputy Chief	13,749
1	GS-15	Personnel Officer	13,749
1	GS-15	Management Analyst	13,749
1	GS-14	Chief, Technical Infor.	12,230
2	GS-14	Supv. Pers. Mgmt. Spec.	24,460
1	GS-14	Management Analyst	12,230
237	All other GS Personnel		1,748,071
30	Wage Board		188,430
275			$2,042,185

FACILITY SERVICES DIVISION

1	Excepted	Chief	$15,517
1	GS-15	Deputy Chief	13,749
1	GS-15	Chief, Construction Br.	13,749
1	GS-15	Asst. Chief, Constr. Br.	13,749
1	GS-15	Chief, Electrical Branch	13,749
1	GS-15	Chief, Res. Equip. Design Br.	13,749
1	GS-15	Chief, Mechanical Branch	13,749
1	GS-14	Planning Officer	12,230
1	GS-14	Architect	12,230
1	GS-14	Chief, Plant Maintenance	12,230
55	All other GS Personnel		405,845
32	Wage Board		219,905
100			$760,451

FINANCIAL MANAGEMENT DIVISION

1	Excepted	Chief	$15,517
1	GS-15	Deputy Chief	13,749
1	GS-14	Chief Accountant	12,230
1	GS-14	Budget Officer	12,230
81	All other GS Personnel		597,699
85			$651,425

PROCUREMENT AND CONTRACTS DIVISION

1	Excepted	Chief	$15,517
1	GS-15	Chief, Apollo Procurement	13,749
1	GS-15	Chief, Mercury Procurement	13,749
1	GS-15	Chief, Plans and Operations	13,749
1	GS-14	Chief, Contr. Negot. & Admin. Br.	12,230
1	GS-14	Supv. Acct. (Contract Pricing)	12,230
5	GS-14	Contract Negotiators	36,690
111	All Other GS Personnel		819,069
120			$936,983

10	All other GS Personnel		116,064
25			$235,729

GEMINI PROJECT OFFICE

1	Excepted	Project Manager	
1	Excepted	Deputy Project Manager	
1	Excepted	Spacecraft Systems Manager	
1	Excepted	Vehicle Systems Manager	
1	GS-15	Flight Oper. Planning Officer	
1	GS-15	Ground Support Require. Officer	
1	GS-15	Tech. Representative (Cape Canave	
1	GS-15	Asst. to Project Manager	
1	GS-15	Asst., Spacecraft Systems Mgr.	
1	GS-15	Asst., Vehicle Systems Mgr.	
5	GS-15	Branch Chiefs	
1	GS-15	Tech. Rep. (Contractor's Plant)	
12	GS-14	Aerospace Technologists	
122	All Other GS Personnel		
150			

NATIONAL AERONAUTICS AND

PROPOSED PERSONNEL

FISCAL YEAR

MANNED SPACECR

OFFICE OF THE DI

1	Excepted	Director
1	Excepted	Associate Director
1	Excepted	Assistant to Director
1	GS-15	Assistant for Project Manage
1	GS-15	Assistant to Associate Direc
1	GS-15	Assistant for Electronics Fl
3	GS-15	Technical Assistants
6	All other GS Personnel	
15		

AUDIT OFFICE

1	GS-15	Supervisory Auditor	$13,749
3	GS-14	Supervisory Auditors	36,690
6	All other GS Personnel		44,274
10			$94,713

PUBLIC AFFAIRS OFFICE

1	GS-15	Chief	$13,749
1	GS-14	Information Officer	12,230
36	All other GS Personnel		265,644
38			$291,623

LEGAL OFFICE

1	GS-15	Chief	$13,749
1	GS-14	Deputy Chief	12,250
13	All Other GS Personnel		97,227
15			$123,106

ASSISTANT DIRECTOR FOR RESEARCH & DEVELOPMENT

1	Excepted	Asst. Director for R & D	$18,013
1	GS-15	Asst. to the Asst. Dir. for R & D	13,749
1	All Other GS Personnel		4,846
3			$36,608

ASSISTANT DIRECTOR FOR OPERATIONS

1	Excepted	Asst. Director for Oper.	$18,512
1	GS-15	Asst. to Asst. Dir. for Operations	13,749
1	All Other GS Personnel		4,846
3			$37,107

ASSISTANT DIRECTOR FOR ENGINEERING SUPPORT

1	Excepted	Asst. Director for Eng. Support	$18,512
1	GS-15	Asst. to the Asst. Dir. for Eng. Support	13,749
1	All Other GS Personnel		4,846
3			$37,107

SPACECRAFT RESEARCH DIVISION

1	Excepted	Chief	$18,013
1	Excepted	Deputy Chief	17,514
1	GS-15	Chief, Systems Integ. Br.	13,749
1	GS-15	Chief, Spacecraft Integ. Br.	13,749
1	GS-15	Chief, Eng. Design & Eval.	13,749
1	GS-15	Chief, Mech. Systems Design	13,749
1	GS-15	Chief, Elec. Systems Design	13,749
1	GS-15	Chief, Special Instrumentation	13,749
1	GS-15	Chief, Flight Dynamics	13,749
1	GS-15	Chief, Structures	13,749
1	GS-15	Asst. to Chief (Technical)	13,749
1	GS-15	Asst. to Chief (Operations)	13,749
1	GS-15	Research Coordinator	13,749
29	GS-14	Aerospace Technologists	354,670
208	All Other GS Personnel		1,534,832
250			$2,076,268

AEROSPACE MEDICAL OPERATIONS OFFICE

1	GS-14	Chief	12,230
14	All Other GS Personnel		103,306
15			$115,536

INSTRUMENTATION AND DATA SYSTEMS DIVISION

1	Excepted	Chief	$18,013
1	GS-15	Deputy Chief	13,749
1	GS-15	Chief, Instrumentation Br.	13,749
1	GS-15	Chief, Data Systems Br.	13,749
1	GS-15	Asst. Chief, Instrumen. Br.	13,749
1	GS-15	Asst. Chief, Data Systems Br.	13,749
6	GS-14	Aerospace Technologists	73,380
153	All Other GS Personnel		1,128,987
163			$1,289,125

PREFLIGHT OPERATIONS DIVISION

1	Excepted	Chief	$17,015
1	Excepted	Deputy Chief	16,016
1	GS-15	Asst. to Chief	13,749
1	GS-15	Chief, AMR Project Off.	13,749
1	GS-15	Chief, Instrumentation Br.	13,749
1	GS-15	Chief, Spacecraft Systems Br.	13,749
1	GS-15	Chief, Launch Coord. Off., Apollo	13,749
1	GS-15	Chief, Preflight Planning	13,749
1	GS-15	Asst. Chief, Instrumentation Br.	13,749
1	GS-15	Asst. Chief, Spacecraft Systems Br.	13,749
1	GS-15	Chief, Technical Services Br.	13,749
20	GS-14	Aerospace Technologists	244,600
74	All Other GS Personnel		546,046
145	Wage Board		911,035
250			$1,858,453

DATA COMPUTATION & REDUCTION DIVISION

1	Excepted	Chief	$18,013
1	GS-15	Deputy Chief	13,749
1	GS-15	Chief, Data Computation Br.	13,749
1	GS-15	Chief, Data Reduction Br.	13,749
1	GS-15	Deputy Chief, Data Comp. Br.	13,749
1	GS-15	Deputy Chief, Data Reduc. Br.	13,749
2	GS-14	Programers	24,460
77	All Other GS Personnel		568,183
85			$679,401

LIFE SYSTEMS DIVISION

1	Excepted	Chief	$18,013
1	GS-15	Deputy Chief	13,749
1	GS-15	Chief, Aerospace Med.	13,749
1	GS-15	Chief, Spec. Equip. Dev.	13,749
7	GS-14	Aerospace Technologists	85,610
69	All Other GS Personnel		509,151
80			$654,021

FLIGHT OPERATIONS DIVISION

1	Excepted	Chief	$18,013
1	Excepted	Deputy Chief	17,514
1	GS-15	Chief, Operations Coord.	13,749
1	GS-15	Chief, Network Coord.	13,749
1	GS-15	Chief, Mission Analysis Br.	13,749
1	GS-15	Chief, Traj. Analysis Br.	13,749
1	GS-15	Chief, Spacecraft Oper. Br.	13,749
2	GS-15	Flight Control Br.	27,498
1	GS-15	Chief, Recovery Br.	13,749
1	GS-15	Chief, Training & Simulator Br.	13,749
1	GS-15	Chief, Spacecraft Systems Br.	13,749
1	GS-15	Chief, Flight Control Facil. Sec.	13,749
1	GS-15	Chief, Training Aids Sec.	13,749
20	GS-14	Aerospace Technologists	244,600
191	All Other GS Personnel		1,409,389
225			$1,854,504

SHOP SERVICES DIVISION

1	GS-15	Chief	$13,749
1	GS-14	Deputy Chief	12,230
8	All Other GS Personnel		59,032
230	Wage Board		1,445,090
240			$1,530,101

DEVELOPMENT, TEST, & EVALUATION DIVISION

1	Excepted	Chief	$18,013
1	Excepted	Deputy Chief	17,514
1	GS-15	Asst. to Chief	13,749
1	GS-15	Chief Research Eng.	13,749
1	GS-15	Materials Engineer	13,749
1	GS-15	Chief, Mech. Eng.	13,749
1	GS-15	Chief, Elec. Systems	13,749
1	GS-15	Test Coordinator	13,749
1	GS-15	Planning Officer	13,749
22	GS-14	Aerospace Tech.	269,060
149	All Other GS Personnel		1,099,471
180			$1,500,301

ENGINEERING DESIGN DIVISION

1	GS-15	Chief	$13,749
1	GS-15	Deputy Chief	13,749
2	GS-15	Branch Chiefs	27,498
2	GS-14	Assistant Branch Chiefs	24,460
44	All Other GS Personnel		324,676
50			$404,132

SPACE PHYSICS DIVISION

1	Excepted	Chief	$18,013
1	GS-15	Deputy Chief	13,749
2	GS-15	Branch Chiefs	27,498
2	GS-15	Research Physicists	27,498
9	GS-14	Aerospace Technologists	110,070
35	All Other GS Personnel		258,265
50			$455,093

ASTRONAUTS & TRAINING DIVISION

1	Excepted	Chief	$18,013
1	GS-15	Deputy Chief	13,749
2	GS-15	Branch Chiefs	27,498
4	GS-14	Aerospace Technologists	48,920
47	All Other GS Personnel		346,813
55			$454,993

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

PROPOSED PERSONNEL STAFFING CHART

FISCAL YEAR 1963

MANNED SPACECRAFT CENTER

OFFICE OF THE DIRECTOR

1	Excepted	Director	$21,008
1	Excepted	Associate Director	19,011
1	Excepted	Assistant to Director	17,514
1	GS-15	Assistant for Project Management	13,749
1	GS-15	Assistant to Associate Director	13,749
1	GS-15	Assistant for Electronics Flight and Support Equipment	13,749
3	GS-15	Technical Assistants	41,247
6	All other GS Personnel		44,274
15			$184,301

CHIEF MEDICAL ADVISORS OFFICE

3	$14,449

PUBLIC AFFAIRS OFFICE

-15	Chief	$13,749
-14	Information Officer	12,230
l other GS Personnel		265,644
		$291,623

LEGAL OFFICE

1	GS-15	Chief	$13,749
1	GS-14	Deputy Chief	12,250
13	All Other GS Personnel		97,227
15			$123,106

ADVANCED STUDIES AND MISSION ANALYSIS OFFICE

1	GS-15	Director	$13,749
1	GS-15	Deputy Director	13,749
1	GS-15	Chief, Mission Analysis	13,749
1	GS-15	Chief, Advanced Studies	13,749
1	GS-15	Chief, Systems Engineering Analysis	13,749
4	GS-14	Aerospace Technologists	48,920
16	All other GS Personnel		118,064
25			$235,729

RELIABILITY AND FLIGHT SAFETY OFFICE

1	Excepted	Chief	$16,516
1	GS-15	Chief, Flight Safety	13,749
1	GS-15	Chief, Reliability	13,749
4	GS-14	Aerospace Technologists	48,920
18	All other GS Personnel		132,822
25			$225,756

PROGRAM ANALYSIS AND EVALUATION OFFICE

1	Excepted	Chief	$16,016
1	GS-15	Deputy Chief	13,749
1	GS-15	Chief, Program Analysis	13,749
1	GS-15	Chief, Program Evaluation	13,749
3	GS-14	Program Analysts (Engineers)	36,690
23	All other GS Personnel		169,717
30			$263,670

ASSISTANT DIRECTOR FOR OPERATIONS

pted	Asst. Director for Oper.	$18,512
5	Asst. to Asst. Dir. for Operations	13,749
Other GS Personnel		4,846
		$37,107

ASSISTANT DIRECTOR FOR ENGINEERING SUPPORT

1	Excepted	Asst. Director for Eng. Support	$18,512
1	GS-15	Asst. to the Asst. Dir. for Eng. Support	13,749
1	All Other GS Personnel		4,846
3			$37,107

ASSISTANT DIRECTOR FOR ADMINISTRATION

1	Excepted	Asst. Director for Admin.	$17,015
1	Excepted	Deputy Asst. Director for Admin.	15,517
3	All other GS Personnel		13,249
5			$45,781

GEMINI PROJECT OFFICE

1	Excepted	Project Manager	$18,013
1	Excepted	Deputy Project Manager	17,514
1	Excepted	Spacecraft Systems Manager	17,514
1	Excepted	Vehicle Systems Manager	17,514
1	GS-15	Flight Oper. Planning Officer	13,749
1	GS-15	Ground Support Require. Officer	13,749
1	GS-15	Tech. Representative (Cape Canaveral)	13,749
1	GS-15	Asst. to Project Manager	13,749
1	GS-15	Asst., Spacecraft Systems Mgr.	13,749
1	GS-15	Asst., Vehicle Systems Mgr.	13,749
5	GS-15	Branch Chiefs	68,745
1	GS-15	Tech. Rep. (Contractor's Plant)	13,749
12	GS-14	Aerospace Technologists	146,760
122	All Other GS Personnel		900,238
150			$1,282,541

APOLLO PROJECT OFFICE

1	Excepted	Apollo Project Manager	$19,011
4	Excepted	Systems Managers	70,056
4	GS-15	Asst. Systems Managers	54,996
1	GS-15	Tech. Rep. (Cape Canaveral)	13,749
1	GS-15	Tech. Rep. (Contractor's Plant)	13,749
1	GS-15	Chief, Systems Design	13,749
1	GS-15	Chief, Systems Engineering	13,749
1	GS-15	Chief, Ground Support Systems	13,749
1	GS-15	Chief, Life Support Requirements	13,749
1	GS-15	Asst. to Project Manager	13,749
15	GS-14	Aerospace Technologists	183,450
119	All Other GS Personnel		878,101
150			$1,301,857

OSPACE MEDICAL OPERATIONS OFFICE

GS-14	Chief	12,230
All Other GS Personnel		103,306
		$115,536

INSTRUMENTATION AND DATA SYSTEMS DIVISION

1	Excepted	Chief	$18,013
1	GS-15	Deputy Chief	13,749
1	GS-15	Chief, Instrumentation Br.	13,749
1	GS-15	Chief, Data Systems Br.	13,749
1	GS-15	Asst. Chief, Instrumen. Br.	13,749
1	GS-15	Asst. Chief, Data Systems Br.	13,749
6	GS-14	Aerospace Technologists	73,380
153	All Other GS Personnel		1,128,987
165			$1,289,125

MANAGEMENT SERVICES DIVISION

1	Excepted	Chief	$15,517
1	GS-15	Deputy Chief	13,749
1	GS-15	Personnel Officer	13,749
1	GS-15	Management Analyst	13,749
1	GS-14	Chief, Technical Infor.	12,230
2	GS-14	Supv. Pers. Mgmt. Spec.	24,460
1	GS-14	Management Analyst	12,230
237	All other GS Personnel		1,748,071
30	Wage Board		188,430
275			$2,042,185

PREFLIGHT OPERATIONS DIVISION

Chief	$17,015
Deputy Chief	16,016
Asst. to Chief	13,749
Chief, AMR Project Off.	13,749
Chief, Instrumentation Br.	13,749
Chief, Spacecraft Systems Br.	13,749
Chief, Launch Coord. Off., Apollo	13,749
Chief, Preflight Planning	13,749
Asst. Chief, Instrumentation Br.	13,749
Asst. Chief, Spacecraft Systems Br.	13,749
Chief, Technical Services Br.	13,749
Aerospace Technologists	244,600
GS Personnel	546,046
d	911,035
	$1,858,453

DATA COMPUTATION & REDUCTION DIVISION

1	Excepted	Chief	$18,013
1	GS-15	Deputy Chief	13,749
1	GS-15	Chief, Data Computation Br.	13,749
1	GS-15	Chief, Data Reduction Br.	13,749
1	GS-15	Deputy Chief, Data Comp. Br.	13,749
1	GS-15	Deputy Chief, Data Reduc. Br.	13,749
2	GS-14	Programers	24,460
77	All Other GS Personnel		568,183
85			$679,401

FACILITY SERVICES DIVISION

1	Excepted	Chief	$15,517
1	GS-15	Deputy Chief	13,749
1	GS-15	Chief, Construction Br.	13,749
1	GS-15	Asst. Chief, Constr. Br.	13,749
1	GS-15	Chief, Electrical Branch	13,749
1	GS-15	Chief, Res. Equip. Design Br.	13,749
1	GS-15	Chief, Mechanical Branch	13,749
1	GS-14	Planning Officer	12,230
1	GS-14	Architect	12,230
1	GS-14	Chief, Plant Maintenance	12,230
55	All other GS Personnel		405,845
25	Wage Board		219,905
100			$760,451

PACE ADMINISTRATION
TAFFING CHART
963
FT CENTER

DR

	$21,008
	19,011
	17,514
	13,749
	13,749
and Support Equipment	13,749
	41,247
	44,274
	$184,301

CHIEF MEDICAL ADVISORS OFFICE

3		$14,449

ADVANCED STUDIES AND MISSION ANALYSIS OFFICE

1	GS-15	Director	$13,749
1	GS-15	Deputy Director	13,749
1	GS-15	Chief, Mission Analysis	13,749
1	GS-15	Chief, Advanced Studies	13,749
1	GS-15	Chief, Systems Engineering Analysis	13,749
4	GS-14	Aerospace Technologists	48,920
6		All other GS Personnel	118,064
15			$235,729

RELIABILITY AND FLIGHT SAFETY OFFICE

1	Excepted	Chief	$16,516
1	GS-15	Chief, Flight Safety	13,749
1	GS-15	Chief, Reliability	13,749
4	GS-14	Aerospace Technologists	48,920
18		All other GS Personnel	132,822
25			$225,756

PROGRAM ANALYSIS AND EVALUATION OFFICE

1	Excepted	Chief	$16,016
1	GS-15	Deputy Chief	13,749
1	GS-15	Chief, Program Analysis	13,749
1	GS-15	Chief, Program Evaluation	13,749
3	GS-14	Program Analysts (Engineers)	36,690
23		All other GS Personnel	169,717
30			$263,670

ASSISTANT DIRECTOR FOR ADMINISTRATION

1	Excepted	Asst. Director for Admin.	$17,015
1	Excepted	Deputy Asst. Director for Admin.	15,517
3		All other GS Personnel	13,249
5			$45,781

GEMINI PROJECT OFFICE

1	Excepted	Project Manager	$18,013
1	Excepted	Deputy Project Manager	17,514
1	Excepted	Spacecraft Systems Manager	17,514
1	Excepted	Vehicle Systems Manager	17,514
1	GS-15	Flight Oper. Planning Officer	13,749
1	GS-15	Ground Support Require. Officer	13,749
1	GS-15	Tech. Representative (Cape Canaveral)	13,749
1	GS-15	Asst. to Project Manager	13,749
1	GS-15	Asst., Spacecraft Systems Mgr.	13,749
1	GS-15	Asst., Vehicle Systems Mgr.	13,749
5	GS-15	Branch Chiefs	68,745
1	GS-15	Tech. Rep. (Contractor's Plant)	13,749
12	GS-14	Aerospace Technologists	146,760
122		All Other GS Personnel	900,238
150			$1,282,541

APOLLO PROJECT OFFICE

1	Excepted	Apollo Project Manager	$19,011
4	Excepted	Systems Managers	70,056
4	GS-15	Asst. Systems Managers	54,996
1	GS-15	Tech. Rep. (Cape Canaveral)	13,749
1	GS-15	Tech. Rep. (Contractor's Plant)	13,749
1	GS-15	Chief, Systems Design	13,749
1	GS-15	Chief, Systems Engineering	13,749
1	GS-15	Chief, Ground Support Systems	13,749
1	GS-15	Chief, Life Support Requirements	13,749
1	GS-15	Asst. to Project Manager	13,749
15	GS-14	Aerospace Technologists	183,450
119		All Other GS Personnel	878,101
150			$1,301,857

MANAGEMENT SERVICES DIVISION

1	Excepted	Chief	$15,517
1	GS-15	Deputy Chief	13,749
1	GS-15	Personnel Officer	13,749
1	GS-15	Management Analyst	13,749
1	GS-14	Chief, Technical Infor.	12,230
2	GS-14	Supv. Pers. Mgmt. Spec.	24,460
1	GS-14	Management Analyst	12,230
237		All other GS Personnel	1,748,071
30		Wage Board	188,430
275			$2,042,185

FACILITY SERVICES DIVISION

1	Excepted	Chief	$15,517
1	GS-15	Deputy Chief	13,749
1	GS-15	Chief, Construction Br.	13,749
1	GS-15	Asst. Chief, Constr. Br.	13,749
1	GS-15	Chief, Electrical Branch	13,749
1	GS-15	Chief, Res. Equip. Design Br.	13,749
1	GS-15	Chief, Mechanical Branch	13,749
1	GS-14	Planning Officer	12,230
1	GS-14	Architect	12,230
1	GS-14	Chief, Plant Maintenance	12,230
55		All other GS Personnel	405,845
35		Wage Board	219,905
100			$760,451

FINANCIAL MANAGEMENT DIVISION

1	Excepted	Chief	$15,517
1	GS-15	Deputy Chief	13,749
1	GS-14	Chief Accountant	12,230
1	GS-14	Budget Officer	12,230
81		All other GS Personnel	597,699
85			$651,425

PROCUREMENT AND CONTRACTS DIVISION

1	Excepted	Chief	$15,517
1	GS-15	Chief, Apollo Procurement	13,749
1	GS-15	Chief, Mercury Procurement	13,749
1	GS-15	Chief, Plans and Operations	13,749
1	GS-14	Chief, Contr. Negot. & Admin. Br.	12,230
1	GS-14	Supv. Acct. (Contract Pricing)	12,230
3	GS-14	Contract Negotiators	36,690
111		All Other GS Personnel	819,669
120			$936,983

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

PROPOSED PERSONNEL STAFFING CHART

FISCAL YEAR 1963

GEORGE C. MARSHALL SPACE FLIGHT CENTER

PIO

1	GS-15	Chief, Public Information Office	$ 13,749
1	GS-14	Public Information Specialist	12,480
21		Other GS Personnel	157,038
23			$ 183,267

RELIABILITY OFFICE

2	GS-15	AST, Project Management	$ 29,744
1	GS-15	AST, Liquid Propulsion Systems	14,061
1	GS-15	AST, Flight Systems	14,061
3	GS-14	AST, Flight Systems	38,480
1	GS-14	AST, Technical Management	12,480
2	GS-14	AST, Liquid Propulsion Systems	25,500
1	GS-14	AST, Flight Structures	12,230
24		Other GS Personnel	179,472
35			$ 326,028

DIRECTOR'S OFFICE

1	Excep.	Director, Space Flight Center	$ 21,808
1	Excep.	Dep/Director for Research & Development	20,010
1	Excep.	Dep/Director for Administration	18,013
1	Excep.	Assoc. Dep/Director for R&D	18,013
1	Excep.	Assoc. Dep/Director for Administration	16,516
2	GS-15	Technical Management	27,810
1	GS-15	Industrial Relations Officer	14,061
1	GS-15	C/Resident Auditor	13,749
1	GS-14	Industrial Specialist	12,230
1	GS-14	Supervisory Auditor	12,480
26		Other GS Personnel	209,383
39			$ 382,774

CHIEF COUNSEL

1	GS-15	Attorney - Advisor	$ 14,061
2	GS-14	Attorney - Advisor	24,960
7		Other GS Personnel	52,346
10			$ 91,367

PATENT COUNSEL

1	GS-14	Patent Advisor	$ 12,750
1	GS-14	Patent Counsel	12,480
8		Other GS Personnel	59,824
10			$ 85,054

FINANCIAL MANAGEMENT OFFICE

1	GS-15	Financial Management Officer	$ 14,706
1	GS-15	Deputy Financial Management Officer	14,394
1	GS-15	Budget Officer	14,061
1	GS-14	Deputy Budget Officer	12,480
1	GS-14	Supervisory Accountant	12,750
1	GS-14	Supervisory Auditor (Internal Review)	12,480
1	GS-14	Financial Program Specialist	12,480
1	GS-14	Supervisory Systems Accountant	12,480
163		Other GS Personnel	1,218,914
171			$1,324,745

MANAGEMENT SERVICES

1	Excep.	C/Management Services Office	$ 15,517
1	GS-15	Deputy Chief, MSO	13,749
1	GS-15	Personnel Officer	14,394
2	GS-15	AST, Technical Management	27,498
1	GS-14	Administrative Services Officer	12,750
1	GS-14	Personnel Management Specialist	12,480
1	GS-14	Security Officer	12,750
2	GS-14	Publication Officers	26,000
270		Other GS Personnel	2,019,060
40		Wage Board Personnel	259,600
320			$2,413,798

PROCUREMENT & CONTRACTS OFFICE

1	Excep.	Chief, Procurement & Contracts Office	$ 15,517
2	GS-15	Procurement Specialists	27,791
2	GS-15	Procurement and Contracting Officer	27,823
6	GS-14	Contract Negotiators	74,130
3	GS-14	Supervisory Procurement Analyst	37,190
3	GS-14	Industrial Specialists	37,710
218		Other GS Personnel	1,630,204
235			$1,850,365

TECHNICAL SERVICES

[illegible]	Excep.	Chief, Technical Services Office	$ 16,016
[illegible]	GS-15	Dep. Chief, Tech. Services (Operations)	14,061
1	GS-15	General Engineer (Safety)	14,061
[illegible]	GS-14	General Engineer	12,480
2	GS-14	Technical Services Planning Officer	12,480
1	GS-14	Industrial Specialist	12,230
[illegible]	GS-14	Chief, Plant Maintenance	12,480
1	GS-14	Supervisory General Supply Officer	13,270
1	GS-14	Technical Services Operations Officer	12,480
383		Other GS Personnel	2,864,074
360		Wage Board Personnel	2,336,400
762			$5,320,032

OPERATIONS ANALYSIS OFFICE

1	GS-15	Management Analysis Officer	$ 15,038
1	GS-14	Supv. Analytical Statistician	12,480
2	GS-14	Supv. Management Analyst	26,000
17		Other GS Personnel	127,126
[illegible]			$ 180,644

LUNAR PROGRAM PLANNING OFFICE

1	Excep.	Chief, LPPO	$ 18,512
1	GS-15	AST, Technical Management	15,038
1	GS-15	AST, Experimental Planning & Equipment	14,706
1	GS-15	AST, Experimental Facilities & Equipment	15,038
1	GS-15	AST, Project Management	14,061
1	GS-14	AST, Space Sciences	13,520
2	GS-14	AST, Experimental Facilities Techniques	24,460
28		Other GS Personnel	209,384
36			$ 324,719

LIGHT & MEDIUM VEHICLE OFFICE

1	GS-18	Chief, Project Office	$ 18,512
1	Excep.	Project Manager	16,016
4	GS-15	AST, Project Management	57,572
3	GS-15	AST, Launch Vehicle Project Mgmt.	43,451
3	GS-15	AST, Flight Systems	44,450
1	GS-15	AST, Flight Systems Test	15,038
1	GS-15	AST, Electrical Systems	14,706
6	GS-14	AST, Flight Systems	76,730
4	GS-14	AST, Electrical Systems	52,270
3	GS-14	AST, Liquid Propulsion Systems	38,750
1	GS-14	AST, Industrial Specialist	12,480
1	GS-14	Publication Officer (Phys. Science & Eng.)	12,480
72		Other GS Personnel	538,416
1		Wage Board Personnel	6,490
102			$ 947,361

MICHOUD OPERATIONS

1	Excep.	Manager	$ 18,01[illegible]
2	GS-15	AST, Technical Management	28,767
3	GS-15	AST, Project Management	44,782
1	GS-15	AST, Launch Vehicle Project Mgmt.	15,038
1	GS-15	AST, Liquid Propulsion Systems	14,394
3	GS-15	AST, Flight Systems	41,559
1	GS-14	Security Officer	12,230
3	GS-14	AST, Flight Systems	37,190
2	GS-14	AST, Liquid Propulsion Systems	24,710
2	GS-14	AST, Propulsion System Project Mgmt.	24,460
3	GS-14	AST, Launch Vehicle Project Mgmt.	36,730
1	GS-14	Publication Officer (Phys. Science & Eng.)	12,230
77		Other GS Personnel	575,806
100			$ 885,909

FUTURE PROJECTS OFFICE

1	Excep.	Chief, Future Projects Office	$ 16,515
1	Excep.	Project Manager	15,517
1	GS-15	AST, Technical Management	14,061
2	GS-14	AST, Technical Management	24,960
17		Other GS Personnel	127,126
22			$ 198,179

TECHNICAL PROGRAM COORDINATION OFFICE

2	GS-15	AST, Technical Management	$ 30,076
1	GS-15	AST, Space Flight Program Coordinator	15,038
1	GS-14	AST, Space Flight Program Coordinator	12,750
6	GS-14	AST, Project Management	74,920
63		Other GS Personnel	471,114
73			$ 603,898

SATURN SYSTEMS OFFICE

1	Excep.	Chief, Saturn Systems	$ 18,512
1	Excep.	Staff Scientist - Engineer	17,015
2	Excep.	Project Manager	31,533
6	GS-15	AST, Project Management	88,900
1	GS-15	AST, Technical Management	15,038
3	GS-15	AST, Launch Vehicle Project Mgmt.	42,849
3	GS-15	AST, Flight Systems	42,516
1	GS-15	AST, Flight Systems - Test	14,394
1	GS-15	AST, Liquid Propulsion Systems	15,038
2	GS-14	AST, Launch Vehicle Project Mgmt.	26,000
6	GS-14	AST, Flight Systems	75,440
2	GS-14	AST, Flight Systems - Test	26,000
9	GS-14	AST, Project Management	110,070
1	GS-14	AST, Technical Management	13,520
2	GS-14	AST, Electrical Systems	25,230
67		Other GS Personnel	501,026
108			$1,063,081

RESEARCH PROJECTS DIVISION

1	Excep.	Chief, R&D Division	$ 18,512
1	Excep.	Deputy Chief, R&D Division	16,515
1	GS-16	R&D Branch Chief	15,517
1	GS-15	AST, Space Sciences	14,394
1	GS-15	AST, Orbital and Trajectory Studies	14,061
2	GS-15	AST, Aerostructural Dynamics	28,787
1	GS-15	AST, Nuclear Propulsion & Power	14,061
3	GS-15	AST, Flight Systems	42,849
1	GS-14	AST, Space Sciences	12,230
1	GS-14	AST, Basic Properties Materials	13,520
1	GS-14	AST, Polymeric Materials	13,520
1	GS-14	AST, Energy Conversion	12,480
1	GS-14	AST, Chemical Energy Processes	12,480
1	GS-14	AST, Nuclear Energy Processes	12,480
2	GS-14	AST, Materials	25,750
2	GS-14	AST, Automated Control Systems	24,710
7	GS-14	AST, Flight Systems	87,920
3	GS-14	AST, Experimental Mfg. Proj. Mgmt.	36,940
3	GS-14	AST, Numerical Analysis Techniques	38,130
4	GS-14	AST, Project Management	48,920
32		Other GS Personnel	239,296
70			$ 743,072

MANUFACTURING ENGINEERING DIVISION

1	Excep.	Chief, R&D Division	$ 16,515
1	Excep.	Deputy Chief, R&D Division	16,016
2	Excep.	Chief, R&D Branch	31,034
2	GS-15	AST, Fluid & Flight Mechanics	29,100
1	GS-15	AST, Aerostructural Dynamics	14,061
2	GS-15	AST, Flight Systems	28,767
3	GS-15	AST, Experimental Mfg. Project Mgmt.	42,242
1	GS-15	AST, Electrical Flight & Support Equip.	14,394
3	GS-15	AST, Electrical Experimental Equip.	42,232
1	GS-15	AST, Experimental Planning & Equip.	14,061
1	GS-15	AST, Technical Management	14,394
4	GS-15	AST, Experimental Fac. & Equip.	57,840
1	GS-15	AST, Structural Materials	14,394
1	GS-15	AST, Structural Mechanics	14,706
2	GS-15	AST, Materials	29,105
2	GS-14	AST, Launch Veh. Project Mgmt.	24,460
4	GS-14	AST, Materials	49,190
7	GS-14	AST, Experimental Mfg. Techniques	88,180
2	GS-14	AST, Structural Mechanics	25,230
8	GS-14	AST, Electrical Systems	104,630
12	GS-14	AST, Experimental Mfg. Project Mgmt.	147,420
4	GS-14	AST, Electric Flight Support Equip.	51,480
3	GS-14	AST, Experimental Facilities & Equip.	38,750
1	GS-14	AST, Industrial Specialist	12,480
336		Other GS Personnel	2,288,268
485		Wage Board Personnel	3,148,650
860			$6,357,599

TEST DIVISION

1	Excep.	Chief, R&D Division	$ 18,512
1	Excep.	Deputy Chief, R&D Division	17,015
1	Excep.	Chief, R&D Branch	16,016
1	GS-15	AST, Technical Management	14,061
6	GS-15	AST, Flight Systems - Test	85,697
2	GS-15	AST, Liquid Propulsion Systems	29,099
1	GS-15	AST, Automated Control Systems	14,706
1	GS-15	AST, Experimental Facilities & Equipment	14,706
1	GS-15	AST, Project Management	13,749
3	GS-14	AST, Liquid Propulsion Systems	37,710
9	GS-14	AST, Flight Systems - Test	112,710
8	GS-14	AST, Flight Systems	100,400
1	GS-14	AST, Launch Vehicle Project Mgmt.	13,000
1	GS-14	AST, Automated Control Systems	12,750
1	GS-14	AST, Launch Operations Project Mgmt.	12,230
1	GS-14	AST, Propulsion Systems Project Mgmt.	12,480
1	GS-14	AST, Industrial Specialist	12,480
265		Other GS Personnel	1,981,670
415		Wage Board Personnel	2,693,350
720			$5,2[illegible]

COMPUTATION DIVISION

1	Excep.	Chief, R&D Division	$ 18,512
1	Excep.	Deputy Chief, R&D Division	16,515
1	Excep.	Tech. Assistant to Chief	15,517
1	Excep.	R&D Branch Chief	15,517
1	GS-15	Digital Computer Systems Admin.	14,394
1	GS-15	AST, Numerical Analysis Techniques	14,061
3	GS-15	AST, Technical Management	44,138
4	GS-15	AST, Data Systems	58,527
1	GS-15	AST, Project Management	13,749
4	GS-14	AST, Flight Systems	51,500
3	GS-14	AST, Electrical Systems	37,460
2	GS-14	AST, Measurement & Instrumentation Sys.	25,480
4	GS-14	AST, Automated Control System	50,460
1	GS-14	AST, Flight Missions Measurement	12,230
6	GS-14	AST, Data Systems	78,550
1	GS-14	AST, Numerical Analysis Techniques	12,480
124		Other GS Personnel	927,272
1		Wage Board Personnel	6,490
160			$1,412,852

ASTRIONICS DIVISION

1	Excep.	Chief, R&D Division	$ [illegible]
2	Excep.	Deputy Chief, R&D Division	33,031
5	Excep.	Chief, R&D Branch	81,578
1	GS-16	Chief, R&D Branch	15,517
6	GS-15	AST, Technical Management	84,536
4	GS-15	AST, Project Management	59,244
1	GS-15	AST, Fluid & Flow Systems	15,038
6	GS-15	AST, Fluid & Flight Mechanics	85,032
12	GS-15	AST, Control & Guidance Systems	175,173
2	GS-15	AST, Fluid Mechanics	28,125
6	GS-15	AST, Flight Systems	87,299
7	GS-15	AST, Measurement & Instrumentation Sys	104,896
9	GS-15	AST, Automated Control Systems	129,112
3	GS-15	AST, RDD Frequency Systems	44,789
1	GS-15	AST, Telemetry	15,038
2	GS-15	AST, Data Systems	15,038
8	GS-14	AST, Fluid & Flight Mechanics	100,390
12	GS-14	AST, Control & Guidance Systems	149,030
3	GS-14	AST, Flight Structures	37,460
22	GS-14	AST, Measurement & Instrumentation Sys.	278,890
2	GS-14	AST, Heat & Light Measurement	24,[illegible]
21	GS-14	AST, Automated Control Systems	265,830
4	GS-14	AST, Radio Frequency Systems	52,790
1	GS-14	AST, Antennas	12,750
3	GS-14	AST, Telemetry	38,750
2	GS-14	AST, Electrical Systems	24,710
5	GS-14	AST, Fluid and Flow Systems	62,170
2	GS-14	AST, Project Management	24,460
477		Other GS Personnel	3,567,006
290		Wage Board Personnel	1,622,500
880			$7,253,144

AEROBALLISTICS DIVISION

1	Excep.	Chief, R&D Division	$ [illegible]
1	Excep.	Deputy Chief, R&D Division	17,015
2	Excep.	Chief, R&D Branch	32,032
1	GS-16	Chief, R&D Branch	15,517
3	GS-15	AST, Technical Management	42,204
2	GS-15	AST, Project Management	28,767
1	GS-15	AST, Experimental Planning & Equip	14,061
6	GS-15	AST, Flight Systems	85,697
3	GS-15	AST, Flight & Fluid Mechanics	43,493
1	GS-15	AST, Orbital and Trajectory Studies	14,394
2	GS-15	AST, Measurement & Instrumentation Sys.	28,767
1	GS-15	AST, Electrical Flight & Support Equip	14,394
1	GS-15	AST, Flight Systems - Test	13,749
2	GS-15	AST, Electrical Systems	28,143
1	GS-14	AST, Space Sciences	12,750
3	GS-14	AST, Aerostructural Dynamics	37,440
1	GS-14	AST, Orbital & Trajectory Studies	13,000
2	GS-14	AST, Electrical Experimental Equip	26,000
1	GS-14	AST, Technical Management	12,480
5	GS-14	AST, Control & Guidance Systems	63,730
1	GS-14	AST, Industrial Specialist	13,000
2	GS-14	AST, Measurement & Instrumentation Sys.	25,750
1	GS-14	AST, Flight Systems	12,750
1	GS-14	AST, Automated Control Systems	13,270
3	GS-14	AST, Launch Opns. Proj. Mgmt.	36,940
1	GS-14	AST, Experimental Planning & Equip.	13,520
231		Other GS Personnel	1,727,418
20		Wage Board Personnel	129,800
300			$2,534,593

PROPULSION & VEHICLE ENGINEERING DIVISION

1	Excep.	Chief, R&D Division	$ 18,512
2	Excep.	Deputy Chief, R&D Division	34,029
1	Excep.	Staff Scientist	15,517
1	Excep.	Chief, Program Office	16,016
3	Excep.	R&D Branch Chiefs	47,549
3	GS-15	AST, Flight Structures	44,143
2	GS-15	AST, Propulsion & Power	28,787
2	GS-15	AST, Liquid Propulsion Systems	28,455
2	GS-15	AST, Electrical Propulsion & Power	28,158
1	GS-15	AST, Nuclear Propulsion & Power	14,394
4	GS-15	AST, Propulsion Systems Project Mgmt.	56,015
[illegible]	GS-15	AST, Flight Systems	1[illegible]0,984
2	GS-15	AST, Flight Systems Test	28,788
1	GS-15	AST, Electrical Systems	14,394
1	GS-15	AST, Flight & Support Equipment	14,394
1	GS-15	AST, Data Systems	14,394
3	GS-15	AST, Experimental Facilities & Equip.	43,806
3	GS-15	AST, Project Management	44,450
4	GS-15	AST, Technical Management	56,577
1	GS-14	AST, Experimental Mfg. Techniques	12,480
1	GS-14	AST, Fluid & Flight Mechanics	13,000
1	GS-14	AST, Materials and Structures	12,480
2	GS-14	AST, Materials	25,230
1	GS-14	AST, Structural Materials	12,480
2	GS-14	AST, Basic Properties Materials	25,250
3	GS-14	AST, Structural Mechanics	36,930
8	GS-14	AST, Flight Structures	102,160
2	GS-14	AST, Propulsion & Power	25,750
1	GS-14	AST, Solid Propulsion Systems	12,480
10	GS-14	AST, Liquid Propulsion Systems	126,670
5	GS-14	AST, Electrical Propulsion & Power	65,540
2	GS-14	AST, Nuclear Propulsion & Power	26,000
10	GS-14	AST, Propulsion Systems Project Mgmt.	124,340
20	GS-14	AST, Flight Systems	268,100
16	GS-14	AST, Project Management	195,680
1	GS-14	AST, Aeronautical Power Plt. Res. Eng.	12,750
8	GS-14	AST, Experimental Facilities & Equip.	102,210
2	GS-14	AST, Electric Flight Suppurt Equip.	24,980
5	GS-14	AST, Technical Management	61,400
3	GS-14	AST, Flight Mechanics	26,000
553		Other GS Personnel	4,135,334
118		Wage Board Personnel	765,820
825			$6,943,426

LAUNCH OPERATIONS DIRECTORATE

1	Excep.	Chief, R&D Division	$ [illegible]
2	Excep.	Deputy Chief, R&D Division	33,530
2	Excep.	Chief, R&D Branch	32,032
1	GS-15	AST, Space Sciences	13,749
2	GS-15	AST, Fluid & Flight Mechanics	29,744
1	GS-15	AST, Control & Guidance Systems	14,394
2	GS-15	AST, Liquid Propulsion Systems	29,392
1	GS-15	AST, Prop. System Project Mgmt.	14,394
10	GS-15	AST, Flight Systems	142,564
5	GS-15	AST, Flight Systems Test	71,483
2	GS-15	AST, Electrical Systems	29,397
[illegible]	GS-15	AST, Launch Veh. Project Mgmt.	[illegible]
3	GS-15	AST, Launch Opns. Project Mgmt	42,242
1	GS-15	AST, Measurement & Instrumentation Sys	13,749
2	GS-15	AST, Electrical Flight & Support Equip	28,436
1	GS-15	AST, Flight Mission Measurement	14,394
1	GS-15	AST, Data Systems	15,038
4	GS-15	AST, Space Flight Program Coordinator	56,559
4	GS-15	AST, Exper. Facilities & Equipment	59,488
4	GS-15	AST, Technical Management	55,953
1	GS-14	AST, Flight Missions Measurement	12,480
1	GS-14	AST, Flight Mechanics	13,000
1	GS-14	AST, Space Center Planning	13,520
6	GS-14	AST, Flight Range Coordination	75,320
1	GS-14	AST, Space Flight Program Coordination	12,480
2	GS-14	AST, Flight Systems Test	25,230
10	GS-14	AST, Launch Opns. Project Mgmt.	123,030
1	GS-14	AST, Numerical Analysis Tech.	12,750
10	GS-14	AST, Experimental Facilities & Equip	127,620
5	GS-14	AST, Experimental Facilities Techniques	61,940
5	GS-14	AST, Project Management	61,150
4	GS-14	AST, Technical Management	49,170
4	GS-14	AST, Industrial Specialist	51,940
3	GS-14	AST, Flight Systems	36,690
10	GS-14	AST, Launch Vehicle Proj. Mgmt	122,300
4	GS-14	Publication Officer (Phys. Science & Eng.)	24,700
627		Other GS Personnel	4,785,563
78		Wage Board Personnel	506,846
828			$6,797,026

QUALITY ASSURANCE DIVISION

1	Excep.	Chief, R&D Division	$ 17,015
1	Excep.	Deputy Chief, R&D Division	16,016
1	Excep.	Chief, R&D Branch	15,517
1	GS-16	Chief, R&D Branch	15,787
2	GS-15	AST, Fluid & Flight Mechanics	29,100
1	GS-15	AST, Control & Guidance Systems	14,394
1	GS-15	AST, Flight Mechanics	15,038
1	GS-15	AST, Fluid Mechanics	13,749
1	GS-15	AST, Project Management	14,706
1	GS-15	AST, Aerostructural Dynamics	14,061
1	GS-15	AST, Experimental Planning & Equip.	14,061
1	GS-15	AST, Liquid Propulsion Systems	14,061
8	GS-15	AST, Flight Systems	117,396
2	GS-15	AST, Flight Systems Test	28,788
2	GS-15	AST, Electrical Systems	28,767
2	GS-15	AST, Technical Management	28,767
2	GS-15	AST, Experimental Facilities & Equip.	29,100
1	GS-15	AST, Automated Control Systems	13,749
8	GS-14	AST, Flight Systems	97,840
2	GS-14	AST, Flight Systems Test	25,750
5	GS-14	AST, Electrical Systems	61,400
1	GS-14	AST, Experimental Mfg. Project Mgmt.	12,230
1	GS-14	AST, Control & Guidance Systems	13,000
5	GS-14	AST, Liquid Propulsion Systems	64,900
2	GS-14	AST, Flight Mechanics	26,000
2	GS-14	AST, Propulsion Systems Proj. Mgmt.	24,460
2	GS-14	AST, Launch Veh. Project Mgmt.	24,460
7	GS-14	AST, Launch Operations Project Mgmt.	85,860
2	GS-14	AST, Exp. Mfg. Project Mgmt.	24,710
2	GS-14	AST, Radio Frequency Systems	24,460
2	GS-14	AST, Elec. Flight Systems Equip	24,980
2	GS-14	AST, Data Systems	24,710
2	GS-14	AST, Exp. Facilities & Equip.	26,000
3	GS-14	AST, Exp. Planning & Equipment	37,460
2	GS-14	AST, Project Management	24,460
10	GS-14	AST, Technical Management	127,190
2	GS-14	AST, Industrial Specialist	26,000
1	GS-14	Publication Officer (Phys. Science & Eng.)	12,230
387		Other GS Personnel	2,893,986
20		Wage Board	129,800
500			$4,251,958

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Proposed Personnel Staffing Chart
FISCAL YEAR 1963

WALLOPS STATION

OFFICE OF DIRECTOR

1	Excepted Director	$18,013
3	GS personnel	27,996
4		$46,009

FLIGHT TEST DIVISION

1	Excepted Chief of division	$15,517
1	GS-14 Assistant branch head	12,480
3	GS-14 Branch head	37,440
1	GS-14 Engineer	12,230
83	Other GS personnel	626,224
95	Wage board personnel	586,675
184		$1,290,566

CONSTRUCTION OFFICE

1	GS-14 Planning engineer	$ 12,750
9	Other GS personnel	74,070
10		$ 86,820

TECHNICAL SERVICES DIVISION

25	GS personnel	$137,076
136	Wage board personnel	841,842
161		$978,918

ADMINISTRATIVE SERVICES DIVISION

1	GS-14 Chief of division	$ 12,230
58	Other GS personnel	340,390
22	Wage board personnel	135,952
81		$488,572

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Proposed Personnel Staffing Chart
FISCAL YEAR 1963

SPACE NUCLEAR PROPULSION OFFICE (CLEVELAND EXTENSION)

OFFICE OF THE CHIEF

1 GS-15 Chief	$14,061
1 Other GS personnel	5,013
2	$19,074

TECHNICAL OPERATIONS

1 GS-15 Assistant Chief, technical operations	$14,706
1 GS-15 Facilities engineer	15,038
4 GS-15 Aerospace technologist	56,889
1 GS-14 Technical site representative	12,230
8 GS-14 Facilities engineer	100,400
10 GS-14 Aerospace technologist	124,860
15 Other GS personnel	107,976
40	$432,099

ADMINISTRATION

1 GS-15 Procurement Officer	$14,061
1 GS-14 Programs Officer	12,480
6 Other GS personnel	38,477
8	$65,018

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

FISCAL YEAR 1963 ESTIMATES

21 TRAVEL AND TRANSPORTATION OF PERSONS

	1961	1962	1963
NASA Headquarters	$1,069,435	$1,982,500	$3,449,000
Western Operations Office	85,623	183,000	271,000
Langley Research Center	569,374	725,000	865,000
Ames Research Center	153,592	261,000	507,000
Lewis Research Center	273,696	481,000	936,000
Flight Research Center	136,417	145,000	178,000
Goddard Space Flight Center	852,240	1,544,000	2,960,000
Manned Spacecraft Center	700,812	1,138,000	3,574,000
Marshall Space Flight Center	1,549,687	2,845,000	3,390,000
Wallops Station	59,518	99,000	204,000
Space Nuclear Propulsion Office	---	37,500	171,000
Total	$5,450,394	$9,441,000	$16,505,000

Analysis by types of travel

Direction and coordination of program and business activities at NASA installations	$618,085	$997,000	$1,817,000
Coordination of program activities with other Government agencies, contractors, and the scientific community	1,855,641	3,387,000	5,861,000
Travel to launching sites and global tracking stations	1,319,768	2,137,000	4,457,000
Meetings of NASA technical committees and working panels, and technical and scientific societies	459,085	741,000	1,234,000
Travel to initial duty stations, temporary assignments and transfers, and emergency relocation site	265,709	549,000	872,000
Travel of consultants and lecturers	38,485	112,000	145,000
Charter aircraft service	654,562	1,195,000	1,585,000
All other travel	48,716	53,000	53,000
Total	5,260,051	9,171,000	16,024,000
Local transportation and toll charges	38,245	78,000	111,000
Rental of passenger motor vehicles	152,098	192,000	370,000
Total	$5,450,394	$9,441,000	$16,505,000

The increase in travel and transportation of persons funds requested should be viewed in context with the size and complexity of space missions and the distances between key space program locations. Over 80% of the increase requested is required in the following major areas:

(1) Direction and coordination of program and business activities at NASA installations,

(2) Coordination of program activities with other Government agencies, contractors, and the scientific community, and

(3) Travel to launch sites and global tracking stations.

The funding level proposed in these estimates includes increased requirements in all program areas, but the majority of the additional funds are required in implementation of the manned lunar landing program. It is evident that the technological problems attending successful accomplishment of this program will require considerable travel on the part of management to direct and coordinate the numerous research and development tasks undertaken by NASA installations. Effective monitoring is imperative to assure that all elements of the program are keeping pace with development and flight schedules. Consultation at the working group level must be maintained to determine new areas to be investigated and to exploit new research information and newly developed techniques. Research conferences must be held periodically to coordinate work among the various Centers and to revise program priorities in those areas where individual program segments are lagging behind mission requirements.

Execution of the agency's space missions is also dependent on the scientific talents and contributions of other Government agencies and the participation of a larger segment of the Nation's research, development and industrial capacity, including significant support from educational institutions and other nonprofit organizations. The coordination and direction of these activities will require substantial travel, particularly in the development of multi-stage launch vehicles and in liquid, solid, and nuclear propulsion systems. Supervision of contractual effort in supporting systems, instrumentation, and the development of advanced electronic tracking systems will also involve considerable travel to contractor plants. Continuous consultations with industry are essential to resolve the numerous technical problems relating to vehicles, spacecraft, and propulsion systems currently under design, the evaluation of contractor performance, the examination of alternate design concepts, and the adaptation of new technology to the development effort. Increased travel will be required for the administration and operation of Government-owned vehicle fabrication and engine test sites and the expanded vehicle launching areas. Further, the distances of NASA installations from the increasing

number of industrial participants in the space program contributes materially to the rise in travel requirements.

The planned launching schedule in both the manned and unmanned flight programs will require a considerable increase in travel for the fiscal year 1963. As a prerequisite to orbital flights of integrated systems, atmospheric, ballistic, and suborbital launchings are performed for the acquisition of scientific data, the evaluation of the flight performance of components and subsystems, and the range testing of telemetry and electronic tracking gear. In this connection, intensive travel of technical personnel to the launching sites is necessary to supervise launch operations and to provide essential logistic support.

Orbital flights, particularly in the manned flight program, necessitate considerable travel of technical teams to launching sites for preflight checkouts, spacecraft assembly, vehicle and spacecraft integration, and to provide necessary support services. Similar tasks will be performed in the launching of operational meteorological and communications satellites, and in the unmanned lunar and planetary missions. During the manned orbital operational periods, a significant increase in travel will be required for the detail of medical and technical personnel to the global tracking stations in order to maintain constant contact with the astronauts while in flight. Other travel requirements include periodic visits by techicians to supervise the calibration and modernization of tracking equipment and the replacement of obsolescent equipment at world-wide tracking sites.

To a lesser degree, increased travel funding is requested for the attendance of personnel at domestic and foreign technical and scientific meetings and symposiums, to defray expenses of travel of newly appointed personnel, and to provide for the reassignment of employees to new duty stations. Funds for chartered aircraft are also increasing in the fiscal year 1963 on routes where passenger density is high and commercial services do not meet the need.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

FISCAL YEAR 1963 ESTIMATES

22 TRANSPORTATION OF THINGS

	1961	1962	1963
NASA Headquarters	$90,528	$248,000	$492,000
Western Operations Office	2,565	15,000	13,000
Langley Research Center	227,733	298,000	324,000
Ames Research Center	41,206	75,000	100,000
Lewis Research Center	158,073	435,000	540,000
Flight Research Center	15,464	21,000	45,000
Goddard Space Flight Center	747,073	1,300,000	1,600,000
Manned Spacecraft Center	285,920	1,200,000	1,329,000
Marshall Space Flight Center	441,346	1,042,000	1,470,000
Wallops Station	90,553	147,000	147,000
Space Nuclear Propulsion Office	---	5,000	10,000
Total	$2,100,461	$4,786,000	$6,070,000

Analysis by types of services

Shipment of household goods	$374,461	$1,517,000	$1,465,000
Transportation of supplies and equipment	1,617,372	3,073,000	4,357,000
Rental of nonpassenger type vehicles	108,628	196,000	248,000
Total	$2,100,461	$4,786,000	$6,070,000

Estimates under this head include requirements for the shipment of personal effects and household goods, the transportation of commodities, and the acquisition of nonpassenger conveyances on a rental basis.

Expenses incurred for the shipment of household goods and personal effects of employees have been instrumental in attracting and retaining qualified personnel in shortage categories. The estimates submitted for this purpose for the fiscal year 1963 are, for the most part, required in connection with the recruiting of employees outside the immediate area of their initial duty stations. Other requirements provide for the transfer of employees between NASA installations when such transfers are considered to be in the best interests of the Government. During the fiscal year 1962, the relocation of personnel engaged in the manned space flight program from Hampton, Virginia, to the Houston, Texas, area will be substantially completed. Reduced requirements are therefore reflected in the fiscal year 1963 request for funds for the shipment of household goods.

Shipping costs relating to the acquisition of supplies and equipment, and in the hauling of such items to and from delivery points, will increase in proportion to the level of funding requested for the procurement of commodities in the fiscal year 1963. Included under this category are requirements for the shipment of spacecraft and components to launching sites, and the movement of electronic gear to the global tracking stations.

The small increase requested for the rental of nonpassenger vehicles is solely related to the contractual motor fleet operations at the Marshall Space Flight Center and other sites under its jurisdiction. The increase in program activity and the maintenance of expanding launching areas and fabrication and engine test sites will require additional leased vehicles in support of operations, including the replacement of Government-owned trucks which are eligibile for replacement. It is considered more economical to meet the expanding vehicle needs on a contractual basis in lieu of any further investments in capital equipment.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

FISCAL YEAR 1963 ESTIMATES

23 RENT, COMMUNICATIONS, AND UTILITIES

Analysis by Location	1961	1962	1963
NASA Headquarters	$603,866	$1,521,000	$2,303,000
Western Operations Office	116,451	179,000	186,000
Langley Research Center	3,427,649	3,853,000	4,780,000
Ames Research Center	2,947,071	3,378,000	4,252,000
Lewis Research Center	2,411,054	2,155,000	3,270,000
Flight Research Center	230,168	427,000	255,000
Goddard Space Flight Center	4,139,107	8,009,000	16,500,000
Manned Spacecraft Center	639,875	1,707,000	3,333,000
Marshall Space Flight Center	7,520,772	9,194,000	10,819,000
Wallops Station	342,061	498,000	735,000
Total	$22,378,074	$30,921,000	$46,433,000

Analysis by Types of Services			
Rents:			
Electronic equipment:			
Research computations	$10,422,344	$15,041,000	$27,214,000
Business operations	1,258,296	1,472,000	1,068,000
Buildings and land	415,982	1,701,000	2,995,000
Other rentals	283,791	749,000	824,000
	12,380,413	18,963,000	32,101,000
Communications:			
Local telephone and exchange service	860,142	1,399,000	1,720,000
Long-distance toll charges	936,839	1,374,000	1,618,000
Leased lines	249,000	751,000	1,182,000
Telegraph service	137,586	225,000	266,000
Postage	6,000	15,000	24,000
Penalty mail	170,100	240,000	270,000
	2,359,667	4,004,000	5,080,000
Utilities:			
Electric power	6,300,708	6,560,000	7,434,000
Other utilities	1,337,286	1,394,000	1,818,000
	7,637,994	7,954,000	9,252,000
Total	$22,378,074	$30,921,000	$46,433,000

Rent

Electronic equipment:

The increasing volume and complexity of mathematical techniques involved in the solution of problems arising in aerodynamics, space technology, and related theoretical fields requires the utilization of electronic data reduction and computing equipment, since man cannot perform the necessary calculations within a reasonable time period. Future investigations in space depend to a considerable extent on the capability of presently available electronic equipment to provide sufficient data from current programs on a timely basis.

Improved equipment for high-speed operation is continually being developed, and the unit costs for purchase or rental of the advanced types of equipment are rising. The NASA must utilize every significant improvement in order to meet its program schedules and increase the probability of successful ventures in space. The funding level proposed for the fiscal year 1963 will provide for additional advanced electronic computing equipment and for continued use of present equipment in multiple shift operations. A list of the equipment proposed to be rented follows.

RENTAL OF ELECTRONIC COMPUTING EQUIPMENT

	Number of units	Fiscal Year 1963 Funding			
		Prime shift	Second shift	Third shift	Total rental
NASA Headquarters:					
ADP computer....	1	$60,000	---	---	$60,000
Autonetics computer.....	1	30,000	---	---	30,000
EAM.....	1	25,000	---	---	25,000
Miscellaneous...	-	35,000	---	---	35,000
		150,000	---	---	150,000
Langley Research Center:					
IBM-7090.....	1	786,000	$164,000	---	950,000
IBM-7070.....	1	317,000	124,000	---	441,000
IBM-1401.....	4	273,000	104,000	---	377,000
IBM-1620.....	2	88,000	12,000	---	100,000
Miscellaneous...	-	269,000	---	---	269,000
		1,733,000	404,000	---	2,137,000

RENTAL OF ELECTRONIC COMPUTING EQUIPMENT - CONTINUED

	Number of units	Fiscal Year 1963 Funding: Prime shift	Second shift	Third shift	Total rental
Ames Research Center:					
IBM-7090.....	1	$861,000	$157,000	---	$1,018,000
IBM-1401.....	3	183,000	52,000	---	235,000
MH-800.....	1	406,000	160,000	$38,000	604,000
Miscellaneous.....	-	60,000	---	---	60,000
		1,510,000	369,000	38,000	1,917,000
Lewis Research Center:					
IBM-7090.....	1	733,000	76,000	---	809,000
IBM-1401.....	1	105,000	25,000	---	130,000
IBM-610.....	1	28,000	---	---	28,000
Miscellaneous.....	-	63,000	---	---	63,000
		929,000	101,000	---	1,030,000
Flight Research Center:					
IBM-704.....	1	125,000	---	---	125,000
Miscellaneous.....	-	20,000	---	---	20,000
		145,000	---	---	145,000
Goddard Space Flight Center:					
IBM-7090.....	7	6,510,000	2,475,000	2,170,000	11,155,000
(4th shift).....		---	---	630,000	630,000
IBM-1401.....	3	270,000	---	---	270,000
IBM-650.....	1	250,000	---	---	250,000
Super-speed.....	1	2,100,000	420,000	---	2,520,000
Miscellaneous.....	-	441,000	---	---	441,000
		9,571,000	2,895,000	2,800,000	15,266,000
Manned Spacecraft Center:					
IBM-7090.....	2	1,050,000	200,000	---	1,250,000
IBM-1401.....	3	253,000	---	---	253,000
Miscellaneous.....	-	243,000	---	---	243,000
		1,546,000	200,000	---	1,746,000

RENTAL OF ELECTRONIC COMPUTING EQUIPMENT - CONTINUED

	Number of units	Fiscal Year 1963 Funding			
		Prime shift	Second shift	Third shift	Total rental
Marshall Space Flight Center:					
IBM-7090.....	2	$2,099,000	$897,000	---	$2,996,000
IBM-1410.....	1	432,000	161,000	---	593,000
IBM-1401.....	8	432,000	125,000	---	557,000
Miscellaneous.....	-	1,393,000	---	---	1,393,000
		4,356,000	1,183,000	---	5,539,000
Wallops Station:					
IBM-7090.....	1	273,000	---	---	273,000
IBM-650.....	1	61,000	---	---	61,000
Miscellaneous.....	-	18,000	---	---	18,000
		352,000	---	---	352,000
Total.....		$20,292,000	$5,152,000	$2,838,000	$28,282,000

Buildings and land:

Because of anticipated increases in staff and the fact that several buildings now occupied are scheduled to be torn down, NASA Headquarters will require approximately 150,000 square feet of office space in the District of Columbia in addition to space now occupied and to become available in 1963. The additional space will be used primarily to house the Office of Manned Space Flight, consisting of about 460 employees. Several small area recruiting offices will also be established at such places as New York, Los Angeles, and Dallas. In some instances, these will require rental of office space.

The Marshall Center will need about 285,000 square feet of office space in Huntsville during 1963 to house a part of their staff. New buildings scheduled for completion in 1963 will free some of this space to house new employees and contractor employees from the Michoud Plant detailed to Marshall for training. In addition, it will be necessary to house a varying number of personnel in space near the Atlantic Missile Range until appropriate facilities become available.

Most of the Manned Spacecraft Center personnel and functions will be transferred from Hampton, Virginia, to Houston, Texas, prior to June 30, 1962. Current construction schedules provide for completion of the first permanent buildings in FY 1964. Until that time, leased office space must be used for a staff which will increase from about 1,200 on June 30, 1962,

to about 2,400 on June 30, 1963. A total of approximately 480,000 square feet will be required.

Rental space will be required in 1963 for a computing facility in New York to be used in the Goddard Space Flight Center's programs involving theoretical studies at various universities in the area. Goddard will also need to rent temporarily office, storage, and laboratory space in the District of Columbia area pending completion of permanent quarters at the Center. Tracking station leases will also continue.

In 1963, it is planned to continue to rent an office building at Santa Monica, California, to house the Western Operations Office, the functions of which have been expanded to include technical as well as administrative work.

Other rentals:

Estimates are included for the fiscal year 1963 to cover other rental requirements for such items as small calculators, duplicators, recorders, tape units, and facsimile posting equipment. Such items are used at all NASA locations.

Communications

The intensified space program is a direct factor in support of the increased funding requested for the fiscal year 1963 for communications. The completion of new research and development facilities, the establishment of a new Center at Houston, Texas, and the proposed staff increases will require additional local telephone and exchange service. Substantially all of the funds requested in this category are for rental of instruments, associated equipment, and switchgear. Relocation of telephone equipment to accommodate necessary reassignment of personnel is also included.

The intensified program, new facilities, and increased staff will also directly affect the need for long distance toll service. The timely execution of the agency's missions necessitates constant communications with other Government agencies, contractors, and the scientific community in coordinating programs of mutual interest. The resolution of difficulties in preparation for launch operations and the necessary contacts with global tracking stations during the immediate post-launch period also require the use of long distance telephone facilities.

Leased lines have been found to be more economical and expeditious in handling communications when traffic load factors are sufficiently high, or when specific need for an independent system arises. Often, traffic load factors may warrant the use of more than one line between certain locations. The proposed schedule of leased lines for the fiscal year 1963 follows.

COMMUNICATIONS - LEASED LINES

Leased Lines	1961	1962	1963
NASA Headquarters:			
Washington to Langley Center.....	$9,000	$9,000	$15,000
Washington to Western Office.....	41,000	56,000	82,000
Washington to Atlantic Missile Range.....	---	18,000	36,000
Washington to Manned Spacecraft Center.....	---	5,000	27,000
Washington to Lewis Center.....	---	1,000	12,000
Washington to New York.....	---	2,000	6,000
Miscellaneous tie lines and circuits.	---	9,000	22,000
	50,000	100,000	200,000
Langley Research Center:			
Langley Center to Wallops Station....	4,000	4,000	4,000
Lewis Research Center:			
Cleveland to Plum Brook Station.....	5,000	10,000	10,000
Cleveland to NASA Headquarters.....	2,000	11,000	---
Cleveland to any point in the eastern half of the United States.....	---	29,000	65,000
	7,000	50,000	75,000
Flight Research Center:			
Edwards, Calif., to Ely and Beatty, Nevada.....	96,000	91,000	---
Edwards and San Bernardino, Calif., to Angel's Peak, Nevada, and Boron, Calif.....	---	18,000	18,000
	96,000	109,000	18,000
Goddard Space Flight Center:			
Silver Spring to NASA Headquarters...	---	3,000	---
Goddard to Valley Forge & Princeton..	---	15,000	28,000
Goddard to local key points.....	---	22,000	30,000
Goddard to Atlantic Missile Range....	---	---	10,000
Goddard to Wallops Station.....	---	---	7,000
	---	40,000	75,000

COMMUNICATIONS - LEASED LINES - CONTINUED

Leased Lines	1961	1962	1963
Manned Spacecraft Center:			
Langley Center to Atlantic Missile Range	---	$18,000	---
Langley Center to St. Louis, Mo.	---	20,000	---
Langley Center to NASA Headquarters	---	9,000	---
Langley Center to Downey, Calif.	---	18,000	---
Langley Center to Houston, Texas	---	28,000	$15,000
Houston to Downey, Calif.	---	12,000	40,000
Houston to Marshall Center	---	10,000	30,000
Houston to Atlantic Missile Range	---	21,000	50,000
Houston to AMR (closed circuit TV)	---	---	93,000
Houston to St. Louis, Mo.	---	---	35,000
Houston to New Orleans, La.	---	---	10,000
Miscellaneous tie lines and circuits	---	20,000	43,000
	---	156,000	316,000
Marshall Space Flight Center:			
Marshall to Atlantic Missile Range	$54,000	124,000	124,000
Marshall to Patrick AFB	14,000	14,000	14,000
Marshall to AMR (video)	---	---	97,000
Marshall to NASA Headquarters	2,000	28,000	28,000
Marshall to Langley Center	---	13,000	14,000
Marshall to New Orleans, La.	---	21,000	54,000
Marshall to Birmingham, Ala.	8,000	17,000	17,000
Marshall to key local points	10,000	23,000	23,000
Marshall to Santa Monica, Calif.	---	40,000	55,000
Pt. Mugu to Pt. Arguello, Calif.	---	---	5,000
Miscellaneous tie lines and circuits	---	---	49,000
	88,000	280,000	480,000
Wallops Station:			
Wallops Island to Wallops Station	1,000	---	---
Wallops Station to NASA Headquarters	---	4,000	5,000
Wallops Station to Goddard Center	---	4,000	5,000
Wallops Station to Langley Center	3,000	4,000	4,000
	4,000	12,000	14,000
Total	$249,000	$751,000	$1,182,000

Minor increases are requested for telegraphic service, postage, and penalty mailings in direct support of the program level proposed for the budget year.

Utilities

Electric power:

Requirements under this head are largely concerned with the operation of research facilities at the Langley, Ames, and Lewis Research Centers. Increased usage of the air removal system for the 16-foot transonic, the 7- by 10-foot tunnels and the Unitary Plan tunnel at the Langley Center will require additional power, and nominal increases are anticipated at the other research centers. The Goddard and Marshall Space Flight Centers will need additional power for newly completed facilities, and the Manned Spacecraft Center at Houston, Texas, will start operations in this time period.

Other utilities:

In addition to routine heat and water consumption, some major facilities such as wind tunnels and nuclear reactors require large amounts of gas, water, and steam under pressure for experimental operation and for facility cooling purposes. These requirements are grouped under the heading of other utilities.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

FISCAL YEAR 1963 ESTIMATES

24 PRINTING AND REPRODUCTION

Analysis by Location	1961	1962	1963
Headquarters	$310,192	$1,437,000	$2,500,000
Western Operations Office	---	3,000	11,000
Langley Research Center	32,072	42,000	40,000
Ames Research Center	7,529	8,000	10,000
Lewis Research Center	4,774	25,000	40,000
Flight Research Center	1,993	2,000	5,000
Goddard Space Flight Center	70,090	70,000	100,000
Manned Spacecraft Center	1,995	30,000	100,000
Marshall Space Flight Center	348,803	450,000	500,000
Wallops Station	2,243	10,000	15,000
Total	$779,691	$2,077,000	$3,321,000

Analysis by Types of Printing			
Scientific and technical reports	$183,625	$ 496,000	$ 744,000
Special reports and brochures	165,090	754,000	1,463,000
Printed forms and letterheads	141,779	243,000	318,000
Micellaneous printing and binding	289,197	584,000	796,000
Total	$779,691	$2,077,000	$3,321,000

NASA printing funds are used primarily to defray the cost of printing scientific and technical reports and publications used by NASA, industrial contractors, other Government agencies, and the scientific community at large; for the preparation and publication of special reports and brochures distributed to the general public and educational institutions; for printing of technical and administrative material largely for use within the agency; and for binding of technical periodicals to be placed in the libraries of the agency for use by the NASA scientific and technical staff.

The scientific and technical reports and publications printed by the NASA include knowledge newly acquired in the conduct of the agency's own research and development programs as well as that acquired through other than NASA sources, such as translations of pertinent foreign publications. Certain of the agency reports are carefully evaluated and selected as permanent reference documents and constitute official public reports on the agency's operations. The reports are widely used by the military organizations, the aircraft industry, the air transport industry, contractors engaged in allied fields, other

Government agencies, educational institutions, and scientific organizations and individuals. A limited distribution is also made to selected public libraries throughout the country. As the data from the various types of space explorations and investigations currently planned becomes available and its significance is analyzed and related to current knowledge, the number of reports will increase, and additional funds will be required for their printing.

There is an increasing public demand for material on the program content, objectives, and accomplishments of the NASA. An active program to meet this demand is now in progress, including the publication and dissemination of material for use by educators at the state and local levels. Material for use in recruiting the scientific talent required in carrying out the agency's programs is also provided for under printing funds.

Printing of technical and administrative materials for use within the agency is an expanding requirement as the size and complexity of the agency increases.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

FISCAL YEAR 1963 ESTIMATES

25 OTHER SERVICES

Analysis by Location	1961	1962	1963
NASA Headquarters	$ 4,812,586	$13,917,500	$30,646,000
Western Operations Office	7,768	14,000	25,000
Langley Research Center	1,966,460	2,293,000	3,015,000
Ames Research Center	831,000	1,250,000	1,897,000
Lewis Research Center	1,295,727	2,003,000	2,336,000
Flight Research Center	338,000	1,092,000	2,232,000
Goddard Space Flight Center	1,739,000	3,620,000	2,840,000
Manned Spacecraft Center	587,000	3,503,000	3,614,000
Marshall Space Flight Center	8,603,861	15,864,000	18,338,000
Wallops Station	977,000	2,217,000	2,750,000
Total	$21,158,402	$45,773,500	$67,693,000
Analysis by Types of Services			
Repairs, alterations, and minor construction	$ 5,524,902	$ 9,208,000	$11,694,000
Miscellaneous services	10,030,000	27,564,000	46,577,000
Services of other agencies	5,603,500	9,001,500	9,422,000
Total	$21,158,402	$45,773,500	$67,693,000

Funds requested under this heading are used for: (1) repairs and alterations to buildings, facilities, scientific equipment, shop and office equipment, and mobile equipment; (2) commercial miscellaneous services in specialized scientific and engineering areas, management analysis and administrative systems and controls, maintenance activities, services requiring large or unusual shop equipment, and in other specialized areas such as preparation and dissemination of educational exhibits and materials for use within and outside the United States; and (3) for services most economically obtained from other agencies of the government, such as security investigations (Civil Service Commission), auditing of major contracts (Army and Navy), downrange tracking and recovery of experimental payloads at Wallops Station (Navy), and miscellaneous maintenance and operational services at specific locations (e.g., Army at the Marshall Space Flight Center, Air Force at the Atlantic Missile Range, and Agriculture at the Goddard Space Flight Center).

Repairs, alterations, and minor construction:

There is a continuing need for routine repairs and alterations to existing buildings, facilities, and equipment, particularly for facilities, and components that are being operated close to maximum capacity on urgent programs related to space missions. In addition, as new techniques are developed and perfected, alterations to facilities become essential to permit their utilization in the most effective manner. For the same reason, minor construction under $250,000 of modest additional facilities often saves considerable time in getting new parts of a program under way which would otherwise have to wait for the next authorization bill for a suitable facility. Modernization of major items of instrumentation and equipment is also done under this heading. Repairs and alterations to shop and office equipment, to utility installations and air compressor systems, and to automotive equipment and aircraft form a minor but necessary part of the requirements.

Miscellaneous services:

As the nation's space program expands there will be a greatly expanded need to utilize commercial and non-profit organizations having specialized scientific, engineering, and technical capabilities not available, or available only to a limited extent, within NASA. In such areas as reliability monitoring, operation and programming of electronic computing and data reduction equipment, and feasibility studies of certain phases of space missions, the utilization of such organizations will assist materially in meeting our launch schedules with the highest probability of success.

Many management and administrative problems associated with rapid organizational expansion can best be analyzed by outside groups who specialize in these services. It is planned to contract for studies on the most important management and administrative problems during the fiscal year 1963.

In order to provide for adequate dissemination of technical and general information to the public and to technical users about the Nation's space program a broad technical information and education program is planned for fiscal year 1963. This will include publications, motion pictures, mobile exhibits, and material for use by teaching staffs, and an effort to collect and collate technical data on past and ongoing programs for wide use. A substantial contractual effort will be needed in this area.

Maintenance services include custodial services, rodent control, and chemical cleaning, the need for which will increase along with increased plant and operational level. Shop services include machine shop services for components too large or too complex for in-house equipment.

Services of other agencies:

Particularly at locations where such services are readily available, the NASA makes use of other agencies of the government on a reimbursable basis. The services obtained vary from maintenance and custodial services to operation of a small weather predicting station, and include auditing, contract administration, downrange tracking and recovery of payloads at Wallops Station, and machine shop services. There is a saving realized by obtaining the services in this manner, and in some cases the service is only available from the agency involved. In 1963, there will be continued need for services of other agencies in support of the space program. The estimate includes $30,000 to cover NASA's share of expenses for the Presidential Missile Sites Labor Commission.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

FISCAL YEAR 1963 ESTIMATES

26 SUPPLIES AND MATERIALS

	1961	1962	1963
NASA Headquarters	$ 365,000	$ 410,000	$ 1,017,000
Western Operations Office	13,000	29,000	35,000
Langley Research Center	3,285,000	3,907,000	5,161,000
Ames Research Center	1,604,000	1,650,000	2,000,000
Lewis Research Center	3,775,000	5,905,000	6,517,000
Flight Research Center	376,000	546,000	768,000
Goddard Space Flight Center	1,094,000	1,718,000	1,800,000
Manned Spacecraft Center	205,000	1,429,000	1,850,000
Marshall Space Flight Center	4,250,000	5,410,000	7,300,000
Wallops Station	849,000	1,000,000	1,200,000
Total	$15,816,000	$22,004,000	$27,648,000

Analysis by types of supplies

Building materials	$ 386,000	$ 545,000	$ 631,000
Chemicals	776,000	911,000	880,000
Electric	1,796,000	2,073,000	2,407,000
Electronic	1,882,000	2,614,000	3,714,000
Fuels and lubricants	1,772,000	2,969,000	3,462,000
General maintenance	547,000	775,000	1,074,000
General operating	1,363,000	1,862,000	2,335,000
General service	402,000	488,000	673,000
Hardware	617,000	974,000	1,031,000
Instrumentation	880,000	1,471,000	1,859,000
Metals	1,795,000	2,076,000	2,905,000
Missiles, aircraft, and vehicles	304,000	660,000	908,000
Office	1,676,000	2,134,000	3,008,000
Photographic	732,000	938,000	1,090,000
Pipes, valves, and fittings	743,000	1,331,000	1,376,000
Publications, pamphlets, and documents	145,000	183,000	295,000
Total	$15,816,000	$22,004,000	$27,648,000

This object heading comprises the supplies and materials used for operations at all NASA locations. Included are materials for fabrication of experimental components, research apparatus, auxiliary equipment and test rigs. Also included are expendable items used in machine shop and instrument work, and materials for maintenance and improvements to buildings and facilities. Propellants, fuels, and lubricants for small-scale and large-scale tests of propulsion devices are other major items. Minor items such as office, medical, security, and safety supplies, together with miscellaneous items such as photographic supplies and subscriptions to publications, make up the balance of the requirements.

As operations at all Centers continue to expand to support larger and more complex space missions, the supplies and materials consumed will increase both in number and in the quantity of each item used. Inventory control is practiced at all NASA locations, and the inventories are kept at the level required for efficient operation. Supplies withdrawn and not used are returned to stock, and surplus lists are exchanged to permit transfers of items between locations.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

FISCAL YEAR 1963 ESTIMATES

31 EQUIPMENT

	1961	1962	1963
NASA Headquarters	$ 149,000	$ 303,000	$ 752,000
Western Operations Office	24,000	50,000	35,000
Langley Research Center	1,963,000	2,293,000	3,017,000
Ames Research Center	1,758,000	1,810,000	2,648,000
Lewis Research Center	3,632,000	5,787,000	5,950,000
Flight Research Center	357,000	578,000	1,228,000
Goddard Space Flight Center	1,442,000	3,432,000	3,325,000
Manned Spacecraft Center	328,000	3,951,000	2,856,000
Marshall Space Flight Center	2,839,000	5,587,000	6,075,000
Wallops Station	560,000	615,000	1,600,000
Total	$13,052,000	$24,406,000	$27,486,000

Analysis by types of equipment

Electrical and mechanical equipment	$ 3,476,000	$ 6,172,000	$ 6,823,000
Instrumentation and electronic equipment	5,482,000	8,722,000	11,080,000
Portable hand tools	175,000	488,000	378,000
Photographic, reproduction, and drafting equipment	521,000	934,000	1,193,000
Machine and fabrication equipment	1,028,000	2,621,000	2,707,000
Chemical equipment	175,000	283,000	553,000
Office and laboratory equipment	1,724,000	3,854,000	3,691,000
Motorized vehicles and manual handling equipment	315,000	514,000	486,000
Firefighting equipment	7,000	43,000	47,000
Medical and safety equipment	54,000	601,000	397,000
Books	95,000	174,000	131,000
Total	$13,052,000	$24,406,000	$27,486,000

The equipment needed to support the research and development activities undertaken at NASA installations is included here. Other equipment items which are directly program-oriented or related to construction of facilities are contained elsewhere in the estimates.

To minimize expenditures for the procurement of capital equipment, surplus listings of other Government agencies are carefully screened for available items. Other economies, particularly in the procurement of electronic and recording instruments, are affected through the establishment of centralized equipment pools at all installations, thereby assuring greater utilization of existing items and reducing requirements for the procurement of new equipment.

The funding level requested reflects, in addition to the procurement of new equipment, a continuation of the agency's conservative replacement program for items which have outlived their economic usefulness. In many instances, replacements will also be required as a result of the technical obsolescence of existing equipment.

As indicated above, approximately 77 per cent of the increase requested is attributable to instrumentation and electronic equipment, such as oscillographs, potentiometers, analog computers, pressure and temperature measuring instruments, telemeters, and recording equipment.

Precise measurements are vitally necessary in the conduct of research investigations and exploratory experiments. To this end, the best instrumentation should be utilized so that test objectives and program requirements are not compromised. A portion of the items which we replaced with new equipment are utilized in research operations where some degree of variance in accuracy is acceptable; others are salvaged to provide components for use in the construction of instruments which are either unavailable commercially or are excessive in cost. In many fields of research, however, a high equipment attrition rate is unavoidable. This is particularly true in those areas where equipment is used to instrument rockets which are launched into the atmosphere and are irretrievable. Work on high-performance military and commercial aircraft also contribute materially to the need for advanced instrumentation. Of the increase requested in the budget year for instrumentation and electronic equipment, 70 per cent is required in support of the fundamental research effort at the agency's research centers.

Increased funding will also be required for electrical and mechanical equipment. Items under this class are primarily required in the erection of research rigs and test stands and for the improvement and modernization of processing systems and service installations. Included are such items as electric motors and generators, transformers, pumps, filters, valves, gyroscopes, and pressure gages. A substantial portion of the total requirement under this head is required in support of operations at the Lewis Center. At this site, research activity on power plants and components, auxiliary power units, and on toxic and exotic fuels are conducted in numerous test cells where research rigs and test stands are constantly being erected, torn down, and rebuilt. Requirements at the other NASA installations are mostly for improving and modernizing utility installations and the replacement of overaged equipment.

All of the increase requested for photographic, reproduction, and drafting equipment is in support of work at the Wallops Station. The expansion of launch operations at this site, and the characteristics of new and improved sounding rockets and small launch vehicles generates the need for modernizing certain items of equipment. The high altitudes now being attained in Wallops launchings and the greater range coverage require improved photographic and optical equipment for support of the radar and telemetry tracking systems. Requirements at other NASA installations are expected to remain constant for the fiscal year 1963.

Minor increases are being requested for chemical and fire fighting equipment to support program requirements and for the maintenance of essential supporting services.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

FISCAL YEAR 1963 ESTIMATES

42 INSURANCE CLAIMS AND INDEMNITIES

	1961	1962	1963
NASA Headquarters	$8,753	$110,000	$110,000
Langley Research Center	---	---	2,000
Ames Research Center	---	---	1,000
Lewis Research Center	---	---	1,000
Goddard Space Flight Center	---	---	1,000
Manned Spacecraft Center	---	---	1,000
Total	$8,753	$110,000	$116,000
Analysis by types of payments			
Tort claims	$5,753	$ 10,000	$ 16,000
Awards	3,000	100,000	100,000
Total	$8,753	$110,000	$116,000

The estimates under this head provide for the payment of accidental damage claims to property resulting from the conduct of the agency's operations, and for the payment of monetary awards for scientific and technical contributions pursuant to Section 306 of the National Aeronautics and Space Act of 1958.

The amounts included for the field installations for the fiscal year 1963 cover the administrative delegation of payments for minor tort claims to the field offices.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

FISCAL YEAR 1963 ESTIMATES

MERCURY

SUMMARY OF REQUIREMENTS

	1961	1962	1963	Page No.
Advanced Technical Development.....	$ 2,737,000	$ 2,258,000	$ --	RDO 1-2
Flight Program.....	121,593,000	66,020,000	13,259,000	RDO 1-2
Total.....	$124,330,000	$68,278,000	$13,259,000	

OBJECTIVES:

Project Mercury is the initial step in the NASA Manned Space Flight Program. The objectives of this project are to determine man's capabilities in the space environment and to develop the technology required for manned space flight missions.

JUSTIFICATION:

All preliminary steps leading up to manned orbital flight were successfully completed by the end of calendar year 1961. These steps included the manned suborbital flights by Astronauts Shepard and Grissom, which qualified the basic flight systems in the space environment; a single-orbit mission of an instrumented spacecraft; and a two-orbit mission with the chimpanzee, Enos, in the spacecraft. The orbital flights tested all of the spacecraft systems and the ground tracking and data acquisition systems.

FY 1963 funding is required for the last flights of Project Mercury. In the final Project Mercury missions, a manned spacecraft will be placed into earth-orbit, will circle the earth for three orbits, and will return to earth. The first of these missions is planned for FY 1962 with several successive manned orbital flights extending into FY 1963. Funds requested will provide for contractor support at Cape Canaveral, recovery operations conducted by the Navy, meteorological support provided by the U. S. Weather Bureau, flight monitors at the world-wide tracking network stations, and the acquisition and analysis of flight data and results.

FUNDING REQUIREMENTS:

	1961	1962	1963
Advanced Technical Development.....	$2,737,000	$2,258,000	---

With the planned completion of Project Mercury in FY 1963, no additional advanced technical development funds will be required for this project.

Flight Programs	1961	1962	1963
Capsules, Equipment, and Services.....	$60,474,000	$30,215,000	$7,569,000
Tracking, Data Acquisition and Control Network.....	25,254,000	---	---
Flight Operations.....	---	4,091,000	2,490,000
Recovery Operations.....	5,029,000	12,833,000	3,200,000
Launch Vehicles.....	30,836,000	18,881,000	---
Total.....	$121,593,000	$66,020,000	$13,259,000

Capsules, Equipment, and Services

FY 1963 funds are required to support the effort of the Mercury spacecraft contractor (McDonnell Aircraft Corporation) through the completion of the project. Funds will primarily be used for contractor effort in the preparation of each spacecraft prior to flight.

Tracking, Data Acquisition, and Control Network

FY 1961 funds for the procurement, installation, testing and operation of the Project Mercury tracking, data acquisition and control network were included in this category. Completion, modification, improvement and operation of the network in FY 1962 and FY 1963 are now funded in the Tracking and Data Acquisition Program.

Flight Operations

FY 1963 funds will support the remaining Mercury manned orbital flights currently planned for that year. Included in this category is the support by the U. S. Weather Bureau for meteorological services, the services of flight monitors at world-wide tracking stations, and the acquisition and analysis of flight data.

Recovery Operations

These funds will provide for reimbursement to the U. S. Navy for their services in recovering the Mercury spacecraft. Recovery support is provided not only in the eight primary recovery areas in the Atlantic Ocean but also on a contingency basis around the entire world.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

FISCAL YEAR 1963 ESTIMATES

ADVANCED MANNED SPACE FLIGHT

SUMMARY OF REQUIREMENTS:

	1961	1962	1963	Page No.
Manned Spacecraft Technology	$ 2,020,000	$ 14,952,000	$ 11,764,000	RDO 2-3
Aerospace Medicine	4,246,000	17,244,000	19,320,000	RDO 2-4
Flight Program	---	115,045,500	832,544,000	RDO 2-6
Total	$ 6,266,000	$147,241,500	$863,628,000	

OBJECTIVES:

To carry out the manned exploration of space, and to develop man's capability to perform effectively in the space environment. As the major step in the present program, to achieve a manned lunar landing and return to earth.

JUSTIFICATION:

Despite impressive accomplishments and improvements in instrument design, precision, and reliability, the most significant achievements in space will result from man's presence in the space environment. Man's unique ability to make critical decisions, to observe, and to reason cannot be duplicated, even by the most advanced technical systems.

The first major step in manned space exploration will be a mission to land man on the moon and return him safely to earth. As the President stated in May, 1961, the earliest achievement of such a landing is one of this Nation's goals. The Advanced Manned Space Flight Program is designed to take advantage of the experience and information gathered from each successive step in the overall program which includes Project Mercury, Project Gemini and Project Apollo.

Project Mercury was planned as the initial effort in the United States manned space flight program. The project, through the ballistic sub-orbital flights of astronauts Shepard and Grissom, has already provided fundamental data on man's reaction to zero gravity and his ability to perform effectively in the space environment. By the end of FY 1962, Project Mercury will have provided detailed information on man's capabilities in a weightless state for periods of up to 4 1/2 hours.

As the next step in manned space flight, and in order to take maximum advantage of the successful Project Mercury experience, Mercury capsules are being modified to accomplish manned missions of one-day duration. These missions will make maximum use of the Mercury system and will expose man to considerably extended periods in the space environment.

Project Gemini, which will follow the manned one-day flights, is based on the decision made in FY 1962 to initiate the development of a rendezvous-in-earth-orbit technique as a means of achieving an early manned lunar landing. By overcoming the limitations of current booster capabilities, and the limitations of boosters available in the near future, the rendezvous technique may make a manned lunar landing possible before one can be achieved through the direct ascent approach. Project Gemini will use advanced two-man Mercury-type spacecraft, and is designed to produce the necessary experience in rendezvous techniques through the practice of rendezvous and docking maneuvers with a modified Agena-B booster stage.

Meanwhile, NASA will continue to press the development of the direct ascent method of reaching the moon, based on the NOVA launch vehicles, as well as the rendezvous method, based on the Advanced Saturn, in order to achieve the earliest possible manned lunar landing. For either method, a common Apollo spacecraft is being developed. Both Project Mercury and Project Gemini will produce data which will be incorporated into the design and operation of the Apollo spacecraft. Project Apollo is progressing on a schedule fully compatible with developments in the necessary launch vehicles.

The Apollo spacecraft will be modular. The crew will be housed in a command module, a service module will contain support and various propulsion systems, and a lunar landing module will be added to land the command and service modules on the moon.

The effort devoted to Apollo will be substantially increased in FY 1963, as the development of the command and service modules builds up, and as the first test hardware is delivered. Tests of flight hardware will be initiated in FY 1963 using solid rocket suborbital launch vehicles.

The Manned Spacecraft Technology effort provides necessary support to Project Gemini and Project Apollo, exploring alternative lunar landing systems and conducting in-house evaluation and testing of contractor developments. It also funds contracts for independent studies of state-of-the-art technology and alternative methods of achieving program objectives.

Aerospace Medicine funds will provide NASA with the data and information necessary to insure that man performs to his maximum capability in space, through research and study of the problems arising in the space environment.

FUNDING REQUIREMENTS:

Manned Spacecraft Technology	1961	1962	1963
Mission analysis	$ 363,000	$ 857,000	$ 480,000
Systems development & analysis	1,657,000	10,520,000	6,120,000
Mission simulation and training	---	1,525,000	2,235,000
Operational methods and systems	---	2,050,000	2,929,000
Totals	$ 2,020,000	$14,952,000	$11,764,000

To insure successful and timely completion of the Gemini two-manned spacecraft and the Apollo lunar landing spacecraft, the Manned Spacecraft Center engages in intensive, in-house test and evaluation of spacecraft and related area contractor developments. Alternate spacecraft systems must also be evaluated as potential backups or replacements for the primary systems. The Manned Spacecraft Center contracts under this project for services to obtain independent evaluations of state-of-the-art technology, for studies of alternate techniques for accomplishing technical objectives, and for procurement of existing hardware to be tested and evaluated by its technical personnel.

Mission Analysis

This area provides for the analysis of manned space flight missions to determine optimum trajectories, guidance and control requirements, abort considerations, and tracking and data acquisition requirements. From such studies, recommendations regarding configurations, guidance and control techniques to be utilized, as well as pilot display requirements and other operational techniques will result. The studies in this area will be theoretical in nature. Development of specific hardware resulting from these studies will be funded under Systems Development and Analysis.

Systems Development and Analysis

This area provides for the evaluation of backup spacecraft systems hardware, spacecraft test instrumentation, and scientific equipment as required to support the manned spacecraft missions.

Mission Simulation and Training

Studies of mission simulation requirements and the development of mission simulators and crew training equipment are funded in this area. All phases of orbital, circumlunar and lunar landing flight are considered in order to simulate on the ground many of the tasks and problems that the astronaut will face in space. Simulation of the rendezvous and docking process is particularly important to both Project Gemini and Project Apollo. Advanced technical studies and developments on these problems provide a base for the requirements of each of the flight projects.

Operational Methods and Systems

Studies and evaluation of operational techniques and sub-systems are funded in this area. All phases of a mission are investigated including preparation for launch, launch, earth-moon communications and control, earth landing and retrieval systems operation, ground handling and displays of flight data.

Aerospace Medicine

	1961	1962	1963
Acceleration and weightlessness effects	$1,830,000	$ 6,130,000	$ 6,275,000
Radiation protection	1,190,000	3,800,000	5,410,000
Life support systems	1,226,000	4,656,000	4,780,000
Crew medical selection and monitoring	--	2,658,000	2,855,000
Total	$4,246,000	$17,244,000	$19,320,000

The Aerospace Medical effort in the Manned Space Flight Programs has the objectives of insuring the safety, reliability and effective performance of the flight and ground operations personnel during the preparation and conduct of manned flight missions. To accomplish these objectives on a time scale compatible with the development and flight schedules, development and testing effort is needed in the following areas: effects of weightlessness and acceleration; radiation protection for Apollo; life support systems requirements; and medical selection and monitoring of crews. In addition to industrial contracts, a substantial portion of this work will be accomplished at Department of Defense facilities on an individual task basis.

Acceleration and Weightlessness Effects

The physiological effects of prolonged periods of zero gravity are not known. It is necessary to evaluate the possibly harmful effects of stress on human subjects due to changes in the gravitational-inertial

force-environment. Human and animal subjects will be exposed to ground based approximations of selected portions of Project Apollo and other space flight profiles in disorientation devices to study their psycho-physiological responses to the varied force environments to be encountered during manned space flights.

Animal experimentation is required to validate findings and extrapolated assumptions obtained from the above study programs. Effort in FY 1963 will provide for the completion of development of animal experiments and the required equipment, which was started in FY 1962.

Booster phase and reentry acceleration forces anticipated during manned space flight profiles will be duplicated in dynamic flight simulators to study human physiological reactions to such forces. Other stress factors such as noise and vibration which may adversely affect pilot performance and produce undesired psycho-motor performance aberrations must be determined. Performance degradation and psycho-physiological tolerance limits must be defined for each planned flight mission profile. The development of bio-sensors is required to evaluate the effects of space flight and for ground based studies. In addition, the development of specific in-flight experiments will be accomplished.

Radiation Protection

Protection of the Apollo flight crews from radiations in space which will be encountered during the circumlunar and manned lunar landing missions is the primary objective of work in this area. Effort in FY 1963 includes the following essential parts: development and biomedical testing of Apollo shielding materials and techniques; development and testing of instrumentation to measure the radiation dose received by the crews; continuing studies to define the biological effects of the energy spectra and flux levels which may be encountered during solar events; and correlation and analysis of physical data obtained on the space radiation environment to evaluate the hazards associated with the several mission profiles.

Life Support Systems

Development and testing in life support and environmental control requirements and methodology in FY 1963 is necessary for the longer duration (7 -14 day) flight mission profiles of Project Gemini and Project Apollo. This effort should determine adequate atmospheric composition and investigate methods of maintaining that atmosphere within permissible tolerances to avoid accumulation of toxic gases and particles, trace contaminants,and humidity in the cabin.

Development of restraint and positional systems and methods to maintain optimal musculo-skeletal tone will parallel development of

nutrition and waste disposal equipment and techniques. Development of intra-and extra-vehicular full pressure suit and system requirements and techniques for escape, transfer, survival, and rescue will constitute a substantial segment of the effort in life support systems studies. Human subjects will be used to study systems performance and psycho-physiological effects of environmental factors to be encountered in manned space flights.

Crew Medical Selection and Monitoring

The success of the manned flight missions will be related directly to the reliability of the crews involved. Because mission profiles extend beyond any heretofore experienced, considerable study will be devoted to the development of well-defined and meaningful psychological and physical examinations and testing of astronaut candidates. It is necessary for groups of subjects with varied physical features and mental postures to be subjected to searching physical examinations and laboratory analysis while under normal and stress conditions. These groups will experience complete batteries of psychological tests to determine the psycho-physiological factors regarded as essential for astronauts. Studies in this area are required prior to the selection of additional astronauts for manned space flight. Development of biomedical monitoring equipment and techniques, and systems for the collection, storing and processing of psycho-physiological data will also be pursued in FY 1963.

Flight Program

Manned One-Day Mission

	1961	1962	1963
Capsules, equipment & services	--	--	$4,500,000
Flight operations	--	--	1,480,000
Recovery operations	--	--	6,200,000
Total	--	--	$12,180,000

Gemini

Spacecraft			
Spacecraft development			
Engineering	--	$ 7,900,000	$22,500,000
Fabrication and procurement	--	26,100,000	86,000,000
Flight test support	--	--	2,150,000
Operational support	--	699,500	15,200,000
Supporting development	--	--	5,500,000

	1961	1962	1963
Launch vehicles			
Titan II	--	$21,900,000	$ 50,000,000
Atlas-Agena	--	4,200,000	21,850,000
Total	--	$60,799,500	$203,200,000
Apollo			
Spacecraft			
Command & service module	--	$35,800,000	$345,000,000
Lunar landing module	--	3,250,000	123,100,000
Guidance and navigation system	--	4,900,000	32,400,000
Instrumentation & scientific equipment	--	1,600,000	11,500,000
Operational support	--	1,100,000	2,500,000
Supporting development	--	2,150,000	3,000,000
Launch vehicles			
Solid, suborbital	--	5,446,000	8,800,000
Saturn, C-1	--	--	90,364,000
Total, Project Apollo and Launch Vehicles	--	$54,246,000	$617,164,000
Total, Flight Programs	--	$115,045,500	$832,544,000

MANNED ONE-DAY MISSIONS

The rapid progress on Project Mercury in the form of successful manned sub-orbital flights and unmanned orbital test flights and the immediate prospect of manned orbital flight in FY 1962 has led to a change in the current planning for the total resources of the project. Effort has been initiated in FY 1962 and will be continued in FY 1963 to modify four Mercury spacecraft to carry astronauts on one-day missions of about eighteen orbits around the Earth. This modification effort will extend the time that a Mercury spacecraft will support a man in orbit from the current $4\frac{1}{2}$-hour mission to a 24-hour mission. Four manned one-day missions are now planned for the latter part of 1962 and early 1963.

The objectives of the manned one-day mission include the achievement of space flight for the longest period possible at the earliest

date possible; the collection of data on man's reaction to zero gravity and to the space environment for extended periods of time; the collection of data on the functioning of spacecraft sub-systems over extended periods of time; and the realization of the maximum potential of Project Mercury. Information from these longer duration flights will be of value to both the two-man spacecraft development, Project Gemini, and the three-man spacecraft development, Project Apollo.

Mercury-Atlas launch vehicles similar to those used on Project Mercury flights will be used for the manned one-day missions as will the Project Mercury ground support equipment. The Mercury tracking network, augmented in FY 1962 specifically for this purpose, will be used to support these one-day flights.

Capsules, Equipment and Services

Funds are requested to support modification of the flight spacecraft by the McDonnell Aircraft Corporation and contractor effort at the launch site through completion of the one-day mission. Modification of the last four Mercury spacecraft will include the addition of more cooling capacity for equipment such as the inverters and telemetry transmitters, the addition of three 3,000 watt-hour batteries, addition of hydrogen peroxide to be used by the attitude control jets and heating equipment to keep the horizon scanner within temperature limits during the longer flights. In a number of areas equipment and supplies will not need to be modified but will be utilized at their designed capacity rather than at the reduced levels used during the three-orbit flights. In order to handle the slightly increased weight of the modified Mercury capsules, posigrade and retrograde rockets more powerful than those used in the current Mercury will be procured. In FY 1962 and early FY 1963 a rocket for the posigrade and retrograde system, using higher specific impulse propellants which are currently available within the state-of-the-art, will be qualified for the one-day mission spacecraft. In the area of services, contractor personnel are located at the launch site for preparation of the spacecraft, monitoring of the spacecraft during flight, and for post flight examination.

Flight Operations

Items in this category support the conduct of the four manned one-day flights. Activities include test and checkout of the launch vehicles, the tracking network and the mission control system to insure adequate preparation for flight. This also includes such items as meteorological support provided by the U.S. Weather Bureau; flight monitors by the Philco Corporation and the acquisition of telemetry data by the Federal Electric Corporation. Funds support these organizations for services to be performed through completion of the one-day missions.

Recovery Operations

Funds budgeted in this category are required for spacecraft recovery services. Recovery services for the one-day mission will be provided by the U.S. Navy, as has been done for Project Mercury. Ships, planes, and helicopters will be deployed in a number of areas to pick up the spacecraft and pilot. These areas include Cape Canaveral to cover the possibility of an abort when the vehicle is just off the pad, near Cape Canaveral for an abort during the early stages of flight, the entire flight path from Cape Canaveral to beyond the predicted landing point in case of a late abort, and the regular impact areas for recovery from orbit. Funds requested oover these services through completion of the planned one-day missions.

GEMINI

A major advance in NASA planning for manned flight has occurred within the last eight months. It has become apparent that the use of the rendezvous technique offers the possibility of achieving a manned lunar landing earlier than does the direct ascent method. By using the Advanced Saturn launch vehicle, expected to be completed prior to the Nova launch vehicle, and rendezvous methods, it may be possible to send the Apollo spacecraft to and from the moon before such a trip would be possible using the Nova. The rendezvous and docking of spacecraft and boosters in space may be compared to aerial refueling in that it makes possible the resupply of a vehicle in space, thus extending its mission capabilities. The rendezvous maneuver makes it possible to put a much larger effective payload in space with a given type of booster. Since our planned manned space flights are limited by the booster capability available, the development of the rendezvous technique will enable us to get the most out of our earlier boosters. Also, as manned orbital flights become more frequent, there will be instances when personnel transfer and spacecraft repair needs will make the mastery of rendezvous technology essential.

In light of the attractiveness of the rendezvous concept it is necessary to determine how best to rendezvous and dock spacecraft and propulsion stages in space and whether this technique should be applied to the manned lunar landing. Project Gemini, a rendezvous and docking technique development effort, has been initiated in FY 1962. The two-man spacecraft to be used in Gemini will be launched into earth orbit by Titan II vehicles. The spacecraft will rendezvous and dock with a specially configured Agena stage that has been launched on an Atlas. The rendezvous capability that is developed here is also directly applicable to the accomplishment of a lunar landing with an Apollo spacecraft.

Project Gemini flight missions are now planned to begin in mid-1963, more than a year before manned flights in Apollo. In addition to developing and testing rendezvous and docking techniques during orbital flight, these missions will train pilots in spacecraft control and maneuver. Gemini missions will also expose astronauts to weightlessness and the space environment for periods of time approximately as long as those necessary for flight to the moon.

Spacecraft Development

The spacecraft that will be used in the Gemini development project is a successor to the Mercury capsule. Development of this two-manned spacecraft has been initiated in FY 1962. By the end of FY 1962, engineering design will have been completed and production of the spacecraft initiated. Peak production of the spacecraft will be reached during FY 1963. The first qualification flight of the spacecraft is now planned for the middle of 1963. Although the spacecraft will be based largely upon Mercury technology, it will require new subsystems for reaction control, on-board power, in-space maneuvering, and control in order to meet the demands of increased spacecraft size and extended manuverable flight.

Spacecraft and subsystem design and development will profit from experience with the Mercury capsule. The spacecraft structure will be designed to allow easy access to component subsystems, an important consideration in spacecraft checkout and repair. Subsystem components will be designed and developed employing a modular concept so that they may also be used in later spacecraft, such as the Apollo, and to permit easy replacement when necessary.

Gemini plans provide for the development and production of twelve (12) two-manned spacecraft of which three (3) will be refurbished for re-use if necessary. Eleven (11) Atlas-Agena booster stages will be modified to act as rendezvous target spacecraft. Three (3) of these will be spares. Of the twelve (12) flight missions planned, eight (8) will involve rendezvous/docking operations.

Operational Support

Operational support services for the flight missions will be provided by organizations other than the primary spacecraft contractor. Flight operations, landing and recovery, at a relatively low level in FY 1962 and part of FY 1963, will make heavy demands during the flight program. Costs for additional contractor personnel deployed with the tracking net and at the control center

and costs of necessary ship operations will appear in this category. Major emphasis in FY 1962 and early FY 1963 is on flight simulation and mission analysis. A ground-based program of rendezvous technique development, simulation, and training has been initiated in FY 1962 and will reach an optimum level during FY 1963.

Supporting Development

Funds in this category cover the development of project components and test items that are not generally included in the prime contractor's effort. Items that have been initiated in the Manned Spacecraft Technology area and are approaching the hardware fabrication stage are continued in this area. An example of this type of item is the paraglider that may be used in the spacecraft landing system.

Spacecraft landing and recovery will differ markedly from the techniques employed with Mercury. Controlled land landings of the spacecraft rather than landings at sea are an objective of the project. The magnitude of the effort required to deploy adequate naval forces for the recovery of the spacecraft at sea is such that any means for avoiding, or at least minimizing this effort is highly desirable. If space flights are to be accomplished on anything like a routine basis, spacecraft must be designed to alight on land at specified locations. Although the spacecraft will be designed to land at sea as well, a vigorous effort is under way to find a solution to the land landing problem. Of the concepts being evaluated and tested, an airplane type of landing using a paraglider shows the most promise. Landing and recovery techniques and experience will be of great value in solving similar problems with the heavier Apollo spacecraft.

Launch Vehicles

The Titan II, as modified for Gemini, will be used as the launch vehicle for the two-manned spacecraft. The Titan II is necessary to boost this larger spacecraft into earth orbit with a minimum pre-launch period on the pad. The minor modification of the Titan II for this project will not require extensive development of new components. FY 1963 funds requested are the second increment for the procurement of fifteen (15) vehicles, of which three are spares.

The Atlas-Agena launch vehicle will be used as the rendezvous target space vehicle. The specially configured Agena stage will serve both as an upper stage on the Atlas launch vehicle and as the rendezvous target. The Agena stage will undertake any necessary

gross orbit changes and maneuvers and the manned spacecraft will carry out the terminal docking maneuvers. Following launch on an Atlas booster, an initial firing of the Agena stage will be required to achieve earth orbit. The Agena restart capability will then be used for the primary rendezvous maneuvers as directed by the astronauts in the spacecraft. FY 1963 funds shown are the second increment for procurement of eleven (11) launch vehicles, of which three are spares.

APOLLO

The Apollo project covers the development and fabrication of a versatile multi-manned spacecraft to carry astronauts on a lunar landing and return mission at the earliest practicable date. The spacecraft, with its associated on-board propulsion stages, is being designed to perform its mission using either the rendezvous or the direct ascent approach.

Development of the Apollo spacecraft will be conducted in three phases.

In the first phase, a manned Apollo spacecraft will be placed in a 300 nautical mile orbit around the earth for periods as long as two weeks. This mission will provide an opportunity to test and evaluate the spacecraft systems and components and to conduct rendezvous maneuvers.

In the second phase, circumlunar flight and flight in orbit around the moon will permit close examination of lunar terrain and assessment of spacecraft systems for the final lunar landing mission.

The third phase of the project will be the manned lunar landing with the Apollo spacecraft and return to the earth.

Formidable obstacles must be overcome in the design and development of a spacecraft that will protect three astronauts from the hazards of the space environment. The Apollo will be the first manned spacecraft to leave near orbits around earth and enter outer space. The problems of exposure to radiation, puncture of the spacecraft by micrometeorites, and the effects of prolonged weightlessness, in addition to the more basic problems of mechanical reliability, all combine to challenge the ingenuity of scientists and technicians.

Based on experience with the Mercury capsule and in-house and contractor studies of the requirements for a lunar landing spacecraft, NASA selected a prime contractor for the Apollo spacecraft in FY 1962. Contractor briefings were held on the requirements and general specifications for the spacecraft, contractor proposals were subsequently evaluated and North American Aviation Corporation was selected as prime contractor. The prime contractor will develop and fabricate the spacecraft and coordinate associate contractor efforts.

Command, Service, and Lunar Landing Modules

The Apollo spacecraft will be constructed of separate modules, each designed to fulfill specific mission requirements. A command module will serve as a control center for spacecraft and launch operations, house the crew during missions, and serve as the entry and landing vehicle for all missions. A service module will house support systems and components, and will incorporate the propulsion systems required for emergency abort, retro-propulsion for return from earth orbit, mid-course flight path correction, lunar orbit, and lunar takeoff. Lunar landing will be accomplished by the addition of a lunar landing module containing a propulsion system.

The modular method of construction offers flexibility in assembling spacecraft configurations; each spacecraft will be composed of the modules necessary to fulfill mission objectives. The same command module configuration will be used for all missions. The lunar landing module will be used only on lunar landing missions.

The prime contractor will develop the command and service modules. An associate contractor will be selected to build the lunar landing module.

Major effort in FY 1962 has been devoted to the study of the many problems to be faced in spacecraft development. Feasibility tests at the laboratory level are also being conducted on potential solutions to design problems. In both FY 1962 and FY 1963 the contractor will design spacecraft modules and components and carry out test programs on early configurations of the design items. Boilerplate models of the command module will be flown as payloads on developmental Saturn flights in 1963 to test various re-entry configurations. By the end of FY 1963 initiation of the spacecraft fabrication for the first phase of the project is planned. Examples of design, development, and test effort on problems connected with the command, service, and lunar landing modules that will be conducted in FY 1963 are noted below.

Off-the-pad and post-launch abort systems must be provided for the command module. The most difficult abort task would occur while the module is in the atmosphere, and it is necessary to separate and clear the module from the launch vehicle. Since the launch vehicle would have relatively less drag than the spacecraft, merely separating from the launch vehicle would not be sufficient. The spacecraft must be able either to outrun the launch vehicle or to get off to one side and let the launch vehicle go by. An escape tower incorporating high thrust rockets, similar in principle to that used for the Mercury, may be used. Once outside the atmosphere, high thrust is no longer required and the escape tower can be jettisoned. The propulsion system on-board the spacecraft will then be used to provide the velocity increments required for return to earth from an aborted mission.

Selection of the command module detailed configuration is a major focus of attention in FY 1962 and will continue to be so during FY 1963. Configuration of the Apollo command module will be markedly different from both the Mercury and Gemini spacecraft. Spacecraft reentering the earth's atmosphere will initially be traveling at speeds in excess of 35,000 feet per second. As a result, the spacecraft will have to withstand reentry heating conditions considerably higher than those previously encountered by manned spacecraft. By jettisoning the service module prior to reentry only the command module will need thermal protection, but the provision of effective protection, particularly from radiative heating, involves extensive design and test of proposed solutions.

In order to minimize guidance problems on return to earth from the moon and problems in landing and recovery, it is essential to give the module maneuverability so that the reentry corridor is wider and the recovery areas can be predetermined. Through the use of module configurations with a lift to drag ratio of 1/2 or higher it is possible to achieve maneuverability without incurring the weight penalty of an additional propulsion system.

The on-board propulsion system that is to be included in the service module will provide propulsion for all space maneuvers and will utilize a highly reliable propellant. Instant start and restart during flight and maximum impulse with minimum weight and space are objectives of this system development. A propulsion system using storable hypergolic propellants will be designed and developed by a North American sub-contractor in FY 1962; other backup designs and developments will be pursued to insure that the best on-board propulsion system is available on a timely basis.

The designing of an Apollo command module shell that is resistant to meteoroid damage is another area of concern. Scientific satellites that will be flown by NASA should help answer the question

of how much hazardous debris is found in space. However, data from studies on material penetration and cratering at meteoric speeds are needed to design and test structures for the Apollo spacecraft.

Guidance and Navigation System

The basic guidance and navigation system for the Apollo spacecraft is being developed by the Massachusetts Institute of Technology Instrumentation Laboratory, an associate contractor on the project. The contract for the system was let in FY 1962 and will continue during FY 1963. The MIT Instrumentation Laboratory will develop the system; however, operational systems will be procured from industrial sources. FY 1963 funding for these sources is included.

The system will be an integral part of the command module and will function in all phases of the lunar landing and return mission. A design requirement for Apollo is that the spacecraft be commanded by the crew. Although information from earth-based tracking and computation may be available, the crew must be able to perform their flight mission without external aid. Navigation measurements, trajectory determinations, and calculation of required corrections will be based on information from a variety of instruments, such as automatic center and edge trackers, optical instruments of the sextant-type and radar altimeters that will be designed and developed for Apollo. Inertial guidance systems will be used during velocity corrections and reentry and as a backup to other parts of the system. During the midcourse phase of the flight, the crew may cross-check the system navigation results with data from the earth, but they will have a capability to navigate without such data input.

Instrumentation and Scientific Equipment

FY 1962 and FY 1963 funds cover analysis of mission requirements for scientific equipment systems and test instrumentation; the funds will initiate the design and fabrication of prototypes of the scientific equipment systems necessary for the different phases of the lunar landing and return mission. These systems will be used to conduct basic scientific tests while the spacecraft is in orbit around the Earth or the moon and eventually on the surface of the moon. Test instrumentation to evaluate the spacecraft and its components in flight will also be designed, developed and fabricated with these funds. A number of individual contracts will be used to procure the required systems and instrumentation.

Operational Support

Low initial levels of operational support are required for Apollo in FY 1962 and FY 1963. Contractual services are required for preparation and conduct of suborbital solid rocket and Saturn firings used

to test Apollo prototype spacecraft module structures and systems. Preparation of the test items for launch, data acquisition, recovery operations and mission analysis must be performed for each of these developmental flight tests. Effort in the operational support category will reach significant levels when first phase flights of the Apollo spacecraft are initiated.

Supporting Development

A number of supporting development tasks for the Apollo spacecraft are included in this category. The Manned Spacecraft Center will develop and test systems and sub-systems not included in the prime contract; Center personnel will also evaluate promising developments in the Manned Spacecraft Technology area and initiate hardware fabrication of items applicable to Apollo. The Center will test recovery devices, beacons, flotation and impact attenuation schemes for the command module. Funds are also included for wind tunnel tests, sled tests, and drop tests of parachute recovery systems, to be performed by other government agencies.

Launch Vehicles

A solid rocket launch vehicle will be developed and procured for the flight test of prototype Apollo spacecraft modules. The modules will undergo short range flights for the purpose of evaluating full scale configuration concepts, systems hardware performance, spacecraft structural integrity, and the Apollo spacecraft launch escape system under simulated Saturn flight conditions. The flight tests will occur during CY 1963, CY 1964 and CY 1965. Development and procurement of fourteen (14) solid vehicles was initiated in FY 1962 and will be completed in FY 1963.

Saturn C-1 launch vehicles of an operational configuration will boost into earth orbit the developmental Apollo spacecraft flown in the first phase of the project. The FY 1963 submission includes incremental funding for ten (10) of these operational Saturn C-1s. Flights of these vehicles are currently planned to begin in CY 1964.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

FISCAL YEAR 1963 ESTIMATES

SATURN C-1

SUMMARY OF REQUIREMENTS:

	1961	1962	1963	Page No.
Vehicle Development...	$116,156,000	$182,106,000	$155,533,000	RDO 3-3
Engine Development....	33,823,000	39,993,000	36,743,000	RDO 3-4
System Support.....	23,929,000	60,094,000	56,961,000	RDO 3-6
Total.....	$173,908,000	$282,193,000	$249,237,000	

OBJECTIVES:

The purpose of the Saturn C-1 development program is to develop a high thrust vehicle for general purpose application in manned or unmanned earth orbit missions, and to provide a test bed for the development of advanced systems and components associated with orbital rendezvous operations and the manned lunar landing objective.

JUSTIFICATION:

The C-1 configuration of Saturn is planned as a two-stage vehicle using clustered engines in each stage, and will be used primarily for placing approximately 10 tons of payload into low earth orbit. The first stage (S-I) is under development at the Marshall Space Flight Center, and uses the H-1 (188,000 pound thrust) engine produced by the Rocketdyne Division of North American Aviation, Inc. Production of the S-I stage will be performed by the Chrysler Missile Division at the NASA Michoud Plant in Louisiana. The second stage (S-IV) is being developed by the Douglas Aircraft Company, and uses the A-3 liquid hydrogen engine produced by the Pratt and Whitney Division of United Aircraft Corporation.

Rocket engines used for the Saturn C-1 vehicle are developed under separate contracts and supplied to the respective stage contractors as government furnished equipment. The H-1 engine that is used on the S-I stage is nearing completion of the development necessary for manned rating. The simplifications that have been incorporated have been successful and should provide a high degree of reliability. The A-3 engine is basically the same as that used on the Centaur launch vehicle This engine will be capable of producing 15,000 pounds of thrust and will be the first flight engine to utilize the high energy propellant combination of liquid oxygen and liquid hydrogen. Changes to the basic Centaur engine are kept to a minimum level consistent with the 6 engine cluster used on the S-IV stage of the Saturn C-1.

The Saturn C-1 development program offers the earliest possibility of the realization of a multi-ton payload capability for the initial phase of the manned lunar landing program. In addition, the Saturn C-1 program will support the development of high vehicle system reliability, which is of great importance to the performance of manned missions. The program will also serve as a prototype effort for gaining essential experience in the development, fabrication, and flight of large multi-stage launch vehicles; in this sense, it will serve as a valid point of departure for the development of the larger and more complex Advanced Saturn and Nova vehicles which will be needed for manned lunar landing and manned interplanetary space flight. Much of the knowledge required for the development of these larger vehicles can be a logical extension of experience gained in the Saturn C-1 program in such areas as system engineering, manufacturing, materials processing, test and checkout procedures, instrumentation and facilities, ground support equipment, transportation of stages, and, even possibly, booster recovery.

The currently planned flight test program is divided into two major phases-Block I and Block II. In Block I (flight vehicles SA-1 through SA-4), the test plan is to launch the Phase I S-I stage with dummy upper stages to explore control and environmental conditions, tracking and instrumentation problems, and the operational requirements of large vehicles. The first Block I vehicle was launched in October 1961 with virtually complete success; analysis of the flight data is now underway to permit the incorporation of any necessary design changes into subsequent vehicles. The Block II flights (flight vehicles SA-5 through SA-10) will consist of the Phase II S-I stage (modified for two-stage use), the S-IV stage, and an instrument unit and payload. The development test missions of the Block II vehicles include the S-I/S-IV staging, the S-IV stage operating capabilities, and the system guidance and control function through S-IV stage cutoff.

In broad terms, the major effort in FY 1962 centered on the preparation and launch of the first two flight test vehicles (SA-1 and SA-2), analysis of test data from those two flights, manufacturing and test on three more flight vehicles (SA-3, 4, and 5), and initiation of manufacturing on flight vehicles SA-6 and SA-7. In FY 1963, three vehicles (SA-3, 4, and 5) are planned for launch; flight data from the FY 1962 and FY 1963 flights will be analyzed; manufacturing and test of vehicles SA-6 and SA-7 will reach advanced status; and manufacturing of the final three flight test vehicles (SA-8, 9, and 10) will be initiated.

A more detailed discussion of the FY 1963 funding requirements and program content follows:

FUNDING REQUIREMENTS:

Vehicle Development	1961	1962	1963
Development Engineering:			
S-I Stage.....	$ 33,231,000	$ 42,882,000	$ 27,586,000
S-IV Stage.....	19,840,000	22,310,000	23,512,000
Guidance System.....	3,620,000	9,437,000	7,425,000
System Integration.....	5,509,000	12,047,000	14,922,000
Total.....	$ 62,200,000	$ 86,676,000	$ 73,445,000
Flight and Expendable Hardware:			
S-I Stage.....	$ 45,177,000	$ 61,410,000	$ 47,569,000
S-IV Stage.....	4,428,000	19,768,000	18,809,000
Guidance System.....	3,683,000	10,552,000	9,075,000
System Integration.....	668,000	3,700,000	6,635,000
Total.....	$ 53,956,000	$ 95,430,000	$ 82,088,000
Total Vehicle Development....	$116,156,000	$182,106,000	$155,533,000

Development Engineering

S-I Stage: The second flight test article has been designed, fabricated, assembled, static test fired, and is undergoing final check-out and assembly prior to shipment to the Atlantic Missile Range. Additional research and development work will analyze flight test data obtained from the second vehicle launch, determine changes to improve reliability based on known flight environments, and complete design modifications for maximum reliability and safety for manned flight. Significant portions of this work will be conducted by the S-I stage production contractor (Chrysler Space Division) at the NASA Michoud Plant and at the Marshall Space Flight Center.

S-IV Stage: Static testing of the S-IV design concept will be conducted in FY 1963 to prepare the first flight test article for launch. Theoretical analyses will be compared with actual test data obtained from structural tests, cold flow tests, static firing tests, and all-systems tests. Manufacturing, assembly, and checkout techniques will be established and extensive subsystem and component testing conducted to achieve a satisfactory degree of reliability which is consistent with manned flight with Apollo payloads.

Guidance System: Development will continue on modification of the basic Jupiter platform which is being used in conjunction with a large capacity ballistic missile computer. Analysis of flight test data will be conducted to determine the changes required for improved guidance system accuracy and reliability.

System Integration: The Apollo capsule, which has been designated as the primary payload for the Saturn C-1 vehicle, is now entering the detailed development phase. As the Apollo design changes evolve, the C-1 vehicle, including both S-I and S-IV stages, guidance system, and ground support equipment, must be revised to assure overall system compatability. In addition, vehicle reliability must be upgraded by improved component and sub-system performance obtained from test and flight information. Transportation methods for stages and associated hardware must be examined for improved program economy.

Flight and Expendable Hardware

S-I Stage: The installation of a production contractor at Michoud will require funds for fabrication and assembly tooling in addition to the actual fabrication and assembly of the SA-8, 9, and 10 flight stages. Spares are also required for the launch of vehicles SA-3, 4, and 5, and for the static test firing of SA-4, 5, and 6.

S-IV Stage: Components will be required for manufacture and assembly of SA-8, 9, and 10. The S-IV program will enter a heavy developmental testing phase requiring spares for the static test vehicle, all-systems test vehicle, and flight vehicles. Modification of hardware and tooling is anticipated to incorporate the changes resulting from the static test program, in addition to requirements for the Apollo spacecraft. Reliability and structural testing hardware will also be required.

Guidance System: Flight vehicle guidance systems and components must be procured for vehicles SA-8, 9, and 10, in addition to the spares required to support the flight test and reliability testing program. Hardware redesign is anticipated to accommodate new developments in vehicle design.

System Integration: Electrical networks and instrument units for each vehicle are required, as well as experimental hardware for solution of system problems. Advanced transportation hardware, reliability test equipment, and scale models for advanced structural aero-thermodynamics, and vehicle dynamic testing will also be required.

FUNDING REQUIREMENTS:

Engine Development

Development Engineering:	1961	1962	1963
H-1 Engine.....	$ 7,518,000	$ 6,164,000	$ 5,176,000
A-3 Engine.....	12,560,000	9,749,000	18,224,000
Total.....	$20,078,000	$15,913,000	$23,400,000

	1961	1962	1963
Flight and Expendable Hardware:			
H-1 Engine.....	$11,434,000	$11,766,000	$ 5,750,000
A-3 Engine.....	2,311,000	12,314,000	7,593,000
Total.....	$13,745,000	$24,080,000	$13,343,000
Total Engine Development.....	$33,823,000	$39,993,000	$36,743,000

Development Engineering

H-1 Engine: The development of the H-1 engine will be continued with concentration on minor modifications necessary to incorporate the results of the vehicle flight testing program. Major emphasis will be placed on improved reliability and safe operation of the booster for successful mission performance after one engine has failed, as required for manned rating.

A-3 Engine: The development of the engine will continue with preliminary flight rating of the common engine (Centaur and S-IV). In addition, the changes generated by the S-IV static and all-systems tests will be engineered. Reliability testing of this engine will continue as it matures to satisfactory manned flight status.

Flight and Expendable Hardware

H-1 Engine: Engine and spares will be produced for vehicles SA-8, 9, and 10, as well as for the reliability program.

A-3 Engine: Engine and spares will be produced for vehicles SA-8, 9, and 10, in addition to the manned rating qualification tests. Additional engines for the ground testing of the S-IV static test and prototype all-systems vehicles are also required.

FUNDING REQUIREMENTS:

System Support	1961	1962	1963
Development Engineering			
Ground Support Equipment...	$ 4,449,000	$ 7,287,000	$ 4,410,000
System Instrumentation.....	1,670,000	4,456,000	1,967,000
Launch Operations.....	104,000	7,518,000	3,551,000
Total.....	$ 6,223,000	$19,261,000	$ 9,928,000
Flight and Expendable Hardware			
Ground Support Equipment...	$ 9,231,000	$16,383,000	$17,642,000
System Instrumentation.....	4,050,000	8,897,000	7,867,000
Launch Operations.....	100,000	5,910,000	10,652,000
Propellants.....	4,325,000	9,643,000	10,872,000
Total.....	$17,706,000	$40,833,000	$47,033,000
Total System Support.....	$23,929,000	$60,094,000	$56,961,000

Development Engineering

Ground Support Equipment: The final design and development of the ground support equipment necessary for launch complexes 34 and 37 (Pads A and B) will be carried out. These two launch complexes will require modification as flight experience is gained from the large scale launching of liquid oxygen and liquid hydrogen stages. Automation in launching operations will be reflected in the ground support equipment development, and the overall program will be analyzed to minimize launch pad time.

System Instrumentation: Development is required for vehicle instrumentation to accommodate the two-stage vehicle flights with the Apollo test capsules to assure that maximum data is gained from each flight. Data acquisition techniques must be constantly examined to improve instrumentation reliability, accuracy, and efficiency.

Launch Operations: Effort in this area is directed toward examination of the launch operation function for effective procedures and techniques. Specific areas of study will include transportation and erection of vehicles, pad checkout prior to flight, and propellant loading prior to actual launch.

Flight and Expendable Hardware

Ground Support Equipment: Launch Complex 34 will undergo modification for launching the full two-stage C-1 vehicle. Additional

equipment will be required to complete launch complex 37 as a two pad (A and B) complex, and automation of this equipment will be incorporated consistent with vehicle reliability and launch pad utilization. These three pads will thus be completed to accommodate the final developmental launches and be ready for the prototype operational vehicle phase.

System Instrumentation: Flight instrumentation will be provided for vehicles SA-8, 9, and 10. In addition, spares are required in support of SA-3, 4, and 5 launches.

Launch Operations: These funds will support the launch operations to be conducted in FY 1963.

Propellants: Propellants must be supplied to the Marshall Space Flight Center for static testing of the S-I flight stages and to the Sacramento Test Facility of Douglas for the S-IV static tests, all-systems tests, and flight stage tests. In addition, propellants for the acceptance testing of both the H-1 and A-3 engines are required. The propellants to be supplied include liquid oxygen, liquid hydrogen, liquid nitrogen, kerosene (RP-1), and gaseous helium and nitrogen.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

FISCAL YEAR 1963 ESTIMATES

ADVANCED SATURN

SUMMARY OF REQUIREMENTS:

	1961	1962	1962 Supplemental	1963	Page No.
Vehicle Development...	$623,000	$26,712,000	$37,600,000	$273,042,000	RDO 4-3
Engine Flight Hardware.....	---	300,000	8,750,000	28,995,000	RDO 4-5
System Support..	---	750,000	3,650,000	33,135,000	RDO 4-6
Total.....	$623,000	$27,762,000	$50,000,000	$335,172,000	

OBJECTIVES:

The purpose of the Advanced Saturn program is to develop a vehicle system with sufficient payload capability to perform manned lunar-landing missions using a single earth-orbital rendezvous; and to provide a basic vehicle for manned circumlunar and lunar orbit missions, and for unmanned lunar and planetary exploration.

JUSTIFICATION:

The advanced Saturn vehicle is designed to be either a two- or a three-stage vehicle depending upon the mission to be performed. The two-stage version will be capable of placing approximately one hundred tons of payload in earth orbit and will be the primary vehicle for orbital rendezvous missions in support of the manned lunar landing objective. The three-stage version will be capable of achieving escape trajectories with payloads up to forty tons and will be used primarily for manned lunar orbit, circumlunar flight, and unmanned planetary exploration.

It is currently planned that the first stage booster will be powered by five F-1 engines, each of which will develop 1.5 million pounds of thrust for a total thrust of 7.5 million pounds. The engines will be arranged in a square pattern of four gimballed outside engines and one fixed engine located in the center of the

square pattern. This basic configuration provides for maximum flexibility in that two of the outside engines can be eliminated without redesign, thus providing a more economical stage for missions which do not require the full 7.5 million pounds of thrust.

The current plans for the upper stages provide that the second stage will be powered by five J-2 engines, each of which will develop 200,000 pounds of thrust, for a total thrust of 1,000,000 pounds. The third stage will use one J-2 engine for a total thrust of 200,000 pounds, and will house the all-inertial guidance system which sends commands to the control systems for each of the vehicle stages in the three stage vehicle configuration. Both the second and third stages will use the high energy propellant combination of liquid hydrogen and liquid oxygen.

The various stages of the Advanced Saturn vehicle will be developed through contracts with industry under the overall systems management of the Marshall Space Flight Center at Huntsville, Alabama, which will include the maintenance of close and continuous coordination between stage contractors and contractors on associated spacecraft development. By end FY 1962, all major contracts will have been placed.

Conceptual and preliminary design studies initiated in FY 1961, and continued into FY 1962, have provided the basis for determining the current configuration of the Advanced Saturn vehicle and the sequence of principle milestones to be accomplished. Major emphasis in FY 1962 will be placed on the procurement of long lead-time items and the initiation of major systems contracts as necessary to meet these configuration and milestone requirements in support of the manned lunar landing objective.

To meet the target schedules currently established, supplemental funds in the amount of $50,000,000 will be required during FY 1962. These funds, combined with the basic amount in FY 1962 and the additional funds for FY 1963, will provide the necessary build-up of development effort to achieve the first flight of the Advanced Saturn in the first half of calendar year 1965 and to meet follow-on schedule requirements for the Apollo development program.

FUNDING REQUIREMENTS:

	1961	1962	1962 Supplemental	1963
Vehicle Development				
Development Engineering:				
First Stage.....	---	$10,367,000	$13,000,000	$68,174,000
Second Stage.....	$312,000	7,500,000	8,800,000	59,052,000
Third Stage.....	---	500,000	2,000,000	15,911,000
Guidance System.....	---	751,000	1,750,000	7,188,000
System Integration....	---	3,568,000	2,500,000	12,637,000
Total.....	$312,000	$22,686,000	$28,050,000	$162,962,000
Flight and Expendable Hardware:				
First Stage.....	---	$1,951,000	$2,950,000	$41,118,000
Second Stage.....	$311,000	1,700,000	6,000,000	38,689,000
Third Stage.....	---	---	---	9,752,000
S-I Stage.....	---	---	---	12,000,000
Guidance System.....	---	375,000	600,000	3,081,000
System Integration....	---	---	---	5,440,000
Total.....	$311,000	$4,026,000	$9,550,000	$110,080,000
Total, Vehicle Development.....	$623,000	$26,712,000	$37,600,000	$273,042,000

Development Engineering

First Stage: Based on preliminary design concepts prepared by the Marshall Center, action has been completed for selection of the first stage contractor. During the balance of FY 1962 and continuing into

FY 1963, major effort will be placed on detailed design; structural testing; initial component testing of the control and propulsion systems; studies on trajectories and the inter-action of structural dynamic effects; and qualification of the various stage components. Development in this area will draw heavily upon test facilities that are now available at the Marshall Space Flight Center and upon new facilities that are planned for the Michoud Plant in Louisiana and the Mississippi Test Facility at Pearl River, Mississippi.

Second Stage: During FY 1962, major effort is being placed on preliminary design and facility planning. In FY 1963 this effort will be extended to include static testing of the propulsion system and vehicle subsystems with specific analysis of pressurization, propellant utilization, and propellant flow. All components will be tested for design verification and subsequently for qualification in accordance with approved test plans. The design of the flight vehicle will be completed in FY 1963 and dynamic testing will be conducted. The all-systems testing will be initiated in FY 1964 to verify stage system design.

Third Stage: The funding in FY 1962 provides for detail design and facilities planning. During FY 1963, static testing and all-systems vehicle testing will be initiated. It is planned that the third stage will have its initial flight test on a Saturn C-1 first stage. In this manner the development can be essentially completed before the stage is incorporated into the final vehicle configuration.

Guidance System: The all-inertial guidance system used in the Advanced Saturn will be a modification of the basic equipment developed under the Saturn C-1 program. During FY 1962 and FY 1963 extensive testing will be undertaken to ensure compatibility of the basic elements with the Advanced Saturn missions.

System Integration: Effort in this area provides for the resolution of interface problems in order to integrate the various stages into an operating vehicle system. During FY 1962 and FY 1963 this effort will include flight environment studies, trajectories studies, control studies, and investigations of structural dynamics. In all areas, maximum emphasis will be placed on integration of the vehicle with the Apollo spacecraft and the orbital rendezvous propulsion stage in support of the manned lunar landing program.

Flight and Expendable Hardware

First Stage: During the FY 1962 and FY 1963 phase of this development program, a lead time of 24 months will be required for most of the components which will be used in test and assembly operations. These components will be procured for qualification tests, for fabrication, for the static test vehicle, for the dynamic test vehicle, and for major structural assemblies. Flight hardware, special tooling, and test equipment for stage assembly and checkout will also be procured for the first and second flight test vehicles.

Second Stage: Procurement of components and sub-assemblies initiated in FY 1962 will be continued in FY 1963 in support of the test and qualification program. Hardware will be procured for static test, one dummy flight stage, and the first flight test vehicle. Facility modification and provisioning will be continued and special tooling and test equipment will be procured to support the assembly operations. Fabrication of structural parts and assembly of vehicles will be initiated.

Third Stage: During FY 1963 hardware will be procured for one static test vehicle, one dynamic test vehicle, one all-systems test vehicle, and the first flight test vehicle. Procurement of tooling and special test equipment will be initiated.

S-I Stage: The long lead-time items for two Saturn C-1 first stage (S-I) boosters will be ordered. These boosters will be used to provide the first flight tests of the Advanced Saturn third stage.

Guidance System: During FY 1963 procurement of components and sub-assemblies for development and testing of the guidance system will be continued. Hardware will also be procured for guidance systems for the first two flight test vehicles.

System Integration: Hardware will be procured to support the various propellant, aerodynamic, thermodynamic, and trajectory experimental programs and to support the overall system reliability program. Models will be procured for wind tunnel investigations and for testing of air transportation schemes.

FUNDING REQUIREMENTS:

Engine Flight Hardware	1961	1962	1962 Supplemental	1963
F-1 Engine.....	-	$300,000	$4,750,000	$16,497,000
J-2 Engine.....	-	-	4,000,000	12,498,000
Total Engine Flight Hardware	-	$300,000	$8,750,000	$28,995,000

Engine Flight Hardware

F-1 Engine: Ten engines will be procured during FY 1963, for the static test vehicle and for engine reliability testing. In addition, long lead-time components will be ordered for the ground test and flight test vehicles to follow.

J-2 Engine: During FY 1963, 33 engines will be procured for the second and third stage static and all-systems ground test vehicles and for engine reliability testing. In addition, long-lead-time components will be ordered for the first flight test vehicles.

FUNDING REQUIREMENTS:

System Support	1961	1962	1962 Supplemental	1963
Development Engineering				
Ground Support Equipment..	-	-	-	$ 6,840,000
System Instrumentation....	-	$500,000	$2,650,000	2,708,000
Launch Operations.....	-	-	300,000	1,531,000
Total	-	$500,000	$2,950,000	$11,079,000
Flight and Expendable Hardware				
Ground Support Equipment..	-	-	-	$ 6,839,000
System Instrumentation....	-	$250,000	$500,000	2,707,000
Launch Operations.....	-	-	-	510,000
Propellants.....	-	-	200,000	12,000,000
Total	-	$250,000	$700,000	$22,056,000
Total System Support	-	$750,000	$3,650,000	$33,135,000

Development Engineering

Ground Support Equipment: An extensive effort will be initiated in FY 1963 on design and fabrication of special support equipment required for initial launching of the Advanced Saturn vehicle. Although the equipment itself will not be required until the time of launch, it must be developed as an integral part of the overall vehicle system. Initial component and reliability testing of this equipment will be undertaken during FY 1963.

System Instrumentation: Development of the instrumentation for the Advanced Saturn will parallel closely the development program for the Saturn C-1. The major effort in FY 1963 will be placed on improved vehicle borne telemetry and measuring components and systems.

Launch Operations: During FY 1963 studies will be undertaken to adapt the integrated test and launch concept to the Advanced Saturn. This technique will minimize the time on the launch stand and thereby ensure maximum utilization of launch facilities. In addition, experimental work will be undertaken to ascertain the hazards that may be peculiar to the Advanced Saturn due to the large-scale mixing of liquid hydrogen and liquid oxygen.

Flight and Expendable Hardware

Ground Support Equipment: During FY 1963, procurement of hardware required for testing will be initiated. Long lead-time items to be used for field checkout, fueling, launching, handling, and transportation will also be procured. In addition, selected components of the automatic

checkout equipment will be procured for installation on the Advanced Saturn launch complex. Contractor field support for this equipment is included as part of the procurement cost.

System Instrumentation: Procurement of instrumentation for developmental testing and for installation in the first two flight test vehicles will be continued in FY 1963 on the basis of approximately eight hundred telemetry channels per vehicle.

Launch Operations: Procurement in this area will cover the ground support equipment and materials that are expended during initial flight testing of the vehicle.

Propellants: Propellants for the Advanced Saturn program will include liquid oxygen, liquid hydrogen, liquid nitrogen, kerosene (RP-1), and helium. These propellants will be used for developmental testing of the Advanced Saturn stages and for reliability testing of the individual engines.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

FISCAL YEAR 1963 ESTIMATES

NOVA

SUMMARY OF REQUIREMENTS:	1961	1962	1963	Page No.
Vehicle Development	$297,000	$6,322,000	$131,916,000	RDO 5-2
Engine Procurement	---	---	3,165,000	RDO 5-4
System Support	---	---	28,493,000	RDO 5-4
Total	$297,000	$6,322,000	$163,574,000	

OBJECTIVES:

The purpose of the NOVA development program is to develop a vehicle with sufficient payload carrying capability to achieve a manned lunar landing by direct ascent from the Earth's surface; and to provide a basic high performance vehicle required for future space missions.

JUSTIFICATION:

The NOVA vehicle to be used for a manned lunar landing by direct ascent will consist of three stages and will be capable of accelerating to escape velocity the 150,000 pounds of payload required. Maximum standardization between the NOVA and Saturn vehicles will be effected to achieve economy of effort and to ensure a high degree of reliability in the final product. The first stage will be powered by eight 1,500,000 pound thrust (F-1) engines, generating a total thrust of 12,000,000 pounds, using RP-1 (kerosene) and liquid oxygen as the propellant combination. The vehicle will involve either a single large tank for each propellant or a cluster of tanks, depending upon which alternative provides the greater advantage in cost, production, transportation, and launching. A study on relative merits of the two approaches is now in process.

For the second stage, four 1,000,000 pound thrust (M-1) engines, which use liquid hydrogen and liquid oxygen propellants, will be used to provide a total thrust of approximately 4,000,000 pounds. In this development the normal problems of clustering engines are increased by the additional requirement to perform the mission even though one engine has failed. This capability, however, is particularly significant in that it provides an estimated 7% increase in stage reliability.

The third stage employs one 200,000 pound thrust liquid hydrogen (J-2) engine and is basically the same third stage that is being developed

for the Advanced Saturn. An all-inertial guidance system, also adapted from the basic Saturn equipment, will be mounted in this stage and will serve as a central command unit for the entire vehicle control system.

Whereas the effort during FY 1962 is primarily concerned with engineering and the determination of detailed requirements, FY 1963 will see an acceleration of hardware development, the procurement of long lead time items, and the start of more extensive analysis, simulation, and related effort associated with the integration of various elements in the vehicle system.

FUNDING REQUIREMENTS:

Vehicle Development	1961	1962	1963
Development Engineering:			
First Stage	---	$2,750,000	$ 65,956,000
Second Stage	---	---	46,963,000
Guidance System	---	822,000	2,639,000
System Integration	$297,000	2,750,000	5,804,000
Total	$297,000	$6,322,000	$121,362,000
Flight and Expendable Hardware:			
First Stage	---	---	$ 6,333,000
Second Stage	---	---	3,166,000
System Integration	---	---	1,055,000
Total, Vehicle Development	$297,000	$6,322,000	$131,916,000

Development Engineering

First Stage: Contractor design and development effort on the first stage will be started in late FY 1962. This effort will be primarily concerned with engineering and the determination of detailed requirements. During FY 1963, there will be an acceleration of hardware development encompassing detailed design of the stage itself and the related interfaces of test and launch facility requirements. Model tests of engine arrangements, both structural and aerodynamic, will also be conducted.

Second Stage: In FY 1963, contractor design and development effort will be initiated on the second stage. The contractor will work closely with the contractor developing the M-1 engine and will carry out engineering necessary for determination of requirements for the test facility design and construction. As in the case of the first stage, model tests will also be conducted.

Third Stage: Funding for the third stage for NOVA will not be required until after FY 1963.

Guidance System: During FY 1963, the development effort started in the previous year will be continued with emphasis on reliability and flexibility in order that NOVA may achieve the planned types of missions, including, but not limited to, the manned lunar landing. In addition, close coordination will be maintained with the Massachusetts Institute of Technology, which is the guidance contractor for the Apollo spacecraft.

System Integration: This effort will be expanded substantially in FY 1963 to resolve the interface problems arising between stages, to study system effects due to the interactions expected during flight, and to perform detailed integration of the initial NOVA payloads. Various studies will be conducted to determine the effect of replacing the liquid first stage with a solid motor first stage if solid motor development progresses favorably. Possible recovery techniques will also be examined.

Flight and Expendable Hardware

First Stage: In the early stages of the NOVA development program, a lead time of 30 months is required for some of the components to be assembled to form the first stage. Although components for the first flight article will not have to be ordered until FY 1964, components required for the static test vehicle and to support the reliability and general development test program must be ordered during FY 1963.

Second Stage: The second stage will have a lead time of 30 months; and, as in the case of the first stage, sufficient hardware must be ordered in FY 1963 to support the static test and general development test program.

System Integration: Components and subsystems will be purchased as required to solve experimentally the various propellant, aerodynamic, thermodynamic, and trajectory problems. Model sized mock-ups of the launch vehicle, manufacturing and test facilities, launch facilities and supporting equipment will be made available to help solve problems associated with the total NOVA system development.

Engine Procurement	1961	1962	1963
1,500,000 pound thrust (F-1) Engine	---	---	$2,110,000
1,000,000 pound thrust (M-1) Engine	---	---	1,055,000
Total, Engine Procurement	---	---	$3,165,000

Engine Procurement

The F-1, M-1, and J-2 are being developed under the Liquid Propulsion Program. Accordingly, funding of these items under NOVA is limited to the procurement of engine hardware for the vehicle stages. During FY 1963 funding in this area will provide for procurement of longlead-time items required for the vehicle static test article. No funding on the 200,000 pound thrust J-2 engine is required in FY 1963.

System Support	1961	1962	1963
Development Engineering			
Ground Support Equipment	---	---	$18,997,000
System Instrumentation	---	---	2,110,000
Launch Operations	---	---	1,055,000
Total	---	---	$22,162,000
Flight and Expendable Hardware			
Ground Support Equipment	---	---	$ 6,331,000
Total, System Support	---	---	$28,493,000

Development Engineering

Ground Support Equipment: The development of ground support equipment will be undertaken at the start of FY 1963 and will be coordinated closely with design and construction of the launch and test facilities. Since it is planned that the NOVA will be assembled and checked out on the launch pad, the time on pad must be minimized in order to provide flexibility to meet launch schedule requirements. Accordingly, emphasis will be placed on development that will achieve high-speed subassembly checkout with maximum reliability.

System Instrumentation: Intensive design and development studies are required during FY 1963 to determine the type and degree of instrumentation required for a vehicle of this size. Instrumentation from the existing Saturn C-1 and that planned for the Advanced Saturn will be modified, where feasible, for adaptation to the NOVA program.

Launch Operations: Studies will be undertaken during FY 1963 on water transportation techniques for the NOVA stages, on the possible use of alternate methods of transporting stages, and on improvements in launching techniques that will minimize vehicle time-on-stand.

Flight and Expendable Hardware

Ground Support Equipment: During FY 1963 initial orders will be placed for the procurement of special ground support equipment required for the NOVA vehicle. The equipment will be used for fueling, launching, handling, and field checkout. Spare checkout equipment for standby or for replacement for items that may be destroyed during the launching operations will also be procured.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

FISCAL YEAR 1963 ESTIMATES

METEOROLOGICAL SATELLITE SYSTEMS

SUMMARY OF REQUIREMENTS:

	1961	1962	1963	Page No.
Advanced Research	$1,870,000	$1,865,000	$1,808,000	RDO 6-4
Advanced Technical Development	2,005,000	4,510,000	9,605,000	RDO 6-4
Flight Program	15,735,000	47,935,000	39,772,000	RDO 6-5
Total	$19,610,000	$54,310,000	$51,185,000	

OBJECTIVES:

The primary objective of the meteorological satellite systems program remains that of establishing and continually improving a meteorological satellite capability for world-wide coverage, to provide the meteorologist with observations of atmospheric elements and storm systems. Observations obtained by meteorological satellites should improve weather prediction procedures and increase our understanding of atmospheric processes. The phenomena to be observed include cloud cover, storm location, precipitation, temperature, wind direction, heat balance and water vapor and other constituents of the atmosphere. An effective meteorological capability will require the development and flight testing of earth-stabilized satellites for 500 to 1000-mile altitude polar orbits and of stationary satellites for 22,300-mile altitude equatorial orbits. Related developments will include suitable on-board detection equipment including television, infrared detectors, spectrometers, radar and sferics; and the development of adequate data storage, processing, communications and presentation equipment and techniques.

The long-range objective of the program continues to be the development of the principles and prototypes for a system of instrumented orbiting satellites and of the appropriate data processing and communications equipment to provide the National Meteorological Center of the Weather Bureau with world-wide meteorological information. These data will be used operationally, disseminated nationally and internationally, and made available to the National Weather Records Center archives for research and climatological purposes.

This program also includes the development and launch of instrumented meteorological sounding rockets to obtain improved data on temperatures and winds. These rocketsondes are effective at levels above those observable by radiosondes or indirect satellite techniques, and below those where satellites can orbit and make ambient measurements.

JUSTIFICATION:

The earth satellite is a new observational tool which has already demonstrated its value to the science of meteorology and to the practice of weather forecasting. Satellites will not provide all necessary meteorological information, but they have already supplied tremendous amounts of useful meteorological data not available from conventional observational techniques. Satellites can potentially give global coverage of some meteorological parameters, in contrast to the five to ten per cent coverage provided by ordinary methods and, because of their unique vantage point above the atmosphere, make new measurements possible. These data will improve basic scientific understanding of atmospheric processes and lead to a more comprehensive knowledge of world and regional climatology which should produce advances in weather forecasting.

The benefits to be derived from improved capabilities in meteorology include protection of life and property from weather disasters; safeguarding transportation; crop planning, control and protection; industrial planning of weather-dependent products, outdoor enterprises, and heating and cooling loads; convenience in planning personal activities; eventual limited weather modification and control; and good will in return for providing current global meteorological data to other nations. In addition the same meteorological data required for world-wide civilian needs can, with proper handling, meet special military needs as well.

The requirements for an operational meteorological satellite system, anticipated benefits and a proposal for implementing such a system have been set forth in the "Plan for an Operational Meteorological Satellite System" prepared by the Panel on Operational Meteorological Satellites under the auspices of the National Coordinating Committee for Aviation Meteorology and with participation of representatives of the United States Weather Bureau, the Department of Defense, the Federal Aviation Agency and the National Aeronautics and Space Adminstration. In accordance with the May, 1961 request of the President, Congress appropriated $48,000,000 to the Weather Bureau in September, 1961 to initiate implementation of an operational meteorological satellite system. The plan contemplates the maximum operational use of data from the Nimbus research and development program, an increased number of spacecraft (using Weather Bureau funds) in the program to insure the continuity of working satellites in orbit, and the transition to fully operational status upon the conclusion of the presently scheduled Nimbus research and development program. This plan will permit the earliest establishment of a limited operational capability. The establishment of a fully effective operational meteorological satellite system is dependent upon the completion of the improvements contemplated in the presently scheduled Nimbus research and development program. The Weather Bureau will transfer funds to NASA to augment the program with additional spacecraft and launch vehicles, and to build ground read-out stations specifically required for operational use.

The development of an operational system depends not only upon specific flight projects but also on sustained programs of advanced research and advanced technical development. The advanced research program deals with the reduction and processing of meteorological satellite data and includes feasibility and initial design studies of more complex sensory systems and advanced satellite configurations. The advanced technical development program provides improved

satellite instrumentation and equipment to measure and interpret critical atmospheric parameters.

Progressively more sophisticated meteorological satellites will be flown, capitalizing upon the experience gained from previous spacecraft. The flight program was begun with the successful launchings of TIROS I, II AND III, and at least four additional TIROS launchings are planned for the remainder FY 1962 and early FY 1963. Four R & D Nimbus spacecraft are planned for launch beginning in FY 1963. The first Nimbus, which will be earth-stabilized and in a near polar orbit will operate concurrently with the last TIROS. Operational Nimbus spacecraft will be interspersed with these progressively more advanced research and development Nimbus flights. Funds for these operational Nimbus satellites and launch vehicles and their support, are not included in this budget, but will be requested separately by the Weather Bureau in Department of Commerce budget submissions. Still later a more advanced satellite called AEROS is planned. A single AEROS stationary satellite will provide continuous data coverage for nearly a third of the earth's surface. The planned satellite flight schedule follows:

Mission R & D	Weather Bureau	Launch Vehicle	Calendar Year of Launch
TIROS I		Thor-Able	1960) Success-
TIROS II		Thor-Delta	1960) fully
TIROS III		Thor-Delta	1961) launched
4th TIROS		Thor-Delta	1962
5th TIROS		Thor-Delta	1962
6th TIROS		Thor-Delta	1962
7th TIROS		Thor-Delta	1962
1st R&D Nimbus		Thor-Agena	1962
2nd R&D Nimbus		Thor-Agena	1963
	1st Weather Bureau Nimbus	Thor-Agena	1963
	2nd Weather Bureau Nimbus	Thor-Agena	1964
3rd R&D Nimbus		Thor-Agena *	1964
	3rd Weather Bureau Nimbus	Thor-Agena	1964
	4th Weather Bureau Nimbus	Thor-Agena	1964
4th R&D Nimbus		Thor-Agena *	1965

*Substitition of the Atlas Agena may be required to carry the full complement of instrumentation. The Weather Bureau funds its own Nimbus flights.

Meteorological sounding rockets are the only feasible vehicles for acquiring data in the 100,000 ft. to 300,000 ft. layer of the atmosphere. This layer is above the altitudes normally reached by radiosonde balloons, is not amenable to indirect sensing techniques from satellites and is below the altitudes where satellites can orbit and make ambient measurements. The small samples of data obtained indicate that significant meteorological processes take place at these altitudes. This layer may hold the key to an understanding of how changes in the sun's radiations influence the weather. Furthermore, these levels may be

utilized by future high flying aircraft and are known to be critical for re-entering space vehicles. Data on the winds and temperatures at such altitudes have been obtained with various techniques, but the most successful is the exploding grenade experiment. This program will continue, using approximately thirty sounding rockets in FY 1963, to provide required additional data, develop improved techniques, and extend present techniques to higher altitudes.

FUNDING REQUIREMENTS:

Advanced Research	1961	1962	1963
Data analysis and research	$1,064,000	$ 216,000	$ 113,000
Studies of potential satellite sensors	-----	379,000	339,000
Radiation data studies	414,000	838,000	847,000
Radiative characteristics of atmospheric gasses	-----	162,000	226,000
Data systems studies	392,000	-----	283,000
Aeros system studies	-----	270,000	-----
Total, Advanced Research	$1,870,000	$1,865,000	$1,808,000

Basic radiation data studies will be continued in FY 1963 to test radiation sensors on balloons and rockets and interpret the data obtained from these flights, to analyze and study data from previous satellite experiments, and to study the amount of atmospheric trace constituents and their influence on observed radiations. Design studies of optimum systems for the reduction, processing and presentation of meteorological satellite data, especially of cloud cover and patterns, begun with funds for earlier fiscal years, will be continued and expanded. Feasibility studies to accomplish at least partial data processing on-board a satellite are included in this effort. Studies of the feasibility and potential value of advanced meteorological sensors for use on satellites (such as radar, sferics, and microwave absorption detectors) will also be continued.

Advanced Technical Development	1961	1962	1963
Radiation detector development	$ 437,000	$ 564,000	$ 655,000
Electronic instrument development	670,000	1,119,000	1,086,000
Electronic component development	112,000	174,000	323,000
Mechanical instrumentation development	338,000	804,000	872,000
Advanced video recorder	-----	186,000	305,000
Advanced sensor development	448,000	1,120,000	1,040,000
Aeros component development	-----	273,000	4,338,000
Advanced data analysis and transmission development	-----	-----	421,000
Advanced Nimbus controls subsystem	-----	270,000	565,000
Total, Advanced Technical Development	$2,005,000	$4,510,000	$9,605,000

Continuing development is necessary to improve the performance and reliability of existing flight instrumentation and to develop new instrumentation to provide additional meteorological data not yet available. Areas of work which will be continued in FY 1963 will include improved radiation detectors; electronic components and instrumentation; mechanical instrumentation such as tape recorders and bearings operating in vacuum; development of an advanced controls system for later Nimbus spacecraft; equipment for processing, communicating and presenting meteorological satellite data; and development of advanced sensors such as electrostatic tape cameras, video systems sufficiently sensitive for nighttime use, radar and improved spectrometers.

Development of Aeros prototype hardware will be accelerated, particularly the items requiring long lead time development.

Flight Program	1961	1962	1963
TIROS II:			
Spacecraft fabrication, modification, integration, testing	$ 776,000	-----	-----
Data acquisition			
PMR support	145,000	-----	-----
PMR ground station	145,000	-----	-----
Ground station support	155,000	-----	-----
Fort Monmouth support	196,000	-----	-----
Infrared interrogation package	185,000	-----	-----
Delta vehicle (procured with Delta vehicle development funds)	-----	-----	-----
	$1,602,000	-----	-----
TIROS III:			
Spacecraft fabrication, modification, integration, testing	$ 336,000	-----	-----
Data acquisition			
Moving ground station	224,000	-----	-----
Ground station operation	403,000	-----	-----
Data reduction, processing, analysis			
Computing and analysis	336,000	108,000	-----
Infrared data	112,000	-----	-----
Delta vehicle (procured with Delta vehicle development funds)	-----	-----	-----
	$1,411,000	$ 108,000	-----
TIROS (4th, 5th, 6th and 7th):			
Spacecraft fabrication, modification, integration, testing			
Fabrication, assembly, test	-----	$3,870,000	$ 622,000
Integration	-----	-----	1,469,000
Data acquisition	-----	455,000	141,000
Data reduction, processing, and analysis	-----	2,155,000	904,000
Infrared subsystem integration	-----	386,000	254,000
Launch vehicles (Delta)	-----	13,525,000	-----
Launch vehicle modification	-----	50,000	-----
	-----	$20,441,000	$3,390,000

Nimbus (First and Second)	1961	1962	1963
Scientific experiments	$ 164,000	$ 170,000	$ 167,000
Integration and testing	1,772,000	8,502,000	2,946,000
Attitude control	1,139,000	2,147,000	1,865,000
Solar power supply	842,000	920,000	1,243,000
Advanced vidicon systems	2,342,000	2,272,000	790,000
High resolution infrared detector	347,000	812,000	56,000
High resolution infrared tape recorder	305,000	-----	-----
Medium resolution infrared detector	362,000	162,000	395,000
Medium resolution infrared tape recorder	224,000	-----	-----
Medium resolution infrared electronics	224,000	-----	-----
Low resolution infrared	168,000	87,000	28,000
Command clock	847,000	432,000	57,000
Clock receivers	-----	54,000	-----
PCM telemetry	744,000	686,000	736,000
S-band transmitters	104,000	54,000	28,000
VHF/FM transmitter	168,000	27,000	28,000
VHF/AM transmitter	168,000	27,000	23,000
Ground station integration	-----	758,000	791,000
Launch support, PMR	-----	-----	339,000
Video data compression equipment	-----	270,000	565,000
Data analysis and processing support	-----	108,000	1,695,000
Tape and film	-----	108,000	226,000
Spacecraft modification and qualification	-----	-----	1,130,000
Launch vehicle (Thor-Agena)	2,802,000	6,817,000	4,746,000
Total	$12,722,000	$24,413,000	$17,854,000

Nimbus (Third and Fourth)			
Scientific experiments	$ -----	$ -----	$ 282,000
Integration and testing	-----	-----	1,695,000
Attitude control	-----	-----	1,808,000
Solar power supply	-----	325,000	791,000
Advanced vidicon systems	-----	-----	678,000
High resolution infrared	-----	-----	170,000
Medium resolution infrared	-----	-----	395,000
Low resolution infrared	-----	-----	113,000
Command clock	-----	-----	226,000
PCM telemetry	-----	-----	395,000
Infrared ground equipment-real time	-----	-----	3,390,000
Infrared data display	-----	-----	1,017,000
Electrostatic tape camera	-----	-----	1,130,000
Spectrometer	-----	-----	565,000
Launch vehicle (Thor-Agena)	-----	2,164,000	4,405,000
Total	-----	$2,489,000	$17,060,000

Meteorological Soundings	1961	1962	1963
Fabrication, rocket instrumentation	$ -----	$ 214,000	$ 530,000
Grenades	-----	54,000	113,000
Dovap field services and data reduction	-----	108,000	226,000
Sound ranging field services	-----	108,000	260,000
International support	-----	-----	339,000
Total	-----	$ 484,000	$1,468,000
Total, Flight Program	$15,735,000	$47,935,000	$39,772,000

TIROS

The first TIROS was launched in FY 1960. During its three-month period of useful operation this extremely successful satellite transmitted almost 23,000 picture frames of which about 60 per cent were of the earth and its cloud cover and applicable to meteorological analysis. TIROS I clearly demonstrated both the operational and research value of satellite cloud pictures. The data continue to be used for meteorological analysis and study by the Weather Bureau and other research groups, including several universities.

TIROS II was successfully launched on November 23, 1960. This satellite contained special radiation detectors for measuring the earth's albedo, the total radiation of the earth and its atmosphere, the direct radiation from the earth's surface of cloud tops, the radiation from the earth's water vapor layer, and for reference purposes, radiation in the visible portion of the spectrum. Gross measurements of the heat budget of the earth and the atmosphere were also made. TIROS II also contained vidicon camera systems like those of TIROS I for cloud cover measurements. Reduction, analysis and study of the radiation data are continuing. TIROS II was still providing useful data more than ten months after launch, and the majority of its components and subsystems was still operating after more than one year in orbit.

TIROS III, launched July 12, 1961, was generally similar to TIROS II; however, it contained an additional heat budget experiment and two cameras, both equipped with wide-angle lenses. This satellite obtained data on many tropical storm systems and provided the first detection of Hurricane Esther.

The performance of TIROS I, II AND III has been highly successful, providing useful meteorological data and experience in the use of ground transmission, storage and analysis systems. The outstanding performance of the TIROS systems and the wide use which has been made of the meteorological data by both civilian and military weather services merit the continuation of the TIROS project through the initial flight of the Nimbus system. The project now provides for an additional four TIROS launches, including two backup Delta vehicles in an attempt to insure four successful flights. Launches will be scheduled at three to four month intervals to provide almost continuous weather coverage through the 1962 time period. The last TIROS launch is planned to overlap the first Nimbus in order to insure adequate coverage during the transition to the new Nimbus capability.

The first TIROS was launched with a Thor-Able launch vehicle funded by ARPA and transferred to NASA. TIROS II, III and the fourth TIROS will use Delta vehicles procured under the Delta development program. The remaining three TIROS satellites will also employ the Delta vehicle. Five of these vehicles (two backup vehicles are included) were funded in FY 1962.

Nimbus

Nimbus is the first in a family of earth-oriented meteorological satellites being designed to carry with flexibility a variety of sensors and experiments. The first Nimbus satellite will weigh about 600 pounds and will be launched in a polar retrograde (about 80°) circular orbit at about a 500-mile altitude. It will consist of power, stabilization and sensory subsystems. The power subsystem will consist of two paddle-like structures covered with solar cells and arranged to face the sun directly whenever the satellite is in sunlight. Nickel-cadmium storage batteries will be used for power storage. The stabilization system will keep the satellite pointing directly at the earth with an accuracy of about 1° in all three axes -- roll, pitch and yaw. The sensory system for the first Nimbus is expected to include an improved television vidicon system to provide almost complete coverage of the globe and a radiation sensing system to provide atmospheric and terrestrial radiation measurements, including data on nighttime cloud cover. Other sensory subsystems planned, which will probably be flown in later satellites of the series, include: an electrostatic tape camera system to permit higher resolution studies of specific meteorological events such as hurricanes; a more comprehensive infrared radiation system containing, in addition to the sensors used in the first Nimbus, low resolution (400-mile) sensors for gross measurements of the earth-atmosphere heat balance and auxiliary measurements of importance to meteorology; and measurements of the solar constant and other factors which may be of significance in determining the influence of the sun on the earth's weather.

The first Nimbus is now planned for completion and launch about the end of calendar year 1962. The second Nimbus will be launched about six months thereafter. It is planned to have the spacecraft structure, power and stabilization fairly well standardized with the successful launch of the second Nimbus.

During FY 1963, the second R&D Nimbus will be modified and requalified in accordance with the experience gained from the first Nimbus. Additional experiments will be incorporated as weight limitations and reliability permit. Also during this fiscal year, work on the third and fourth R&D Nimbus satellites will be started. These satellites will be launched after the initial spacecraft of the Weather Bureau funded Nimbus series, and are expected to carry one of the more advanced sensory systems such as a radar, a spectrometer or an image orthicon camera system which can view clouds under lower levels of illumination. On-board analysis techni-

ques and ground data analysis and presentation systems now being developed will be included in the advanced Nimbus flights to reduce the amount of redundant data transmitted by the satellite.

Funding is also requested in this project for the Thor-Agena vehicles used to launch Nimbus satellites. The Thor-Agenas for Nimbus are incrementally funded in FY 1961, FY 1962, and FY 1963.

Meteorological Sounding Rockets

The primary NASA meteorological sounding rocket experiment has been the exploding rocket grenade. In this technique the time and location of the explosions are observed and the time of arrival of the sound waves at an array of sensitive microphones is recorded. These data permit calculation of the wind and temperature in each level between the altitudes of the explosions. Several series of successful firings have been held at Wallops Island and Fort Churchill. These data have revealed several previously unsuspected types of seasonal and shorter period variations of the structure of the atmosphere in the upper stratosphere.

Future work will include additional series of approximately thirty FY 1963 launchings to provide a more statistically reliable sample for data reduction and analysis of both new and earlier data, and development of more powerful rocket grenades that will permit the technique to be employed at still higher altitudes. Studies and developments toward possible better methods of observing the properties of the atmosphere in the upper stratosphere will be initiated.

The funds for International Support will be used in partial support of cooperative meteorological rocketsonde programs in overseas areas. In such programs one or more foreign countries would provide for a significant portion of the costs, with NASA funds requested being used for equipment or components not readily available outside the United States. The data obtained would help to extend our information on the higher atmosphere, since data to date have been obtained primarily from the North American area. Specific consideration is being given to a series of launchings in connection with the International Indian Ocean Expedition.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

FISCAL YEAR 1963 ESTIMATES

COMMUNICATIONS SATELLITE SYSTEMS

SUMMARY OF REQUIREMENTS:

	1961	1962	1963	Page No.
Advanced Research.....	$ 1,250,000	$ 1,170,000	$ 2,688,000	RDO 7-4
Advanced Technical Development.....	790,000	2,272,000	2,473,000	RDO 7-5
Flight Program.....	31,793,000	45,035,000	80,216,000	RDO 7-6
TOTAL.....	$ 33,833,000	$ 48,477,000	$ 85,377,000	

OBJECTIVES:

The objectives of space exploration can be broadly categorized as (1) the advancement of man's knowledge of the universe, leading to a better understanding of its workings, and as (2) the application of this knowledge, resulting in tangible benefits to mankind.

One application of the use of space which has great potential for aiding all mankind is the field of world-wide communications. By making use of satellites as relay stations between earth terminals dispersed about the globe, the quality of long-distance radio communications can be greatly improved, and many countries which are now dependent on the uncertainties of high frequency radio for communicating with other locations in the world can be linked to distant areas with microwave circuits which will be as effective as those now used in domestic service.

The objective of the communications satellite systems program is, therefore, the pursuit of research and development to give maximum assurance of rapid and continuous scientific and technological progress toward operational global communications satellite systems for civilian use.

JUSTIFICATION:

The effective conduct of the Nation's business depends on fast, reliable communications. In the political, economic and social fields the capability for rapid transportation of people and goods and for communicating over great distances has become essential. Also, in contrast to pre-World War II times, the travel and communications must necessarily be to and with all parts of the world.

Great strides have been made in international communications between the United States and Europe. The installation of trans-Atlantic telephone cables has broadened the communications base between those continents, and more cables are being planned for this service and for service to Asia. However, it has been the experience of the communications industry that as new kinds of service are offered, the demand grows rapidly and soon overtakes the supply.

High-frequency radio, used for the present world-wide communications system, is not a reliable means of communication. It depends for its use on the ionosphere, which varies diurnally, seasonally, and geographically. In addition, the capability of the ionosphere for reflecting radio waves in the high-frequency region of the spectrum varies with the 11-year sun-spot cycle. During periods of high solar activity, such as occurred between 1957 and 1959, the ionosphere is capable of reflecting radio waves over a range of frequencies between approximately 3 and 50 megacycles; when the solar activity declines to low levels, frequencies above 20 megacycles are seldom reflected. In the latter case, the number of communications circuits possible would be decreased by more than 60 percent.

Neither high-frequency radio nor present submarine cables provide television and high speed data transmission. These services, as well as most of the long lines telephone calls, are normally carried within the United States by microwave radio. However, for all practical purposes, communication by microwave is limited to points within line-of-sight of each other.

Communications satellites offer the possibility of microwave communication over long distances by providing relay stations at altitudes where they can be viewed simultaneously from all points within vast areas of the earth's surface. Thus they offer the potential for providing all types of telecommunications services on a world-wide basis.

The NASA communications satellite systems program is designed to advance by research, technical development and space flight the technology for application of these systems to civilian use. Both active and passive systems are being pursued. Satellites of both types have already been flown, either by NASA or the Department of Defense, and have demonstrated the fundamental feasibility of these systems. Detailed investigations of alternative configurations for the eventual operational system are now required.

The flight schedule for the communications satellite systems program is as follows:

Mission	Launch Vehicle	Calender Year of Launch
ECHO (rigidized sphere)		
Suborbital test (2 flights)	Thor	1962
Orbital test	Thor-Delta	1962
Radiation Measurements Satellite (24-hour orbit)		
2 flights	Atlas-Centaur	1963
Relay (low altitude active repeater)		
2 flights	Thor-Delta	1962
2 flights	Thor-Delta	1963
Syncom (24-hour orbit, narrow band active repeater)		
1 flight	Thor-Delta	1962
1 flight	Thor-Delta	1963
Rebound (multiple passive reflectors)		
2 flights	Atlas-Agena	1963
Intermediate Altitude Satellite (active repeater)		
3 flights	Altas-Agena	1964
Advanced Synchronous Communications Satellite (wideband active repeater, 24-hour orbit)		
2 flights	Atlas-Agena	1964
1 flight	Atlas-Agena	1965

FUNDING REQUIREMENTS:

Advanced Research	1961	1962	1963
Technical and operational studies.....	$ 336,700	---	$ 538,000
Influence of ultimate utilization on communications satellite system design-study.....	152,000	---	---
Frequency interference problems - study.....	108,600	---	---
Interference by communications satellites to optical and radio astronomical endeavors - study.....	119,500	---	---
Utilization of nuclear power supplies - study.....	---	---	215,000
Optimum antenna arrays for communications satellites...	---	$ 111,000	215,000
High-gain reflective space structures.....	---	336,000	161,500
Modulation and demodulation techniques.....	---	111,000	752,500
Simulation of communications satellite systems.....	43,500	155,000	215,000
Quasi-passive satellite techniques.....	54,300	167,000	322,500
Satellite materials and components.....	435,400	167,000	161,500
K-band RF power sources.....	---	---	107,000
Photography of passive satellites.....	---	12,000	---
FM Receivers with feedback...	---	111,000	---
Total, Advanced Research	$ 1,250,000	$1,170,000	$2,688,000

The achievement of any new operational system must be preceded by research and invention. NASA has undertaken a program of advanced research and study to provide such support for ultimate communication satellite systems. Two types of research are carried out: comprehensive studies which provide a basis for program direction; and theoretical and experimental investigations which indicate lines for worthwhile hardware development.

The first type of research is represented by several studies funded in FY 1961. The study of the technological and operational problems of communications satellite systems will be continued in FY 1963. A broad range of problems such as orbital perturbations affecting satellite use, relative technical advantages of the various communications satellite systems, and how best to locate earth terminals for world-wide service will be studied. A new study to begin in FY 1963 will investigate the applicability of nuclear power supplies, such as the SNAP-8, to communication satellites.

In the second type of research are investigations of reflective space structures which may provide more gain than spheres. Some of these structures are strictly passive, while other, called "quasi-passive", employ active techniques on a much simpler scale than active satellites. Funded initially in FY 1961 and FY 1962, these investigations will be continued in FY 1963.

FY 1963 funds are also required to continue experimentation in modulation and demodulation techniques to determine the best methods for various operational systems, and to continue the work on electronic and mechanical components directly applicable to communications satellites.

Advanced Technical Development	1961	1962	1963
Development of radiation resistant materials and components.....	---	$ 334,000	$ ---
Development, fabrication and testing of high-gain reflective structures..	---	---	1,882,000
Development of improved spaceborne batteries.....$	598,000	---	---
Long-lived travelling wave tubes.....	56,000	278,000	269,000
Rigidization techniques for space structures.....	136,000	---	---
Precision data system for antenna pointing.....	---	975,000	---
Attitude stabilization techniques....	---	558,000	322,000
Solid-state spaceborne transmitter...	---	127,000	---
Total Advanced Technical Development$	790,000	$ 2,272,000	$ 2,473,000

In exploiting the knowledge gained from its own and other research programs, NASA develops materials and prototype hardware which have application to the flight program, such as radiation resistant materials and components, efficient satellite batteries, a precision data system for antenna pointing, long-lived travelling wave tubes and attitude stabilization devices. A continuing effort will be made with FY 1963 funds to develop a high-efficiency, high-power travelling wave tube having low inter-modulation distortion. These tubes presently offer the most promise for achievement of long, useful life as active satellite final output stages.

Of utmost importance to the passive satellite program is the development of reflecting structures which will direct more of the received energy back toward earth than does a sphere such as ECHO I. This is desirable if passive satellite systems are to be employed at operational altitudes (3000-6000 miles, to reduce the number required) for wideband transmissions, in order that the power radiated by the earth terminal can be kept within reasonable limits (20 KW or less). FY 1963 funding will provide for the development, fabrication and ground testing of scale models and full-size structures with gain applicable to future passive satellite flight programs. Testing will include a determination of the suitability of their erection techniques, mechanical integrity and electromagnetic gain.

Flight Program	1961	1962	1963
ECHO I			
Passive satellite reflection characteristics	$ 250,000	---	---
Total ECHO I	$ 250,000	---	---
ECHO (rigidized sphere):			
Spacecraft			
Sphere development and procurement	831,000	---	---
Canisters and spacecraft environmental tests	1,630,000	---	---
TV system	402,000	---	---
Beacons	325,000	---	---
Ground equipment for TV system	90,000	---	---
Data reduction and analysis-contract	---	$ 330,000	$ 135,000
Thor launch vehicles	3,200,000	---	---
Thor-Agena launch vehicle	2,200,000	4,680,000	---
Total ECHO (rigidized sphere)	$8,678,000	$ 5,010,000	$ 135,000

Flight Program cont'd.	1961	1962	1963
Rebound			
Spacecraft design study	$325,000	$555,000	---
Spacecraft	---	4,750,000	$1,612,000
Satellite flight units	---	1,115,000	1,075,000
Systems analysis, coordination and planning	---	836,000	807,000
Receivers, antenna feeds and terminal equipment	---	---	807,000
Communications experiments	---	---	618,000
Atlas-Agena launch vehicles	---	6,244,000	11,828,000
Total, Rebound	$325,000	$13,500,000	$16,747,000
Relay			
Systems engineering study	500,000	---	---
Spacecraft fabrication and checkout	5,500,000	4,720,000	6,237,000
Systems coordination and planning	3,650,000	---	3,011,000
Command and control equipment	1,000,000	2,007,000	---
Special ground equipment	2,000,000	446,000	1,075,000
Operations	---	1,450,000	2,258,000
Thor-Delta launch vehicles	8,000,000	---	6,560,000
Total, Relay	$20,650,000	$8,623,000	$19,141,000
Radiation Measurements Satellite			
Engineering services	1,100,000	527,000	---
Structures	260,000	---	---
Solar paddles	175,000	446,000	---
Flight data systems	75,000	---	---
Mechanical systems	120,000	100,000	---
Systems integration	160,000	235,000	---
Total, Radiation Measurements Satellite	$1,890,000	$1,308,000	---

Flight Program Cont'd.	1961	1962	1963
Synchronous Communications Satellite (Syncom)			
Spacecraft	------	$ 4,450,000	$2,043,000
Backup travelling wavetube	------	446,000	---
Special telemetry equipment	------	223,000	---
Command transmitter	------	335,000	---
Reliability services	------	112,000	---
Injection motor	------	558,000	---
Tracking and data acquisition and services			
Communication equipment	------	200,000	---
Minitrack operational support test	------	223,000	323,000
Computer services	------	---	108,000
Data reduction	------	---	430,000
Side tone ranging equipment	------	1,004,000	---
Transportation, installation, and operation of ground station			
Station operation	------	---	1,022,000
Transportation	------	670,000	107,000
Logistic support	------	23,000	54,000
Thor-Delta launch vehicles	------	8,350,000	---
Total Syncom	---	$16,594,000	$4,087,000
Intermediate Altitude Satellite			
Spacecraft	---	---	$ 6,452,000
Systems coordination and planning	---	---	2,150,000
Radiation experiment	---	---	1,613,000
Special ground equipment	---	---	1,075,000
Atlas-Agena launch vehicles	---	---	10,215,000
Total Intermediate Altitude Satellite	---	---	$21,505,000

Flight Program cont'd.	1961	1962	1963
Advanced Synchronous Communications Satellite			
Spacecraft	---	---	$6,450,000
Ground control and communications equipment	---	---	5,915,000
Atlas-Agena launch vehicles	---	---	6,236,000
Total Advanced Syncom	---	---	$18,601,000
Total Flight Program	$31,793,000	$45,035,000	$80,216,000

Of the possible general types of communications satellite systems, three appear to be logically the most applicable to the problem of practical communications. These are passive satellites in low-altitude orbits (2,000--3,000 miles), active satellites in low-to-intermediate altitude orbits (3,000--12,000 miles) and active satellites in 24-hour (22,300 miles) synchronous orbits. Each type has particular advantages and disadvantages. Selection of system type for operational application requires a quantitative comparison of the particular system characteristics. Data for such a comparison are not now available, and can only be obtained through actual test of the system types in the space environment. The NASA communications satellite systems flight program contains flight experiments involving each of these three types of satellite systems. Results of the program will materially aid in final system type selection and will provide a background of hardware and operating experience requisite to developing operational systems.

ECHO I

ECHO I was a successful flight experiment conducted to demonstrate the feasibility of using large, lightweight, inflatable spheres as communications reflectors and to study the behaviour of these structures in the space environment. ECHO I was launched on August 12, 1960, and a series of successful communications experiments were carried out.

All work on ECHO I was carried out with prior year funding; because of the continued life of ECHO I in orbit, FY 1961 funds were allocated to provide for continuation of experiments to determine the nature and type of degradation experienced by the satellite.

Echo (Rigidized Sphere)

Project Echo (rigidized sphere) will cover development and flight-testing of a passive communications satellite larger than ECHO I and possessing inherent rigidity capable of maintaining a spherical shape in the space environment for a extended period of time. The program includes two ballistic shots from Atlantic Missile Range (AMR) and an orbital launch from Pacific Missile Range (PMR). The ballistic shots will utilize Thor launch vehicles and will test satellite ejection and inflation. Each Thor will carry a television camera and recoverable film cameras, and will be attitude stabilized during coast and after ejection to permit recording of the sphere ejection and inflation.

The orbital launch will utilize a Thor-Agena launch vehicle, which will place the satellite in a circular orbit of 650 miles altitude. Functioning of the sphere in orbit as a reflector of radio waves will be determined through monitoring its radar cross-section.

The development of the Echo (rigidized sphere) spacecraft was initiated with FY 1961 funds, which will cover the cost of the five flight models and the flight instrumentation for the vertical tests. Two spacecraft will be used in vertical tests, one will be used in the orbital launching, and two more will be available in case of failure. Funding in FY 1962 and 1963 will cover cost of support and of radar cross-section experiments. FY 1961 funds also provide for procurement of the two Thor vehicles required for the vertical tests and for the first increment of the Thor-Agena procurement. Funding in FY 1962 will complete payment for the Thor-Agena vehicle required for the orbital test.

Rebound

Project Rebound covers development and flight test of a multiple communications satellite launching technique, using a single spacecraft in order to establish the feasibility of an economical method for placing in orbit the large number of satellites required for a "low orbit" satellite system. As planned, the Rebound spacecraft will deploy three passive satellites of the Echo (rigidized sphere) type in predetermined locations in the same orbit. Two launches, using Atlas-Agena launch vehicles, are planned in calendar year 1963 from PMR into a circular orbit, inclined 82°, at 1,700 miles altitude. Although planned for passive satellites, the techniques developed in Rebound will be equally applicable to active satellites. The existing design study contract, placed July 1, 1961, is expected to be completed with a satisfactory design in March 1962. It is expected that communications experiments with Rebound satellites will be conducted jointly with the Air Force using Air Force facilities. The same foreign nations participating in Project Relay may also participate

in Project Rebound through operation of communications ground stations. The design of the spacecraft was initiated with FY 1961 funds. FY 1962 and 1963 funds provide for the development and fabrication of the two (2) flight model spacecraft for the orbital tests. FY 1962 funds will provide the first increment, and FY 1963 funds will complete funding for the two (2) Atlas-Agena launch vehicles required.

Relay

Project Relay covers development and flight testing of an experimental wideband, low orbit, active communications satellite and measurement of effects of the space environment on such a spacecraft. The Relay spacecraft will be an 8-sided prism, 29 inches in maximum width and weighing 125 pounds. It will be spin-stabilized and will have a degree of attitude control through use of a coil interacting with the earth's magnetic field. The spacecraft will contain two complete and separate communications transponders each capable of relaying a standard TV channel or equivalent high-speed data or duplex telephone channels. Only one transponder is operated at any time; the other is for backup, representing 100 per cent redundancy. The spacecraft also contains a radiation experiment for monitoring the radiation levels encountered by the satellite and measuring radiation damage to selected solid-state devices. In addition, the spacecraft includes a solar cell/nickle-cadmium battery power supply, solar attitude sensors, and command and telemetry equipment. Relay spacecraft will be launched with Thor-Deltas from AMR into elliptical orbit with 3,000-mile apogee, 900-mile perigee and 50 degrees inclination.

Communications experiments with the Relay spacecraft will be conducted between the East Coast of the United States, Europe and South America. Relay communications ground stations are to be erected by the United Kingdom, France, the Federal Republic of Germany, and Brazil. Services of ground stations in the United States at Nutley, N.J. and Andover, Me., will be contracted for by NASA. In addition to the communications ground stations, NASA is assembling equipment at Wallops Station, Va. and Goldstone, Calif. to test the functioning of the Relay spacecraft.

Two Relay spacecraft will be placed in orbit during the latter half of calendar year 1962. Two more spacecraft of improved design will be flight tested in calendar year 1963. A back-up launch is provided for each series.

Supplemental FY 1961 funds were used to initiate spacecraft development and fabrication and to procure three Thor-Delta vehicles (including one back-up). FY 1962 funds are being used to continue spacecraft fabrication and test, to provide special ground equipment, to procure the services of ground stations in the United States, and to begin development of the second series of spacecraft. Funding in FY 1963 is necessary to complete

the second series of Relay flight models and to fund incrementally the procurement of three Thor-Delta vehicles.

Radiation Measurements Satellite (24-hour orbit)

The extent of damage to solar cells and solid state components caused by radiation existing in the space environment is being investigated in Project Relay at the 3,000-mile altitude. At 24-hour altitudes, only fragmentary information on the composition and intensity of radiation has been obtained by scientific satellites. The Radiation Measurements satellite will provide such information. From these measurements and the damage data obtained from Relay, some estimate can be made of the efficient lifetime of components of the Syncom and Advent satellites. Launch will be on developmental Atlas-Centaur vehicles from AMR.

FY 1961 and 1962 funding has been used to develop and procure three flight spacecraft for two launches. Vehicle funding is being provided by the Centaur development program.

Syncom

Project Syncom covers development and flight testing of a narrow band active communications satellite in a 24-hour circular orbit.

The Syncom spacecraft will be 28 inches in diameter and will weigh 125 pounds, of which approximately 70 pounds is the weight of the injection rocket motor.

It will contain a communication transponder capable of accommodating one full duplex radio telephone channel. It will also contain the "apogee kick" rocket motor; vernier rockets; nitrogen gas jets with gas supply and valves for attitude and position control; solar attitude sensor; solar cell/nickle-cadmium battery power supply; telemetry and control equipment; and radiation experiment. The spacecraft will be launched by a Thor-Delta into a highly eccentric orbit with apogee at synchronous altitude. When apogee is reached, the "apogee kick" rocket motor will be fired, and will provide sufficient additional velocity to inject the spacecraft into a circular, near 24-hour orbit inclined 33 degrees to the equator. The appropriate number of vernier rockets will then be fired by ground command to provide the incremental velocity for the exactly desired 24-hour period. Three transportable communication ground stations for Project Syncom are being developed and procured by the Department of Defense. It is planned that one ground station will be located overseas, and two in the United States.

The development of this satellite has been initiated with FY 1962 funds. These funds plus the FY 1963 funds will provide the major increment for the development and fabrication of the three (3) flight model spacecraft, of which one will be launched in calendar year 1962, and two in calendar year 1963. FY 1962 funds also provide for the three Thor-Delta launch

vehicles required. Development and fabrication of the communications ground station equipment is being funded by the Department of Defense.

Intermediate Altitude Communications Satellite

The project for an intermediate altitude communications satellite, a logical extension of the Relay type of communication satellite, will cover development and flight testing of a stabilized active repeater satellite capable of simultaneous two way wideband intercontinental transmission. Atlas-Agena launch vehicles from AMR will be used to achieve the 6,000 to 10,000 mile orbital altitude, which will provide long mutual visibility times. This orbit will represent a compromise between the lower orbits, with their large number of required satellites and extensive ground station antenna requirements, and the 24-hour orbit, which requires somewhat larger vehicle capacity, and which may result in shorter satellite life-time due to the necessity for position keeping.

FY 1963 funds will enable NASA to begin spacecraft development and fabrication of the first three spacecraft, and to provide the first increment of funding for the launch vehicles for the three flights in calendar year 1964 and one flight in calendar year 1965.

Advanced Synchronous Communications Satellite

The project for an advanced synchronous communications satellite will develop and flight test a wideband active communications satellite capable of transmitting four television channels or 300 two-way radio telephone channels. The satellite will represent the logical extension of the Syncom satellite to a wide-band capability and will use similar techniques for achieving orbit, and maintaining position and orientation. Launch will be from AMR into a 24-hour circular equatorial orbit (22,300 miles altitude). In this orbit the satellite will appear stationary to an observer on earth, and can serve as a link between suitably equipped ground stations over almost a complete hemisphere.

FY 1963 funds will begin spacecraft development, and commence fabrication of the first two spacecraft. FY 1963 funds will also provide the first increment of funding for the Atlas-Agena launch vehicles leading to two flights in calendar year 1964 and one flight in calendar year 1965.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

FISCAL YEAR 1963 ESTIMATES

SOUNDING ROCKETS

SUMMARY OF REQUIREMENTS:

	1961	1962	1963	Page No.
Advanced Research ..	$ 419,000	$ 617,000	$ 784,000	RDO 8-2
Advanced Technical Development	1,386,957	1,046,638	1,685,000	RDO 8-2
Flight Program	10,524,043	12,597,362	16,688,000	RDO 8-4
Total	$12,330,000	$14,261,000	$19,157,000	

OBJECTIVES:

To investigate geophysical phenomena from the earth's surface out to one earth's radius. To perform astronomical observations by measuring the radiation arriving from other celestial bodies from above the obscuring and distorting effects of the earth's atmosphere. To investigate the structure of the atmosphere, the ionosphere, the geomagnetic field, energetic particles, and the chemistry of and solar effects on the upper atmosphere. To flight test instrumentation prior to use in satellites and space probes.

JUSTIFICATION:

A substantial expansion of the sounding rocket program is planned for FY 1963 to permit continuation of existing research and an expanded program of university research. New experimenters will use sounding rockets as a means to participate in the national space effort. Contracts and grants will be placed with selected universities for preparation of experiments, and engineering support will be provided on a contractual basis to assist the experimenters in preparing their instrumentation for flight. Approximately 160 sounding rocket vehicles will be procured.

FUNDING REQUIREMENTS:

Advanced Research	1961	1962	1963
Aeronomy:			
Atmospheric temperature studies	$ 43,000	$ 45,000	$ 51,000
Ultraviolet scattering densitometer and composition	---	50,000	---
Special techniques for atmospheric measurements	66,000	220,000	351,000
	$ 109,000	$ 315,000	$ 402,000
Galactic Astronomy:			
Design of flight optical systems for interstellar studies	$ 85,000	$ 81,000	$ 131,000
Study of interstellar and intergalactic media	75,000	121,000	151,000
	$ 160,000	$ 202,000	$ 282,000
General Support:			
Sounding rocket handbook	$ 150,000	$ 100,000	$ 100,000
Total, Advanced Research	$ 419,000	$ 617,000	$ 784,000

Most of the advanced research conducted in geophysics and astronomy is funded under the Scientific Satellite Program. However, a limited amount of this research is specifically aimed at the development of techniques for atmospheric and astronomical studies using sounding rockets. Continuation of studies of performance capabilities and design characteristics of available sounding rocket vehicles is also planned. These studies are published in the form of a sounding rocket handbook for use by experimenters in planning flight missions and designing payloads.

Advanced Technical Development	1961	1962	1963
Aeronomy:			
Instrumentation for upper atmospheric research	$ 450,820	$ ---	$ ---

Advanced Technical Development (continued)	1961	1962	1963
Sodium vapor experiments	$ 392,432	$ ---	$ ---
Ultraviolet spectra of the upper atmosphere	---	310,000	---
Mass spectrometers	25,000	140,638	125,000
Magnetic spectrometer development	---	---	195,000
Development of cases and gages		88,000	161,000
	$ 868,252	$ 538,638	$ 481,000
Energetic Particles:			
Neutron measurements	$ 42,194	$ ---	$ ---
Plasma and Ionospheric Physics:			
Electron density probes	$ 138,924	$ 46,000	$ 109,000
Galactic Astronomy:			
Soft x-ray equipment	$ 70,587	$ ---	$ ---
Flight detector development for interstellar studies	---	21,000	90,000
	$ 70,587	$ 21,000	$ 90,000
Astrophysics:			
Radio astronomy	$ ---	$ 115,000	$ ---
Sounding Rocket Systems:			
Transitorized telemeter	$ ---	$ 40,000	$ 50,000
Dovap development data	---	100,000	100,000
Aspect sensors	---	80,000	85,000
Vibration studies	207,000	---	85,000
PPM/PCM telemetry	---	---	40,000
Instrumentation development	25,000	67,000	218,000
14 channel digital tape system	---	---	30,000
Wind tunnel studies	---	---	50,000
Vehicle systems development ...	35,000	39,000	347,000
	$ 267,000	$ 326,000	$1,005,000
Total, Advanced Technical Development	$1,386,957	$1,046,638	$1,685,000

Emphasis in this area is on the development of advanced spectrometers, cases and gages for determining the composition, pressure, temperature and density of the upper atmosphere. Work on advanced electron density probes for ionospheric research is being continued, and support is provided for development of astronomical instrumentation by the Goddard Space Flight Center. An expanded effort is also planned for development of improved telemetry systems and data systems for future sounding rocket payloads. Work will also be done on the improvement of existing sounding rockets to give them greater load carrying capability and more precise stabilization and pointing control.

Flight Program	1961	1962	1963
Aeronomy:			
Sodium vapor experiments	$ 26,100	$ 204,741	$ 272,000
Neutral composition of upper atmosphere	276,000	270,000	275,000
Pressure, temperature density measurements.....	327,000	335,000	260,000
Wind shear and D region correlation	---	51,898	62,000
Falling sphere accelerometer	---	---	175,000
Rocket grenade experiments .	448,000	---	---
Ion composition measurements	---	240,000	285,000
	$1,077,100	$1,101,639	$1,329,000
Space Chemistry:			
Airglow photometry	$ ---	$ ---	$ 215,000
Induced chemiluminescence experiment	---	---	315,000
Spectrometry and composition measurements	---	---	265,000
Induced airglow reactions ..	---	---	215,000
High resolution ultraviolet photometry	---	---	215,000
Earth's albedo and scattering phenomena	170,000	161,000	161,000
	$ 170,000	$ 161,000	$1,386,000
Micrometeorites:			
Meteor streams collection program	$ ---	$ 201,000	$ 115,000

Flight Program (Con't.)	1961	1962	1963
Energetic Particles:			
Low energy heavy primary cosmic rays	$ 55,000	$ 57,000	$ 57,000
Nuclear emulsion experiments	440,500	189,000	195,000
Solar beam experiments	135,000	156,000	160,000
	$ 630,500	$ 402,000	$ 412,000
Magnetodynamics:			
Investigation of the electrojet	$ 25,943	$ 445,000	$ 330,000
Magnetic fields and ionospheric currents	23,000	75,600	75,000
	$ 48,943	$ 520,600	$ 405,000
Plasma and Ionospheric Physics:			
Electron density probes	$ ---	$ 23,123	$ ---
Langmuir ionosphere probes	---	140,000	140,000
DC and VLF measurements	161,000	246,000	281,000
RF ionosphere measurements	344,000	326,000	144,000
Measurements of the ionosphere during solar eclipse	---	---	270,000
Ionosphere measurements for the International Quiet Sun Year (IQSY)	----	---	215,000
	$ 505,000	$ 735,123	$1,050,000
Galactic Astronomy:			
Stellar x-ray mapping	$ ---	$ ---	$ 132,000
Ultraviolet photometry	86,000	145,000	273,000
Stellar and nebular spectrometry	633,000	547,000	506,000
	$ 719,000	$ 692,000	$ 911,000
Solar Physics:			
Solar ultraviolet spectrometry	$ 490,500	$ 307,000	$ 350,000
X-ray spectrophotometry	---	130,000	242,000
	$ 490,500	$ 437,000	$ 592,000
Astrophysics:			
Radio astronomy	$ ---	$ ---	$ 115,000
Meteorology Photo Probe	$ 146,000	$ 206,000	$ 40,000

Flight Program (Con't.)	1961	1962	1963
Rocket Systems:			
Aerobee 100	$ 45,800	$ 165,000	$ ---
Aerobee 150/150A	1,048,000	723,000	932,000
Nike Cajun	262,000	270,000	268,000
Iris	252,000	---	127,000
Argo D-8	152,000	1,008,000	1,449,000
Aerobee 300	---	---	151,000
Argo D-4	442,000	---	441,000
Nike Apache	52,000	163,000	162,000
Arcas	---	---	46,000
Aerobee 350	---	---	192,000
	$2,253,800	$2,329,000	$3,768,000
General Flight Support:			
Launcher modifications	$ 55,000	$ 55,000	$ 55,000
Attitude control systems	29,000	360,000	430,000
Ground electronics and instrumentation	---	104,000	80,000
Airborne electronics	---	770,000	745,000
Telemetry support	470,000	400,000	395,000
Dovap support	175,000	125,000	125,000
Antenna support	104,000	75,000	75,000
Wind effects	145,000	---	---
Transistorized FM/FM telemeter packages	105,000	---	---
MCR 105 airborne 10 channel command receivers (24)	131,000	---	---
Airborne pulse position telemeter transmitter	70,000	---	---
FM/FM telemetry ground station	52,000	---	---
Supersonic wind tunnel test	50,000	---	---
Mircom model CM-100 video band recorder	60,000	---	---
NERV modifications	126,000	---	---
Argo D-4 vehicle performance study	165,400	---	---
Support services, facilities and materials	1,268,800	1,149,000	1,093,000
Iris - ONR overhead adjustment	---	56,000	---
Despin systems	---	25,000	25,000
Checkout and launch operations	1,477,000	2,188,000	2,937,000
Engineering services to universities for coordination of fabrication of experiments	---	505,000	605,000
	$4,483,200	$5,812,000	$6,565,000
Total, Flight Programs	$10,524,043	$12,597,362	$16,688,000

During FY 1961, 69 sounding rockets were launched. The number of flights is expected to be increased to 166 in FY 1963. FY 1961 funds procured 104 sounding rockets primarily of the Aerobee, Iris, Nike Cajun and Nike Apache types. FY 1962 funds procured 108 sounding rockets of the Aerobee, Nike Cajun, Nike Apaches and Journeyman (Argo D-8) types. FY 1963 procurement will consist of about 158 sounding rockets of the Aerobee, Iris, Nike Cajun, Nike Apache, Journeyman, Javelin (Argo D-4), and Arcas types. The major areas in which sounding rockets will be used are listed below.

Aeronomy

Direct measurements will be made of atmospheric temperature, density, pressure, composition and dynamics using various types of sensors, gauges, spectrometers, spectrophotometers and accelerometers. Indirect measurements of winds, turbulence, diffusion rates, density and temperatures will be made by the ejection of sodium vapor from rockets in the upper atmosphere. These sodium releases are conducted at twilight in the morning and evening so that the sodium vapor is illuminated by the sun. The sun makes the cloud glow and the drifting and twisting of the vapor trail gives information on the winds and turbulence. The expansion of the cloud gives information on diffusion rates and densities. Observation of these clouds using instrument techniques based on interferometric and absorption principles will measure upper air temperature. Ion traps and ion mass spectrometers will be used to determine the number, temperatures and identities of the various ions in the upper atmosphere.

Space Chemistry

New efforts to study the chemistry of the earth's upper atmosphere will be initiated. These experiments will employ spectrometers, photometers and other sensors to study natural and induced chemical reactions in the upper atmosphere. Simple photometers in sounding rockets will be used to study the relative importance and speed of the principle reactions believed to be occurring in the upper atmosphere. The controlled addition of small amounts of chemicals to the upper atmosphere to produce local reactions will be conducted with sounding rockets and these reactions will be observed from ground and rocket borne instrumentation to study chemical phenomena. Ultraviolet spectrometers designed to perform detailed measurements of known atmospheric chemical reactions will be used to study the day to night changes, the speed with which the reactions occur, and the extent of reaction products and competing reactions. Sensors will be flown to study the spectral distribution of ultraviolet, visible and infrared light scattered or reflected by the molecules, ions and particulate matter in the upper atmosphere to identify the responsible species and determine particle size and quantity.

Micrometeorites

Sounding rockets will be launched into meteor streams to detect and collect micrometeorites for laboratory analysis.

Energetic Particles

Sounding rockets are used for investigation of the lower reaches of the inner Van Allen radiation belt and for determination of the origin, nature, motion, spatial distribution and temporal variations of various energetic particles entering the earth's atmosphere. On September 19, 1960, a Journeyman rocket was flown along a trajectory closely corresponding to the magnetic meridian, extending from the Pacific Missile Range to a point 1780 kilometers away in the Pacific. This rocket carried a special nose-cone fitted for the exposure and recovery of nuclear emulsions for the measurement of the flux and energy spectrum of the trapped protons in the inner Van Allen belt. This successful flight has given scientists the first measurements of these quantities as a function of position in the belt.

Interest in the problem of the spectral characteristics of the solar particle beams associated with major solar flares led to a rocket probe study of these events between June and November 1960. In the course of the experiment, ten firings were made into four solar particle beams and four other firings were made for comparison purposes during quiet periods and periods of auroral absorption. Both counters and emulsions were carried, and the solar proton flux was measured. These rocket data have been correlated with balloon measurements and other data, and the correlation between solar flares and the solar proton flux has been broadly defined.

Sounding rockets are also being used in coordination with balloons to study the energy spectrum of solar cosmic rays down to energies below 1 MEV.

Magnetodynamics

Sounding rockets are being used to carry magnetometers to altitudes of about 200 km to study the equatorial electrojet and other aspects of the earth's magnetic field. Relationships between the earth's magnetic field and ionospheric currents will be studied. Sounding rockets are used for this purpose because the altitudes to be studied are below satellite altitudes and vertical profiles are desired.

Plasma and Ionospheric Physics

Measurements of electron and ion density, and electron temperature and energy distribution will be continued. The effects on the ionosphere

of the cutoff of solar ionizing radiation during the mid-1963 solar eclipse will be studied. An effort will be made to prepare new experiments for the International Quiet Sun Year (1964).

Galactic Astronomy

Sounding rockets will be used in increasing numbers to make survey measurements and to test and calibrate instruments being developed for the Orbiting Astronomical Observatories. One such rocket fired in November 1960 obtained low dispersion spectra for ten stars. These were all very bright stars, varying in temperature from slightly hotter than the sun up to the hottest stars observable in the sky. The ultraviolet spectrum of only one of these stars agrees well with the prediction of existing theory. This particular star was among the cooler ones, and the spectrum followed closely what one might expect from a knowledge of the sun. However, the hotter the star, the greater the disagreement with current theory. Other flights have revealed and made detailed observations of nubulocity which was invisible in the normally observed spectral regions but unexplainably bright in the ultraviolet. The discovery that the sun is an unexpectedly interesting source of X-rays suggests the possibility of being able to learn much about the stars in the X-ray region of the spectrum. These experiments with sounding rockets have demonstrated that sounding rocket spectrometry can yield valuable information for development of astronomical theories and for optimization of the design of instrumentation for the more comprehensive experiments to be flown in the more expensive satellite observatories.

Solar Physics

Flights will be conducted to study the sun and solar activity using ultraviolet and X-ray instrumentation. The ultraviolet studies are expected to increase our understanding of solar activity and its effects on the earth's atmosphere since ultraviolet radiation produces auroral and airglow effects as well as the stable ionosphere. Flights with X-ray instrumentation are expected to yield information on the temperature structure of the quiet corona and hence contribute to our knowledge of the mechanism responsible for coronal heating. X-ray observations of the active sun will give information on the type of solar activity responsible for particle showers near the earth.

Astrophysics

Sounding rockets are being used for the development of radio astronomy receivers. Although radio astronomy is conducted from the earth's surface, there are substantial ranges of the spectrum which can be observed only, or with much greater accuracy, from above the earth's atmosphere. Radio astronomy techniques will be used to study the planets and other

cold celestial bodies from which the primary electromagnetic radiation is in the extremely high frequency radio region.

Meteorology Photo Probe

Sounding rocket flights with recovery provisions are utilized to develop photographic equipment and techniques for meteorological research. Polaroid filters have been used on cameras to determine the effectiveness of the filters in distinguishing clouds from a snow and ice background.

Rocket Systems

Sounding rockets for the experiments described in this program are procured with these funds to meet NASA, university and some contractor requirements. Rocket development, modification and improvement are funded to meet the current and new performance characteristics required by more sophisticated scientific payloads.

General Flight Support

This category covers preparation for launch, and the launch itself, including ground instrumentation and telemetry readout, rocket handling and minor modifications, performed primarily at Wallops Station and Fort Churchill, Canada. Instrumentation and launch services are maintained for the year-round flight activities of the sounding rocket program.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

FISCAL YEAR 1963 ESTIMATES

SCIENTIFIC SATELLITES

SUMMARY OF REQUIREMENTS:

	1961	1962	1963	Page No.
Advanced Research .	$ 6,793,824	$ 13,847,000	$ 17,418,000	RDO 9-3
Advanced Technical Development . . .	6,207,176	13,124,000	16,261,000	RDO 9-6
Flight Program. . .	41,397,000	90,647,000	141,486,000	RDO 9-8
Total . . .	$54,398,000	$117,618,000	$175,165,000	

OBJECTIVES:

To increase man's knowledge of the earth, the sun, interplanetary space, the universe in general and the relationship between solar processes and geophysical phenomena. More specifically:

1. To determine and understand the structure, composition and dynamics of the Earth's atmosphere and ionosphere.

2. To investigate and determine the nature of the great radiation belts, the nature and origin of cosmic rays, the characteristics of other energetic particles in space, the characteristics of magnetic and electric fields, solar activity, the ionospheric and atmospheric conditions, and the relationships among these phenomena.

3. To understand the origin, present state and evolution of the universe by observation of the stars, nebulae, galaxies and planets from above the obscuring influence of the Earth's atmosphere.

4. To investigate the physical processes occurring in the universe including the nature of gravity, the gross features of the Earth's gravitational field and the behavior of elementary particles in rapid motion.

5. To study the effects of space environment on living organisms.

6. To provide basic scientific knowledge required for manned and instrumented space flight and for advancement of the state-of-the-art in meteorology, communications, and navigation.

7. To support international cooperative efforts in the exploration of space.

JUSTIFICATION:

Earth orbiting satellites offer a means of conducting comprehensive scientific investigations in space over long periods of time. Direct measurements can be made of geophysical phenomena with accurate reference to time and space. The Earth's ionosphere and atmosphere can be examined in situ and from above, and astronomical observations can be made from above the absorbing and distorting effects of the Earth's atmosphere.

Major emphasis is being placed on the development of geophysical, astronomical and solar observatories capable of carrying a wide variety of experiments using a basic spacecraft, power supply, stabilization system, command system, data storage system and telemetry system in an effort to achieve a high degree of reliability. However, there is a continuing requirement for smaller satellites in special orbits and small space probes to conduct experiments which are incompatible with the larger observatories.

FY 1963 funds provide for continuation of the development and production of the three types of observatories, for initiation of the development of one Scout-sized satellite and a series of geophysical and biological probes for specialized experiments. FY 1963 funds also provide for continuation of a program of international cooperation, providing launch vehicles and spacecraft for experiments by scientists of the United Kingdom and other countries.

In conjunction with the program of flight experiments, increased emphasis is being placed on support of research and advanced technical development efforts in universities, non-profit institutions and industry. This research and development effort in the space sciences provides the theoretical framework upon which the program of flight experiments is built. It develops the techniques and instrumentation for the flight experiments and provides for analysis of the data obtained.

FUNDING REQUIREMENTS:

Advanced Research	1961	1962	1963
Aeronomy			
Planetary atmosphere studies. .	$ 549,280	$1,164,414	$1,160,000
Calibration of photon counters.	108,839	---	---
Atom density measurements . . .	---	128,000	233,000
Interplanetary gas and dust . .	---	---	100,000
	$ 658,119	$1,292,414	$1,493,000
Space Chemistry			
Chemistry of the upper atmosphere	$ 334,700	$ 378,000	$ 616,000
Investigate physical chemistry of comets	---	394,000	515,000
	$ 334,700	$ 772,000	$1,131,000
Micrometeorites			
Micrometeorite simulation . . .	$ 217,375	$ 260,000	$ 263,000
Radar studies of meteors. . . .	11,000	235,000	280,000
Meteorite recovery and atmospheric ballistics. . . .	---	165,000	250,000
	$ 228,375	$ 660,000	$ 793,000
Energetic Particles			
Cosmic ray studies.	$ 759,708	$ 437,700	$ 561,000
Studies of energetic particles.	187,955	443,000	952,000
Radiation belt studies.	290,038	780,000	966,000
Solid state detector research .	---	330,000	666,000
Recoverable nuclear emulsion study	---	250,000	---
	$1,237,701	$2,240,700	$3,145,000
Magnetodynamics			
Geohydromagnetic theory	$ 160,071	$ 340,000	$ 409,000
Magnetodynamics and orbit theory.	---	---	100,000
Studies of magnetic storms. . .	---	100,000	150,000
	$ 160,071	$ 440,000	$ 659,000

Advanced Research	1961	1962	1963
Plasma and Ionospheric Physics			
Ionospheric propagation research	$1,043,018	$1,192,942	$ 797,000
Plasma physics studies.	---	741,376	877,000
Studies of VLF emissions. . . .	164,938	160,000	466,000
Separating capsule electron density technique	25,230	25,000	25,000
Ionosphere reaction studies . .	---	196,139	208,000
Studies of the structure of the Ionosphere.	---	---	125,000
Theoretical studies in ionospheric physics	172,200	130,000	148,000
	$1,405,386	$2,445,457	$2,646,000
Galactic Astronomy			
UV laboratory spectroscopy. . .	$ 135,000	$ 290,000	$ 458,000
Interstellar extinction and polarization in the UV . . .	72,900	---	---
Stellar atmospheres	115,000	378,000	328,000
Gamma ray data handling	29,742	---	---
Optical constants in the extreme UV	102,000	---	---
Support of International Astronomical Union.	25,000	---	---
Studies of interstellar gas . .	99,400	65,000	107,000
Radiometric standards	112,000	---	---
Optical and electronic properties of solids	224,000	---	---
Parameters of solids.	---	---	42,000
High resolution infrared studies	---	43,089	37,000
Formation and properties of interstellar matter	---	32,000	32,000
Image tube research	---	122,000	237,000
High altitude recoverable experiments	---	87,000	138,000
Ultraviolet detectors	---	62,000	113,000
	$ 915,042	$1,079,089	$1,492,000
Solar Physics			
Solar monitoring.	$ 105,000	$ 205,190	$ 213,000
Theoretical research in solar activity.	144,800	298,000	558,000
Interpretation and observation of solar phenomena.	---	153,000	176,000
Solar UV research	---	315,000	383,000

Advanced Research

Solar Physics (Continued)	1961	1962	1963
Studies of solar flares	$ ---	$ 37,000	$ 126,000
Solar parallax.	---	57,000	---
	$ 249,800	$1,065,190	$1,456,000
Astrophysics			
Radio astronomy	$ 35,000	$ 215,000	$ 218,000
Rotation and gravitation on statistical systems. . . .	76,000	120,600	183,000
Celestial mechanics	72,000	471,000	472,000
Gravity and relativity.	---	65,000	170,000
	$ 183,000	$ 871,600	$1,043,000
Space Biology			
Research in space biology . . .	$ 174,000	$1,326,000	$1,114,000
Study of micro-organisms in the upper atmosphere.	21,000	24,000	---
	$ 195,000	$1,350,000	$1,114,000
Scientific Satellite Support			
Theoretical studies of guidance techniques during orbit	$ ---	$ ---	$ 113,000
Theoretical studies of stabilization systems reliability. .	---	---	113,000
Theoretical stuides of orbit rendezvous guidance systems .	---	---	113,000
Investigation of improved techniques, processes, and materials	---	86,400	121,000
	$ ---	$ 86,400	$ 460,000
General Support			
Theoretical research in the space sciences.	$ 676,930	$ 600,000	$ 718,000
Biographic and bibliographic services.	---	75,000	82,000
Support of Rocket and Satellite Sub-center of the World Data Center	---	30,150	32,000
Mathematical and computing services.	549,700	839,000	1,154,000
	$1,226,630	$1,544,150	$1,986,000
Total, Advanced Research. .	$6,793,824	$13,847,000	$17,418,000

The broad range of scientific investigation conducted with satellites must be based on firm laboratory and theoretical research in order to define the nature of investigations to be undertaken, to devise methods and techniques for these investigations, to assess the results of flight experiments and to relate them to existing theory and knowledge. Universities and other non-profit institutions play a predominant role in this research. In FY 1962 and FY 1963, an intensive effort will be made to increase the number of universities participating in the program and to expand the programs of those universities already participating.

Advanced Technical Development	1961	1962	1963
Aeronomy			
Instrumentation, composition of the upper atmosphere	$ 286,837	$ 266,000	$ 349,000
Mass spectrometers	206,000	434,000	478,000
Development of radiological sensors	117,000	---	---
	$ 609,837	$ 700,000	$ 827,000
Space Chemistry			
Chemical release for artificial comets	$ ---	$ ---	$ 290,000
Study for optically observed comet head	---	----	102,000
	$ ---	$ ---	$ 392,000
Micrometeorites			
Velocity, energy and direction detectors	$ ---	$ ---	$ 227,000
Micron particle impact studies	211,400	294,000	325,000
Hypervelocity neutron beam	---	77,000	107,000
Collection sensors and special analysis	---	212,000	218,000
	$ 211,400	$ 583,000	$ 877,000
Energetic Particles			
Cosmic radiation detectors	$ 335,498	$ 160,000	$ 520,000
Isotopic abundance of helium	24,700	10,000	---
Interplanetary radiation instrumentation	----	560,000	160,000
Polar radiation experiments	----	260,000	260,000
Particle detectors	391,000	597,300	805,000
Study of avalanche process	71,300	---	---
Logic system development	---	57,000	47,000
Test Balloon flights	---	32,000	32,000
	$ 822,498	$ 1,676,300	$ 1,824,000

Advanced Technical Development (Continued)

	1961	1962	1963
Magnetodynamics			
Magnetometer development.....	$ 188,900	$ 1,130,300	$ 1,185,000
Magnetic field and ionosphere noise.....	215,480	215,000	225,000
	$ 404,380	$ 1,345,300	$ 1,410,000
Plasma and Ionospheric Physics			
Interplanetary plasma probe..	$ ---	$ 651,000	$ 160,000
Polar ionosphere instrumentation	---	125,000	125,000
RF spectrometer development..	227,000	---	---
Comprehensive specification for data acquisition and processing systems.....	111,400	---	---
Development of electro-ion analyzers.....	148,000	273,000	270,000
Studies of plasmas.....	---	195,000	222,000
	$ 486,400	$ 1,244,000	$ 777,000
Galactic Astronomy			
Stratoscope experiments.....	$ 344,000	$ ---	$ 419,000
Optical instrumentation.....	382,446	223,000	447,000
Ultraviolet spectrometer.....	310,000	322,000	327,000
Image converter.....	---	41,000	67,000
X-ray astronomy.....	---	355,000	137,000
Ultraviolet stellar polarization	---	162,000	340,000
Photodiodes and photomultipliers	184,100	---	---
	$ 1,220,546	$ 1,103,000	$ 1,737,000
Solar Physics			
X-ray instrumentation	$ 130,000	$ 265,000	$ 69,000
Gamma ray instrumentation....	114,000	110,000	139,000
Ultraviolet instrumentation..	227,726	603,600	600,000
Instrumentation-polarization of the zodiacal light	65,000	---	---
Development of image orthicon with UV and X-ray response..	202,400	418,000	404,000
	$ 739,126	$ 1,396,600	$ 1,212,000
Astrophysics			
Radio astronomy receivers....	$ 412,589	$ 333,000	$ 389,000
Infrared astronomical optics and detectors.....	---	250,000	640,000
Directive antennae.....	---	---	206,000
Relativity experiments.....	---	55,000	157,000
	$ 412,589	$ 638,000	$ 1,392,000

Advanced Technical Development (Continued)

	1961	1962	1963
Scientific Satellite Support			
Temperature control device and coatings	$ 218,000	$ 473,000	$ 564,000
Wide band flight recorders	208,300	726,200	886,000
Attitude control and guidance subsystems	259,500	677,200	595,000
Advanced telemetry	92,000	487,700	654,000
Advanced video techniques	86,000	352,500	524,000
Design and development of special bearings	91,100	89,000	90,000
Precession damping and spin control devices	42,300	78,000	175,000
Spacecraft propulsion	89,800	442,500	569,000
Antenna development	39,900	100,200	175,500
Vibration measurements and technology	129,800	---	---
Mobile field test facilities	43,700	---	---
Development of reliability techniques for evaluation of spacecraft	---	844,500	1,281,000
Ultra high vacuum system	---	167,000	299,500
	$ 1,300,400	$ 4,437,800	$ 5,813,000
Total, Advanced Technical Development	$ 6,207,176	$13,124,000	$16,261,000

Before experiments are selected for specific flight projects, it is necessary to demonstrate that a given method or technique can be employed within the constraints of available materials and the size, weight and environmental limitations of satellite flights. For this purpose, laboratory models are designed, built and tested. The increasing interest in the program on the part of universities, other scientific institutions and industry is providing a large number of promising proposals for development of instrumentation for future satellite flights. In addition, the increasing complexity of scientific experiments makes it necessary to place greater emphasis on the development of satellite subsystems to provide the necessary stabilization, environmental control, data storage and transmission, and mechanical control for future scientific satellites.

Flight Program	1961	1962	1963
Orbiting Geophysical Observatories			
Study of particle population of space	$ ---	$ 333,000	$ 691,000
Magnetic field experiment	201,100	672,000	1,297,000
Optics of the atmosphere	---	39,000	164,000
Directional mapping of dust particles	---	112,300	393,000

Flight Program (Continued)	1961	1962	1963
Orbiting Geophysical Observatories (Continued)			
Ion electron measurement.....	$ ---	$ 146,000	$ 183,000
Instrumentation for ELF and VLF emissions.....	---	240,300	149,300
Rubidium vapor magnetometer..	---	185,400	186,000
Atmosphere detectors and spectrometers.....	93,000	322,000	862,000
Preparation of experiments not yet selected.....	---	2,185,000	6,533,000
R&D on communications, data handling system and power system.....	125,000	221,000	1,411,000
Reliability contract to monitor prime contractor....	---	103,000	132,000
Design, development, fabrication, test and evaluation of spacecraft.....	4,718,000	17,016,300	23,177,700
Studies of OGO control systems.	---	170,000	203,000
Mission studies and systems support.....	---	96,700	108,000
OGO control system component development.....	220,900	539,000	696,000
Data reduction and analysis..	---	---	936,000
Atlas-Agena launch vehicles..	---	5,790,000	17,565,000
Thor-Agena launch vehicles...	---	---	3,908,000
	$ 5,358,000	$28,171,000	$58,595,000
Orbiting Astronomical Observatories			
Ultraviolet sky mapping experiment.....	$ 710,543	$ 2,143,000	$ 1,318,000
Ultraviolet broad band photometry	455,000	1,075,000	768,000
Galactic astronomy study of stellar structure.....	582,000	205,000	398,000
Absorption spectrum of interstellar gas.....	455,000	410,000	1,368,000
Spectrophotometric measurements	39,400	1,141,000	1,572,000
Experiments for fourth mission (to be selected).....	---	---	1,136,000
Communications and data handling systems.....	68,000	165,000	144,000
Control system.....	31,500	142,000	264,000
Structures and systems integration	---	60,000	59,000
Spacecraft development, test and checkout.....	4,774,100	23,309,000	19,000,000
Reliability contract.....	---	157,000	219,000
Star-Tracker backup.....	---	1,445,000	655,000
Computers.....	356,000	233,000	---
Compressed and liquified gases.....	---	---	514,000

Flight Program (Continued)	1961	1962	1963
Orbiting Astronomical Observatories (Continued)			
Magnetic tape.....	$ ---	$ ---	$ 307,000
Ground support operation.....	---	---	636,000
Test and evaluation.....	---	---	313,000
Atlas-Agena launch vehicles..	---	1,943,000	16,997,000
	$ 7,471,543	$32,428,000	$45,668,000
Orbiting Solar Observatory #1			
Spacecraft development, test and checkout.....	$ 428,000	$ 1,447,600	$ ---
Solar ultraviolet radiation experiment.....	73,800	---	---
Thermal vacuum system.....	275,400	461,000	---
Solar X-ray instrumentation..	312,800	---	---
Satellite data analysis.....	---	---	340,000
Data reduction.....	---	---	534,000
	$ 1,090,000	$ 1,908,600	$ 874,000
Orbiting Solar Observatory #2			
Spacecraft development, test and checkout.....	$ 1,477,000	$ 915,000	$ 2,334,000
Power supply equipment.....	173,400	---	---
Pointing control.....	177,600	---	---
White light coronagraph.....	598,000	---	---
Gamma ray telescope.....	172,000	---	---
Zodiacal light experiment....	80,000	---	---
Communications and data handling systems.....	---	37,000	---
Wheel and pointed experiments	149,000	971,400	---
X-ray spectrophotometer.....	---	139,000	---
Digital command system.....	---	165,000	---
Attitude control subsystems..	---	85,000	---
Thermal systems development..	---	27,000	---
Data analysis.....	---	---	611,000
	$ 2,827,000	$ 2,339,400	$ 2,945,000
Advanced Orbiting Solar Observatory			
Design Phase I spacecraft....	$ ---	$ 330,000	$ ---
Prototype spacecraft.....	---	---	6,704,000
Experimental systems.....	---	---	1,383,000
Atlas-Agena launch vehicles..	---	---	3,600,000
	$ ---	$ 330,000	$11,687,000

Flight Program (Continued)	1961	1962	1963
Topside Sounders			
Spacecraft development, test and checkout	$ 1,354,000	$ 631,000	$ 136,000
Research	88,000	---	---
Data analysis	---	---	390,000
Scout launch vehicles	52,000	1,860,000	326,000
Thor-Agena launch vehicles	3,300,000	9,500,000	---
	$ 4,794,000	$11,991,000	$ 852,000
Inosphere Monitor			
System development	$ ---	---	$ 1,203,000
Construction and test of satellite spacecraft	---	---	986,000
Instrumentation development	---	---	794,000
	$ ---	$ ---	$ 2,983,000
Geoprobes			
Antenna measurements	$ ---	$ ---	$ 47,000
Design, fabrication and assembly of nose cones	---	---	214,000
Experiments	---	---	931,000
Telemetry encoders	---	---	114,000
Field service	---	---	47,000
Data system development	---	---	595,000
Transmitter, antenna, programmers and recorders	---	---	69,000
Thermal systems development	---	---	89,000
Monitoring effect	---	---	35,000
Integration of payload	---	---	1,256,000
Scout launch vehicle	---	---	1,000,000
	$ ---	---	$ 4,397,000
Energetic Particles Satellite			
Study particle population of space	$ 586,000	$ 630,400	$ 336,000
Development of optical aspect and power systems	542,000	371,600	---
Basic payload structure, design, development and test	615,000	476,000	---
Fabrication, spacecraft integration	1,399,000	584,000	---
	$ 3,142,000	$ 2,062,000	$ 336,000

Flight Program (Continued)	1961	1962	1963
Atmospheric Structure Satellite			
PCM telemetry ground stations.....	$ 599,000	$ 147,300	$ ---
Optical aspect and power systems.....	540,500	251,000	---
Basic payload design, development and test.....	766,200	270,800	---
Spacecraft integration.....	507,000	449,000	---
Experiments.....	1,093,300	503,700	---
Data processing and analysis	---	179,200	558,000
	$ 3,506,000	$ 1,801,000	$ 558,000
International Ionosphere Satellite (U.K.#1)			
Development of encoder and power supplies.....	$ 531,200	$ 434,400	$ ---
Development of programmer tape recorder, transmitter, receiver and antenna.....	199,700	135,500	---
Thermal systems development.	50,000	50,000	---
Design, manufacture, integration and test of structure and mechanisms...	342,900	774,900	---
Data processing and analysis	---	---	338,000
Spacecraft integration.....	349,200	529,700	---
Scout launch vehicles.....	1,200,000	1,700,000	---
	$ 2,673,000	$ 3,625,000	$ 338,000
International Satellite (U.K. #2)			
Design and development of telemetry encoder and power system.....	$ 20,000	$ 372,900	$ 336,000
Programmer tape recorder transmitter, receiver and antenna development.....	20,000	295,400	378,000
Design, development and manufacture structure and mechanisms	20,000	326,000	305,000
Spacecraft integration.....	---	745,700	1,300,000
Thermal systems development	---	---	78,000
Scout launch vehicles.....	---	---	2,850,000
	$ 60,000	$ 1,740,000	$ 5,247,000

Flight Program (Continued)	1961	1962	1963
International Satellite (U.K.#3)			
Structure contracts.....	$ ---	$ ---	$ 341,000
Systems integration.....	---	---	1,313,000
	$ ---	$ ---	$ 1,654,000
International Satellite (#4)			
Structure contracts.....	$ ---	$ ---	$ 354,000
Systems integration.....	---	---	1,365,000
	$ ---	$ ---	$ 1,719,000
Space Biology			
Biological investigation of outer space (BIOS).....	$ 165,000	$ 2,110,000	$ 3,633,000
Inospheric Direct Measurement Satellite			
Data analysis.....	$ 225,000	$ 135,000	$ ---
Spacecraft integration, test and checkout.....	999,000	---	---
Juno II launch vehicle.....	730,000	---	---
	$ 1,954,000	$ 135,000	$ ---
Micrometeoroid Satellite			
Spacecraft development, test and checkout.....	$ 2,101,000	$ 150,000	$ ---
Experiments.....	546,000	75,000	---
Data reduction and analysis.	207,000	268,000	---
	$ 2,854,000	$ 493,000	$ ---
Gamma Ray Astronomy Satellite			
Spacecraft development, test and checkout.....	$ 918,000	$ ---	$ ---
Juno II launch vehicles.....	705,000	---	---
	$ 1,623,000	$ ---	$ ---
Electron Density Profile Probe			
Experiments.....	$ 621,000	$ 505,000	$ ---
Scout launch vehicle	950,000	900,000	---
	$ 1,571,000	$ 1,405,000	$ ---

Flight Program (Continued)	1961	1962	1963
Ionosphere Beacon Satellite			
Spacecraft development, test and checkout.....	$ 639,000	$ ---	$ ---
Juno II launch vehicles.....	1,413,457	---	---
	$ 2,052,457	$ ---	$ ---
Vanguard III			
Data analysis.....	$ 144,700	$ 94,500	$
Computing services.....	22,300	13,500	---
	$ 167,000	108,000	---
X-15 Aircraft			
Modify X-15 for astronomy payload.....	$ 89,000	$ ---	$ ---
Total, Flight Program....	$41,397,000	$90,647,000	$141,486,000

Orbiting Geophysical Observatories

The objective of this project is to design and construct a series of spacecraft capable of carrying a wide variety of related geophysical experiments which can be selected as close as possible to the flight date. This capability would make it possible to conduct a program based upon the most recent flight experiments and laboratory research. One spacecraft could then provide as many as 20 or more different types of measurements, which would be correlated to determine the interrelationships between geophysical phenomena.

These observatories will be launched into two general types of orbits: (1) a highly eccentric orbit passing through the Great Radiation belts; and (2) a less eccentric polar orbit providing for coverage of the upper atmosphere and ionosphere, with special emphasis on the polar regions.

The first Eccentric Orbiting Geophysical Observatory (EGO) will be launched into a highly eccentric orbit by an Atlas-Agena vehicle. Experiments tentatively selected for EGO include: instrumentation to measure energetic electron intensities, energy distribution, density and temperature, solar cosmic ray fluxes, and galactic cosmic radiation; magnitude fluctuations and direction of magnetic fields; and concentration, energy distribution and densities of charged particles.

Experiments for the first Polar Orbiting Geophysical Observatory (POGO) will be selected in 1962.

The development of the Orbiting Geophysical Observatories was initiated in FY 1960. FY 1962 funds continue development and initiate fabrication of the first three spacecraft and flight experiments. FY 1963 funds complete the funding of the first three spacecraft and their experiments and provide a major portion of the cost of three additional spacecraft and experiments. Two Eccentric Orbiting Geophysical Observatories (EGO) will be launched in CY 1963 and two in CY 1964 on Atlas-Agena vehicles. There will be two attempts to launch a Polar Orbiting Geophysical Observatory (POGO) on Thor-Agena vehicles in 1964. If the first attempt in any year is successful the spare spacecraft will be rescheduled for a later flight. FY 1962 funds also provide for the first increment of the procurement of two Atlas-Agena launch vehicles for EGO. Funding for these vehicles will be completed in FY 1963, as well as the first increment of the cost of two additional Atlas-Agenas for EGO and two Thor-Agenas for POGO.

Orbiting Astronomical Observatories

The purpose of this project is to place into orbit a series of astronomical observatories above the absorbing atmosphere for precision telescopic observations of the emission and absorption characteristics of the Sun, stars, planets and nebulae in the ultraviolet, infrared and X-ray regions of the electromagnetic spectrum. A standard stabilized spacecraft is being developed to carry various types of astronomical observing equipment.

The first of these spacecraft is scheduled for launch in late CY 1963 and will carry two major experiments.

A study of the celestial sphere in three ultraviolet ranges will map the sky in ultraviolet down to a wavelength of 1100Å (Angstroms) with three broad band television photometers and will record the brightness of at least 200,000 stars.

A broad band photometry study of individual stars and nebulae will help determine the stellar energy distribution in the spectral region from 800 to approximately 3000Å, and the measurement of emission line intensities of diffuse nebulae in the same spectral region. These investigations are expected to provide data which will not only be useful to the astronomical community but will also aid in designing future instrumentation.

The second OAO, to be launched in CY 1964, will contain a system designed to obtain absolute spectrophotometric data on selected stars, nebulae and galaxies. The optical system will employ a relatively fast 36-inch Cassegrain telescope with a large aperture spectrophotometer and will use both the coarse (1 minute of arc) and the fine (1 second of arc) control systems. The usable spectral region will be approximately 912 to 4000Å.

The absorption experiment in the third observatory,,to be launched in CY 1964 will make quantitative observations of the absorption spectrum of the interstellar gas in the regions between 800 and 1500Å and 1600 to 3000Å. This spacecraft may also be used to repeat the first set of experiments should the first attempt fail.

A set of experiments for a fourth spacecraft will be selected in CY 1962.

The development of satellite astronomical observing equipment and the design of the standard stabilized spacecraft were begun in previous years. FY 1961 and FY 1962 funds provided for the completion of design, the development of the spacecraft, and initiation of fabrication of the first two observatories. Current plans call for a continuing series of observatories and experiments at an anticipated rate of one attempt every six months, with an objective of one successful flight per year. Vehicle funding, begun in FY 1962, continues in FY 1963 and includes development of a special 10-foot diameter Agena nose to accommodate the OAO.

Orbiting Solar Observatories

The Orbiting Solar Observatories (OSO) are stabilized space platforms designed primarily for solar-oriented experiments. These experiments will provide continued observation of the Sun and the solar atmosphere in the X-ray, ultraviolet, and infrared regions of the spectrum. The first spacecraft designed for this purpose is a rotating wheel-like structure composed of nine wedge-shaped compartments connected to fan-shaped stabilized section by an aluminum shaft. The oriented spacecraft is continuously pointed at the center of the Sun to an accuracy of ±1 minute of arc. Sky mapping experiments in the wheel-like structure compare radiation from the sun to that in other portions of the sky. The observatories will be launched from AMR by Thor-Delta vehicles into a circular Earth orbit at an altitude of 300 miles.

The first OSO is scheduled to be launched in early CY 1962 and will include:

(1) solar pointed experiments for X-ray, gamma ray, and dust particle measurements;

(2) experiments in the lower section of the spacecraft, such as solar, gamma ray and ultraviolet measurements; and neutron, proton and emissivity stability measurements of surfaces in a vacuum.

The experiments for the second solar observatory, scheduled to be launched late in CY 1962, include stellar and ultraviolet spectometric measurements, gamma ray telescope measurements, and X-ray, white light coronograph, and Lyman-alpha measurements.

Development of the OSO and the construction of two flight spacecraft and flight experiments were funded in previous years. FY 1962 funds add two backup spacecraft with the final increment of funding in FY 1963. Delta vehicles for the two flights and their backups are pro-

vided from the Delta vehicle development program and by sharing backup vehicles with other projects. Two attempts to launch observatories are scheduled in FY 1962 and FY 1963. In each case the second attempt is scheduled as backup to the first.

FY 1962 funds also provide for study and design of an Advanced Solar Observatory capable of pointing much larger experiments at the Sun. This observatory will also have an offset capability for study of the solar corona and a scan capability which can be centered on any selected region of the Sun. FY 1963 funds will initiate development and fabrication of the first four spacecraft and experiments for launch attempts in CY 1964 and CY 1965. The first increment of procurement of three Atlas-Agena vehicles for this observatory will be funded in FY 1963.

Topside Sounders

The topside sounders will examine the structure of the ionosphere from above in a manner similar to that now used by ground-based sounding stations. Two different experimental approaches were selected for meeting the scientific objective. One approach involves a sounding technique based on the use of six fixed frequencies. Work on a satellite based on this approach was initiated in FY 1960. The spacecraft development, flight hardware and spares and launch vehicle were funded in FY 1961 and FY 1962. The second approach uses a sounding technique based on the continuous sweep over a range of frequencies, proposed by the Defense Research Telecommunications Establishment (DRTE) of Canada. NASA funding for this project in FY 1961 and FY 1962 provides for the launch vehicles and for integration of the satellite with the vehicle. The satellite cost is being borne by the Canadian Government. These flights are currently planned for FY 1963. Funds are needed in FY 1963 to provide for data acquisition, reduction and analysis.

Ionosphere Monitor

This new project to be initiated in FY 1963 will involve the launching of a series of smaller satellites into a near circular orbit to monitor continuously the structure of the ionosphere and its variation over the solar cycle. These measurements will be correlated with measurements of solar activity and other geophysical phenomena.

Funds are requested in FY 1963 to begin development of the satellite and construction of two flight spacecraft. These spacecraft are scheduled to be launched, using Scout Vehicles, in CY 1964. The object of this project is to keep a monitor in orbit on a continuous basis through a complete solar cycle.

Geoprobes

Another new project to be initiated in FY 1963 will involve the launching of two non-recoverable probes to obtain vertical profiles of atmospheric and ionospheric structure and composition and of absorption

of solar radiation. Funds are requested in FY 1963 to begin development and construction of these probes and to procure the first Scout launch vehicle. The first probe is scheduled for launch before mid-1964. Completion of the development and construction of the two spacecraft and procurement of a second Scout vehicle is planned for FY 1964.

Energetic Particles Satellite

This satellite is designed to make repeated observations of the solar wind, the Earth's magnetic field, the interplanetary magnetic fields, the particle population of interplanetary space and the trapped radiation regions. The satellite will traverse the Van Allen Belts twice in 24 hours with an apogee of 40,000 miles and a perigee of 180 miles.

The first of these satellites (Explorer XII) was successfully launched on August 15, 1961 and all experiments functioned very satisfactorily. The second satellite is scheduled to be launched in CY 1962 to continue the observations after the useful life of the first satellite. FY 1961 funds completed the funding of the first satellite and initiated fabrication of the second satellite. FY 1962 funds complete the funding of the second satellite with the exception of data acquisition and reduction cost which will be funded in FY 1963. Delta vehicles for this project were funded as a part of the Delta development program.

Atmospheric Structure Satellite

This satellite is designed to measure the density, composition, pressure and temperature of the earth's atmosphere from 160 statute miles to 700 statute miles and to determine the variations in these parameters with time and latitude. The initial launch is planned for early CY 1962 with a second flight in early CY 1963. Funding of this satellite is complete with FY 1962 funds with the exception of data acquisition and reduction costs for the second flight. The Delta launch vehicles were funded as a part of the Delta development program.

International Ionosphere Satellite (UK #1)

The primary scientific objectives of this satellite are to determine the electron temperature, electron density, and ion mass spectrum in the region 300 to 1000 km. This satellite is also one of a series to promote international cooperation in the space sciences.

FY 1963 funds complete the work on this satellite. NASA funds in FY 1961 and FY 1962 provided for the basic spacecraft and backup hardware. The flight of this satellite is scheduled during CY 1962. The instrumentation of this satellite is being provided by the scientists of the United Kingdom. The Delta launch vehicles were funded by the Delta development program.

International Satellite (UK #2)

This is the second satellite in the cooperative space science program with the United Kingdom. The primary scientific objectives of the satellite are to measure the galactic noise in the 0.75 to 3.0 Mc region and the ozone in the upper atmosphere. In addition, a micrometeorite detector of new design will be flown.

The basic spacecraft design furnished by NASA is the same as for the International Ionosphere Satellite (UK #1). Scientists of the United Kingdom are furnishing the experiments. Construction of the prototype satellite and initiation of flight hardware was provided with FY 1962 funds. FY 1963 funds are to provide for fabrication of the flight spacecraft and backup and procurement of the Scout launch vehicles. The flight is planned for CY 1963.

International Satellite (UK #3)

Negotiations will be initiated during FY 1962 with the United Kingdom leading to the selection of experiments and determination of spacecraft and orbit requirements for a third international satellite. Procurement of the spacecraft will be initiated in FY 1963 for launching early in 1965.

International Satellite #4

Discussions are under way with a number of governments concerning possible participation by their scientists in a cooperative program. It is expected that a commitment will be made by the United States during FY 1962 to provide the spacecraft, support and launch vehicle for flight experiments prepared by scientists of one or more of the countries concerned. FY 1963 funds will provide for initiating procurement of the spacecraft for launching in early 1965.

Biological Investigation of Outer Space (BIOS)

This project is an advanced and continuing program to make biological dosimetry evaluation of the inner Van Allen radiation belt and to conduct subgravity tests; to make a further nuclear emulsion study of thee inner belt and to study time variations of the belt in comparision with the NERV I data; to record, collect and recover extraterrestrial interplanetary matter from a known meteor stream.

FY 1963 funding will provide for two flight operations and one ground test spacecraft system. A backup system is provided for each operation.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

FISCAL YEAR 1963 ESTIMATES

LUNAR AND PLANETARY EXPLORATION

SUMMARY OF REQUIREMENTS:

	1961	1962	1963	Page No.
Advanced Research..	$ 5,432,000	$ 5,584,000	$ 15,000,000	RDO 10-5
Advanced Technical Development.....	11,670,000	12,809,000	17,000,000	RDO 10-6
Flight Program:				
Lunar Programs...	58,670,000	106,837,000	151,800,000	RDO 10-7
Planetary and Interplanetary Programs.....	15,247,000	44,734,000	89,760,000	RDO 10-14
Total.....	$91,019,000	$169,964,000	$273,560,000	

OBJECTIVES:

The objectives previously stated for the Lunar and Planetary Exploration Program remain unchanged.

Modern science and technology present challenging possibilities for the unmanned exploration of the solar system. An accelerated program to exploit these possibilities is being undertaken by the NASA. In addition to its direct contributions to science, this program will provide a sound scientific and technological foundation for subsequent manned exploration. Before man lands on the moon, for example, far more must be known about the lunar surface and environment than can be determined from earth.

The scientific objectives of this program include studies of the physics of the moon and planets, solar and interplanetary physics, biosciences and extraterrestrial life, and cosmology. Nearly all of the scientific disciplines are involved in these categories. Physics of the moon and planets is comparable to geophysics of the earth, and as such includes studies of atmospheres, ionospheres, trapped radiation, magnetic and gravitational fields, and properties of the surface and sub-surface. Solar and interplanetary physics is concerned with the solar atmosphere and radiations, and with the properties of interplanetary space as in-

fluenced by the sun, the solar system itself, and sources from outside the solar system. Bioscience encompasses the search for extraterrestrial life and the study of the behavior and propagation of earth life forms in extraterrestrial environments. Lastly, cosmology is the effort to integrate the results of all these studies into a better understanding of the nature and origin of the solar system, and the universe itself.

Lunar Program

The scientific objective of the lunar science program is the exploration and investigation of the moon for the information which it can provide on the history of the earth-moon system, and on the origin of planetary bodies in the solar system. The experiments are directed toward the determination of surface structure and physical properties of the surface, the origin of the surface features, chemical composition, properties of the moon as a planetary body, and the thermal history of the moon.

Surface features and structure will be determined by television systems. Physical properties of the surface to be measured include electrical and thermal conductivity, and the size distribution of surface rocks and particles. The chemical composition will be studied by a variety of methods, including X-ray fluorescence spectrometry and gamma ray spectrometry. The detection of radioactive elements in the surface will be an important part of this study. Information regarding the thermal history of the moon will come from the measurement of heat flow through the surface, and from the simultaneous analysis of the chemical composition, the surface features and structure, and the degree of differentiation of the moon's interior. The primary source of information on the differentiation of the interior will be by analysis of the orbit of an advanced lunar satellite. Seismic and gravimetric measurements will be the principal source of information regarding the properties of the moon as a planetary body. The seismic and gravimetric data may also yield information on the differentiation of the moon's interior.

In addition, the moon has a biological interest through the possible occurrence of organic molecules, precursors of living organisms, in the layer of dust which has accumulated over many aeons. The chemical analysis of this surface dust layer may prove to be of immeasurable importance to the biological sciences.

Finally, the exploration of the lunar surface, and the analysis of its physical and chemical properties, are necessary steps in the planning and designing of manned instrument stations and the solution of the problems of construction and life-support for a manned lunar station.

Planetary and Interplanetary Program

The objective of the planetary and interplanetary science program is the extension of man's knowledge of the solar system. Investigations for signs of planetary life are among the most important currently planned. These will be undertaken by measurements in the infrared spectrum, survey-

ing the surface for organic molecules and solvents, and by examining planetary atmospheres for carbon and oxygen compounds, such as CO and ozone, to determine if the planet environment is compatible with the support of life. Some information can be obtained from earth-based observations. Additional knowledge can be learned from balloon observations at great enough height above earth to eliminate most of the ultraviolet absorption. Still additional measurements will be required from planet fly-bys, orbiters and ultimately from probes directly examining the planetary atmosphere and surface. In addition, measurements of planetary physics, atmospheres, magnetic fields, radiation belts, and surface features are required.

Little is known about the structure and composition of interplanetary space. Observations of this medium, the solar effects upon it, and its relationship to the terrestrial condition will be made with the long-range objective of understanding the nature of the solar system. This will be accomplished by obtaining measurements of the interplanetary plasma density and its energy spectrum and some data on the angular, spatial and temporal dependence of the flux. Detailed measurements of interplanetary plasma during periods of minimum solar activity as well as during periods of great sunspot activity will be emphasized. An important objective is the correlation of measurements between interplanetary probes, planet orbiters and lunar orbiters which should make it possible to establish the scale size of plasma clouds ejected by the sun and compare the interplanetary densities at different portions of the solar system. Also a particularly important objective is the study of cosmic dust which, as representative of the building blocks of stars and galaxies, may be a key in the study of the origin of the solar system and the universe.

JUSTIFICATION:

From a scientific viewpoint, the exploration of the moon is of great importance because its surface has not been subjected to the erosion of winds and water, and therefore may carry on the surface a record of the early history of the solar system. This record, lost forever on the Earth, Mars, or Venus, may only be available on the moon. The moon may also have on its surface, in the layer of dust which has accumulated there, organic molecules which may provide a better understanding of the development of physical life on the Earth.

Exploration of the planets presents a different type of attraction. They all differ markedly from the Earth. In these very differences may lie clues to the nature, origin, and evolution of the solar system. From the study of other planets it is almost certain that more will become known about the Earth. The expected discovery of organic molecules and life forms may have tremendous implications in basic chemistry and biology and in medicine. The scientific study of solar and interplanetary space will strengthen the understanding of the sun-earth relationships upon which man's comfort and life cycle intimately depend. Vital information will be gathered on potential hazards which await future space travellers. Included in

this category are solar radiation streams, lunar and planetary terrains, and even planetary meteorological conditions. Hopefully, knowledge may be gained to permit utilization of natural resources at these distant destinations.

The lunar and planetary exploration program is designed to avoid duplication and to promote reliability in the development of spacecraft. Efforts have been made to minimize the number of types of spacecraft and to maximize the number of uses for each type. Wherever possible, the same basic subsystems, or their advanced derivatives, will be employed in successive spacecraft series. This will result in the evolutional development of a family of unmanned exploration spacecraft, wherein the relatively simple systems and limited capabilities of early spacecraft will be extended and refined as launch vehicle weight-lifting capability is increased to the point where later spacecraft will be capable of the more sophisticated operations necessary to achieve the objectives. This building-block concept will permit exploitation of early unmanned scientific and technological missions as part of an orderly flight-qualification sequence prior to undertaking manned exploration activities.

The proposed schedule under the Lunar and Planetary Exploration Program follows:

Lunar Projects	Mission Objectives	Launch Vehicle	Calendar Year of first launch
Ranger	Rough landing; high resolution TV reconnaissance of the lunar surface	Atlas-Agena	1961
Surveyor Lander	Soft landing	Atlas-Centaur	1963
Surveyor Orbiter	Precise orbit	Atlas-Centaur	1965
Prospector	Soft landing-mobile	Saturn	1965
Planetary Projects			
Mariner R	Fly-by	Atlas-Agena	1962
Mariner B	Fly-by	Atlas-Centaur	1964
Voyager	Orbit and land	Saturn	1965
Interplanetary Projects			
Pioneer 5	Radiation spectrum and fields	Thor-Able	1960
Magnetometer probe	Plasma and fields	Thor-Delta	1961
Ranger, Mariner Voyager test vehicles	Spacecraft test plus interplanetary physics	Various	1961

FUNDING REQUIREMENTS:

Advanced Research	1961	1962	1963
Lunar Advanced Research:			
Mapping the Lunar Surface.....	$ 349,000	$ 466,000	$ 795,000
Lunar Fields & Atmospheric Studies...	223,000	85,000	495,000
Lunar Surface & Interior Studies.....	686,000	1,195,000	1,845,000
Instrumentation Research.....	---	---	1,708,000
Data Analysis & Interpretation.....	---	445,000	1,258,000
Spacecraft Systems & Mission Research	232,000	---	370,000
Materials & Structures Research.....	670,000	---	712,000
	$2,160,000	$2,191,000	$7,183,000
Planetary and Interplanetary Advanced Research:			
Planetary Atmospheric, Surface & Subsurface Studies.....	$ 555,000	$ 643,000	$1,300,000
Interplanetary Particles & Fields....	501,000	765,000	1,110,000
Biological Studies.....	496,000	115,000	1,000,000
Materials & Structures Research.....	93,000	680,000	1,000,000
Instrumentation Research.....	---	---	260,000
Planetary Astronomy.....	771,000	430,000	645,000
Cosmology.....	215,000	80,000	230,000
Spacecraft Systems & Mission Research	526,000	680,000	1,862,000
Data Analysis & Interpretation.....	115,000	---	410,000
	$3,272,000	$3,393,000	$7,817,000
Total, Advanced Research.....	$5,432,000	$5,584,000	$15,000,000

Advanced Research

Advanced Research forms the core from which new ideas are drawn to attain the objectives of the NASA space program.

Advanced Research funds for FY 1962 were used in two main areas: support of the scientific research groups at the Jet Propulsion Laboratory (JPL) and support of research at universities and non-profit research institutes. The increase requested for FY 1963 over the FY 1962 level of effort is due to the following factors. First, it is desirable to broaden the base of Advanced Research to insure a sound scientific knowledge of lunar, planetary, and interplanetary environments in which man may venture in the next decade. Second, an increase is required in the funding level of the items concerned with the reduction, analysis, and interpretation of data because of the expanding flight program. Third, many projects at JPL heretofore separately itemized under Spacecraft Technology are now combined here under the Advanced Research heading.

Advanced Technical Development	1961	1962	1963
Lunar Advanced Technical Development:			
Feasibility, Design & Reliability Studies & Services	$ 596,000	$ 1,218,000	$ 1,050,000
Data Processing Systems	70,000	107,000	295,000
Guidance & Control Systems	964,000	818,000	1,030,000
Communications & Electronics Systems	329,000	270,000	1,300,000
Lunar Surface Analysis Instrumentation	1,170,000	1,432,000	1,695,000
Development of Radiometers & Spectrometers	375,000	562,000	625,000
Materials & Structures Development	478,000	356,000	555,000
Documentation Support	115,000	39,000	30,000
	$ 4,097,000	$ 4,802,000	$ 6,580,000
Planetary and Interplanetary Advanced Technical Development:			
Feasibility, Design, & Reliability Studies	$ 991,000	$ 673,000	$ 885,000
Guidance & Control Systems	294,000	912,000	1,405,000
Communications & Electronics Systems	298,000	819,000	1,047,000
Planetary Surface Analysis Instrumentation	175,000	600,000	1,190,000
Planetary Atmospheric Instrumentation	250,000	279,000	438,000
Bioscience Instrumentation	321,000	950,000	1,000,000
Interplanetary Probe Instrumentation	347,000	318,000	400,000
Materials & Structures Development	---	309,000	1,000,000
Documentation Support	---	29,000	35,000
Propulsion Systems Development	4,897,000	3,118,000	3,020,000
	$ 7,573,000	$ 8,007,000	$10,420,000
Total, Advanced Technical Development	$11,670,000	$12,809,000	$17,000,000

Advanced Technical Development

Advanced Technical Development provides the connecting link between Advanced Research and future flight programs by taking the discoveries in the Advanced Research program and translating them into devices with engineering feasibility and program utility.

FY 1962 funds support the development of scientific payloads to be flown on available launch vehicles. The FY 1963 request reflects planned

preparation for the best possible use of later generation boosters with larger weight-carrying capability. Scientific instruments of increased sophistication and means to perform complicated mid-course and terminal spacecraft maneuvers are required. Of immediate concern are the complex guidance, control, observation, and communications systems needed when data is to be collected and telemetered after contact with the lunar surface on Ranger and Surveyor missions, and the Martian surface on the 1964 Mariner missions.

Advanced technical development for chemical and physical exploration of the moon and planets by Surveyors and Voyagers is to be accelerated with FY 1963 funding in response to the developing needs of the manned lunar program. Developmental requirements include instruments which will provide continual monitoring of the environment on a self-operating basis, and equipment which will make surface travel and point-to-point communication possible.

The Mariners, Surveyors, and subsequent orbiting and soft landing spacecraft, such as Voyager, will demand a high degree of component and system reliability over extended periods. Much of the increase in Advanced Technical Development funds requested for FY 1963 is to support a greater effort on reliability programs.

FY 1963 funds are also requested to continue spacecraft propulsion effort at the Jet Propulsion Laboratory. The problems of spacecraft maneuvering require the use of various propulsion systems. Mid-course and terminal corrections to the flight path are made by sensitive controllable thrust elements. Retrorocket systems are needed to cancel or reduce the impact velocity of a landing package. The results of this propulsion system development effort will have across-the-board application.

FLIGHT PROGRAM SUMMARY:

Lunar Program:	1961	1962	1963
Atlas-Able	$ 5,975,000	$ ---	$ ---
Ranger	45,066,000	64,000,000	44,022,000
Surveyor	7,054,000	41,037,000	97,378,000
Prospector	575,000	1,800,000	10,400,000
Total, Lunar Flight Programs	$58,670,000	$106,837,000	$151,800,000
Planetary & Interplanetary Flight Program:			
Magnometer Probe	$ 462,000	$ ---	$ ---
Mariner A	13,068,000	7,620,000	---
Mariner R	---	23,778,000	9,240,000

Planetary & Interplanetary Flight Program (Continued):	1961	1962	1963
Mariner B.....	$ 1,717,000	$ 12,958,000	$ 73,720,000
Voyager.....	---	378,000	6,800,000
Total, Planetary & Interplanetary Flight Programs.	$15,247,000	$ 44,734,000	$ 89,760,000
Lunar Program:			
Atlas-Able.....	$ 5,975,000	$ ---	$ ---
Ranger:			
Project Management and Support.....	$ 768,000	$ 1,153,000	$ 913,000
Systems Analysis & Integration.....	2,024,000	1,712,000	1,614,000
Structural Design & Development.....	2,508,000	1,798,000	995,000
AMR Facilities & Administration.....	374,000	470,000	540,000
Lunar Capsule.....	1,467,000	3,503,000	1,200,000
Documentation & Reports.....	633,000	455,000	450,000
Impact TV Systems.....	1,138,000	8,001,000	5,780,000
Data Reduction & Processing...	1,707,000	1,299,000	1,040,000
Operations.....	470,000	523,000	525,000
Scientific Experiments.....	2,284,000	2,053,000	1,209,000
Environmental Requirements & Testing.....	1,237,000	527,000	425,000
Experiment Analysis.....	317,000	840,000	1,125,000
Communications & Telemetry....	4,363,000	3,232,000	2,126,000
Guidance & Control.....	5,249,000	3,312,000	2,135,000
Power Systems & Energy Control.....	2,141,000	1,391,000	400,000
Pyrotechnics Design & Development.....	221,000	260,000	195,000
Instrumentation Systems.....	236,000	757,000	625,000
Computer Support.....	1,259,000	2,074,000	1,825,000
	$28,396,000	$ 33,360,000	$ 23,122,000
Atlas-Agena Launch Vehicles...	$16,670,000	$ 30,640,000	$ 20,900,000
Total, Ranger.....	$45,066,000	$ 64,000,000	$ 44,022,000
Surveyor:			
Project Management & Support..	$ ---	$ 363,000	$ 965,000
Systems Analysis & Integration	715,000	209,000	480,000
Structural Design & Development.....	35,000	158,000	225,000

Surveyor (Continued):	1961	1962	1963
Spacecraft Development Contract	$ 4,871,000	$ 23,150,000	$ 29,100,000
Orbiter Spacecraft Development Contract	---	7,050,000	18,050,000
Planning & Documentation Support	76,000	136,000	275,000
Data Reduction & Processing	---	1,849,000	8,450,000
Scientific Experiments	759,000	6,840,000	10,110,000
Environmental Requirements & Testing	---	49,000	350,000
Scientific Experiment Analysis	454,000	329,000	570,000
Communications & Telemetry	88,000	124,000	150,000
Guidance & Control	56,000	206,000	280,000
Alternate Mission Package	---	---	5,100,000
Orbiter Surveillance Subsystem	---	---	5,478,000
Computer Support	---	37,000	495,000
	$ 7,054,000	$ 40,500,000	$ 80,078,000
Centaur Launch Vehicles	---	537,000	17,300,000
Total, Surveyor	$ 7,054,000	$ 41,037,000	$ 97,378,000
Prospector:			
Project Management and Support	$ ---	$ ---	$ 885,000
Systems Analysis & Integration	575,000	1,800,000	2,565,000
Spacecraft Development Contract	---	---	6,800,000
Experiment Analysis	---	---	150,000
Total, Prospector	$ 575,000	$ 1,800,000	$ 10,400,000
Total, Lunar Flight Program	$58,670,000	$106,837,000	$151,800,000

Lunar Program:

The lunar flight program provides for the orderly progress of scientific and technological experiments necessary to the detailed exploration of the moon. An evolutionary family of spacecraft, providing a maximum of continuity in developments from one series to the next, is a principal part of this program.

All of the lunar program projects are steps toward a common goal and each of the earlier projects will contribute significantly to subsequent projects. The funding includes new developments in spacecraft and instrumentation for specific lunar requirements. The fact that many new

developments are required for the achievement of a successful lunar program results in high non-recurring costs for these spacecraft and associated experiments.

Atlas-Able

The purpose of this lunar orbiting spacecraft utilizing the Atlas-Able V launch vehicle was to obtain scientific measurements of solar and interplanetary phenomena while "anchored" in the vicinity of the moon within convenient communication range of the earth, and to measure the magnetic field around the moon. This spacecraft effort was terminated following the failure of the launch vehicle.

Ranger

The Ranger project consists of nine flights using Atlas-Agena B vehicles launched from the Atlantic Missile Range. The overall objectives of this program are to create and test a new spacecraft design whose features can be exploited in the performance of lunar and interplanetary flight missions, and to use this spacecraft to perform scientific investigations close to and on the surface of the moon, and to study particles and fields in interplanetary space. The nine flights are divided into three series as follows:

Ranger 1 and 2: The first two Ranger flights were intended to (1) provide engineering tests of the basic elements of the spacecraft system and the Deep Space Instrumentation Facility, (2) to measure significant characteristics of the interplanetary medium along the selected trajectory, and (3) to ascertain the performance of and gain operating experience with the Atlas-Agena B launch vehicle. For these flights, a sixty-day, 700,000 mile, highly-elliptical earth-satellite orbit was chosen.

The Ranger spacecraft consisted of a basic hexagonal structure, or bus, upon which were mounted the scientific instruments, together with equipment to provide attitude-control, communications, electrical power, and spacecraft environmental control. The spacecraft had a total injected weight of 675 lbs.

Instruments carried on the first two Ranger spacecraft included a solar corpuscular detector, a rubidium vapor magnetometer, semi-conductor detectors and thin-walled Geiger counters, an ion chamber, triple-coincidence telescopes, and a Lyman-Alpha scanner.

Rangers 1 and 2 were launched on August 23, 1961, and November 18, 1961, respectively. Because of malfunctions of the Agena launch vehicle, both spacecraft remained in near-earth orbits instead of being propelled into the planned highly-elliptical orbits. Nevertheless, telemetry data indicated that most of the spacecraft subsystems performed properly, thus confirming the basic design of the Ranger spacecraft.

Ranger 3, 4, and 5: The next three Ranger spacecraft are intended to approach the moon and rough land about 56 pounds of survivable payload. This series of spacecraft has been designed for gaining detailed data on lunar surface characteristics. Each spacecraft has two major parts: the "bus", the basic hexagonal structure with power supplies, communications equipment, attitude-control, and mid-course guidance; and the "capsule", a separable survivable instrument package, and its retro-rocket. The total weight of the spacecraft is 750 lbs.

The complete spacecraft will be launched on a lunar impact trajectory with midcourse corrections applied to improve accuracy. At a suitable distance from the lunar surface the spacecraft will be properly oriented, and the landing capsule launched. The bus will continue on to crash into the moon, but a retrorocket will decelerate the capsule, allowing it to impact at a nominal speed not exceeding several hundred feet per second. A balsawood impact absorber will cushion the landing shock to a level which can be sustained by the instruments.

Experiments will be carried by both bus and capsule. The primary experiments mounted on the bus will be an advanced vidicon system, a gamma-ray spectrometer, and a radar reflectivity experiment. The major experiment in the landing capsule will be a single-axis seismometer.

The spacecraft will complete its terminal maneuvers, including stabilization and the establishment of a telemetry link with the tracking station, before the first picture is exposed. Thereafter, one complete picture will be transmitted to the tracking station every 13 seconds, providing a total of 100 pictures during the lunar approach. The first picture will contain a field of view 25 miles square with a resolution of 650 feet. The final picture will be of an area 2,000 feet square with a resolution of 10 feet.

The gamma-ray spectrometer experiment is intended to determine whether or not the moon, like the earth, has formed a crust which contains a high concentration of naturally radioactive isotopes. The information will bear on questions such as how the moon was formed, its heat balance, and the source of chondritic meteorites.

Ranger 6 to 9: The mission for the last four Ranger flights will be to obtain very high-resolution television pictures of the lunar surface. The spacecraft will be basically the same as that used for the previous three flights, except that the landing capsule will be replaced by a cluster of six television cameras fixed to the bus. The spacecraft weight for these missions will be about 800 lbs. The television system will begin operation at a distance above the lunar surface that will provide pictures of a resolution equivalent to present earth-based photographs. Coverage will continue until impact, with the resolution of the last picture on the order of 0.2 to 0.3 meters. In addition to the television equipment, several experiments for studying the radiation environment around the spacecraft during its flight will be included.

Surveyor

The Surveyor project includes two related spacecraft systems, namely the Surveyor Soft-Lander and the Surveyor Orbiter.

Surveyor Soft-Lander: The Surveyor Soft-Lander spacecraft is currently scheduled to be launched by Atlas-Centaur vehicles from the Atlantic Missile Range. The objectives of the Surveyor Lander are to successfully soft-land a number of scientific payloads on the lunar surface, to provide for a minimum of 30 days (design goal: 90 days) of scientific observations and measurements on the lunar surface, and to telemeter the data to earth for reduction and timely dissemination to the engineering and scientific community.

The scientific objectives of Surveyor are to provide close-up views of the lunar landscape, to measure the physical properties of the moon, and to analyze the composition of the lunar surface and subsurface in various selected regions visible from earth. The scientific measurements are intended to aid in establishing a better understanding of the internal structure and composition of the moon and its local atmosphere, and to obtain additional data that may provide clues to the origin of the moon and an understanding of the physical phenomena associated with the origin of the solar system.

Additional objectives are to demonstrate the engineering feasibility of lunar exploration with soft-landing spacecraft systems, and to contribute to the technology required for the successful accomplishment of eventual manned lunar landings and operations.

The Surveyor bus consists of those elements of the spacecraft required to accomplish the transit phase and soft-landing on the lunar surface. The principal elements of this basic spacecraft bus are the spacecraft structure and landing gear, the power supply consisting of batteries and solar cells, the FM wideband telecommunications system, a multiple-mode guidance system, a cold gas attitude-control system, and a propulsion system consisting of a solid rocket engine for the main retro phase and small throttlable liquid vernier engines for mid-course velocity correction, main retro-thrust-vector control, and terminal descent deceleration.

To obtain maximum flexibility in accommodating selected scientific instruments in various combinations, the spacecraft is designed to provide a simple and standardized interface between the bus and the scientific mission payloads.

The spacecraft will be injected into a lunar impact trajectory with a transit time of 66-hours. Midway in flight a midcourse-trajectory-correction maneuver will be performed to ensure impact on the moon. The terminal maneuver consists of orienting the spacecraft and firing the main retromotor and vernier engines in a controled manner, so as to arrive at the lunar surface at near zero velocity.

Surveyor Orbiter: Much of the basic Surveyor technology and subsystems, such as structure, guidance and control and telecommunications, will be utilized in the Surveyor Orbiter. This advanced spacecraft system will provide an oriented space platform for overall lunar reconnaissance and topographic mapping as well as preliminary selection of desirable sites for subsequent Surveyor landings and later manned landings. The Orbiter will function as a long-life lunar space station to investigate and monitor the radiation environment and other physical parameters in the immediate vicinity of the moon. It will also yield new knowledge on the size and shape of the moon and the properties of its gravitational field.

Prospector

The Prospector project spacecraft will have the ability to land anywhere on the moon, to inspect particular areas prior to landing, and to carry to the moon a variety of mission payloads, such as roving lunar-surface exploration vehicles and lunar sample-return systems. In addition to its purely scientific functions, Prospector will be capable of providing direct support for manned landings on the moon by performing detailed landing-site surveys, emplacing guidance aids, and monitoring the manned landings. The Prospector roving vehicle would be useable by manned expeditions as a remotely controlled scout in potentially hazardous areas, and to extend the radius of exploration activity. The Prospector spacecraft will also be capable of providing logistic support both prior to and during manned operations on the moon. Such support will include transportation of supplies, equipment and shelter required for the establishment of a lunar base, as well as any emergency resupply needed by the expedition.

Flight Program	1961	1962	1963
Planetary and Interplanetary Program:			
Magnetometer Probe:	$ 462,000	$ ---	$ ---
Mariner A:			
Project Management and Support.	$ 498,000	$ 431,000	$ ---
Systems Analysis & Integration.	740,000	409,000	---
Structure Design & Development.	891,000	195,000	---
Documentation & Reports.....	369,000	90,000	---
Data Reduction & Processing....	803,000	735,000	---
Scientific Experiments.....	2,569,000	1,871,000	---
Environmental Requirements & Testing.....	432,000	465,000	---
Communication & Telemetry.....	1,562,000	1,928,000	---
Guidance & Control.....	3,638,000	951,000	---
Power Systems & Energy Control.	765,000	250,000	---
Pyrotechnics Design & Development.....	185,000	---	---
Instrumentation Services & Facilities.....	143,000	197,000	---
Computer Support.....	473,000	98,000	---
Total, Mariner A.....	$13,068,000	$ 7,620,000	$ ---
Mariner R:			
Project Management and Support..	$ ---	$ 1,370,000	$ 270,000
Systems Analysis & Integration..	---	1,038,000	457,000
Structural Design & Development.	---	851,000	145,000
AMR Facilities & Administration.	---	99,000	90,000
Documentation & Reports.....	---	239,000	80,000
Data Reduction & Processing.....	---	365,000	280,000
Operations.....	---	238,000	340,000
Scientific Experiments.....	---	1,310,000	285,000
Environmental Requirements & Testing.....	---	1,232,000	---
Communications & Telemetry.....	---	2,949,000	450,000
Guidance & Control.....	---	2,065,000	350,000
Instrumentation Service & Facilities.....	---	201,000	50,000
Power Systems & Energy Control	---	697,000	28,000
Computer Support.....	---	832,000	175,000
	$ ---	$13,486,000	$ 3,000,000
Atlas-Agena Launch Vehicles...	---	10,292,000	6,240,000
Total, Mariner R.....	$ ---	$23,778,000	$ 9,240,000

Flight Program (Continued)	1961	1962	1963
Mariner B:			
Project Management and Support.	$ ---	$ 765,000	$ 3,100,000
Systems Analysis & Integration.	157,000	1,022,000	4,900,000
Structural Design & Development	278,000	1,635,000	4,050,000
AMR Facilities & Administration	---	---	260,000
Documentation & Reports.....	47,000	190,000	360,000
Data Reduction & Processing....	---	296,000	3,600,000
Operations.....	---	---	520,000
Scientific Experiments.....	410,000	2,320,000	8,845,000
Environmental Requirements & Testing.....	---	142,000	3,495,000
Communications & Telemetry.....	183,000	1,268,000	7,030,000
Guidance & Control.....	594,000	3,202,000	10,757,000
TV Systems	---	364,000	1,700,000
Power Systems & Energy Control.	48,000	509,000	6,543,000
Instrumentation Services & Facilities.....	---	101,000	875,000
Computer Support.....	---	70,000	585,000
	$ 1,717,000	$11,884,000	$56,620,000
Centaur Launch Vehicle	---	1,074,000	17,100,000
Total, Mariner B.....	$ 1,717,000	$12,958,000	$73,720,000
Voyager:			
Project Management and Support.	$ ---	$ ---	$ 765,000
Systems Analysis & Integration.	---	186,000	602,000
Structural Design & Development	---	84,000	625,000
Scientific Experiments.....	---	78,000	923,000
Communications & Telemetry.....	---	---	1,005,000
Guidance & Control.....	---	30,000	2,265,000
Power Systems & Energy Control.	---	---	615,000
Total, Voyager.....	$ ---	$ 378,000	$ 6,800,000
Total, Planetary and Interplanetary Flight Program	$15,247,000	$44,734,000	$89,760,000

Planetary and Interplanetary Program:

A long-term objective of the planetary series is to place spacecraft in orbit about Venus and Mars capable of gathering fundamental scientific knowledge of the planetary environments and of the planets themselves and to land instrumented capsules on the surface of these planets. Spacecraft technology must thus provide for long life (over one year), proper environment for the scientific instruments, adequate guidance, communication power and bandwidth for the scientific objectives, and an atmosphere entry and landing capsule.

An important constraint from the planning viewpoint on the near planet missions, as opposed to most other flights, is the relatively long time between launch opportunities. This wait is the result of periodicity between planet oppositions, and amounts to one and one-half years for Venus and just over two years for Mars. Achievement of optimum progress toward the scientific program objectives requires a successful shot at almost every opportunity. This requires that each new spacecraft series be preceded by complete ground and flight testing. Lead times for the flight tests must be sufficient to incorporate needed changes. The development sequence of planetary spacecraft begins with the FY 1962 missions as fly-bys, which are defined as passing within several thousands of miles of a planet, and progresses through planet orbiters at about mid-decade and planet landers toward the end of the decade.

Interplanetary long-term objectives are to map and investigate the interplanetary medium and solar influence on this medium. The interplanetary medium consists of charged particles, solar radiation, electro-magnetic and gravitational fields, neutral gas, and dust.

Typical instruments carried by interplanetary spacecraft will consist of plasma and radiation detectors, magnetometers, micrometeorite detectors, and Lyman-Alpha telescopes. Besides providing new insights into solar-terrestrial relationships, such as the distribution of electric currents in the outer radiation belt of the earth and the form of the earth's field in regions where it merges with interplanetary space, experiments may provide the basis for a new theory for the understanding of the modulation of cosmic rays.

Explorer X (Magnetometer Probe)

Explorer X successfully launched on March 25, 1961 by a Thor-Delta, was the second flight in the interplanetary program; Pioneer V had been flown in 1960. Objectives of Explorer X were observation of the fluctuations in the radiation and fields both in interplanetary space and in the region where they interact with those of the earth.

During the next few years, interplanetary measurements will be made on test and operational spacecraft for lunar and planetary missions.

Mariner

The first objective of the Mariner project is to make flights to Venus in 1962. The Mariner A spacecraft, designed for launch on the Centaur vehicle, was intended to accomplish this mission. However, recent delays in the Centaur schedule made it advisable to plan a lighter version of the Mariner spacecraft, Model R, to be launched on the Atlas-Agena in 1962.

The Mariner B, designed to fly on Centaur in 1964, will be capable of fly-by missions to both Mars and Venus and, in addition, will be able to carry a small planetary atmospheric entry capsule.

The fly-by mission is a natural first step, both scientifically and technologically. Scientific information on planetary environment will add to fundamental knowledge and provide the necessary input for later, more refined experimentation. A major portion of the technology needed for later orbiter flights can be proved and evaluated on a fly-by mission.

Two flights with Mariner R in CY 1962 will be timed to take advantage of the Venus opportunity. Modifications and remedial action, based upon lessons learned in this first planet fly-by attempt, will be incorporated and test flown as an interplanetary mission during CY 1963. Although this mission will be interplanetary, the trajectory will be chosen to proof-test all spacecraft subsystems required for the CY 1964 planet missions.

The choice of scientific instruments to be carried on Mariner is governed both by the basic scientific objectives and by the fact that the fly-bys are preludes to more thorough investigation with orbiters and landers. During the course of the Mariner project - 1962 to 1967 - the instruments will gradually change. As more knowledge is gained, their purposes will become more specific and their desired ranges more clearly defined.

For Venus, items of initial interest are the nature of the atmosphere, the surface temperature, the rotation rate, the spin axis, and magnetic field and particle measurement experiments. The structure of the Cytherean atmosphere is of great scientific interest. Knowledge of its pressure, temperature profile and constituents is of immediate importance in planning a long-range planetary program. Assuming that current estimates of the surface temperature and pressure are correct, designing a spacecraft that can survive entry and landing will be a formidable task. On the other hand, if a predicted surface temperature of 600°K is much too high, it is probable that the unseen surface of Venus us covered by oceans. If this is true, then spacecraft design problems become very different.

The strength of the magnetic field of Venus is also important to the understanding of the science of the solar system and to the engineering of spacecraft. If the magnetic field is exceptionally strong, trapped radiation may present subtle communication problems. If, on the other

hand, the field is very weak, it is possible that the planet could sustain a very dense ionized layer which would account for the high brightness temperature detected from earth with microwave telescopes.

The Venus mission will carry experiments directly concerned with the planet plus an instrument package to obtain interplanetary data enroute. The planet experiments will include a radiometer to measure temperature brightness, a fluxgate magnetometer to determine the approximate strength and character of the magnetic field, and experiments for sampling particle radiation trapped in the magnetic field.

For Mars the basic question is the existence of life. Early experiments will, therefore, be oriented toward this detection problem. An infrared spectrograph will be carried to determine the existence and location of organic molecules. The upper atmosphere should be examined for ozone to determine whether or not the surface of the planet is protected from ultraviolet radiation which in large doses is damaging to life as it is known on earth.

A Mars mission could thus include an ultraviolet spectroscope, a magnetometer, and an infrared spectrometer which would search for organic molecules on the Martian surface. In addition, since the Martian atmosphere is clear, the spacecraft would carry an optical system mated to a vidicon capable of taking and transmitting photographs of the terrain.

The capsule which leaves the spacecraft to enter the planetary atmosphere would carry pressure-accelerometer instrumentation, experiments to determine the nature of the atmosphere and instruments to detect the existence of life.

Mariner A funding terminates in FY 1962 because of its replacement by Mariner R. Much of the hardware developed for the Mariner A is being used on Mariner R; similarly, much of the development effort on the various Mariner A subsystems will be used in Mariner B.

Mariner R funding peaks sharply in FY 1962 reflecting the fact that almost all work must be completed by the end of the fiscal year in order to meet the launch opportunity date.

The Mariner B request for FY 1963 reflects the heavy hardware requirements, since it is in this year that equipment must be purchased for both the test flight late in CY 1963 and the Venus missions early in CY 1964. FY 1962 funds met the Mariner B pre-hardware requirements; the FY 1963 request is to cover prototype and flight hardware, the necessary ground equipment for check-out and test, and the testing phase itself.

Voyager

Planetary missions in the Mariner project are the initial phase of the planetary exploration program. In order to meet scientific objectives, follow-on missions will require advanced spacecraft to fly in proximity of the planets for long periods of time. This, in turn, establishes the requirement for spacecraft refinements, associated instrumentation and technological development. The planetary spacecraft series that follows Mariner is phased with the Saturn launch vehicle development. This series, the Voyager planetary orbiters, begins with test shots planned in CY 1965.

The Voyager, the second phase in planetary exploration, will provide a lengthy tarrying capability to permit mapping of the environment. A landing capsule will provide details of the lower atmosphere and surface. Spacecraft orbit elements will also permit the evaluation of planetary mass and mass distribution. Scientific experiments carried on the Voyager will be advanced versions of those of the Mariner series.

The complete orbiter mission, including the ability to carry a large entry and landing capsule, will utilize advanced versions of the Saturn launch vehicle.

Studies on the design and utilization of Vorager spacecraft began in FY 1962. Effort will continue at an accelerated pace in FY 1963, including studies and initial breadboard hardware for each of the advanced subsystems required for the Voyager spacecraft.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

FISCAL YEAR 1963 ESTIMATES

SCOUT

SUMMARY OF REQUIREMENTS:

	1961	1962	1963	Page No.
Vehicle Development.....	$4,550,000	$3,263,000	$3,297,000	RDO 11-2
Motor Development.....	1,250,000	2,600,000	4,000,000	RDO 11-3
System Support.....	3,852,000	2,343,000	1,650,000	RDO 11-4
Total.....	$9,652,000	$8,206,000	$8,947,000	

OBJECTIVES:

The purpose of the SCOUT program is to develop a reliable, relatively inexpensive vehicle for general space research. The vehicle's capabilities include orbital, probe and re-entry missions. It is the smallest of the basic NASA family of launch vehicles and will fulfill a large variety of requirements for small sized payloads. Operational SCOUT vehicles are funded under the various flight programs using SCOUT.

JUSTIFICATION:

The SCOUT vehicle development flight test program comprises a total of eight vehicles. Of the seven launchings to date, four have been succesful and three unsuccessful. SCOUT No. 4, launched in February 1961, was the first all-solid propelled vehicle to place a satellite in orbit. The remaining development vehicle will be launched in early 1962.

In late 1960, a prime vehicle contractor was established for the second four development vehicles and the subsequent operational vehicles.

The SCOUT vehicle, in its present configuration, is capable of placing a 150-pound payload with a maximum diameter of 25 inches into a 300 nautical mile orbit. Both NASA and DOD missions require that this capability be increased to approximately 250-pounds and a maximum diameter of 32 inches. By increasing the performance of the basic vehicle to meet the requirements of both agencies a standard vehicle can be achieved with a resulting economy of production and simplicity of logistics. The SCOUT development program is oriented in this direction.

All operational vehicles will be built to the same specifications and on a single production line. Only three will be specially modified to meet a unique mission requirement. Further, the logistic support of the three launch sites (Atlantic Missile Range, Pacific Missile Range and Wallops Island) has been thoroughly integrated into a single program.

The FY 1961 funding completed procurement of the eight development vehicles and initiated a motor improvement program to obtain the performance required of the SCOUT vehicle. Further improvement of performance, standardization of the basic design, completion of component qualification and design of the larger diameter payload compartment is being accomplished under 1962 funding. Completion of the motor improvement program and qualification of the entire vehicle to the operational standards required will be accomplished in 1963. In addition, the accuracy of the vehicle will be increased to meet the requirements of a number of missions for near-circular orbits or orbits at exact inclinations. These improvements will be validated by static test and other means without procurement of development vehicles in addition to the eight development vehicles now provided.

FUNDING REQUIREMENTS:

	1961	1962	1963
Vehicle Development			
Vehicle.....	$1,900,000	$1,850,000	$1,847,000
Guidance and Control.....	2,650,000	1,413,000	1,450,000
Total, Vehicle Development...	$4,550,000	$3,263,000	$3,297,000

FY 1962 funds are being applied to standardization of the vehicle, modification of the separation system to correct a serious problem discovered on the SCOUT 6 flight test, and simplification of the check-out procedures at the launch site. The FY 1963 funding will be utilized to complete the detailed qualification necessary for continued reliable operation with three different launch crews at three different sites and to improve the accuracy of the vehicle.

Vehicle

The vehicle consists of the airframe, instrumentation, electrical networks and destruct systems. Additional qualification of the entire vehicle is required to meet the operational situation now established. Three separate launch crews will be in operation at three different locations. This requires a vehicle which is thoroughly qualified in all aspects. In addition, major modification to both the ignition and destruct systems is required to meet the safety regulations being applied by the launch ranges. These new systems will be designed, and qualified for incorporation in the operational vehicles. Also, the use of SCOUT with minimal guidance and control for probe applications will be investigated. The reduction in guidance and control systems will result in a lower cost vehicle for those missions which do not require precise guidance.

Guidance and Control

Testing of the SCOUT to date has indicated that an improvement in the vehicle's guidance and control system is required to meet some missions now planned for SCOUT. A detailed study of the actual requirements and their effect on the system will be accomplished during 1962. FY 1963 funds will be used to modify the existing guidance system and to develop a very lightweight unit for installation in the fourth stage, if necessary.

Motor Development	1961	1962	1963
Motor Procurement.....	$ 140,000	$ ---	$ ---
Motor Development.....	1,110,000	2,600,000	4,000,000
Total, Motor Development....	$1,250,000	$2,600,000	$4,000,000

Motor Procurement

The FY 1961 amount completed the funding for the first eight development vehicle motors. All subsequent motor procurement is funded by the operational vehicles.

Motor Development

By utilizing recent advancements in the propellant state-of-the-art, significant improvements in SCOUT performance can be obtained. In conjunction with the Department of Defense, a program was initiated in 1961 to develop new motors for the third and fourth stages. The remaining portion of this particular program is being funded with FY 1962 funds. Also with FY 1962 funds, the first stage motor is being up-rated. This program consists of using the identical motor case, but loading it with the improved propellant being used on Minuteman. The improved motor will provide approximately 50 pounds increase in payload and will be operational by mid-calendar year 1962. During 1963, the second stage motor will be modified and improved to match with the other three motors. The utilization of existing state-of-the-art techniques to improve the SCOUT motors results in a significant increase in payload capability for considerably less cost than would have been required to actually develop new motors. Final performance will be approximately 230 pounds in a 300 nautical mile orbit.

System Support	1961	1962	1963
Ground Support Equipment.....	$1,425,000	$ 793,000	$ 550,000
Launch Services.....	1,800,000	1,100,000	---
Engineering Coordination.....	627,000	450,000	1,100,000
Total, System Support.....	$3,852,000	$2,343,000	$1,650,000

Ground Support Equipment

The FY 1962 funding will complete the design and manufacture of the horizontal pre-flight check-out system for the Pacific Missile Range SCOUT launch site. A continuing need exists in FY 1963 for a small allowance to modify the Wallops Island and the Pacific Missile Range equipment and to replace items which are worn out.

Launch Services

With the completion of the development flight test program in early calendar year 1962, there is no requirement for funding in this area in FY 1963. Future launch services are funded as part of the cost of operational SCOUT vehicles.

Engineering Coordination

Analysis of improvement change recommendations, detailed analysis of flight and field failures and special reliability programs are a continuing requirement. This amount is the estimated annual cost of developmental support for successful operational utilization of the vehicle.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

FISCAL YEAR 1963 ESTIMATES

DELTA

SUMMARY OF REQUIREMENTS:

	1961	1962	1963	Page No.
Vehicle Development.....	$ 3,500,000	$ 760,000	$ 268,000	RDO 12-2
Engine Development.....	105,000	51,000	---	RDO 12-2
System Support.....	6,874,000	2,116,000	---	RDO 12-2
Total	$10,479,000	$ 2,927,000	$ 268,000	

OBJECTIVES:

To provide a reliable launch vehicle for medium payload satellites and small payload space probes.

JUSTIFICATION:

The DELTA vehicle is being used to launch a variety of scientific and applications satellites and space probes. The DELTA is a three-stage vehicle with the first stage being a production Thor missile with the nosecone and the guidance unit removed. The second stage is similar to that of Thor-Able and Vanguard with a new engine thrust chamber and an improved radio inertial guidance system. The third stage is a solid propellant rocket motor developed for Vanguard.

Although similar in design to the Thor-Able series, the DELTA incorporates a number of changes, including a coast-phase attitude control system that will permit higher injection altitudes and additional flexibility in establishing trajectories. The capabilities of this vehicle were demonstrated on August 12, 1960, when the second DELTA vehicle successfully placed the Echo satellite in a precise, nearly circular orbit, at an altitude of about 1,000 miles; and again on November 23, 1960, when the third DELTA placed into orbit the Tiros II meteorological satellite at an altitude of approximately 400 miles. Of the six DELTA launches to date, five have been successful and one (DELTA No. 1) was unsuccessful. DELTA has a payload capability of up to 500 pounds for satellite applications and up to 75 pounds for space probes.

FUNDING REQUIREMENTS:

Vehicle Development	1961	1962	1963
Design and engineering.....	$1,075,000	$305,000	$268,000
Fabrication.....	2,425,000	455,000	---
Total, Vehicle Development.....	$3,500,000	$760,000	$268,000

During FY 1961, the basic soundness of the DELTA design was firmly established through the successful firing of DELTAS 2 and 3. Fabrication of the twelve development vehicles will be completed with FY 1961 and 1962 funds. A small amount of FY 1963 funds will be required to complete final review and analysis of the development program.

Engine Development	1961	1962	1963
Changes to third stage motors.....	$105,000	$51,000	---
Total, Engine Development.....	$105,000	$51,000	---

Changes in the third stage solid propellant motor originally developed for Vanguard were relatively minor and consisted principally of applying closer control over dimensions and performance characteristics. FY 1962 changes included work on delayed ignition and the replacement of an overage motor.

System Support	1961	1962	1963
Guidance services.....	$555,000	$910,000	---
Range support services.....	658,000	75,000	---
Contractor launch services.....	5,661,000	1,131,000	---
Total, System Support.....	$6,874,000	$2,116,000	---

Guidance services are procured through the Air Force and cover utilization of the radio guidance systems during each of the DELTA launches. Range support services include such items as the purchase of propellants, range overtime compensation, provision of telemetry support services, and direct work orders issued to the Atlantic Missile Range. Funding for contractor launch services in FY 1962 covers the reception assembly,

check out, and launch of the vehicles, and required guidance services. The requested funding will complete all requirements for the twelve-vehicle DELTA program. The last development vehicle launch is planned for mid-calendar year 1962.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

FISCAL YEAR 1963 ESTIMATES

CENTAUR

SUMMARY OF REQUIREMENTS:

	1961	1962	1962 Supplemental	1963	Page No.
Vehicle Development...	$37,373,000	$42,900,000	$ 9,000,000	$46,960,000	RDO 13-2
Engine Development....	23,960,000	19,936,000	---	11,140,000	RDO 13-3
System Support	3,340,000	3,004,000	---	8,564,000	RDO 13-4
Total.....	$64,673,000	$65,840,000	$ 9,000,000	$66,664,000	

OBJECTIVES:

The purpose of the CENTAUR development program is to develop a launch vehicle of high performance and reliability for NASA unmanned lunar and planetary exploration missions and DOD missions using communications satellites in a high earth orbit. The costs of CENTAUR operational vehicles are funded under the various programs using the CENTAUR vehicle.

JUSTIFICATION:

CENTAUR is a high energy upper stage using liquid hydrogen and liquid oxygen. The lower stage is an Atlas vehicle with a cylindrical top section for mounting the upper stage.

Ten developmental CENTAURS are planned for flights in the 1962-1964 period. Some of the development flights will carry test payloads and an operational vehicle is expected for 1964 NASA and DOD missions.

CENTAUR occupies a position of key significance in the NASA space program. It is planned for launching unmanned reconnaissance spacecraft into orbit about the moon and unmanned spacecraft for lunar landings to gather vital information about the moon and its environs needed for manned lunar landing. It is also planned for unmanned flights to Mars and Venus. It will carry a DOD communications satellite into a high earth orbit which keeps the satellite stationary with respect to a position on earth. It will provide this country with our first experience and technology in using liquid hydrogen in flight. The successful use of liquid hydrogen in flight is highly important to our national space program. The upper stages of Saturn will use liquid hydrogen, as will future nuclear propulsion systems.

FUNDING REQUIREMENTS:

Vehicle Development	1961	1962	1962 Supplemental	1963
Second-stage design engineering	$ 9,108,000	$10,323,000	$ 4,319,000	$ 7,600,000
First-stage procurement and modification....	4,500,000	3,950,000	---	7,400,000
Fabrication of second-stage test vehicles.	14,874,000	15,506,000	825,000	13,860,000
Ground testing	8,891,000	7,452,000	3,856,000	7,400,000
Launch support	---	5,669,000	---	10,700,000
Total, Vehicle Development ...	$37,373,000	$42,900,000	$ 9,000,000	$46,960,000

This portion of the program includes the design, engineering, fabrication, and ground testing for the CENTAUR second stage (less engines); the design of modifications to, and fabrication of, the first stage (Atlas); and the equipment and services involved in launching the complete vehicle. The basic design of the second stage is substantially complete. One first stage and one second stage have been delivered to the Atlantic Missile Range and are undgergoing checkout preparatory to first launch early in 1962. Two additional Atlas boosters have been manufactured. Four additional CENTAUR stages are in various stages of the fabrication process.

The $9 million requested as FY 1962 supplemental funds are required in support of the second-stage vehicle development to provide for unforeseen requirements. During the past year, unanticipated problems in design and development arose which degraded the vehicle's predicted performance. In order to meet design payloads, a number of vehicle improvements have been started and others are under study. Improvements started to reduce weight consist of such things as removal of telemetry installed primarily for development, relocation of tracking equipment from the second to the first stage, and redesign of certain electrical components (shielding, wire length, connectors, harnesses, power systems). Other improvements under study include redesign of insulation techniques to reduce heat propellant loss, alternate materials and tank design, redesign of propellant utilization system, repackaging of guidance components, and increasing engine performance.

Second-Stage Design and Engineering

Included here are engineering services for the design of the CENTAUR second stage, engineering studies of various flight trajectories, and technical reports.

First-Stage Procurement and Modification

This includes design of necessary modifications in the Atlas booster to adapt it for use with the CENTAUR second stage, and the fabrication and check-out of the modified Atlas. Ten such Atlases are provided for in the program.

Fabrication of Second-Stage Test Vehicles

The manufacture of CENTAUR second-stage vehicles (less engines) and their check-out is included. Ten such vehicles are provided for in the program.

Ground Testing

This includes the preparation of a special test vehicle and other vehicle components, and the conduct of tests to obtain data on storage, pumping and heat transfer characteristics of liquid hydrogen, operation of integrated attitude control systems, jettisoning of heat insulation panels, and on the operation of integrated second-stage flight propulsion systems.

Launch Support

Equipment and services necessary to prepare flight test vehicles for launching, and to launch them at the Atlantic Missile Range are included.

Engine Development	1961	1962	1963
Engine design and engineering.....	$ 5,662,000	$ 4,035,000	$ 2,940,000
Fabrication of prototype and production engines.....	7,946,000	8,401,000	6,000,000
Ground testing.....	10,352,000	7,500,000	2,200,000
Total, Engine Development.....	$23,960,000	$19,936,000	$11,140,000

The CENTAUR second-stage engine is the first flight-configured rocket engine utilizing liquid hydrogen and liquid oxygen as propellants. This portion of the program includes the design, engineering, fabrication, and ground testing of the CENTAUR second-stage engines and the auxiliary ground equipment necessary to support the transportation, check-out, and firing of CENTAUR engines in ground tests and in the flight program. Preliminary flight rating tests of the CENTAUR liquid hydrogen engine have been completed. Twelve engines have been delivered to date. Ground test engines and sufficient flight engines for the ten CENTAUR flight vehicles, plus spares, are provided for in the program. Ground tests at the West Palm Beach test facility are currently under way in support of the coming flight program.

Engine Design and Engineering

Engineering services for the design of the CENTAUR second-stage hydrogen engine, engineering studies of the engine's adaptability to operation under off-design conditions, and technical reports are included.

Fabrication of Prototype and Production Engines

This includes the manufacture of CENTAUR second-stage engines and their check-out prior to delivery.

Ground Testing

Funds are requested here for the fabrication of ground support equipment and of developmental engines, their installation in the West Palm Beach test facility, and the conduct of the tests in that facility. It also includes technical services provided by the engine contractor during engine-vehicle tests at the vehicle contractor's test facilities.

System Support	1961	1962	1963
NASA Support.....	$ 2,180,000	$ 600,000	$ 1,388,000
Air Force Support.....	---	1,250,000	900,000
Marshall Space Flight Center Support.....	1,160,000	654,000	2,276,000
Propellants.....	---	500,000	4,000,000
Total, System Support.....	$ 3,340,000	$ 3,004,000	$ 8,564,000

This portion of the program includes supporting services provided by the NASA Centers, such as the Lewis Research Center (for example, study of propellants under zero gravity and engine altitude tests) and the technical divisions of the Marshall Space Flight Center. It also includes support provided by the Air Force, such as the altitude test of the Centaur stage at the Arnold Engineering Development Center, Tullahoma, Tennessee. In addition, the purchase of propellants, such as hydrogen, oxygen, hydrogen peroxide, and nitrogen required in the development program is provided.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

FISCAL YEAR 1963 ESTIMATES

SPACECRAFT TECHNOLOGY

SUMMARY OF REQUIREMENTS:

	1961	1962	1963	Page No.
Advanced Research and Technology	$25,376,000	$25,220,000	$30,894,000	RDO-14-2
Flight Programs	1,750,000	11,925,000	23,190,000	RDO-14-10
Totals	$27,126,000	$37,145,000	$54,084,000	

OBJECTIVES:

The objectives of the spacecraft technology program are to obtain the research information and technical design data required to advance the state-of-the-art, and to provide a rational technological basis for the design of increasingly sophisticated spacecraft having improved performance, reliability, and safety.

JUSTIFICATION:

A balanced program of research and testing in ground facilities and of carefully selected flight tests must be pursued in a number of areas to provide the basis for advanced spacecraft design for unmanned and manned flight to the moon and planets, and for other space missions. As successful as a number of space missions have been, many of the systems and flight techniques employed in these early spacecraft are rudimentary when compared to those that will be required.

Advanced mission requirements are characterized by long flight durations and consequent long-duration exposure to the environment of space, which poses special difficulties with respect to reliable spacecraft performance and hazards to manned flight. The ever increasing flight speeds required for interplanetary missions and the implications of such speeds with respect to atmospheric entry, the continuous demand for greater precision of navigation and flight control, and the demands for better materials and more efficient structures, require expanding research programs to provide the required solutions.

Inherent in the study and solution of these problems is the continued development of the laboratory tools required for experimental investigations. While ground-based facilities will be utilized to the maximum extent, some of the research programs require space flight experiments because combined space environment and effects cannot be properly duplicated in the laboratory.

FUNDING REQUIREMENTS:

Advanced Research and Technology	1961	1962	1963
Spacecraft Materials and Structures			
Physics and chemistry of solids	$ 650,000	$ 500,000	$ 540,000
Metallurgy	1,125,000	980,000	1,030,000
High-temperature structures and heat protection systems	2,450,000	2,500,000	2,500,000
Erectable space structures	400,000	545,000	610,000
Space hazard protection	750,000	740,000	910,000
Advanced structural design and fabrication	655,000	545,000	610,000
Totals	$6,030,000	$5,810,000	$6,200,000
Spacecraft Physics			
Fluid mechanics	$1,065,000	$ 805,000	$ 850,000
High-temperature gas properties	385,000	280,000	310,000
Plasma physics	1,350,000	1,050,000	1,459,000
Totals	$2,800,000	$2,135,000	$2,619,000
Reentry Heating and Aerodynamics			
Hypervelocity heating and heat transfer	$2,980,000	$2,800,000	$2,750,000
Spacecraft configuration aerodynamics	2,610,000	2,550,000	2,230,000
Spacecraft dynamics and control	1,050,000	1,150,000	1,225,000
Reentry trajectory mechanics	1,110,000	950,000	795,000
Totals	$7,750,000	$7,450,000	$7,000,000
Spacecraft Landing and Recovery			
Landing impact	$ 350,000	$ 350,000	$ 370,000
Rocket landing technology	300,000	325,000	585,000
Atmospheric recovery systems	850,000	900,000	645,000
Totals	$1,500,000	$1,575,000	$1,600,000
Spacecraft Environment and its Simulation			
High vacuum technology	$ 846,000	$ 725,000	$ 835,000
Thermal radiation effects and simulation	400,000	325,000	535,000
High energy particle radiation effects	450,000	545,000	620,000
Meteoroid impact research	650,000	545,000	505,000
Fluid behavior and system design for zero gravity	300,000	360,000	305,000
Totals	$2,646,000	$2,500,000	$2,800,000

	1961	1962	1963
Control, Guidance, and Navigation			
Guidance and navigation.....	$ 845,000	$1,115,000	$2,130,000
Automatic control and stabilization.....	920,000	1,110,000	2,290,000
Advanced communications and instrumentation.....	475,000	675,000	2,110,000
Manned flight control and simulation.....	1,010,000	1,350,000	2,645,000
Totals.....	$3,250,000	$4,250,000	$9,175,000
Advanced Data Handling, Reduction, Analysis, and Computation	$1,400,000	$1,500,000	$1,500,000
Total, Advanced Research and Technology.....	$25,376,000	25,220,000	30,894,000

Spacecraft Materials and Structures

It is essential that space vehicle structures and materials research technology be developed not only at the same rate but at a faster rate than the overall program particularly with regard to materials for future generations of vehicles. In order to provide the basic knowledge for a vehicle program in the future, the major research programs in the areas of materials and structures will be continued.

The materials program will include basic materials research. Research on refractory metals and ceramics will range from the basic study of the nature of the atomic lattice and the effects of foreign atoms in the lattice through the plastic behavior of such materials. This class of materials will have a steadily increasing utilization for many high temperature structural applications in space.

Research on high strength-to-weight materials has as its goal an increase in the maximum stress that materials can withstand. Typical materials being studied include stainless steel, titanium alloys, beryllium, and certain reinforced polymers. The temperatures of interest range from -423° Fahrenheit for liquid hydrogen (for rockets using cryogenic fluids) to about 1500° Fahrenheit.

The increased insight provided by basic research on the nature of solids is expected to reduce future development costs. This research will include studies of several aspects of diffusion, kinetics, chemical reactions with activated species, and the extension of theories on dislocation motion.

Research on structures and materials applications for spacecraft will include studies of space vehicle dynamics. A serious lack of knowledge on the dynamic characteristics of space vehicles currently exists which affects spacecraft requirements.

Analytical methods for predicting the failure of thin shells and pressure vessels are inadequate for determining optimum configurations and for establishing accurate design methods. Research study on the analytical aspect of the problem was initiated during FY 1961. These have resulted in some improvement in accuracy and fundamental research to improve these analytical methods will continue in FY 1963.

Major structural advances can be made by improving utilization of existing materials. Examples of these improvements are the application of filaments, flakes, foils and foams in composite, expandable structures, and impact energy absorbing systems.

The methods of protection against space hazards will be improved as environmental data and adequate test facilities are provided. Current research has shown great potential for active radiation protection systems in terms of effectiveness and efficiency. The FY 1963 request will provide for accelerated programs designed to develop systems for protecting against meteoroid impact, high-energy radiation, hard vacuum, and thermal radiation.

Thermal protection of vehicles during orbital reentry has reached the first objective of demonstrated feasibility. Research conducted in FY 1962 has indicated that increased efficiency and reliability can be achieved. Funds included in the FY 1963 request provide for development of thermal protection systems which must be developed if reentry from lunar and planetary orbits is to be successful.

Spacecraft Physics

The physics of fluids and fluid flow systems are basic to the design and operation of spacecraft systems-- from the external flows which determine overall configuration design and heat protection systems to details of internal flows in power generation and propulsion devices. The demands of space technology require a radical extension of knowledge of fluid properties and flows to temperature, pressure and speed conditions which differ very significantly from those presently encountered. Research will be continued to determine the transport and radiation properties of air and other planetary gases at high temperatures for use in calculating the flow fields of reentry spacecraft at extreme speeds and in various planetary atmospheric gaseous environments.

During FY 1963, theoretical and experimental research of a basic nature will continue to be conducted in order to understand and explain the physical and chemical phenomena which occur in the shock-heated plasma surrounding a reentry spacecraft.

Because of the wide potential application to hypersonic flow simulation and heating, communications, power generation, and propulsion of space systems, the FY 1963 funds requested will provide for intensified research in plasma physics, particularly to take advantage of the use of newly developed cryogenic techniques in the generation of large magnetic fields with lightweight, low power magnets. Before the applications can be realized, however, much more knowledge is required of the physical processes whereby plasmas are generated, contained, stabilized, and accelerated.

Reentry Heating and Aerodynamics

Successful reentry at satellite velocities, about 18,000 miles per hour, has been demonstrated with ablation-cooled spacecraft, and the associated aerodynamic heating problems at these speeds are reasonably well understood. However, at the higher speeds of lunar and planetary flight, additional sources of heating become important. Spacecraft heating due to radiation from the incandescent gas cap becomes significant at lunar return speed. At speeds characteristic of planetary flight this source of heating is many times larger than the more familiar convective heating of satellite reentry and has a profound effect on spacecraft design and heat protection systems. Present knowledge is based almost entirely on theoretical studies and on meager experimental data obtained in small-scale experimental facilities.

Another source of heating for spacecraft is air ionization during reentry. The effects have recently been predicted on theoretical grounds and some experimental confirmation has been obtained. Its potential importance makes it necessary that a firm experimental verification be initiated in FY 1963.

Funds requested for FY 1963 will provide a continued program of experimental research in laboratory facilities to provide understanding of these heating problems at extreme speeds and to provide data for spacecraft design. Speeds in excess of 21,000 miles per hour have been obtained for the first time in ground based facilities, and efforts will be channeled in FY 1963 to provide even more advanced laboratory techniques.

Critical flight experiments designed to verify laboratory results are essential as a basis for sound technical decisions in planning spacecraft development programs. Such a flight program, begun in FY 1962, will be actively pursued in FY 1963.

Aerodynamic control during planetary atmospheric entry continues to offer advantages. The FY 1963 estimate provides for research essential to the development of spacecraft reentry shapes which have minimum heat problems, which are aerodynamically stable, and which can effectively utilize aerodynamic control forces.

The FY 1963 estimate also provides for continued research in aerodynamic and heat transfer theory for parabolic and hyperbolic reentry, and the development of advanced laboratory techniques for experimental study.

Spacecraft Landing and Recovery

Safely returning manned and unmanned spacecraft to earth, or of landing on other planets of the solar system, is one of the more critical objectives of the space exploration program. Manned vehicles must, of course, be returned safely, and many unmanned spacecraft must be landed and returned to the laboratory to allow a complete assessment of the mission results.

Parachutes which have high load carrying efficiencies at both subsonic and supersonic speeds need to be designed and perfected. During FY 1962, research is continuing, particularly at the supersonic speeds, on new conical and annular ribbon, hemisflo, and rotofoil parachute types. Additionally, new concepts, such as inflatable paragliders and rotors, for recovery devices are being investigated. With FY 1961 and 1962 funds much work was accomplished in wind tunnels on paraglider configurational design. Limited flight experience has been obtained by the Langley Research Center on paraglider efficiency, operational characteristics, and actual deployment. Additional laboratory and flight experiments concerning techniques for deployment for inflatable paragliders is included in the FY 1963 request. Research is also planned on the use of deceleration drag devices for the initial slowing of vehicles returning to the earth.

The techniques discussed above involve the use of the atmosphere to effect a soft landing. The moon has no sensible atmosphere; therefore, the entire vehicle energy must be absorbed by the use of retrorockets and by the vehicle structure. In either an impact landing or a soft landing on the moon usable instrumentation must survive. During FY 1962 research centered around such techniques as braking rockets, gas filled bags, and collapsible structures such as frangible metal tubing, aluminum honeycomb, and balsa wood. Research will be continued in FY 1963 on various techniques and systems for effecting a successful landing of unmanned and manned spacecraft on the moon.

The FY 1963 request also provides for research to be initiated on the problems associated with landing on planets which have atmospheres different from that of the earth.

Spacecraft Environment and Its Simulation

Spacecraft for advanced missions must be designed to function properly and reliably for long periods of time in a hazardous environment that is only partly defined, and whose effects on spacecraft materials, components, and systems are largely unknown. This environment includes hard vacuum, extreme cold, exposure to unattenuated solar thermal and ultra-violet radiation, high-energy particle radiation, meteoroids, and zero-gravity effects. In FY 1963 increased attention will be given to a more complete definition of the total nature of the space environment, to the determination of environmental effects important to spacecraft design, and to means of simulating these effects in the laboratory.

Studies are required on vacuum effects on materials of all kinds, particularly in the presence of solar thermal radiation. Continuing effort in FY 1963 will be placed on the techniques of producing a hard vacuum and on instruments for its reliable measurement. Effort will also be directed to acquire the techniques for reproducing the sun's radiant energy spectrum through the ultra-violet portion in the laboratory.

Limited experiments have been conducted with prior year funding in existing particle accelerators simulating the exposure of materials and components to Van Allen belt radiation. A variety of effects have been discovered such as the susceptibility of solar cells and transistors to radiation damage. The needs for investigation are extensive and include study of the effects of radiation on heat shield and other polymeric materials, transparency of glasses, surface coatings used for temperature control, and on elements of communication and guidance equipment. Studies will be initiated with FY 1963 funds on secondary radiation behind materials used for shielding in composite spacecraft design, and on possible new techniques of shielding by electromagnetic means against energetic charged particles.

Laboratory experiments in high-speed particle impact have produced a limited understanding of impact phenomena and possible means for protection against penetration. Continuing efforts in FY 1963 will be made to increase impact speeds to simulate natural meteoroid velocities in order that a greater understanding can be achieved.

The problem of the behavior of fluid systems under a zero-gravity condition is of prime importance. Experiments in laboratory facilities and in flight tests have produced insight into certain aspects of the behavior of fluids under a zero-gravity environment. These experiments will be continued.

Control, Guidance and Navigation

An advancing space program constantly demands extreme accuracy and precision of navigation and flight control, and the utmost reliability in system performance for both unmanned and manned missions.

In the navigation and guidance problem of accurately determining spacecraft position and velocity, on-board measurements are significantly augmented in near-earth flight by radio techniques. In deep space, or when earth-based systems are inactivated by communication blackout, on-board navigational data become the only reliable source of information. Funds requested will provide for expanded research on a variety of advanced inertial and electromagnetic techniques, systems, and components, all of which should provide improved sensitivity and precision together with long-life performance and low power consumption. Cryogenic and electrostatic gyro and accelerometer research has progressed to the point where feasibility has been demonstrated. An increase in development effort is planned for FY 1963.

Rendezvous, lunar and planetary operations require the development of a new generation of sensors for the measurement of range, velocity, and orientation with respect to lunar and planetary surfaces and to other spacecraft. Research and advanced development on advanced optical techniques for improved resolution and image intensification for deep space navigational purposes are included in the FY 1963 request. Current research efforts on celestial body tracking, together with component developments such as sextants and theodolites, will be continued.

Spacecraft stabilization and control technology will be continued with the objectives of minimizing weight and power consumption and improving accuracy and lifetime. Current developments include gas jets, inertial techniques, the use of gravity gradients and magnetic fields, solar sails, horizon sensing, spacecraft rate sensing, and advanced circuitry. Initial Orbiting Astronomical Observatories dictate the employment of new stabilization techniques, because of fine pointing accuracy requirements. Research to provide future spacecraft with greater orientation control accuracy will be conducted in FY 1963.

In order to command and obtain useful data from future satellite and deep space craft, communications technology must be continued and expanded. Long communication distances, noisy environments, and time delays require extensive investigation into methods and components for achieving transmission and reception of reliable and accurate data. Research being conducted in FY 1962 on several specific techniques includes ground based multiple antenna arrays, unfurlable spacecraft antennas and methods for overcoming communications blackout during reentry.

The FY 1963 request will provide for expanded research in the field of communication theory in order to improve information handling rates and, in particular, to investigate the problems of speech communications at lunar and planetary distances. Reliable speech transmission is considered of extreme importance in order that astronauts may be able to communicate by voice.

In close parallel with information transmission techniques, it is necessary to develop instrumentation which will generate such information. In FY 1963, investigations will be expanded in the techniques of measuring physical and biological phenomena and methods of converting and handling that information for use with advanced communications devices.

For navigation and flight control of manned spacecraft, research will be continued in FY 1963 toward defining the best role of man in the system so that he may be relieved of over-difficult, fatiguing, and repetitive tasks so that his higher abilities of judgment, experience, and observation may be most profitably used. With funds previously provided, considerable effort is already underway in this area, including extensive simulator tests as well as X-15 and Mercury flight experience. Work will be continued in FY 1963 to improve flight and ground data displays and means for generating these displays with lightweight, low-power, and highly reliable devices.

Research on linear and non-linear servomechanism theory will be continued and expanded in FY 1963 utilizing university grants and contracts to provide the basic data for developing improved mechanization of control systems.

Advanced Data Handling, Reduction, Analysis and Computation

Additional work must be done in the field of data handling, reduction, analysis, and computation if future space missions are not to be inhibited by lack of ability to handle an extensive mass of data from a variety of continuous and rapid-sampling measurements. In computer technology, work funded in FY 1961 and FY 1962 has been underway in a number of areas with potential for achieving major improvements in terms of reduced size and weight, increased reliability, increased data handling capacity, and reduced power consumption. Items such as microelectronic elements, functional electronic elements, cryotonic thin film and wire wound elements for storage and switching (using superconductivity phenomena in a cryogenic environment) and adaptive logical networks which exhibit a learning capability have been studied and developed in FY 1962 for use in advanced computation devices. In FY 1963 this work will continue. An area requiring increased research effort is electronic and computing elements which exhibit resistance to space radiation.

FUNDING REQUIREMENTS:

	1961	1962	1963
Flight Program:			
Radio Attenuation Measurements.....	$ 500,000	$1,835,000	$ ---
Aerodynamic Noise Measurements.....	---	200,000	---
Trailblazer Reentry Project.....	50,000	200,000	200,000
Horizon Sensors.....	700,000	700,000	700,000
Recoverable Micrometeoroid Probe.....	---	220,000	140,000
Reentry Heating and Materials Experiments:			
Spacecraft and support.....	500,000	1,300,000	500,000
Scout launch vehicles.....	---	2,000,000	2,000,000
	$ 500,000	$3,300,000	$2,500,000
Micrometeoroid Satellites:			
Spacecraft and support.....	---	610,000	1,500,000
Scout launch vehicles.....	---	---	2,000,000
	---	$ 610,000	$3,500,000
Engineering Test Flight Experiments:			
Scientific experiments.....	---	880,000	1,950,000
Launch vehicle (available under other programs).....	---	---	---
	---	$ 880,000	$1,950,000
True Environment Engineering Test Satellites:			
Spacecraft and support.....	---	---	2,000,000
Scout launch vehicles.....	---	---	2,000,000
	---	---	$4,000,000
Flight Reentry at Hyperbolic Velocities:			
Design and fabrication of spacecraft.....	---	880,000	2,970,000
Instrumentation development and support.....	---	60,000	1,480,000
Velocity package.....	---	640,000	1,750,000
Atlas launch vehicles.....	---	2,400,000	4,000,000
	---	$3,980,000	$10,200,000
Total, Flight Program.....	$1,750,000	$11,925,000	$23,190,000

OVERALL OBJECTIVES

The objectives of the flight test program are to obtain data on those aspects of the space environment which influence the design of space vehicles; to acquire by actual flight vehicle technology where ground facilities do not provide adequate simulation of the space environment; and to permit correlation with data on vehicle technology obtained in laboratory facilities.

Trailblazer Reentry Project

This project is a study of the reentry physics phenomena at speeds up to 22,000 feet per second and is particularly concerned with measurement of the radar cross section of reentry objects as affected by the surrounding ionized gas during reentry. A unique Trailblazer rocket vehicle has been developed for these tests. This project is a joint program conducted by the Langley Research Center and the Lincoln Laboratories of the Massachusetts Institute of Technology for the Department of Defense. Funds requested for FY 1963 are to allow a continuation of this program by providing modification and improvement of instruments, and tracking and data acquisition equipment essential to the success of the program.

Horizon Sensors

Means for precisely determining position and velocity in space are essential to the midcourse and reentry guidance systems for all lunar and deep space missions. The relatively large size of the earth as viewed from a spacecraft offers the possibility of using the earth's horizon as a reference point. In this project information will be obtained to determine how the electro-magnetic spectrum of the earth's horizon varies with altitude. This project will accurately locate the effective earth horizon and will assist in the determination of the type of horizon sensor best suited for use in future guidance systems. Three flight experiments are planned, using a modified Javelin sounding rocket.

Recoverable Micrometeoroid Probe

This project concerns the use of a new technique for measuring the concentration and energy spectrum of micrometeoroids in a near-earth environment. Sounding rockets will be used to place a large light-weight surface outside the atmosphere for a short time in order to permit direct measurement of the frequency of impact of small micrometeoroids and of the resulting penetration depths. This surface material will be in the form of a paraglider to facilitate its recovery to permit study of cratering resulting from the micrometeoroid impacts.

The FY 1962 funds provide for the initial design of the experiments, including the paragliders, and for development of the technique for detecting penetrations. The FY 1963 request will provide for completing the development of the technique including tests of two flight units, and will permit exploitation of the developed technique by means of four flights to secure impact, penetration, and cratering data. These data will have direct application to the design of those elements of spacecraft which are sensitive to micrometeoroid damage.

Reentry Heating and Materials Experiments

An essential part of the research program on the reentry problems of spacecraft involves a series of reentry flight experiments using Scout vehicles. A program was initiated in FY 1962 involving three reentry flight experiments to measure, respectively, total heating, radiative heating, and the performance of one heat shield material of the charring ablator type. The objective of these initial flight experiments is to provide data at reentry speeds up to approximately 30,000 feet per second to permit correlation with small-scale data obtained in laboratory facilities and to provide data on heat shield performance in real flight environments at very high velocities. The funds requested for FY 1963 are to expand this program to include an additional radiative heating experiment and an experiment on the performance of pyrolitic graphite as a heat shield material.

Micrometeoroid Satellites

A satellite having a large exposed surface placed into an orbit around the earth for a long period of time offers a valuable technique for acquiring statistical data on the distribution of micrometeoroids in space along the earth's path around the sun, for studies of the probable frequency of micrometeoroids colliding with spacecraft operating in the vicinity of the earth, and for investigating the penetrations of spacecraft that may result from such collisions. In FY 1963, funds are requested for detail design and procurement of hardware for two satellites, using Scout launch vehicles, to investigate these phenomena in detail as a follow-on to the research initiated with the micrometeoroid satellite funded in FY 1962. Such information is required to permit design of space vehicles able to withstand collisions with micrometeoroids or small meteoroids.

Engineering Test Flight Experiments

The technology of materials and structures for spacecraft applications requires engineering evaluation tests in a true space environment. Part of these tests can be readily accomplished by including experiments on space vehicles performing other space missions. These "piggyback" individual experiments will be less expensive than special flight experiments, and permit necessary exploration of the suitability of various materials and structural concepts for space vehicles. The

funds requested for FY 1963 are for the development of special experimental packages suitable for incorporation on a non-interference basis in other space vehicles.

True Environment Engineering Test Satellites

This project concerns the use of specially constructed engineering test satellites to study the effects of the combined elements of the space environment, such as high vacuum, zero gravity, micrometeoroids, and radiation, on the properties of materials and structures which appear, based on ground research, to meet the requirements for use in advanced spacecraft. These satellites will be launched with Scout vehicles. The funds requested for FY 1963 provide for two Scout vehicles and for the development of two spacecraft payloads incorporating the engineering test materials and structures experiments.

Flight Reentry at Hyperbolic Velocities

The primary objective of this flight project is to investigate the heating environment of a reentry object at 37,000 feet per second. This flight project includes investigation of the total heat transfer as well as the hot air radiance. The determination of materials response to this environment as well as radio blackout effects are important secondary objectives. These flight experiments constitute an extension of the Scout reentry flight tests to higher speed as a part of a coordinated laboratory-flight reentry research program. An Apollo shaped spacecraft is to be used in order to draw on a large reservoir of ground-based facility data for correlation. These flight experiments are required to provide a basis for expanding the usefulness of theoretical analyses and ground facility tests in providing critical information for reentry flight. The launch vehicle will be the Atlas D mated to a velocity package consisting of a Scout third stage solid rocket motor (Anteres) capable of giving a 200-pound payload a 37,000 feet per second reentry velocity. Two such flights are planned.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

FISCAL YEAR 1963 ESTIMATES

LAUNCH VEHICLE TECHNOLOGY

SUMMARY OF REQUIREMENTS:

	1961	1962	1963	Page No.
Advanced System Studies	$ 5,029,000	$ 6,116,000	$ 7,452,000	RDO 15-2
Vehicle Technology	8,822,000	16,964,000	24,238,000	RDO 15-3
TOTAL	$13,851,000	$23,080,000	$31,690,000	

OBJECTIVES:

The purpose of the Launch Vehicle Technology program is to advance the technology which will be required to support design and development of future launch vehicles; to solve technical problems faced by launch vehicles that are now being designed; and to examine alternate design concepts and systems for general application to space missions.

JUSTIFICATION:

In order to meet the long range goals of manned flight, lunar orbits and landings, and eventually planetary missions, the basic technology must keep pace with advancing vehicle concepts. Effort in this area is an integral part of the planning and development required for both current and future vehicles.

The need for high system reliability for manned space flight and the fact that the required large vehicle systems are now in their infancy dictate the need for a Vehicle Technology effort that is aimed well beyond the requirements of current developmental vehicles. Similarly, the long lead times associated with the development of these advanced vehicles requires that experimental and prototype hardware be developed in sufficient time to permit integration into the detailed design requirements of a particular vehicle. For example, improved electronic systems will be required that are capable of surviving the very long operating periods associated with lunar and planetary missions. The problems associated with the use of the high energy propellant liquid hydrogen for space missions must also be resolved.

Technical problems characteristically arise during the design phase of a vehicle and must be solved before design and development can proceed effectively. The problems of providing effective instrumentation and data for multi-barrelled rocket engine systems, the motion and state

of liquefied gaseous propellants after long periods of weightlessness, and the sloshing of propellants in large diameter booster tanks are but a few of the areas in which an intense technology effort will be conducted.

FUNDING REQUIREMENTS:

Advanced Systems Studies	1961	1962	1963
Operational and Systems Analysis	$ 4,059,000	$ 3,701,000	$ 3,950,000
Vehicle Studies	970,000	2,415,000	3,502,000
TOTAL	$ 5,029,000	$ 6,116,000	$ 7,452,000

In FY 1962, the major areas of effort were directed toward design requirements for the clustering of very large thrust engines for use in the Saturn and Nova class vehicles, and toward conceptual studies of orbital operations as a means of achieving manned earth orbit, lunar, and space exploration missions. This work has formed the basis for the current vehicle systems plans for the accomplishment of the manned lunar landing program. This effort will be continued in FY 1963 to consolidate and refine the results already accomplished; in addition, specific emphasis will be directed toward other requirements beyond the early lunar landings, as noted below.

Operational and Systems Analysis

This effort will include the operational and systems analysis required to establish future missions and system requirements with respect to vehicle design criteria, applications, and environment. During FY 1963 a major effort will be directed toward defining the vehicle systems that will be required after the first manned lunar landing. In this area, particular attention will be given to the requirements for lunar bases, earth-lunar transportation and early manned planetary flights. Current study efforts concerning the economic aspects of advanced space transportation systems will be continued as a basis for developing cost optimization standards.

Vehicle Studies

Vehicle studies will be conducted to analyze and evaluate advanced propulsion systems and their applications to stage or vehicle design; to establish conceptual and preliminary design requirements; to determine optimum stage sizes; and to evolve performance evaluation methods and techniques. In FY 1963, specific attention will be given to the Advanced Saturn class with a nuclear upper stage and to the post Nova vehicle.

FUNDING REQUIREMENTS:

Vehicle Technology	1961	1962	1963
Vehicle Navigation and Stabilization	$ 1,696,000	$ 2,893,000	$ 5,597,000
Materials & Structural Design	3,455,000	6,791,000	7,461,000
Flight Dynamics	1,316,000	3,802,000	4,658,000
Communications and Data Processing	512,000	1,868,000	1,865,000
Instrumentation and Test	1,843,000	1,356,000	2,792,000
Electrical Power Sources and Distribution	---	254,000	1,865,000
TOTAL	$ 8,822,000	$16,964,000	$24,238,000

In FY 1962, the Vehicle Technology effort was oriented toward the medium and smaller launch vehicles, which are primarily intended for unmanned space flight, and the Saturn C-1. In FY 1963, the emphasis will shift to the new class of large vehicles to be developed for manned space flight, the Advanced Saturn and the Nova, and to orbital operations; the level of effort will be raised in FY 1963 commensurate with the emphasis on the larger, more complex manned space flight vehicles.

Vehicle Navigation and Stabilization

This area covers the research, development, and test necessary to evolve reliable and economical guidance and control systems, subsystems, and components for launch vehicles. It also includes studies on the feasibility of self-adapting control systems; studies on the relative emphasis to be placed on manned versus automatic guidance and control; trajectory analysis; energy management; and analysis of advanced guidance and control concepts. Specific technical developments will be carried out in the areas of miniaturization and reliability improvement of electrical and electronic components.

Materials and Structural Design

Development and testing of materials, structures, and fabrication techniques are required on a continuing basis. Efforts include tests on materials at cryogenic temperatures, high energy forming techniques,

large diameter (33 - 50 feet) tank fabrication, fuel sloshing control, titanium technology, effects of high temperature, structures for multiple engine stages, and investigation of advanced materials and methods.

Flight Dynamics

Effort in this area will be directed towards investigations of atmospheric effects on vehicle dynamics, interaction of structures and guidance systems, interstage structural requirements, dynamics and transient characteristics of engine-out situations, base heating, effects of fuel sloshing, and structural flight dynamics. Specific hardware development and analysis will be performed on self-adapting controls, real-time computer evaluation, trajectory optimization, and aeroelasticity.

Communications and Data Processing

This area covers the development and test of reliable and economical communications and data processing systems, subsystems, and components required in future launch vehicles and those now under development. Specific areas of effort include vehicle telemetry, ascent tracking, computer integration, advanced techniques for communications, data storage and processing, and studies of integrated launch vehicles and spacecraft communications and data processing systems.

Instrumentation and Test

This technology supports the development of new instruments and test methods for launch vehicles including mass flowmeters, simple leak detectors, failure detection systems, reliable engine-out detectors, automatic checkout equipment, propellant instrumentation, and transducers for launch vehicle flight tests.

Electrical Power Sources and Distribution

Effort in this area is required to provide reliable and economical components and systems for the supply and distribution of electric power for launch vehicle equipment. The effort will include integration of launch vehicle and spacecraft power supply and distribution systems, with specific work on batteries, fuel cells, gas-driven generators, rotary equipment, and electrical conductors.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

FISCAL YEAR 1963 ESTIMATES

LAUNCH OPERATIONS DEVELOPMENT

SUMMARY OF REQUIREMENTS:

	1961	1962	1963	Page No.
Launch Operations Studies	$100,000	$ 596,000	$ 2,901,000	RDO 16-2
Advanced Instrumentation	-	1,193,000	322,000	RDO 16-3
Range Support Operations	-	-	18,263,000	RDO 16-4
TOTAL	$100,000	$1,789,000	$21,486,000	

OBJECTIVES:

The purpose of the Launch Operations Development program is to analyze operational requirements and to provide advanced ground instrumentation and equipment for launch vehicle operations. In addition, the required operational support for activities to be conducted in the new area at the Atlantic Missile Range (AMR) will be provided in this program.

JUSTIFICATION:

During FY 1963 a substantial increase in the level of effort for launch operations studies is anticipated in order to meet the planned and potential requirements for launch facilities for liquid, solid and nuclear propulsion vehicles. Propellant safety hazards, new concepts in ground support and launch facilities, and the transportation and recovery of large missiles and space capsules are areas of investigation and development which are directly related to these requirements. A continuing requirement is the development of the special ground instrumentation needed to meet the increased complexity and data requirements for vehicles significantly larger than Saturn C-1. Special equipment and techniques will be studied and developed to accommodate the new problems associated with the use of the liquid hydrogen and nuclear upper stages.

With the initiation of the manned lunar landing program and the resulting increase in launch operations at the AMR, it was determined that the increased cost at the AMR for this program will be borne by NASA. The effort in FY 1963 will support spacecraft flights on the C-1

vehicle and will provide a build-up for the Advanced Saturn and later for the Nova launch vehicles. The scheduled use of Air Force personnel for FY 1963 provided for an average military and civil service strength in support of the manned lunar landing program of 500 and an average range contractor support staff of 870.

FUNDING REQUIREMENTS:

Launch Operation Studies	1961	1962	1963
Handling of Very Large Solid Propellant Vehicles	-	-	$ 430,000
New Concepts in Ground Support	-	$179,000	430,000
New Concepts in Launch Facilities	$100,000	369,000	430,000
Ground Support Equipment for Sub-Cooling Liquid Hydrogen	-	-	215,000
Transportation of Large Vehicles	-	-	966,000
Effects of Jet Impingement on Water	-	-	430,000
Acoustic Studies	-	48,000	-
TOTAL	$100,000	$596,000	$2,901,000

Handling of Very Large Solid Propellant Vehicles

The possible use of very large solid propellant engines as boosters for a Nova type vehicle will require new techniques and new equipment to assemble the segments and the separate engines into a clustered first stage. In addition, cluster assembly and alignment in a vertical position on the launch pad will require different equipment than that used in handling the engines at the manufacturer's plant. Optimum handling concepts will be developed to meet the new requirements for these large stages.

New Concepts in Ground Support

This effort provides for development of new concepts in ground support to achieve the rapid launch rates required for manned space flight programs. One major concept under consideration involves the assembly of the vehicle and spacecraft at a spot remote from the launch pad, from which it can be moved vertically to the launch position. Transportation of the fully assembled vehicle would be accomplished though the use of a floating platform that is conveyed to the launch site via canals.

By use of this concept, it is estimated that the vehicle could be transported in a vertical position and launched within approximately a week's time, thus reducing appreciably the critical time required on the launch pad. The same mobile platform might be used also for vehicle transport at the manufacturing plant and at the static test site.

New Concepts in Launch Facilities

New launch concepts and launch facility design must be investigated to meet the requirements for large diameter vehicles and for nuclear and solid stages. In addition, protective measures must be devised to meet the increased hazards associated with these larger, higher performance vehicles.

Ground Support Equipment for Sub-Cooling Liquid Hydrogen

A system has been designed for initial sub-cooling of liquid hydrogen at the launch sites. A study will be conducted to determine a method of maintaining the sub-cooled temperature in the storage tank while transferring the hydrogen and while the hydrogen is in the launch vehicle fuel tank during countdown holds and countdown recycles.

Transportation of Large Vehicles

It is anticipated that the size and weight of vehicles planned during the next decade will create unique problems in the transportation of vehicle stages. In addition, the critical phasing of manufacturing, test, and launch schedules requires that rapid modes of transportation be available. All feasible methods will be investigated including the use of low performance aircraft.

Effects of Jet Impingement on Water

The planned use of water-borne platforms to facilitate movement of launch vehicles into the launch position may pose a problem of water removal at time of launch since a flame pit is required to avoid flame flash-backs on the base of the vehicle. To avoid a system of locks and pumps to remove the water from the flame pit, it may be possible to blast directly into the water. A study to determine the effects of this technique with multi-engine configurations will be undertaken.

FUNDING REQUIREMENTS:

Advanced Instrumentation	1961	1962	1963
Development of Optical Equipment and Devices	-	$ 567,000	-
Development of Telemetry Equipment	-	328,000	$184,000

	1961	1962	1963
Offset Frequency Reference Station	-	$ 298,000	-
Acoustic Measuring System	-	-	$138,000
TOTAL	-	$1,193,000	$322,000

Development of Telemetry Equipment

This effort concerns the development of UHF telemetry antennas with a self-tracking capability. These antennas will be required during the experimental development of the transmitting equipment and later as operational equipment when the UHF band is activated.

Acoustic Measuring System

Launches of Saturn, Advanced Saturn, and Nova will produce extremely high acoustic decibel levels. To appraise accurately the effect on equipment and surrounding buildings and people, an accurate acoustic measuring and recording system will be developed.

FUNDING REQUIREMENTS:

Range Support Operations	1961	1962	1963
Supporting Vehicles, Equipment and Supplies	-	-	$ 7,037,000
Rentals, Utilities, Contractual Services, and Support	-	-	11,226,000
TOTAL	-	-	$18,263,000

In the development of a launch operations capability for the Advanced Saturn and Nova launch vehicles in the new area at AMR, both the NASA Launch Operations Directorate (LOD) and the Air Force will provide extensive support. The Air Force support of NASA missions in the new area will be provided on a reimburseable basis. Funds requested in FY 1963 will be used for support in the areas described below.

Supporting Vehicles, Equipment and Supplies

The funds in this category will provide for 120 general purpose vehicles; 187 special purpose vehicles; a diesel locomotive, a utility boat, and two barges; miscellaneous shop machinery tools, photographic, reproducing and drafting equipment, accessories, plant maintenance parts, test equipment, furniture, office equipment, laboratory equipment,

food service, and dispensary equipment; and petroleum products, office supplies, replacement parts, construction and repair materials, chemicals, photographic supplies, hand tools, laboratory test supplies, and electronic and electrical spares.

Rentals, Utilities, Contractual Services and Support

This includes rental of electronic data processing equipment, power and water utilities including the cost of power for cryogenics manufacture; contractual services for maintenance and operation of the launch area; boat and barge operation; reproduction services; lease, operation, and maintenance of motor vehicles; rental of passenger motor vehicles; rental of trucks and other transportation equipment; motor pool operation; professional engineering; administrative services; insurance and other miscellaneous services such as laundry and printing; and salaries for an additional 870 range contractor employees and an additional 500 military and civil service personnel required in FY 1963 by the Air Force at AMR.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

FISCAL YEAR 1963 ESTIMATES

ELECTRIC PROPULSION

SUMMARY OF REQUIREMENTS:

	1961	1962	1963	Page No.
Advanced Research	$4,575,000	$6,659,000	$12,198,000	RDO 17-2
Advanced Technical Development	$2,204,000	$5,770,000	$10,725,000	RDO 17-4
Flight Programs	$ 385,000	$5,152,000	$ 7,724,000	RDO 17-5
Total	$7,164,000	$17,581,000	$30,647,000	

OBJECTIVES:

The continuing objective of the Electric Propulsion program is to develop the technology of thrust generators required for accomplishment of missions utilizing advanced electric rocket systems. Development of thrust devices for nuclear-electric rocket systems is coordinated with the NASA nuclear power generation program which includes the NASA-AEC SNAP-8 program covered under the Nuclear Systems Technology budget.

JUSTIFICATION:

Electric propulsion systems are to be developed to propel spacecraft on a variety of missions. They hold promise for providing adequate propulsion to transport heavy payloads to all the planets within the solar system.

Typical missions for which these systems will be applicable during the period 1967-1975 are propulsion for:

(a) Vernier corrections of satellite orbits and space vehicle trajectories.

(b) Interorbital transport of large payloads from low orbits to higher orbits about the Earth.

(c) Transport of large payloads from low orbits about the Earth to low orbits about the Moon.

(d) Manned and unmanned interplanetary and deep space probes.

The three major types of electric propulsion systems which are presently under investigation are the arc-jet, the ion jet, and the magnetohydrodynamic (MHD or plasma) jet. At the present time, basic research, development, and flight programs are under way to establish

the feasibility of the three types. The arc jet will be developed to an operational status in the 30 to 60 kilowatt size. After the development of the 30 kilowatt ion and plasma types, it should be possible to determine which of these two types merits development in the megawatt size. Should a marked superiority of one of these types become evident, it is likely that only one type will be developed in the megawatt size.

FUNDING REQUIREMENTS:

ADVANCED RESEARCH

	1961	1962	1963
Ion Rocket Engine Research			
Ion Generation and Acceleration	$1,119,000	$1,552,000	$2,346,000
Propellant Research	229,000	385,000	890,000
Beam Neutralization	384,000	473,000	1,108,000
Arc-Jet Research	573,000	798,000	1,184,000
Plasma-Jet Research	1,307,000	1,658,000	4,008,000
General Research			
Propellant Feed Systems	321,000	847,000	1,190,000
High Vacuum Research	275,000	388,000	584,000
Mission Analysis	367,000	558,000	888,000
Total	$4,575,000	$6,659,000	$12,198,000

ION ROCKET ENGINE

The propulsion principle of the ion rocket engine is based on the acceleration of charged particles. New knowledge is continually necessary to improve the materials, techniques and equipment for developing, testing and extending the operating life time of electric engines and their components. Some of the major problems requiring active research are higher temperature materials, larger ion sources, surface ionization, sputtering, secondary emission, voltage breakdown, high temperature insulators, and propellant selection and flow. A program of advanced research in these areas is essential to provide the information for advanced technical development and the propulsion systems which will operate the spacecraft for future flight missions.

Ion Generation and Acceleration

In order to realize the potential performance of electric propulsion systems, the ionization and acceleration components must operate as efficiently as possible. Research is underway on materials, designs and concepts for such systems. Individual investigations include study of contact ionization, catalytic ionization, and production of high intensity electrostatic fields.

Propellant Research

Cesium is currently used as a propellant for ion engines because it is easily and efficiently ionized and has desirable physical properties. However, cesium is a scarce and expensive element. Many other materials have been considered and investigated. One type of propellant material of interest is a colloidal suspension. The suspension is capable of being readily sprayed and can be given an electrostatic charge and thus would be promising as a propellant. However, to date, it has not been possible to impart a large enough charge to the spray droplets, nor are the physical properties of the suspensions compatible with the system requirements. Research on colloidal suspensions, as well as on other promising materials, will continue in FY 1963 with the funds requested.

Beam Neutralization

An ion engine develops thrust by the acceleration and expulsion of positively charged ions. The ions are accelerated by a negatively charged electrostatic field. The ions must be neutralized with electrons when they have attained maximum velocity or they will slow down and remain in the electrostatic field. Continuing research in FY 1963 is necessary to provide data and new concepts to insure efficient and reliable operation of future ion engines in the space environment.

ARC-JET RESEARCH

The propellant of an arc jet is a plasma (electrically-neutral ionized gas) generated by a high temperature electric arc and accelerated through a jet nozzle. Research funded in FY 1961 and FY 1962 has made it possible to begin development of an experimental engine for flight tests. However, continuing research with funds requested for FY 1963 is necessary on high temperature materials for electrodes and nozzles, electrode erosion, nozzle cooling, and propellant distribution and flow in order to improve the efficiency and performance of future arc-jet engines.

PLASMA JET RESEARCH

In the plasma, or MHD jets, the plasma is produced from the propellant by a high-energy, low temperature, electrical discharge accelerated by a high-intensity magnetic field. Research support of this kind of electric propulsion includes studies on sputtering, secondary emission, voltage breakdown, and efficient low weight production of high intensity magnetic fields. A variety of configurations and concepts for utilizing MHD propulsion are being studied in FY 1962. From these studies, one or more concepts will be selected and a feasibility demonstration program will be initiated in FY 1963.

GENERAL RESEARCH

This effort is to support research on problems common to all systems.

Propellant Feed Systems

The propellant feed system for electrical rockets includes propellant tanks, propellant heaters, pumps and pipes. Research to support the development program includes corrosion resistant high temperature material research, pump system technology, and heat transfer data and mechanisms.

High Vacuum Research

Since the electric propulsion systems will be designed to operate only in the space environment ground facilities which simulate space conditions must be used in conducting research on these systems. One of the problems faced is the simulation of the almost perfect vacuum in space. Concepts, such as very low temperature condensers and chemical reactions of the gas molecules, are being investigated as methods for retaining as perfect a vacuum as possible in a ground-based facility while testing an operating propulsion device.

Mission Analysis

Analysis of future applications for electric propulsion systems is necessary to determine configurations and operational requirements for future systems. Identifying key problem areas is a prerequisite for orienting the necessary research effort.

ADVANCED TECHNICAL DEVELOPMENT

	1961	1962	1963
Prototype Development			
1 and 30 KW Arc Jet Engines..	$ 614,000	$1,500,000	$2,000,000
30 KW Ion Engine.....	$ 610,000	$2,300,000	$4,975,000
Advanced Systems and Components.....	$ 980,000	$1,970,000	$3,750,000
Total	$2,204,000	$5,770,000	$10,725,000

Arc-Jet Engines

Two sizes of arc-jet engines are currently under development. The 1 kilowatt attitude control system is planned for flight evaluation in FY 1963 on a Scout vehicle using battery power. It can be powered by solar or SNAP-type power units when they are available. This system is expected to be available for application by 1965. The 30 kilowatt arc-jet engine is the first electric propulsion engine under development that will have operational use for prime propulsion of a spacecraft, with the capability of providing propulsion for orbit changes, such as raising a spacecraft from a 300 mile orbit to a 24 hour orbit. It is planned that

this engine will be tested late in FY 1963 or early FY 1964 with a battery system supplying the power.

30 KW Ion Engine

The development of the ion engine for operational use is predicated upon a successful feasibility demonstration at the 30 kilowatt power level. In order to test the feasibility of the concept, a very low thrust flight experiment will be flown in FY 1963. Further exploratory work on ion systems will be continued.

Advanced Systems and Components

Funding in this area is required to improve the materials, techniques and equipment for developing, testing and extending the operational life of electrical engines and their components. Some of the major problems involve higher temperature materials, larger ion sources, propellant selection and flow, parallel operation of engines, and techniques for the best utilization of various type electrical engines in conjunction with other propulsion systems. Continuing effort at an accelerated pace is requested for FY 1963 to support the advancement in technology necessary in order to have the propulsion systems which will operate future spacecraft.

FLIGHT PROGRAM

	1961	1962	1963
Test and Evaluation Support.....	$385,000	$ 759,000	$1,424,000
Flight Packaging.....	$ --	$2,893,000	$3,800,000
Flight Vehicles.....	$ --	$1,500,000	$2,500,000
Total	$385,000	$5,152,000	$7,724,000

FLIGHT TEST PROGRAM

The electric propulsion flight test program is aimed toward studying those problems which cannot be studied in ground facilities, in addition to conducting various tests required to demonstrate component or system feasibility and reliability in a space environment. These experiments are planned to verify or correct the performance obtained in ground facilities so that development of components and systems in ground facilities can proceed with confidence.

FY 1962 funds provided for two Scout vehicles and associated electric propulsion experiments. These tests are to investigate the ion beam neutralization problem which cannot be demonstrated in ground facilities. The first vehicle will carry two small thrust ion engines on a ballistic path to investigate this problem with the second vehicle as a back-up. If the first test is fully successful, the second vehicle is to carry a 1 kilowatt arc-jet to demonstrate its feasibility in a space environment, or a higher thrust ion engine to study the scaling effects on the

neutralization problem. The engine selected will depend on the results of the first test. FY 1963 funds provide the required amount to complete these tests.

FY 1963 funding also provides for two additional Scout vehicles and flight experimental payloads to investigate the feasibility of using ion or arc-jet engines for satellite missions having a station keeping requirement.

Funds provided for FY 1962 and funds in the FY 1963 request provide electric engines for use in the SNAP-8 project.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

FISCAL YEAR 1963 ESTIMATES

LIQUID PROPULSION

SUMMARY OF REQUIREMENTS:

	1961	1962	1962 Supplemental	1963	Page No.
1,500,000 pound thrust engine...	$ 50,849,000	$ 56,798,000	---	$ 55,316,000	RDO 18-3
200,000 pound thrust hydrogen-oxygen engine...	18,574,000	37,885,000	---	38,732,000	RDO 18-5
1,000,000 pound thrust hydrogen-oxygen engine...	---	---	$26,000,000	55,316,000	RDO 18-7
Analysis and experimental systems and component development.....	3,303,000	9,218,000	---	13,738,000	RDO 18-9
Total.....	$ 72,726,000	$103,901,000	$ 26,000,000	$163,102,000	

OBJECTIVES:

The purpose of the Liquid Propulsion program is to develop liquid propellant rocket engines of improved reliability and performance to support launch vehicle development; to anticipate requirements for space operations involving rendezvous between vehicles, lunar orbiting and landing operations, and long duration flights to planets or deep space; and, further, to undertake the required advanced design and experimental investigations so that the basic technology will be available when specific equipment developments are needed.

JUSTIFICATION:

Since one of the NASA objectives in space exploration is manned operation in space, improved propulsion systems of greater thrust, improved reliability, better performance, and lower cost will be required. The Liquid Propulsion Program is oriented to the development of a small number of reliable, appropriately-sized engines to meet these requirements. Supporting this effort is the propulsion technology for spacecraft that will provide a technological base for the propulsion developments necessary to carry out space exploration missions planned by NASA for the next decade.

NASA is currently engaged in the development of three major new engines to support the launch vehicle requirements for the manned lunar exploration mission. These are the 1,500,000 pound thrust RP-1-oxygen engine (F-1), the 200,000 pound thrust hydrogen-oxygen engine (J-2) and a 1,000,000 pound thrust hydrogen-oxygen engine (M-1). The latter engine is being undertaken in FY 1962 to meet the requirements of the NOVA vehicle. Also provided, as a continuing effort, is a program of analysis and experimental development to provide design specifications and to demonstrate the practical application of advanced design concepts for spacecraft propulsion.

F-1 Engine

The 1,500,000 pound thrust engine will be clustered to provide the high thrust required in the Advanced Saturn and NOVA vehicles to launch manned spacecraft and to conduct manned lunar explorations. Development of the engine is being performed by Rocketdyne, a Division of North American Aviation, Inc., under the technical direction of the Marshall Space Flight Center. Engineering design and fabrication are accomplished at the Rocketdyne Plant in Canoga Park, California. Component test operations are conducted in the Santa Susana, California facility of Rocketdyne and engine tests are run on test facilities provided at Edwards Air Force Base in California. The current development program is scheduled to complete preliminary flight rating tests of the engine during 1963. These tests will be followed by a continuing improvement program leading to engine qualification for launch vehicle use during 1965.

J-2 Engine

The 200,000 pound thrust hydrogen-oxygen engine is a high specific impulse rocket engine that will be used in upper stages of advanced vehicles. It is specifically planned for use in the second and third stages of the Advanced Saturn configuration and in the third stage of the NOVA vehicle. The 200,000 pound thrust engine project is also being produced by Rocketdyne under the technical direction of the Marshall Space Flight Center. The development program is scheduled to complete preliminary flight rating tests in 1963, with qualification of the engine during 1964.

M-1 Engine

The 1,000,000 pound thrust class liquid hydrogen-liquid oxygen engine will be developed primarily for the NOVA second stage. The M-1 engine will make it possible to accomplish manned lunar landing and return without refueling in the space environment. In the absence of such an engine, it would be necessary to resort to multiple clustering of smaller engines in the NOVA second stage, thus forcing a compromise between a smaller number of engines (with sacrifice in payload capability) and a larger number of

engines (resulting in increased system complexity and jeopardy to system reliability). The contractor, when selected, will perform engineering design and development leading to early accomplishment of a preliminary flight rating test and qualification for use in manned missions. As in the case of the F-1 and J-2 engines, M-1 development and test effort will be under the technical direction of the Marshall Space Flight Center.

FUNDING REQUIREMENTS:

	1961	1962	1962 Supplemental	1963
1,500,000 Pound Thrust Engine (F-1)				
Design.....	$535,000	$468,000	---	$442,000
Component Development.....	21,232,000	11,357,000	---	8,408,000
Component Test....	5,509,000	9,619,000	---	10,465,000
Engine Development.....	13,353,000	13,132,000	---	12,537,000
Engine Test.....	2,631,000	10,271,000	---	10,631,000
Fabrication and Test Equipment..	4,736,000	5,032,000	---	4,536,000
Propellants.....	2,853,000	6,557,000	---	8,297,000
Propellant Transport Equipment..	---	362,000	---	---
Total, 1,500,000 Pound Thrust Engine.....	$50,849,000	$56,798,000	---	$55,316,000

The development of the 1,500,000 pound thrust engine has progressed through design and component development to operation of the engine for long duration and rated thrust. The first full-scale engine run was made in August 1961 at reduced thrust. In December 1961 the engine was operated at full thrust. A major phase of engine system design effort, which began in FY 1959, will terminate in FY 1963 with the completion of the preliminary flight rating tests; engineering effort will continue thereafter for full engine qualification, reliability improvement, product improvement, and support of flight programs. Engines funded under the respective vehicle development programs, will be delivered for use in vehicle development programs in the first half of 1963.

Design

Component engineering design and the integration of individual components into a complete system is the primary objective. Emphasis during 1963 will be directed towards detailing the engineering modifications that have resulted from vehicle application studies, from newly acquired fabrication techniques, and from engine test results.

Component Development

During FY 1963, design, fabrication, and test of the individual engine components will continue. Development costs will include engineering supervision, purchase of materials, tooling for shop support, and fabrication labor and supervision. Incorporation of desirable component modifications, as indicated by vehicle design and application studies, will also be included.

Component Test

Every major engine component is tested experimentally in accordance with a planned series of tests that is continued throughout the life of the engine development program. Major engine components include the thrust chamber turbopumps, the gas generator, and the engine valves and controls.

Engine Development

During FY 1963 development testing will be conducted on 10 engines completed in FY 1962 and 12 additional engines completed in FY 1963. To insure that engine development schedules do not lag, it will be necessary to provide, in addition to the fabricated engines, an inventory of test hardware to rebuild engines damaged or worn as a result of test operations. Long lead-time hardware items must also be purchased in anticipation of the engine qualification test.

Engine Test

The complete engine test program will be conducted at Edwards AFB, California, on Test Stands 1A and 1B. Funding covers not only test runs, but also the data reduction, test data analysis, and preparation of engineering reports required to support the test effort.

Fabrication and Test Equipment

The cost of special instrumentation, fabrication machinery, and tooling required for manufacturing and testing of the engine and its components is provided in this area. The specific items that must be covered are gauging and inspection equipment, systems handling jigs, transportation equipment, instrumentation, and expendable materials for the tests. In addition, funds must be provided for replacement of equipment items rendered unsuitable by wear, deterioration, or obsolescence.

Propellants

Approximately 150,000 tons of liquid oxygen, 50,000 tons of liquid nitrogen and 10,000,000 gallons of kerosene will be needed for FY 1963. Propellants will be procured through Air Force procurement channels and will be used to accomplish engine component and systems testing.

FUNDING REQUIREMENTS:

	1961	1962	1962 Supplemental	1963
200,000 Pound Thrust Hydrogen-Oxygen Engine (J-2)				
Design.....	$725,000	$451,000	---	$353,000
Component Development..	5,467,000	6,779,000	---	4,763,000
Component Test.....	1,125,000	6,431,000	---	6,086,000
Engine Development.....	609,000	5,169,000	---	6,861,000
Engine Test.....	---	4,596,000	---	7,524,000
Fabrication and Test Equipment.....	6,315,000	6,926,000	---	4,072,000
Propellants.....	4,333,000	7,533,000	---	9,073,000
Total, 200,000 Pound Thrust Hydrogen-Oxygen Engine.....	$18,574,000	$37,885,000	---	$38,732,000

The 200,000 pound thrust hydrogen-oxygen engine was initiated in September 1960 and is being developed on a time schedule which will bring it to preliminary flight rating tests at approximately the same time as the 1,500,000 pound thrust engine. The major part of the FY 1962 funding was devoted to development testing of the engine components. The first engine test is scheduled for February 1962. The major emphasis in FY 1963 will be in the engineering design, fabrication, and testing of engines leading to completion of the preliminary flight rating tests in late FY 1963. Thereafter testing to full thrust and duration will be continued toward the objective of developing an upper stage engine of very high reliability. The present development contract with Rocketdyne extends beyond the preliminary flight rating tests to include development and testing for the purpose of qualifying this engine for use in manned vehicle systems.

Design

During FY 1963, the design effort will be directed toward refinement of design improvements resulting from the engine test program. Inasmuch as the 200,000 pound thrust engine is approximately the same size as several missile engines that have been developed by the contractor and since the fuel pump is similar to that being developed for Project Rover, a relatively nominal effort is required in this area.

Component Development

Major components include engine controls and valves, the rocket chamber assembly, the gas generator, and the individual oxidizer and fuel turbopumps. The development of these components involves engineering, procurement of materials, and the fabrication of components and sub-assemblies for the complete engines.

Component Test

Component testing is required to identify and eliminate design and fabrication deficiencies to achieve maximum reliability and performance of components prior to their incorporation in the complete engine system. To meet this requirement, funds must be made available for materials other than propellants; for test engines and labor; procurement and maintenance of general and special test equipment; data acquisition; and, finally, for the preparation of engineering reports.

Engine Development

In FY 1963 activity in this area will increase measurably as the development effort reaches its peak. Major funding items are: engineering, purchase of materials, fabrication, assembly, inspection, final checkout, and the creation of engineering models and mock-ups.

Engine Test

Testing will begin during FY 1962 and will continue at an accelerated rate into FY 1963. These engine tests consist of experimental test runs to prove reliability and performance, and to detect and eliminate system design and construction faults that cannot be detected during the component test phase. Funding for these test operations includes costs of engineering and test crews, special test equipment, transportation, data reduction and analysis, and the preparation of final reports.

Fabrication and Test Equipment

Procurement of special fabrication, assembly and testing equipment and the associated tooling and jigs is required to support the combined development and test effort during FY 1963. As the development program progresses, it will be necessary to provide funding in this area, not only for maintenance and replacement costs, but also for tooling to produce deliverable engines in quantity for the vehicle program.

Propellants

The increased test effort in FY 1963 will result in a commensurate increase in propellant requirements. Liquid hydrogen (approx. 7,000 tons) will be obtained from commercial sources and liquid oxygen (approx. 25,000 tons) will be purchased through Air Force channels.

FUNDING REQUIREMENTS:

	1961	1962	1962 Supplemental	1963
1,000,000 Pound Thrust Hydrogen-Oxygen Engine (M-1)				
Design.....	---	---	$1,000,000	$885,000
Component Development..	---	---	7,000,000	9,072,000
Component Test.....	---	---	5,500,000	9,957,000
Engine Development.....	---	---	3,500,000	11,063,000
Engine Test.....	---	---	---	7,744,000
Fabrication and Test Equipment.....	---	---	7,000,000	3,319,000
Propellants.....	---	---	2,000,000	13,276,000
Total, 1,000,000 Pound Thrust Hydrogen-Oxygen Engine.....	---	---	$26,000,000	$55,316,000

Since the M-1 engine is an entirely new development, it constitutes a critical lead-time element in the NOVA development schedule. The supplemental funds requested in FY 1962 will provide for the early initiation of the program effort needed to insure availability of a reliable engine to meet the NOVA program schedule requirements. FY 1962 funds will be used primarily to provide necessary fabrication and test equipment and to design and develop engine components. During FY 1963 component work will be continued and testing of the full-scale engine will be initiated.

Design

Since the M-1 engine is in the initial stage of development, the engineering components and the integration of components into the complete engine system constitute an important aspect of the development program in both FY 1962 and FY 1963.

Component Development

The development of the engine components and sub-assemblies will be performed concurrently with the design effort and is comprised of engineering, procurement of materials, and the necessary fabrication and shop support.

Component Test

Experimental testing will be conducted on each major engine component; this will be continued throughout the development life of the engine. Funding during FY 1963 will include the costs of test materials, test labor and supervision, data reduction and analysis, and the preparation of engineering reports.

Engine Development

This funding covers the engineering and fabrication of the complete engine system including the cost of materials, engineering, shop supervision, fabrication, assembly and inspection, and quality control.

Engine Test

Initial testing of the full-scale engine will be undertaken during FY 1963. These engine tests are of an experimental nature and consist of complete engine assembly runs to detect and eliminate design and construction faults that were undetected during the component test phase. Funding for this operation includes the cost of engineering and test crews, special test equipment, transportation, data reduction and analysis, and the preparation of reports.

Fabrication and Test Equipment

Fabrication and test equipment covers the cost of special instrumentation, necessary fabrication machinery, and special tooling required for manufacturing and testing of individual components and the complete engine system. Specific items include gauging and inspection equipment, systems handling jigs, transportation equipment, and the various instrumentation and expendable materials utilized during the testing phase.

Propellants

Procurement of propellants in FY 1963 will provide for approximately 10,000 tons of liquid hydrogen and 40,000 tons of liquid oxygen.

FUNDING REQUIREMENTS:

	1961	1962	1962 Supplemental	1963
Analysis and Experimental Development				
Launch Vehicle Engines.....	$ 1,156,000	$ 4,213,000	---	$ 7,899,000
Spacecraft Engines	2,147,000	5,005,000	---	5,839,000
Total, Analysis and Experimental Development	$ 3,303,000	$ 9,218,000	---	$13,738,000

To ensure that the required developmental capabilities will exist when needed, it is necessary to continue an aggressive analysis and experimental development program in anticipation of the requirements for booster and space propulsion. A second important benefit is the minimization of costly "quick fixes" which are inevitable if the required engineering foundations have not been established before development programs are undertaken.

Launch Vehicle Engines

Among the most promising advances that can be made in this area are those that develop integrated system design concepts. Investigations undertaken in FY 1961 and FY 1962 have shown the desirability of utilizing rigidly mounted engines employing "unconventional" nozzles. These nozzles are conceptually different from those used today and they are amenable to a variety of configurations which can be tailored to result in an improved engine-vehicle system. Feasibility work, involving both hot and cold testing at suitable scales, must continue in FY 1963 in order to evaluate definitively the capabilities of these improved designs and to make it possible to bring them to early use.

Another promising technique that is applicable to conventional engines as well as to the new designs is the utilization of higher combustion chamber pressures. This utilization would result in reduced engine size and in increased performance per pound of burned propellant. In FY 1962 investigations were initiated to uncover potential difficulties associated with high pressure operation. The major problems under consideration for FY 1963 are those associated with transients in the combustion process, high pressure pumping with rotating type compressors, and heat transfer in the engine chambers and nozzles.

In FY 1962 work was initiated to resolve some of the major areas of engine operating reliability problems. Among the most pressing problems is that of system leakages. Determination of fault characteristics and the influence of the extreme operating environments, currently underway, is already leading to new design and installation criteria for rocket engines.

Spacecraft Engines

The advanced design and development projects of FY 1961 and 1962 provided rapid progress in determining propulsion and operational requirements for various missions and in relating the capabilities of known concepts and technologies to spacecraft engines. Also, refined concepts regarding propellant pressurization systems, positive expulsion devices, pressurized storage, chamber cooling, chamber construction, controllable injectors, large area ratio nozzles, control and shut-off valves, static and dynamic seals and other components were evolved.

Work is planned in FY 1963 to evaluate and prove the feasibility of these refined approaches. Integration of certain components into sub-systems must also be carried out to permit the experimental evaluation of compatibility. The sub-systems which will require investigation are those needed for spacecraft engines that will provide trajectory adjustments, rendezvous and extra-terrestrial landing. Similar work must also be undertaken on new concepts for small, highly reliable, long-life propulsion devices that are capable of repeatedly delivering accurate impulses for the attitude control of spacecraft.

Investigations to determine the effects of space environment on the storability of propellants, on engine components and on engine operation have been proceeding. These are now pointed at the development of practical insulating materials for the storage of cryogenic materials in space and at the development of suitable micrometeorite protection devices. Work in this area is a continuing effort which is constantly oriented and intensified as new information on space environment becomes available.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

FISCAL YEAR 1963 ESTIMATES

SOLID PROPULSION

SUMMARY OF REQUIREMENTS:

	1961	1962	1963	Page No.
Systems and Components Development.....	$1,899,000	$4,297,000	$7,944,000	RDO 19-2
Total.....	$1,899,000	$4,297,000	$7,944,000	

OBJECTIVES:

The purpose of the Solid Propulsion program is to develop the solid propellant rocket motors and systems that may be required for space missions, and to establish advanced designs, concepts, and materials for improving performance and reliability of solid rocket motors and components.

JUSTIFICATION:

The solid propulsion program is directed toward the application of the inherent virtues of solid rockets to the space missions. These desirable characteristics, already applied in weapons systems, are simplicity, reliability, relative ease of handling and use, and long storage life with continuous readiness for operation.

The program has two main categories: those tasks that support a possible solid propellant booster stage of a launch vehicle for the direct lunar ascent, and those that support space propulsion systems first used after long-term exposure to the space environment. In the first category, the special vehicle problems associated with the use of the very large solid propellant stage must be defined. Special systems, such as an abort warning system analogous to those available for liquid booster stages, must be defined and developed. Optimum component design and fabrication methods must be investigated. The satisfactory integration of solid propulsion elements into the complex lunar launch vehicle requires a vigorous attack on these and similar problems by the National Aeronautics and Space Administration. The Department of the Air Force has been assigned development responsibility for the large solid motor which may be used in a solid stage vehicle for manned space flight.

In the second category of space propulsion, the potential ability of solid propellant systems to withstand prolonged exposure to space

environment must be verified, and high performance motors for possible lunar or planetary retro or takeoff use must be demonstrated in prototype form.

FUNDING REQUIREMENTS:

Systems and Components Development	FY 1961	FY 1962	FY 1963
Mission, Motor and System Studies	$ 306,000	$ 457,000	$ 953,000
Solid Motor Feasibility Demonstration	921,000	1,968,000	2,065,000
Motor Subsystem Investigations	380,000	936,000	2,383,000
Components and Materials	---	312,000	1,907,000
Storage and Environment Effects	292,000	624,000	636,000
Total Systems and Components Development	$1,899,000	$4,297,000	$7,944,000

During FY 1962, effort is being directed primarily to complete feasibility demonstration of a large solid propellant booster motor started in FY 1961, and to advance the technology by which greater performance and reliability of solid propulsion systems may be realized. Examples are propellant chemistry, nozzle design and fabrication, inspection techniques, case fabrication, and propellant-case bond.

In FY 1963, the technology effort will be continued with specific emphasis on the requirements of the manned lunar landing program. Particular attention will be given to the development of higher specific impulse propellants, thrust modulation techniques, and "stop-start" capabilities needed for spacecraft application.

Mission, Motor and System Studies

This work is analytical in nature, although it may lead to feasibility demonstrations and/or to specific development tasks. It defines the missions to which solid motors are applicable, establishes specific motor and system design characteristics, and investigates special problems resulting from or accompanying the use of solid propellant motors, for example, the effect of high acoustical energy level produced by a solid stage on the remaining stages.

Solid Motor Feasibility Demonstrations

The purpose of this effort is to demonstrate the feasibility and applicability of solid propulsion systems for the space propulsion requirements of lunar and planetary missions by the development of reasonably-sized prototype motors. Also included is the development of data relating to the interaction of solid motors or stages with other elements of the system, in order that satisfactory integration of solid components into vehicles can be assured. Effort will be expended to establish the hazard conditions associated with the use of solid motors, and to support investigations for improving overall reliability of the vehicle system.

Motor Subsystem Investigations

The tasks in this area cover the investigation of major elements of solid propulsion systems for the purpose of increasing reliability of the total system, improving performance, or meeting requirements not adequately satisfied by the existing state of knowledge. Each subsystem contains a number of individual devices and components, and a major purpose for these investigations is to demonstrate satisfactory functioning of the subsystems under environmental conditions closely simulating the end use. A typical example is the vector control subsystem for the possible solid propellant booster stage of the Nova launch vehicle. Here special nozzles, seals, torque elements, feedback instruments and power supply must be demonstrated together to form a complete vector system.

Components and Materials

Effort in this area will investigate structural materials with characteristics which have not previously been evaluated under the conditions established by the propulsion requirements of manned missions.

Storage and Environment Effects

These tasks will establish the ability of solid motors to remain effective after exposure to space environment for the time periods required by the lunar and planetary missions, and will determine remedial measures if necessary.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

FISCAL YEAR 1963 ESTIMATES

SPACE POWER TECHNOLOGY

SUMMARY OF REQUIREMENTS:

	1961	1962	1963	Page No.
Advanced Research	$3,938,000	$4,885,000	$6,934,000	RDO 20-2
Advanced Technical Development	4,975,000	9,759,000	13,238,000	RDO 20-4
Total	$8,913,000	$14,644,000	$20,172,000	

OBJECTIVES:

The objective of this program continues to be the development of the technology of generating electrical power from solar and chemical energy sources for use in space vehicles.

JUSTIFICATION:

All space vehicles are critically dependent upon their electrical power systems for the power to operate instruments, communications equipment and other equipment. Solar cells and batteries have been successful in meeting these needs to date. However, these devices have limitations and disadvantages which make them undesirable for some of the more advanced spacecraft. It is, therefore, necessary that other promising concepts such as solar heated systems using turboelectric or thermionic power converters, chemical combustion auxiliary power systems, and fuel cells for energy conversion or energy storage be developed. Such characteristics as higher reliability, lighter weight, longer life, radiation resistance, lower cost and higher power capability are the objectives.

FUNDING REQUIREMENTS:

Advanced Research	1961	1962	1963
Solar Cell Research	$1,090,000	$1,534,000	$2,300,000
Fuel Cell Research	250,000	665,000	900,000
Thermionic Conversion	700,000	970,000	1,200,000
Solar Concentrators	400,000	600,000	750,000
Distribution and Control Technology	253,000	300,000	384,000
Magneto fluid dynamic power generation	300,000	450,000	500,000
Battery Research	---	100,000	400,000
Thermal Energy Storage	400,000	266,000	500,000
Thermal Radiation Properties	545,000	---	---
Total	$3,938,000	$4,885,000	$6,934,000

Solar Cell Research

Because of the inherent simplicity of solar cells and their excellent performance in the past, it is anticipated that solar cells will continue to be very important indefinitely. However, major problems have been encountered in such areas as performance degradation caused by the high energy electrons and protons of the Van Allen belts and solar flares, high cost and weight. More efficient solar cells would therefore be desirable. In FY 1963, the extensive theoretical and experimental program on radiation damage initiated in FY 1962 will continue, in conjunction with efforts to develop radiation resistant solar cells and other static devices for the direct conversion of solar energy to electricity. A large effort will be directed toward the development of low cost solar cells using thin film techniques or other processes which can be automated. Reduced expenditures for solar cells in flight programs, as well as higher reliability should result from this program.

Fuel Cell Research

Fuel cell research offers the possibility of direct and highly efficient conversion of chemical energy or heat to electricity in a static system with a minimum of moving parts. This technology should reduce system weight, improve reliability, and permit the construction of higher power systems than are possible with present methods. For certain missions such as manned flights, the elimination of the requirement for orientation of the spacecraft to the sun and the availability of by-products such as water for crew consumption or equipment cooling are attractive features.

Thermionic Conversion

Thermionic conversion, the direct conversion of concentrated solar energy to electricity by a static device, is advantageous due to its

radiation resistance and small radiator. A broad in-house program as well as work with industry and universities is expected to provide the theoretical understanding of this process and solve the materials and fabrication problems associated with high efficiency and long life of thermionic conversion devices. Past research has indicated that tantalum, molybdenum, tungsten, and uranium carbide are possible materials for use as cathodes. In FY 1963, research will emphasize studies on the vaporization rates of these materials and on the effect of cesium vapor (used for reduction of space charge effects) on the vaporization rates. Research on the use of ion injection and auxiliary electrodes will be continued.

Solar Concentrators

In order to make use of the abundant and free energy from the sun which is of too low an energy density for current conversion techniques usable in space projects, large parabolic mirrors are being developed to concentrate this energy. However, the problems of fabricating such mirrors, the materials to be used, the construction of forms for shaping these materials and the methods for erecting large, light weight, geometrically accurate surfaces in space and orienting them toward the sun must be solved. In addition, further study is needed to make such mirrors light in weight, radiation resistant and of long life. Studies already under way on inflatable, foamed plastic and rigid, honeycomb structures will continue in FY 1963.

Distribution and Control Equipment

A useful power system must contain more than a device for generating electric power. For example, equipment must be provided to change the raw output power to the voltage and/or frequency required by the load, to control the dynamic behavior of the system and to protect the system from dangerous abnormal conditions. Advanced research on improved methods of providing these functions will be pursued in FY 1963 as part of this program with particular emphasis on developing methods to efficiently and reliably convert low voltage d.c. power (the raw output of most of the converters of interest) to power at useful voltages.

Magneto Fluid Dynamic Power Generation

Research in this area is prompted by the potential high efficiency and absence of moving parts for "MFD" generators. It is believed that an "MFD" generator could be used in conjunction with a conventional turbine for efficient, light weight power generation, particularly where high power and relatively short life are the requirements. Studies are required on the plasma properties, electrode processes and design optimization. Basic research in magnetofluiddynamics has been in progress

for several years (i.e., fusion research) and recent research on power generation has been able to advantageously use much of the available technology. Projected research in FY 1963 will stress high-temperature containment materials, plasma physics and the generation of high magnetic fields.

Battery Research

Batteries are of fundamental importance to the space program both as primary energy sources for short duration and as rechargeable devices for energy storage in conjunction with other sources such as the solar cell. Research should continue, however, towards lighter weight, higher reliability, and longer life. Studies to provide a better understanding of the causes of self discharge, polarization, and other conditions, in addition to advanced experimentation with electrochemical cells offering lighter weight should be conducted for future application. Major research emphasis has been on high energy density systems such as cadmium-silver oxide and zinc-silver oxide in battery structures to solve problems of temperature. The FY 1963 effort will continue this work in close cooperation with the Department of Defense.

Thermal Energy Storage

For many potential applications of solar heated power converters, such as thermionic converters, means must be provided for storing energy within the system so that operation is not interrupted due to the spacecraft being eclipsed by earth or the moon. For example, heat can be stored at appropriate temperatures by melting chemical compounds, such as magnesia, which will release their heat of fusion at constant temperature on freezing. Work will continue to identify suitable materials for this purpose and to solve the problems associated with their containment. Studies and experiments are required which will provide the necessary information on thermal properties such as conductivity, thermal expansion, heat of fusion, and melting and freezing heat transfer characteristics before this technology can be applied to an experimental system.

Advanced Technical Development	1961	1962	1963
Solar Cell Technology.....	$ 540,000	$ 600,000	$ 500,000
Fuel Cell Technology.....	500,000	850,000	750,000
Solar-Thermionic Power.....	---	900,000	1,000,000
Solar Concentrator Development.	100,000	1,030,000	1,150,000
Distribution and Control Equipment.....	535,000	950,000	1,688,000
Thermoelectric Power Conversion.....	225,000	390,000	600,000
Battery Improvement Program....	475,000	839,000	1,300,000
Dynamic Power Conversion.....	2,600,000	4,200,000	6,250,000
Total.....	$ 4,975,000	$ 9,759,000	$13,238,000

Solar Cell Technology

Continuing activity in this area will be concerned with reducing the weight and cost and improving the reliability of solar cell power supplies. Methods to be used include the concentrating of solar panels so that the reflective surface is an integral part of the panel structure in order to increase the solar intensity impinging on the solar cells thus resulting in more power output per solar cell. Work on improved assembly techniques for solar panels using welding in place of soldering where possible, improved thermal coatings for lower cost, lighter weight and higher reliability will be pursued.

Fuel Cell Technology

Prototype system development to solve hardware problems and investigate long life and reliability problems are the objective of this project. Some types of fuel cells which have developed sufficiently to be nearly ready for flight use will be emphasized. One type involved will be regenerative hydrogen-oxygen cells which may be used as replacements for batteries in solar power systems and in primary systems with potential applications in manned vehicles. The development of auxiliary devices such as special pumps, controls, and water separators will be included. The selection of a fuel cell as the first choice for a power supply on manned lunar vehicles emphasizes the requirements for increased system development work.

Solar-Thermionic Power

A solar-thermionic development program was initiated in FY 1962. The continuation of the development of this prototype flight weight solar-thermionic power system, generating 1 to 5 kilowatts, will help solve engineering problems directly affecting life, reliability and weight problems. This project will provide valuable information on practical problems which must be solved in the development of the thermionic diode and the solar concentrator. It is anticipated that effort will also be conducted in integrating the thermal energy technology into a solar-thermionic power system.

Solar Concentrator Development

Work in this field is the technical development effort which complements the work on solar concentrators conducted under the Advanced Research program. Emphasis will be on the development of prototype mirrors using the materials and fabrication technology acquired under the research program. Early flight tests will be conducted to study deployment and orientation problems for light weight storable mirrors. An engineering experiment is being prepared for an orbital test to

determine the life time of various reflective surfaces in the space environment, with complementary additional laboratory experiments under simulated conditions.

Distribution and Control Equipment

An improvement in the reliability of converters and inverters is required because of numerous failures of this equipment. Funds are requested for FY 1963 for development of improved devices, circuits, packaging techniques, and testing methods. Effort will also be directed toward improved power control equipment such as battery charge controls, system protective devices, and switchgear development.

Thermoelectric Power Conversion

For certain applications, such as solar probes, power generation by thermoelectric conversion is highly desirable. It offers several important features such as radiation resistance, ability to operate in a high temperature environment and lower cost. In previous years emphasis has been directed toward materials research by government-sponsored research with limited engineering work done on the development of reliable, long life generators for space use. In FY 1963 funds for this project will provide for initiation of the required development effort to fill this need.

Battery Improvement Program

Although batteries have been used with some success in space vehicles, limitations of present hardware continue to be of concern. Efforts to solve technical problems associated with seals, separators and process control have been effective and must continue in FY 1963. Extensive work is planned in battery evaluation including life testing, qualification testing and detail failure analysis for use as a guide in further product improvements. Life tests are of particular importance as the results will bear directly on the margins of safety adopted, system weight, and reliability. Development of improved types of batteries with lighter weight and greater reliability will also continue.

Dynamic Power Conversion

In previous years technology has been developed in the extraction of power from heat by use of turbines and reciprocating engines. For higher power systems, dynamic conversion is advantageous because of its light weight and economy. The Sunflower 3 kilowatt auxiliary power system, for example, produces power, by concentrating solar energy with a parabolic mirror to boil mercury with the vapor being used in a closed system to drive a turbine connected to a generator. Under this project the technology of moderately large solar power systems is being developed in

anticipation of space vehicles requiring several kilowatts and up to one year's life.

Work will also be done on dynamic conversion of chemical energy through development work on engines for use with cryogenic fuels. Application of this technology will involve both relatively short missions requiring several kilowatts and missions where mechanical power is required for roving vehicles in future planetary probes.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

FISCAL YEAR 1963 ESTIMATES

NUCLEAR SYSTEMS TECHNOLOGY

SUMMARY OF REQUIREMENTS:

	1961	1962	1963	Page No.
Advanced Research.....	$3,902,000	$5,814,500	$15,327,000	RDO 21-2
Advanced Technical Development.....	20,750,000	43,000,000	73,690,000	RDO 21-6
Flight Programs.....	398,000	1,420,000	33,945,000	RDO 21-8
	$25,050,000	$50,234,500	$122,962,000	

OBJECTIVES:

The purpose of the Nuclear Systems Technology program continues to be the acquisition of the technology required for the development of nuclear rocket propulsion systems capable of carrying large payloads on space missions over extended time and distances, and the technology to develop nuclear electric power generating systems for application to electrical space propulsion or as auxiliary power sources in spacecraft.

JUSTIFICATION:

The accomplishment of advanced manned missions in space will require vehicles utilizing engines having greater specific impulse than is now thought possible with chemical rocket engines. Nuclear rocket engines using hydrogen as the propellant can meet this requirement. The application of a nuclear upper stage to large launch vehicles will increase vehicle payload capability significantly for extended missions (e.g. interplanetary flight). Conversely, a given payload can be carried by lighter and simpler launch vehicles, having fewer total stages, if a nuclear stage is incorporated. Depending upon the chemical vehicles available, certain space missions, requiring rendezvous if performed by all-chemical rockets, can be accomplished without rendezvous by the use of nuclear stages.

The current joint AEC-NASA program for the development of nuclear rockets is aimed at the design, development and testing of nuclear rocket reactors, engines, and flight test vehicles leading

to an initial series of flight tests in the 1966-1967 period. In FY 1963 the development and test of KIWI reactors will have reached the point where the full nuclear rocket engine (NERVA) development program, involving the procurement and testing of engine components, subsystems and complete systems will be expanded. Also in FY 1963, the major development effort leading to the flight test vehicle stage initiated in FY 1962, will be expanded. In addition to the effort aimed at the 1966-1967 flight test series, research, development, and test of an advanced reactor design will be included in the AEC-NASA program. Basic research in support of the entire nuclear rocket program will also be continued.

The nuclear electric generating systems portion of the program is directed toward the general advancement of the basic technology with specific application in demonstration of the feasibility of a long-life, compact, lightweight, nuclear turboelectric system (SNAP-8) at the 30 kilowatt power level. In addition, the technology required for the design and development of more advanced and higher power systems in the megawatt range will be supported. This advanced work will include work on turbogenerator and direct conversion systems.

FUNDING REQUIREMENTS:

Advanced Research	1961	1962	1963
Nuclear Propulsion			
Hydrogen Properties.....	$330,000	$400,000	$780,000
Radiation Effects.....	761,000	806,000	1,940,000
Dynamics and Control.....	120,000	280,000	1,276,000
Engine Systems and Components.....	810,000	980,000	2,471,000
Advanced Concepts.....	650,000	680,500	1,562,000
Power Generation			
Mechanical Component Research.....	416,000	728,000	1,810,000
Direct Power Conversion.....	215,000	520,000	1,540,000
Liquid Metal Research.....	290,000	670,000	1,720,000
Waste Heat Rejection.....	200,000	440,000	1,270,000
Advanced Concepts.....	110,000	310,000	958,000
Total.....	$3,902,000	$5,814,500	$15,327,000

NUCLEAR PROPULSION

Hydrogen Properties

Hydrogen is the propellant of most interest for the nuclear rocket because of the high specific impluse that results from its low molecular weight. Although hydrogen has been studied for many years, many of its physical and thermodynamic properties in the lidquid-gas state are not

sufficiently well known to design the optimum configurations for cooling passages, pumps, reactor heat exchangers, flow meters, rocket nozzles, and other components. A continuing research program in FY 1963 and subsequent years is, therefore, necessary to determine accurate properties, such as density-temperature relationships, transport properties, and dissociation and recombination rates. This research will also contribute to the NASA liquid propellant rocket engine development program (Centaur, 200,000 pound thrust, and 1,000,000 pound thrust engines).

Radiation Effects

In order to provide a proper technological basis for design and development of optimun systems compatible with a nuclear radiation environment, the following supporting research areas must continue to be investigated in FY 1963:

(1) Radiation damage to materials is of particular importance at cryogenic temperatures, because the temperature is too low for self-annealing of the materials. Present data are insufficient for design and development purposes.

(2) Radiation damage to specific major components must be studied; examples are stressed materials such as those in turbines and pumps, and guidance and control equipment. In addition, liquid propellant heating (critical with liquid hydrogen) due to radiation must be studied.

(3) Although much basic data on shieding is available, effort is required to simplify calculation techniques for the numerous combinations of materials, physical shapes, and design concepts.

Dynamics and Control

The entire flight system is subjected to acceleration forces varying from many times the force of gravity during launch to zero gravity during coasting periods; therefore the dynamic behavior of all components and the integrated system must be accurately known. Research is planned in FY 1963 to determine such phenomena as the dynamic behavior of liquid hydrogen in a zero gravity field and the resultant effect of heat transfer to the hydrogen.

Various possible methods of reactor start-up, engine start-up, and integration of reactor, engine and vehicle control systems must be investigated. Analog and digital computer simulation, plus physical analog using actual components where possible, will be used for this research.

Engine Systems and Components

Since nuclear rockets operate at conditions and with materials radically different from previous power plants, considerable basic research data are lacking for component design parameters to insure the development of efficient and reliable nuclear rocket systems. The heat flux to the nuclear rocket nozzle is much higher than has been previously encountered and studied. Therefore, basic heat transfer research provided by FY 1961 and FY 1962 funds is underway to determine heat transfer coefficients and transport properties of gases and liquids of most interest to the nuclear rocket program. Research is also underway on basic chemical and physical properties of various materials for these systems, and on the fundamental nature of pump cavitation and two-phase flow phenomena in liquid hydrogen. Continuation of these studies is provided for in the FY 1963 request.

Advanced Concepts

The performance of the heat transfer nuclear rocket will be limited by the temperature limitation of materials, particularly in the fuel elements. Research funded in FY 1961 and FY 1962 on several concepts, such as gaseous core, dust bed and fluid bed reactors, is being conducted in an attempt to overcome this limitation. Fundamental studies to assist in the determination of feasibility of these various advanced concepts include turbulent mixing of gases, heat transfer in two-phase flowing systems, and separation of gaseous mixtures. Other studies to improve the performance of the heat transfer rocket engine included advanced high-temperature materials research. The FY 1963 request provides for continuation of this research.

POWER GENERATION

The development of compact, lightweight, long-lived nuclear electric power generating systems is critical to achieving the performance potential of electrical propulsion systems and large space electrical power sources. The specific requirements are ten pounds or less total system weight for each kilowatt of electrical power delivered, with reliable operating life of well over a year and electrical power levels of a megawatt and higher. The method used to convert nuclear thermal energy to electrical energy may be either by Rankine cycle mechanical systems, such as those presently used in central power station plants, or by direct conversion thermionic devices.

Mechanical Component Research

The mechanical components of an advanced turboelectric system will be required to operate in the 1800 to 2500 degrees Fahrenheit temperature environment and for unattended periods of a year or more. These

components include compact heat exchangers, pumps, vapor separators, multi-stage turbines, and other auxiliary equipment. The performance requirements are well beyond present-day capabilities as typified by central power station design and current gas turbine practice. The FY 1963 request provides for research effort directed toward the accumulation of design information and the development of the technology required to build such components.

Direct Power Conversion

The direct conversion of reactor thermal energy to electrical energy without rotating machinery is an attractive approach for the development of high-powered systems. It appears that increased reliability and reduced system weight may result from the achievement of direct power conversion if long life and high efficiency can be achieved in these advanced systems. Continued studies in this area are included in the FY 1963 request.

Liquid Metal Research

Construction of advanced Rankine mechanical systems, as well as direct conversion systems, depends largely upon the development of high strength, refractory alloys capable of containing alkali metals in both the liquid and vapor state for long periods of time. Programs dealing with corrosion, erosion, heat transfer, and physical and metallurgical properties are continued in FY 1963.

Waste Heat Rejection

Unwanted excess heat from space electric power generating systems must be removed by radiation to space since there are no other cooling methods available in space vehicles. Radiator design is of major concern in the advanced nuclear electric systems since the radiator may comprise as much as sixty percent of the total system weight. Special problems include radiator deployment, zero gravity operation, micrometeoroid penetration, high temperature capability, emissivity, and multi-tube parallel flow and compatibility with liquid metals.

Advanced Concepts

Limitations in presently known power generation systems make it necessary to examine advanced concepts for possible utilization in nuclear space power systems. In FY 1963, these may include magnetohydrodynamic generators and fission fragment converters.

	1961	1962	1963
Advanced Technical Development			
Nuclear Propulsion			
Reactor Test Support.....	$4,495,000	$5,900,000	$5,500,000
Nuclear Rocket Engine Development.	2,300,000	18,000,000	36,000,000
System and Component Technology...	6,100,000	6,600,000	7,300,000
Propellants.....	2,105,000	2,700,000	12,500,000
Power Generation			
SNAP-8 Development.....	2,400,000	6,000,000	7,000,000
Megawatt System Design Studies....	50,000	200,000	710,000
Component Technology	3,300,000	3,600,000	4,180,000
Total.....	$20,750,000	$43,000,000	$73,690,000

Reactor Test Support

NASA has the responsibility for supplying and developing non-nuclear components for the reactor test program of the AEC. The nozzles and liquid hydrogen feed systems used by AEC in their conduct of the KIWI-B series of reactor tests have been and are being provided by NASA. In FY 1963, AEC will support development testing of reactors aimed at higher power-density reactor operation. NASA will continue to develop, and will deliver, nozzles capable of withstanding the higher heat fluxes involved in these tests. In addition, NASA will continue to develop, and will deliver, a liquid hydrogen turbopump with the increased capacity needed for these reactor tests.

Nuclear Rocket Engine Development

During FY 1963, the nuclear rocket engine contractors will carry out a program of engine design, component development and testing, and hardware procurement aimed at complete engine tests in FY 1964 and flight tests in the CY 1966-1967 period. The design of the reactors to be used in the engine will be based on the results of the KIWI-B reactor test series, but will incorporate features necessary to allow handling and operation in a flight rocket system. The nuclear rocket engine tests will provide information on structural and mechanical design, reactor transients and control, radiation, and thermal considerations; and will aid in familiarization of personnel with the assembly and operation of nuclear systems. Non-nuclear engine components will be subjected to tests under conditions which simulate engine conditions as realistically as possible to determine the

reliability of such components and systems. "Side-by-side" experiments will be conducted in connection with the reactor tests to demonstrate the utility of these components in a radiation environment. The data resulting from this phase of the program, and the design decisions based upon these data, are necessary to insure the timely prosecution of later development and test effort.

System and Component Technology

Many of the problems of nuclear rocket systems are unique and require extension of the available technology. Because the heat flux to the nozzle of a nuclear rocket is considerably higher than the heat flux in the nozzle of a chemical rocket, new problems in design, materials and heat transfer arise in the nuclear rocket nozzle. Advanced concepts, based on results of basic research, are also needed for design of flow measurement instrumentation, control valves, and bearings and seals in order to provide reliable operation with liquid hydrogen. Extension of the current technology is required in FY 1963 to design and develop pumps and their turbine drives to insure efficient pumping of large quantities of hydrogen over a wide range of conditions. In addition to component studies, analytical and experimental investigations are necessary in FY 1963 for successful integration of the components into successful propulsion systems.

Propellants

Liquid hydrogen is used in the nuclear rocket reactor tests and in development of non-nuclear components required in reactor tests and engines. In addition, nitrogen and helium are required at the various test facilities to purge, and to precool or chill, the system. Propellant funding in FY 1963 is based upon these combined requirements in the nuclear rocket engine, reactor-test support, and flight test vehicle stage development programs.

SNAP-8 Development

The present schedule and funding plan for SNAP-8 are aimed at a flight test in mid-1965. During FY 1963, development and endurance testing of the power conversion systems (at full power) will be conducted in four test cells at the contractor's plant. In support of integrated testing of the conversion unit with the reactor, AEC is currently building (with AEC funds) a nuclear ground prototype test facility with beneficial occupancy scheduled early in FY 1963. Testing of the complete nuclear electric generating system in this shielded facility will begin shortly thereafter.

Megawatt System Design Studies

The aim of these studies is to lead to the development of high-powered nuclear-electric systems as soon as technically feasible. The limiting factor in the development of such high-powered nuclear-electric propulsion systems continues to be the electric power generating system. In FY 1963, the latest data from the advanced research and technology programs will be used to initiate design studies of a power generation system in the megawatt class.

Component Technology

The component technology effort initiated with prior year funds will continue in FY 1963, because research knowledge and data can be utilized in development programs only if they are thoroughly studied using models of various components and sometimes full-scale hardware. For example, aerodynamic and hydrodynamic research results form the basis for the design of pumps and turbines. However, many compromises must be made before the most reliable, lightest weight components can be built. At the same time results from corrosion research must be evaluated for determining the selection and performance of materials for the pump and turbine. During the course of this technology development, problems that can be solved by additional research are encountered, and thus, the advanced research program is influenced by the technology development programs, as well as by the hardware development programs. In the same way other components of the power generation system, such as radiators, boilers, vapor-liquid separators and power conversion devices, will be studied as single component and multi-component systems in order to lower the cost and time of developing final systems for space application.

	1961	1962	1963
Flight Program			
SNAP-8 Vehicle Integration.....	---	---	$7,600,000
Nuclear Rocket Flight-Test Stage (RIFT) Development.....	$300,000	$1,300,000	25,700,000
Operational Safety	98,000	120,000	645,000
Total.....	$398,000	$1,420,000	$33,945,000

SNAP-8 Vehicle Integration

Development testing during FY 1963 will provide the data needed for subsequent endurance testing of the flight prototype system in early FY 1964. The funds for SNAP-8 vehicle integration requested in FY 1963 will provide the first increment for flight integration and test payload development needed for a test flight in mid-1965.

Nuclear Rocket Flight-Test Stage (RIFT) Development

The nuclear rocket flight-test stage development consists of the design, development, fabrication and testing of a nuclear upper stage incorporating the NERVA engine, and flight test of this nuclear propulsion system in an upper stage on an Advanced Saturn booster. The flight test stage development project will therefore provide the first opportunity to demonstrate the practicability of nuclear rocket propulsion and to obtain nuclear rocket flight data.

In FY 1963, it is planned that selection of materials, stage design, component design and testing, environmental testing, and a mock-up of the stage will be completed. Fabrication jigs and fixtures will be selected, but major fabrication and assembly, which will be paced by progress in the nuclear rocket reactor and engine program, will be initiated after FY 1963. During FY 1963 effort will be directed toward the development of adequate interface information related to the problems of engine-stage integration.

Operational Safety

This area includes basic considerations such as materials selection, as well as techniques of launch operations and nuclear rocket recovery. System materials must be studied for radiation characteristics or chemical toxicity in the event of catastrophic failure. Test facilities, test operations, transportation of nuclear components, vehicle assembly, launch procedures, and trajectories must be taken into consideration in insuring safe nuclear system operations. The two primary considerations are avoidance of nuclear radiation hazards and hydrogen explosion hazards.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

FISCAL YEAR 1963 ESTIMATES

AIRCRAFT AND MISSILE TECHNOLOGY

SUMMARY OF REQUIREMENTS:

	1961	1962	1963	Page No.
Advanced Research.....	$22,000,000	$24,000,000	$30,000,000	RDO 22-3
Advanced Technical Development.....	8,000,000	9,000,000	9,500,000	RDO 22-11
Flight Programs.....	7,857,000	8,479,000	13,088,000	RDO 22-12
Total.....	$37,857,000	$41,479,000	$52,588,000	

OBJECTIVES:

To generate the technology for the design, construction, and operation of advanced aeronautical vehicles and missiles to support current and projected civil and military requirements and to maintain United States leadership in these fields.

JUSTIFICATION:

NASA's Aircraft and Missile Technology program generates data which are used extensively in the following areas:

1. On June 28, 1961, a National program was initiated by the Federal Aviation Agency, Department of Defense, and the NASA toward the development of an economically competitive supersonic commercial air transport. NASA's role is to produce the advanced research information necessary for the project. The major goals of the program are the attainment of the capability to compete economically with the long-range subsonic transport of the 1970's, public acceptability with regard to such factors as noise and sonic boom, satisfactory safety and reliability characteristics, and the maintenance of United States leadership in aeronautics. In addition, the design must be capable of future performance growth in terms of range, payload, speed, and economy of operation to protect the Nation's investment.

2. Several types of short take-off and landing (STOL) or vertical

take-off and landing (VTOL) aircraft are under consideration in the civil transport field, following extensive NASA research efforts. Among these are an airplane intended to operate in underdeveloped territory in advance of road and rail systems, a feeder transport capable of operating efficiently from small fields and of making use of the relatively free connecting strips perpendicular to the main airport runways; and a long-range STOL transport capable of competing with the present transports on moderate length intercity routes by virtue of its ability to operate from relatively small airports located close to the centers of cities. The first two types of aircraft have military counterparts with full vertical take-off (VTO) capability in the United States short-range Tri-Service transport and the NATO medium-range transport. In the case of helicopters, NASA's research work is directed toward determining ways of attaining all-weather capability, increased ferry range, increased component life, improved flying qualities, reduced noise, and reduced complexity.

3. For several years, NASA has concentrated on a continuing program to develop the means for providing true multi-mission combat aircraft, thus reducing the number of types necessary to meet military requirements. As a result, a variable swept-wing tactical aircraft, known as the TFX, is now in the initial stages of procurement by the Department of Defense. This unique aircraft is a two-man, twin-engine, fighter-bomber designed principally for the medium-range strike and reconnaissance roles of the Tactical Air Command. It has extensive capability also as an air-to-air interceptor for close air-support, and as a Navy combat air-patrol or strike airplane. In addition, the Navy and Army currently have under study a second close-support multi-mission aircraft, known as VAX or ASCAS (All-Service Close Air-Support). The performance requirements for this airplane have not yet been finally determined, but are expected to follow those of the TFX airplane in general, except that the gross weight will be about half that of the TFX and it will have more stringent requirements for short take-off and landing performance.

4. The potential of hypersonic aircraft has generated much interest in the Department of Defense. The Dyna-Soar project in particular demands advances in the state-of-the-art in the areas of propulsion, hypersonic aerodynamics, structures, and materials. The X-15 flight research program, the Dyna-Soar development program, and various reentry vehicle programs are providing some of the required information. Further work will be conducted in this area in FY 1963. NASA has also conducted numerous studies of recoverable boosters in an effort to make the space program as economical as possible. One method studied is the possibility of a manned hypersonic aircraft to replace the first stage booster of a launch vehicle to carry the payload and upper stage rockets to a high-altitude, high-velocity condition

before they are launched. This method might be economically attractive provided the aircraft is capable of a sufficiently high velocity and there are a large number of relatively small spacecraft to be launched. The aircraft would also possess the advantage of being self-ferrying to desirable launch points and of providing the very important capability of off-set launch.

5. Advanced technical development to support both military and civil aircraft procurement is continually conducted in the NASA Research Centers. This work is performed in cooperation with government-sponsored contractors at the request of the cognizant government agencies when in the national interest.

6. NASA will also continue to conduct in FY 1963 advanced technical development in support of missile programs of the Department of Defense. In the case of maneuverable missiles, the work includes the aerodynamic stability and control aspects and critical navigation and guidance component development.

FUNDING REQUIREMENTS:

Advanced Research

Supersonic Commercial Transport	1961	1962	1963
Aerodynamics	$10,200,000	$10,300,000	$11,000,000
Propulsion	2,500,000	3,500,000	4,000,000
Structures & materials	2,000,000	1,500,000	2,000,000
Operating improvements	500,000	700,000	1,000,000
Sub-Total, Supersonic Transport	$15,200,000	$16,000,000	$18,000,000
V/STOL Aircraft			
Aerodynamics	$ 1,700,000	$ 1,500,000	$ 1,500,000
Propulsion	100,000	500,000	1,000,000
Structures & materials	300,000	500,000	1,000,000
Operating improvements	200,000	500,000	1,000,000
Sub-Total, V/STOL Aircraft	$ 2,300,000	$ 3,000,000	$ 4,500,000
Multi-capability Aircraft			
Aerodynamics	$ 3,000,000	$ 2,500,000	$ 2,500,000
Structures & materials	300,000	300,000	1,000,000
Operating improvements	200,000	200,000	1,000,000
Sub-Total, Multi-capability Aircraft	$ 3,500,000	$ 3,000,000	$ 4,500,000

Hypersonic Aircraft

Aerodynamics	$ 450,000	$ 1,000,000	$ 1,000,000
Propulsion	350,000	600,000	1,000,000
Structures & materials	200,000	400,000	1,000,000
Sub-total, Hypersonic Aircraft	$ 1,000,000	$ 2,000,000	$ 3,000,000
Total, Advanced Research	$22,000,000	$24,000,000	$30,000,000

Supersonic Commercial Transport

Aerodynamics

An intensive aerodynamic research effort to establish the technical feasibility of an economically-competitive, high-performance, supersonic commercial transport and to identify critical problem areas for further detailed investigation has been underway by NASA since FY 1960. The results have played a major role in the inception of the current program of government assistance toward the timely development of a suitable prototype.

Although broad technical feasibility has been satisfactorily demonstrated, the research has shown that an aerodynamic configuration to satisfy the stringent requirements of the airlines and the public has not yet been fully achieved, and the technology to arrive at an optimum solution for the United States' needs is not yet available to the aircraft industry. The NASA effort during FY 1963 must, therefore, be substantially increased. Critical areas for the enlarged effort include theoretical and experimental studies of ways to improve flight efficiency, dynamic stability, and handling qualities throughout the wide speed range implicit in the complex transport mission; accumulation of additional basic data for predicting the characteristics of alternate design solutions before the prototype is frozen; and further application of high-lift devices and speed brakes to the preferred aerodynamic configurations in order to maintain current take-off and landing speeds on present runways.

Propulsion

Extensive research information on airbreathing engines is available; however, because of problems peculiar to the development of a suitable propulsion system for the supersonic transport, additional research is necessary.

Studies have been initiated, and will be continued in FY 1963, to determine the optimum type of engine for a supersonic transport aircraft, its required design features and mode of operation. In these analyses, each class of engine cycle will be mated to representative airframe configurations and the cycle design and operating variables (e.g.,

pressure ratios, temperatures, by-pass ratios, match lines) as well as the flight profile will be varied in order to ascertain the most favorable design conditions. Of particular importance is the off-design performance of compressors, turbines, fans, and burners, the satisfactory matching of these components throughout the operating range, and avoidance of operating limits such as rotating stall and engine surge. The inlet, exit, noise suppressor, and thrust reverser performance must be examined, and the weights of the propulsion system components must be determined accurately by preliminary design procedures.

Continuing research over the past several years has furnished information on the design principles of aircraft inlets capable of satisfactory operation at one specific Mach number; however, these principles have not been combined into an inlet design which is matched to the particular airflow requirements of the propulsion system needed for a supersonic transport. Also, the performance of such an induction system operating off-design, through a range of angles of attack and sideslip, cannot be analyzed adequately by simulation, and must, therefore, be determined experimentally. Another inlet problem which is known in principle, but which must be determined experimentally for particular designs, is the area of inlet controls, sensor location, and sensor type. Research to be initiated in FY 1963 in this direction will embrace all operating variables, such as inlet geometry changes, Mach number, altitude, and airframe interactions.

Another investigation to be undertaken in FY 1963 is the exploration of fuels available for use in a supersonic transport. The concentration of non-hydrocarbon components in fuel introduces problems of thermal instability that will become severe in a Mach 3 transport where aerodynamic heating may expose the fuel to moderately high temperatures for very much longer periods of time than those currently encountered. Small amounts of solids from the trace impurities in petroleum-derived fuels can clog nozzles, and foul fuel controls. Analyses and investigations will be conducted in FY 1963 to obtain a typical time-temperature history of fuels in supersonic commercial transport operation. Work will also be done to determine the degradation of fuel which can be expected under operating conditions, the effect of this degradation on engine and airframe overhaul life, and the relative benefits to be obtained through the upgrading of these fuels.

Structures & Materials

Minimum structural weight is imperative to the development of an efficient, reliable supersonic transport. The aircraft structure must have the capability of withstanding the loads, temperatures and acoustic environment over the 10-15 year lifetime of the airplane. This more severe environment must be withstood with no increase in the percentage of structural weight compared to present-day subsonic aircraft.

Over the past several years the amount of structural research applicable to aircraft has been declining. Research aimed at problems

of structural design has shown a marked decrease, and research aimed at flutter and other dynamic problems has been continued at a lower level of effort than previously. The feasibility of the supersonic transport has given impetus to new structural research, in particular research relating to structural materials.

Of primary importance is an increased knowledge of the basic properties of the materials of which supersonic transport is to be constructed. Research initiated in FY 1962 on temperature range and long material lifetime will be expanded in FY 1963. An experimental and analytical program is required to provide means of predicting the stress corrosion of materials under consideration for both steady-state and fatigue loads in atmospheres that may be contaminated with sea salt and other contaminants. In addition, a program will be initiated to evaluate the effects of fusion and resistance welds or other fastening methods on the parent metal properties under time, temperature, fatigue and corrosive environment.

Also urgently needed is an evaluation of the properties of nonmetallic components of the airplane which must also withstand the environment of supersonic flight. A compilation of data and sponsorship of necessary research programs for other materials for items such as tires, bearings, windows, seals, insulation, hydraulics is projected for FY 1963.

Equally important is the efficient utilization of these materials to derive optimum structural designs. Studies and tests of types of structures to find optimum parameters for wings and fuselage construction using steel and titanium for the structural indexes and structural rigidity requirements are planned. These will include tests of specimens and segments of components up to full size including fabrication techniques under test conditions of time, temperature, and loading cycles which simulate the supersonic flight time history.

Operating Improvements

FY 1962 and prior year funds provided for research in supersonic aircraft operating problems which are directly related to the supersonic commercial transports are:

a. Studies of runway requirements and the response of aircraft configurations to runway roughness.

b. Studies of atmospheric turbulence at altitudes up to 100,000 feet.

c. Generalized studies in the fields of air traffic control, communications and meteorology.

d. Studies of sonic booms using wind tunnel and flight investigations.

e. Studies of landing approach techniques using simulator and flight experiments.

f. Studies of handling qualities of various aircraft configurations using simulator derived data.

The FY 1963 request provides for continuing work in these areas. In the past two years, these research efforts have provided much of the basic information required for the development of a supersonic commercial transport. The research in sonic boom problems has indicated the need and direction for further research. Past research efforts which have required the use of simulators have been handicapped by the lack of proper facilities such as the five degree of freedom simulator at the Ames Research Center which began operations in the fall of 1961 and the simulator planned for the Langley Research Center. FY 1963 funds requested will also be used to support the major research efforts required in such operating problem areas for the supersonic transport as sonic boom, information display systems and air traffic control. The results of the research effort on these problems will have a direct influence upon aircraft configuration. The mission profile of the supersonic transport and the combination of airframe and powerplant characteristics required to fly the mission profile are directly dependent upon the solution of the sonic boom problem. Research will be directed with FY 1963 funds toward further flight tests using various supersonic aircraft and specialized wind tunnel tests to determine both the effect of total lift and aerodynamic design on sonic boom intensity. An extended flight test program will be undertaken to ascertain the effects of changing meteorological conditions on boom propagation.

Simulator facilities, both existing and planned for the Ames and Langley Research Centers, will be the principle research tools used to study the problems associated with information display. Simulators will permit the economical and simultaneous study of variable aircraft characteristics, flight situations and navigational problems with the pilot in the simulator with the goal of optimizing information display systems for the extremely demanding task of supersonic commercial aircraft operation.

Air traffic control presents a severe problem today and the problem will be magnified as speeds and volume of air traffic increase. A systems analysis approach which considers both the aircraft and the ground control system will be studied in FY 1963. Research in this area will tie together aircraft simulators, computing facilities and air traffic control simulators for study of the resultant situations.

Vertical and Short Take-off and Landing (V/STOL) Aircraft

Aerodynamics and Propulsion

Funds for continuing wind-tunnel studies on a variety of configurations considered suitable for various aircraft missions requiring vertical or short take-off and landing are included in the FY 1963 request. Although additional research studies will be required on tilt-wing and tilt-duct models, which FY 1961 and FY 1962 studies have shown to be particularly useful for the subsonic V/STOL transport, research emphasis will be placed on more-advanced, high-performance concepts utilizing lifting fans and deflected jets. Special attention will be given in FY 1963 to studies of the air flow into lifting-fan wing-mounted engines on advanced configurations, and to means for overcoming the possible adverse characteristics of these configurations.

Operating Improvements

An important unachieved requirement for the helicopter or any V/STOL aircraft is all-weather operation. Studies are planned utilizing the Ames height-control test apparatus to stimulate steep approach for landing under instrument-flight conditions. In addition, ground-simulation studies initiated in FY 1961 will continue in FY 1963 on possible improvement of V/STOL aircraft stability and control to define acceptable ranges of stability parameters, and to examine the characteristics of specific V/STOL concepts.

Multi-capability Aircraft

Recent developments in variable-sweep-wing technology provide the capability for optimizing, within a single airframe, the conflicting aerodynamic requirements of subsonic and supersonic flight. Such an aircraft with wings swept forward can have superior take-off and landing characteristics, intercontinental ferry range, and long-duration "hold" on station. Also, with the wings in the sweptback mode, it can have excellent high-altitude supersonic performance combined with good efficiency and low gust accelerations in low-altitude flight. This significant advance in mission versatality was made possible largely by the efforts of the Langley Research Center which, in FY 1961 and FY 1962, conceived and developed a rational basis for the design of a variable-sweep-wing configuration having adequate stability and control characteristics throughout a wide range of sweep angles. Recent investigations have been concerned with configurations considered applicable to the Tactical Fighter-Bomber airplane.

Aerodynamics

In order for the new multipurpose aircraft to realize the maximum benefits of the variable-sweep concept, significant technical advances are required in several areas. The new realm of vehicle

inertia ratios (wings fully swept) leads to problems of dynamic response and flying qualities. In the area of aerodynamics the FY 1963 request includes funds for research on skin-friction drag at the very high Reynolds number corresponding to low-level supersonic flight, development of new aerodynamic controls for the fully swept-wing sweep condition, and research to overcome trim drag with sweep angle.

Structures & Materials

From the structural standpoint the deflection characteristics of the wing pivot of a variable sweep aircraft combined with the high speeds at low altitude poses serious flutter problems. Flutter research aimed at optimizing such configurations will be conducted in FY 1963. The already numberous occurrences of panel flutter for current fighter aircraft will be greatly increased for more advanced aircraft. The FY 1963 request also provides for basic studies to establish acceptable prediction methods and boundaries of panel flutter.

Operating Improvements

Low altitude attack modes and long distance low altitude penetrations required for successful military mission accomplishment of future tactical aircraft systems pose new problems in navigation, aircraft and pilot response to low altitude gusts and in design of terrain avoidance equipment. Simulators have been used in recent preliminary studies of the handling characteristics of typical variable-sweep tactical fighter-bomber configurations and will continue to be used to study the low-altitude problem areas for a basic understanding of the requirements and then to check out the characteristics of integrated navigation, terrain avoidance and aircraft control systems. For these studies, in which motion cues are very important, moving base simulators which subject the pilot to aircraft motions resulting from environmental and system response inputs are required.

Hypersonic Aircraft

Aerodynamics

To about the Mach 5 and 6 range, it appears that the hypersonic airplance can evolve in a logical manner from work being done on the X-15, advanced military aircraft and on the supersonic transport. Beyond Mach 6, however, analyses indicate that hydrogen must be used as the fuel in order to provide an adequate heat sink capacity for handling the very intense aerodynamic heat input. The use of this low density fuel intensifies aerodynamic and structural problems by requiring a major increase in the volume of the aircraft and also introduces major problems with regard to the handling of cryogenic liquids. Provision for continuing research is included in the FY 1963 request.

Propulsion

The biggest single hurdle to be faced in the development of an hypersonic aircraft is the development of an entirely new propulsion system utilizing as its basic component some as-yet-undeveloped turboramjet, subsonic or supersonic burning ramjet, a liquid air-cycle engine, or a similar engine. Facilities for the development of such engines do not exist in this country and are likely to cost hundreds of millions of dollars. The cost of these facilities will increase progressively with increasing flight speed. Because of this situation, the principal objective of current research by NASA is directed toward obtaining information needed to establish the basic feasibilities of these types of airplanes. The FY 1963 request includes funds for studies to better define the propulsion problem areas which will be encountered in continuous flight at hypersonic speeds. Analytical studies will be conducted to define the potential of possible engine cycles, and their relation to the airframe. Engines capable of operating over a portion of the required Mach number must be compounded to achieve hypersonic flight; therefore matching of potential propulsion systems with each other and integration with the airframe will be studied. Methods for the collection of liquid air and the separation of liquid oxygen while in flight will be investigated. Since the attainment of supersonic combustion offers promise as a hypersonic propulsion system, basic studies of burning in a supersonic steam will also be undertaken.

While considerable research has been conducted in prior years by NASA on inlets at Mach numbers up to 3.0, there is a void in comparable information at the higher speeds. Research effort in FY 1963 will be directed toward development of induction systems designed for Mach numbers in excess of 6 and will include tests at lower speeds to obtain information at off-design operating conditions. Because of the high temperatures involved, the hypersonic inlet must have a simple design; however, it is apparent that some form of variable geometry is required to achieve satisfactory performance at other than the design cruise Mach number. The inlets to be investigated in this program, while of a general research type, will have provision for control of the boundary layer as a means for improving the propulsive efficiency. The integration of the inlet into the airframe will also be studied to determine design and location which will prove to be of benefit to both the airframe and the propulsion system.

Structures and Materials

There are major structures and materials problems which increase in severity as the design cruise Mach number increases. The structure of a hypersonic aircraft must perform its load carrying task under a high temperature environment of 1000° to 1700° Fahrenheit. The selection of appropriate materials and their utilization in a structural arrangement represent problem areas of critical importance to the hypersonic aircraft. Studies will be undertaken in FY 1963 to

evaluate materials for the high temperature environment and to develop protective coatings which may be required for some materials. Inasmuch as refractory materials are characteristically of high density, new concepts in structural design will be required. An intensive research program is included in the FY 1963 estimate to develop efficient structural concepts which will furnish the desired strength and stiffness.

Advanced Technical Development

	1961	1962	1963
Missile Technology	$1,000,000	$1,000,000	$1,000,000
Hypersonic Aircraft	1,700,000	2,500,000	2,500,000
Military and Civil Aircraft Support	5,300,000	5,500,000	6,000,000
Total, Advanced Technical Development	$8,000,000	$9,000,000	$9,500,000

Missile Technology

The FY 1963 estimate provides for continuous NASA wind-tunnel model studies in support of current and proposed military missile projects. This is a continuation of the traditional assistance which the NASA has provided to the military services in the past, including assistance in the initial design of advanced concepts, determination of the anticipated flight performance of new weapons, and improvement of the capability of existing military weapon systems. During the last year, such support included investigations of the aerodynamic characteristics of the Skybolt air-to-surface missile; the stability and control characteristics of the GAR-9, the Subroc, the Pershing, the Redhead-Roadrunner, and ARGMA ramjet missiles; and the flutter characteristics of the Typhon missile.

Hypersonic Aircraft

The purpose of the Dyna-Soar program is to determine the military potential of hypersonic boost-glide type weapon systems, to provide a basis for such developments, and to provide research information on the characteristics and problem of flight in the boost-glide flight regime up to orbital speeds. As a partner with the Air Force in the development of the Dyna-Soar vehicle, the NASA is responsible for providing the technological information for its development. Also, NASA has the responsibility for defining the research instrumentation for the flight phase of the program. In performing these prescribed responsibilities, NASA is conducting a continuing effort at its Research Centers in the form of experimental wind-tunnel, analytical, and ground-based simulator studies. Even though considerable work has been conducted, much remains to be done in order to develop the technology necessary to provide adequate stability, control and performance characteristics. With FY 1963 funds, work will continue on a variety of configurations on flutter characteristics, structural

dynamics, and aerodynamic and structural heating in addition to guidance and control, energy management, cockpit displays, and flight operation techniques.

General Military and Civil Aircraft Support

Research on specific aircraft will also continue to be conducted during FY 1963 at the request of the military services. In the past year, investigations have included aerodynamic studies of models of the B-58 and B-70 bombers; Avrocar, Hawker, Fairchild, Vertol, Ryan, and Doak VTOL aircraft; the HU1A and HU2K helicopters; and the C-141 transport airplane. It is anticipated that the current level of military support will be about the same level during FY 1963. The anticipated program for FY 1963 is expected to include specific tests of such vehicles and their components as fighter and bomber aircraft, VTOL aircraft, anti-aircraft and anti-missile missiles, target drones, recovery devices, and ground support weapons.

If the competitive position of the United States is to be maintained, additional work will be required during FY 1963 to improve the already excellent subsonic transports. Studies indicate that reductions in direct operating costs of one-third or more are possible through increasing the airplane size to the maximum permissible for trunk-line airports (350,000 to 400,000 pounds), increasing the force-break Mach number by 0.05 to 0.1, and by developing a geared turbofan engine with a bypass ratio in the range of 3 to 5. Necessary additional aerodynamic research is planned in FY 1963 in the areas of aerodynamic interference effects at high subsonic speeds, optimization of wing camber and twist, and optimization of engine installation.

Flight Programs

	1961	1962	1963
B-58 flight simulation of Supersonic Transport operation	$ 100,000	$ 500,000	$1,600,000
B-70 flight simulation of Supersonic Transport operation	----	200,000	1,500,000
X-15 hypersonic environment studies	7,000,000	7,000,000	8,000,000
V/STOL aircraft	757,000	779,000	1,988,000
Total, Flight Programs	$7,857,000	$8,479,000	$13,088,000

B-58 and B-70 Flight Simulation of Supersonic Transport

The design, development, and operation of a supersonic transport present a wide variety of challenging problems, many of which cannot be solved by analytical methods or model tests alone. The problems can be divided into two categories: basic research in problem areas that are difficult to simulate in wind tunnels or where flight

verification is required, and operational problems where human factors and aircraft utilization are important factors. Flight research is the means for investigating these problems and in order to provide the necessary information on a timely basis for the design of a practical supersonic transport, flight research must be initiated in FY 1962 and continued in subsequent years. To obtain the required research information, it is planned to fly a B-58 aircraft and a B-70 aircraft in simulated transport operation. The program using the B-58 will begin in late FY 1962. It will be used to study turbulence and make gust measurements at the cruise altitudes of the projected supersonic transport; to investigate and define operational techniques in the take-off, climb, approach, and landing phases of a transport flight pattern; to study and define handling qualities and control requirements; and to study and define navigation and guidance and air traffic integration. The B-58 airplane can be used effectively to partially simulate a supersonic transport and will supply much needed valuable information at an early date. However, the B-70 aircraft currently scheduled to fly in December 1963, will provide data not attainable with the much smaller and slower B-58. For example, total airplane lift and drag, boundary-layer and internal noise, boundary-layer transition and skin friction drag are functions of Reynolds number, and fullscale flight information is needed for verification of theoretical analyses and wind tunnel studies. The B-70 will be instrumented to obtain direct measurements of skin friction, noise, and boundary-layer transition. Also instrumentation is required for direct measurement of thermal stresses, deformations of the large structural components such as the fuselage, wing, and control surfaces to determine the requirements for structural design and safety factors for supersonic transports. Navigational aids, and allweather systems and other piloting aids and displays will be studied. Funds are requested for FY 1963 to procure and install the required instrumentation in the B-70 for the planned flight studies. The B-70 is currently in the fabrication stage and the instrumentation installation should be accomplished during this stage in order not to delay the supersonic transport development program.

X-15 Program

The three X-15 research airplanes were developed to explore the hypersonic flight environment and to obtain fundamental research information under realistic flight conditions pertinent to the problems of hypersonic flight. The X-15 research airplane program consists of studies in the research areas of vehicle performance, aerodynamics, heating, flight control and control systems, and physiological phenomena. During FY 1963, this program will be continued to explore the flight conditions at higher altitudes possibly as high as 90 miles and at speeds up to 4000 MPH. The exceptional performance of the X-15 airplane, particularly with regard to its altitude capability, makes it a valuable test vehicle for many useful experiments. Some of the experiments planned in FY 1963 for inclusion in this program include ultraviolet stellar photography, horizon definiton, infrared exhaust signature and a landing computer.

V/STOL Aircraft

Extensive flight studies to better define and understand the handling characteristics of a variety of concepts will be continued in FY 1963. One of the early findings of the study of a Vertol tilt-wing test bed at Langley was that it was limited to very low rates of descent due to wing stalling which adversely affected stability and control. The initial flight tests have been completed and the aircraft is now being modified by the addition of large wing leading- and trailing-edge flaps to alleviate the stalling characteristics. These modifications together with an increase in power to exploit its increased capabilities should provide early experience and information applicable especially to tilt-wing type aircraft planned for the Tri-Service assault transport.

Another VTOL test bed aircraft on which originally planned flight tests have been completed is the Bell tilt-rotor vehicle. These tests indicated that use of the flapping rotor as a propeller in the cruise condition generated forces that reduced the stability and increased airframe vibration, adversely affecting flight handling qualities. The airplane is now being modified to examine the efficiency of several design changes which, theoretically, will overcome these deficiencies and to determine the feasibility of using the tilt-rotor concept in an operational VTOL vehicle.

Because of the limitations inherent in ground-based simulation, flight studies are planned in FY 1963 utilizing the Bell X-14 deflected jet airplane, and the Vertol YHC1A helicopter. These basic aircraft have been modified to provide variable stability, damping, and control which will enable the pilot to choose during flight from a wide variation of parameters from hover through transition to normal flight. These aircraft will provide additional extensive information on the flying qualities required for satisfactory V/STOL aircraft and will provide a means of evaluating and modifying various proposed VTOL designs.

Further study is planned during FY 1963 using the C-130 airplane equipped with boundary layer control over the wing to study operational characteristics of a large STOL airplane in steep landing approaches.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

FISCAL YEAR 1963 ESTIMATES

TRACKING AND DATA ACQUISITION

SUMMARY OF REQUIREMENTS:

	1961	1962	1963	Page No.
Systems Development. . .	$11,512,000	$13,051,000	$15,950,000	RDO 23-2
Network Operations . . .	24,067,000	55,376,000	67,815,000	RDO 23-8
Equipment and Components	8,751,000	26,417,000	74,645,000	RDO 23-12
Total	$44,330,000	$94,844,000	$158,410,000	

OBJECTIVES:

To provide the tracking and data acquisition services required by NASA flight programs.

JUSTIFICATION:

Every space flight mission, whether rocket development, scientific satellite, space probe, or manned spacecraft, is undertaken to gather information. The critical element in getting such information back to the managers of the mission is the worldwide network of tracking and data acquisition stations. These stations, linked together and to the NASA data centers by a communications net, receive and record telemetered data, track the spacecraft in order to determine its position, and transmit command signals as required. Each flight mission has its own specific requirements for tracking accuracy, amount and kind of spacecraft-gathered information to be transmitted, command signals to be received, and location of ground instrumentation to perform these functions. The NASA networks, supplemented as required by cooperating stations, are a flexible and responsive tool used to fulfill the requirements of the flight missions.

FUNDING REQUIREMENTS:

Systems Development	1961	1962	1963
Improvement of Existing Systems and Operations:			
Data acquisition.....	$1,029,000	$1,004,000	$1,503,000
Electronic tracking	867,000	761,000	794,000
Data processing	1,575,000	1,461,000	2,213,000
Spacecraft command	476,000	805,000	994,000
Antennas	1,138,000	2,419,000	2,493,000
Calibration	343,000	515,000	628,000
System testing	895,000	852,000	911,000
	$6,323,000	$7,817,000	$9,536,000
Sub-system Development:	783,000	1,050,000	1,111,000
New Systems Development:			
Data acquisition	1,225,000	1,165,000	1,194,000
Electronic tracking	564,000	668,000	975,000
Data processing	1,158,000	1,137,000	1,285,000
Spacecraft command	334,000	357,000	450,000
Optical	580,000	440,000	837,000
Timing	545,000	417,000	562,000
	$4,406,000	$4,184,000	$5,303,000
Total, Systems Development.	$11,512,000	$13,051,000	$15,950,000

One of the basic functions of tracking and data acquisition is to provide the necessary ground instrumentation support required by the NASA spaceflight program. As the number and complexity of the spacecraft planned for the following years has substantially increased, the capabilities of the ground instrumentation must be augmented by developing new systems and making improvements to existing systems and operations. In many instances, state-of-the-art sub-systems and equipment are being developed for incorporation into the ground instrumentation to meet the more demanding requirements of the spacecraft missions in a technically and economically sound manner.

Improvements of Existing Systems and Operations

Data acquisition:

The current sensitivity of data acquisition receivers will be further improved by including parametric and maser preamplifiers in operational systems. Although a reasonable background of development work has been performed, three areas must be pursued. Since certain high-sensitivity devices, such as the maser, are not yet fully ready for operational field use, there must be an effort to make such systems optimum for field operation and to reduce their current complexity. Work must also be performed to make these ultra-sensitive systems operational at the new frequencies which NASA will soon be using. Lastly, work will be performed to improve certain currently used devices, such as cooled parametric preamplifiers, to provide even greater sensitivity for meeting planned spacecraft requirements.

Electronic tracking:

The NASA satellite tracking system, used since 1959, has provided most of the locational data on all NASA earth-orbiting spacecraft. It is necessary to assess the accuracy of the tracking system in light of the proposed new spacecraft programs and to improve the system capability. The trajectories and orbits of the planned spacecraft missions will be analyzed and also evaluated in comparison with data already obtained. To increase the flexibility of the current satellite angle measuring system, which uses a fixed-beam type of interferometer, and to provide an economic system for data acquisition, work will be performed on the addition of electronic scan sub-systems to existing systems. Techniques for swinging the fixed beam in order to provide angle tracking over greater spatial volumes than presently possible and arraying of smaller apertures will be major areas of emphasis. The satellite tracking system measures angular data by radio as a primary means to determine spacecraft position. The propagation of radio waves through the ionosphere, including auroral effects, is a limiting factor on system accuracy. In order to meet tracking accuracy requirements of planned spacecraft, work will be performed to obtain better information concerning these propagation errors and improvements in current methods of compensation. Development in other fields of propagation, such as transmission through planetary atmospheres and rocket exhaust media, will be undertaken to improve current techniques. This work will meet the requirements of present programs such as Ranger and Mariner which must maintain communication during maneuvers and after landing on extra-terrestial bodies.

Data processing:

Improvements will be made on the speed and economy of current data reduction operations. Work will be performed on the use of high-speed computers to better advantage in the handling and reduction of the telemetry data. It is known that the orbit computation program currently used causes

errors in the spacecraft position output data independent of inaccuracies in the input data. The error is a function of the orbit being computed, the computation equations, and errors in constants used. Work will be done to improve the quality of orbital calculations, especially as applied to the new types of orbits planned for future spacecraft. Work will also be done on methods to speed orbital computations in order to affect economies in computer usage time.

Spacecraft command:

Improvements will be made in the command receivers currently used on spacecraft. One objective will be modifications to allow ranging as well as command. If this proves possible, it will not be necessary in certain spacecraft to provide a second receiver solely for ranging. This would decrease spacecraft weight and power while increasing reliability. A second objective is to improve the sensitivity of the spacecraft receivers now in use. This work will involve both coherency of reception and lower noise components to meet planned spacecraft requirements. Work will also be performed on improving existing equipment and operation of real time data handling systems for Earth command control of large complex satellites like OAO, OGO, and OSO. These spacecraft will require real-time operational control from the Earth for maximum effectiveness in gathering data.

Antennas:

The extensive use of large reflector antennae in NASA ground instrumentation has resulted in the recognition of many deficiencies in present-day equipment of this type. Improvements in virtually every sub-system of the antenna are warranted. One area of improvement will be in basic drive systems. Work will be done to develop electrical drive systems with capabilities over the presently used hydraulic drive systems. Work will also be performed in the area of eddy-current clutches and differential drives, the latter to alleviate current problems of separate motors for two speed ranges of operation causing servo transients at switchover. The measurement of reflector surface accuracy will be improved. Few significant measurements are currently available on the reflector surface accuracy of large antennae, particularly under typical field operating environment conditions. Another area of improvement is in antenna reflector surfaces. Work will be continued on wind tunnel models of currently used antennae to identify possible structural improvements or additions. In a closed automatic tracking mode, the antenna structure becomes part of the servo loop. Such items as resonant frequencies and structural compliance of current antennas will be examined for improvement. Antenna pointing improvement will involve combating problems of breakout forces and backlash and incorporating better shaft position sensors for angular readout. A major field of improvement will be in feed systems, which, to a large extent, determine antenna efficiency, noise input, and pointing accuracy.

Significant improvement has already been accomplished by NASA in the development of a very low noise "shaped illumination" feed and in the use of Cassegrain microwave optics. Further improvements appear feasible, especially in the simultaneous lobing feeds used for tracking. Work will also be performed in modifying existing feed designs to operate in the new space communication frequency band.

Calibration:

In the area of tracking, the proper reception of data and the absolute accuracy of a measurement are directly dependent on calibration. There have been many technical problems involved with calibration, both for earth satellite and deep space instrumentation. Work will be done to improve both the earth and airborne portions of existing optical and electronic calibrating equipment. The calibration equipment for large antenna pointing and range and range-rate tracking will be improved. Emphasis will be on making certain calibration equipment more automatic to eliminate human error, reduce operating time, and to make certain calibration techniques more repeatable for reducing systematic errors. Evaluation of the usefulness of the Sun and radio stars for certain calibrations will be continued.

System Testing:

Toward the end of any development phase, new systems and sub-systems must be thoroughly tested. It must be determined if theoretical or laboratory performance is actually obtained in practice. The equipment must be operated under field conditions to determine true reliability and potential operational problems. Such testing in advance of the equipment use on a planned spacecraft mission is vital to insure success of the mission and the ability of the ground instrumentation to meet reliably the spacecraft requirements. Equipment tests also allow the field personnel to become thoroughly trained in the operation, calibration and use of the new systems or sub-systems. Such tests vary widely with the type of new system involved. Current methods include use of simulators, airplane targets, collimation towers, and extra-terrestial bodies. As an illustration, a test program called "astrometrics" is in use on deep space instrumentation. A series of measurements was conducted very successfully last year integrating for the first time many new sub-systems, including maser, parametric amplifier, ten-kilowatt transmitter, ultra-stable frequency devices, and a new range correlation coder. This test program was also directed toward measuring more accurately physical constants of the solar system. Knowledge of these constants is vital in performing the NASA space missions. The foremost advance during the past year was the improvement in the accuracy of the astronomical unit by a factor of 100. The information is necessary to generate proper guidance equations in order to have a spacecraft intercept a planet with minimum energy expenditure. This series of measurements has also resulted in increased knowledge of the surface roughness and dielectric constant of Venus, needed for optimum design of planetary spacecraft altimeters.

Sub-System Development

The state of art in electronics is advancing rapidly. Many new sub-systems have recently been developed for applications generally not associated with space work. Development will be undertaken to make these sub-systems suitable for inclusion in new instrumentation systems or, where possible, as augmentation to existing systems. Some sub-systems in this development category are thin films, cryogenic elements, adaptive displays, micro-electronic circuits, super-conductive materials, and direct energy conversion devices. Sophisticated automation and new digital techniques will be incorporated into existing equipment. The development work planned is to meet requirements of the spaceflight program, including improvement of sub-system reliability in support of Apollo requirements.

New Systems Development

Data acquisition: Development of new data acquisition receiving systems using current state-of-the-art components is highly desirable. The goal of this work is to reduce substantially the volume, power requirements, and complexity of the current equipment and to increase its reliability, maintainability, and operational simplicity. This will be done by the use of solid-state components, improved packaging, sub-system automation, failure detection, and automatic calibration. The design of the equipment will be optimized for operator use and minimum time maintenance. Such systems will tend to lower future operating facilities and utility costs. A new portable data acquisition system will be developed to meet certain short-term requirements for data coverage at a point on a spacecraft orbit which is not visible from existing Earth stations. This system will support a spacecraft, such as EGO (Eccentric Geophysical Observatory), in an elliptical orbit where certain data coverage is required at the fairly low altitude perigee portions of the orbit. It is not always possible to place the perigee within view of existing Earth instrumentation and, if it were possible, a relatively small change in launch vehicle performance might place the perigee in an area where no coverage was possible. This system may also receive information on the spacecraft performance soon after injection. With the planned use of parking orbits by many spacecraft missions, the points of injection will be located over different areas of the world, many of which have no instrumentation facilities. A prototype system of this type will initially be developed.

Electronic tracking: The present deep space ranging system is currently hampered by ambiguities in the measured data after targets are more than several million miles away. A unique code system will be developed to provide unambiguous and precise measurement of ranges at interplanetary distances. Development work will also be initiated on an Apollo tracking system with initial emphasis on an integrated mission system and its application to the injection and re-entry phases of flight.

Data processing: The current data processing system is not capable of handling the increased data volume and speed requirements of planned spacecraft. A new data processing system will be developed with higher speed, more versatile data outputs and display, greater capacity, and almost fully automatic data reduction capability. Despite past developments in data acquisition techniques, the recorded data is often still contaminated by noise. Even with the projected advancements in both the spacecraft transmitted capabilities and the data acquisition systems, low signal-to-noise data will still have to be processed. Systems must therefore be developed to process such noise data using improved techniques, new correlation detection devices, and signal-to-noise enhancement circuits.

Spacecraft command: A new digital-type Earth-based command system will be developed for satellite spacecraft. The current command system uses a band in the VHF range which is currently overcrowded and will be saturated by planned projects. The new command system will operate in a higher frequency band where spectrum room is available and fewer possibilities of interference exist. As part of this development a new adaptive real-time data handling and command system will be developed to meet the requirements of the geophysical and solar observatories and Project Relay. The major elements of the pulse code modulated (PCM) command system are data conditioning, computation, display and synchronizing equipment.

Optical: The accuracy of making angular measurements of spacecraft location from the Earth by radio means is limited by various technical factors. A very significant increase in angular accuracy can be achieved by the use of frequencies in the visual and non-visual portions of the light spectrum. New optical-type systems of high accuracy and without current operational difficulties will be developed. The requirements are for optical systems which can track in either full daylight or full darkness, track a target automatically and present the tracking data in real-time or easily reducible form with higher accuracy than now achievable. Another optical system to be developed, both as a separate system and possibly for use in the previously described optical tracking system, involves the laser, a light amplification device. Initially, the technical feasibility of using the laser to meet future spacecraft requirements for high capacity data transmission, especially over great distance, must be determined.

Timing: An orbit for any spacecraft is essentially derived by using independent measurements of spacecraft location from different points on the Earth's surface. These measurements must be tied together by a common time base and any measurement incorrectly tied in time to another measurement will cause an error in the calculated orbit. Currently the Earth stations in various positions around the world use the WWV time signal for a common time base. Due to uncertainties in propagation time, it is currently estimated that the absolute time base accuracy is only 3 to 5 milliseconds. A new timing system with improved accuracy (using VLF frequencies) will be developed. A more accurate

individual station timing system will also be developed.

Network Operations	1961	1962	1963
Satellite Network.....	$ 9,620,000	$11,441,000	$17,794,000
Deep Space Network.....	4,233,000	7,020,000	9,272,000
Manned Space Flight Network...	293,000	22,690,000	24,047,000
Network Communications.....	6,915,000	12,290,000	13,234,000
Data Processing.....	3,006,000	1,935,000	3,468,000
Total, Network Operations.	$24,067,000	$55,376,000	$67,815,000

Satellite Network Operations

The stations in this network provide the prime tracking and data acquisition support for scientific and applications satellites. They are the twelve optical stations operated by the Smithsonian Astrophysical Observatory and fourteen electronic stations operated by the Goddard Space Flight Center.

The optical stations use Baker-Nunn Satellite Tracking Cameras which provide certain satellite tracking measurements more accurately than the electronic systems. Data obtained from these stations can show extremely small variations and perturbations in the orbits of satellites. These data can be used to determine the density and variation of density of the upper atmosphere, the gravitational field of the Earth, the shape of the Earth and more precise distances between continents and islands on the Earth.

Only certain satellites of generally simple shapes and at proper altitudes are useful for the precision tracking studies mentioned above. Furthermore, the optical stations are limited in the total tracking support they can give since they can track only during periods of clear skies and at dawn and dusk when the satellite is in sunlight and the camera is in darkness.

The electronic stations provide most of the tracking and data acquisition support for the scientific and applications satellites. This includes tracking data used to compute predictions for stations so that data acquisition antennae can be pointed at the satellite. The tracking data are also used to obtain satellite position in relation to time so that measurements made by the satellite can be related to its position relative to the earth. The data acquired by telemetry from the satellites include scientific measurements made by instruments on the satellite, engineering information concerning performance of the satellites such as temperatures, battery voltages and status of on-board systems, as well as wide-band picture data such as the cloud cover photographs obtained from the meteorological satellites.

Tracking of the majority of satellites is accomplished through the use of radio interferometers which provide a measurement of angular position with respect to the station in relation to time using the radio signal transmitted by the satellite. In this system, the telemetry transmitter can be used to track the satellite and can operate day and night in any kind of weather.

All stations are capable of receiving and recording the relatively narrow band telemetry which shows the status of systems on the satellites and the scientific data from the smaller scientific satellites such as those launched by Scout and Delta. The data acquisition capability of this network is being improved and expanded in order to handle the wider bandwidth and greater accuracy needed for the more complex satellites being launched. This capability is also needed to handle the increased number of satellites which will be in orbit.

In addition, large data acquisition facilities are being established to handle the vast amounts of stored data that must be collected from the larger scientific and applications satellites such as Eccentric Geophysical Observatory, Polar Orbiting Geophysical Observatory, Orbiting Astronomical Observatory and Nimbus. Such facilities, using 85-foot parabolic antennae, are under construction in Alaska and the East Coast of the United States. A Far East facility of this type is included in the Construction of Facilities appropriation estimates for FY 1963.

The stations are operated under several different arrangements. Those in the United States and in certain foreign countries are operated under commercial contract, while other foreign stations are operated by cooperating foreign government agencies.

It will be necessary to provide additional support at all stations during FY 1963 to meet the requirements of the flight program which includes first launches of the communications satellites Relay and Syncom, of the meteorological satellite Nimbus and of the observatory satellite EGO and an increase in the numbers of small scientific satellites in orbit. The East Coast Data Acquisition Facility will become operational during this period, requiring an increase in personnel to adequately staff this station.

Deep Space Network Operations

The stations in this system are used to obtain tracking and telemetry data from and to send commands to space vehicles at lunar and interplanetary distances. Because of the extreme distances and the modest spacecraft powers involved, high gain, large parabolic antennae are needed, along with the most advanced receiving and detection equipment available.

There are three prime stations in this network spaced approximately every 120° of longitude around the world so that space vehicles more than eight thousand miles from the Earth will be visible to at least one of the stations. In addition, there is a mobile tracking station which can be moved to the proper location during the launch of various missions to provide "gap filling" tracking data and acquisition information during the critical launch phase. This is an important function since early trajectory data must be obtained within a short period after launch so that the relatively narrow beam antennae at the prime stations can be pointed in the proper direction and lock on the spacecraft.

A transportable data acquisition system has been built which can be located at existing antenna facilities such as the antenna at Jodrell Bank and the 210-foot antenna operated by CSIRO in Australia. This equipment will be used to provide back-up to the prime deep space stations and for certain planetary missions which will require the higher gain of the large antenna facilities to provide the desired data rate not possible with the relatively low gain primary 85-foot antennae.

The stations are operated by commercial contractors, other agencies, and non-profit contractors.

In FY 1963, it will be necessary to operate the deep space stations three shifts a day, seven days a week in order to meet the tracking and data acquisition requirements for the Mariner R and Ranger missions which will be in flight concurrently. In addition, the transportable data acquisition system will be in operation for the first time.

Manned Space Flight Network Operations

The network consists of 16 prime stations that provide real-time information concerning the location of the manned spacecraft, status of the equipment on board and, most important, the condition of the astronaut. This information must be immediately and continuously available to the control center so that corrective actions can be taken if emergencies should arise during the mission.

To meet these requirements, tracking is obtained by radars at key stations which allow real-time orbital determinations. All stations receive telemetry data from the capsule concerning the condition of the astronaut and the functioning of systems in the capsule. In addition, all stations have radio voice communications with the astronaut. Data received by all stations are transmitted in real-time to a processing and computation center and on to the manned space flight control center for display and mission direction.

NASA has overall responsibility for network operation, station modification and implementation. Five stations are operated by a commercial contractor, nine are operated by the Department of Defense and two are operated under an inter-governmental agreement by the Weapons Research Establishment of Australia.

The network became operational at the beginning of FY 1962. Increased flight activity and longer duration missions in FY 1963 will make it necessary to increase the personnel to meet the program requirements.

Network Communications

The tracking and data acquisition stations must have communications circuits to tie them into the control centers and to obtain satellite and probe acquisition data. In addition, summarized data concerning the status and operation of the space vehicles is sent from the stations to control centers so that decisions may be made concerning future operations of the vehicles.

The majority of the communications circuits consist of teletype links, however wide band links for the weather satellites are used to transmit the rapidly changing cloud cover photographs from the acquiring stations to the control center. Voice channels link the manned space flight stations to provide critical information such as "hand-over" tracking instructions from station-to-station and to pass emergency instructions from the control center. The communication center is located at Goddard Space Flight Center with subcenters at Jet Propulsion Laboratory and Smithsonian Astrophysical Observatory.

Commercial common carriers, both foreign and domestic, provide the main source of NASA communications but where available military and other government agency lines are used.

Data Processing

It is necessary to supplement in-house data processing for tracking and data acquisition through the use of contracted support. The level of this additional support is a function of the flight schedule and the available in-house capability. Additional contracted data processing services are necessary in FY 1963 in order to handle the extra load generated by the increased number of space vehicles planned for launching during the year.

Equipment and Components	1961	1962	1963
Satellite Network:			
Maintenance, spares and replacement	$ 3,622,000	$ 2,765,000	$ 6,778,000
Expansion of network capability:			
Antennae	2,366,000	---	4,674,000
Receiving and recording	1,358,000	951,000	3,168,000
Command	---	618,000	2,175,000
Data handling and processing	---	166,000	1,654,000
Tracking	---	---	1,781,000
	$ 7,346,000	$ 4,500,000	$20,230,000
Manned Flight Network:			
Maintenance, spares, and replacement	$ ---	$ 3,260,000	$ 3,269,000
Expansion of network capability:			
Augmentation of ground voice communications	---	3,803,000	---
Automatic telemetry read-out equipment	---	2,445,000	---
AN/FPS-16 radar equipment	---	2,988,000	---
Telemetry decommutation equipment at command sites	---	1,494,000	---
Data terminal equipment for Bermuda station	---	2,716,000	---
Data and computer terminal equipments for the computer center	---	1,630,000	---
Computer reprogramming	---	1,090,000	---
PCM ground station equipment receivers, recorders, discriminators, demodulators	---	---	14,379,000
S-band ground-to-capsule data and voice communications systems	---	---	5,882,000
Modification of telemetry and acquisition aid systems	---	---	5,882,000
Control center equipment	---	---	2,615,000
Ranging and positioning equipment for terminal trajectory instrumentation	---	---	2,615,000
FM/FM telemetry equipment	---	---	1,308,000
	---	$19,426,000	$35,950,000

Deep Space Network:	1961	1962	1963
Maintenance, spares, and replacement.....	$ 1,179,000	$ 1,945,000	$ 4,095,000
Expansion of network capability:			
Masers.....	---	---	1,396,000
Recording and data processing instrumentation.....	---	---	785,000
Modifications to DSIF antennae.....	---	---	3,050,000
Multi-channel receivers and automatic detection and frequency acquisition.....	---	---	2,789,000
Automatic checkout and calibration equipment.....	---	---	3,316,000
Precision ranging.....	---	---	1,569,000
	$ 1,179,000	$ 1,945,000	$17,000,000
Ground Communications Network:	$ 226,000	$ 546,000	1,465,000
Total, Equipment and Components	$ 8,751,000	$26,417,000	$74,645,000

Satellite Network

This network has been in operation since the International Geophysical Year. New stations have been added and major improvements have been made to existing stations through Construction of Facilities projects. Four new stations became operational in late FY 1961. A new wide-band data acquisition facility in Alaska will be operational in FY 1962, and a similar East Coast facility in FY 1963. Only emergency maintenance, spares and minimal replacement equipment were provided during FY 1962. The heavy workload of the planned flight program will require that a blacklog of replacements and improvements be met in FY 1963.

The satellite network must support not only the smaller scientific satellites such as those launched by Scout and Delta but also the larger observatory satellites and the applications satellites in communications and meteorology. Each new satellite launched, regardless of its size, contains more extensive and more accurate instrumentation. The satellites are also becoming more reliable. The ground reception equipment must not only keep pace in quality of instrumentation, but must also be expanded to handle the greated number of satellites which provide useful data for longer periods of time. Techniques must be developed and equipment provided to allow automatic handling and processing of the data if program requirements and goals are to be met.

During the International Geophysical Year period and immediately following, the simple radio signals from the satellites could be followed by hand-directed antennae of very simple construction. However, as the satellites have increased in number, the bandwidth or

amount of information transmitted per unit of time has also increased, requiring higher gain ground antennae. The provision of 136-megacycles yagi self-tracking antennae for all stations, begun in fiscal 1961, will be completed in fiscal 1963. These antennae will meet the data acquisition requirements for small scientific satellites as well as receive status reporting telemetry of observatory and application satellites on the 136-megacycle band. In addition, mobile stations of medium bandwidth capability, between the yagi type and the large data acquisition facilities of the Alaska type, will be provided to give perigee coverage for Eccentric Geophysical Observatories and emergency support to Orbiting Astronomical Observatories, Polar Orbiting Geophysical Observatories, and Nimbus satellites.

In order to support the housekeeping telemetry requirements of satellites such as Relay, Syncom, the Observatories, Nimbus and the follow-on small scientific satellites which use the latest techniques in data encoding and transmission, the satellite network stations must be provided with new receiving, detection and signal conditioning equipment. Pulse code modulation systems including signal conditioning, synchronizing, and decommutation instrumentation plus sufficient display equipment to allow the station operating personnel to assure proper receiving conditions will be installed at ten stations. Coherent and pulse code modulation detectors, and miscellaneous equipment to handle special-purpose requirements of satellites that fail to obtain programmed orbital altitudes and positions will also be installed. Funding in this category in earlier years provided the basic 136-megacycle capability of the network.

The satellites which will be launched in Fiscal Years 1962, 1963, and 1964 must have very sophisticated command systems to carry out their missions. The procurement and installation of the specialized command instrumentation including antennae, transmitters and encoders was begun in FY 1962 and will be completed for ten stations in FY 1963. Special real time readout telemetry at selected sites will also be installed to assist in command control of satellites such as Eccentric Geophysical Observatories and Orbiting Astronomical Observatories.

Equipment must be installed at Goddard Space Flight Center to process and reduce the quantity of data obtained from the increasing number of satellites producing progressively larger amounts of information. The equipment includes digital recording, memory and translation equipment plus analog and digital computing units.

Satellites such as Eccentric Geophysical Observatories and Syncom require tracking data more sophisticated than that obtained by the normal satellite network which provides tracking based on angular data. The additional tracking information will come from range and range-rate tracking. Equipment to provide these data will be installed at selected stations to meet such requirements.

Manned Flight Network

Planned augmentation of the Manned Flight Network in FY 1962 provided for the instrumentation necessary to support the manned one-day missions using modified Mercury capsules. In FY 1963, it is necessary to expand the capability of the tracking network to support Project Gemini, and Project Apollo spacecraft missions.

Additional equipment is needed at the Mercury sites and at other existing sites to provide the necessary tracking, communication, control and telemetry capability for the Gemini spacecraft missions and orbital missions of the Apollo spacecraft. The final site locations for this equipment will be determined when the exact orbital parameters and airborne instrumentation techniques have been determined. The docking techniques, the location of the approach and docking maneuvers, and the accuracy requirements of the ground tracking net for the Gemini missions establish the required ground instrumentation. By utilizing presently planned techniques and presently instrumented areas for tracking and data acquisition, little additional ground instrumentation should be required. The planned equipment supports the minimum requirements consistent with the latest trajectory and spacecraft mission instrumentation plans. The necessary augmentation is described as follows:

Pulse code modulation (PCM) telemetry ground equipment is needed at all stations and real-time telemetry read-out equipment is needed at selected sites to handle the increased accuracy and data volume requirements of the Apollo spacecraft. PCM in digital format provides a more efficient telemetry system and is required to handle the increased data quantity desired from the Apollo spacecraft.

Initial installation of S-band ground-to-capsule communication, telemetry and tracking equipment is required at selected sites to provide the capability of monitoring R&D S-band equipment on the orbital Apollo flights preparatory to the use of S-band equipment on the lunar Apollo missions. It is intended to use S-band communication equipment on the Apollo lunar mission to insure compatibility with the existing Deep Space Network instrumentation.

Modification of the present telemetry, tracking, and acquisition aid systems and antennae is required to make them compatible with the airborne PCM telemetry equipment indicated above.

Augmentation of the present Mercury control center, including additional communication terminal equipment and data transfer equipment, is required to accommodate the increased communications and data transmitting workload associated with the more complex Apollo missions.

Initial implementation of ranging and positioning terminal equipment is required at selected existing sites to provide for reentry and landing operations of the orbital Apollo spacecraft designed to land on land rather than at sea as in Mercury.

Standard frequency modulation telemetry ground equipment is needed at the few sites not so equipped to increase the orbital coverage of the early Apollo missions. The earliest Apollo missions will be equipped with standard FM/FM telemetry equipment, and because of the increased data transmitted and coverage required, all of the sites will be equipped with FM/FM receiving equipment.

Deep Space Network

Provision must be made for maintenance, spares and replacements for equipment including support units such as generators, pumps, and hydraulic and electrical machinery at the deep space stations. Construction of the full three-station network was completed in early FY 1962, when only minimal spares were available. The flight schedule during FY 1963 requires that station operations be increased to a full three-shift, seven-day week. This will result in increased maintenance requirements and heavy replacement of worn-out equipment.

Improvement of the deep space stations' capabilities will enable them to meet the data reception requirements of the Mariner and Surveyor spacecraft and to improve the efficiency of the stations, allowing them to handle multiple missions.

In order to meet the additional data reception requirements, several improvements must be made to the stations. The noise level of the electronic equipment will be reduced by the installation of masers at all stations. This will allow detection of signals from greater distances and will allow wider bandwidth data to be received. Additional data recording and handling equipment will be installed to meet Mariner and Surveyor requirements.

Modifications will be made to the antennae to convert them from prime-focus-feed to a Cassegrain feed system, further increasing the overall system sensitivity. Additional modifications will be made to one antenna at Goldstone in an effort to lower further the system noise level. This modification will not be made to other sites until the antenna has been thoroughly tested under operational conditions. Modifications will also be made to the antenna servo systems at all sites to increase the operational reliability and performance of the pointing system in order to meet the 24-hours-per-day operating requirement.

The increase in probe tracking workload requires that the stations be capable of supporting more than one mission at a time. The flight schedule calls for concurrent Mariner and Surveyor missions with the probability that more than one Surveyor will be active on the moon at a given time. The deep space frequency band of 2290-2300 megacycles has been divided into three channels to allow non-interfering trans-

missions from the spacecraft. Multi-channel receivers in the deep space band capable of receiving transmissions from more than one spacecraft on the moon, and automatic detection and frequency acquisition electronics will be installed at all stations, enabling them to shift quickly from support of one mission to another.

The Goldstone station acts as the controlling station during the immediate post-launch period of lunar and planetary missions. Goldstone acquires the majority of the tracking data which is used to determine the mid-course correction of the spacecraft to guide it to the desired trajectory. The correction must be made as soon after injection as possible to conserve fuel. The accuracy of the tracking data to accomplish these maneuvers must be high, since slight errors early in flight result in large errors at the destination. To accomplish this very accurate tracking, automatic checkout and calibration equipment will be installed at Goldstone to reduce pre-flight and post-flight preparations and to provide maximum accuracy of tracking data as early in the flight as possible. For similar reasons, secondary microwave standards and special receiver and antenna checkout instrumentation will be installed at Goldstone.

Precision time standards, angle encoding equipment and star tracking and pointing equipment will be installed at all sites to upgrade the network tracking accuracy to meet the mission requirements of Mariner and Surveyor.

The precision ranging instrumentation required at the deep space stations for the post-injection maneuver determination of the planetary probes will serve a second purpose which is vital to the planetary exploration program. In order to land probes successfully on a planet, the solar system constants such as planetary distances, gravitational fields, and rotational period, must be accurately determined. The precision ranging equipment at the deep space stations will be used to determine the solar system constants as well as the position of the probes enroute to the target planets.

Ground Communications Network

The Nimbus and Observatory class satellites and the Surveyor spacecraft all require large amounts of data to be transmitted between the stations and the control centers. Updated terminal equipment, video monitoring facilities and test equipment, channelization equipment and circuit assurance and checkout equipment must be provided to give reliable data transmission.