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CRS Report for Congress

Federal R&D Funding Trends In Five Agencies: NSF, NASA, NIST, DOE (Civilian) and NOAA

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FEDERAL R&D FUNDING TRENDS IN FIVE AGENCIES: NSF, NASA, NIST, DOE (Civilian) and NOAA

SUMMARY

This report includes a brief analysis of federal research and development (R&D) funding trends for the past six years as well as R&D funding projects to FY2000. The majority of the report focuses on five R&D agencies and the potential impacts of the budget projections on their R&D programs. For the five agencies examined, the President has recommended a 19.2% reduction between FY1997 and FY2000, while Congress (FY1997 Budget Resolution) would cut these R&D programs by an estimated 19.6%, in real terms. These reductions, if realized would force each of the agencies (findings summarized below) to make decisions regarding continued support for individual researchers and agency programs. The five agencies account for an estimated 47.8% of all federal civilian R&D funding ($34.365 billion) in FY1997.

The National Science Foundation (NSF) has enjoyed considerable growth during a period of constrained R&D budgets, increasing 27% (12.2% in constant dollars) since FY1992. According to the President's FY1997 budget, between FY1997 and FY2000, total funding for NSF could decline by 7 percent, or $90 million, in real terms. Such reductions would likely result in fewer research grants, and a decline in academic research support. The Administration's budget projections for R&D funding at the National Aeronautics and Space Administration (NASA) propose a 21.6% decline by FY2000, while the 104th Congress projected an 18% cut, in constant dollars. These projections are significantly lower than NASA's FY1996 outyear plan. In either the Administration or congressional funding scenario, NASA's R&D programs most likely would be significantly impacted.

Civilian R&D programs in the Department of Energy are projected to decline, between FY1995 and FY2000, by 31 to 35% according to the budget outlooks presented by the Administration and Congress. All of the programs are expected to decline over that period with the smallest cuts in basic research programs and the largest for renewable energy and conservation. The principal consequences of these declines are likely to be fewer projects undertaken in all of the programs, and a greater fraction of the budgets devoted to upkeep of the major research facilities.

R&D funding for the National Oceanic and Atmospheric Administration (NOAA), in the Department of Commerce, peaked for most programs in FY1995, and then declined by 9%, in real terms, by FY1997. Both the President and Congress project further reduction for NOAA R&D through FY2000. Total funding for NIST has fluctuated over the past five years, mostly due to a shift in Congressional support for the Advanced Technology Program (ATP). The 103rd Congress more than tripled funding for NIST between FY1992 and FY1995, while the 104th Congress decreased total NIST funding by 33% between FY1995 and FY1997. Congressional and Administration NIST budget projections for FY1996 through FY2000 indicate flat budgets (Congress) or declining budgets (Administration 8%) for funding of NIST intramural programs (laboratories), while extramural programs, such as ATP, are likely to receive additional congressional opposition.

NOTE

Most of the material contained in this report was gathered for and presented in a CRS memo originally prepared at the request of Senator John Glenn. It is reproduced here for general congressional availability with the Senators' permission.

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FEDERAL R&D FUNDING TRENDS: FIVE SELECTED AGENCIES

INTRODUCTION[1]

Most of the material contained in this report is taken from a memo CRS prepared for Senator John Glenn. The report begins with a brief overview of congressional appropriations actions on the FY1997 research and development (R&D) budget.[2] This is followed by a review of federal R&D funding for the past six years as well as R&D funding projects to FY2000, based on the President's FY1997 budget proposal, and the FY1997 congressional budget resolution. The majority of the report contains information about R&D funding trends, both past and future projections for five agencies and their potential impacts on the agencies' R&D programs. These agencies include: the National Science Foundation (NSF); the National Aeronautics and Space Administration (NASA); the Department of Energy (DOE, civilian R&D only); the National Institute of Standards and Technology (NIST); and the National Oceanic and Atmospheric Administration (NOAA).

The FY1997 R&D Budget

For FY1997, CRS estimates that Congress appropriated $73.750 billion for R&D, an increase of 3.2% over FY1996. Civilian R&D is estimated to increase to $34.365 billion, about 1% over FY1996, while defense R&D[3] would increase to $39.385 billion, almost 5.5% above FY1996. However, in constant dollars, total federal R&D funding showed no growth when compared to FY1996. Defense R&D actually increased 2.6% over FY1996, while concomitantly, civilian R&D declined 2%, in real terms. In current dollars, the $73.750 billion estimate is a new high for federal R&D spending. This noted, according to a recent NSF publication, as a percent of the Nation's total expenditures for R&D, the federal

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[1]Prepared by Michael E. Davey.

[2]For further details on the FY1997 R&D budget see *Research and Development Funding: Fiscal Year 1997.* IB96014

[3]Defense R&D consists of the Department of Defense's R&D programs and the Department of Energy's defense related R&D activities.

share has dropped from about 50% in 1980, to 33% in 1996.[4] This represents the lowest share ever reported in NSF's 44 year-old data series.

The only two major R&D funding agencies that received R&D increases above inflation for FY1997 were DOD and NIH. Together, these two agencies account for 67% of all federal R&D funding. As part of the Omnibus Consolidated Appropriations Bill (P.L. 104-208), funding for DOD's RDT&E programs is to increase $36.733 billion, 5.4% over what DOD had available in FY1996 despite provisions in the FY1997 bill that contained a $700 million reduction in RDT&E for FY1997. Congress increased funding for DOD's science and technology programs by 4% providing $7.9 billion.

The National Institutes of Health (NIH) is the only major civilian R&D agency that received an increase above inflation, with Congress approving $12.747 billion, a 6.9% increase over FY1996. Since FY1995, overall funding for NIH gas increased 7% in real terms.

NSF's overall budget of $3.270 is about a 1% increase above FY1996. However, the research and related activities' account (comprising the bulk of NSF money that goes to universities) increased 5.1% ($118 million) over FY1996, but $40 million below the President's request. Congress continues cutting DOE's civilian R&D programs (3.1% in FY1997), while cutting DOE's civilian technology programs by 11%. Congress approved a 6.8% increase for DOE's defense R&D programs.

Spending for R&D in NASA continued to decline, with Congress approving $7.817 billion, or about $264 million below FY1996 estimated levels. Congress approved a slight increase for NIST, the final figure of $588 million, $238 million below what the President had requested. Funding for basic research continued to enjoy congressional support reaching an estimated $14.816 billion in FY1997, an increase of 2.7% over FY1996. Almost all of this growth can be attributed to the large increase in NIH's budget.

Notably, a number of Members continued to oppose most federally funded university and/or industry cooperative initiatives aimed at developing civilian technology, seeing it as "corporate welfare," (subsidized commercial research that should be privately funded). Nevertheless, Congress continued funding (although at levels below the Administration's request) for such programs as NIST's Advanced Technology Program, DOE's Partnership for the New Generation of Vehicles, and the Department of Defense's Dual Use Applications Program.

Overall Federal and Agency R&D Trends

Table 1 provides a six-year history of federal R&D funding, divided between defense R&D and nondefense R&D (or civilian R&D). As indicated in table 1, in constant 1987 dollars, total federal R&D has declined nearly 5% since

[4] *R&D growth Exceeded 1995 Expectations, but May Slow in 1996.* SRS Data Brief, National Science Foundation. Oct. 25, 1996. p. 2.

FY1992. During that time, nondefense R&D increased almost 6%, in real terms, while defense R&D has declined over 13%. On the other hand, starting from FY1995, the trends are reversed. Beginning in FY1995, nondefense R&D declined from $25.9 billion to an estimated $24.9 billion in FY1997, nearly 4%, while concomitantly defense R&D is showing a slight increase. As a percent of total R&D, defense R&D declined from 58.6% in FY1992, to an estimated 53.4% in FY1997.

For FY1997, basic research funding is estimated to reach $14.816 billion, an increase of 2.7% over FY1996. As indicated in table 1, CRS estimates that federal funding for basic research increased about 4.6%, in real terms, between FY1992 and

Table 1
Total Federal R&D Budget Authority
Defense & Nondefense FY1992-FY1997
(millions of $)

	1992	1993	1994	1995	1996	1997	Percent Change 92-97
Defense R&D	40,061	41,248	37,764	36,875	37,351	39,385	-1.7%
Nondef. R&D	28,337	28,635	30,567	33,948	34,051	34,365	21.3%
Total R&D	68,398	69,883	68,331	70,823	71,382	73,750	7.8%
Basic Research	12,490	13,399	13,553	13,776	14,431	14,816	18.9%
Total Federal R&D Budget Authority (millions of 1987$)							
Defense R&D	32,891	32,972	29,480	28,140	27,788	28,513	-13.3%
Nondef. R&D	23,265	22,890	23,862	25,915	25,347	24,879	6.9%
Total R&D	56,156	56,862	53,342	54,055	53,135	53,392	-4.9%
Basic Research	10,252	10,708	10,578	10,513	10,742	10,726	4.6%

FY1997. Since FY1995, basic research funding has increased 2%, with NIH leading the way with a 7% increase. Basic research funding for all other federal agencies (excluding NIH) actually declined 2%, in real terms. Federal support for basic research at the Nation's colleges and universities continues to grow increasing almost 7%, in real terms, between FY1992 and FY1996. (FY1997 estimates for academic research are not available.)

Between FY1995 and FY1997 total civilian R&D declined 4.1%, in real terms. Within this decrease, subtracting out NIH funding, which **increased** 7.2%, funding for the remaining civilian R&D agencies declined 9.6%

Tables 2 and 3 contain projected R&D spending estimates to FY2000, for defense and nondefense R&D, in both current (table 2) and constant dollars (table 3). The data contained in tables 2 and 3 were derived from two major sources, the President's FY1997 budget submittal (FY1997 Administration) and Congress' FY1997 budget resolution[5] (FY1997 Congressional). As is noted above, actual appropriations differed from both. Further, for reasons to be discussed at the end of this section of the report, it is unlikely that the President's as well as Congress' outyear R&D funding projections will materialize.

As indicated in table 3, from FY1996 to FY2000 the President proposed about a 14.5% cut for nondefense R&D, and a 16.8% cut for total R&D, in constant dollars. As with last year's submission, the President proposes that defense R&D decline at a faster rate than nondefense R&D. Congress, on the other hand, would cut total R&D 10.2% by FY2000, including a projected 14.1% reduction in nondefense R&D, in real terms. However, Congress protects defense R&D with cuts that are about one-third less than the President's. Figures 1 and 2 show these data graphically, at the end of this section.

Table 2
Total Estimated Federal R&D Funding Comparisons FY96-FY00
(billions of dollars)

Budget Estimates	1996	1997	1998	1999	2000
FY97 Administration	70.89	72.33	71.36	68.66	65.65
FY97 Congressional	70.88	71.95	69.73	70.10	70.78
Nondefense Estimated R&D Funding Comparisons					
FY97 Administration	33.15	34.59	33.66	32.45	31.54
FY97 Congressional	33.26	34.14	31.53	31.55	31.88
Defense Estimated R&D Funding Comparisons					
FY97 Administration	37.74	37.74	37.70	36.21	34.11
FY97 Congressional	37.62	37.81	38.20	38.55	38.90

Table 3
Total Estimated Federal R&D Funding Comparisons FY96-FY00
(billions of 1987 $)

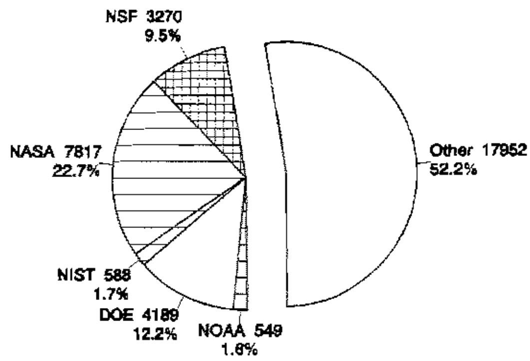
Budget Estimates	1996	1997	1998	1999	2000
FY97 Administration	52.77	52.36	50.32	47.17	43.93
FY97 Congressional	52.76	52.09	49.17	48.16	47.36
Nondefense Estimated R&D Funding Comparisons					

[5]H. Con. Res. 178, H. Rpt. 104-612.

Table 3 Total Estimated Federal R&D Funding Comparisons FY96-FY00 (billions of 1987 $)					
Budget Estimates	1996	1997	1998	1999	2000
FY97 Administration	24.68	25.04	23.74	22.29	21.10
FY97 Congressional	24.76	24.71	22.24	21.67	21.33
Defense Estimated R&D Funding Comparisons					
FY97 Administration	28.09	27.32	26.58	24.88	22.83
FY97 Congressional	28.00	27.38	26.93	26.49	26.03

Figure 3

Comparison of Civilian R&D Agencies



FY1997 Millions $, Tot. $34,365

Figure 3, compares funding for the five selected agencies with R&D funding for the remaining civilian R&D agencies. The five agencies included in our analysis account for almost 48% of all federal civilian R&D in FY1997. The largest of the five is NASA, with $7.817 billion of the $16.413 billion total. In the "Other" category, the National Institutes of Health (NIH), with a FY1997 budget of $12.747 billion, makes up almost 71% of the total. In FY1997, NIH will account for an estimated 37% of all federal civilian R&D.

Figure 4 (at the end of this section) compares the President's and Congress' out year R&D funding projections for the five agencies only. Between FY1997 and FY2000, the President recommended a 19.2% reduction, while Congress would cut these agencies' R&D programs by an estimated 19.6%, in real terms. These projections are higher than the President's recommended 14.5% reduction and Congress' 13.8% cut, for **all** civilian R&D, between FY1997 and FY2000 (see table 3).

Most individuals in the federal R&D community believe that these outyear R&D projections are not likely to be realized. Already there have been substantial changes between the R&D projections made in the FY1997 budget submission and congressional resolutions, than those made in the same FY1996 documents. Table 4 compares the President's and Congress' budget estimates made prior to FY1996 for R&D funding with their budget estimates made prior to FY1997. The President's FY1997 R&D budget proposal was 8% higher for defense R&D and 4% higher for total R&D than in his FY1996 budget submittal. Congress' FY1997 budget resolution had defense R&D funding 4% lower and nondefense R&D 12.8% higher than in its FY1996 budget resolution. Overall, Congress' total projection for R&D funding increased 3% over its FY1996 budget resolution.

Table 4
Comparison of R&D Funding Projections for FY1997
(billions of 1987 $)

	President's Budgets			Congressional Budgets		
Category	FY96	FY97	Change	FY96	FY97	Change
FY97 Defense	25.2	27.3	8.3%	28.7	27.4	-4.5%
FY97 Nondefense	24.9	25.0	.4%	21.9	24.7	12.8%
FY97 Total	50.1	52.1	4%	50.6	52.1	3%

For FY1997, Congress actually appropriated $53.4 billion for total R&D, in constant 1987 dollars (see table 1). This figure is about 2.5% higher than the President and Congress had estimated in their respective FY1997 budget documents. Further, it also may be important to note that because Congress and the President did not reduce R&D funding as much as originally anticipated, the President and Congress would have to cut total R&D, in real terms, 6.1% and 8.6% respectively, (see table 3) in order to match their projected funding levels for R&D in FY1998.

For over the past 20 years, there has been a strong relationship between total federal discretionary spending and total federal R&D spending. Since the early 1970s, total federal R&D spending has remained around 12% of total discretionary spending (about $500 billion in FY1996). This is also true for the relationship between nondefense discretionary funding and nondefense R&D funding. Consequently, as discretionary funding declines, as it is projected to, it is likely that R&D will decline proportionately. However, Congress or the President could intervene to protect R&D from potential future reductions or increase them. Preliminary figures for FY1997 indicate that R&D funding will comprise over 14% of both total and nondefense discretionary funding. In fact, this increase has been evident for the last couple of years. Between FY1995 and FY1997, total nondefense discretionary funding declined 10%, in real terms, while total nondefense R&D declined only 4.1%.

Both Congress and the Administration have submitted plans to balance the federal budget by FY2002 which include significant reductions for nondefense discretionary spending. It is likely therefore, that R&D funding will decline even if the year-by-year appropriations are greater than current projections.

The remainder of the report reviews past and future R&D activities in each of the selected five agencies.

Figure 1

R&D Projections

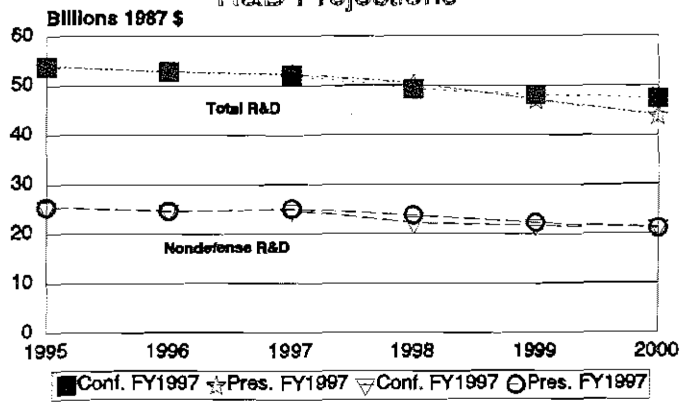
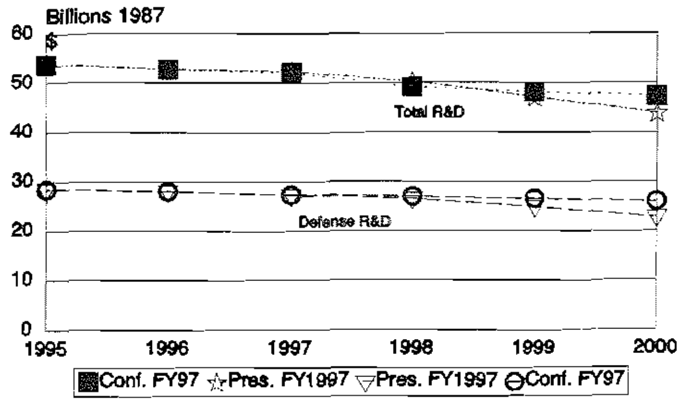


Figure 2

R&D Projections



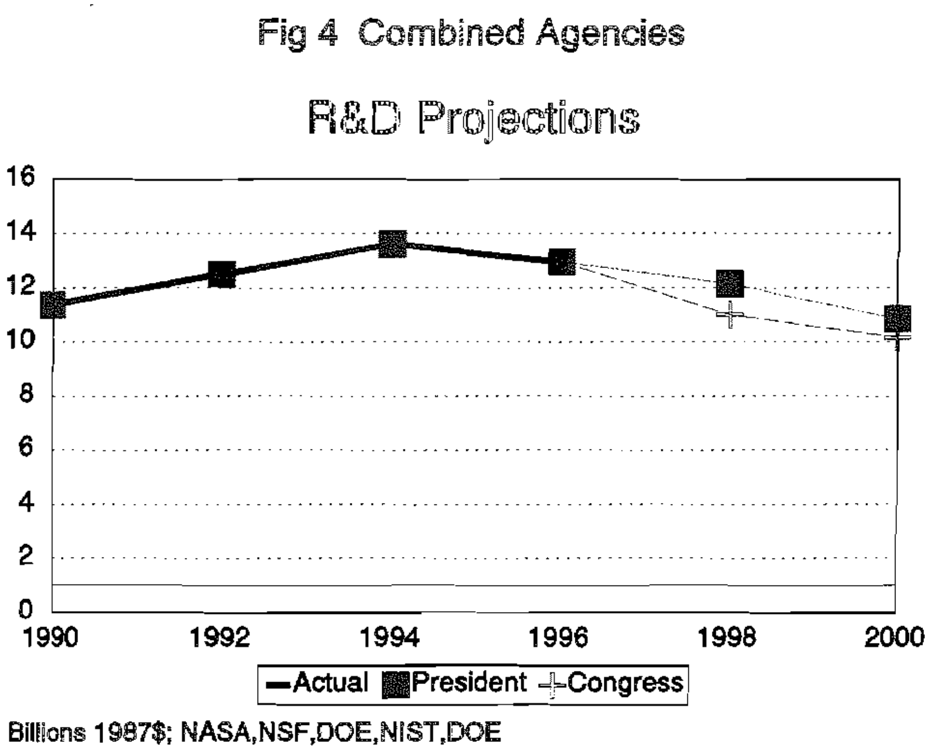


Fig 4 Combined Agencies
R&D Projections
16
14
12
10
8
6
4
2
0
1990
1992
1994
1996
1998
2000
Actual
President
Congress
Billions 1987$; NASA,NSF,DOE,NIST,DOE

NATIONAL SCIENCE FOUNDATION[6]

RESEARCH AND DEVELOPMENT FUNDING: FY1992 THROUGH FY1996

The National Science Foundation (NSF) has enjoyed considerable growth during a period of constrained R&D budgets. When measured in current dollars, its total appropriation increased by approximately 27.2 percent between FY1992 and FY1997. Even when inflation is taken into account, its growth increased, in constant 1987 dollars, by 12.2 percent. (See table 5 below for current and constant dollar support.) An analysis of its annual growth during the same six-year period reveals slower growth and even a slight decline, in real terms, over the last three fiscal years. Between FY1993 and FY1994, the total NSF budget in current dollars grew by 9.1 percent; between FY1994 and FY1995, total growth was recorded at 8.2 percent. However, from FY1995 to FY1997, the total NSF budget, in current dollars, increased only 1.3 percent, but, in real terms, declined 3.9 percent.

The major program accounts in the NSF are the Research and Related Activities (R&RA) and the Education and Human Resources Directorate (E&HR). Between FY1992 and FY1997, the R&RA account increased, in current dollars, 30 percent. In constant 1987 dollars, the increase for the R&RA is 14.6 percent for the six-year period. The EHR enjoyed an even larger increase from FY1992 to FY1997. In current dollars, the increase is approximately 33 percent; in constant 1987 dollars, the increase for the EHR is 17.4 percent. (Again see table 5 for current and constant dollar support of these two major programs for FY1992 through FY1997.)

Table 5. NSF: Trends in R&D Funding
Major Program and Total Support
(dollars in millions)

	FY1992	FY1993	FY1994	FY1995	FY1996	FY1997
Res. & Rel. Act. (R&RA)	1,872.0	2,081.4	2,163.7	2,244.1	2,314.0	2432.0
Educ. & Hum. Resources(EHR)	465.0	487.5	569.6	605.8	599.0	619.0
Total NSF	2,570.5	2,733.5	2,982.8	3,227.4	3,220.0	3,270.0
Constant 1987 $						
R&RA	1,536.9	1,663.8	1,689.1	1,712.5	1,722.5	1,760.7
EHR	381.8	389.7	444.7	462.3	445.9	448.1
Total NSF	2,110.4	2,185.1	2,328.5	2,462.9	2,396.9	2,367.3

[6]Prepared by Christine M. Matthews

The NSF's primary responsibility is to maintain the health and vitality of the U.S. academic science and engineering enterprise. In addition to ensuring the Nation's supply of scientific and engineering personnel, the NSF promotes academic basic research and science and engineering education across many disciplines. Support for research across the various disciplines is contained primarily in selected directorates in the R&RA. Support for science and mathematics education and the training of scientific personnel can be found in the EHR Directorate. Table 6 details program support for the various disciplines within the R&RA of the NSF along with all levels of support for science and engineering personnel. FY1997 breakdowns for the R&RA Directorates are not yet available.

TABLE 6. Directorate and Program Support: FY1992-FY1996
($ in millions)

	FY92	FY93	FY94	FY95	FY96
Res. & Rel. Act.					
Math & Phy. Sci.	622.3	585.9	617.8	$645.2	$651.0
Engineering	258.1	256.1	296.7	322.9	316.4
Social, Behav. & Econ. Sciences	86.0	90.7	98.2	110.4	114.0
Geosciences	402.0	381.6	404.2	419.6	418.0
Biol. Sciences	274.4	271.3	287.9	300.8	300.0
Comp. & Info. Sci. & Eng.	210.4	215.6	239.5	257.8	255.0
Polar Res. Prg.	[78.0]	180.7	158.4	160.0	154.4
Antarctic Log. Act.	[10.0]	63.4	64.1	62.6	62.6
Critical Tech. Inst.	0.0	1.0	1.5	2.0	2.6
Subtotal, R&RA	1,871.1	2,081.4	2,163.7	2,244.1	2,314.0
Ed. & Hum. Resr.	465.0	487.5	569.6	605.8	599.0
Acad. Res. Infras.	33.0	50.0	105.0	118.1	100.0
Major Res. Equip.	0.0	0.0	17.0	126.0	70.0
Total NSF	2,570.5	2,733.5	2,982.8	$3,227.4	$3,220.0

Agency officials employ internal accounting procedures to allocate funds throughout the R&RA, with support, for the most part, provided to each program and directorate proportionally. Table 7 shows the percentage of support provided the various directorates and programs in NSF for FY1992-FY1996. Funding levels received by the programs and directorates remained relatively stable during the five-year period.

Table 7.
NSF Directorate and Program Support -- Percentage of R&RA and of Total NSF Funding, FY1992-FY1996

	FY1992	FY1993	FY1994	FY1995	FY1996
Math & Phys. Sci.	33.3	28.1	28.6	28.8	28.1
Engineering	13.8	12.3	13.7	14.4	13.7
Soc. & Behav Sci.	4.6	4.4	4.5	4.9	4.9
Geosciences	21.5	18.3	18.7	18.7	18.1
Biological Sci.	14.7	13.0	13.3	13.4	13.0
Comp. & Inf. Sci.	11.2	10.4	11.1	11.5	11.0
Polar Res. Prog.		8.7	7.3	7.1	6.7
Antarctic Log. Act.		3.0	3.0	2.8	2.7
R&RA	72.8	76.1	72.5	69.5	71.9
Educ & Hum. Res.	18.1	17.8	19.1	18.8	18.6
Acad. Res. Infrastr.	1.3	1.8	3.5	3.7	3.1
Major Res. Equip.			1.0	3.9	2.2

While the Research and Related Activities account of the NSF has been restructured since FY1992, it has averaged 72.6 percent of the total budget from FY1992-FY1996 in current dollars.[7]

The level of support provided social and behavioral science research in the NSF has been questioned and debated at various times. There has been some skepticism within the NSF, the Congress, and the scientific community concerning the scientific merit of supporting social science research through the Social, Behavioral, and Economic Sciences Directorate (SBES). The efforts of the 104th Congress to reduce the federal deficit included proposals for priority changes in federal funding for R&D. Representative Robert S. Walker, Chair, House Science Committee, and Vice Chair, Budget Committee, had stated that in the current budget climate, research support for the physical sciences in the NSF should have a higher priority over the social sciences. While the social sciences would receive some level of funding, efforts would be made to guarantee that the research was fundamental in nature and warranted continued federal support. There was a proposal to reduce the number of directorates in the agency, presumably the SBES, and integrate some of its research activities into another directorate. However, the SBES survived all congressional attempts to reduce it in NSF's portfolio of multidisciplinary research. The SBES has averaged 4.6 percent of the R&RA between FY1992 and FY1996. It can be

[7]R&RA restructuring--The FY1994 appropriation retitled the U.S. Antarctic Program -- U.S. Polar Research Programs. FY1993 includes funding of $21.2 million for the Arctic Research Programs that was transferred and reported in the U.S. Polar Research Programs beginning in FY1994. Beginning in FY1995, all polar activities were included within the R&RA account. The Critical Technologies Institute was a separate account prior to FY1995. Funding for the Experimental Program to Stimulate Competitive Research was transferred to the EHR Directorate in FY1993.

assumed that it will receive approximately that proportion of the $2,432 million for the R&RA in FY1997.[8]

The NSF's mandated mission to develop and maintain a diverse talent pool of scientific and technical personnel is evident in the EHR. The EHR supports science and mathematics education at the precollege, undergraduate and graduate level.[9] The slight decline in support for the EHR beginning in FY1995 followed a period of rapid growth for science education activities. It was determined that a period of assessment was needed to evaluate the effectiveness of the programs already in place.

On October 14, 1994, the NSF released its strategic plan, *NSF in a Changing World*. The report stated that with the current need to reduce the federal budget deficit, it, as an agency, should determine what activities should be started, strengthened, or phased down while simultaneously maintaining the agency's primary responsibility. One of the activities of the NSF which witnessed reduced support was the polar activities -- both the U.S. Polar Research Program and the U.S. Antarctic Logistical Activities. Their proportion of the R&RA began a slight decline beginning in FY1994.

Currently, there are concerns about future options for the U.S. Antarctic Program and the South Pole Station. (The NSF has primary responsibility for U.S. Polar Research Programs.) During the 104th Congress, the House Science Committee held a hearing to assess U.S. policy and polar research activities. The committee was interested in determining, among other things, if maintaining a year round presence in the Antarctic was essential to U.S. interests, and determining the feasibility of creating an external panel to explore options for sustaining polar activities within realistic funding levels. Additional congressional interest focused on whether the $25 million in the FY1996 appropriation was adequate to address the needed safety, health, and environmental concerns at the south pole station and how to structure a long-term solution to the many problems.

It is somewhat problematic to determine if the support for academic research infrastructure (ARI) has been maintained over this period of five years because of its continued restructuring. At one point, this account supported facilities, and another time it supported both facilities and instrumentation. For FY1993, NSF sought $33 million for an academic instrumentation program and zeroed out the academic facilities modernization program. The Congress objected, funding academic research facilities at $37.5 million, and appropriating $12.5 million for instrumentation.

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[8]Specific funding levels for programs and directorates in the R&RA account in the FY1997 appropriations will not be available until late December or early January 1997.

[9]NSF's increased responsibilities in science and mathematics education contributed to a reorganization of the EHR in FY1993. Support for science and mathematics education is funded in the EHR and in selected activities of other NSF directorates.

The FY1996 budget had proposed $100 million for ARI, with funds equally divided between facilities and instrumentation. The 103rd Congress had appropriated $250 million, with language stipulating that unless the FY1996 request included $250 million for this program, the funds would be rescinded. The NSF determined that while there is a recognizable need for facility investment, support at the level of $250 million would greatly distort the priorities and require severe cuts in essential research and education programs. The Administration, henceforth, rescinded $131.9 million from the FY1995 appropriation.

Again, the ARI was proposed for restructuring in the submission of the FY1997 budget. A major shift resulting from the NSF's attempt to achieve a balance in the portfolio of investments for the agency was to eliminate the $50 million facilities modernization portion of the ARI. The NSF determined that academic faculties modernization was not a core responsibility of the agency. (Core responsibility was determined to be support for highly specialized, shared used facilities.) The $50 million in the ARI that appeared in the FY1996 appropriation was folded into other programs of the R&RA in the FY1997 appropriation.

Support for the major research equipment account has varied because of the stages of completion of the projects supported by this account. In FY1995, when it comprised 3.9 percent of the total NSF budget, one of its projects, the Laser Interferometer Gravitational Wave Observatory (LIGO), was undergoing major construction. Currently, LIGO is moving toward completion and operation. However, it is also LIGO, an international project, that has caused considerable concern and received increased federal scrutiny because of cost overruns.

Administration and Congressional Budget Projections: FY1997-FY2000

There is concern, specifically in the academic community, that continued congressional pressure to limit discretionary spending would threaten support of civilian science and have an adverse impact on growth in the NSF. Total discretionary spending, which currently comprises one-sixth of the total federal budget, is projected to decline to one seventh by the year 2002. Federal investment in research, including that supported in universities, could decrease in real terms by 18 percent between FY1995 and FY2000 if the current trends continue.

In testimony before the House Committee on Science in July 1996, Neal Lane, Director, NSF, cautioned about the difficulties inherent in economic forecasting. The need to place future priorities within a framework of overall declining budgets was at best problematic. Such a priority setting exercise could mean increases in one area, yet require decreases in others. Lane reminded the Committee that in FY1988, then President Reagan, presented a plan to double the NSF over a period of six years. The proposal for doubling entered the debate during the development of the President's budget and during the annual appropriation process. While support for the NSF did increase, it did not even begin to approach that which was detailed in the initial proposal. However, during each year of the six-year period, both the Administration's request and the annual appropriation activity used this "proposal" as the basis for planning and discussion.

Total funding figures for NSF out to FY2000 (table 8) were obtained from the President's FY1997 budget submittal. These numbers have been converted to constant FY1987 dollars in table 9. For the various programs and directorates in the NSF, the proportional support received in FY1996 was calculated and applied to the outyears. Outyear projections for the NSF present a scenario in which by the year 2000, total support could fall to $3,287 million. When adjusted for inflation, the budget could be recorded at $2,199 million. According to the President's budget, between FY1997 and FY2000 total funding for NSF could decline 7 percent in real terms. Concomitantly, funding for R&RA could decline 6 percent in real terms.

Table 8. NSF: Selected Directorate and Program Support
(Millions of Current Year Dollars-Admin)

Year	SBES	Polar	Antrc	R&RA	EHR	ARI	MRE	Total
1992	86.0	78.0	10.0	1,871.1	465.0	33.0	0.0	2,570.5
1993	90.7	180.7	63.4	2,081.4	487.55	50.0	0.0	2,733.5
1994	98.2	158.4	64.1	2,163.7	69.6	105.0	17.0	2,982.8
1995	110.4	160.0	62.6	2,244.1	605.8	118.1	126.0	3,227.4
1996	114.0	154.4	62.6	2,314.0	599.0	100.0	70.0	3,220.0
1997	122.9	168.0	67.7	2,432.0	648.6	108.1	76.7	3,270.0
1998	115.1	157.3	63.4	2,473.0	607.5	101.2	71.8	3,297.0
1999	112.6	154.0	62.1	2,474.0	594.7	99.1	70.3	3,291.0
2000	110.2	150.7	60.7	2,475.0	581.9	97.0	68.8	3,287.0

Table 9. NSF: Selected Directorate and Program Support
(Millions of Constant 1987 Dollars-Admin)

Year	SBES	Polar	Antrc	R&RA	EHR	ARI	MRE	Total
1992	70.6	64.0	8.2	1,536.2	381.8	27.1	0.0	2,110.4
1993	72.5	144.4	50.7	1,663.8	389.7	40.0	0.0	2,185.1
1994	76.7	123.7	50.0	1,689.1	444.7	82.0	13.3	2,328.5
1995	84.2	122.1	47.8	1,712.5	462.3	90.1	96.2	2,462.9
1996	84.9	115.0	46.6	1,722.5	445.9	74.4	52.1	2,396.9
1997	89.0	121.6	49.0	1,761.0	469.6	78.3	55.5	2,367.0
1998	81.2	110.9	44.7	1,743.0	428.4	71.4	50.6	2,325.0
1999	77.3	105.8	42.7	1,699.0	408.5	68.1	48.3	2,261.0
2000	73.7	100.8	40.6	1,656.0	389.4	64.9	46.0	2,199.0

Table 10 contains estimated budget levels for the Research and Related Activities (R&RA) account based on the FY1997 Congressional Budget Resolution, and the President's FY1997 budget submittal. The R&RA account contains approximately 80 to 85 percent of all NSF's basic research funding. It's important to note that none of the figures contained in table 10, include the

Department of Defense's (DOD) logistics costs ($62.6 million in FY1997) for the Antarctic program, which are part of the R&RA account. In its FY1997 budget resolution, Congress approved a 3 percent increase, through FY2000, in the R&RA programs, but did not include DOD's Antarctic logistics cost as part of that increase.

Table 10. Comparison of R&RA Projected Funding
Millions $

Year	President	President 1987 $	Congress	Congress 1987 $
1997	$2369	$1715	$2369	$1715
1998	2415	1701	2346	1654
1999	2421	1703	2416	1660
2000	2428	1625	2489	1665

In real terms, between FY1997 and FY2000, the President would cut R&RA 5.2 percent, while concomitantly Congress reduces it almost 3 percent. Because Congress approved $51 million more for R&RA in FY1997 than they had approved in the FY1997 budget resolution, Congress would have to cut R&RA by $23 million, or 3.6 percent, in real terms, to match its projected FY1998 funding levels. As illustrated in figure 1, the President's cuts would be less severe in FY1998, however, by FY2000 the President's R&RA budget is lower than Congress' in both current and constant dollars.

Finally, the table below shows what percent of basic research NSF supports at the Nation's colleges and universities by field of science. In FY1995, according to NSF estimates, the Foundation will support about 23% of all federally sponsored basic research received by colleges and universities. However, as indicated in table 11, NSF is the primary sponsor of basic research in mathematics and computer sciences (62%), environmental sciences (53%), and the physical sciences and social sciences (42%). Funding for all of these programs comes from the R&RA account.

Table 11. NSF Support for Basic Research at Universities by Field of Science FY1995 est. dollars in millions

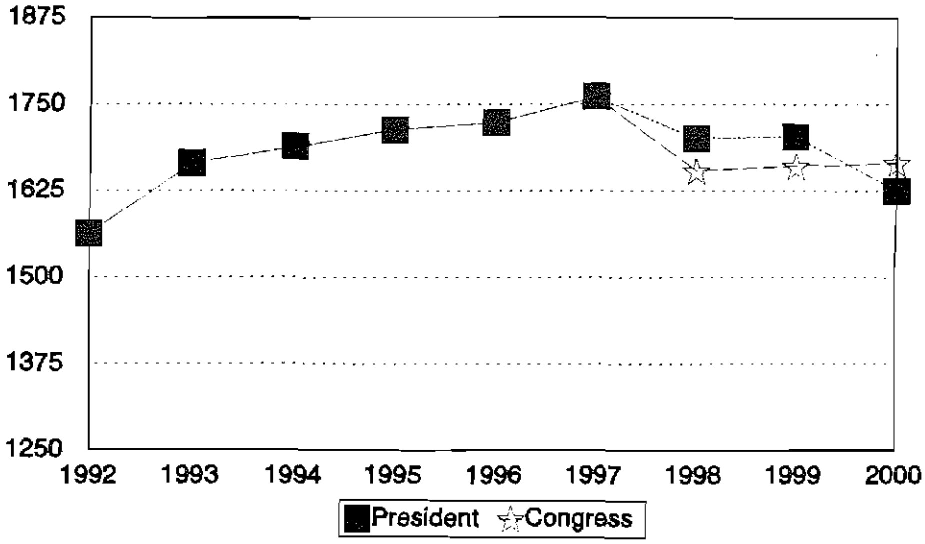
Fields of Science	Total	NSF Total	Percent NSF
All Fields	$7,450.4	1,674.8	23%
Math & Computer	391	241	62%
Environment	624	328	53%
Physical	1,045	435	42%
Social	114	48	42%
Engineering	631	183	30%

According to NSF officials, any real cut in the R&RA account will force the Foundation to make a number of difficult decisions. For example, NSF usually compensates for the gradual increase in research costs by increasing the average size of its grants. However, with declining resources, NSF could either keep increasing the average size of its grants (paying the full costs of doing research), thus funding fewer grants, or freeze grant costs (not paying the full costs of research), so it can fund the same number of grants.

NSF usually funds renewal grants at a much higher rate than other proposals. Consequently, declining resources will force NSF to either reduce its percent of renewal awards, or reduce the number of first time grant recipients. Choosing between keeping a senior researcher funded or bringing new researchers into the Foundation creates significant problems for NSF, as well as the entire university research community. For example, according to an NSF official, a $100,000 award, the average size of a grant, provides partial support for three people; the principle investigator, a graduate student, and a post doctoral student. Consequently, if R&RA were to decline $70 million, in real terms (the average between the President's and Congress' projections) by FY2000, approximately 2100 researchers could lose NSF support.[10] Nevertheless, according to NSF officials, these concerns reflect the types of difficult decisions that will have to be made in order to maintain the viability of NSF's research programs.

[10]While some in the university research community would view this as a tremendous opportunity loss for basic research in the U. S., others might argue that this may help alleviate the problem of excess production of PhDs, in certain fields of science.

Figure 5 NSF
Res. & Rel. Activ.



millions of 1987 $

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION RESEARCH AND DEVELOPMENT[11]

INTRODUCTION

This section contains an analysis of the Administration's and Congress's balanced budget plans on R&D activities at the National Aeronautics and Space Administration (NASA). The analysis includes discussions of NASA's R&D budget history from FY1992 to FY1996, NASA's FY1997 request, and the projections for NASA R&D programs from FY1997 to FY2000 under both the Administration's and Congress's budget plans. The potential implications of following either of the two projected budget plans are discussed by the major R&D funding categories listed below.

NASA's R&D programs are funded in two appropriations: Human Space Flight (HSF) and Science, Aeronautics, and Technology (SAT). HSF provides funding for the Space Station and Space Shuttle programs, including flight support for cooperative programs with Russia. The R&D programs under HSF are the Space Station, Russian Cooperation, and Payload Utilization. SAT provides funding for NASA's R&D activities, including all science activities, global monitoring, aeronautics, technology investments, education programs, mission communication services, and direct program support. R&D programs included under SAT are Space Science, Life & Microgravity Sciences, Mission to Planet Earth, Aeronautical Research & Technology, Space Access & Technology[12], Mission Communication Services, and Academic Programs.

FY1992 through FY1996

Although NASA's R&D budget rose from $6,011.3 million in FY1992 to $6,485.6 million in FY1994, before declining in FY1995 and FY1996, the agency's R&D programs were always under difficult funding constraints (see Table 13 and 14 for FY1992 through FY1996 funding).[13] NASA R&D funding increased 7.9% from FY1992 to FY1994 when R&D funding peaked.[14] From FY1994 to FY1996 R&D funding declined by 6.4%, nearing its FY1992 funding level (in 1987 dollars).

In FY1992, several observers asserted that NASA's funding estimates from FY1993 to FY1997 exceeded the agency's likely budgets for those years, and the

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[11]Prepared by David P. Radzanowski.

[12]Space Access & Technology was eliminated in 1996, however, it is used in this report for comparison purposes.

[13]These numbers are in 1987 dollars.

[14]All stated percentages in the NASA section of this report were calculated using constant dollars (in 1987 dollars).

General Accounting Office (GAO) estimated that NASA would have to reduce its program plans by $13 billion in current year dollars over that period to meet expected budgets.[15]

Since proposing its FY1993 estimates, NASA reduced its 5-year program through FY1997 by about $20 billion in current year dollars, or almost 22%. NASA accomplished these reductions through a variety of techniques such as eliminating some programs, scaling down program scopes, identifying program efficiencies, stretching some programs beyond the 5-year planning period, and reducing the number of civil service personnel. The reductions were actually more than $20 billion, since the agency's FY1996 request included nearly $3 billion for new R&D programs over 5 years.[16]

Five of NASA's largest programs, the Space Station, Space Shuttle, the Earth Observing System (EOS), the Cassini probe, and the Advanced Astrophysics Facility (AXAF) accounted for about $13 billion of the $20 billion reduction and represent 56% of NASA's FY1996 5-year program estimates. All of these projects, except the Space Shuttle, are R&D efforts. The reductions from the R&D programs are shown in Table 12.

Table 12. Funding Changes for Major NASA R&D Projects FY1993 - FY1996 (in millions of current year dollars)

Project	FY1993 5-Year Total	FY1996 5-Year Total	Dollar Change
Space Station	13,000	8,600	-4,400
EOS	5,300	5,100	-200
AXAF	1,700	800	-900
Cassini	1,400	500	-900

Source: General Accounting Office.

The reductions and impacts to these individual R&D projects were as follows.

Space Station

- Redesigned station to reduce and control costs;
- Funding capped at $2.1 billion per year;
- Restructured program management;

[15]NASA Budget: Potential Shortfalls in Funding NASA's 5-Year Plan. GAO/T-NSIAD-92-18. March 17, 1992.

[16]These new programs include the new millennium spacecraft, the reusable launch vehicle (RLV) program, the Space Infrared Telescope Facility (SIRTF), and the Stratospheric Observatory for Infrared Astronomy (SOFIA), a suborbital observatory.

- Renegotiated development contract; and
- Included Russia in the program.

Earth Observing System

- Revised program twice;
- Delayed some flights of spacecraft;
- Reduced algorithm development and standard data products;
- Increased reliance on international participants;
- Decreased science content (eliminated instruments); and
- Reduced funding reserves.

AXAF

- Split mission into two parts.
  - AXAF-I designed as smaller satellite in higher orbit; and
  - AXAF-S spacecraft terminated.
- Increased technical risk because of higher orbit.

Cassini

- Restructured program to reduce costs and satellite size;
- Reduced flexibility because instruments made stationary rather than movable; and
- Revised approach so operations personnel shared with other operations processes.

By 1995 NASA asserted that the reductions to programs resulted in a 5-year plan that was more realistic when compared to expected future budgets. In January 1995, however, NASA's 5-year plans once again became incongruent with expected budgets when the Administration directed NASA and other agencies to make additional funding reductions. Specifically, NASA was directed to freeze its budget at the FY1996 funding level--$14.3 billion--and make increasingly larger reductions from that level for each year from FY1997 through FY2000. Under this plan, the agency's budget would have been reduced from $14.3 billion in FY1996 to $13.2 billion in FY2000 (in current year dollars). The cumulative reductions totaled $4 billion in current year dollars for the 5-year period.

The agency undertook what is known as the Zero Base Review (ZBR) to meet the future reductions without resorting to cuts in R&D programs or program content. By its FY1997 budget submission, NASA had developed a plan to meet these reductions without cuts to R&D programs and program content.

FY1997 Request

In March 1996 NASA submitted its FY1997 budget request of $13.804 billion, an $80 million decrease below the agency's FY1996 operating level of $13.885 billion. Of the total FY1997 request, $7.912 billion was for R&D, $5.846 billion in 1987 dollars. Although the FY1997 request levels were relatively flat compared with FY1996, the Administration's outyear funding projections raised concern inside the agency and in Congress. Two weeks before NASA released its request, the agency was informed by the Administration that the agency's outyear projections had to include an additional $3 billion reduction in current year dollars over 5 years. This was in addition to the $4 billion current year dollar reduction directed in FY1996.

In these revised projections, NASA's budget would decline to a FY2000 level of $11.6 billion. In estimating NASA's outyear funding levels, the Office of Management and Budget (OMB) protected several programs from future cuts. These programs were the Mission to Planet Earth (MTPE) program, the Space Station, the High Speed Research and Advanced Subsonic Technology aeronautics programs, the High Performance Computing and Communications program, and New Millennium class projects. A percentage cut was then taken in subsequent years from the "unprotected" part of the budget. Areas such as Space Science and Space Access & Technology were left at risk. Such priorities put the Administration at odds with some in Congress. Although both maintain that Space Station funding is a priority, funding for MTPE has been controversial.

It should be noted, however, that a statement inserted into NASA's FY1997 budget documents by OMB asserted that the "outyear numbers should not be considered final policy numbers." Despite this caveat, NASA officials and many Members have stated that such future levels would be devastating and result in the cancellation of major programs and the closing of field centers.

In 1996 NASA Administrator Dan Goldin decided to focus the agency on the FY1997 budget and not take any "precipitous actions" to address the outyear funding levels. As such, NASA's current 5-year R&D plan is based on the FY1996 budget's outyear projections. In this plan, NASA's R&D programs would decrease from $5,845.9 million in FY1997 to $5,230.5 million in FY2000 (in 1987 dollars, see Table 15 and 16).

Administration and Congressional Budget Projections: FY1997 - FY2000

To meet the goal of a balanced federal budget by FY2002, Congress and the Administration have put forth projected budgets from FY1997 through FY2002 through the FY1997 Budget Resolution and the FY1997 budget request, respectively.[17] NASA's R&D funding is contained in Function 252 and

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[17]*Concurrent Resolution on the Budget for Fiscal Year 1997.* Conference Report (H.Rept. 104-612). U.S. House of Representatives. Washington, DC. June 7, 1996; and *Budget of the United States Government: Fiscal Year 1997, Analytical Perspectives.* U.S.

Function 402 of the federal budget. Function 252 contains funding for all NASA human space flight and science and technology R&D programs. Function 402 contains funding for all aeronautics R&D programs.

Using these budget documents, total NASA R&D levels and program levels were calculated from FY1997 through FY2000 using certain assumptions (see below). Finally, the OMB deflators were used to covert the calculations into constant, 1987 dollars. The assumptions used are as follows.[18]

Administration Assumptions. NASA's FY1997 budget request included a 5-year funding plan based on the agency's FY1996 plan. However, total funding for the HSF and SAT appropriations categories was provided taking into account the required reductions to meet the Administration's budget plan. The total reductions from the FY1996 plan were stated, but where in the budget the reductions would take place was not specified. In making the outyear calculations in this report, it was assumed that the Space Station, the Mission to Planet Earth (MTPE) program, the High Speed Research and Advanced Subsonic Technology aeronautics programs, the High Performance Computing and Communications program, and New Millennium class projects would be fully funded in the outyears (as was stated in the FY1996 plan). Since NASA aeronautics is funded in Function 402, the resultant aeronautics level was calculated from the budget authority outlook. A constant percentage was then taken from each remaining R&D program in NASA's FY1996 plan to meet the stated total reductions in each year.

Congressional Assumptions. Overall NASA R&D funding was calculated for each year using the budget authority levels provided in the FY1997 Budget Resolution. First, it was assumed that the Space Station would be fully funded according to NASA's current plans. Second, a constant percentage was then taken from each remaining R&D program in NASA's FY1996 plan to meet the calculated total value for NASA R&D for each year.

A Comparison of Total R&D Funding Levels

Using the Administration's projections, NASA R&D funding in 1987 dollars would fall from $5,845.9 million in FY1997 to $4,581.3 million in FY2000 (see Table 17 & 18), a reduction of 21.6%. Using Congress' FY1997 Budget Resolution, NASA R&D funding would fall 18% to $4,790.2 million in FY2000 in 1987 dollars (see Table 19 & 20). The Administration projections would fund NASA R&D at a higher level than the congressional projections in FY1997 and FY1998, but at a lower level in FY1999 and FY2000.

Govt. Print. Office. Washington DC.

[18]Please note that under both scenarios, a constant percentage reduction is taken from all non-protected programs. This was done for comparison purposes, but may have limited application. It is unlikely that Congress or the Administration would make such across-the-board cuts to meet future reductions.

NASA FY1997 R&D Appropriations

On September 26, 1996, President Clinton signed the FY1997 VA-HUD-IA appropriations act (P.L. 104-204). This act provides $13.709 billion for NASA in FY1997 in current year dollars. Of this amount $7.980 billion is for R&D, a reduction of $95 million from the R&D request. The $95 million decrease was taken as a general reduction from the science, aeronautics, and technology funding category.

When compared to Administration and congressional projections for FY1997, the R&D funding level is $95 million less than the Administration projected, but $286 million more than the congressional FY1997 budget resolution.

NASA's Outyear R&D Funding Versus Administration and Congress Projections

As stated previously, NASA's current 5-year R&D plan is based on the FY1996 budget's outyear projections. In comparing this plan with Administration and Congress outyear projections, NASA's plan is significantly higher than future budgets expected by the Administration and Congress. In comparing the plan to the Administration levels, NASA's R&D budget plan would have reductions of $410 million, $610 million, and $970 million in FY1998, FY1999, and FY2000, respectively (in current year dollars). This is a cumulative reduction of $1,990 million over three years. In comparing the plan to the congressional levels, NASA's R&D budget plan would have reductions of $586 million, $560 million, and $658 million in FY1998, FY1999, and FY2000, respectively (in current year dollars). This is a cumulative reduction of $1,804 million over three years.

NASA intends to make as many future reductions that it can in non-program areas such as civil servant and contractor personnel. The agency also hopes to further reduce other administrative costs and space shuttle costs. These reductions, however, most likely will not be enough. In either the Administration or congressional funding scenario, NASA's R&D programs most likely would be significantly impacted. The majority of NASA R&D funding is comprised of major programs that are strongly supported and will be difficult to cut. Since the Administration and Congress both strongly support the Space Station, it is unlikely that any reductions would be taken from that program. MTPE also is strongly supported by the Administration and the Senate. One of the major technology development programs, the Reusable Launch Vehicle (RLV) program, also maintains strong support in the Administration and Congress. This leaves NASA's space science and other technology programs susceptible to future cuts.

The potential problem with reducing funding for these programs is that several missions funded under these programs are touted by the agency as examples of a "new way of doing business." These projects are meant to be innovative and cost efficient allowing the agency to do more with less funding.

If these projects are curtailed, however, the ability of the agency to change its culture and do more R&D projects with less funding may be limited. Future R&D reductions to the agency could slow the NASA's transition to the "smaller, faster, cheaper, better" agency that is envisioned by NASA Administrator Dan Goldin and the Administration.

The following sections provide potential implications--based on the aforementioned assumptions--of the Administration and Congress budgets on the agency's major R&D funding categories.

Space Station (HSF Funding)

The Space Station HSF category provides funding for the development of the International Space Station (ISS).[19] ISS is a high priority of both the Administration and Congress. Current plans have the ISS HSF funding category declining from $1,387.5 million in FY1996 to $977.6 million in FY2000 (in 1987 dollars).[20] ISS construction is scheduled to begin in late 1997.

The assumption made in this analysis is that both the Administration and Congress will fully fund ISS regardless of how much NASA's budget declines. In support of this assumption, in its FY1997 appropriation, Congress is providing NASA the authority to transfer up to $177 million (in current year dollars) from the SAT account to the Space Station HSF account to cover potential cost overruns in development. Future funding levels could change dependent upon whether Russia will be able to meet its commitment to the ISS program.

Russian Cooperation

The Russian Cooperation category provides funding for the contract signed with the Russian Space Agency which provides services and hardware for Phase I and selected Phase II activities related to ISS. Phase I involves joint participation by U.S. and Russian crews in the Russian space station *Mir* and Space Shuttle operations. Phase II combines U.S. and Russian hardware to build the early structure of ISS and the systems capability to complete ISS.

Russian cooperation funding is scheduled to conclude in FY1998 with $17 million in current year dollars. With its relationship to ISS and the limited funding required in the outyears, it is assumed in this analysis that Congress and the Administration will fully fund Russian Cooperation in FY1998.

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[19]Funding for ISS science and technology activities also is included under the Science, Aeronautics and Technology category. The total funding request for ISS in FY1997 was $2,148.6 million.

[20]The total ISS funding profile declines from $2,143.6 million in FY1996 to $1,914.6 million in FY2000.

Payload Utilization

The Payload Utilization category supports the processing and flight of Space Shuttle payloads in the Spacelab module and the engineering and technical base for operation of space flight laboratories, facilities, and testbeds. Spacelab is a reusable observatory and laboratory facility located in the Space Shuttle payload bay to support a wide variety of science and technology development experiments which are developed by NASA and other external organizations.

Funding requirements for Payload Utilization have been declining steadily since FY1992 due to the phasing out of the use of Spacelab. The program declined 50% from FY1992 to FY1996. With the construction of ISS, most likely all space flight experiments will be done on ISS instead of Spacelab. Under the Administration's scenario, Payload Utilization is estimated to decline 42% from FY1996 to FY2000. Under Congress's budget the category is estimated to decline 44% by FY2000. Current NASA FY1996 plans have this category declining 41% by FY2000.

Although the decline is very large, by FY2000 there are no plans for Spacelab flights. The funding for the engineering and technical base (ETB) program, under Payload Utilization, will be the only remaining fundamental requirement. Currently, ETB is funded at $108 million in 1987 dollars. The budget projections estimate a funding level of $131 million and $135 million in FY2000 by Congress and the Administration, respectively (in 1987 dollars). It would appear that the funding projections could fund ETB at its current level. It should be noted, however, that the ETB program is initiating reductions resulting from the agency's Zero Base Review that will result in a reduced level of science and engineering support to human space flight programs. This will have an impact on workforce skills, analytical tools, and facilities dedicated to institutional engineering support. With reduced funding, it may be difficult to maintain core support for areas such as independent assessments, simulation, anomaly resolution, and systems engineering activities.

Space Science

The Space Science category provides funding for research and spacecraft that seek to expand our understanding of the origin and evolution of the universe, the fundamental laws of physics, the formation of stars and planets, and the processes by which our solar system developed. Space Science also seeks to discover and investigate extra-solar planets, and to determine the origin and evolution of life in the universe.

From FY1992 to FY1995, Space Science funding rose 20% to $1,551.4 million (in 1987 dollars). However, beginning in FY1996 and continuing in FY1997, Space Science has been declining. In those two fiscal years, Space Science declined 13.3%. This decline reflects the on-going pressure on NASA's total budget. In fact, no new starts in Space Science were requested in FY1997.

Even when the program had increasing funding, substantial reductions were made to Space Science because of lower outyear funding than was originally expected in the early 1990s. From FY1993 through FY1996, NASA reduced costs and outyear funding requirements for Space Science by $7,310 million in current year dollars. To get these savings the Cassini project to Saturn was restructured, the Comet Rendezvous and Asteroid Flyby project was canceled, the Advanced X-Ray Astrophysics Facility (AXAF) was restructured and AXAF-S was canceled, the research and analysis and suborbital programs were held at constant levels, and the mission operations and data analysis program was reduced in cost.

To meet future budget constraints, Space Science has become the focus of the agency's drive to do programs "faster, smaller, cheaper, and better." Space Science's current goal is to undertake more small missions, reduce large mission proposals to intermediate missions, and not undertake any new large missions. AXAF and Cassini are the last of the large Space Science missions. For example, a proposed Pluto Flyby mission was originally estimated in 1991 to cost $4,152 million in current year dollars to develop. Current estimates for a revised mission cost out at $390 million for development. If the mission is done cooperatively with Russia, the total development cost may drops even more. Such efforts may make it possible to continue a strong Space Science program in times of declining budgets. However, some science requires the use of large spacecraft. With the end of large space science spacecraft, some science efforts will probably have to be omitted for the present time.

For the Administration projection, Space Science would decline an additional 33% from FY1997 to FY2000. For the Congress projection, the decline would be 25%. Both of these funding levels would be significant reductions to NASA's Space Science program. The agency was already planning for a 20% reduction from FY1997 to FY2000. In the two scenarios, the Administration funds Space Science at a slightly higher level than Congress in FY1998, but at lower levels than Congress in FY1999 and FY2000.

In the Administration scenario, the Discovery, Explorer, Mars Surveyor, and New Millennium missions would be fully funded. The 33% reduction from FY1997 to FY2000 would have to come from the remaining Space Science programs which include AXAF, Cassini, the Relativity Mission, mission operations and data analysis, supporting research and technology, the suborbital program, and launch services. Since AXAF and Cassini have declining funding requirements due to their approaching launches, these two projects would probably not be reduced. As a result there may be great pressure to cancel the Relativity Mission and mission operations, data analysis, and technology development may be severely curtailed. Planned future missions such as Pluto Flyby and the Space Infrared Telescope Facility (SIRTF) would probably not be initiated. The actual science research undertaken in the Space Science program is funded under data analysis. A severe reduction in data analysis funding could result in a scenario where data are collected from science spacecraft, but limited research is conducted on the data due to lack of funding.

Under the Congress scenario, no missions are protected. Since AXAF and Cassini have declining funding requirements due to their approaching launches, these two projects would probably be fully funded. Current excitement about the potential for past life on Mars also may help protect Mars Surveyor funding. This situation will make it difficult to maintain funding for new space science projects such as the Relativity Mission, SIRTF and the Pluto Flyby and the Discovery series of small planetary probes. Mission operations and data analysis also may be curtailed.

The potential problem with reducing funding for newer space science programs is that they are touted by the agency as examples of a "new way of doing business." These projects are meant to be innovative and cost efficient allowing the agency to do more with less funding. If these projects are curtailed, however, the ability of the agency to change its culture and do more R&D projects with less funding may be limited.

Life & Microgravity Sciences

The Life & Microgravity Sciences category provides funding for experiments, both ground-based and space-based, to research the impact of the space and microgravity environment on humans and materials. This category also funds the development of Space Station payload facilities.

From FY1992 to FY1994, Life & Microgravity Sciences funding increased 206%. This substantial increase was due mainly to increased funding for future Space Station science payloads and facilities. From FY1994 to FY1997, funding declined 8.8% as levels remained constant in current year dollars.

For the budget projections, Life & Microgravity Sciences funding would increase 6.4% and 15% from FY1997 to FY2000 under the Administration and Congress scenarios, respectively. Such increases appear to bode well for Life Sciences, except that NASA currently expects an 18% increase over the same period. Under both scenarios, funding for Space Station payloads would not be reduced. Reductions from current plans, particularly under the Administration scenario, would probably come from experiments on other Space Shuttle flight programs and cooperative efforts with the National Institutes of Health (NIH). A negative impact of reducing experiments on the Space Shuttle is that such experiments are often precursors to planned experiments on the Space Station.

Mission to Planet Earth

The Mission to Planet Earth (MTPE) category provides funding for spacecraft and ground-based research to understand the total Earth system and the effects of natural and human-induced changes on the global environment. The centerpiece of the MTPE program is the series of spacecraft in Earth orbit, and its associated ground systems, known as the Earth Observing System (EOS).

Funding for MTPE has increased 26% from FY1992 to FY1997. The majority of this increase is due to EOS which was initiated in FY1991. The launch of the first EOS spacecraft, known as EOS-AM1 is scheduled for 1998. MTPE was strongly supported by the Bush Administration and is a top NASA priority for the Clinton Administration.

From FY1997 to FY2000, MTPE would increase 2% under the Administration's budget plan. In contrast, the Congressional budget plan would have a 4.6% decrease in MTPE funding during the same period. Since it is a priority of the Administration, MTPE would be fully funded in the outyears in the Administration scenario. The decrease in the Congressional scenario may be accommodated by delaying the launch of some EOS spacecraft, breaking up some planned EOS spacecraft into smaller, cheaper spacecraft, and/or by eliminating some science measurements. The elimination of any of the currently planned 21 science measurements is deemed by global change scientists to be severely detrimental to the science content of the program.

Aeronautical Research & Technology

The Aeronautical Research & Technology category is to provide the Nation with leadership in the development of high-payoff, critical aeronautical technologies. It also is to ensure the effective transfer of research and technology products to industry, the Department of Defense, and the Federal Aviation Administration for application to safe, environmentally responsible, and economically superior U.S. civil and military aircraft and safe national airspace system.

Aeronautical funding has remained relatively flat in 1987 dollars from FY1992 through FY1997. The notable exception was FY1994 when Aeronautical funding increased by 35% over FY1992 and subsequently declined 24% the following year. This one year increase was mainly due to a Clinton Administration initiative to refurbish and upgrade several of NASA's aeronautical facilities.

The Administration projection has Aeronautical funding decreasing 22% from FY1997 to FY2000. The Congress projection has a 28% decrease over the same period. These two scenarios decline substantially more than the 11% decrease currently planned by NASA over the same period.

Under the Administration scenario, the focused programs known as the High Performance Computing and Communications (HPCC) program, the High Speed Research (HSR) program, and the Advanced Subsonic Technology (AST) program would be fully funded. This leaves the Research and Technology (R&T) base as the only program remaining to absorb the 22% decrease to aeronautics. The R&T base provides the foundation to develop advanced technology concepts and methodologies for application to industry; to respond quickly to critical safety, security, and environmental issues; and to provide facilities and expert consultation for industry during their product design and development process. Such a reduction could be detrimental to an area which is known as the foundation or "seed corn" of the nation's aeronautics competitiveness. Although the projections in the Administration's budget would dictate such a reduction, given the assumptions previously stated, it is unlikely that such a large cut would be made to the R&T base.

Although the Congress scenario reduces Aeronautical funding by more than the Administration, the reduction would not solely be directed at the R&T base. A few in Congress have singled out the AST program as an area more suitably funded by the private sector rather than the Government. As such, some of the reduction in the Congress scenario would probably come from the AST program. The AST program is focused on developing high payoff technologies to benefit the civil aviation industry and the flying public by increasing safety and aircraft efficiency. Opponents to reducing the AST program believe it is important for the Government to fund technology development to improve safety to the flying public and maintain the competitive advantage held by the U.S. aviation industry.

Space Access & Technology[21]

The Space Access & Technology category provides funding for projects, in cooperation with industry, that pursue new and innovative technologies which may meet the challenges and lower the costs of future space missions. This category also includes funding for NASA's Small Business Innovation Research (SBIR) program requirements and the agency's technology transfer program.

From FY1992 to FY1997, Space Access & Technology funding increased steadily by a total of 40%. This increase is due to a refocusing of NASA, prompted by the Administration and Congress, for the development of advanced technologies to reduce future space mission costs and increase private sector involvement in the space program. A major portion of the increase is comprised of increases for NASA's Reusable Launch Vehicle (RLV) program to develop and flight test reusable launch technologies for a future RLV vehicle to replace the Space Shuttle.

The Administration projection has Space Access & Technology funding decreasing 25% from FY1997 to FY2000. The Congress projection has a 4.5% decrease over the same period. For comparison purposes, NASA's 1996 plans have Space Access & Technology increasing by 4.5% over the same period.

Under the Administration scenario the Advanced Smallsat Technology program would be fully funded. It also is likely that the RLV program would be fully funded too. SBIR funding requirements also will have to be met according to current law. This leaves areas such as spacecraft and remote sensing technology development and space processing programs susceptible to the 25% reduction. These areas, however, are particularly important for the

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[21]NASA's Space Access and Technology office was eliminated in 1996. As such the Space Access & Technology funding line item may be eliminated and the office's programs may be funded under different categories within NASA. For purposes of this comparison, however, the Space Access & Technology funding category is used for projections.

development of technologies for reducing the costs by maintaining the performance of future space science missions. Reductions to these areas could make it more difficult for the Space Science program to meet its future mission needs in a constrained budget environment.

Under the Congress scenario the RLV program also would probably be fully funded with the reduction coming from other programs. Since the projected reduction is much less than the Administration projection, the impact to Space Access & Technology programs would probably be significantly less resulting only in the delay or scaling back of some technology development projects.

Mission Communication Services

The Mission Communication Services category provides funding for telecommunications support for all HSF and SAT programs. Services include tracking, orbit and attitude determination, communications scheduling, spacecraft command, spacecraft health and safety data acquisition, and science data acquisition.

From FY1992 to FY1997, funding for Mission Communication Services has declined 34% due to the consolidation and streamlining of major support contract services and communications facilities. The introduction of cheaper and more efficient communications hardware also has reduced funding requirements.

The Administration projection has Mission Communication Services funding decreasing 29% from FY1997 to FY2000. The Congress projection has a 9% decrease over the same period. The current NASA plan has a reduction of 3% over the same period. The large reduction under the Administration scenario could have a severe impact on the agency's ability to communicate with and collect data from its spacecraft on orbit or in the solar system. Cutbacks to facilities and telecommunications hardware could lead to outdated equipment and increase the risk of having communications blackouts resulting in the loss of important scientific data. As the agency moves toward the use of smaller spacecraft in greater numbers, the ability of the agency to communicate with higher numbers of spacecraft could be impaired if such reductions were made.

Academic Programs

The Academic Programs provides funding for NASA's education programs to increase interest and promote excellence in science and technological competence in the U.S. education system. The program also provides funding for strengthening the research infrastructure capabilities of minority universities.

From FY1992 to FY1995, funding for Academic Programs has increased by 48%. The increase is due mostly to increases in NASA's education programs focused on minority universities. Since FY1995, however, funding levels have remained flat in 1987 dollars due do funding constraints on the agency's budget.

The Administration projection has Academic Programs funding decreasing 31% from FY1997 to FY2000. The Congress projection has a 13% decrease over the same period. The current NASA plan has a reduction of 5% over the same period. The large reduction under the Administration scenario may be met through a reduction in funding for minority university programs and programs that provide exposure to NASA missions in order to train students in science, mathematics, engineering, and technology. Some argue that the National Science Foundation (NSF) is more suited to providing education support in the sciences. However, the space program is often cited as an area that is exciting to students and encourages students to enter the science and engineering fields.

Table 13. National Aeronautics and Space Administration (NASA) Research and Development (R&D) Funding FY1992 - FY1996 (in millions of current year dollars)

	FY1992	FY1993	FY1994	FY1995	FY1996
HUMAN SPACE FLIGHT	**2,577.8**	**2,683.8**	**2,515.6**	**2,360.0**	**2,308.0**
Space Station	2,002.8	2,162.0	1,937.2	1,890.0	1,864.0
Russian Cooperation	0.0	79.5	170.8	150.0	129.0
Payload Utilization	575.0	442.3	405.6	320.0	315.0
SCIENCE, AERONAUTICS, & TECHNOLOGY	**4,744.0**	**4,908.7**	**5,792.5**	**5,882.0**	**5,846.0**
Space Science	1,570.9	1,510.4	1,920.9	2,033.0	2,033.0
Life & Microgravity Science	157.6	407.5	507.5	467.0	489.0
Mission to Planet Earth	985.1	936.3	1,068.0	1344.0	1,289.0
Aeronautical Research & Technology	788.2	769.4	1,067.2	846.0	846.0
Space Access & Technology	456.9	464.9	562.4	605.0	641.0
Launch Services	155.8	180.8	---	---	---
Mission Communication Services	562.8	546.5	581.1	481.0	441.0
Academic Programs	66.8	92.9	85.5	106.0	107.0
TOTAL R&D	**7,321.8**	**7,592.5**	**8,308.1**	**8,242.0**	**8,154.0**

Source: NASA

Table 14. National Aeronautics and Space Administration (NASA) Research and Development (R&D) Funding FY1992 - FY1996 (in millions of 1987 dollars)

	FY1992	FY1993	FY1994	FY1995	FY1996
HUMAN SPACE FLIGHT	**2,166.4**	**2,145.3**	**1,963.8**	**1,801.0**	**1,718.0**
Space Station	1,644.3	1,728.2	1,512.3	1,442.3	1,387.5
Russian Cooperation	0.0	63.5	133.3	114.5	96.0
Payload Utilization	472.1	353.6	316.6	244.2	234.5
SCIENCE, AERONAUTICS, & TECHNOLOGY	**3,894.9**	**3,923.8**	**4,521.9**	**4,488.7**	**4,351.6**
Space Science	1,289.7	1,207.4	1,499.5	1,551.4	1,513.3
LIfe & Microgravity Science	129.4	325.7	396.2	356.4	364.0
Mission to Planet Earth	808.8	748.4	833.7	1,025.6	959.5
Aeronautical Research & Technology	647.1	615.0	833.1	645.6	629.7
Space Access & Technology	375.1	371.6	439.0	461.7	477.1
Launch Services	127.9	144.5	---	---	---
Mission Communication Services	462.1	436.9	453.6	367.1	328.3
Academic Programs	54.8	74.3	66.7	80.9	79.6
TOTAL R&D	**6,011.3**	**6,069.1**	**6,485.6**	**6,289.7**	**6,069.7**

Table 15. NASA Outyear R&D Projections
Based on the Agency's FY1996 Budget
FY1997 - FY2000
(in millions of current year dollars)

	FY1997	FY1998	FY1999	FY2000
HUMAN SPACE FLIGHT	**2,212.0**	**1,951.0**	**1,873.0**	**1,670.0**
Space Station	1,802.0	1,704.0	1,675.0	1,461.0
Russian Cooperation	138.0	17.0	0.0	0.0
Payload Utilization	272.0	230.0	198.0	209.0
SCIENCE, AERONAUTICS, & TECHNOLOGY	**5,863.0**	**6,049.0**	**6,020.0**	**6,147.0**
Space Science	1,857.0	1,711.0	1,621.0	1,609.0
Life & Microgravity Science	499.0	556.0	615.0	639.0
Mission to Planet Earth	1,402.0	1,476.0	1,455.0	1,548.0
Aeronautical Research & Technology	858.0	997.0	914.0	829.0
Space Access & Technology	725.0	796.0	808.0	820.0
Mission Communication Services	421.0	411.0	444.0	443.0
Academic Programs	101.0	102.0	102.0	102.0
Future Planning	0.0	0.0	61.0	157.0
Total R&D	**8,075.0**	**8,000.0**	**7,893.0**	**7,817.0**

Source: NASA

Table 16. NASA Outyear R&D Projections
Based on the Agency's FY1996 Budget
FY1997 - FY2000
(in millions of 1987 dollars)

	FY1997	FY1998	FY1999	FY2000
HUMAN SPACE FLIGHT	**1,601.4**	**1,375.8**	**1,286.6**	**1,117.4**
Space Station	1,304.6	1,201.6	1,150.6	977.6
Russian Cooperation	99.9	12.0	0.0	0.0
Payload Utilization	196.9	162.2	136.0	139.8
SCIENCE, AERONAUTICS, & TECHNOLOGY	**4,244.6**	**4,265.6**	**4,135.2**	**4,113.1**
Space Science	1,344.4	1,206.5	1,113.5	1,076.6
Life & Microgravity Science	361.3	392.1	422.4	427.6
Mission to Planet Earth	1,015.0	1,040.8	999.5	1,035.8
Aeronautical Research & Technology	621.2	703.1	627.8	554.7
Space Access & Technology	524.9	561.3	555.0	548.7
Mission Communication Services	304.8	289.8	305.0	296.4
Academic Programs	73.1	71.9	70.1	68.2
Future Planning	0.0	0.0	41.9	105.1
Total R&D	**5,845.9**	**5,641.4**	**5,421.8**	**5,230.5**

Table 17. NASA Outyear R&D Projections
Based on the Administration's FY1997 Budget
FY1997 - FY2000
(in millions of current year dollars)

	FY1997	FY1998	FY1999	FY2000
HUMAN SPACE FLIGHT	**2,212.0**	**1,948.2**	**1,868.3**	**1,662.8**
Space Station	1,802.0	1,704.0	1,675.0	1,461.0
Russian Cooperation	138.0	17.0	0.0	0.0
Payload Utilization	272.0	227.2	193.3	201.8
SCIENCE, AERONAUTICS, & TECHNOLOGY	**5,863.0**	**5,642.0**	**5,415.0**	**5,184.0**
Space Science	1,857.0	1,613.0	1,465.5	1,342.4
Life & Microgravity Science	499.0	538.0	577.7	574.6
Mission to Planet Earth	1,402.0	1,476.0	1,455.0	1,548.0
Aeronautical Research & Technology	858.0	815.0	772.0	727.0
Space Access & Technology	725.0	730.7	685.1	591.9
Mission Communication Services	421.0	376.0	373.8	325.2
Academic Programs	101.0	93.3	85.8	74.9
Total R&D	**8,075.0**	**7,590.2**	**7,283.3**	**6,846.8**

Table 18. NASA Outyear R&D Projections
Based on the Administration's FY1997 Budget
FY1997 - FY2000
(in millions of 1987 dollars)

	FY1997	FY1998	FY1999	FY2000
HUMAN SPACE FLIGHT	**1,601.4**	**1,373.8**	**1,283.3**	**1,112.6**
Space Station	1,304.6	1,201.6	1,150.6	977.6
Russian Cooperation	99.9	12.0	0.0	0.0
Payload Utilization	196.9	160.2	132.8	135.0
SCIENCE, AERONAUTICS, & TECHNOLOGY	**4,244.6**	**3,978.6**	**3,719.6**	**3,468.7**
Space Science	1,344.4	1,137.4	1,006.7	898.2
Life & Microgravity Science	361.3	379.4	396.8	384.5
Mission to Planet Earth	1,015.0	1,040.8	999.5	1,035.8
Aeronautical Research & Technology	621.2	574.7	530.3	486.5
Space Access & Technology	524.9	515.3	470.6	396.1
Mission Communication Services	304.8	265.1	256.8	217.6
Academic Programs	73.1	65.8	59.0	50.1
Total R&D	**5,845.9**	**5,352.4**	**5,003.0**	**4,581.3**

Table 19. NASA Outyear R&D Projections
Based on the Congress's FY1997 Budget Resolution
FY1997 - FY2000
(in millions of current year dollars)

	FY1997	FY1998	FY1999	FY2000
HUMAN SPACE FLIGHT	**2,194.7**	**1,936.5**	**1,860.5**	**1,656.2**
Space Station	1,802.0	1,704.0	1,675.0	1,461.0
Russian Cooperation	138.0	17.0	0.0	0.0
Payload Utilization	254.7	215.5	185.5	195.2
SCIENCE, AERONAUTICS, & TECHNOLOGY	**5,499.3**	**5,477.6**	**5,472.6**	**5,502.7**
Space Science	1,739.2	1,602.9	1,518.4	1,503.1
Life & Microgravity Science	485.2	542.7	600.1	623.1
Mission to Planet Earth	1,313.0	1,382.7	1,362.9	1,446.1
Aeronautical Research & Technology	794.0	723.0	723.0	672.0
Space Access & Technology	679.0	745.7	756.8	749.2
Mission Communication Services	394.3	385.0	415.9	413.9
Academic Programs	94.6	95.6	95.5	95.3
Total R&D	**7,694.0**	**7,414.1**	**7,333.1**	**7,158.9**

Table 20. NASA Outyear R&D Projections
Based on the Congress's FY1997 Budget Resolution
FY1997 - FY2000
(in millions of 1987 dollars)

	FY1997	FY1998	FY1999	FY2000
HUMAN SPACE FLIGHT	**1,588.9**	**1,365.6**	**1,278.0**	**1,108.2**
Space Station	1,304.6	1,201.6	1,150.6	977.6
Russian Cooperation	99.9	12.0	0.0	0.0
Payload Utilization	184.4	152.0	127.4	130.6
SCIENCE, AERONAUTICS, & TECHNOLOGY	**3,981.2**	**3,862.6**	**3,759.2**	**3,682.0**
Space Science	1,259.1	1,130.3	1,043.0	1,005.8
Life & Microgravity Science	351.3	382.7	412.2	416.9
Mission to Planet Earth	950.6	975.0	936.2	967.6
Aeronautical Research & Technology	574.8	509.8	496.6	449.6
Space Access & Technology	491.6	525.8	519.9	501.3
Mission Communication Services	285.5	271.5	285.7	276.9
Academic Programs	68.5	67.4	65.6	63.8
Total R&D	**5,570.1**	**5,228.2**	**5,037.2**	**4,790.2**

Fig. 6 NASA R&D Funding

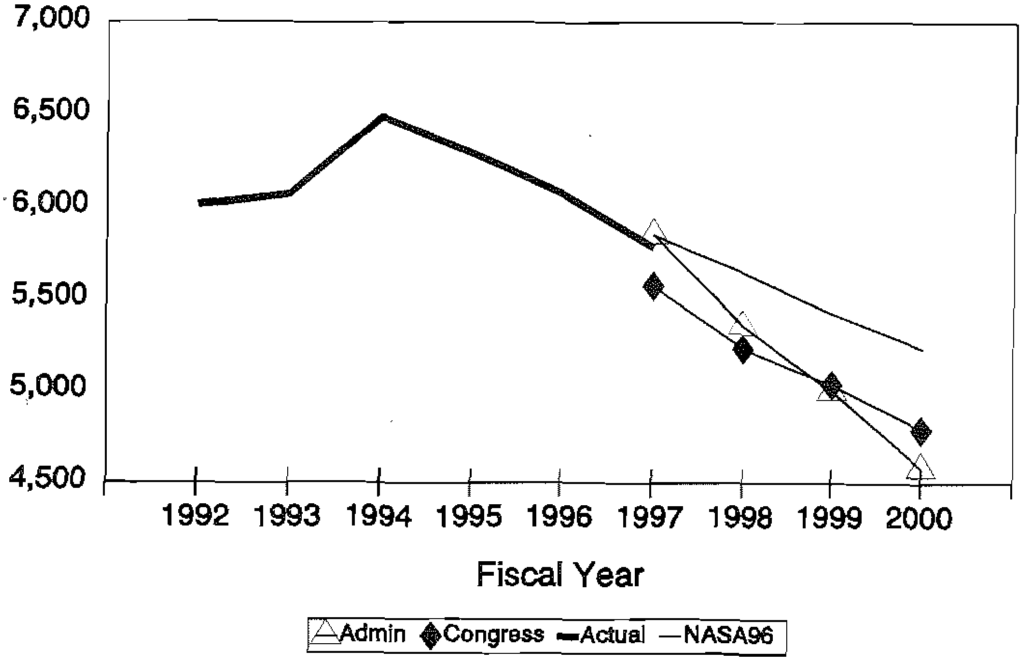
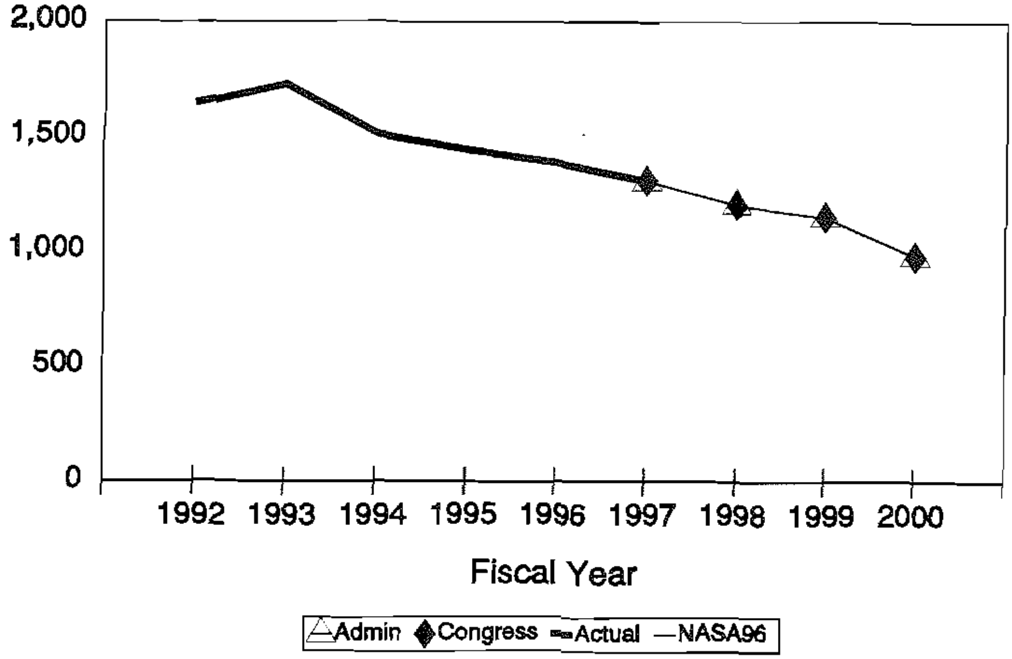


Fig. 7 NASA - Space Station (HSF Funding)



Does not include Space Station SAT funds or potential transfers from SAT.

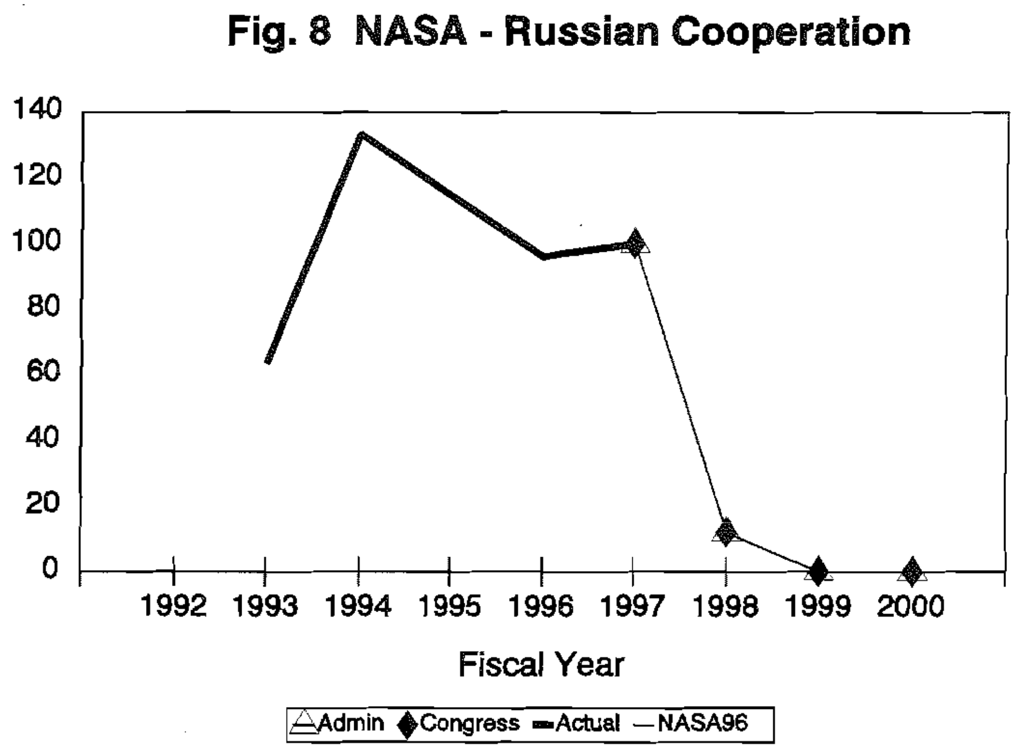


Fig. 8 NASA - Russian Cooperation
140
120
100
80
60
40
20
0
1992
1993
1994
1995
1996
1997
1998
1999
2000
Fiscal Year
Admin
Congress
Actual
NASA96

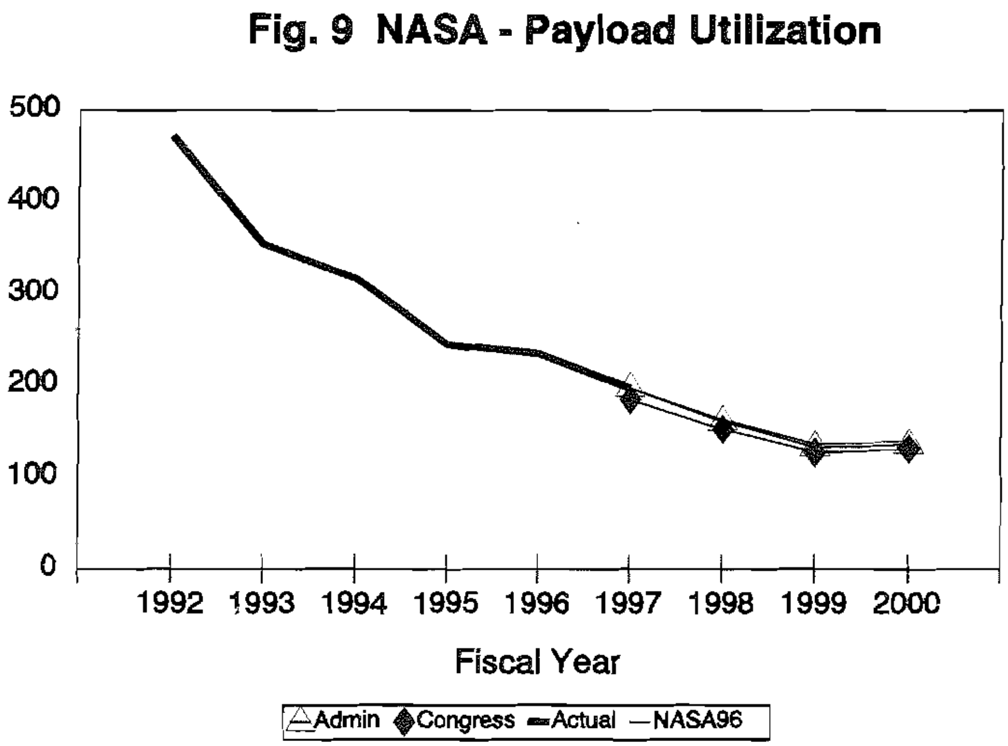
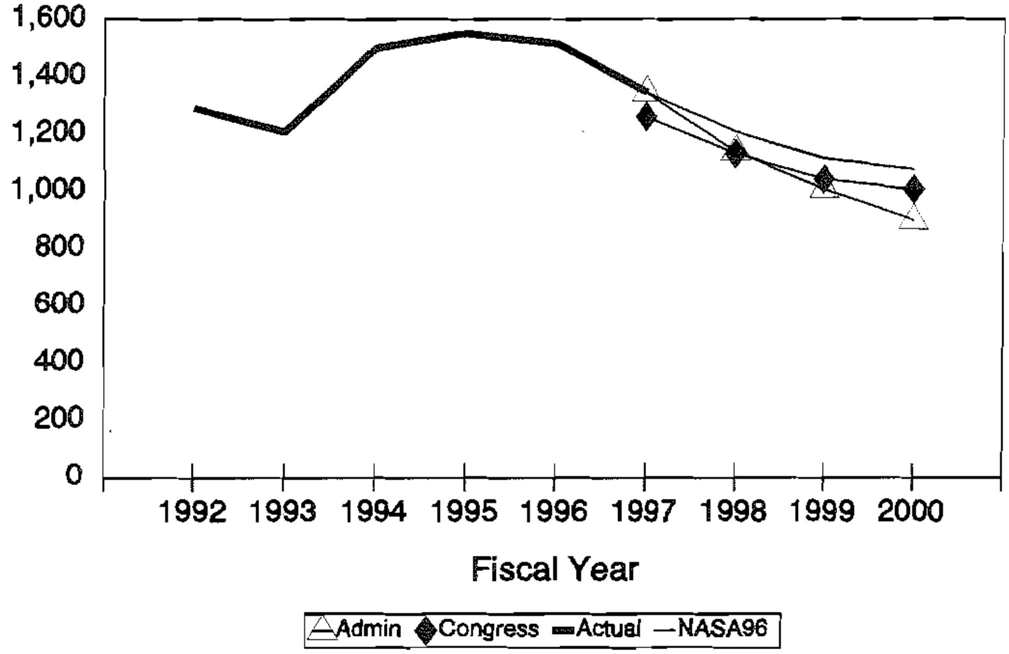


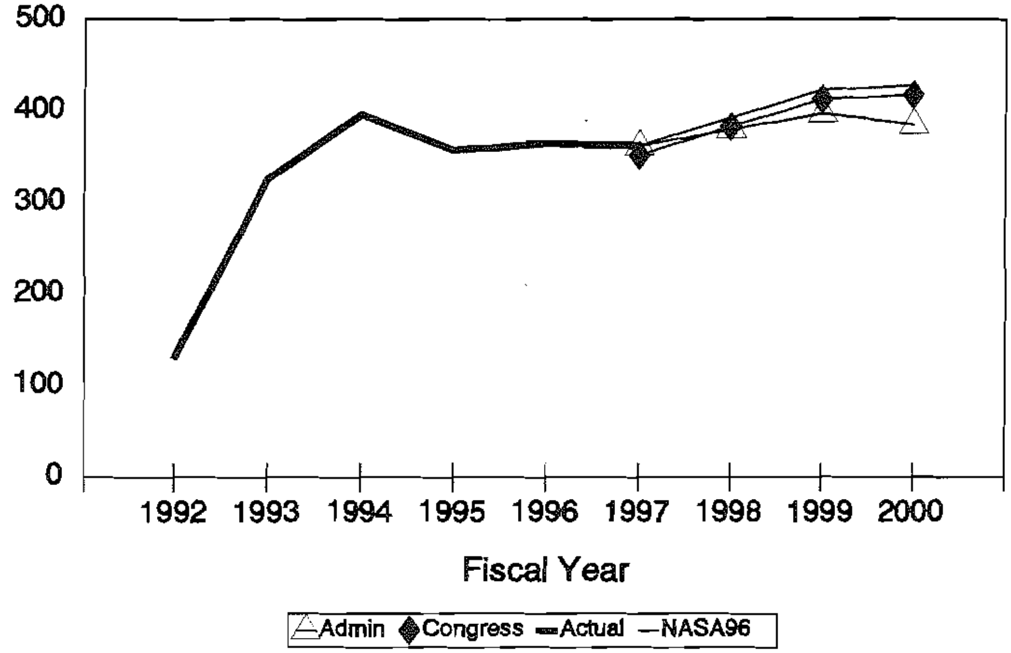
Fig. 9 NASA - Payload Utilization
500
400
300
200
100
0
1992
1993
1994
1995
1996
1997
1998
1999
2000
Fiscal Year
Admin
Congress
Actual
NASA96

Fig. 10 NASA - Space Science

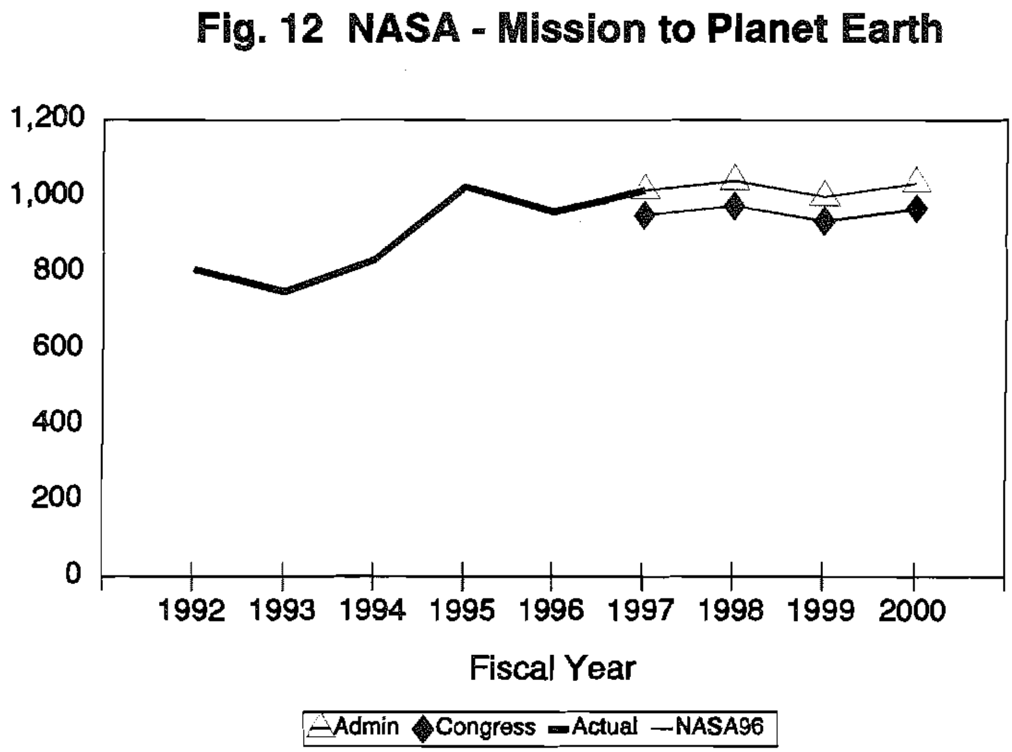


FY1997 Actual number does not reflect potential changes resulting from the congressionally directed $95 million SAT reduction.

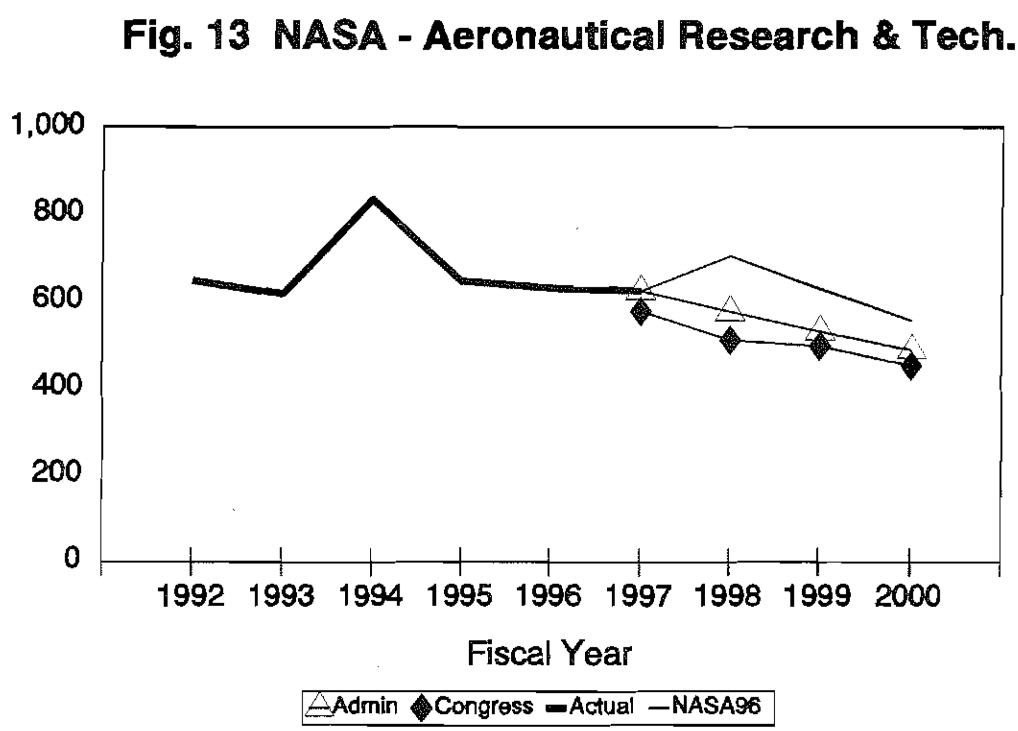
Fig. 11 NASA - Life & Microgravity Science



FY1997 Actual number does not reflect potential changes resulting from the congressionally directed $95 million SAT reduction.

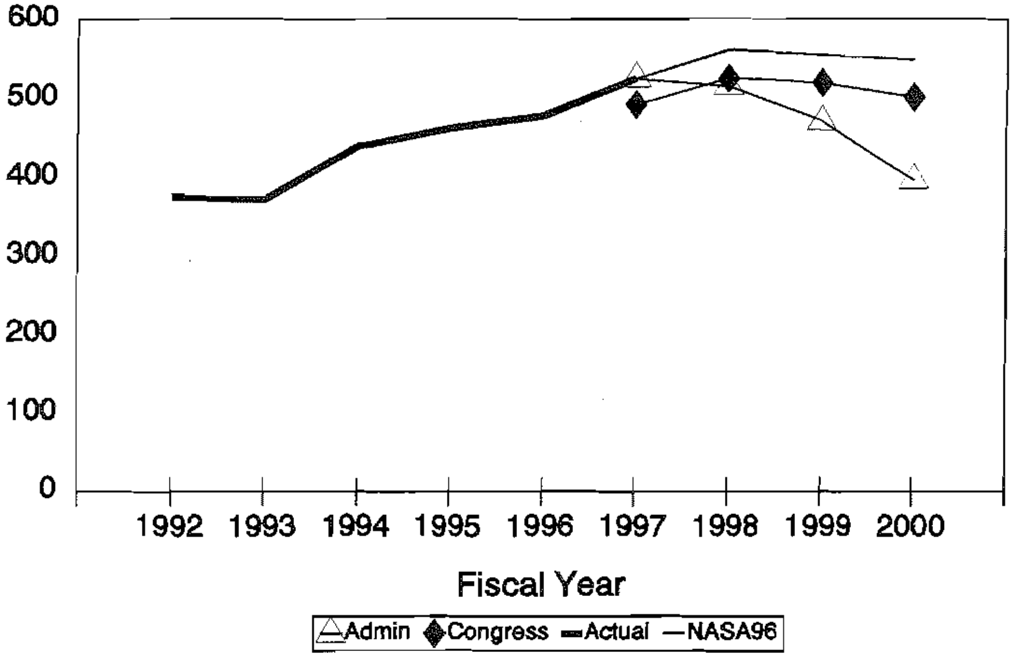


FY1997 Actual number does not reflect potential changes resulting from the congressionally directed $95 million SAT reduction.



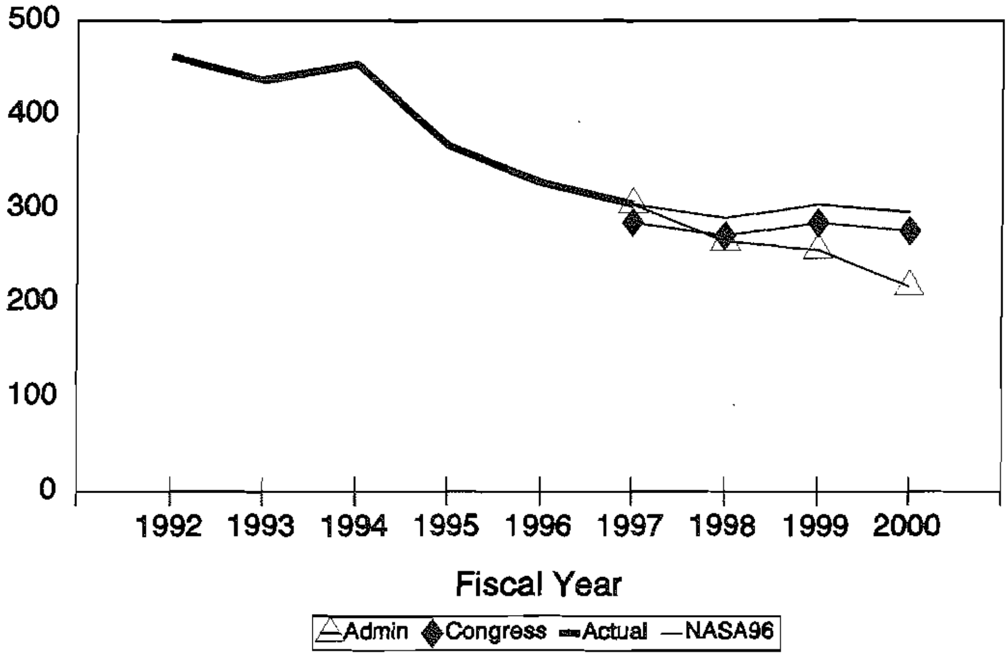
FY1997 Actual number does not reflect potential changes resulting from the congressionally directed $95 million SAT reduction.

Fig. 14 NASA - Space Access & Technology

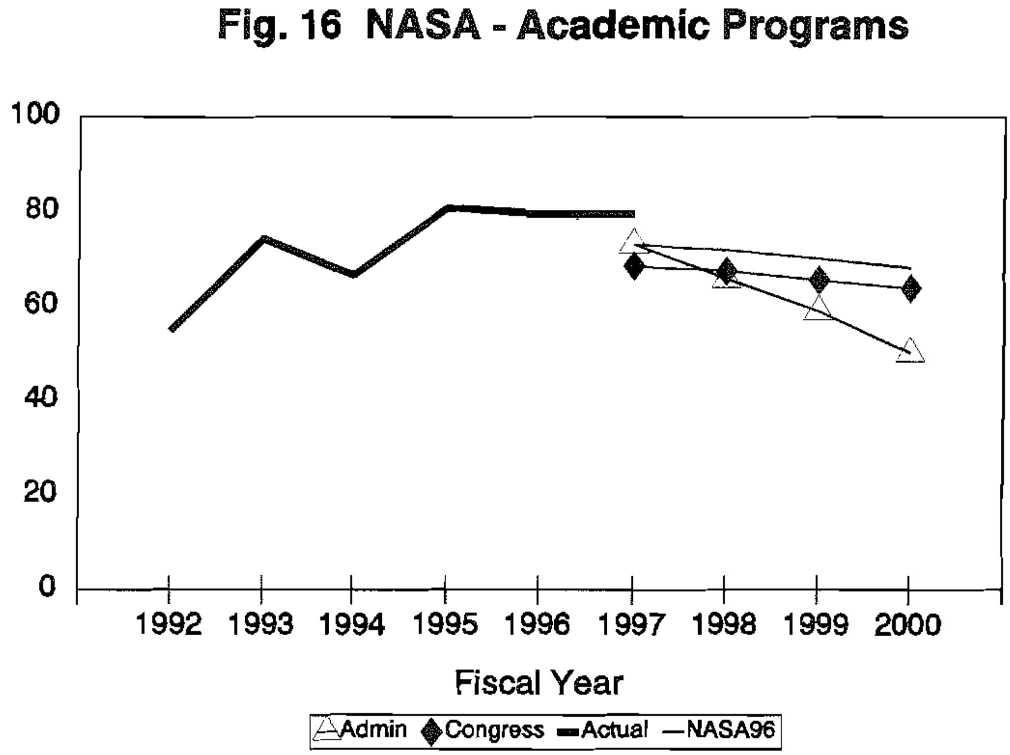


FY1997 Actual number does not reflect potential changes resulting from the congressionally directed $95 million SAT reduction.

Fig. 15 NASA - Mission Communication Services



FY1997 Actual number does not reflect potential changes resulting from the congressionally directed $95 million SAT reduction.



FY1997 Actual number does not reflect potential changes resulting from the congressionally directed $95 million SAT reduction.

THE DEPARTMENT OF ENERGY CIVILIAN RESEARCH AND DEVELOPMENT

INTRODUCTION

This section presents a brief analysis of the potential implications of the Administration's and Congress's balanced budget plans on principal civilian R&D activities at the Department of Energy (DOE). The analysis considers seven programs within DOE; energy conservation, renewable energy, basic energy sciences (including computation and technology research), fusion energy sciences, biological and environmental research, and general science research (high energy physics and nuclear physics). Budget histories from FY1990 and projections to FY2000 (from both the Administration and Congress) are presented along with a brief discussion of the content of each program, the budget history from FY1990 to FY1997, and the possible consequences of following either of the two budget tracks to FY2000.

The budget projections for the several programs were estimated from the budget authority outlook given in the Administration's FY1997 budget request,[22] and the Congressional budget resolution for FY1997.[23] For DOE's civilian programs, the relevant budget functions are 250 and 270. To determine the outyear estimates, the ratio of each program's FY1997 appropriation to the total FY1997 appropriation included with the budget function was calculated.[24] This ratio was then assumed to remain constant for the years FY1998 to FY2000. The ratios were then multiplied by the totals given in the budget function for each of the outyears to get a value for the individual program for that year. Finally, the Office of Management and Budget deflators were used to convert these values into constant, 1987 dollars.

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[22]*Budget of the United States Government:Fiscal Year 1997, Analytical Perspectives.* U.S. Govt. Print. Off., Washington, DC. p. 343.

[23]Concurrent Resolution on the Budget for Fiscal Year 1997. Conference Report (H.Rpt.104-612). U.S. House of Representatives. Washington, DC. June 7, 1996. p.59.

[24]The level of detail provided by each budget is considerably different. The congressional resolution only gives one number for the entire budget function 250 and one for function 270. The Administration's budget provides separate amounts for general science and research (within function 250), energy research and development and energy conservation (both within function 270). When determining the estimates for Fy1998 to FY2000, the most detailed number available was used. For example, for the BES, BER, FES and renewable programs, the energy research and development numbers given in the Administration's budget document were used to calculate the Administration projections for these programs, while the single number given for function 270 in the congressional resolution was used to calculate congressional projections for these same programs.

Table 21 gives the budget history and projection for the two cases for all DOE civilian R&D.[25] [26] Funding is given in constant, 1987 dollars. The table shows a real increase from FY1990 to FY1995 of about 24%. At that point, overall budget constraints began to force funding downward which dropped about 18% between FY1995 to FY1997. The projections given in the table show DOE civilian R&D funding continuing to decline to FY2000. According to the Administration's budget outlook, a reduction from FY1997 to FY2000 of 16% (in 1987 dollars) is forecast while according to the congressional budget resolution, the reduction would amount to 21% (in 1987 dollars).

Table 21 - DOE Civilian R&D - Total (Billions of 1987 dollars)

Budget	Fiscal Year										
	90	91	92	93	94	95	96	97	98	99	00
Congress	3.25	3.54	3.88	4.00	4.03	4.02	3.46	3.29	2.79	2.76	2.62
Admin	3.25	3.54	3.88	4.00	4.03	4.02	3.46	3.29	3.45	3.00	2.77

From the FY1994-1995 DOE civilian R&D funding peak to FY2000, the total reduction would be 31% under the Administration's budget forecast and 35% under the congressional budget resolution (both in 1987 dollars). Declines of this size have had and are likely to continue to have substantial effects on DOE civilian R&D programs in terms of projects that can be funded and facilities that can be maintained.[27] The consequences of these effects are considered in more detail for the principal civilian program in the next part of this section. Included at the end of that discussion are tables II through V giving historical and projected funding levels for the seven programs considered for both the administration and congressional budget forecasts. Both current year and constant, 1987 dollars are given.

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[25]In addition to the seven programs analyzed in this section, civilian R&D at DOE contains programs in nuclear energy research, environmental R&D, environmental restoration, fossil energy R&D and other energy programs.

[26]Funds for the superconducting supercollider are not included in these totals.

[27]It is worth noting that the projected FY2000 funding levels are a lot closer to those experienced by DOE during the late 1980s. For example, compared to the FY1987 total, the FY2000 projections represent potential reductions of 13.5% and 18.0% for the Administration and congressional forecasts respectively.

DOE PROGRAMS

ENERGY CONSERVATION R&D

The Energy Conservation R&D program is divided into three sectors -- buildings, industry and transportation.[28] The principal focus of energy efficiency research is to reduce those sector's energy requirements while maintaining or improving services, and enhancing environmental quality. The buildings sector focuses on the building as an integrated system, exploring ways to make the building envelope, equipment and appliances more efficient. The transportation sector directs its R&D at improving efficiency of the current generation of engines, developing new engine technology and supporting alternative transportation fuels. This sector also leads the Partnership for a New Generation of Vehicles (PNGV) initiative.[29] This initiative is a joint effort between the federal government and the Nation's three largest automakers to develop an automobile for the next century which will be substantially more efficient without sacrificing features or invoking a price penalty. The industry sector funds R&D on process improvements in basic manufacturing whose goal is increased productivity and energy efficiency. It also focuses on developing technology to reduce or re-cycle process waste streams, and on advanced, on-site energy generating technology. Finally, this program has responsibility for application of energy efficiency and renewable energy technologies in public sector facilities.

The funding history of the DOE Energy Conservation program in since 1990 is shown in the figure I on the next page. A more detailed breakdown of the funding history from FY1990 to FY1997 is shown in table 26 where funding data, also in 1987 dollars, are given for programs' three sectors. All data are in 1987 dollars. The conservation program increased by a 133 percent from 1990 to 1995. The transportation sector saw the most rapid buildup, growing 141 percent over that period. For FY1997, however, the appropriation for the entire program is 20 percent below the FY1995 peak, although it is still well above the FY1990 level. The buildings sector has had the largest percentage drop, declining by 34 percent.

The major driving forces behind the FY90-FY95 increase were a growing concern about global warming and the need to develop energy efficient technologies to reduce greenhouse gas emission, a renewed interest in developing energy demand technologies to reduce dependence on oil in the wake of the Gulf War, and continuation of DOE's policy objective to help economic growth through more efficient use of energy. The major new initiative over that period was the PNGV launched in 1993. As contributing technologies to this program, electric and hybrid propulsion R&D projects, and the alternative fuel vehicle

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[28]Sissine, Fred. *Energy Efficiency: A New National Outlook?* Congressional Research Service. IB95085. Regularly updated.

[29]Sissine, Fred. *The Partnership of a New Generation of Vehicles.* Congressional Research Service. 96-191 SPR. Feb. 28, 1996.

(AFV) project received substantial increases during that period. In addition, buildings systems and equipment R&D grew rapidly from FY90-FY95. The decline in funding levels since the FY95 peak, have in FY96 and FY97 resulted in the sharpest cuts being felt by these same areas, AFV and building systems and equipment, and by R&D projects within certain industries in the industrial sector. Most other project areas were held near their FY95 levels or received small increases. The principal consequences of these actions may be slower development of new vehicle power plants which could significantly reduce fuel consumption, and of more energy efficient appliances. It is also possible, however, that the private sector will pick up some of the R&D in these areas. In addition, it is important to note that despite the cuts, FY1997 levels in these are still well above FY1990 levels.

The congressional budget resolution for FY1997 projected a real decline of about 22% while the Administration's budget outlook projects a slight increase of about 1% from FY1997 to FY2000. The major implication of a decline is likely to be a general contraction of the subprograms. The cuts that have taken place so far have followed that path with each subprogram receiving comparable reductions. If the budget stays flat, as the Administration hopes, the programs will essentially be static with new projects or expansions occurring only at the expense of other remaining projects. It is unlikely, however, within the range of funding futures bounded by these projections that major initiatives, such as the PNGV, will be eliminated or reduced proportionately until their completion. Indeed under the Administration's plans, that project is likely to expand as well as those projects directed toward global climate change. Under either budget outlook, therefore, there could be a sharp decline in R&D projects funded in other areas. Whether such cuts will have a significant effect on the Nation's energy future depends on how rapidly energy resources decline and the degree to which the private sector invests in energy efficiency R&D.

Energy Efficiency and Renewable Energy R&D

The Energy Efficiency and Renewable Energy R&D program focuses on a wide range of technologies.[30] Major efforts are directed toward solar energy, primarily photovoltaic (PV) technology, solar thermal central power plants and fuel production from biomass. The PV activity is aimed at reducing production costs and improving conversion efficiency. The program also is funding R&D on solar heating and cooling for buildings, improving the cost performance of wind machines, exploitation of geothermal resources, and the development of hydrogen as an energy carrier. Finally, the program includes research on potential health effects of electromagnetic field effects, electric energy storage technologies, and application of high temperature superconductivity.

The budget history of the renewable energy program is shown in Figure 17 above. Like the energy conservation program, the renewable energy program saw its budget climb steeply from FY1990 to FY1995, and then undergo sharp

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[30]Sissine, Fred J. *Renewable Energy: A New National Outlook?* Congressional Research Service. IB93063. Regularly updated.

reductions the next two years. Funding for the program climbed 144% during the first five year period and dropped 35% between FY1995 and FY1997. Some forces driving the increase were similar to those driving growth of the conservation program; growing concerns about global warming and unstable oil resources. In addition, Administration initiatives in 1993 to increase deployment of renewable energy technologies and to help build a sustained renewable energy industry added to the sharp rise in funding from FY93 to FY95. The decline in FY1996 was driven to a great degree by congressional concerns that the program was investing too heavily in development of technologies best left to the private sector. The subprograms which received the largest reductions were photovoltaic energy systems, wind energy systems, deployment and geothermal. To Congress these subprograms represented the major areas where DOE was making such investments.

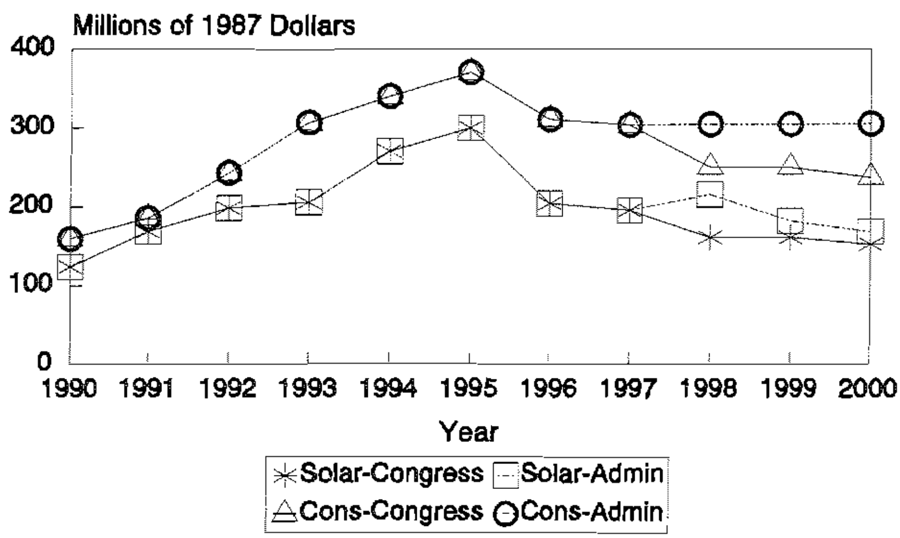

Figure 17 - Conservation and Renewable (Solar) Energy

The projections suggest that funding for renewable energy R&D for FY2000

would drop by 22% according to the congressional budget resolution and 13% according to the Administration's budget outlook. If these forecast reductions are driven by the same criteria currently in operation, the consequences would be elimination of projects deemed to be near term technology. The funding would shift to more emphasis on basic research and long term applications less likely to be taken up by the private sector. Such actions could have implications for the readiness of renewable energy technologies if the availability of mainline energy resources should suddenly contract for economic or environmental (e.g., global climate change) reasons. Another future path would be general contraction of all of the subprograms which would probably permit some development to be funded, but at a significantly lower level than now.

Basic Energy Sciences and Computational and Technology Research

The Basic Energy Sciences (BES) program is the most diverse research program within DOE. Its stated goals are to carry out scientific research related to energy technology development, and to maintain and develop major research facilities for national use. The research in BES consists of a wide range of basic research activities in materials, chemistry, engineering, earth sciences, and energy biosciences. In addition to energy technologies, this BES research has potential applications in a wide variety of industrial areas. The major user facilities operated by BES at the DOE labs are used extensively by industry, universities and government on a cost shared basis. In FY1997, DOE established a new program, Computational and Technology (CT) research, which assumes the mathematics and computer science, and advanced energy projects subprograms formerly housed in BES. A new BES program was formed containing the remaining elements which are listed above. The Computational and Technology Research program has similar goals and applicability as the BES program. In order to maintain comparability between the BES program as defined prior to FY1997 and projections for funding to FY2000, this discussion combines the newly defined BES program and those elements of the CT program which were previously part of the old BES program.

The funding history for BES is shown in the figure 18 on the next page. Funding increased by 12% between FY1990 and FY1995, reaching a peak in FY1993. Unlike energy technology programs, such as renewable energy and energy efficiency, funding for BES rose between FY1995 and FY1997, although by only 2%. The rationale behind this increase was the basic research nature of the two programs. In particular, DOE launched an initiative in FY1996 to upgrade and expand its major user facilities with the BES program. This $60 million effort was funded in FY1996 although the slight decline in funding in FY1997 may stretch out the completion of the initiative.

The projections show a decline of 22% by FY2000 according to the Congressional budget resolution and 13% according to the Administration's budget outlook. It is quite possible, however, that funding for these two programs will not decline by either of these rates. Because these two programs support basic research, their funding levels for the next few years may be constant in current year dollars. Even in this case, however, the programs will likely have to constrict their activities because real funding would decline about 8%. The consequences of a decline in or even level funding appears to be fewer projects undertaken and, possibly, a decrease in user facility availability. Already, there is indication of the later in the cancellation of the Advanced Neutron Source that was to be built at Oak Ridge National Lab. If the

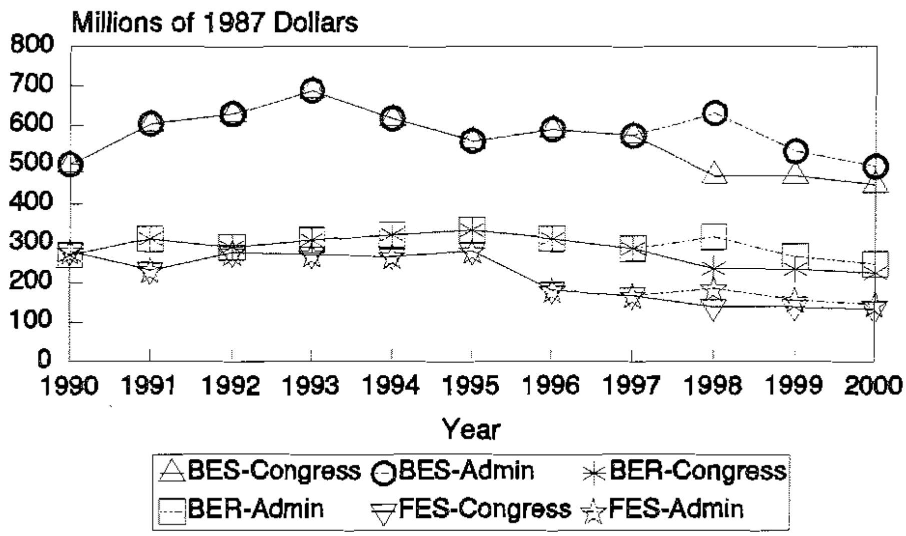

Figure 18 - Energy Research

availability of user facilities were to decline in order to maintain other research efforts within the programs, there could be significant negative consequences for many high technology research areas in the private sector. In addition to use by DOE researchers, these facilities are used by many large high technology firms for research on advanced technology such as materials' structure. It is possible, however, that larger contributions from the private sector users could offset some of the funding decline. Finally, if the actual decline in funding for these programs is less than projected, there will probably be even greater decreases in other DOE programs such as energy efficiency, fusion energy science and renewable energy.

Fusion Energy Science

The Fusion Energy Science (FES) program, formerly called Magnetic Fusion Energy,[31] will concentrate on basic research in plasma and fusion science and technology in order to expand the knowledge base needed to develop fusion based power reactors and to enhance the application of plasma science in industry. Prior to this year, the program's major goal was development of a demonstration power reactor by 2025. The shift in focus is a result of budget reductions for FY1996 and congressional mandate. The FES program also participates in the International Thermonuclear Experimental Reactor (ITER)

[31]Rowberg, Richard. *Magnetic Fusion Energy (Fusion Energy Sciences)*. Congressional Research Service. IB91039. Regularly updated.

project, the major international effort to harness the energy of the fusion reaction for electric power production.

The budget history for the FES program is shown in the figure 18 above. Program funding was flat from FY1990 to FY1995 in real terms. During that period, the program was attempting to develop the foundation for an fusion driven demonstration reactor in the 2025 time frame. In FY1996, however, funding for FES (then called Magnetic Fusion Energy) declined by 35% and the program underwent a major change in focus and scope as explained above. For FY1997, the program's funding level declined another 7.5%. While the Congress expressed its approval of the changes the program had made, it did not provide the funding DOE requested.

The projections show a continued real decline for the program of either 22% or 14% by FY2000 depending on whether the Congressional budget resolution or the Administration's budget outlook track is followed. Such a decline would bring the fusion budget to levels comparable to those of the early 1970s before its rapid buildup began during the first oil price shock. The implications of these projections are likely to be a continued constriction of the program's efforts on major confinement systems including a complete withdrawal from the ITER project should it continue past the engineering design stage. In addition, the program may not be able to sustain a significant research effort into alternate concepts which it is now developing. The major consequences of these reductions have already been felt, namely that the U.S. will not be in a position to be a significant player in any international effort to build a demonstration fusion reactor based on the tokamak concept in the next century. On the other hand, these large funding declines may allow the fusion research effort to focus on the basic science and technology more completely with the possibility of developing a more attractive candidate for fusion power. Continued reduction in the fusion budget, however, may put even that possibility at risk.

Biological and Environmental Research

The Biological and Environmental Research (BER) program is focused on basic research in the biomedical and environmental sciences for the purposes of understanding potential long-term health and environmental effects of energy production and use. The program supports research in the various environmental media, in biotechnology, and in medical applications of radiation and radioactive materials. Included are research on global climate change,[32] radionuclide medicine and DOE's portion of the human genome project.

The funding history of the BER program since FY1990 is shown in figure 18 above. Funding for this program, in 1987 dollars, showed a gradual increase of 23% from FY1990 to FY1995 followed by a 14% decline from FY1995 to FY1997. The major sources of the increase were growth in funding for the human genome project and, from FY1993 to FY1995, research on global climate

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[32] Justus, John and Wayne Morrissey. *Global Climate Change.* Congressional Research Service. IB89005. Regularly updated.

change. Although the latter was criticized by many Members during debates over the FY1996 appropriations, the global climate research of BER did not receive any greater cuts than the rest of the program's budget. For FY1997, the reductions were general and due primarily to completed projects and lower construction requirements. Indeed, the appropriation for FY1997 is 2.6% above the request.

The projections show a real decline of 22% and 14% for BER from FY1997 to FY2000 depending on whether the congressional budget resolution or the Administration's budget outlook is used. As with the BES and CT programs, however, this projection may overstate the actual change because BER is considered a basic research program and, consequently, enjoys strong support in Congress. Still, it is unlikely that the budget will keep up with inflation and a real decline will probably take place. The most likely implications of a decline are a contraction of the number of projects underway. Since DOE will probably try to maintain its efforts in the Human Genome Project and global climate change research, additional pressure would fall on the other elements of the program such as medical applications and environmental remediation research. The major consequences of these actions would probably be a slow down in the rate of investigation of novel remediation processes which may benefit cleanup of DOE sites, and in the development of advanced medical diagnostic tools.

General Science and Research (High Energy and Nuclear Physics)

The General Science and Research programs include High Energy (HEP) and Nuclear Physics (NP) research. The former focuses on experimental and theoretical studies of the fundamental structure of matter and energy. The High-Energy Physics program operates several large accelerators including the tevatron at Fermilab and the linear accelerator at the Stanford Linear Accelerator Center (SLAC).[33] The Nuclear Physics program supports research into the structure of the nucleus of the atom and the forces holding the nucleus together. Large research facilities within Nuclear Physics programs include the continuous electron beam accelerator facility (CEBAF) in Newport News, VA, and the relativistic heavy ion collider (RHIC) at Brookhaven National Lab.

The budget histories of the two programs are shown in the Figure 19. For the HEP program, funding has declined from FY1990 to FY1995 by about 3%, in 1987 dollars, while for the NP program there has been no net change. The decline in the HEP program is somewhat misleading because during the same period, the budget for the superconducting supercollider increased rapidly until it was canceled. For the NP program, the fluctuations in the funding levels resulted from changes in major construction projects. Both programs, however, had reached a fairly stable funding level by FY1990 (with the exception of the SSC) within DOE's budget priorities. From FY1995 and FY1997, the HEP program's funding declined just 1% as the Congress regarded its basic research as an important priority for the Federal government. Similarly the NP program

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[33]Morgan, Daniel and Richard Rowberg. *High-Energy Physics Research: Description and Issues*. Congressional Research Service. 95-210 S. Jan. 27, 1995.

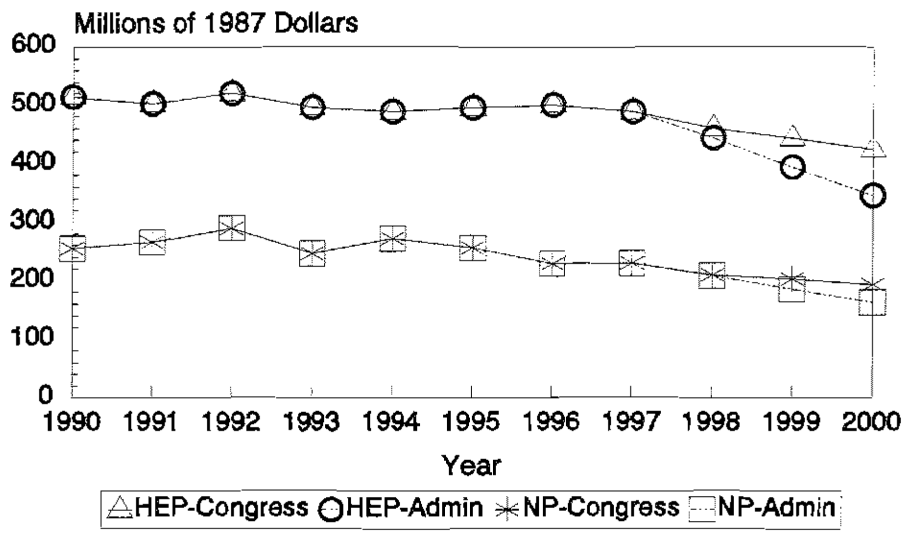

Figure 19 - General Science

received strong support because of its basic research orientation. The 10% drop from FY1995 to FY1997 was largely the result of a substantial add-on by Congress to the FY1995 request which was not repeated in FY1996 or FY1997.

In both years, the two programs received nearly all of their requests.

The projections show continued declines in the two programs under either budget future. For the Congressional budget resolution, a decline of 13% would take place between FY1997 and FY2000 while for the Administration's budget outlook, the decline would be much sharper, about 30%.[34] For both programs, such declines would put pressure on existing facilities probably causing some of the older facilities to shut down or, at least, to forego important maintenance and upgrades. Following the Administration's budget projection, such shutdowns seem certain. For the HEP program, one consequence of funding level declines could be that the U.S. would not be able to participate in the Large Hadron Collider project at the European Center for Nuclear Research (CERN) in Geneva. DOE forecasts that U.S. participation will cost about $500

[34]It is not clear why the Administration's projects such a sharp drop in these two programs, particularly compared to the Congressional budget resolution. The latter has been a strong supporter of the DOE HEP and NP programs because of their basic research nature. It is possible that the Administration's actions are a result of keeping National Science Foundation funding level in the out years. These two DOE programs are included in the same budget function as NSF, Function 251.

million over the next few years, and such funds may not be available if existing U.S. facilities are to have sufficient resources. For the Administration's budget projection, such participation would be very problematical. Finally, lower funding levels may also force DOE to reduce its support of university research in order to provide enough for its major facilities. The need for these large facilities to continue advancement in both high energy and nuclear physics puts extra pressure on these programs.

Table 22 - DOE Energy Research Programs (Millions of current year dollars-Congress)							
Year	Solar	BES	FES	BER	Cons	HEP	NP
1990	139.1	564.1	316.7	305.4	179.7	580.1	287.2
1991	198.5	711.8	273.6	368.6	218.7	592.6	313.3
1992	241.8	764.7	337.1	353.3	296.0	634.4	354.4
1993	257.3	860.7	339.7	385.2	384.1	621.7	309.1
1994	347.4	790.4	343.6	412.3	436.4	626.5	348.6
1995	393.6	733.9	368.4	436.6	486.4	649.0	334.9
1996	275.2	791.6	244.1	419.5	418.2	673.5	308.0
1997	270.0	790.8	232.5	395.5	419.9	676.9	319.1
1998	228.4	668.9	196.7	334.5	355.2	653.1	298.7
1999	234.5	686.7	201.9	343.5	364.6	645.1	295.0
2000	228.4	668.9	196.7	334.5	355.2	633.2	289.6

Table 23 - DOE Energy Research Programs (Millions of 1987 dollars-Congress)							
Year	Solar	BES	FES	BER	Cons	HEP	NP
1990	123.3	500.0	280.7	270.7	159.3	514.2	254.6
1991	168.5	604.1	232.2	312.8	185.6	502.9	265.9
1992	198.5	627.7	276.7	290.0	243.0	520.7	290.9
1993	205.6	687.8	271.5	307.8	307.0	496.8	247.0
1994	271.1	616.9	268.2	321.8	340.6	489.0	272.1
1995	300.4	560.1	281.1	333.2	371.2	495.3	255.6
1996	204.9	589.3	181.7	312.3	311.3	501.3	229.3
1997	195.5	572.5	168.3	286.3	304.0	490.0	231.0
1998	161.0	471.7	138.7	235.9	250.5	460.5	210.6
1999	161.1	471.7	138.7	235.9	250.5	443.1	202.7
2000	152.8	447.6	131.6	223.8	237.7	423.7	193.8

Table 24 - DOE Energy Research Programs (Millions of current year dollars-Admin)							
Year	Solar	BES	FES	BER	Cons	HEP	NP
1990	139.1	564.1	316.7	305.4	179.7	580.1	287.2
1991	198.5	711.8	273.6	368.6	218.7	592.6	313.3
1992	241.8	764.7	337.1	353.3	296.0	634.4	354.4
1993	257.3	860.7	339.7	385.2	384.1	621.7	309.1
1994	347.4	790.4	343.6	412.3	436.4	626.5	348.6
1995	393.6	733.9	368.4	436.6	486.4	649.0	334.9
1996	275.2	791.6	244.1	419.5	418.2	673.5	308.0
1997	270.0	790.8	232.5	395.5	419.9	676.9	319.1
1998	305.6	895.0	263.2	447.6	432.2	630.7	297.3
1999	265.4	777.4	228.6	388.8	444.0	574.3	270.7
2000	252.1	738.2	217.0	369.2	456.9	516.5	243.5

Table 25 - DOE Energy Research Programs (Millions of 1987 dollars-Admin)							
Year	Solar	BES	FES	BER	Cons	HEP	NP
1990	123.3	500.0	280.7	270.7	159.3	514.2	254.6
1991	168.5	604.1	232.2	312.8	185.6	502.9	265.9
1992	198.5	627.7	276.7	290.0	243.0	520.7	290.9
1993	205.6	687.8	271.5	307.8	307.0	496.8	247.0
1994	271.1	616.9	268.2	321.8	340.6	489.0	272.1
1995	300.4	560.1	281.1	333.2	371.2	495.3	255.6
1996	204.9	589.3	181.7	312.3	311.3	501.3	229.3
1997	195.5	572.5	168.3	286.3	304.0	490.0	231.0
1998	215.5	631.2	185.6	315.7	304.8	444.7	209.7
1999	182.3	534.0	157.0	267.1	305.0	394.5	186.0
2000	168.7	494.0	145.2	247.0	305.7	345.6	162.9

Table 26 - DOE Energy Conservation Research (Millions of 1987 dollars)			
Year	Buildings	Industry	Transportation
1990	26.6	67.2	60.6
1991	36.6	70.9	71.2
1992	38.9	80.0	90.5
1993	47.6	90.1	134.2
1994	63.5	97.6	139.4
1995	72.7	105.3	145.8
1996	57.9	86.1	131.5
1997	60.6	85.1	126.8

NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY[35]

The National Institute of Standards and Technology (NIST), formerly the National Bureau of Standards (NBS), was established by the NBS Organic Act of 1901 (P.L. 56-177). NIST is part of the Technology Administration of the Department of Commerce. Prior to 1988, the mission of NBS was to develop and maintain standards and measurement support for scientific investigations, engineering, manufacturing, commerce and educational institutions, as well as to provide technical and advisory services to other government agencies on scientific and engineering problems. The Omnibus Trade and Competitiveness Act of 1988 (P.L. 100-418) changed the name of NBS to NIST, and explicitly charged the agency with the additional responsibility of providing technical services to facilitate U.S. industry's competitiveness objectives.

The NIST budget is comprised of three elements.

- NIST in-house laboratory programs (known as Scientific and Technical Research and Services, or STRS) provide standards, measurements, calibrations, and quality assurance techniques for industry and other government agencies. NIST laboratory programs date back to the establishment of the National Bureau of Standards in 1901.

- External grant programs, known as Industrial Technology Services, include the Advanced Technology Program (ATP) and the Manufacturing Extension Partnership (MEP). These programs were established by the Omnibus Trade and Competitiveness Act of 1988 to enhance the competitiveness of American companies by providing appropriate support for industry's development of pre-competitive generic technologies and diffusing government-developed technological advances to users in all segments of the American economy.

- Construction of research facilities, an ongoing construction program begun in 1993, intended to upgrade or replace NIST's aging physical plant.

NIST BUDGET TRENDS, FY1992-FY1997

Table 27 provides a historical profile of the NIST appropriation in current dollars, while table 28 provides the same data in constant 1987 dollars. As these tables show, the annual NIST funding level has fluctuated over the past five years. Much of this fluctuation is due to a shift in congressional support for the Advanced Technology Program. During the 103rd Congress, NIST was viewed as a major player in the Clinton Administration's strategy for civilian technology development, and as such, received substantial budget increases. Between FY1992 and FY1995, overall NIST funding provided by the 103rd Congress more than tripled (a 246 percent increase). The 104th Congress

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[35] Prepared by Lennard G. Kruger.

reversed this trend, however, first rescinding $153 million from the FY1995 appropriation (bringing the total from $853 million to $700 million), and then cutting NIST funding between FY1995 to FY1997 by 33% from the pre-rescission FY1995 level, and by 18% from the post rescission FY1995 level.

The following three sections provides background information and discusses budget trends related to the three elements of the NIST budget.

Scientific and Technical Research and Services

The NIST in-house R&D effort is conducted by approximately 3,200 scientists, engineers, technicians, and support personnel (plus some 1,200 visiting scientists per year from industry, academia, and other government agencies). This work is performed in seven research laboratories in Gaithersburg, Maryland and Boulder, Colorado. These research laboratories are: Electronics and Electrical Engineering, Manufacturing Engineering, Physics, Chemical Science and Technology, Materials Science and Engineering, Building and Fire Research, and Information Technology.

NIST laboratory research directly supports standards and measurement related functions and services which NIST provides to industry and to other government agencies. NIST sees these activities as supporting basic "infrastructural technologies" which enable the development of advanced technologies, and which industry can use to characterize new materials, monitor production processes, and ensure the quality of new product lines. For example, NIST's super-accurate atomic clock is used to calibrate time and frequency signals critical in electric power grids, communications networks, banking systems, and satellite navigation systems. Another example is NIST's development of sophisticated measurement techniques for semiconductor chips, which enable industry to achieve ultra-precise manufacturing controls necessary to develop next generation semiconductor technologies. A major emphasis of NIST laboratory work is cooperative research with industry aimed at overcoming technical barriers to commercialization of emerging technologies. NIST participates with U.S. companies in cooperative research and development programs in over 200 research areas.[36]

NIST laboratory work also provides research, technology, and technical expertise to NIST's "Technology Services" program. Technology Services provides measurement and standards related services to U.S. industry, government, and the public. Many of these services are geared towards increasing the competitiveness of U.S. industry and/or overcoming barriers to international trade. Specific Technology Services activities include: providing technical standards expertise to support negotiation and implementation of international trade agreements such as the North American Free Trade Agreement (NAFTA) and the General Agreement on Tariffs and Trade (GATT);

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[36]U.S. Dept. of Commerce. Technology Administration. National Institute of Standards and Technology. Cooperative Research Opportunities for Industry at NIST, June 1994. p. 1.

coordinating federal, state and local government efforts to ensure that consistent weights and measures are used in the marketplace; developing, producing, and distributing Standard Reference Materials; providing Standard Reference Data; providing calibration and laboratory accreditation services; and planning, organizing, and managing the placement of technical standards experts in selected U.S. embassies to provide technical expertise in the identification and resolution of standards-related technical barriers to trade.

Tables 29 and 30 show a laboratory-by-laboratory breakdown of the STRS appropriation over the past five years. As can be seen in the tables, the laboratories in general enjoyed substantial increases between FY1993 and FY1995, most notably in the areas of computer science, materials science, chemical science, and manufacturing engineering. The increases for the NIST labs would have been even greater if not for the $17 million rescission of FY1995 laboratory funding during the first session of the 104th Congress. Between FY1995 and FY1997, the appropriations for the NIST laboratories began to flatten, and in some cases decrease in constant 1987 dollars (e.g. computer science, physics, building and fire research).

Both congressional and Administration NIST budget projections for FY1996 through FY2000 would indicate minimal future growth in direct laboratory funding. Congressional budget projections (table 31) assume a 3% yearly growth in the STRS account, which would yield virtually no growth if inflation is accounted for (table 32). The Administration's budget projections are more stark. The Administration projections of Budget Function 376 for science and technology (of which NIST constitutes over 90%) call for flat funding between FY1997 and FY2000 (table 33). This translates to an 8% decline in constant 1987 dollars between FY1997 and FY2000 (table 34). In constant dollars, FY2000 would only slightly exceed FY1995 levels. While the budget projections used in tables 33 and 34 are not disaggregated into the individual NIST budget elements, the overall trend indicates that constant dollar funding for the NIST laboratories could decline over the next several years if the Administration's budget projections are realized, and assuming that decreases are proportionally distributed across the NIST budget.

The impacts of stagnant funding for the NIST laboratories are difficult to quantify. Given that the state of modern technology is advancing, and critical measurement technologies are becoming more sophisticated, complex, and essential, NIST supporters argue that the capabilities and responsibilities of the NIST laboratories must necessarily expand. Another issue to consider is the dependency of the NIST labs on other agency funding. During the 1970s and 1980s, the laboratory programs had a flat direct appropriation in constant dollars, resulting in an increasing reliance by the laboratories on performing work for other agencies. With significant increases in direct appropriations since 1991, priority programs for industry have been increased and core competencies reinvigorated. In its 1995 annual report on NIST, the Visiting Committee on Advanced Technology (VCAT) addressed this issue as follows:

> The Committee has said for several years that the fraction of other agency sponsored research at NIST is too high. In order to take control of its own agenda, NIST strategy calls for the use of increased funding to reduce the rate of support of laboratory programs by other federal agencies, with no increase of laboratory staff. This is to be accomplished by replacing contract research that is not strongly tied to NIST's industrial support mission with more mission-oriented base-funded research that implements NIST's strategic vision. NIST Director Arati Prabhakar reported to us that significant progress has been made; what was once a 35% dependency on contract support dropped to 22% in Fiscal Year 1995, and would have dropped to well under 20% in the budget proposed by the President for Fiscal Year 1996. However, at the present 1996 NIST budget level, the dependence on other agency funding will remain essentially unchanged from Fiscal Year 1995.[37]

Industrial Technology Services

External grant programs, including the Advanced Technology Program (ATP) and the Manufacturing Extension Partnership (MEP), were created by Title V of the Omnibus Trade and Competitiveness Act of 1988, which ". . . significantly expands the role of NIST as the government's lead laboratory in support of U.S. industrial quality and competitiveness . . . ." These programs were designed to facilitate industrial activities to utilize advanced process technology; to promote cooperative ventures between industry, universities, and government laboratories; and to promote shared risks, accelerated development, and increased skills. Beginning in FY1991, the total NIST budget began marked growth as Congress started funding external grant programs authorized by the Omnibus Trade and Competitiveness Act.

Advanced Technology Program -- The Advanced Technology Program (ATP) provides seed funding, matched by private-sector investment (of at least 50% of costs), to companies or consortia of universities, businesses, and government laboratories for development of generic technologies that have broad application across industries. Awards, based on technical and business merit, are made for work which is high-risk and past the basic research stage but not yet ready for commercialization.[38]

While established and funded during the Bush Administration, the Clinton Administration views the ATP as a linchpin in its overall strategy of increased federal support for civilian technology development. As such, the ATP

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[37]Visiting Committee on Advanced Technology. National Institute of Standards and Technology. Annual Report 1995. February 1996. p. 15.

[38]For more information on the ATP, see: U.S. Library of Congress. Congressional Research Service. The Advanced Technology Program. CRS Report 95-36 SPR, by Wendy Schacht. Washington, May 7, 1996.

was slated for significant expansion; the Clinton Administration envisioned a $750 million budget for the ATP by FY1997. As shown in tables 27 and 28, funding for the Advanced Technology Program tripled between FY1993 and FY1994, and peaked in FY1995.

The 104th Congress strongly disagreed with the philosophy that government should pursue a "technology policy" by providing federal funds to industry for development of precompetitive generic technologies. Congress immediately moved to decrease the ATP budget, passing in early 1994 a rescission of $90 million from the FY1995 budget (from $430 to $340 million). Since that time, the 104th Congress has repeatedly attempted to eliminate the ATP throughout the authorization, appropriations, and budget processes. Proponents of terminating ATP cite this program as a prime example of "corporate welfare," whereby the federal government invests in applied research programs which they maintain should more appropriately be conducted in the private sector. The Administration has defended the ATP, arguing that it helps industry (including small manufacturers) develop generic technologies that, while crucial to industrial competitiveness, would not or could not be developed by the private sector alone.

The survival of the ATP has proven to be one of the major points of contention between the Administration and Congress during negotiations over the FY1996 and FY1997 appropriations legislation. President Clinton cited the attempted zero funding of the ATP among the reasons for his December 19, 1995 veto of H.R. 2076, the FY1996 Commerce, State, Justice (CSJ) appropriations bill. The FY1996 budget agreement between Congress and the Administration resulted in the continuation of the ATP, but at a reduced funding level ($221 million, down 35% from FY1995). For FY1997, House and Senate versions of the CSJ appropriations would have sharply reduced ATP funding (House: $110.5 million; Senate: $60 million) and imposed restrictions on funding new projects. Again, the Administration disagreed with the congressional approach to ATP funding. The final FY1997 levels as set forth in the Omnibus Consolidated Appropriations Act (P.L. 104-208) provides the ATP with funding at virtually the same level as FY1996, and with no restrictions on spending.

The original Clinton Administration vision of a $750 million ATP budget has not been realized, nor has the 104th Congress been successful in eliminating the program. Future budget trends for the ATP are impossible to address at this time, given that the viability of the program will depend on the dispositions of future Congresses and Administrations.

Manufacturing Extension Partnership -- The Manufacturing Extension Partnership (MEP) is a network of manufacturing extension services that provides small and medium-sized manufacturers with technical assistance as these firms modernize their operations to increase their competitiveness. From a base of seven Manufacturing Technology Centers (MTCs) established between 1989 and 1992, the Clinton Administration's original plan was to expand the MEP to over 100 extension centers by 1997. As shown in table 27, funding for the MEP quadrupled between FY1993 and FY1995. Opposition to the MEP in the 104th Congress dampened the expansion of the MEP; $16.3 million was rescinded from the FY1995 budget, and the growth in funding was slowed to 28% between FY1995 and FY1997. Like the ATP, the MEP was unsuccessfully targeted for elimination during the first session of the 104th Congress. By the end of the 104th Congress, however, the continuation of the MEP became more accepted,[39] albeit at lower funding levels than was originally requested in the Administration's FY1997 budget proposal.

The Administration now considers the MEP network completed and in place, with 78 centers either existing or newly funded.[40] MEP affiliate centers are now available in all 50 states and Puerto Rico. Thus any future funding increases for the MEP are expected to be minimal, in order to maintain current services. To the extent that future NIST appropriations might decrease in constant dollars (see table 32), existing MEP services might be curtailed.

Construction of Research Facilities

NIST has expressed concern that its facilities have become technologically obsolete, making it difficult, if not impossible, to conduct the state-of-the-art research needed for advanced technologies. The Gaithersburg, Maryland site (over 30 years old) and the Boulder, Colorado site (over 40 years old) feature 45 specialized laboratory buildings used to conduct a wide range of advanced measurement research. The 1995 Annual Report issued by VCAT reviewed concerns over NIST laboratory facilities:

> In a special report issued in 1990, we concluded that "NIST's physical plant is deteriorating and urgently needs attention that requires budgetary action. Aging and obsolescence, coupled with years of underinvestment due to insufficient funding, have produced critical deficiencies in NIST's facilities that must be remedied. At present, some of the Institute's facilities are inadequate for world-class science and engineering research, and for scientific and technical support to our nation's industry." In our 1993 report, we concluded that "The single most important

[39]The MEP received modest increases from House and Senate appropriators -- $89.9 million and $99.9 million respectively -- in the original CSJ appropriations bill, H.R. 3814. However, the House budget resolution, H.Con.Res. 178 continued to call for the termination of the MEP as part of its endorsement of Department of Commerce elimination. For further information on Department of Commerce elimination proposals and their possible impacts on NIST, see: U.S. Library of Congress. Congressional Research Service. Department of Commerce Science and Technology Programs: Impacts of Dismantling Proposals. CRS Report 96-537 SPR, coordinated by Lennard G. Kruger. Washington, July 11, 1996. 30 p.

[40]Jacobson, Ken. MEP Claims 'Completion'; Gains Facing Challenges? New Technology Week, v. 10, No. 36. Sept. 9, 1996. p. 1,4.

> problem to the long-term health of the NIST laboratories is, in our opinion, the substandard condition of the physical plant."[41]

The 1995 VCAT annual report cites Sam Kramer, NIST Associate Director, who reported to the committee:

> These facilities no longer provide adequate temperature and humidity control, vibration isolation, electrical services, and air cleanliness to meet today's research and program needs. Furthermore, the performance of the existing laboratories has deteriorated with age and will continue to worsen as future program needs increase and deterioration continues.[42]

A 1992 external study concluded that a multi-year capital improvements facilities program was required, totaling $1.2 billion dollars. In response, the Clinton Administration and the 103rd Congress endorsed a $540 million, 10-year plan to address the most critical research facilities needs. The plan featured construction of a $150 million Advanced Technology Laboratory (ATL) and a $57.4 million Advanced Chemical Sciences Laboratory at Gaithersburg. At Boulder, NIST planned a new ATL ($61 million) and a new central utility plant ($26 million). From FY1993 to FY1995, Congress appropriated over $200 million for construction (see table 27). Starting in FY1996 however, NIST experienced net losses in appropriated funds from the construction account. In FY1996, $60 million was appropriated, while $75 million was rescinded from unobligated funds. For FY1997, the Omnibus Consolidated Appropriations Act (P.L. 104-208) provides no funding for construction, while rescinding $16 million from prior year carryover amounts from the construction account. Conference language allows NIST to spend $27.6 million of unobligated funds to complete the Advanced Chemical Sciences Laboratory, and for maintenance and safety upgrades of existing NIST facilities.

House and Senate FY1997 Appropriations Committee reports, as well as the conference report on P.L. 104-208, have called upon NIST to reassess its long term facilities needs in light of reduced program and staffing levels and overall budget constraints. Thus, while work on the Advanced Chemical Sciences Laboratory has begun and is expected to be completed, beginning construction of the new Advanced Technology Laboratory will likely be delayed.

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[41]Visiting Committee on Advanced Technology. Annual Report 1995. p. 6.

[42]Ibid.

Table 27 -- NIST Appropriation, FY92-FY97 ($ millions of current dollars)

Program	FY92	FY93	FY94	FY95	FY96	FY97[43]
Scientific and Technical Research and Services	179.9	192.9	226.0	246.9	258.7	268.0
Advanced Technology Program	49.9	67.9	199.1	340.5	221.0	225.0
Manufacturing Extension Partnership	16.9	18.2	30.2	74.2	80.0	95.0
Quality Program	--	--	3.2	3.4	*	*
Construction of Research Facilities	--	105.0	61.7	34.6	-15.0[44]	-16.0[45]
Total	**246.7**	**384.0**	**520.2**	**699.7**	**545.0**	**572.0**

*Starting in FY1996 funding for the Quality Program ($2.9 million) was shifted into the STRS account.

Table 28 -- NIST Appropriations, FY92-FY97 (in millions of constant 1987 dollars)

Program	FY92	FY93	FY94	FY95	FY96	FY97
Scientific and Technical Research and Services	147.7	154.2	176.4	188.4	192.5	194.0
Advanced Technology Program	41.0	54.3	155.4	259.8	164.5	162.9
Manufacturing Extension Partnership	13.9	14.5	23.6	56.6	59.5	68.8
Quality Program	--	--	2.5	2.6	*	*
Construction of Research Facilities	--	83.9	48.2	26.4	-11.2[8]	-11.6[9]
Total	**202.5**	**306.9**	**406.1**	**533.9**	**405.7**	**414.1**

[43]As appropriated by the Omnibus Consolidated Appropriations Act (P.L. 104-208), signed into law on September 30, 1996.

[44]P.L. 104-134 provided $60 million for construction, but also rescinded $75 million of unobligated balances from the same account.

[45]P.L. 104-208 provides zero funding for construction, while also rescinding $16 million of prior year carryover amounts from the construction account.

Table 29 -- STRS Appropriations, FY92-FY97 (in millions of current dollars)

Labs	FY92	FY93	FY94	FY95	FY96	FY97[46]
Electronics and Electrical Engineering	23.1	26.5	29.4	32.3	34.3	37.1
Manufacturing Engineering	9.3	10.1	13.6	17.1	18.3	18.5
Chemical Science and Technology	18.3	19.3	22.2	30.4	30.7	32.0
Physics	25.5	26.4	26.7	26.0	26.9	27.0
Materials Science and Engineering	27.2	35.6	43.3	47.2	49.4	52.0
Building and Fire Research	11.0	12.0	12.8	12.1	12.5	12.0
Computer Science and Applied Mathematics	18.1	18.9	35.8	41.1	41.5	41.5
Technology Services	10.6	8.5	10.9	13.9	14.4	18.0
Research Support Activities	23.7	35.6	31.1	26.6	27.7	27.0
Quality Program	--	--	--	--	2.9	2.9
TOTAL	**167.1**	**193.0**	**226.0**	**246.9**	**258.7**	**268.0**

[46]Based on House Appropriations Committee recommended distribution of FY1997 funds (H.Rept. 104-676, p. 61).

Table 30 -- STRS Appropriations, FY92-FY97 (in millions of 1987 dollars)

Labs	FY92	FY93	FY94	FY95	FY96	FY97[47]
Electronics and Electrical Engineering	19.0	21.2	22.9	24.6	25.5	26.8
Manufacturing Engineering	7.6	8.1	10.6	13.0	13.6	13.4
Chemical Science and Technology	15.0	15.4	17.3	23.2	22.9	23.2
Physics	20.9	21.1	20.8	19.8	20.0	19.5
Materials Science and Engineering	22.3	28.4	33.8	36.0	36.7	37.6
Building and Fire Research	9.0	9.6	10.0	9.2	9.3	8.7
Computer Science and Applied Mathematics	14.9	15.1	27.9	31.4	30.9	30.0
Technology Services	8.7	6.8	8.5	10.6	10.7	13.0
Research Support Activities	19.4	28.4	24.3	20.3	20.6	19.5
Quality Program	--	--	--	--	2.1	2.1
TOTAL	**137.2**	**154.3**	**176.4**	**188.4**	**192.5**	**194.0**

[47]Based on House Appropriations Committee recommended distribution of FY1997 funds (H.Rept. 104-676, p. 61).

Table 31 -- Congressional Budget Projections. Budget Authority, in millions of current dollars (Source: H.Con.Res. 178, H.Rept. 104-575, p. 89)

Program	FY1996 (est)	FY1997	FY1998	FY1999	FY2000
STRS	251	281	289	298	307

Table 32 -- Congressional Budget Projections. Budget Authority, in millions of 1987 dollars

Program	FY1996 (est)	FY1997	FY1998	FY1999	FY2000
STRS	186.84	203.43	203.79	204.70	205.42

Table 33 -- Administration Budget Projections. Budget Authority, in millions of current dollars (Source: Analytical Perspectives, Budget of the U.S. Government, Fiscal Year 1997. Table 25-1, Federal Spending by Function, Subfunction, and Major Program. p. 347.)

	FY95	FY96	FY97	FY98	FY99	FY00
Budget Function 376, Science and Technology	737	672	854	854	852	851

Table 34 -- Administration Budget Projections. Budget Authority, in millions of 1987 dollars

	FY95	FY96	FY97	FY98	FY99	FY00
Budget Function 376, Science and Technology	562	500	618	602	585	569

THE NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION[48]

INTRODUCTION

The National Oceanic and Atmospheric Administration (NOAA) is the largest agency in the Department of Commerce (DOC). NOAA accounts for a little more than half of total funding for DOC, and has the largest R&D budget in DOC (averaging about 25 percent of NOAA's budget). R&D funding at NOAA transcends five major budget program activities: (1) National Ocean Service (NOS); (2) Oceanic and Atmospheric Research (OAR); (3) National Marine Fisheries Service (NMFS); (4) National Weather Service (NWS); (5) National Environmental Satellite, Data, and Information Services (NESDIS).

Most of NOAA's research-supporting spending is funded under (6) Program Support. Collectively, these six budget activities make up what is know as NOAA's Operations, Research, and Facilities (ORF) Account. The ORF Account is comprised of many Agency-wide sub-activities in R&D and also programs which contribute to federal R&D crosscutting activities administered under the White House Committee on Environment and Natural Resources (CENR). These include the U.S. Global Change Research Program and High Performance Computing research. A small percentage of R&D funding is provided from a non-ORF account which has historically funded R&D for Promotion and Development of American Fisheries and R&D for Fleet Modernization and Development of NOAA marine and aircraft research vessels. Non-ORF R&D funding constitutes about 3 percent of total conduct of R&D at NOAA.

Unlike many other federal agencies which fund R&D, NOAA has always invested most of its R&D spending intramurally, all of which is for applied research. Only about 14 percent of R&D is funded extramurally in the form of grants to institutions; however, all R&D investments are by design to support the operational components of NOAA's mission.

Overview of Total Conduct of R&D at NOAA

In general, R&D at NOAA had enjoyed a modest ramp up in funding since its establishment as an agency in the Department of Commerce in 1970, as did many S&T-related R&D programs throughout the U.S. Government. For the period of this study (FY1992-FY2000), that trend continued until FY1995 when R&D funding at NOAA peaked at about $419.3 million in constant 1987 dollars ($549.5 million in FY1997 current dollars).[49]

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[48]Prepared by Wayne A. Morrissey.

[49]All funding figures given in this study are in constant FY1987 dollars.

Between FY1992-FY1995, there was an increase in spending for total conduct of R&D of about 24 percent. R&D funding was at its peak in FY1995, and then is followed by a gradual decline for both Presidential and congressional projections out to FY2000. The largest (negative) annual percentage change actually occurred in FY1995-FY1996, when a decrease of about 10 percent in total conduct of R&D is realized. However, this is to be considered in context of a 19 percent increase which occurred between FY1994-FY1995 (see tables 35 & 36).

For historical R&D spending trends between FY1992 and FY1997, congressional appropriations reflect significant administrative changes at NOAA, including a change in agency funding priorities. Beginning with the FY1993 budget submission for NOAA, all funding was thereafter directed toward seven "strategic elements" of a Strategic Plan, and reflected in the R&D crosscut which accompanied NOAA's FY1994 Budget submission to Congress. NOAA's Strategic Plan was later revised to focus on NOAA's mission through the FY2005. Asked by Congress to define the core elements of its mission for future funding purposes, NOAA now characterizes itself as an agency responsible for "Environmental Stewardship and Environmental Assessment and Prediction," and the seven strategic elements reflect this goal:

- Build Sustainable Fisheries
- Recover Protected Species
- Sustain Healthy Coastal Ecosystems
- Modernize Navigation and Positioning Services
- Advance Short-Term Warning and Forecast Services
- Implement Seasonal to Interannual Climate Forecasts
- Predict and Assess Decadal to Centennial Change.

Consequently, many of NOAA's traditional activities, including some of those in R&D, have been or are currently planned for elimination.

In the President's projection for total R&D spending in FY2000, there is actually a slight funding increase, if one considers the difference between funding levels in FY1992 and FY2000. Congressional projections for FY2000, on the other hand, show a decline of about 25 percent from the peak spending level in FY1995, and a decline of about 1.8 percent in FY2000 from FY1992 spending levels. But a truer picture of the nature of recent R&D funding at NOAA is actually found between FY1994 and FY1997.

Since, FY1994, funding for facilities, construction and maintenance at NOAA, in general, has been on the decline. The one exception occurred in FY 1994, when Congress, at the request of the Administration, appropriated $85.7 million (constant 1987 dollars) to upgrade NOAA's research vessel fleet, and to purchase a new research aircraft. Also, in FY1994, NOAA had completed many of its construction projects that had been previously authorized by Congress. Funding for construction for new R&D facilities has been earmarked since, on a case by case basis, for projects with special priorities for Congress.

In the Conference agreement on the 1997 Appropriations for Commerce, State, Justice and the Judiciary, Congress gave instructions to make NOS, NMFS, and OAR responsible for funding their own data collection activities. This redirection of Program Support funding will be first evident in the FY1998 budget submission. Consequently, the projections for both the President and the Congress for FY1998-FY2000, and the percentages of distribution of R&D funding by budget activity across NOAA, in this study, would be affected.

Other factors are important in understanding R&D budget trends for FY1992-FY1997. For example, by FY1994, an increase in spending for R&D realized since FY1989 for the National Weather Service has significantly declined by FY1997, as many of the technological elements and systems acquisitions for the weather modernization effort have been implemented. As a result, these activities were shifted from R&D to operational support elements of the budget. Also, over time, several Administrations have proposed cost cutting measures which would directly affect R&D spending at NOAA. For many years, there has been pressure by the Administration to reduce funding for the Sea Grant program and to eliminate the National Undersea Research Program, both of which have strong ties to State government, local communities, and universities. Also, certain targeted services, such as fire and fruit frost warnings and marine weather facsimile services provided to specific user communities have been called into question in recent budget submissions. While slated for elimination by the Administration since the FY1993 budget submission for NOAA, many of these programs have survived because of congressional add-backs. However, reflected in FY1995-FY1996 congressional appropriations submissions are the priorities of the new congressional majority in the 104th Congress, who was determined to streamline the cost of government for U.S. taxpayers, and to discontinue government subsidies for-profit, applied research. Consequently, many of these programs targeted for specific users have been, or are in the process of being eliminated.

On the other hand, other R&D programs such as promotion and development of American fisheries, restoration of endangered and declining fish stocks, protection of marine mammals, research to assess and predict severe weather, and global climate research have been supported by NOAA's constituent base, which consequently has prompted continuing support for these programs by some Members of Congress and, most notably, the Senate, regardless of their politics. What has been under reconsideration by Congress and the Administration alike, has been the continuation of federal funding for a large in-house fleet of research vessels (marine and air) and whether it is cost effective to retain a dedicated corps of commissioned officers, the NOAA CORPS, to pilot them.

By FY1995, amid congressional attempts to tighten its fiscal spending, NOAA was already engaged in cost cutting efforts which had been spurred on by Vice President Gore's *reinventing government* initiative (REGO). For example, NOAA had already proposed elimination of several programs in its FY1995 budget which, it was agreed, had been designed only to serve a small contingent of its constituents. NOAA had already been in the midst of reducing staff levels by about 16 percent by FY2000, across the agency. In FY1995 Congress instructed NOAA, and other agencies, to seek out partnerships with the private sector to offset costs incurred by the federal government and to stimulate economic growth for the private sectors. An added goal would be to reduce federal services that may have been perceived as duplication of effort between the public and private sectors, and which might be acquired more cost effectively through competitive bidding.

Other political and economic forces have also influenced recent U.S. budget deliberations at the Department of Commerce (DOC). For example, a decline in the FY1996 NOAA's total budget for R&D should be viewed in the context of proposals by some Members of Congress in the 104th Congress to eliminate the Department of Commerce, to disperse the functions of NOAA throughout the federal government, and to divest public resources, such as NOAA's research fleet and NOAA labs.

After FY1995, the decline in spending at the agency is also motivated by the Agency's initiative to implement REGO I&II. In successive years, under the Government Performance and Results Act (GPRA), Congress has required U.S. government agencies which perform R&D to be held more accountable for their outcomes. NOAA had been selected as one of thirteen agencies to participate in a pilot program to implement GPRA. NOAA has made GPRA a major part of its annual budget cycle, which guides periodic assessments, and has claimed that implementing GPRA has resulted in a more accurate estimates of how its R&D is being funded and what paybacks are being realized, forming the basis for future R&D investment spending decisions.

The Administration's outyear estimates for NOAA R&D spending are based on projections for Natural Resources spending in the President's budget for FY1997. Congressional projections are calculated based upon discretionary spending limits found in the conference report on H.Con.Res. 158, "FY1997 Budget Resolution" (see tables 35 & 36). For both projections, NOAA represents about 18.3 percent of the total for OMB budget function 306 (Natural Resources and Environment). A remaining 3 percent of R&D spending at NOAA is found under budget function 376, and is mainly used for acquisition of technological improvements for research vessels, and for R&D for the promotion and development of American Fisheries. Congress has redirected these later funds, in the past few years, mainly to offset other R&D programs such as climate change research, coastal estuarine research, and non-indigenous marine species research, under the OAR activity in the ORF account.

Although highly speculative, the President's projections for out years FY1997-FY2000 demonstrate a general flat trend in spending for total conduct of R&D. When deflators are applied to obtain constant $1987, and using FY1997 congressional appropriations as a base, there is a 2 percent increase in R&D spending in FY1998, followed by a 4.3 percent decrease for FY1999, then followed by a total decline of about 7.5 percent in R&D spending by FY2000. Congressional projections portray somewhat of a different picture. R&D

funding for FY1998 would drop by 12.7 percent, and decline by 18.5 percent by FY2000.

A Detailed Look at Selected NOAA R&D Sub-Activities

While an overview of the total conduct of R&D shows how NOAA fares in comparison with other major R&D funding agencies, the real trends are often to be found when analyzing the funding provided for major R&D programs at the sub-activity level.

National Ocean Service (NOS)

R&D in NOS has been most important for NOAA's continued responsibilities for marine Mapping, Charting, and Geodesy, and has since been adopted as a White House Committee on Environment and Natural Resources (CENR) cross-cutting activity. Major accomplishments have included the development of a digital bathymetric map for various sections of the ocean floor, and digital updates of many of the nautical charts which serve commercial and recreational boating communities. R&D had been responsible for the development of new cartographic data collection and display technologies, but, in many cases, the actual data collection has been transferred to the private sector, or other entities, under both an initiative proposed by the agency and at the urging of Congress. Aeronautical charting responsibilities, formerly shared with the Federal Aviation Administration, have since been transferred to the DOD Defense Mapping Agency.

Coastal Ocean Science, another interagency initiative, was begun in FY1992 to examine and protect coastal estuarine areas from pollution and to ensure the health and restoration of marine ecosystems. In FY1992, NOS received a relatively larger proportion of R&D funding than successive years. Two-thirds of the NOS R&D budget was for start up of Coastal Ocean Science. NOAA's Coastal and Geodetic Survey, was instrumental in developing a revised vertical datum plane and a national spatial reference system which is closely tied into the Global Positioning System. The spatial reference system is expected to go fully operational by FY1997, thus eliminating R&D funding for this effort. In the past few NOAA budgets, funding has been transferred from the Coastal Zone Management Program (Non-ORF) to support the construction of National Marine Estuarine Research Centers.

Unlike most other NOAA budget activities, peak R&D funding occurred in NOS FY1992, and then has gradually declined. In both the President's and congressional projections, funding would decline by about 36 percent and 43 percent from FY1992 levels, respectively. This large decrease comes from elimination of NOAA CORPS and a federally-supported fleet of marine and air research in favor of bidding for private contracts and undertaking closer cooperation with the University-National Oceanographic Laboratory Systems (UNOLS) for ship time and with the DOD Office of Naval Research in support of NOAA research activities.

National Marine and Fisheries Service

R&D activities under this budget activity include research into the restoration of American fisheries where stocks have declined critically. Heightened public attention to this problem drew the largest funding increase for NMFS in FY1994, and has perpetuated healthy R&D funding levels since. Efforts have been underway to restore declining stock in the North Atlantic and Arctic Pacific areas. The largest proportion of R&D spending in NMFS is for enhancing information collection and analysis, such as stock inventories. However, NMFS is also responsible for research for conservation and management dealing with the Marine Mammals Protection Act and the Endangered Species Act, and the Dolphin-Safe Fisheries Protection Act.

The Endangered Species Act has affected many commercial and game anadromous species, such as trout and salmon. Although there has been some question as to whether ESA would be re-authorized in the 104th Congress, there has been significant constituent pressure especially in the Pacific Northwest to ensure that ample funding was provided to preserve economic interests in this region and to rebuild research hatcheries destroyed by flooding. The largest increase in R&D funding since FY1992 for NMFS was 32 percent, and is found in FY1994. Increased appropriations have continued through FY1997. Thereafter, there is a 14.3 percent decrease projected by the President and a 25 percent decrease projected by Congress. Cuts, however, would be most likely targeted in larger proportion at the coastal ocean science program, which some consider somewhat less important than NOAA's responsibilities for fisheries management and endangered species enforcement.

Oceanic and Atmospheric Research (OAR)

About half of all R&D funding at NOAA is for OAR's budget activities. Funding for NOAA's so-called "wet and dry" research programs are divided up into Atmospheric Research and Oceans and Great Lakes Programs accounts in a ratio of 6:4. OAR's R&D budget is the clearest example, other than NMFS, of how R&D funding is tied to improvements for NOAA's operational responsibilities. Forecasting and warning of severe weather events, and protection of inland waterways from non-indigenous pest species such as the zebra mussel, are two important examples. Global climate change research at NOAA also falls under OAR, and is divided between short-term and interannual research, which predominantly studies the El Nino phenomenon, and long-term climate change which occurs over decades to centuries. NOAA's climate and atmosphere R&D programs have played an important role in understanding stratospheric ozone depletion, global warming, and regional air pollution, and developing substitutes for environmentally-harmful chlorofluorocarbons (CFCs). OAR also provides R&D funding for weather research which has improved weather forecast and warning capabilities, developed flood warning systems, and furthered severe storm, weather modification, and solar weather research. All of NOAA's environmental research labs are funded under OAR; however, NMFS also operates labs which are critical to its mission.

Congressional projections for FY1997-FY2000, demonstrate a decrease of 18 percent in R&D spending for OAR. This can be viewed in the context of plans by some in Congress to divest NOAA of its public holdings including its fleet and research laboratories, with some of the research responsibilities turned over to the private sector. On the other hand, Presidential projections actually show near level funding for the same period; however, by FY2000, funding would have declined by 7 percent, by comparison. Interestingly, the largest annual increase for OAR R&D funding, 28 percent, is found between FY1994 and FY1995, but is soon followed by a 21 percent decrease in FY1995-FY1996. Much of this increase can probably be attributed to increases in NOAA's contribution to the U.S. Global Climate Research Program.

While several Administrations have proposed funding cuts for the popular Sea Grant Program and the National Undersea Research Program (NURP), which NOAA has argued creates strong ties to the States and local communities and has played a major role in marine environmental education and some local marine-based economies. Sea Grant and NURP have mainly survived because of congressional add-backs, and a strong constituent base, over the past several fiscal years.

The National Weather Service (NWS)

R&D Funding in NWS has been predominantly driven by its efforts to improve, modernize, and automate its weather observations and warnings. NWS has received consistent and increased funding over the period of FY1989-FY1992, which has helped in implementing a national Weather Modernization Demonstration Program (MARD). Peak R&D funding for NWS can be seen in FY1993, when there is the greatest effort to get many new technologies including NEXRAD Radar through a development and demonstration phase into operation. R&D funding for NWS then dips slightly but rises again as problems are discovered with the Automated Surface Observing System (ASOS) and software needs to be reworked. Congressional hearings were held in FY1996 to review schedule delays and the progress of AWIPS (the Automated Interactive Weather Processing System), which NOAA has claimed will bring its weather modernization efforts to fruition. Also, for the earlier period of this study, R&D funding had been invested in a new generation of Geostationary Orbiting Environmental Satellites, which would improve hurricane forecasts by understanding more clearly deep layer convection and atmospheric moisture transport in tropical cyclones.

The National Environmental Satellite Data and Information System (NESDIS)

During the period of this study NESDIS has received nearly level and consistent R&D funding. While the President's projections show an increase in FY1998, and then level funding, congressional projections show increases for FY1998 and FY1999 and then a return to funding at FY1997 levels. Peak R&D funding in NESDIS occurs in FY1992, and is associated with NOAA's continuing responsibilities for stewardship of environmental information derived from satellites, and its development of an archive for data from the Landsat 4 & 5 missions. Earlier, discussion and debate ensued about giving responsibility to a private corporation for distribution and creation of value-added environmental data products, however, NOAA retained responsibility for collection and distribution of civil weather data. Eventually, responsibility for Landsat 6, which includes maintaining a data archive and managing the program was given to the EROS Data Center of USGS and NASA, respectively. Subsequent responsibilities for management of the Landsat 7 program have since been divided between NASA and DOD. This transfer of responsibilities is, in part, grounds for a $20 million rescission of unobligated funds in FY1997 appropriations for NESDIS.

In FY1995, Congress directed NOAA to cease R&D spending into improvement of the GOES satellite technology, in favor of using off the shelf technology at least for the next several GOES launches. From FY1992-FY1997, a large portion of R&D also went into creating an environmental information data system and environmental data products for consumption by the public. NESDIS was also instrumental in releasing several years worth of Advanced High Resolution Radiometer Data, and GOES satellite data, in the form of visual images, for public scientific research use.

Program Support (PS)

Program Support funds many of the adjunct services which enable research programs under the five above budget activities to take place. Practically all PS funding is divided between acquisition, repair, and maintenance of marine and aircraft research vessels, but this budget activity has also funded the NOAA CORPS under Marine Services, and NOAA administrative personnel at Headquarters in Washington, DC. Program support has remained relatively constant over the period of FY1992-FY1997, with some notable jumps in earlier years when NOAA undertook an effort to modernize its research vessel fleet. A modest decline of 12 percent by FY2000 is seen in congressional projections. This may be viewed in the context of some in Congress' plans for a general divestiture of NOAA's research fleet and elimination of the NOAA CORPS. In contrast, in presidential projections, there is a modest increase of 9 percent, for FY1998, and then back to FY1997 levels by FY2000.

In the FY1997 appropriations for NOAA, Congress instructed the agency to divest its Marine Services account, which traditionally has been responsible for operation of research vessels, and for data collection activities, and transfer that funding to NOS, NMFS and OAR. Consequently, this would affect outyear projections including both the total levels and relative percentages of R&D Funding under those budget activities. The ORF account also funds construction of new R&D facilities. However, by FY1995, many of those which had been previously authorized, had been completed. Funding levels for construction declined significantly after FY1995, except for earmarks for specific projects.

Non-ORF R&D Funding

Non-ORF R&D funding is mainly provided for the promotion and development of American fisheries and for research for modernization of NOAA's marine and aircraft research vessels. Funding levels have been somewhat erratic but, in general, funding has been about 2-3 percent of total conduct of R&D. A distinct anomaly occurs in FY1994, when a major expense for fleet modernization and the one time purchase of a research aircraft increased that fiscal year's spending, and the Non-ORF account, by $87.5 million. Both presidential and congressional projections show a slight decline from FY1997 levels out to FY2000, with deeper cuts proposed by Congress, which anticipates no new net growth in the size or cost of maintaining the NOAA Fleet.

CONCLUSION

While R&D activities at NOAA have enjoyed a modicum of support from FY1992-FY1997, both Administration and congressional budgetary pressures have forced NOAA to take a look at how it spends R&D funding and what returns can be demonstrated for those investments. Other pressures to reduce staff and budgets have caused NOAA to refocus its mission under a "Strategic Plan" which would prioritize funding at the Agency. At various times in the 104th Congress the fate of NOAA was in question. Would NOAA remain an "intact" agency or would its function be redistributed among other federal agencies? Would its research labs be sold to the private sector? Would its research fleet be sold off? NOAA, like many other R&D funding agencies, has been slated in some congressional proposals for significant spending cuts. However, many R&D programs have enjoyed strong support from a vocal constituent base, and otherwise may have been eliminated, were it not for constituent pressure on Congress and the Administration.

In summation, the President's projections for R&D for NOAA show a decline by FY2000 for most R&D programs and, in the case of congressional projections, those declines are much steeper. During FY1992-FY1997, a number of demonstration projects relating to systems acquisition and development of new technology have skewed R&D budgets up or down depending on when these programs have become operational components within NOAA. For many, final FY1997 Appropriations proved to be a great surprise. Many of the deep cuts proposed for R&D by the House of Representatives were eventually neutralized and some budgets were even increased in conference. Strong constituent pressure helped to restore much of the funding requested by President Clinton for environmental protection initiatives. New funding to restore South Florida ecosystems, is a prime example. According to some analysts, while the future of R&D spending was beginning to look dim in FY1996, with the results of FY1997 congressional appropriations for R&D, the outlook may not be that dire. In any event, the "FY1997 funding surprise" is likely to cast many uncertainties about future projections of both the Congress and President for R&D spending.

Table 35 Federal R&D at NOAA (FY1992-FY2000), in millions of constant $ 1987
Historical Funding & *President's Projection*[50]

FY	NOS[51]	NMFS	OAR	NWS	NESDIS	PS	Non-ORF	TOTAL R&D
1992	25.5 (8.0)[52]	95.7 (29.9)	121.2 (37.9)	22.8 (7.1)	7.0 (2.2)	34.2 (10.7)	13.6[53](4.3)	320.0
1993	16.1 (5.4)	90.2 (30.2)	111.0 (37.2)	28.5 (9.6)	6.3 (2.1)	41.8 (14.0)	4.7 (1.6)	298.6
1994	13.3 (3.9)	132.9 (38.9)	122.0 (35.7)	22.2 (6.5)	6.1 (1.8)	39.7 (11.6)	90.9[54] [5.2] (1.5)	427.1 [341.4]
1995	15.7 (3.7)	143.8 (34.3)	170.6 (40.7)	25.4 (6.1)	6.5 (1.6)	42.9 (10.2)	14.4 (3.4)	419.3 (19.0)[55]
1996	12.2 (3.2)	141.7 (37.6)	134.4 (35.7)	27.0 (7.2)	5.9 (1.6)	43.3 (11.5)	12.4 (3.3)	377.0 (18.0)
1997	14.6 (3.8)	144.8 (37.6)	143.3 (37.2)	24.5 (6.4)	5.7 (1.5)	40.6 (10.5)	11.9 (3.1)	385.4 (18.0)
1998	*18.1 (4.6)*[56]	*136.7 (34.8)*	*146.9 (37.4)*	*28.3 (7.2)*	*7.1 (1.8)*	*44.8 (11.4)*	*11.4 (2.9)*	*392.8 (18.3)*
1999	*17.3*	*130.8*	*140.6*	*27.1*	*6.4*	*42.9*	*11.7*	*376.0 (18.3)*
2000	*16.4*	*124.1*	*133.4*	*25.7*	*6.1*	*40.7*	*10.3*	*356.6 (18.3)*

[50]Budget of the United States Government, Fiscal Year 1997 (Budget Authority by Function and Program (Table 25-1).

[51]NOAA Budget activities are: National Ocean Service (NOS), National Marine Fisheries Service (NMFS), Oceanic and Atmospheric Research (OAR), National Weather Service (NWS), National Environmental Satellite Data and Information Service (NESDIS), and Program Support (PS).

[52](In parentheses) Percent of Total R&D for each budget activity at NOAA.

[53]Includes Promotion & Development of American Fisheries R&D and Fleet Modernization R&D.

[54]Includes one time expenditure of $85.7 million for acquisition of marine and aircraft research vessels.

[55](In parentheses) Percent total for NOAA of Budget Function 306.

[56]Projection amounts derived from average percentage of previous 6 fiscal years.

Table 36 Federal R&D Funding for NOAA FY1997-FY2000, in millions of constant $ 1987 *Congressional Projection*[57]								
FY	NOS(4.6)[58]	NMFS (34.8)	OAR (37.4)	NWS (7.2)	NESDIS (1.8)	PS (11.4)	Non-ORF (2.9)	TOTAL NOAA
1997	14.6	144.8	143.3	24.5	5.7	40.6	11.9	385.4
1998	*15.5*	*117.1*	*125.9*	*24.2*	*6.1*	*38.4*	*9.8*	*336.6*
1999	*15.8*	*119.5*	*128.5*	*24.7*	*6.2*	*39.2*	*10.0*	*343.5*
2000	*14.5*	*109.4*	*117.6*	*22.6*	*5.7*	*35.8*	*9.1*	*314.3*

[57]Congressional totals ($1987 millions) are derived from H.Con.Res. 158 (104th Congress) conference report. Outyear projections derived from budget function 300 (Natural Resources) with deflators applied. Function 306 is approximately 13.8 percent of that total. NOAA R&D is 18.3 percent of budget function 306.

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[58](In parentheses) Percent of NOAA Total R&D as averaged over FY1992-FY1997.