REPORT TO THE COMMITTEE ON SCIENCE AND TECHNOLOGY HOUSE OF REPRESENTATIVES BY THE COMPTROLLER GENERAL OF THE UNITED STATES

Civil Aviation Research And Development Programs And Facilities

Department of Transportation

This report provides information on the projects, facilities, and personnel at the three principal Department of Transportation installations conducting research and development related to civil aviation. These installations spent $38 million for aviation projects in fiscal year 1975.

The projects contributed to 19 of the 21 research, engineering, and development programs of the Federal Aviation Administration. Planned expenditures for the 21 programs amount to about $890 million over the next 10 years.

PSAD-76-146

JULY 29, 1976

COMPTROLLER GENERAL OF THE UNITED STATES
WASHINGTON, D.C. 20548

B-180466

The Honorable Olin E. Teague, Chairman
Committee on Science and Technology
House of Representatives

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HSF 03500

Dear Mr. Teague:

This report describes civil aviation research and development programs and facilities at three principal installations of the Department of Transportation.

Your letter of June 25, 1975, requested that we assist your Subcommittee on Aviation and Transportation Research and Development in its review of the Nation's civil aviation research and development programs and facilities.

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HSE 03501

Sincerely yours,

Comptroller General
of the United States

Contents

ABBREVIATIONS

ARTS	Automated Radar Terminal System
ATC	air traffic control
ATCRBS	Air Traffic Control Radar Beacon System
CAMI	Civil Aeromedical Institute
FAA	Federal Aviation Administration
GAO	General Accounting Office
MLS	microwave landing system
NAFEC	National Aviation Facilities Experimental Center
NASA	National Aeronautics and Space Administration
OMS	Office of Management Systems
PAA	Program Area Agreement
R&D	research and development
RNAV	area navigation
TSC	Transportation Systems Center

COMPTROLLER GENERAL'S
REPORT TO THE COMMITTEE
ON SCIENCE AND TECHNOLOGY
HOUSE OF REPRESENTATIVES

CIVIL AVIATION RESEARCH AND DEVELOPMENT PROGRAMS AND FACILITIES Department of Transportation

D I G E S T

The National Aviation Facilities Experimental Center, the Transportation Systems Center, and the Civil Aeromedical Institute spent about $38 million for civil aviation research and development programs in fiscal year 1975. Estimated expenditures for fiscal year 1976 total $44.7 million. (See p. 3.)

Through fiscal year 1985 the Federal Aviation Administration plans to spend about $25.5 billion to develop and operate an upgraded air traffic control system. Accomplishment of this plan is closely related to how well the agency manages its 21 research, engineering, and development programs. Planned expenditures for these programs amount to about $890 million. (See p. 4.)

Department of Transportation and Federal Aviation Administration officials reviewed a draft of this report. Agency officials stated that the report was factual and accurately reflected conditions at the three activities.

NATIONAL AVIATION FACILITIES EXPERIMENTAL CENTER

This Center tests and evaluates aviation concepts, procedures, and equipment. It was heavily involved in 18 of the 21 civil aviation programs in fiscal year 1975 and spent $25.4 million. (See p. 11.) The Center had real property valued at $48.3 million (see p. 15), equipment valued at $63 million (see p. 15), and 1,760 employees. (See p. 29.)

For several years the Center has experienced problems in meeting scheduled milestones. It has taken action to curtail in-house project delays but cannot control

problems caused by budget fluctuations and contract approvals. (See p. 13.)

The Center's actual responsibility for test and evaluation sometimes excluded one or more of the functions of test planning, performance, and reporting. (These functions are sometimes performed by contractors or Government agencies.) Officials agreed that the Center's test and evaluation responsibility needed clarification. This is being done now. (See p. 14.)

The Center plans to replace many World War II era temporary buildings with a complex of technical and administrative buildings. They will cost about $45 million. If approved, construction could begin by January 1, 1977. (See p. 26.)

TRANSPORTATION SYSTEMS CENTER

This is a multimodal management and technology center; that is, it supports all of Transportation's research and development programs. The Center spent $46.5 million in fiscal year 1975 for research and development. Civil aviation received $10.4 million for work in 8 of the 21 programs. (See p. 43.)

The Center had real property valued at $23 million (see p. 46), equipment valued at $25 million (see p. 47), and 660 employees, including 165 persons assigned to civil aviation research and development projects. (See p. 48.)

Civil aviation research and development funding has remained relatively constant since the Center was established in July 1970. As a percentage of total funding, however, civil aviation research and development has decreased from a high of 58 percent of total funding in fiscal year 1971 to a low of 22 percent in fiscal year 1975. The trend reflects increased effort in support of other Department of Transportation programs. (See p. 42.)

CIVIL AEROMEDICAL INSTITUTE

The Institute does medical research for the Federal Aviation Administration's aviation medicine program. Research and development funding during fiscal year 1975 was $2.3 million. (See p. 55.) The Institute had no real property; it leased its facilities for $423,000 each year. (See p. 59.) The Institute had equipment worth $4 million (see p. 60) and employed 202 people. (See p. 61.)

The Institute has had a relatively constant level of appropriated funds during recent years, and an increasing proportion of its funds is being allocated to salaries and related costs. (See p. 62.)

The Institute has a highly trained and capable research staff and facilities for handling additional personnel and projects. The Federal Air Surgeon stated that the Institute could be more productive if its staff and facilities were used by other Department of Transportation administrations. In a May 1975 Department study, it was recommended to the Secretary that

--the Institute become more responsive to the biomedical research needs of the modal administrations of the Department and

--all biomechanics work presently done by the Occupant Restraint Division of the National Highway Transportation Safety Administration's Safety Research Laboratory be transferred to the Institute. (See p. 60.)

In July 1976, GAO inquired about the status of the recommendations contained in the study. Department of Transportation officials advised GAO that the recommendations have been substantially adopted and that implementation plans are underway.

GAO believes that these actions should result in more efficient use of the Institute's personnel and facilities.

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CHAPTER 1

INTRODUCTION

By letter dated June 25, 1975, the Chairman of the House Committee on Science and Technology asked the General Accounting Office (GAO) to assist its Subcommittee on Aviation and Transportation Research and Development in a review of the Nation's civil aviation research and development (R&D) programs and facilities. The request was directed toward programs and facilities managed by the National Aeronautics and Space Administration (NASA) and the Department of Transportation. Attached to the Chairman's letter was a work plan prepared by the Subcommittee Chairman, Congressman Dale Milford. (See app. I for copy of letter and work plan.)

The Subcommittee's overall objectives were broadly directed toward

--insuring that the United States retains its predominant role in world aviation,

--insuring that U.S. governmental agencies and private industry are cooperating, and

--insuring that Federal expenditures for aeronautical R&D and facilities are being spent effectively.

To comply with the Subcommittee's request, GAO initiated two separate reviews.

--Review of the Nation's civil aviation R&D programs and facilities.

--Review of the acquisition and utilization of wind tunnels.

The results of our review of the acquisition and utilization of wind tunnels were forwarded to the Chairman under separate cover, as requested by the Subcommittee.

SCOPE OF REVIEW

Our review was performed at three Department of Transportation activities: the Transportation Systems Center (TSC), Cambridge, Massachusetts; the National Aviation Facilities Experimental Center (NAFEC), Atlantic City, New Jersey; and the Civil Aeromedical Institute (CAMI), Oklahoma City, Oklahoma. The latter two are under the direct control and management of the Federal Aviation Administration (FAA).

Our review did not involve an assessment of management effectiveness or efficiency. Rather, the objective was to obtain information on technical programs, facilities, personnel, and related costs for the Subcommittee's use during the annual authorization process. We examined regulations, operating manuals, accounting and budget records, and technical program files and interviewed officials charged with management responsibility over technical programs, facilities, and personnel. In some instances statistical data was provided by the agency and accepted by GAO after test checks for accuracy.

AGENCY COMMENTS

Draft copies of this report were provided to the Department of Transportation and FAA for review and comment. Agency officials stated that the report was factual and accurately reflected conditions at the three activities.

CHAPTER 2

CIVIL AVIATION R&D PROGRAMS

The major goals of the Federal Aviation Administration civil aviation engineering and development programs, broadly stated, are:

--Increase and improve performance.

--Maintain and improve safety.

--Constrain and reduce costs.

These goals were derived from a consideration of several factors, including forecasts of air traffic requirements, analysis of aircraft accident reports, and trends in operation and maintenance costs.

FAA has established specific objectives under each goal. Areas of effort designed to achieve these objectives are categorized into 21 groupings or programs. Any one of the programs may receive input from industry, other Government agencies, or FAA.

The National Aviation Facilities Experimental Center, the Transportation Systems Center, and the Civil Aeromedical Institute provide direct support to FAA's engineering and development and safety programs. These activities spent about $38 million in research and development funds during fiscal year 1975. Estimated R&D expenditures for 1976 total $44.7 million.

NAFEC's primary mission is to test and evaluate aviation concepts, procedures, and equipment. In 1975 NAFEC was involved in 18 of the 21 FAA programs and R&D expenditures totaled $25.4 million. Estimated R&D funding in 1976 is $27.4 million with involvement anticipated in 17 of the FAA programs.

TSC is a multimodal management and technology center supporting all of Transportation's R&D programs; consequently, its contributions to FAA programs are not as wide ranging as NAFEC's. TSC's total R&D expenditure for 1975 was $46.5 million and for 1976 is estimated at $58.7 million. Civil aviation's share of 1975 expenditures was $10.4 million and for 1976 is expected to be about $15 million. TSC participated in eight of FAA's 21 programs.

CAMI conducts medical research for FAA. These efforts are categorized under one FAA program--aviation medicine.

R&D funding for CAMI during 1975 was $2.3 million, and the estimate for 1976 is also $2.3 million.

A list of the 21 FAA programs follows and shows whether NAFEC, TSC, or CAMI performed any work in those program areas during 1975.

FAA program	NAFEC	TSC	CAMI
01 - System	X		
02 - Radar	X		
03 - ATC Radar Beacon System/Beacon	X	X	
04 - Navigation	X	X	
05 - Airborne Separation Assurance	X	X	
06 - Communications	X	X	
07 - Approach and Landing Systems	X	X	
08 - Airports/Airside	X	X	
09 - Airport/Landside			
10 - Oceanic	X		
11 - ATC Systems Command Center Automation			
12 - En Route Control	X		
13 - Flight Service Station	X		
14 - Terminal Tower Control	X		
15 - Aviation Weather	X		
16 - Technology	X	X	
17 - Satellite	X	X	
18 - Aircraft Safety	X		
19 - Aviation Medicine			X
20 - Environmental Protection	X		
21 - Support	X		

Note: Each program is described in appendix II.

Many engineering and development programs are aimed at upgrading the third-generation air traffic control (ATC) system.

Through fiscal year 1985 FAA plans to spend about $25.5 billion to develop and operate an upgraded ATC system, including navigation and associated systems, and an adequate system of airports. Accomplishment is closely related to how well FAA manages its 21 research, engineering, and development programs. Planned expenditures for these programs are about $890 million. About $564 million of the development effort is planned for the "Upgraded Third Generation Air Traffic Control System," which includes major system acquisitions designed to improve the ATC safety, cost, and capacity in the 1980s and 1990s.

The detailed results of our review at NAFEC, TSC, and CAMI are contained in chapters 3, 4, and 5, respectively.

CHAPTER 3

NATIONAL AVIATION

FACILITIES EXPERIMENTAL CENTER

BACKGROUND

In 1957 President Eisenhower recognized the serious aviation facilities problem confronting the Nation as a result of the rapid technical advances in aviation and the remarkable growth in the use of air transportation. In May of that year, a published report on a study of this problem stated:

> "An independent Federal Aviation Agency should be established into which are consolidated all the essential management functions necessary to support the common needs of the military and civil aviation of the United States."

The report suggested that the time necessary to implement the new permanent organization might be as long as 2 or 3 years. The urgent need to modernize the airways prompted a further recommendation for an interim plan that included the creation of an Airways Modernization Board to begin modernizing the national system of aviation facilities pending longer range action. One of the interim agency's responsibilities was to establish "a national experimental activity * * * a joint experimental facility" geared to requirements for extensive systems experimentation.

In July 1957 President Eisenhower appointed a Special Assistant for Aviation Affairs and directed him to insure implementation of the recommended action. The Congress quickly approved the Airways Modernization Act (Public Law 85-133) establishing the Airways Modernization Board.

By April 1958 the board had selected a 5,000-acre site at the Atlantic City Naval Air Station for the experimental research and development center. This site, designated the National Aviation Facilities Experimental Center, was chosen on the basis of the following considerations.

--Availability of free airspace over the Atlantic Ocean and the high-density air traffic in the New York, Philadelphia, and Washington corridor.

--The proximity of McGuire Air Force Base.

--Weather patterns variable enough to provide all conditions.

--Availability of a facility with buildings, hangars, and runways that could be occupied and used immediately.

Officially commissioned in August 1958, NAFEC was absorbed into the newly established Federal Aviation Agency, 1/ along with the rest of the Airways Modernization Board and the Civil Aeronautics Administration. At present, the experimental center includes a modern airfield with standard and developmental installations; a fleet of aircraft; range instrumentation, navigation, and electronic test-bed facilities; air traffic control laboratories and simulators; a variety of computers; and other special- and general-purpose facilities. The 184 buildings and structures at NAFEC comprise about 1 million square feet of floor space. Most of the buildings were originally designed for temporary use. However, 13 permanent buildings housing aircraft safety test facilities have been contructed since NAFEC operations began, as well as a modern aircraft hangar, fire/crash rescue station, and central utilities plant. Plans are under way to modernize the aircraft fleet and to provide new buildings for laboratories and administrative support offices. (See p. 26.)

MISSION AND ORGANIZATION

NAFEC's mission is to:

--Operate and administer a national test center providing laboratories, facilities, skills, and services responsive to the FAA R&D programs.

--Conduct technical and operational test and evaluation of aviation concepts, procedures, and equipment.

--As requested by the appropriate developmental office or service, assist in research, development, and implementation of aviation concepts, procedures, software, and equipment.

--Perform other program and support functions as assigned.

When established in 1958, the Center's mission was "to develop, modify, test, and evaluate systems, procedures,

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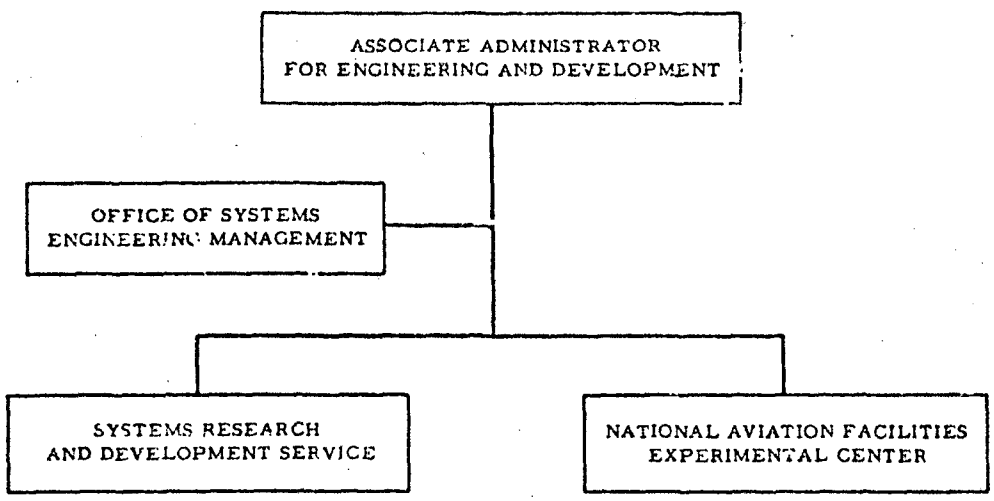
1/Presently the Federal Aviation Administration.

facilities, and devices to meet the needs for safe and efficient air traffic control of all civil and military aviation." Early in its development, NAFEC promoted military and contractor participation in its activities and tried to foster industry development in the aviation field through demonstration, as well as evaluation, of new concepts. However, military participation declined, and contractors were content to rely on the Government for conducting tests at the facility. The work became more limited in scope as specific test and evaluation requirements were generated by the developmental organizations in Washington.

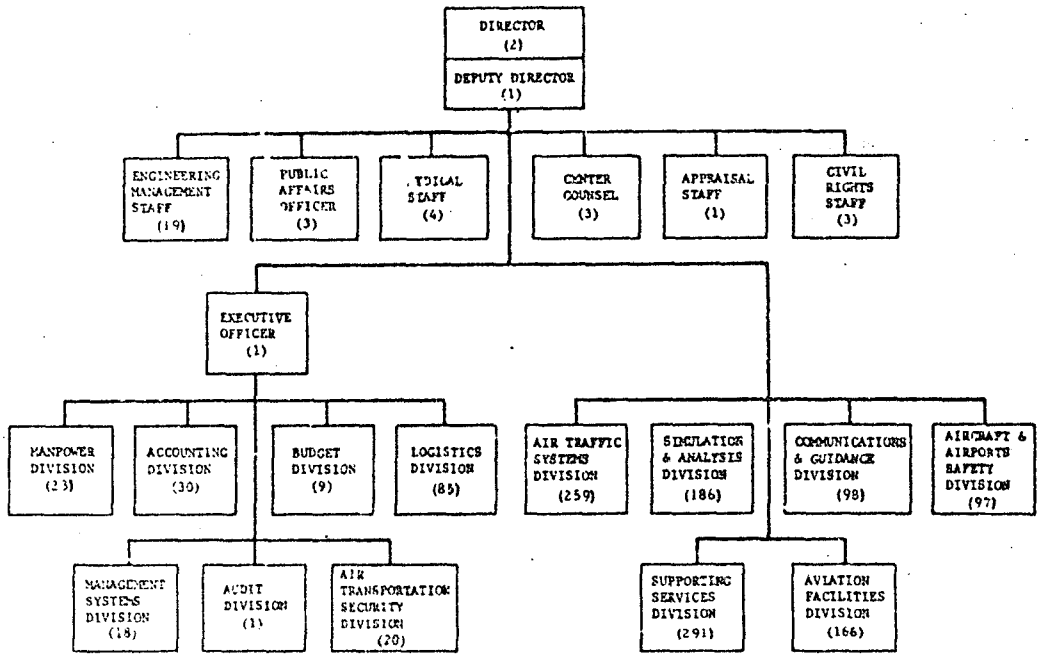
Despite numerous organizational changes affecting NAFEC's internal structure and its role within FAA, its primary mission since inception has been to test and evaluate aviation concepts, procedures, and equipment. FAA headquarters elements are responsible for overall R&D management, including determination of test and evaluation requirements. The relationship between NAFEC and other FAA elements, and the procedures for planning, funding, and accomplishing work have not changed greatly.

FAA HEADQUARTERS ENGINEERING AND DEVELOPMENT ORGANIZATION



Although NAFEC has undergone several internal realinements, especially during its first 8 years, its organization has been stable since 1972. As a result of a study of the NAFEC mission by FAA's Office of Management Systems (OMS), the Center's technical divisions were realined and an engineering management staff was created in March 1972 to improve technical achievement.

ORGANIZATIONAL STRUCTURE AND FULL-TIME PERSONNEL DISTRIBUTION
AT NAFEC AS OF OCTOBER 31, 1975



A description of the responsibilities and functions of major NAFEC offices and divisions follows.

Under the executive direction of FAA's Associate Administrator for Engineering and Development, the Office of the Director

--manages the functions assigned by the Administrator and insures mission accomplishment;

--directs all assigned programs and activities, insuring that each receives proper emphasis and conforms to prevailing policies, standards, procedures, and priorities;

--maintains relationships with other offices on matters related to NAFEC plans, programs, and services; and

--within the scope of delegated authority, represents the agency in dealings with public and private representatives on matters concerning NAFEC.

The Engineering Management Staff serves as the principal engineering adviser to the director and provides engineering consultation to project managers and supporting activities in the interest of technical achievement. This staff also

--develops long- and mid-range technical and program planning and oversees the execution of NAFEC plans and programs;

--schedules and uses resources in accordance with approved plans, projects, and programs; and

--reviews programs and project planning, execution, and accomplishment in both managerial and technical terms, establishes tolerances, and standards of operation and accomplishment, and arranges or recommends corrective action.

The Air Traffic Systems Division investigates, tests, and evaluates the concepts, techniques, equipment, procedures, and systems within the areas of primary and secondary radar surveillance and ATC to determine suitability for implementation. The division also performs other functions, as assigned, in support of agency research, development, and field implementation programs.

The Simulation and Analysis Division conducts projects to investigate, test, and evaluate aviation concepts, procedures, and equipment in analytical and simulated environments to determine technical and operational performance suitability for development. It also serves as the focal point for the agency on matters pertaining to the development and implementation of simulation facilities and procedures.

The Communications and Guidance Division conducts technical program activities to investigate, test, and evaluate aviation concepts, procedures, and equipment for voice and special communications, data transfer, and aircraft navigation and guidance. The division is also responsible for other functions, as assigned, in support of agency research, development, and field implementation programs.

The Aircraft and Airports Safety Division conducts technical program activities to investigate, test, and evaluate aviation concepts, procedures, and equipment for aircraft structures, engines, instruments, propulsion methods, flight sciences, cockpit environments, aircraft safety, flight simulation, airport lighting and visual guidance, airport weather, safety and capacity of runways and taxiways, and

other functions as assigned to support agency research, development, and field implementation programs.

The Supporting Services Division manages and provides supporting services for plant operation, assigned automatic data processing and technical support facilities, communications, space, and mail service. It also performs planning, engineering, architecture, construction, preparation, and maintenance functions.

The Aviation Facilities Division manages the research and development aircraft assigned to NAFEC and performs associated planning, engineering, operation, maintenance, inspection, and related services in support of technical projects. The division also maintains NAFEC-based flight inspection aircraft; manages the NAFEC airport; provides firefighting, crash and rescue, and fire and police communications. It also develops and coordinates emergency operations plans and performs other functions as assigned.

FUNDING

NAFEC's funding is categorized by the following appropriations:

Appropriations	Fiscal year 1975	1976
	(000 omitted)	
Operations	$20,629	$23,617
Research, engineering, and development	17,275	17,498
Facilities--Engineering and development	3,797	1,608
Facilities and equipment	4,192	2,618
Facilities--Capital improvements	5,160	5,836
	$51,053	a/$51,177

a/Includes preliminary planning amounts for contractors' efforts subject to fluctuations in program budgets and priorities.

As shown above, the largest funding is from the operations appropriation which includes NAFEC operating costs. Included in such costs are base and airfield maintenance, administration, logistics, medical, and field support functions. The operations appropriation for general base support totaled $8.5 million and $11.5 million for fiscal years 1975 and 1976, respectively. The balance of the operations appropriation is applied to the tenant organizations. The roles of

tenant organizations assigned to Washington headquarters but located at NAFEC for administrative support are described on page 38.

NAFEC's technical effort is funded by the remaining appropriations. A cost accounting system tracks these technical program costs, but it does not include the "Facilities--Capital Improvements" appropriation, nor does it allocate the related operating costs to the technical programs. It was recognized at the time the cost system was set up that this allocation could be done, but it was considered of questionable benefit.

FAA's accounting system principles and standards have been approved by GAO, which plans to approve the accounting system design by fiscal year 1977.

TECHNICAL PROGRAM

NAFEC's technical program covers its mission responsibilities for

--technical and operational testing and evaluating of aviation concepts, procedures, and equipment and

--assisting, as requested by the appropriate FAA developmental office or service, in R&D.

The engineering management staff estimates that about 65 percent of NAFEC's technical program in fiscal years 1975 and 1976 is devoted to the test and evaluation mission while the remaining 35 percent pertains to R&D. The effort, which involves NAFEC funding of about $25.4 million for fiscal year 1975 and $27.4 million for 1976, is principally applied to several generations of the ATC system.

The proportions of technical program effort are changing.

Technical program category	Fiscal year 1974	1975	1976
Field support	30%	20%	20%
Third-generation implementation	45	10	5
Upgraded third-generation development	10	35	40
Continuing engineering for safety, etc.	15	35	35

These changes are due mostly to (1) a decreasing need for NAFEC's sustaining engineering of ATC systems already fielded and engineering associated with implementing the third-generation system and (2) an increasing need for engineering

to support development of the upgraded third-generation ATC system and for engineering related to aircraft safety, weather, and environment.

NAFEC officials told us that upgrading the third-generation ATC system will take on increasing importance over the next few years. FAA estimates that this development program, which started in fiscal year 1971, will cost $657 million through fiscal year 1983.

Program review

The technical program is carried out in response to product/service and schedule requirements in program area agreements (PAAs). Those yearly agreements form "contracts" between NAFEC and the headquarters activities that sponsor FAA's engineering and development work. PAA managers control the agreements which are related to major FAA programs and subdivisions of these programs. Those programs involving NAFEC in 1975 and 1976 are identified and discussed in appendix III along with our reviews of selected PAAs. The PAAs selected represent more than 25 percent of the NAFEC technical program.

The following table shows NAFEC personnel and funding distribution among the 21 FAA programs for fiscal years 1975 and 1976.

Staff-years and funding by NAFEC

FAA program	Fiscal year 1975 Personnel Years	Personnel Percent	Funding In-house	Funding Contract	Funding Total	Funding Percent	Fiscal year 1976 Personnel Years	Personnel Percent	Funding In-house	Funding Contract	Funding Total	Funding Percent
			($000 omitted)						($000 omitted)			
01 System	47	5.7	$ 1,146	$ 534	$ 1,680	6.6	19	2.2	$ 482	$ 937	$ 1,419	5.1
02 Radar	12	1.4	294	45	339	1.3	17	2.0	431	10	441	1.6
03 ATC rad / beacon system/beacon	91	11.0	2,205	349	2,554	10.1	111	13.0	2,807	750	3,557	13.0
04 Navigation	100	12.1	2,441	184	2,625	10.3	94	11.0	2,396	388	2,784	10.2
05 Airborne separation assurance	53	6.4	1,275	347	1,622	6.4	53	6.2	1,351	216	1,567	5.7
06 Communications	32	3.9	764	48	812	3.2	26	3.0	674	9	683	2.5
07 Approach and landing systems	93	11.2	2,259	641	2,900	11.4	116	13.6	2,966	526	3,492	12.7
08 Airport/airside	23	2.8	559	76	635	2.5	38	4.5	969	210	1,178	4.3
09 Airport/landside	-	-	-	-	-	-	-	-	-	-	-	-
10 Oceanic	8	1.0	206	-	206	0.8	-	-	-	-	-	-
11 ATC systems command center automation	-	-	-	-	-	-	-	-	-	-	-	-
12 En route control	118	14.2	2,830	299	3,129	12.3	130	15.3	3,347	263	3,610	13.2
13 Flight service stations	20	2.4	496	48	544	2.2	20	2.4	503	591	1,094	4.0
14 Terminal/tower control	79	9.5	1,920	83	2,003	7.9	104	12.2	2,651	201	2,852	10.4
15 Aviation weather	11	1.3	260	16	276	1.1	11	1.3	281	17	298	1.1
16 Technology	10	1.2	247	76	323	1.3	7	0.8	178	145	323	1.2
17 Satellite	21	2.5	504	63	567	2.2	26	3.1	661	80	741	2.7
18 Aircraft safety	48	5.8	1,164	274	1,438	5.7	43	5.1	1,118	485	1,603	5.8
19 Aviation medicine	-	-	-	-	-	-	-	-	-	-	-	-
20 Environmental protection	29	3.5	711	2,081	2,792	11.0	27	3.2	679	795	1,474	5.4
21 Support	34	4.1	830	103	933	3.7	9	1.1	231	75	306	1.1
Total	829	100.0	$20,111	$5,267	$25,378	100.0	843	100.0	$21,724	$5,698	$27,422	100.0

Overall results of PAA reviews

The work involved in the PAAs we reviewed is directly related to NAFEC's assigned development, test, and evaluation mission. The projects were selected on the basis of FAA and NAFEC priority assignments with additional consideration given to those efforts deemed most important by NAFEC's engineering management staff in terms of both NAFEC and FAA engineering and development goals. The significance of the PAAs reviewed in relation to NAFEC's overall role in the 21 engineering and development program areas is shown in the following table.

	Fiscal year 1975	Fiscal year 1976
PAAs:		
Total number (note a)	46	41
Portion reviewed	12	12
Percent	26	29
Funding (thousands):		
Total in-house	$20,111	$21,724
Portion in PAAs reviewed	$ 7,107	$ 7,996
Percent	35	37
Total contracted	$ 5,267	$ 5,698
Portion in PAAs reviewed	$ 1,358	$ 1,887
Percent	26	33
In-house staff-years:		
Total	829	851
Portion in PAAs reviewed	292	274
Percent	35	32

a/For 1975, this represents the number of PAAs with cost accounting system charges. For 1976, this represents the number of active PAAs as of November 1975.

Schedule performance

In its 1971 study (see p. 7), OMS found a lack of timeliness in meeting schedules and generally attributed the problems to a need for improved management both by NAFEC and by FAA headquarters. While we did not concentrate on evaluating management, schedule performance problems were noted in the programs reviewed. Overall, slippage averaging about 7 months has occurred or is anticipated in 138 of 192 (72 percent) of NAFEC's milestones for planning, performance, and reporting of its technical effort under the PAAs reviewed. Individually, the slippages ranged for 1 to 25 months. The specific causes of project delay included

--difficulty in contracting and in the delivery of equipment or the performance of delivered equipment,

--staff reassignment, retirement, or sickness of key personnel,

--untimely processing of technical reports,

--scheduling conflicts for facilities and equipment support or need for improved facilities, and

--difficulty with the NAFEC/headquarters relationship in such areas as funding, methodology, and objectives.

While NAFEC's engineering management staff recognizes that there are problems with schedule accomplishment, they believe that things have improved since the 1971 OMS study. Furthermore, they told us that problems related to staff, reports processing, and facilities are controllable and present opportunities for management to improve schedule performance. Action was taken in December 1975 to increase the staff responsible for reports processing, and Center officials told us they intend to take action in the other controllable areas. However, problems caused by budget fluctuations and contract approvals are not controllable by NAFEC.

Test and evaluation responsibility

In our review of the PAAs, we found that NAFEC's actual responsibility for test and evaluation sometimes excludes one or more of the functions of test planning, performance, and reporting as these may be done in part by contractors or other agencies on a case-by-case basis.

Since NAFEC's chartered mission seems to infer broader responsibilities, i.e., to provide a national test center for technical and operational test and evaluation, we discussed this matter with the director and the acting chief of his engineering management staff. They agreed there was a need to enhance NAFEC's test and evaluation responsibility, and the director told us that subsequent meetings have been held with the FAA's Associate Administrator for Engineering and Development, the Systems Research and Development Service, and the Transportation Systems Center to clarify and enhance NAFEC's test and evaluation responsibility.

FACILITIES

NAFEC's facilities cover a range of services and capabilities in support of test and evaluation activities. The

center is equipped with a fully instrumented airfield; range instrumentation, radar surveillance; navigation and electronic test-bed facilities; air traffic control laboratories which include both standard and experimental equipment; flight and ATC simulators; computers; a fleet of aircraft; and a variety of other special- and general-purpose facilities.

The capitalized value of real property, based on Navy transfer costs when NAFEC was established and subsequent costs of improvements and additions, is shown below.

Real property	June 30, 1974	June 30, 1975
	(millions)	
Land	$ 2.9	$ 2.9
Buildings	24.4	25.9
Other structures/systems	19.1	19.1
Total	$46.4	$48.3

Some of NAFEC's real property is considered obsolete with limited market value.

The capitalized value of equipment at NAFEC, based on cost, is shown below.

	June 30, 1974	June 30, 1975
	(millions)	
Administrative	$ 3.4	$ 3.4
Developmental	45.8	47.9
Other	8.6	11.7
Total	$57.8	$63.0

These figures do not include an additional $7.3 million in research and development aircraft "owned" by FAA that are based at NAFEC, nor do they include eastern region commissioned facilities 1/ on the base and used by NAFEC. In addition, some equipment at NAFEC is being stored for future project use. The total value of this "reserve" equipment as of October 31, 1975, was $2.5 million.

1/A commissioned facility provides a service common to civil, commercial, and military air traffic, and is operated to the same standard and tolerance as any identical facility found in the continental United States.

Functions and capabilities of NAFEC's technical facilities

NAFEC's technical facilities are grouped into 10 general functional areas.

1. Aircraft facilities
2. Airfield facilities
3. Range instrumentation and measurement facilities
4. Simulation facilities
5. Surveillance radar facilities
6. Communications and navigation facilities
7. ATC systems laboratory
8. Data processing facilities
9. Aircraft safety facilities
10. Laboratory service facilities

Following are descriptions of these facilities, their use, and plans to improve them.

Aircraft facilities

These facilities provide aircraft and various services for project support and for general use. The facilities include a flight operations organization to operate aircraft, an aviation engineering organization to design modifications to aircraft, and a maintenance and modification facility to maintain the aircraft and install equipment and modifications.

Six aircraft are assigned to NAFEC for use in support of project requirements. The fleet consists of an Aero Commander 680E, a Convair 580, a Convair 880, a Douglas DC-6B, and two Grumman Gulfstream aircraft. All aircraft are configured for R&D.

The estimated value of the aviation facilities as of June 30, 1975, was:

Aircraft	$ 7,328,000
Hangar and office building	2,468,000
Support equipment	1,695,000
	$11,491,000

The fleet is used to support a wide variety of programs at NAFEC. Some of the aircraft and their uses are described below.

The Aero Commander 680E is considered as representative of the general aviation community. It is currently used in evaluating area navigation (RNAV) systems. In the near future, it will be used in the windshear program and to test a low-cost microwave landing system (MLS).

The Convair 580 is used for general-purpose flight support for navigation improvement projects. It also supports an Airborne Beacon Interference Locator project and the Minimum Safe Altitude Warning program. Plans are to use the Convair 580 for the Discrete Address Beacon System program.

The Convair 880 is used in terminal and landing systems projects. It has also been used in support of wake vortex, and ATC Radar Beacon System programs. Planned program applications include RNAV and MLS, as well as continued support in the areas mentioned.

The Douglas DC-6B is used for the MLS program. It also supports the collision avoidance and other very low frequency navigation efforts.

The two Grumman G-159 aircraft are used in general support of projects involving landing systems, RNAV, collision avoidance systems, and ATC Radar Beacon System improvement programs.

Aircraft utilization

Analysis of project utilization data for fiscal years 1974 and 1975 showed that for both years NAFEC-assigned aircraft were used about 45 percent of available aircraft hours (net of maintenance hours). This rate is comparable to the findings of the 1971 OMS study in which it was found that the annual use of NAFEC aircraft for projects was between 40 percent and 60 percent.

	Fiscal year 1974			Fiscal year 1975		
	Inservice hours (note a)	Hours not scheduled for project use	Percent of hours not scheduled	Inservice hours (note a)	Hours not scheduled for project use	Percent of hours not scheduled
Aero Commander	2,639	1,257	76.7	1,661	693	41.7
Convair 580	1,783	924	51.8	1,240	768	61.9
Convair 880	1,498	290	19.3	781	413	52.9
Douglas DC-6B	1,478	657	44.4	1,485	896	60.3
Grumman G-159 (N-316)	1,172	583	49.7	1,520	713	46.9
Grumman G-159 (N-377)	1,483	1,093	73.7	1,322	649	49.1
Twin Otter	242	167	68.9	-	-	-
Air Force C-118	1,156	646	55.9	-	-	-
	10,451	5,617	53.7	8,009	4,132	51.6
Hours charged to projects		4,843(46.3%)			3,470(43.3%)	

a/Total hours available net of maintenance.

We have drawn no conclusions on the reasonableness of NAFEC's use of aircraft since this would require analysis of project requirements, scheduling practices, and aircraft capabilities.

Planned change to aircraft fleet

Most NAFEC aircraft have reciprocating or turboprop engines. Only the Convair 880 is a pure jet, and it is considered obsolete by NAFEC. Because of questions concerning the capability of the fleet to support projects for development, test, and evaluation of the upgraded third-generation system and to adequately represent current air carrier and general aviation aircraft in 1973, NAFEC contracted with Booz-Allen Applied Research, Inc., to study the Center's 10-year needs. The contractor concluded that program needs through 1983 could not be met in any substantial manner by the present fleet and recommended the purchase of four jet aircraft, retention of one of the existing aircraft, and disposal of five aircraft. Based on this study, NAFEC planned to purchase the following aircraft.

1976:	Short-haul jet (DC-9, Boeing 737)	$4.5 million
1977:	Medium jet (Boeing 727)	4.9 million
	Business jet (Sabreliner)	2.7 million
1979:	Business jet (Sabreliner)	2.7 million

The existing fleet would be phased out concurrently, except for the Convair 580. We were later told that procurement of the short-haul jet had been deferred until fiscal year 1977 and that, if the price is advantageous, NAFEC may buy the medium jet before the short-haul jet.

Airfield facilities

NAFEC's airfield provides both an operational airport and a test-bed facility for engineering and development projects and experimental lighting projects.

The airport consists of three runways and a network of connecting taxiways and ramps as follows.

--A main runway 10,000 feet long and 200 feet wide which is equipped with an instrument landing system and approach lights.

--An instrument runway 6,100 feet long and 150 feet wide.

--A runway 5,000 feet long.

As of June 30, 1975, the capitalized value of the airfield was $8.9 million and no improvements were planned. The only facility improvement underway is completion of an airfield wiring replacement program.

Range instrumentation and measurement facilities

These facilities obtain space-position-time data on test aircraft and provide an environment for testing and evaluating new navigation systems, procedures, or equipment.

The range instrumentation facilities include (1) a phototheodolite system to provide accurate space-position-time data for flight testing of aircraft landing systems, (2) an extended-area instrumentation radar which tracks aircraft up to 200 miles from the center, and (3) a range control central facility which employs a special-purpose digital computer to integrate and synchronize range instrumentation data.

The value of NAFEC's range instrumentation and measurement facilities is estimated at $2.3 million, including the buildings in which they are housed.

The range instrumentation facilities are being used on a broad scope of programs. The branch chief responsible for operating the facilities characterized the use of the phototheodolite system, extended-area instrumentation radar, and range control central facility as high.

Two additions are planned to the range instrumentation facilities. The first is two mobile, laser/radar trackers to provide precision tracking of aircraft during approach and landing under all weather conditions and at sites other than NAFEC. These trackers will be used for the All Weather Landing Program and for MLS. The systems were to be delivered in April 1976 and were expected to cost about $727,000. The second addition is a long-range radar to enable tracking more than one aircraft at extended ranges. This capability is required for the intermittent positive control program and to test collision avoidance and RNAV systems. To meet this requirement, two Army Nike/Hercules tracking radars are being converted to instrumentation radars by the Navy and will be delivered to NAFEC. The conversion will cost about $1.1 million.

Simulation facilities

These facilities are capable of simulating, in a controlled laboratory environment, a variety of situations, such

as control of air traffic for en route and terminal areas, evaluation of flight procedures, and evaluation of various ATC equipment systems and components. The facilities are used both to guide developmental activities and to test and evaluate concepts, procedures, and hardware.

The principal facility of this group is the Digital Simulation Facility which can simulate a large-scale air traffic situation. This has a design capacity to simulate 300 controlled aircraft, 12 radar surveillance inputs, and 24 air traffic controller positions. It is composed of computers that power the facility, a pilot display, and a controller display system. Aircraft flight plans are inserted into the computer which "flies" the aircraft and modifies the flight plan as requested by controllers.

A second simulation capability is provided by the Cockpit Simulation Facility, which consists of two general aviation trainers or flight simulators. This offers a dual testing capability allowing evaluation of cockpit instrumentation and pilot reaction to various test conditions.

The third major simulation capability is the Controller/Computer Interface Laboratory which enables the investigation of problems, processes, and possibilities in linking the air traffic controller and the computer to control air traffic. This effort primarily involves the development and evaluation of data and display techniques from the human factors and human engineering viewpoints.

The estimated equipment value of the Digital Simulation Facility is >2.3 million and the building in which it is located is valued at $1.2 million. The Cockpit Simulation Facility is valued at about $600,000.

A variety of projects are currently using the Digital Simulation Facility and the Cockpit Simulation Facility, including the ATC Radar Beacon System and Intermittent Positive Control programs; RNAV, Collision Avoidance Systems and Visual Collision Prevention. The Controller/Computer Interface Laboratory is being used for the Modernized Flight Service Station Design Evaluation and ATC Terminal Area Experimental programs, as well as for data entry and display technology and controller performance measures.

NAFEC's cost accounting system generates usage data for computer and pilot/controller display components of the Digital Simulation Facility and for the Cockpit Simulation Facility. Comparison of the number of hours charged to projects during fiscal year 1975 to the practical capacity is shown on the following page.

Sigma 5 computer	94.9%
Sigma 8 computer	83.6
Pilot display	18.1
Controller display	17.9
Cockpit Simulation Facility	111.1

Several improvements are planned to the simulation facilities over the next 5 years. The Digital Simulation Facility will be modified to allow small problems to be run without gearing up the entire facility, adding memory and processing capability, and replacing existing controller displays as they complete their useful life. These improvements are estimated to cost $1 million. NAFEC plans to improve the Cockpit Simulation Facility by adding a visual system, estimated to cost about $400,000, to support various programs including All Weather Landing, Visual Guidance, and Airport Lighting. Also, procurement of a twin-jet cockpit simulator is contemplated to permit simulation of the parameters and variables of jet aircraft cockpit installations for the Intermittent Positive Control program, and for RNAV. NAFEC estimates this procurement will cost about $650,000.

Surveillance radar facilities

These facilities provide information concerning the location and movement of aircraft at and around NAFEC and also provide test-bed environments in which radar systems, equipment, and components can be subjected to development testing, evaluation, and experimentation. Data from the surveillance radars and the simulation facilities can be combined to integrate live and simulated air traffic targets to provide both a realistic and controllable environment for the investigation of ATC concepts and procedures.

There are three surveillance radar facilities: one each for terminal and en route automation/surveillance testing and a terminal radar/beacon test facility. They provide test beds for proposed modifications, procedure changes, and resolution of field problems to upgrade and improve field installations. In addition, these facilities provide signals for other projects.

The estimated value of the three surveillance radar facilities, including the buildings in which they are housed, is about $2.5 million. The facilities have been used to support the ATC Radar Beacon System Improvement program and the En route and Terminal Automation programs. In the future they are to be used for the Discrete Address Beacon System program.

The branch manager responsible for operating these facilities told us that, while occasionally the en route facility is not fully used, the terminal facilities are and will be further used when NAFEC begins work on the Discrete Address Beacon System program.

An improvement planned for NAFEC's surveillance radar facilities is the replacement of an ASR 5 terminal radar with a newer type ASR 8 that the FAA is installing in the field. The unit at NAFEC will be used as a test bed for the Discrete Address Beacon System program and is expected to cost $400,000.

Communication and navigation facilities

NAFEC has a variety of experimental test beds representative of FAA operating facilities including instrument landing systems, navigation facilities, and communication facilities.

Generally, the navigation facilities allow inservice improvements to be made and evaluated in a controlled environment before introducing a change to any field operating facility.

The communications facility supports NAFEC project activity by giving two-way radio capability between testflight aircraft and ground facilities.

The estimated value of the communications and navigation facilities, including buildings, is about $1.4 million. The navigation facility is used on a continuing project, and the communications facility is used in a general support role. NAFEC's cost accounting system does not generate usage data for these facilities; however, the branch manager responsible for operating the navigation facilities stated that they are not fully used and additional project work could be scheduled.

No new general-purpose communication or navigation facilities are planned for NAFEC--only modernization and maintenance of the present systems.

ATC systems laboratory

This laboratory provides capabilities for testing and evaluating new systems, items of equipment, and procedures in a total system environment. It is comprised of four individual facilities; the Terminal Automation Test Facility, the Terminal Systems Support Facility, the En route System Support Facility, and the ATC Communication Facility.

The Terminal Automation Test Facility is located in the former Atlantic City airport terminal building which is leased from the city. It provides a test bed used to support terminal and tower engineering and development. The facility is equipped with experimental and developmental Automated Radar Terminal System (ARTS) equipment.

The Terminal Systems Support Facility is comprised of an ARTS III configuration similar to the systems in use at 60 terminals across the United States. This provides the capability to support field sites in software problem resolution, modernization, and acceptance testing and in development and testing of hardware modifications.

The En route System Support Facility was established for test and development activities which could not be accomplished at an operational site without disrupting day-to-day ATC operations. It includes computers, an en route display laboratory, and other facilities for conducting real-time ATC tests. The facility is used by contractor and Government personnel engaged in National Airspace System activities. Contractor personnel use the facility to develop and test operational computer programs, as well as in system design and improvement. FAA personnel use the facility for conducting tests and for development, production, and maintenance of engineering and data reduction and analysis programs. The facility also acts as a quality control vehicle for equipment engineering changes and supports operational computer program testing conducted by the FAA's Air Traffic Service.

The ATC Communication Facility provides communication support for the ATC Systems Laboratory and the Center's simulation facilities. The equipment in the ATC Communications Facility is leased.

The estimated value of the ATC Systems Laboratory facilities is:

	(million)
Terminal Automation Test Facility	$ 4.7
Terminal Systems Support Facility	1.4
En route System Support Facility	27.3
Other	.3
	$33.7

In addition, the estimated value of the leased communication equipment is $8 million.

The en route support facility is operated 6 days a week, 3 shifts a day. NAFEC plans to use it 7 days a week when full-scale testing of the Upgraded Third Generation ATC System begins. The terminal support facility operates 5 days a week, 3 shifts a day so that there is capacity available for additional project use on weekends. The terminal automation facility is operating 7 days a week, 3 shifts a day.

The en route support facility is used for programs in FAA's Beacon (Area 03) and En route Control (Area 12) program areas, as well as in support of programs conducted by the Air Traffic and Airway facilities organization located at NAFEC. The terminal support facility is used for these programs and, in addition, supports the FAA's Terminal/Tower Control program. The Terminal Automation Facility supports FAA's terminal/tower control and radar/beacon programs.

Two additions are planned to NAFEC's ATC Systems Laboratory. The first is an expansion of the en route facility computer systems to meet anticipated program requirements at an estimated cost of $2.5 million. An addition to the terminal automation facility estimated to cost $360,000 is planned to meet the needs of the Terminal/Tower Control program.

Data processing facilities

The data processing facilities are used to support a variety of projects in almost every technical program area, as well as for administrative applications. The facility is built around an IBM 7090 computer and uses an IBM 1401 computer as an input-output device. 1/ The facility is also equipped with a data plotter, high speed printers and punched-card equipment.

NAFEC cost accounting records show that in fiscal year 1975 about 80 percent of the capacity of the 1401/7090 computers was actually charged to projects. This rate is comparable to the usage levels found by OMS in their 1971 study of NAFEC's operations.

1/There are a total of 66 computers at NAFEC, ranging from minicomputers to large general-purpose equipment. However, all except the 1401/7090 are "dedicated" to special purposes and are part of other facility groupings. For example, NAFEC has about 11 IBM 9020 computers which are used to drive the ATC Systems Laboratory and therefore are not considered part of the data processing facilities.

NAFEC is acquiring a new computer to replace the 7090 model, which is considered obsolete. The procurement has been approved by the Office of the Secretary of Transportation and funded at $2 million. As of October 1975, NAFEC was preparing to evaluate six contractor proposals. Delivery is expected in November 1976.

Aircraft safety facilities

These facilities provide an environment for test and evaluation of aircraft components, structural equipment, and materials to provide data for improving the safety of aircraft.

Thirteen buildings house the facilities which include a wind tunnel type fire test cell, two large engine test cells, a catapult and track for rapid decelerations or impact tests, a 50-foot drop tower, a compressed-air gun, cells for fire testing components and equipment, and a crash/fire test facility to simulate crash conditions. All facilities are instrumented and in operation, and their estimated value is about $3.3 million.

The aircraft safety facilities are used primarily in support of programs in the FAA's Aircraft Safety, Environmental Protection and Airport/Airside Safety program areas. No utilization data is maintained on these facilities.

Several improvements are planned. The most costly involves construction of a full-scale indoor fire test laboratory in fiscal year 1977 large enough to house a wide-body fuselage for testing in a completely controlled environment. NAFEC estimates the cost to construct this facility at $495,000. Another planned major improvement involves construction of an additional catapult facility for dynamic testing of various structures and equipment subject to being struck by aircraft. NAFEC may acquire the catapult on a loan basis from the Marine Corps or as a transfer from the Navy. Aircraft Safety Division officials told us that this additional catapult is necessary to test heavier vehicles at faster speeds to meet requirements in FAA's Airworthiness and Crash Safety program. The anticipated cost is $450,000. NAFEC also plans to add noise suppression measures to its engine test cell facility to comply with State noise pollution standards. The anticipated cost is $228,000.

Agency officials informed us that the catapult facility and the noise suppression modification will not be funded in fiscal year 1977.

Laboratory service facilities

NAFEC has a variety of specialized service facilities which support project work--a video tape capability, calibration services, photographic, printing and graphics services, and a fabrication shop.

Correlation of NAFEC facilities with applicable FAA programs

The previously described facility groupings were used with the FAA engineering and development programs (01, 02, etc.) during 1975 as follows.

NAFEC facilities	FAA engineering and development program																
	01	02	03	04	05	06	07	08	12	13	14	15	16	17	18	20	21
Aircraft	X	X	X	X	X	X	X	X	X	X	X	X		X	X		
Airfield	X	X	X	X	X	X	X	X	X	X	X	X		X	X		
Range instrumentation/ measurement			X	X	X	X	X	X			X	X		X			
Simulation	X		X	X	X	X	X	X	X	X	X		X			X	X
Surveillance radar		X	X					X	X		X						
Communications/navigation			X	X	X	X	X	X			X	X		X	X	X	X
ATC systems laboratory			X						X		X						
Data processing	X	X	X	X	X	X	X	X	X		X	X		X	X	X	X
Aircraft safety								X							X	X	
Laboratory service																	

All program areas as required.

Facilities improvement program

NAFEC and FAA plan to replace many of the World War II era temporary buildings at NAFEC with new technical and administrative buildings. The estimated cost is about $45 million.

Background

The building plan, or facilities improvement program, dates back to September 1961 when a master plan for the replacement of the existing temporary facilities at NAFEC was prepared by an architectural firm and recommendations were made to the FAA Administrator that construction be undertaken immediately. The master plan envisioned a time-phased program for replacing the existing buildings at NAFEC. These phases were:

Phase I, the Flight Operations Complex, provided for a new aircraft hangar and operations building, fire/crash station, and central utilities plant to replace five of the most deteriorated buildings and was completed in 1968 at a cost of $12 million.

Phase II, the Technical and Administrative Complex, provided for new technical laboratories, engineering offices, staff functions, and administrative support facilities to replace 34 buildings. Effort has not been started on this phase which is the subject of the current building program.

Phase III, the Industrial Complex, provided for new warehousing and material support facilities and for automotive and buildings and grounds maintenance shops. It would replace 30 buildings and structures. No action has been taken on this phase.

Since 1968 several attempts have been made to start construction on the three technical and administrative buildings in Phase II; however, each funding request has been turned down by FAA, the Office of the Secretary of Transportation, or the Office of Management and Budget. The only exception occurred in 1963 when the Phase I construction was approved by the Congress.

Again, in the fall of 1974, NAFEC submitted a construction plan to FAA for the technical and administrative complex. The Administrator did not approve the plan but asked for a study to determine whether NAFEC would remain in its present location or be relocated. NAFEC officials told us that, although the results of the study were never officially released, the Secretary of Transportation decided in the spring of 1975 that NAFEC would remain in its present location. As a result, NAFEC reactivated its planning for the facilities improvement program.

Description of proposed construction

Phase II provides for constructing technical and administrative buildings to consolidate the functions located in World War II era temporary structures. These buildings will be located adjacent to the new hangar and operations building and will use the central utilities plant built during Phase I. Included will be:

--An administrative/central services building of approximately 106,000 square feet to house the Center staff, technical library, cafeteria, auditorium, dispensary, and printing services.

--A general laboratory building of approximately 166,000 square feet to house engineering offices, electronic laboratories, drafting facilities, and data analysis.

--An ATC Systems Laboratory building of approximately 211,000 square feet. This building would house the en route system support facility, terminal system support facility, terminal automation test facility, upgraded third-generation system digital simulation facility, and NAFEC's computer complex.

Construction alternatives

Three alternatives have been considered for improving NAFEC's facilities--new construction, new construction and rehabilitation of some older buildings, and rehabilitation only. FAA and NAFEC have concluded that new construction is the most cost effective plan and will provide facilities designed for the needs of future technical programs and the most efficient work environment.

Funding alternatives

Two alternatives are being considered for financing the construction (1) a congressional appropriation for Federal construction and ownership of the buildings or (2) a congressional appropriation for lease of the buildings with construction funded by the Atlantic County Improvement Authority. The latter alternative arose when NAFEC's continued location in the Atlantic City area was in doubt. Civic leaders proposed a program to the FAA Administrator whereby the improvement authority would construct the facilities and lease them to the FAA. In September 1975 NAFEC entered into discussions with the authority to develop the feasibility of the construction/lease alternatives.

Relationship of facilities improvement program to NAFEC technical programs

Information provided by the center indicates that about 70 percent 1/ of its existing buildings and equipment would be used in varying degrees to support expected program requirements associated with FAA's upgraded third-generation ATC system development. So far, specific responsibilities and schedules have not been set to fully define NAFEC's effort and the timing of that effort for evaluating various

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1/Based on in-place building and equipment costs accumulated through fiscal year 1975.

system components under development. Although specific technical program cost and schedule impacts (assuming either approval or disapproval of the building program) have yet to be quantified, NAFEC officials told us the new facilities would greatly enhance capability and efficiency. Advantages cited include:

--Simplifying NAFEC's radar signal and communication facility and eliminating the need for leased lines between buildings.

--Improving coordination between organizations because they will be physically closer which will reduce setup time for projects and minimize the need for duplicate test equipment.

--Greater operating efficiency because support elements will be centralized, which will thereby improve opportunities for better use of personnel and more effective use of data processing facilities.

It was indicated that these advantages would apply to all components of the upgraded system and in particular to the Aeronautical Satellite and Increased Automation programs.

Current status

In December 1975, FAA and Atlantic County Improvement Authority officials announced that construction plans had been completed and would be forwarded to the Secretary of Transportation for approval. The plan calls for the sale of a $50 million bond issue by the Authority and a 20-year lease with FAA. If approved, construction could begin by January 1, 1977.

PERSONNEL

As of November 1975, 1,760 personnel were assigned to NAFEC--1,322 full-time permanent employees, 172 temporary employees, and 266 FAA headquarters personnel assigned as tenants at NAFEC. Following is profile data for NAFEC's full-time permanent personnel and for personnel directly involved in technical programs, including FAA managers. In some areas, comparisons are made between the results of FAA's May 1971 OMS study and our review. Equal employment opportunity data is also provided for NAFEC and FAA tenant organizations at NAFEC.

Personnel profile

NAFEC's personnel complement includes a wide range of skills and disciplines. The distribution as of October 31, 1975, was:

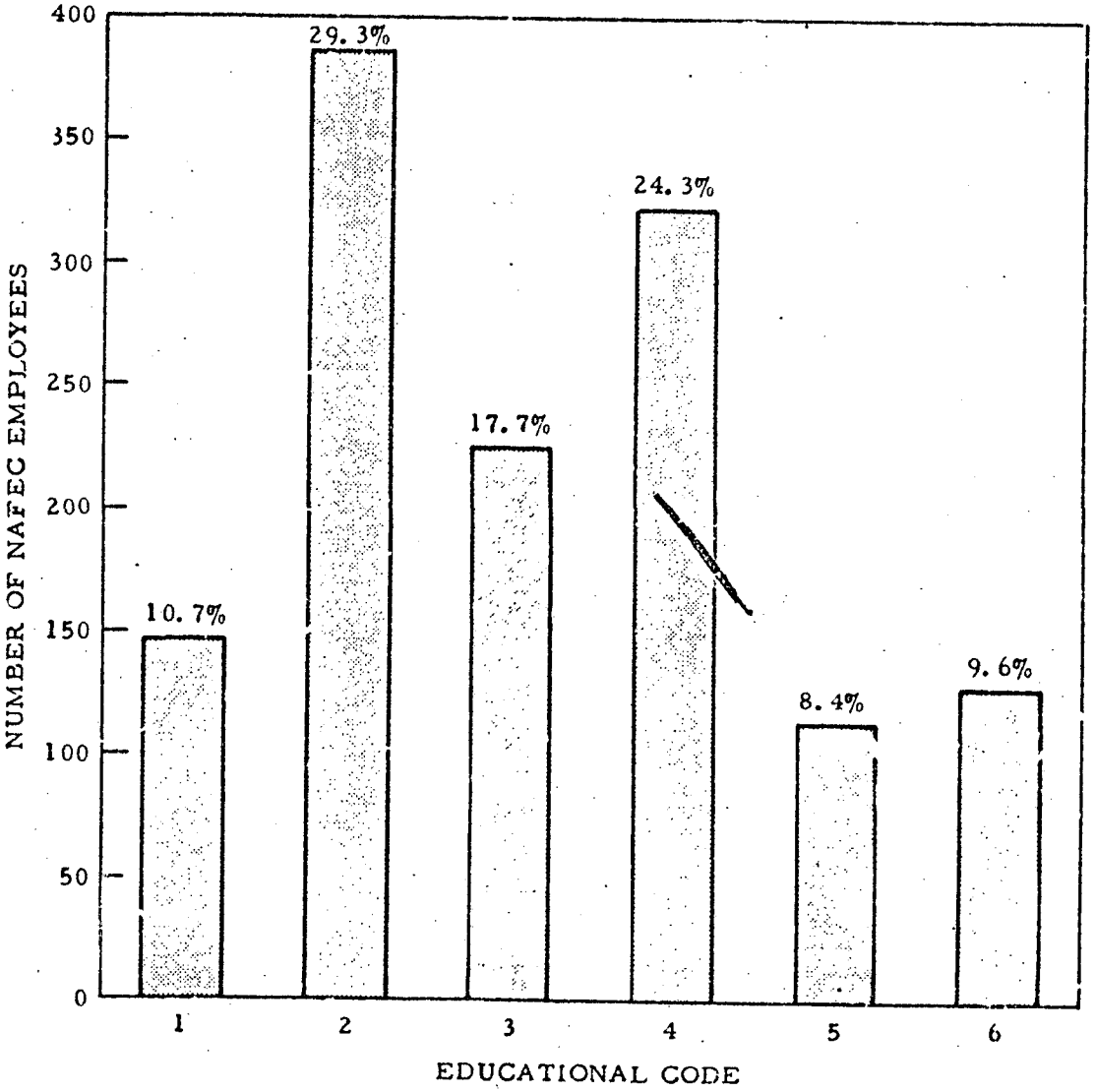
Engineers (various engineering and physical sciences)	222
Technicians (electronics, engineering, specialists, and inspectors)	358
Computer sciences (analysts, programers, mathematicians, operators, etc.)	160
Wage grade (skills, crafts, and maintenance)	167
Pilots	17
Air traffic controllers	77
Administrative management (accounting, analysis, budget, etc.)	98
Logistics (supply and procurement)	83
Director's staff	15
Security (fire and police)	41
Secretarial, typist, and clerical	84
	1,322

Statistics on educational level show that 18 percent of the full-time permanent employees held baccalaureate degrees or higher as of November 19, 1975. Another 42 percent have some education beyond high school.

EDUCATION LEVEL FULL-TIME EMPLOYEES AT NAFEC

EDUCATIONAL CODE

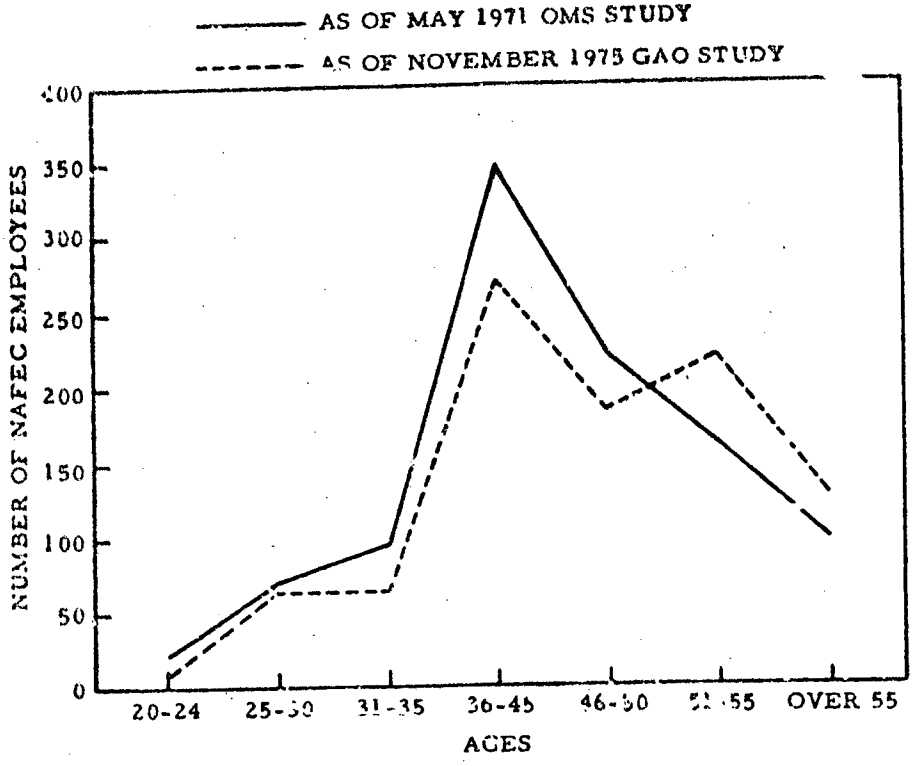
1. LESS THAN HIGH SCHOOL EDUCATION
2. HIGH SCHOOL GRADUATES
3. ATTENDED TECHNICAL SCHOOL
4. SOME COLLEGE - LESS THAN DEGREE
5. BACHELORS DEGREE
6. POST BACHELORS, MASTERS & DOCTORATE



The distribution of NAFEC's employees by age grouping is shown below. Two charts comparing age distribution and retirement eligibility as of November 1975 follow, with statistics developed from the May 1971 OMS study report. This information shows that more than 55 percent of NAFEC's full-time permanent employees are 46 years of age or older and that, when compared to 1971, the work force has aged and has more employees eligible for retirement in the near term but fewer eligible in the long term.

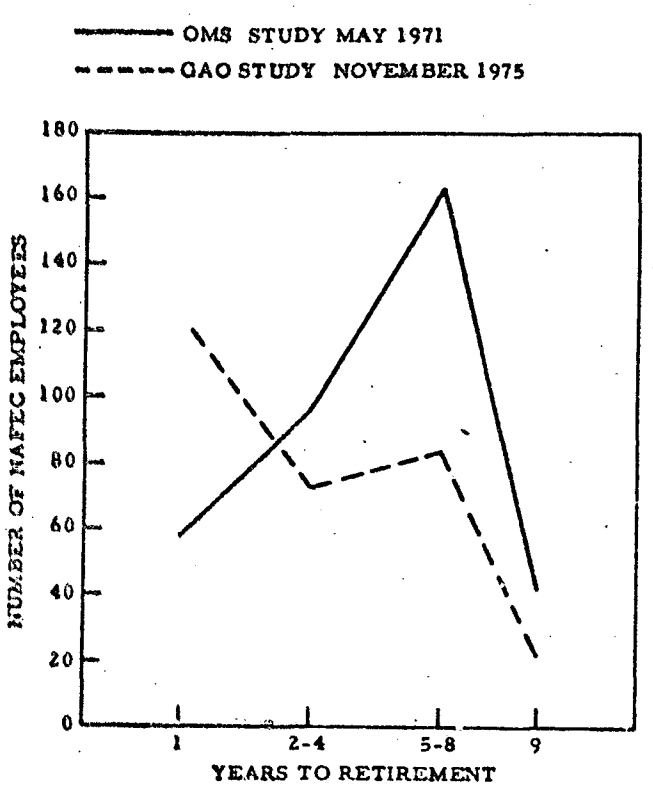
Age	Number	Percent
Under 36	212	16.0
36 to 45	366	27.7
46 to 55	510	38.6
Over 55	234	17.7

AGES OF TOTAL NAFEC EMPLOYEES
(DOES NOT REFLECT WAGE GRADE OR POSITIONS BELOW GS-6)



YEARS TO RETIREMENT

YEARS TO RETIREMENT ELIGIBILITY
OF TOTAL NAFEC EMPLOYEES



Technical program personnel profile

The distribution of NAFEC's technical program personnel by occupational specialty as of October 31, 1975, is shown in the following table.

Engineers:		
Electronics	149	
Aerospace	32	
General	6	
Electrical	2	
Mechanical	1	
Engineering research psychologist	9	
Operations research analyst	9	
Meteorolcgist	2	
Statistician	1	
Physicist	1	
Chemist	1	213
Technicians:		
Electronics	154	
ATC simulator operators	32	
Aerospace	21	
Engineering	20	
Flight operations	6	233
Computer sciences:		
Operators	64	
Flight data processors	12	
Programers	10	
Computer aides	8	
Analysts	7	
Mathematicians	6	107
Air traffic controllers		76
Total		629

In its 1971 report, OMS commented that, although a number of key officials were at or near retirement age, this in itself did not seem to pose a problem. What did cause concern was that "a surprising number of key people have no degree and many of these have no education beyond high school."

This situation has improved since NAFEC's 1972 reorganization as is shown in the following chart comparing educational levels in 1971 and 1975 in the Center's technical program divisions:

	OMS study (May 1971)		GAO study (November 1975)	
	Number	Percentage	Number	Percentage
Supervisors/advisers (GS-13 and above)	74	100	59	100
With degrees	50	67.6	48	81.3
With some college	11	14.9	5	8.5
With high school or less	13	17.5	6	10.2

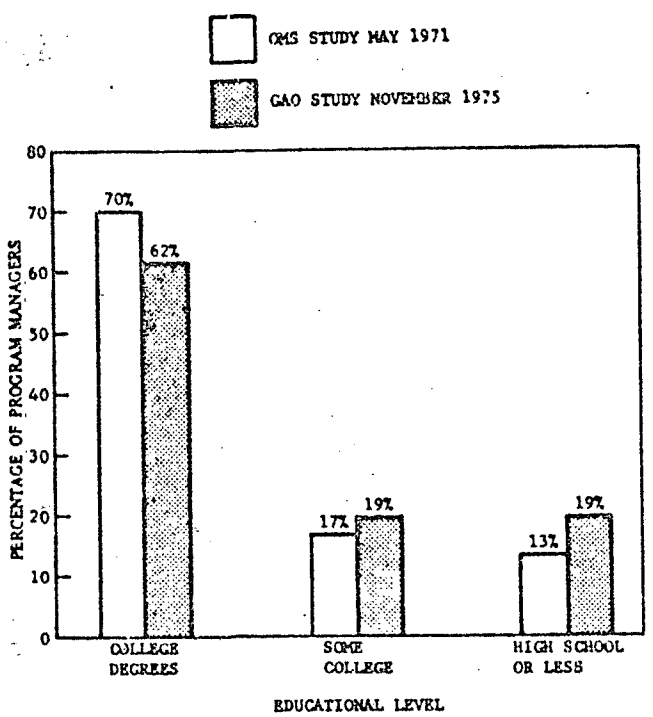
Technical program managers

OMS commented that the educational level of technical program managers was reasonably high, and they expressed no concern in this area. However, the situation has changed since the OMS study and subsequent NAFEC reorganization in 1972.

--The responsibility of technical program managers has increased due to a consolidation of tasks. As a result the number of managers decreased from 147 in 1971 to 37 in 1975.

--The educational level of technical program managers as a group has declined, so that today 38 percent of the managers have no college degree (see following chart).

EDUCATIONAL LEVEL OF NAFEC PROGRAM MANAGERS

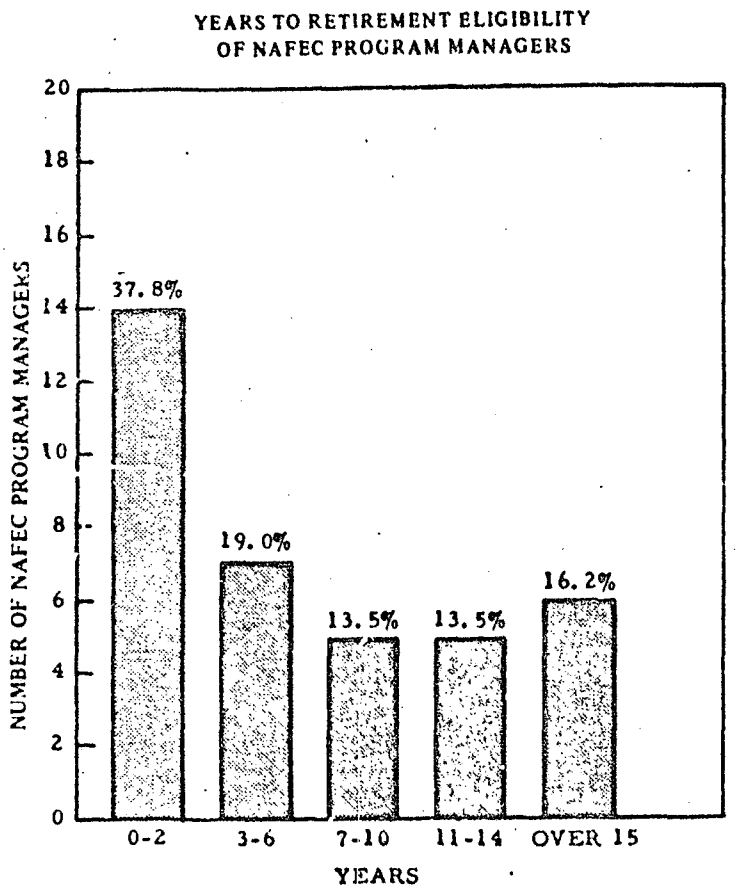


The first chart below compares the age distribution of technical program managers in 1971 and 1975. The second chart shows present retirement eligibility statistics for NAFEC's 37 managers.

Chart 1

Age category	Technical program managers: Number and (percentage) as of May 1971	Technical program managers: Number and (percentage) as of November 1975
Under 46	66 (44.9)	11 (29.7)
46 to 50	39 (26.5)	4 (10.8)
51 to 55	29 (19.7)	15 (40.6)
Over 55	13 (8.9)	7 (18.9)
	147 (100)	37 (100)

Chart 2



Further analysis of the data on educational level and retirement eligibility showed that half of the program managers without college degrees will be eligible for retirement within 2 years. Center management officials advised us that

necessary steps have been taken to insure that the educational level of program managers as a group is upgraded over the next several years.

Employment and recruitment of minorities and women

Overall, minorities accounted for 121, or 9.5 percent, of the full-time general schedule employees at NAFEC in September 1972. By November 1975, their number had increased by 43 to a total of 164, or 11.6 percent of the work force. Females accounted for 271, or 21.4 percent, of the general schedule employees in September 1972. In 1975 females accounted for 323, or 22.8 percent, of total personnel. Over the 3-year period, general schedule employment increased by 145 so that minorities and females accounted for about 30 and 36 percent of NAFEC's employment growth, respectively. Details of general schedule and wage grade employees are shown below.

Category	Employees 1972	Employees 1975	Number and (percent) of employees by category: Minorities 1972	Minorities 1975	Females 1972	Females 1975
Grade Schedule						
1 to 4	149	127	42 (28.2)	38 (29.9)	113 (75.8)	104 (81.9)
5 to 8	242	271	45 (18.6)	61 (22.5)	128 (52.9)	156 (57.6)
9 to 12	480	534	25 (5.2)	45 (8.4)	26 (5.4)	58 (10.9)
13 to 17	397	481	9 (2.3)	20 (4.2)	4 (1.0)	5 (1.0)
Total	1,268	1,413	121 (9.5)	164 (11.6)	271 (21.4)	323 (22.8)
Wage grade						
1 to 4	131	3	14 (10.7)	1 (33.3)	1 (0.8)	1 (33.3)
5 to 11	78	178	6 (7.7)	23 (12.9)	-	1 (0.6)
12 to 15	15	15	1 (6.7)	-	-	-
Total	224	196	21 (9.4)	24 (12.2)	1 (0.4)	2 (1.0)
Total	1,492	1,609	142 (9.5)	188 (11.7)	272 (18.2)	325 (20.2)

An analysis of full-time general schedule NAFEC and FAA tenant personnel is shown below.

Category	Average grade September 1972	Average grade November 1975	Percentage grade increase 1972 to 1975
Total work force	9.88	10.15	2.7
Minority portion	6.67	7.64	14.5
Nonminority portion	10.21	10.48	2.6
Female portion	5.42	5.98	10.3
Male portion	11.09	11.38	2.6

Equal employment opportunity accomplishments during fiscal year 1975

In its July 31, 1975, affirmative action plan, NAFEC reported some equal employment progress in spite of limited hiring opportunities and the uncertainty of the Center's status. Accomplishments claimed included:

--Formation of a part-time Federal Women's Program Committee.

--Appointment of a part-time Spanish Speaking Coordinator.

--Participation in the Comprehensive Employment and Training Act program with the Atlantic County Board of Freeholders.

One aspect of NAFEC's affirmative action plan for the current fiscal year has been the development of an upward mobility program.

TENANTS

Tenants occupy almost 20 percent of the building space at NAFEC. Agreements with the tenants stipulate the support and services to be furnished by or for NAFEC and any reimbursement provisions. A listing of the larger tenant activities and a brief description of their functions is provided below. The first of these are FAA organizations for which NAFEC performs such administrative functions as budgeting, accounting, and personnel.

Tenant Manpower Distribution as of January 1976

Tenant	Personnel
Air Traffic Service (National Data Systems Branches)	a/177
Airway Facilities Service (Automation Engineering Support Branch)	a/84
Systems Research and Development Service (Development Programming Branch)	a/40
New Jersey Air National Guard	b/320
System support contractors	160
Logistical support	79
Others	112
Total	972

a/Authorized full-time permanent FAA employees.
b/Excludes weekend members.

Air Traffic Service

The National En Route and Terminal Data Systems Branches of this organization maintain the operational ATC computer software programs and use NAFEC's computer hardware.

Airways Facilities Service

The Automation Engineering Support Branch, under this organization and its Automation Engineering Division, is responsibile for maintaining operational software for both en route and terminal computer programs and documenting engineering changes which may affect computer software and hardware.

Systems Research and Development Service

The Development Programming Branch, once organizationally part of NAFEC, now reports directly to Washington headquarters. It is responsible for software development and for specification documentation and testing of programs to determine whether they meet specifications.

New Jersey Air National Guard

The 177th Fighter Group of the Guard is part of the North American Aerospace Defense Command. As such, its mission is to be ready to intercept, identify, and, if necessary, destroy hostile airborne targets and assist in destroying hostile surface forces. The Guard reimburses NAFEC for such things as aviation fuel, heat, light, and power.

System support contractors

Several contractors, such as IBM, UNIVAC, MITRE, Raytheon, and Computer Sciences Corporation, assist FAA in technical programs at NAFEC.

Logistical support

Contractors supply janitorial service and operate the steam plant and cafeteria.

Other tenants

Other personnel and activities located at NAFEC are airport tower and maintenance personnel; pilots and investigators to insure the accuracy and reliability of navigational aids; weather service; General Services Administration motor pool, post office, and credit union.

CONCLUSIONS

Slippages in schedule milestones have been a continuing problem at NAFEC for several years. Officials have tried to minimize in-house project delays; however, budget fluctuations and contractual approvals are not controllable by NAFEC.

We found that NAFEC's actual responsibility for test and evaluation sometimes excluded one or more of the functions of test planning, performance, and reporting, as these functions may be performed in part by contractors or other Government agencies. We brought this matter to the attention of the director, and he agreed that there was a need to further delineate NAFEC's test and evaluation responsibility. He later reported that after meetings with the FAA's Associate Administrator for Engineering and Development action was being taken to accomplish this.

CHAPTER 4

TRANSPORTATION SYSTEMS CENTER

ORGANIZATION AND MISSION

In 1969, the National Aeronautics and Space Administration decided to phase out its Electronics Research Center in Cambridge, Massachusetts. This facility was deemed acceptable for projects relating to transportation and on June 30, 1970, all land, buildings, and equipment were transferred to the Department of Transporation.

TSC was then established on July 1 to provide (1) information for policy formulation and decisionmaking through research, data management, and system evaluation, (2) program management and technical support for research and development programs, and (3) transportation technology sharing with State and local government units. The principal TSC offices and number of employees as of June 30, 1975, were:

	Number
--Office of the Director	15
--Office of the Associate Director for Plans and Program Development which integrates and coordinates program planning, development, and evaluation.	11
--Office of Systems Research and Analyses which supports transportation planning and policy analyses and performs various studies in support of ongoing projects.	97
--Office of Systems Development which manages major projects for ground and air transportation and traffic control.	114
--Office of Engineering which provides the technical expertise (scientific and engineering disciplines) needed to support projects.	257
--Office of Administration which provides the management, administration, and operational support for activities.	166
	660

While TSC's Aeronautical Systems Division, within the Office of Systems Development, manages most civil aviation R&D programs with a staff of 32, other TSC divisions also have program responsibilities.

TSC provides R&D support to the Department of Transportation and its operating administrations, which include the Federal Aviation Administration, Federal Highway Administration, Federal Railroad Administration, Urban Mass Transportation Administration, U.S. Coast Guard, National Highway Safety Administration, and St. Lawrence Seaway Development Corporation.

The broad needs for R&D projects are established by the sponsors who request TSC to do the work. Tasks are jointly established for specific projects annually. However, TSC does not have a formal priority system for aviation and other R&D work.

CIVIL AVIATION R&D ACTIVITIES

For fiscal years 1971 through 1975, Transportation, NASA, and the National Science Foundation provided TSC with over $178 million for R&D activities. (See p. 43.) About $66.3 million, or 37 percent, of this amount is related to 65 civil aviation R&D projects.

Customer	Number of projects	(millions)
FAA	42	$47.9
Secretary of Transportation	7	11.5
NASA	15	5.9
U.S. Coast Guard	1	1.0
Total	65	$66.3

As of September 29, 1975, 14 FAA projects, 7 Department of Transportation projects, and 11 NASA projects had been completed. When NASA closed its Electronics Research Center, it transferred some R&D projects to TSC.

For fiscal year 1976, TSC planned about $58.7 million of R&D activity. Over $15 million or about 26 percent, is for 20 continuing projects and 8 new civil aviation projects.

Over the 5-year period ending June 30, 1975, civil aviation R&D projects diminished in comparison to total TSC effort. Funding for civil aviation R&D compared to total R&D funding decreased from a high of 58 percent in 1971 to 22 percent in 1975.

Funding of R&D Activities by Sponsor
Fiscal Years 1971-75 (note a)

Sponsor	1971	1972	1973	1974	1975	Total
Civil aviation R&D						
FAA	$ 5.9	$10.5	$ 8.8	$12.9	$ 9.8	$ 47.9
Secretary of Transportation	2.4	4.3	3.6	1.1	.1	11.5
NASA	5.3	.6	(b)	(b)	(b)	5.9
U.S. Coast Guard	-	-	.1	.4	.5	1.0
Total	$13.6	$15.4	$12.5	$14.4	$10.4	$ 66.3
Percent of overall total	58	45	41	33	22	37
Other R&D						
Total (note c)	$10.0	$19.0	$17.9	$28.8	$36.1	$111.8
Percent of overall total	42	55	59	67	78	63
Total all R&D	$23.6	$34.4	$30.4	$43.2	$46.5	$178.1

a/Dollars in millions.

b/NASA funding during these periods was: 1973 ($20,000), 1974 ($40,000) and 1975 ($9,000).

c/Includes: Secretary of Transportation, Modal Administrations, U.S. Coast Guard, and National Science Foundation.

Major R&D projects

Ten R&D projects received over $45 million, or about 70 percent of TSC's civil aviation R&D funding for 1971-75. Three projects were completed, one was terminated, and six were active as of September 29, 1975. Estimated 1976 funding for these active projects is $7.6 million, or about one-half of the funding for all TSC aviation projects. The projects we reviewed are listed below and described in appendix IV.

Major Projects

FAA program	R&D project	Fiscal year started	Funding through FY 1975	Estimated FY 1976
			(000 omitted)	
03	Air Traffic Control Radar Beacon System	1971	$ 5,785	$ 600
04	Short Take-Off and Landing Navigation and Guidance Study	1971	1,890	Completed
05	Airborne Proximity	1971	2,782	Terminated
06	Air-Ground Data Link Development Program	1971	3,377	90
07	Instrument Landing System Performance Prediction	1971	1,936	170
08	Aircraft Wake Vortex Avoidance	1971	6,415	1,850
08	Airport Surface Traffic Control	1972	6,350	2,500
16	Future Data Processing For Air Traffic Control System	1971	2,114	Completed
17	Aeronautical Satellite Systems	1971	5,758	2,450
-	Advanced Air Traffic Management System (Department of Transportation program)	1971	9,453	Completed
Total			$45,860	$7,660

Outside R&D procurement

TSC spent about $95 million--over 52 percent of R&D funding received from its sponsors for fiscal years 1971-75--for R&D contracts and outside procurement of project materials, equipment, and services. In March 1975, Transportation asked TSC to perform some contracted R&D work in house if facilities were available. On March 13, 1975, TSC advised Transportation that:

--Its general policy was to maximize the effectiveness of its technical staff by contracting for services which require specialized facilities or expertise not available at TSC.

--It does not seek to develop extensive in-house facilities. Its facilities, supplemented by the use of NAFEC, other Government, and contractor facilities, appear to be adequate.

--Its technical staff cannot handle more in-house work and expects to increase out-of-house R&D over the next 5 years because of increased demands.

Support service contracts

TSC awarded support service contracts for over 200 staff-years of effort annually from fiscal year 1973 through 1975. In 1975, TSC contracted for 207 staff-years of effort costing about $3,384,000.

Contract service	Amount	Staff-years
	(000 omitted)	
ADP services	$1,610	101
Technical information and library	1,486	77
Other services (cleaning, custodial, etc.)	288	29
Total	$3,384	207

The ADP services and the technical information and library services have been contracted out by TSC since 1972. Cost comparisons showed that it costs less to contract for the work than to perform it in house. We did not verify the cost comparisons.

FACILITIES

On June 30, 1975, TSC had real property (land, buildings, and improvements) and equipment valued at $47.3 million.

All of the land and buildings and a major portion of the equipment was acquired from NASA in 1970.

TSC's activities are multimodal; that is, it provides R&D support for all Transportation operating administrations in Washington. Although TSC's Aeronautical Systems Division is responsible for managing most civil aviation R&D projects, some work, such as ground systems research, is performed by other TSC divisions. These other divisions provide support for civil aviation R&D programs and can have program management responsibility.

Because divisional support activities are dispersed, it was not feasible to determine allocated building floor space utilization. The Aeronautical Systems Division does, however, occupy an entire floor in the program management building. We also ascertained which laboratories and equipment are used for aviation programs.

Aeronautical Systems Division officials said their real property and equipment are adequate for the civil aviation R&D mission. TSC officials said no facilities expansions were planned for civil aviation R&D activities.

Real property

TSC occupies 6 buildings with a usable area of 223,355 square feet situated on 14.3 acres of land in Cambridge, Massachusetts. These include a 13-story program management building; a personnel services building, including a 350-seat auditorium with adjoining offices, conference rooms, and technical information center; a 2-story technology building; a 3-story systems development building; a support building; and a building formerly used for shipping and receiving, which is being converted into a dynamometer laboratory for automobile testing.

The land was originally acquired by NASA in June 1966 and the six buildings were constructed between December 1967 to April 1970. The initial land and buildings value was $21.7 million but improvements of $1.3 million increased the capital value of these facilities to $23 million as of June 30, 1975.

The buildings' capacity is about 1,100 people. The facilities office estimated that as of November 19, 1975, 942 people (including over 200 contractor personnel) were housed at TSC. A TSC facilities study in March 1975 showed that by fiscal year 1980 or 1981, it would have a housing need for about 1,100 people, which is its current capacity.

Equipment

From fiscal year 1971 through 1975, TSC (1) acquired $18.1 million of excess NASA equipment, (2) obtained $12.1 million of equipment for R&D projects, and (3) disposed of $6 million of excess equipment. As of June 30, 1975, TSC had the following equipment balances:

Equipment at TSC	$22,060,652
Equipment in custody of contractors and others	1,265,050
Equipment on loan to TSC from sponsors	38,289
Equipment excess to TSC needs	872,649
Total	$24,236,640

The types of equipment as of November 14, 1975, are summarized below. Over $4 million of equipment, or 16.5 percent of the total, was acquired through FAA-sponsored civil aviation R&D projects.

TSC Equipment as of November 14, 1975

	Sponsor		
Equipment	FAA	Other (note a)	Total
Automatic data processing	$ 930,614	$ 4,915,002	$ 5,845,616
Furniture and office	35,977	688,342	724,319
Maintenance	36,840	650,600	687,440
Motor vehicle and transportation	30,054	820,889	850,943
Research and development	1,670,176	9,704,268	11,374,444
Other (note b)	1,385,207	3,901,790	5,286,997
Total	$4,088,868	$20,680,891	$24,769,759

a/Includes other Transportation operating sections and NASA.

b/Includes medical, training, and food preparation equipment.

The March 1975 TSC study identified facilities and equipment used on R&D projects. A discussion of some of the facilities and equipment used primarily for civil aviation R&D projects follows.

--TSC has a communications channel measurement and simulation test facility located in its technology building. This test facility has a wide range of transportation systems communications channels and is applied on urban radio, satellite aircraft, and aircraft-to-ground channels.

--An Air Traffic Control Radar Beacon Systems (ATCRBS) tracking laboratory in the program management building was established solely to develop FAA ATCRBS improvements under actual and "worst case" field conditions. The major laboratory components include a beacon interrogator, special phased array antenna, and transponders.

--A program management building laboratory is used to evaluate pilot computer use needed to obtain pilot briefings. Briefing terminals are coupled to a computer via telephone line to brief pilots and approve flight plans as part of an FAA-funded Automated Flight Service Station Concept project. Another facility used for this project, a cockpit simulator, is located in the systems development building.

TSC also has mobile laboratories at O'Hare International Airport, Chicago, and Kennedy Airport, New York, which house electronic and data processing equipment used for processing data received from aircraft wake vortex sensors deployed at these locations. These mobile laboratories are being used for an FAA wake vortex project.

PERSONNEL

When TSC was established, the initial staff was about 400 personnel. Many of these employees were former NASA personnel. From fiscal year 1972 through fiscal year 1975, the full-time staff increased from 580 to 660.

Full-Time Personnel

Skill mix	Fiscal years 1972	1973	1974	1975
Professional:				
Science	27	26	25	22
Engineering	212	220	232	225
Data management	63	65	70	69
Socioeconomic	1	10	25	29
Planning and analysis	17	24	26	32
Administration	55	55	59	59
Management	20	20	19	19
Total	395	420	456	455
Administrative specialist	34	34	29	29
Technician	52	51	51	50
Clerical	94	96	101	107
Wage grade	5	5	5	19
Total personnel	580	606	642	660

The number of employees with socioeconomic skills (sociologists, economists, and political scientists) increased from 1 to 29 in 3 years.

The average grade for full-time personnel was 10.7 in 1972; 10.6 in 1973; and 10.9 in 1974 and 1975. An official estimated that the staff's average age was less than 40.

At October 11, 1975, 165 TSC employees were working on civil aviation R&D projects. Thirty-two were assigned to the Aeronautical Systems Division which works exclusively on aviation R&D projects. The remaining 133 were assigned to other activities, such as engineering, systems research, ground systems, traffic control systems, and automation and control, which provide support for all TSC R&D projects. The amount of time devoted by those support personnel to aviation R&D may vary with the daily operational needs. The background of the 32 Aeronautical Systems Division employees follows.

Profession	Employees	Average		Education		
		Age	Grade	No degree	Bachelor	Masters
Scientist or engineer	24	39.6	13.4	-	13	11
Administration	1	47.0	11.0	1	-	-
Technicians	2	43.0	11.0	2	-	-
Clerical	5	25.4	5.0	5	-	-
Total	32	37.3	11.8	8	13	11

The average grade of 11.8 is higher than the 11.1 for all TSC employees as of August 31, 1975. Twenty-four of the 32 employees have bachelor and advanced degrees within the following disciplines.

Degree major	Number of employees
Mathematics	1
Physics	5
Electrical engineering	7
Aerospace engineering	3
General engineering	1
Administration	2
Mechanical engineering	1
Electronic engineering	4
Total	24

Minority employees

At March 31, 1974, 54 of 606 full-time employees (8.9 percent) were minorities compared to 63 of 649 (9.7 percent) for September 30, 1975. On March 31, 1974, TSC had employed five college-level minority cooperative students. On August 31, 1975, seven minority cooperative students, two temporary summer minorities, and one temporary minority were employed. Summary minority employment data was not available prior to March 1974. A comparison of full-time minorities by grade follows.

Employee grades (note a)	March 31, 1974			August 31, 1975		
	Total TSC	Minority	Percent	Total TSC	Minority	Percent
1 to 4	25	15	60.0	26	8	30.8
5 to 8	95	13	13.6	101	18	17.8
9 to 11	128	7	5.5	149	11	7.4
12 to 13	206	12	5.8	230	21	9.1
14 to 15	138	5	3.6	132	3	2.3
16 to 18	14	2	14.2	11	2	18.2
Total	606	54	8.9	649	63	9.7

a/Includes equivalents for wage board employees.

The average grades for minorities employed on March 31, 1974, and August 31, 1975, were 8.5 and 9.2 compared to 11.2 and 11.1 for all full-time employees. Additional minority statistical data is shown on page 51.

Two minority employees with bachelor degrees were employed in the Aeronautical Systems Division at August 31, 1975, as GS-7 and GS-12. In addition, seven minority employees from other divisions performed work in support of the aviation R&D program.

Female employees

At October 31, 1974, 151 of 672 employees were females (22.5 percent) compared to 143 of 650 (22.0 percent) 1 year later. Additional data on the status of female employees is shown on page 51.

Transportation Systems Center

(3/31/74 and 8/31/75)

Numbers (Percentage)

Full-time Minority Employee Status

Grades	All employees 1974	All employees 1975	Black 1974	Black 1975	Spanish 1974	Spanish 1975	Orientals 1974	Orientals 1975	Total Minority 1974	Total Minority 1975
1 to 4	25	26	13 (52.0)	7 (27.0)	1 (4.0)	-	1 (4.0)	-	15 (60.0)	7 (27.0)
5 to 8	95	101	12 (12.6)	16 (15.8)	1 (1.1)	2 (2.0)	-	1 (1.0)	13 (13.6)	19 (18.8)
9 to 11	128	149	4 (3.1)	8 (5.4)	-	-	3 (2.3)	3 (2.0)	7 (5.5)	11 (7.4)
12 to 13	206	230	5 (2.4)	10 (4.3)	4 (1.9)	4 (1.7)	3 (1.5)	7 (3.0)	12 (5.8)	21 (9.1)
14 to 15	138	132	1 (0.7)	-	2 (1.4)	1 (0.8)	2 (1.4)	2 (1.5)	5 (3.5)	3 (2.3)
16 to 18	14	11	1 (7.1)	1 (9.1)	-	-	1 (7.1)	1 (9.0)	2 (14.3)	2 (18.2)
All grades	606	649	36 (6.0)	42 (6.4)	8 (1.3)	7 (1.1)	10 (1.6)	14 (2.2)	54 (8.9)	63 (9.7)

Full-time Women Employees Status

Grades	All employees 1974	All employees 1975	Women employees: Minorities 1974	Minorities 1975	White 1974	White 1975	Total 1974	Total 1975
1 to 4	31	28	11 (35.5)	8 (28.5)	20 (64.5)	20 (71.4)	31 (100)	28 (100)
5 to 8	117	101	16 (13.7)	13 (12.8)	74 (63.2)	67 (66.3)	90 (77.0)	80 (79.2)
9 to 11	143	144	1 (1.0)	2 (1.4)	16 (11.2)	19 (13.2)	17 (11.9)	21 (14.6)
12 to 13	222	234	2 (1.0)	2 (1.0)	9 (4.1)	10 (4.3)	11 (5.0)	12 (5.1)
14 to 15	145	131	-	-	2 (1.4)	2 (1.5)	2 (1.4)	2 (1.5)
16 to 18	14	12	-	-	-	-	-	-
All grades	672	650	30 (4.5)	25 (3.7)	121 (18.0)	118 (18.2)	151 (22.5)	143 (22.0)

CONCLUSIONS

Civil aviation R&D funding has remained relatively constant since the establishment of TSC in July 1970. As a percentage of total R&D funding, however, it has decreased from a high of 58 percent of total funding in 1971 to a low of 22 percent in 1975. The trend reflects increased efforts in support of other Transportation programs.

CHAPTER 5

CIVIL AEROMEDICAL INSTITUTE

BACKGROUND

The Civil Aeromedical Research Institute was created as an organization of the Bureau of Aviation Medicine in 1960 and was located at the FAA Aeronautical Center in Oklahoma City, Oklahoma. In 1962 certain nonresearch medical programs were transferred to the Institute, and it was renamed the Civil Aeromedical Institute.

In 1965 the FAA administrator recognized the need for strong centralized direction at the Aeronautical Center; therefore, he gave the Director managerial authority over all activities at the Center. Thus, CAMI was placed under the administrative control of the Center Director, but it was responsible to FAA's Office of Aviation Medicine for policy and programs.

MISSION AND ORGANIZATION

CAMI's mission is to:

--Conduct medical research which is applicable to the FAA mission.

--Develop, maintain, and manage a system for the medical examination and certification of U.S. civil airmen.

--Develop, maintain, and administer aviation medical education programs to meet the FAA needs.

--Provide for and administer the agency employee health programs at the Aeronautical Center.

CAMI is comprised of four branches--the Aeromedical Clinical, Aeromedical Certification, Aeromedical Education, and Aeromedical Research branches. A brief description of the mission and functions of each follow.

Aeromedical Clinical Branch

The Aeromedical Clinical Branch provides and administers the employee health program for Aeronautical Center employees, and administers the FAA industrial hygiene program for the western United States.

Aeromedical Certification Branch

This branch is the central repository within the FAA for collecting, processing, adjudicating, investigating, and analyzing applications for airmen medical certification and related regulatory programs. It is also the source of medical and technical data which is requested by airmen, aviation medical examiners, FAA scientists, and statisticians.

Aeromedical Education Branch

The Aeromedical Education Branch is the general aviation community's safety information contact with research activities of the FAA's Aviation Medicine program. In addition to distributing medical information that is vital to aviation safety and the growth of general aviation, the Branch administers the agency's designated Aviation Medical Examiner System (approximately 7,500 examiners).

Aeromedical Research Branch

The Aeromedical Research Branch conducts studies relating to the biomedical and human performance aspects of civil aviation. In addition, it provides consultative services in the medical and scientific fields and provides instruction on aviation medical subjects; provides motion picture, engineering, and electronic services in support of scientific research; and develops and furnishes biostatistical support for medical research.

The Branch has four laboratories which conduct research for preventing aircraft accidents and injuries and increasing the efficiency of the civil aviation system.

1. The Aviation Toxicology Laboratory conducts research into the toxicological, pharmacological, and biochemical aspects of the human in the aviation environment. It is subdivided into five units, each of which conducts research in a specialized area of toxicology as it relates to aviation safety. The research includes forensic toxicology, radiobiology, pathology, neuropharmacology, and biochemistry.

2. The Aviation Physiology Laboratory undertakes studies relating to current and anticipated physiological problems in aviation activities. Research includes understanding and evaluating the effects of environmental conditions, shift rotation, time zone crossing, drugs, and alcohol; and measuring, evaluating, and reducing stress and fatigue in aviation personnel.

3. The Aviation Psychology Laboratory is responsible for evaluating problems concerned with the influence of speech and hearing systems on the safety and well being of personnel in noisy environments; evaluating attitudes and motivational factors; assessing performance under stress, fatigue, or monotonous working conditions; evaluating effects of workload and work-and-rest schedules on performance; determining relative importance of psychological test measures on predicting job performance; and assessing disorientation responses and eye-to-hand coordination during vehicular motion. Effects of alcohol are also studied.

4. The Protection and Survival Laboratory undertakes research to reduce the loss of life resulting from civil aircraft emergencies. The research includes methods of attenuating or preventing crash injuries; determining causes of death or injury from impact; devising concepts and evaluating survival equipment used under adverse environmental and emergency conditions; establishing human physical limitations; and evaluating emergency procedures of downed aircraft.

FUNDING

The fiscal year 1976 CAMI budget was about $4.4 million with $2.3 million for research and development and $2 million for operating expenses. Annual expenditures have remained about the same for the last 3 years as shown in the following table.

Appropriation	FY 1974 actual	FY 1975 actual	FY 1976 budget
	(thousands)		
Research, Engineering, and Development	$ 557.0	$ 574.3	$ 512.5
Facilities, Engineering, and Development	1,852.9	1,787.6	1,822.0
Total	2,409.9	2,361.9	2,334.5
Operations	1,947.1	1,954.9	2,115.9
Total	$4,357.0	$4,316.8	$4,450.4

Expenditures in all three appropriations are categorized by object class--personnel compensation and benefits, travel, transportation, other services, contractual services, supplies, and equipment. Contractual services include such items as payments to human subjects for experiments, automatic data processing, and maintenance of equipment.

The 5-year plan for CAMI shows the following funding estimates for all appropriations:

FY 1976	$4,908,000
FY 1977	$6,371,000
FY 1978	$4,996,000
FY 1979	$5,040,000
FY 1980	$5,063,000

The 1976 figure does not reflect a $458,000 congressional cutback of the final CAMI budget submission. The 1977 figure includes an increase of $1,533,700 for the initial installation and operation of facilities, including a new crash impact facility, aircraft simulator, electron microscope, and a mass spectrometer. Agency officials later said that these items will not be procured during fiscal year 1977 because of budget cuts imposed by the Office of Management and Budget.

MEDICAL RESEARCH PROGRAM

CAMI is responsible to FAA's Office of Aviation Medicine for program and policy guidance, which sets priority research areas based on input from other organizations. After the priorities have been established, CAMI researchers prepare resumes describing each task and forward them to a special review panel consisting of representatives of the Office of Aviation Medicine and CAMI.

The panel meets with the researchers who prepared the resumes and summaries are written for each project. The summaries, along with the panel's recommendations, are submitted to the Federal Air Surgeon, Office of Aviation Medicine, for approval. Research tasks and projects continued from one year to another must be updated annually, reviewed by the panel, and approved by the Federal Air Surgeon.

The medical research program at CAMI is divided into five task areas. Specialized groups have been established to carry out research in each area.

1. Task Area A: Aeromedical Factors in Systems and Operations

Task Area A investigates environmental and operational factors related to the health and physical fitness of airmen, crews, and passengers; and studies detection of, prevention of, and recovery from cardiovascular, respiratory, and other diseases related to aviation activities. Specific task groups include:

a. Cardiovascular and other diseases.

b. Alcohol and drug abuse.

c. Toxicology.

2. Task Area B: Aircrew and Passenger Protection

Task Area B makes studies of aircraft impact injuries through on-the-scene accident investigations; studies of aircraft evacuation techniques and devices under simulated land and water conditions; tests of new techniques, procedures, and devices to protect personnel from fire and toxic smoke in aircraft; evaluations of oxygen masks and systems to determine the biomedical response to various altitudes and to provide effective protection against hypoxia and decompression; and psychological reconstruction of aircraft accidents in order to prevent unwarranted loss of life and aircraft. Specific task groups include:

a. Impact injury.

b. Improved means for emergency escape and survival.

c. Fire, smoke, and toxic fumes.

d. Accident investigation.

3. Task Area C: Personnel Performance and Efficiency

Task Area C makes studies to help the Air Traffic Controllers (1) cope with stressful situations and (2) avoid errors which endanger the efficient operation of the ATC system. The effect of work-rest cycles, desynchronization of physiological functions, and fatigue on the performance of aircrews and ATC personnel are included. Task groups include:

a. Air Traffic Controller selection, training, and utilization.

b. Air Traffic Controller workload and environment.

c. Aircrew workload and flight-induced stress.

4. Task Area D: Aeromedical Factors in Flight Management

Task Area D investigates disorientation and loss of aircraft control; the physiological and psychological functions required for safe operations in the air and on the ground; the biomedical factors involved in aircraft visibility, detection, and visual collision avoidance; and use of simulators in research and training. Task groups include:

a. Pilot perception and orientation in flight.

b. Analysis of pilot error.

c. Collision avoidance.

5. Task Area E: Public Acceptance of Aircraft Operations

Study items in this area are community noise survey and responses; determination of the interference of aircraft operation with public activities; and problems of environmental protection against air pollution, toxic chemicals, and other waste products released by aircraft and aviation-supporting ground facilities. Task groups include:

a. Community relations.

b. Environmental protection.

Program reviews

CAMI worked on 50 research projects in fiscal year 1975 at an actual cost of $2,230,100. At the time of our review, it had approved 43 projects for fiscal year 1976 with an estimated cost of about $2.6 million. All of the projects have been or will be done in house as CAMI does not contract with outsiders for research and development.

Of the 43 projects approved for fiscal year 1976, we selected 17 for detailed review. These account for 43 percent of CAMI's research and development funds and over 50 percent of the staff-years. The 17 projects were initiated at the request of:

CAMI (in-house)	9
Office of Aviation Medicine (including Federal Air Surgeon)	3
Other FAA organizations	4
National Transportation Safety Board	1
	17

Descriptions of these 17 projects may be found in appendix V.

FACILITIES AND EQUIPMENT

CAMI is located in a three-story structure known as the CAMI building. All of CAMI's operations are housed in this building except the Aeromedical Certification Branch which is located in the Aviation Records Building. The CAMI building is owned jointly by the Oklahoma City Airport Trust and Oklahoma City and is leased to FAA on a long-term basis.

The CAMI building houses the executive offices, administrative staff, and three of the four branches--Acromedical Clinical, Aeromedical Education, and Aeromedical Research. There is a total of 142,759 square feet of available work space, of which 92,677 is assigned to the Research Branch. The Aeromedical Certification Branch occupies 11,731 square feet of space in the Aviation Records Building.

FAA leases the CAMI building from the Oklahoma City Airport Trust and Oklahoma City at an annual rental of $423,000, which includes debt service, insurance, and ground rental cost. This amount does not include rental for the Aeromedical Certification Branch located in another building.

The CAMI building has total capitalized leasehold improvements of $89,000 with a net amortized value of $73,000. Some of these improvements include modification of the water system, installation of photo lighting, and construction of an emergency passageway.

Facility use

The CAMI facility has not been used to the extent FAA originally intended. It was designed and built to accommodate 350 people, but only about half that number are housed at the facility. Major justification for the building was that all FAA medical operations except program planning and management would be moved to the new facility. The medical operations were moved as planned, but several years later parts of the facility were still vacant.

In 1967 FAA investigated the feasibility of locating nonresearch programs in the building and tried unsuccessfully to bring research facilities of other Federal agencies to CAMI. That same year a private consulting firm hired by Transportation reported that CAMI could possibly conduct research related to highway safety. As a result, in 1969, FAA and the National Highway Transportation Safety Administration reached an agreement which would involve CAMI in research of driver and passenger crash injuries. The work was never undertaken because the Safety Administration could not furnish manpower for the experiment.

A May 1975 Department of Transportation study entitled "Review of DOT Research, Development, Test and Evaluation Centers" recognized that CAMI's operation was too small for the facilities. The study pointed out that the CAMI facility was designed to accommodate approximately double the number of employees which now occupy it and that some of CAMI's unique technical facilities, such as the sonic boom simulation room, anechoic chamber, morgue, environmental chambers and survival tank, were very seldom used. The study mentioned that the Federal Air Surgeon believed CAMI could be more productive if it was used by other Transportation administrators, but a lack of funds and personnel prohibited such use.

The study team's report recommended that CAMI become a Department of Transportation facility under FAA management and be responsive to the biomedical research needs of the various modal administrations of the Department. It also recommended to the Secretary of Transportation that all biomechanics work presently conducted by the Occupant Restraint Division of the National Highway Safety Administration's Safety Research Laboratory be transferred to CAMI.

Equipment at CAMI

As of January 4, 1975, equipment costing about $4 million was assigned to CAMI. About 75 percent, or $3 million worth, was technical development equipment. Most of the remainder was administrative and office equipment.

The technical development equipment includes many chemical analysis instruments, environmental and altitude chambers, crash simulation sleds, a water survival tank, a morgue, and computers. Some of the computers are combined with task simulators involving aircraft and air traffic control.

In fiscal years 1974 and 1975, amounts expended by CAMI for equipment upgrading and new purchases totaled about $258,000 and $170,000, respectively. One of the larger purchases was a graphic display system costing about $71,000.

We have been informed that CAMI has had difficulty obtaining funds for equipment acquisitions. For example, we noted that a modification to CAMI's crash impact test facility was included in CAMI's 1969 budget. It was also included in several later budgets, but attempts to obtain the funds have not been successful. The requested modification was included again in CAMI's 1977 budget and, according to agency officials, subsequently disallowed because of budget cuts imposed by the Office of Management and Budget.

There is concern among Office of Aviation Medicine and CAMI officials about the decreasing amount of R&D funds available for equipment purchases and facility improvements. Apparently the situation has been caused in part by a fairly constant R&D budget ceiling and increasing labor costs. (See below.)

PERSONNEL

CAMI has an authorized ceiling of 226 personnel spaces and as of October 8, 1975, had 202 employees. Eight were assigned to the Office of the Chief or to the administrative staff, and the balance divided among the four major branches.

Aeromedical Research Branch	92
Aeromedical Certification Branch	72
Aeromedical Education Branch	17
Aeromedical Clinical Branch	13
Total	194

Personnel costs

Salaries and fringe benefits for all CAMI personnel totaled about $3.3 million in 1974 and $3.5 million in 1975.

	FY 1974	FY 1975
	(000 omitted)	
Aeromedical Research Branch	$1,640	$1,800
CAMI Chief, Secretary Administration Staff	317	273
Aeromedical Certification Branch	812	889
Aeromedical Education Branch	327	334
Aeromedical Clinical Branch	225	231
	$3,321	$3,527

Salaries and fringe benefits comprised the major portion of all CAMI expenditures and were 76 percent of the total budget in 1974 and 82 percent of the total budget in 1975. Office of Aviation Medicine and CAMI officials see salaries as becoming an even more significant portion of total appropriations. They believe that if the total CAMI appropriated funds remain about the same, as they have the last several years, most money will eventually go for personnel costs.

About 50 percent of CAMI's personnel are assigned to the Aeromedical Research Branch and account for about 50 percent of personnel costs. The personnel in the Aeromedical Research Branch are paid out of the Facilities, Engineering and Development and the Research, Engineering and Development appropriations. The CAMI chief, his secretary, the administrative staff, and the personnel in the other three CAMI branches--Certification, Education, and Clinical--are paid out of the Operations appropriation.

Personnel data, Aeromedical Research Branch

This Branch is the organization within CAMI that conducts R&D and is comprised of the following sections.

Section	Number of personnel
Staff	2
Veterinary Section	4
Biostatistical Section	3
Technical Section	4
Aviation Toxicology Laboratory	20
Aviation Physiology Laboratory	18
Aviation Psychology Laboratory	20
Protection and Survival Laboratory	21
Total	92

Characteristics of the 92 employees were:

Average grade level--9.82.

Average age--42.54.

Of the 92 people 62 had degrees and worked in the following 20 areas.

	Number
Field of endeavor:	
Medicine	2
Mechanical engineering	2
Geography	1
Biostatistics	1
Psychology	18
Veterinary	1
Metallurgy	1
Physiology	9
Biology	6
Anthropology	2
Computer	1
Business education and administration	1
Hearing	1
Mathematics	1
Educational research	1
Chemistry--biochemistry	9
Medical technician	2
Botany	1
Optometry	1
Industrial management	1
Total	62
Profession or type of work:	
Senior researcher, scientist, educator	26
Medical doctor	1
Technician	56
Clerical	9
Total	92
Level of education:	
Doctorate	21
Masters	19
Bachelor	22
No degree	30
Total	92

The ratio of supervisory to nonsupervisory personnel in the branch was as follows:

--The number of actual supervisors or section heads to total branch personnel was 8:92, or 1 supervisor for each 11.5 individuals.

--Senior researchers, including scientists, educators, and medical doctors, to total branch personnel was 27:92, or 1 senior researcher for every 3.41 people.

--Senior researchers to technicians was 27:56, or 1 senior researcher for every 2.08 technicians.

--Senior researchers to clerks was 27:9, or 3 senior researchers to 1 clerk.

Minority data

CAMI's minority staff increased from 19 to 22 between June 1973 and June 1975 while the total number of employees at CAMI decreased from 215 to 202. Grade levels of the minority staff also increased during the past 2 years. For example, average grade level increased from 5.3 in 1973 to 6.1 in 1975. The highest grade minority employee was a GS-11 in 1973, but in 1975 there was one GS-12 and one GS-14. A detailed analysis of all employees by grade is shown on page 65.

Women employees

From June 30, 1973, to June 30, 1975, the number of women employed at CAMI increased from 95 to 98. The distributions by grades are shown in the following table.

	June 30, 1973			June 30, 1975		
	Total personnel	Total women	Percentage of women	Total personnel	Total women	Percentage of women
CAMI	215	95	44.2	202	98	48.5
GS-1 to 4	63	46	73.0	50	47	94.0
GS-5 to 8	61	40	65.6	64	41	64.1
GS-9 to 11	47	9	19.1	41	10	24.4

There were no women above a GS-11 in either year. A more detailed analysis of women employees is shown on page 65.

Civil Aeromedical Institute

Employees by Grade and Minority Status

	Total employees		Black		Spanish surnamed		American Indian		Oriental		Total Minority		Total Nonminority	
	1973	1975	1973	1975	1973	1975	1973	1975	1973	1975	1973	1975	1973	1975
All (note a)	215	202	11	14	2	2	6	5	-	1	19	22	196	180
Percent of total	100	100	5.1	6.9	0.9	1.0	2.8	2.5	-	0.5	8.8	10.9	91.2	89.1
GS-1 to 4	63	50	7	10	-	-	4	1	-	-	11	11	52	39
Percent of total	100	100	11.1	20.0	-	-	6.3	2.0	-	-	17.5	22.0	82.5	78.0
GS-5 to 8	61	64	3	3	-	-	1	1	-	1	4	5	57	59
Percent of total	100	100	4.9	4.7	-	-	1.6	1.6	-	1.6	6.6	7.8	93.4	92.2
GS-9 to 11	47	41	1	1	2	1	1	2	-	-	4	4	43	37
Percent of total	100	100	2.1	2.4	4.3	2.4	2.1	4.8	-	-	8.5	9.8	91.5	90.2
GS-12 to 18	44	47	-	-	-	b/1	-	c/1	-	-	-	2	44	45
Percent of total	100	100	-	-	-	2.1	-	2.1	-	-	-	4.2	100	95.8

a/GS and wage board.

b/GS-12.

c/GS-14.

Women Employees by Grade and Minority Status

	Total employees		Minority women		White women		All women		All men	
	1973	1975	1973	1975	1973	1975	1973	1975	1973	1975
All	215	202	7	7	88	91	95	98	120	104
Percent of total	100	100	3.3	3.5	40.9	45.1	44.2	48.5	55.8	51.5
GS-1 to 4	63	50	6	6	40	41	46	47	17	3
Percent of total	100	100	9.5	12.0	63.5	82.0	73.0	94.0	27.0	6.0
GS-5 to 8	61	64	1	1	39	40	40	41	21	23
Percent of total	100	100	1.6	1.6	63.9	62.5	65.6	64.1	34.4	35.9
GS-9 to 11	47	41	-	-	9	10	9	10	38	31
Percent of total	100	100	-	-	19.1	24.4	19.1	24.4	80.9	75.6
GS-12 to 18	44	47	-	-	-	-	-	-	44	47
Percent of total	100	100	-	-	-	-	-	-	100	100

CONCLUSIONS

CAMI has had a relatively constant level of appropriated funds during recent years, and an increasing proportion of its funds are being allocated to salaries and related costs.

CAMI appears to have a highly trained and capable research staff and the facilities for handling additional personnel and projects. The Federal Air Surgeon stated that CAMI could be more productive if its expertise and facilities were used by other transportation administrations. Also, in May 1975, a Department of Transportation study team recommended to the Secretary that

--CAMI become responsive to the biomedical research needs of the modal administrations of the department.

--All biomechanics work presently conducted by the Occupant Restraint Division of the National Highway Transportation Safety Administration's Safety Research Laboratory be transferred to CAMI.

In July 1976, we contacted officials at the Department of Transportation and inquired about the status of the recommendations contained in the Department study. We were advised that the recommendations have been substantially adopted and that implementation plans are underway.

We believe these actions should result in more efficient use of CAMI's personnel and facilities.

APPENDIX I

COMMITTEE ON SCIENCE AND TECHNOLOGY
U.S. HOUSE OF REPRESENTATIVES
SUITE 2321 RAYBURN HOUSE OFFICE BUILDING
WASHINGTON, D.C. 20515

June 25, 1975

Mr. Elmer B. Staats
Comptroller General of the United States
The General Accounting Office
441 G Street, N.W.
Washington, D.C 20548

Dear Mr. Staats:

As part of the Committee on Science and Technology oversight activity during the 94th Congress, the Subcommittee on Aviation and Transportation Research and Development, chaired by the Honorable Dale Milford, will examine in depth selected national aeronautical facilities and programs. In order to accomplish this task, additional assistance will be required. Therefore, I am requesting that you provide appropriate personnel in support of the Subcommittee's activity.

Attached is a Subcommittee program plan submitted to me by Mr. Milford. You will note that there are three items concerning GAO in this work plan:

(a) development of a selected data base on programs and facilities.

(b) examination of selected FAA/NASA centers.

(c) examination of specific types of facilities.

Under item (a), the Subcommittee wishes to accomplish a thorough review of the nation's civil aviation R&D programs and facilities. Assistance by the GAO for accomplishing the review would take the form of assembling information on selected programs and facilities to help achieve the objectives identified in the enclosed program plan. Primarily, these objectives are related to assuring that the U.S. retains its predominant role in world aviation, to insuring that U.S. governmental agencies and private industry are cooperating, and insuring that federal expenditures for aeronautical R&D and facilities are being spent effectively.

Under item (b), the Subcommittee's first priority is an examination of the FAA's National Aviation Facilities Experimental Center (NAFEC). The Subcommittee has recently acquired jurisdiction over R&D activities of the FAA and is therefore extremely interested in the function of the NAFEC facility. In order to become thoroughly acquainted with the NAFEC operations, the Subcommittee needs definitive information concerning NAFEC personnel, facilities, equipment, and programs. It is requested that this information be furnished by February 1976, so that your report may be utilized during the annual authorization process. Subsequently, other centers would be examined during 1976.

Under item (c), the Subcommittee is primarily interested in obtaining an inventory and examining the status of the nation's wind tunnels. The Subcommittee has recognized that many of our wind tunnels were built in the 1940's and that this is of major concern to aviation interests in this country. Proposals have been made by NASA and the Department of Defense for a number of new, advanced aeronautical R&D facilities. If approved, these facilities would involve the expenditure of many hundreds of millions of dollars.

Therefore, a thorough understanding of our current wind tunnel resources is needed by the Subcommittee in order to act properly on the pending requests for new facilities. The preliminary phase of examination would consist of a study of NASA and FAA facilities, and the secondary phase would necessitate cooperation from DOD for examination of military facilities. It is requested that this information be furnished in a report by February 1976, in time for the authorization process.

My staff will be working with those people you assign to this task on a periodic basis. I would assume that you would designate a person to lead your effort and provide guidance to GAO personnel involved. Our expectation is that GAO assistance, in varying degrees, will be required until the end of the 94th Congress.

Since we wish to initiate these efforts at an early date, please provide me with your comments and recommendations at your earliest convenience.

Sincerely,

JOHN E. TUNNEY
Chairman

T/S/ps

APPENDIX I

SUBJECT: REVIEW OF NATIONAL AVIATION R&D FACILITIES AND PROGRAMS

Overall Objectives

1. Attain a broad perspective of the nation's policies and programs concerning aviation.

2. Understand the goals and objectives of the NASA and DOT aviation R&D programs.

3. Determine the inter-relationships between NASA, the DOT the Department of Defense and industry in establishing objectives and priorities in conducting aviation R&D.

4. Determine if overall aviation R&D objectives are being pursued in an effective manner.

Program Objectives

1. Identify NASA and DOT aviation R&D programs and review the relationship of these programs to agency objectives.

2. Identify major DOD aviation R&D programs (in cooperation with the Armed Services Committee).

3. Determine whether unwarranted duplication exists in R&D programs.

4. Determine if sufficient attention and resources are being devoted to aviation R&D programs.

Facilities Objectives

1. Identify NASA and FAA aviation R&D facilities and review the utilization of such facilities.

2. Identify DOD aviation R&D facilities and review the utilization of such facilities (in cooperation with the Armed Services Committee).

3. Determine whether unwarranted duplication exists in agency aviation R&D facilities.

4. Determine if sufficient attention and resources are being devoted to aviation R&D facilities and programs.

Approach

1. Review prior government examination of the nation's aeronautical programs.

2. Examine selected FAA/NASA Centers.

3. Compile data file on all FAA/NASA Centers.

4. Examine specific types of facilities (e.g. wind tunnels).

Basic Work Plan

CAO

1. Prepare file on each FAA/NASA center where aeronautical R&D is being performed.

2. Definitive examination of selected NASA/FAA Centers.

3. Examination of specific types of facilites, such as wind tunnels.

Library of Congress

1. Review prior government examinations of the nation's aeronautical programs.

2. Summarize major recommendations of such examinations.

NASA/FAA

1. Update Aeronautics and Space Engineering Board (ASEB) Study (Civil Aviation R&D).

2. Expand study as necessary (include facilities, safety, etc.)

Subcommittee Staff

Mr. Read -- to coordinate and control all phases of the study for the Subcommittee. Monitor items 1 and 4.

Mr. Staub -- Monitor items 2 and 3.

DESCRIPTION OF FAA PROGRAM AREAS

01--SYSTEM PROGRAM

This program provides overall system engineering direction and guidance to integrate the efforts of all other engineering and development programs. The objectives of this program are to be consistent with the objectives of an improved air traffic control system; maintain or improve safety levels; constrain or reduce costs to users and operators; and improve performance. This program involves design activities, cost-benefit analyses, and simulation and test of new components.

02--RADAR PROGRAM

This program encompasses activities to upgrade and improve the operation and performance of airport surveillance radars and en route surveillance radars, as well as activities to develop new techniques for future radar systems. Activity is focused on (1) reducing or eliminating the problems of radar clutter which obscure and limit the "electronic vision" of present radar systems and (2) improving the ability of present radar systems to detect small aircraft.

03--ATC RADAR BEACON SYSTEM PROGRAM

This program encompasses efforts to improve the performance of the present surveillance and data acquisition system and to develop a new one to be known as the Discrete Address Beacon System. The program includes activities to (1) eliminate site-peculiar problems with the present system, (2) eliminate problems of system degradation caused by shared Government/industry use, and (3) develop new equipment and techniques to upgrade performance. In addition, this program covers all efforts associated with defining and developing the new Discrete Address Beacon System which is aimed at meeting the ATC surveillance and data link requirements for the 1980-90 period. This new system is being developed to meet capacity, safety, and efficiency requirements of the Upgraded Third Generation System.

04-NAVIGATION PROGRAM

The accurate navigation of aircraft ranks in importance with their surveillance by ground-based tracking radars. Pilots depend on a variety of ground-based navigation aids. FAA's Navigation Program is based on the continuing role of

ground-based stations, commonly referred to as VORTACS, 1/ as the primary means of airways system navigation into the 1980s. Efforts to meet the requirements of higher accuracy, greater capacity, and better operational capability are continuing. In additon, programs are included to adopt the VORTACS to allow greater flexibility through the use of Area Navigation techniques. Concurrently, programs have been established to determine the feasibility of adopting Very Low Frequency navigation systems for use in both oceanic and continental applications. Work on self-contained airborne systems, such as Inertial Navigation Systems and Doppler radar, are also included for oceanic applications.

05--AIRBORNE SEPARATION ASSURANCE PROGRAM

The main thrust of this program is to consider alternative ways to reduce or eliminate the threat of mid-air collisions. This program has been planned and coordinated with the Department of Defense and the National Aeronautics and Space Administration. This joint effort involves testing and evaluating competing systems, improving airborne lighting for increased conspicuity and insuring the compatibility of evolving airborne collision avoidance systems with the ground-based ATC system.

The primary objective of this program is to foster the development and implementation of cost-effective and ATC-compatible hardware and software and, in the event of its failure, to provide protection (to aircraft) into geographical areas not covered or serviced by the ground-based ATC. The secondary objective is to enhance the aircraft's visibility.

06--COMMUNICATIONS PROGRAM

This program covers engineering and development for all communications systems (air-to-ground, ground-to-ground, and intrafacility) for the continental United States. It includes the overall communication systems efforts which define the subsystem requirements and performance characteristics required for the Upgraded Third Generation System. Increasing the speed, capacity, and flexibility of the communication subsystems that link the ATC facilities, while maintaining an adequate level of service for the existing configuration, is a major objective. The increased capability

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1/Very High Frequency Omni-Directional Range, Tactical Air Navigation System.

sought by development programs for en route and terminal ATC operations must be matched by compatible upgrading of communications systems if the full potential of the improvements are to be realized. The communications program excludes the integral data links of the Discrete Address Beacon System and satellite systems which are covered by the ATC Radar Beacon System/Beacon Program (03) and Satellite Program (17), respectively.

07--APPROACH AND LANDING SYSTEMS PROGRAM

Development of the Microwave Landing Systems is the primary task of this program. The program is also directed toward improvement of the present Instrument Landing System and existing lighting systems to meet current and near-term operational requirements.

MLS is a part of the Upgraded Third Generation ATC system. It is to provide the precision, flexibility, and reliability needed to match the operational procedures and capacity of the rest of the ATC system. Conventional Instrument Landing System improvements are intended to increase the present system's precision and decrease the siting effects. In both cases, the advancement of safe all weather landing capability is a goal.

08--AIRPORTS/AIRSIDE PROGRAM

This program covers airport layout and capacity improvement; pavement design, testing, and rehabilitation; safety support and airport surface surveillance, control, and guidance.

FAA states that capacity requirements, construction and operation costs, scarcity of land, safety, and community concern are all generally opposing factors which must be treated as an entity in order to exact maximum capacity and cost effectiveness from contemporary and future airport systems. Results of this program must be proven to be viable to airport owners and operators to assure acceptance and use.

09--AIRPORT/LANDSIDE

This program will measure and evaluate the capacity of large airports from the landside: access to and egress from airports, terminal buildings, parking, and loading and unloading. It will measure landside capacity restrictions of major airports and analyze possible corrective measures to improve capacity. If feasible, simulation techniques

will be used to assess bottlenecks and evaluate methods of correcting these bottlenecks.

10--OCEANIC

The objective of this program is to increase the capacity and efficiency of oceanic air traffic control through the development of an automated oceanic ATC system and the development of the concepts and capabilities for interfacing this system with satellite information systems. Included will be the development of a data processing and display system to provide air traffic controllers with the characteristics to meet oceanic control requirements.

11--ATC SYSTEMS COMMAND CENTER AUTOMATION (FLOW CONTROL)

The objective of this program is to define and develop the automation support required to improve the efficiency of national airspace system management operations in the ATC System Command Center. The program includes the development of a centralized flow control capability which, with the local flow control accomplished at the Air Route Traffic Control Center, will exercise strategic control and coordination of national air traffic flow requirements.

12--EN ROUTE CONTROL PROGRAM

This program includes system engineering, development, and test of advanced automation capabilities for en route control. The program also provides the test-bed facilities at the National Aviation Facilities Experimental Center to support the en route development activities and other engineering and development efforts to upgrade the third generation ATC system.

13--FLIGHT SERVICE STATION PROGRAM

This program is directed toward developing an improved configuration of flight service station facilities which will incorporate design advances and automated features to replace present labor-intensive methods of providing flight services. FAA considers this essential for handling the projected user demands for services at a reduced cost per service unit. The development of an automated aviation weather data base and automated pilot self-briefing and flight plan filing terminals is part of the program.

14--TERMINAL/TOWER CONTROL PROGRAM

This program is designed to provide a family of automated systems suitable for the varied types and sizes of terminal and tower ATC facilities. FAA's objective is to provide terminal/tower control facilities which can achieve much higher levels of performance in safely expediting the movement of air traffic.

15--AVIATION WEATHER PROGRAM

This program is to improve and modernize (through automation and improved techniques and sensors) acquisition, processing, and dissemination of aviation weather information. FAA has increased its emphasis on the detection, sensing, tracking, and display of hazardous weather (severe storms). Aviation weather information is becoming increasingly necessary to enhance safety and insure the utility and overall performance of the Nation's airspace system in light of automation and the growing capacity of the en route and terminal ATC operations.

16--TECHNOLOGY PROGRAM

This program evaluates technological advancements and their potential applications to present and future ATC systems. The program is divided into two main areas--ATC display technology and advanced computer technology--and will provide the technology for follow-on development activities for specific applications in ATC systems and subsystems.

17--SATELLITE PROGRAM

This program is designed to investigate and evaluate satellite subsystems for potential applications in oceanic and continental United States ATC and navigation. FAA plans to use simulations and existing National Aeronautics and Space Administration experimental satellite systems to establish the characteristics and operational standards for a potential aeronautical satellite system. FAA believes that improved communications in oceanic airspace will be required to meet traffic growth projections. It has been agreed internationally that satellite technology offers the most promising solution. Further benefits to the airspace system may accrue from satellites by incorporation of a capability to perform navigation and surveillance. The FAA engineering and development plans also state that the potential for meeting future continental ATC requirements by use of satellites is sufficiently promising to be investigated. The AEROSAT

portion of this program is a joint effort with the European Scientific Research Organization.

18--AIRCRAFT SAFETY PROGRAM

This program covers engineering and development to enhance civil aircraft safety. It demonstrates technical, operational, and economic feasibility of safety improvements and provides criteria for aircraft design, operations, maintenance, and pilot performance; and for weapon and bomb detection specifications. The program is divided into fire safety, transport safety, general aviation flight safety, and aviation security program elements.

19--AVIATION MEDICINE

This program is aimed at reducing the probability of accidents or incidents due to biomedical factors. The program is also concerned with the health, performance, and efficiency of aircrews under various environmental conditions.

20--ENVIRONMENTAL PROTECTION PROGRAM

This program encompasses FAA efforts to identify and minimize undesirable environmental effects attributable to the air transportation system, including noise, emissions, and land use. Increased air traffic, particularly by jets, has focused public, governmental, and industry attention on the need to reduce adverse environmental impact. This program demonstrates the technical, operational, and economic feasibility of ways to accomplish these goals and provides the data for rulemaking, certification compliance techniques that meet the requirements in relevant public laws, and environmental assessments.

21--SUPPORT PROGRAM

This program is designed to provide engineering and development in areas that are not directly accommodated under any other program. At present, these include the development of improved and more economical terminal, en route, and landing system performance assurance techniques, which transfer the burden from flight measurements to ground-based systems.

A program to minimize or eliminate the effects of wake turbulence, which would permit reduced aircraft separation requirements, was included in this program but recently transferred to program 08--Airport/Airside.

MAJOR FAA PROGRAMS INVOLVING NAFEC

01--SYSTEM PROGRAM

The National Aviation Facilities Experimental Center, under this program, is involved in system planning and design and carries out flight and air traffic control simulations in support of system design.

FAA review results:
ATC systems performance measures and separations standards (PAA 01-203)

NAFEC's effort in this program area agreement deals with studies and analyses of criteria for aircraft separation in domestic and international ATC environments. The work involves collection, reduction, and analysis of performance data, such as that pertinent to existing and proposed airspace separation standards. This information will be used to provide collision-risk analysis, cost-effectiveness analysis, and studies of the impact of proposed levels of safety on separation standards and ATC system performance needs.

Previous NAFEC work in this area involved looking at ATC system performance data from the standpoint of voice communications and automation.

In our review of the center's continuing work in the area of separation standards, we found that NAFEC, along with the MITRE Corporation, has planned for and carried out data collection pertaining to the United States mainland to Hawaii oceanic route. Preliminary studies on risk and cost analysis in the use of separation standards have also been completed.

Personnel and funding resources applied by NAFEC during fiscal year 1975 and anticipated in 1976 are:

	NAFEC staff-years	NAFEC funding distribution		
		In-house	Contract	Total
		(000 omitted)		
1975 (note a)	28	$ 675	$ 98	$ 773
1976 (note a)	13	334	279	613
Total	41	$1,009	$377	$1,386

a/PAA 01-203.

02--RADAR PROGRAM

At NAFEC the program provides the test and evaluation support required to obtain improved airport and en route surveillance radar detection capability. This work involves

--sustaining engineering;

--new and improved subsystems; and

--improved radar tracking for automated facilities.

03--ATC RADAR BEACON SYSTEM/BEACON PROGRAM

Under this program, NAFEC is to provide surveillance data of sufficient quality and reliability to permit automatic processing and display of these data for air traffic control. Activities include improving existing performance and testing new concepts and equipment.

PAA review results:
Intermittent positive control simulation
(PAAs 01-260 and 03-260)

In these PAAs NAFEC makes preliminary simulation investigations of ATC system interactions with the new Intermittent Positive Control development program and assesses pilot reactions to the program by using a general aviation aircraft simulator. Intermittent Positive Control is a ground-based collision avoidance service being developed to provide pilots with warning advisories and collision avoidance commands to prevent impending collisions.

NAFEC has completed initial verification tests of the simulation test bed, and tests to determine ATC system interactions are now underway. Some improvements in software logic have been claimed as a result of these tests.

Pilot reactions are being assessed by Lincoln Laboratory, Lexington, Massachusetts, through flight testing. FAA planning of NAFEC's and the contractor's work was not coordinated, and a possible overlap has recently been identified. As yet, the FAA program manager has not come to a decision on the action to be taken. Pending a decision, NAFEC continues to plan the simulations.

Personnel and funding resources applied by NAFEC during fiscal year 1975 and anticipated in 1976 are:

	NAFEC staff-years	NAFEC funding In-house	Contract	Total
		(000 omitted)		
1975 (note a)	26	$ 640	-	$ 460
1976 (note b)	29	730	-	730
Total	55	$1,370	-	$1,370

a/PAAs 01-260 and 03-260.

b/PAA 03-260.

04--NAVIGATION PROGRAM

At NAFEC, this program includes area navigation, as described in the following section of PAA review results, and other effort to improve navigation systems. Specific activities include the evaluation of antenna systems, citing criteria and new system equipment. Distance Measuring Equipment efforts provide for the development of techniques and equipment for increased capacity and digital data broadcasting. Efforts to supplement the present navigation system with very low frequency techniques and replace Long-Range Navigation are underway.

PAA review results:
RNAV (PAAs 04-210, 04-276, 04-310 and 04-363

Generally, airplanes do not fly in a straight line from the point of takeoff to destination. Flight routes usually follow a series of straight courses that angle and dogleg because they are set up around ground-located navigation aids. RNAV permits navigation on direct routes to any destination or intermediate point. This simpler means of navigation should save flight time and cost, reduce pilot and controller workloads, and reduce the amount of needed radio communication.

RNAV is a part of FAA's program to upgrade the present ATC system and is unique because it is the only part of that program, so far, being implemented. A number of avionics firms have developed equipment of varying sophistication. Comparatively simple units have been installed in several thousand general aviation aircraft and more complex units in a few airline aircraft. Some high-altitude and terminal-area routes and approach procedures have been established to permit the use of RNAV.

In spite of the advantages claimed for RNAV, users and controllers of the ATC system are reluctant to accept this new approach to navigation. As a result, implementation has been much slower than anticipated by RNAV advocates. FAA attributes this to

--evaluations being conducted in areas where congested airspace prevented the application of ideal RNAV routes,

--low numbers of aircraft involved in the evaluation which resulted in few pilots who were really "at home" with the equipment and procedures,

--the mixture of RNAV and non-RNAV aircraft, which seriously complicated terminal area control, and

--studies indicating that expected shorter route advantages were considerably less than expected.

FAA is identifying user and Government costs and benefits, establishing avionics standards, validating concepts, and providing the basis for new route structures and procedures. The objective is to enable FAA and users to weigh the pros and cons of RNAV, determine implementation impact on operations, and, if necessary, modify the degree and timing of implementation.

RNAV investigation simulation studies (PAAs 04-210 and 04-276)

These PAAs involve development and simulation activities leading to the application of RNAV equipment and techniques. Objectives of the work are to provide (1) design concepts and methods for route structures, (2) requirements for navigational aids and RNAV equipment, (3) payoff analysis for RNAV applications in high-density terminals, (4) ATC procedures for RNAV use, and (5) resolution of man-to-machine interface problems.

In its route structure work, NAFEC is part of a team including contractor and FAA personnel. This work involves manual design, as it was previously found that developing route structures for air navigation is judgmental and can be automated only to a limited degree. Effort is being directed to both high- and low-altitude routes, interfaces between them and with terminals within the structures. Navigational aid requirements are being addressed, along with route structuring. NAFEC has developed a hypothetical high-altitude route structure for payoff analysis and validation of concepts

and has completed an interim report on this development. Plans for low-altitude structure development were recently completed.

Various RNAV simulation activities involving NAFEC and the contractor are underway to aid in determining avionics requirements and to identify and resolve man-to-machine problems in the cockpit related to the pilots' use of equipment. NAFEC recently completed plans for a high-altitude route simulation to (1) validate findings of contractor simulations, (2) identify RNAV advantages or disadvantages, and (3) support route structure design. A joint NAFEC and contractor activity is also underway for New York terminal area simulation.

Personnel and funding resources applied by NAFEC during fiscal year 1975 and anticipated in 1976 are:

	NAFEC staff-years	NAFEC funding		
		In-house	Contract	Total
		(000 omitted)		
1975 (note a)	31	$ 757	$ 95	$ 852
1976 (note b)	36	931	139	1,070
Total	67	$1,688	$234	$1,922

a/PAA 04-210.

b/PAAs 04-210 and 04-276.

RNAV avionics investigation
(PAAs 04-310 and 04-363)

NAFEC's effort in these programs involves laboratory and flight test and evaluation to support RNAV application in the Nation's airspace system. Objectives include evaluation of representative RNAV equipment of varying levels of sophistication for general aviation and air carrier use. Another objective is to validate RNAV simulation studies. NAFEC has planned and conducted tests and expects to report on the results of their work.

Personnel and funding resources applied by NAFEC during fiscal year 1975 and anticipated in 1976 are:

	NAFEC staff-years	NAFEC funding In-house	Contract	Total
		(000 omitted)		
1975 (note a)	27	$660	$10	$ 670
1976 (note b)	13	320	35	355
Total	40	$980	$45	$1,025

a/PAA 04-310.

b/PAA 04-363.

05--AIRBORNE SEPARATION ASSURANCE PROGRAM

The overall NAFEC objective in this program is to support the preparation of concepts and recommendations for airborne systems and subsystems to minimize the probability of midair collisions under Instrument Flight Rule and Visual Flight Rule operating conditions. Engineering data is being collected through flight testing, laboratory simulations, analysis, and experimentation. NAFEC's work complements that of the Transportation Systems Center, National Bureau of Standards, Air Force, and industry. Investigation of human factors in NAFEC's collision prevention laboratory supports the development of conspicuity enhancement techniques for airborne proximity warning displays.

PAA review results:
Airborne collision avoidance system (PAA 05-111)

This PAA included the planning, performance and reporting of flight tests of a McDonnell Douglas Electronics Company airborne collision avoidance system to acquire engineering data for evaluating and comparing this system with other contractors' systems. Another NAFEC task dealt with sensitivity simulations and studies on the effect of such equipment on the ATC system.

The McDonnell Douglas system consisted of two commercial aviation (air carrier) units, two general aviation units, and associated ground equipment. An Air Force test of a similar system in 1973 revealed problems in the general aviation units. The contractor redesigned the units, and these are being tested by NAFEC. The Naval Air Development Center, Warminister, Pennsylvania, assisted FAA in evaluating competing contractors' airborne collision avoidance equipment. This Navy activity tested units built by Honeywell, Inc., and RCA.

Sensitivity investigations were also conducted by NAFEC to arrive at quantitative expressions of potential ATC/airborne collision avoidance systems interactions leading to (1) how the air traffic controller adapts to such equipment and (2) whether additional regulations would be needed.

NAFEC has recently been asked to provide engineering assistance and support to the Transportation Systems Center in the procurement, testing, and evaluation of another collision avoidance system, the Litchford system. This work is scheduled for completion in September 1976.

Personnel and funding resources applied by NAFEC during fiscal year 1975 and anticipated in 1976 are:

	NAFEC staff-years	NAFEC funding		
		In-house	Contract	Total
		(000 omitted)		
1975 (note a)	53	$1,275	$347	$1,622
1976 (note a)	42	1,081	168	1,249
Total	95	$2,356	$515	$2,871

a/ PAA 05-111

06--COMMUNICATIONS PROGRAM

NAFEC's participation in this program involves the improvement of existing equipment and development of new equipment or systems for the exchange of intelligence. The center's efforts deal with (1) ongoing laboratory and field test and evaluation of equipment, systems, and components proposed as improvements to the air-to-ground voice communications systems and (2) support of FAA and contractor personnel in the design and evaluation of an air-to-ground communications facility.

07--APPROACH AND LANDING SYSTEMS PROGRAM

NAFEC's activities in this program support the development, test, and evaluation of MLS, Improved Instrument Landing Systems, flight controls and displays, and Visual Guidance/Airport Lighting Systems. It also provides assistance to the field by evaluating modifications to improve operational systems.

PAA review results:
Microwave landing systems (PAA 07-315)

In this program NAFEC supplied ground and airborne test facilities to support contractors' testing of feasibility models. These tests were aimed at evaluating alternative MLS techniques. During a subsequent test, NAFEC will technically and operationally evaluate prototype systems at the center and at operational sites.

MLS is being developed to overcome shortcomings of the present main guidance system--the Instrument Landing System. The Instrument Landing System guides aircraft through any weather on a single approach to the runway. However, it cannot be located at every runway since the surrounding terrain can be a problem. Furthermore, it is susceptible to interference from reflecting objects, such as buildings, hangars, and other aircraft. MLS is being designed to minimize these problems and permit instrument approaches from a variety of angles. MLS is scheduled to replace the Instrument Landing Systems in the 1980s.

NAFEC will test the MLS at airports having known Instrument Landing System siting problems. Static and flight tests will be conducted to determine the performance of the units in problem operating environments.

NAFEC personnel and funding during fiscal year 1975 and anticipated in 1976 are:

	NAFEC staff-years	NAFEC funding		
		In-house	Contract	Total
		(000 omitted)		
1975 (note a)	37	$ 909	$ 629	$1,538
1976	63	1,606	395	2,001
Total	100	$2,515	$1,024	$3,539

a/PAA 07-315.

08--AIRPORTS/AIRSIDE PROGRAM

NAFEC is directly involved in two areas:

--Airport safety--Support work in this area involves the development of new firefighting agents, equipment, systems, and techniques applicable to jet airports. Airport pavement activities provide test and evaluation

in runway surface friction including development of an optimum configuration for grooving runways, effects of rubber removal by high pressure water jets, and dynamic load on flexible pavements. An additional activity involves determining the physical properties of ATC tower cab glass applicable to a national standard.

--Airport Surface Traffic Control--Activities in this area involve technical support for the development of a system for airport surface traffic control by the Transportation Systems Center.

NAFEC estimates of funding and manpower for this program increased substantially during fiscal year 1976 because of the shift of FAA efforts on low-level air turbulence (wind shear/wake vortex) from program 21, Support, to program 08, Airport/Airside.

12--EN ROUTE CONTROL PROGRAM

Under this program NAFEC evaluated hardware and software improvements and additions to the en route portion of the Nation's airspace system. System engineering support is provided for designing and testing system improvements and for resolving local and field problems.

FAA review results:
Upgraded third ATC functional and system development (FAA 12-126)

NAFEC personnel with air traffic controller background evaluate proposed ATC hardware and software improvements using simulation equipment. This work involves the en route portion of the airspace system rather than the terminal area portion, which is covered in program 14, Terminal/Tower Control. Past simulation testing has involved work with a conflict alert enhancement feature in high-altitude sectors, and this effort is continuing. Conflict alert provides air traffic controllers with a warning on their displays of possible violations of aircraft separation standards. NAFEC completed tests verifying the program design and conducted operational system tests before delivery to the field. NAFEC personnel also participated in the first field site test.

Personnel and funding by NAFEC during fiscal year 1975 and anticipated in 1976 are:

	NAFEC staff-years	NAFEC funding In-house	Contract	Total
		(000 omitted)		
1975 (note a)	25	$600	$15	$615
1976	14	368	-	368
Total	39	$968	$15	$983

a/FAA 12-126.

13--FLIGHT SERVICE STATION PROGRAM

The effort at NAFEC is described in the following section and includes preliminary planning for the establishment of a test facility wherein long-term improvements and system enhancements may be developed and evaluated.

PAA review results: Modernized flight service station design evaluation--upgraded ATC system/near-term flight service station engineering improvements (PAAs 13-251 and 13-265)

NAFEC's work is related to improving the flight service station system, both for the FAA program to upgrade the ATC system and for near-term improvements to existing stations. The flight station facilities serve pilots through specialists who provide weather data and navigation assistance, accept flight plans, and offer other services, such as preparing and distributing notices about the operational status of ATC facilities and airports.

In the flight service station area pertaining to the FAA program to upgrade the ATC system, NAFEC participates in several activities which involve (1) assessing the value of automation aids for weather information and equipment/airport operational notices, (2) developing and evaluating a new en route flight advisory service console for station specialists, and (3) investigating the usefulness of self-briefing terminals for pilots in remote locations. The center has started its evaluation of the en route advisory service console and has completed field experiments on pilot self-briefing terminals. NAFEC plans to report on the results of this work.

The center is also involved in the development and evaluation of near-term improvements for the existing flight service station system. Although specific work definition and

funds are needed, the work generally requires (1) establishing a laboratory for evaluating flight service station developments and improvements, (2) developing an updated medium-size station by using off-the-shelf equipment, and (3) evaluating proposed improvements. Some effort leading to testing an improved automatic telephone weather answering service has been completed by contractors with NAFEC support.

NAFEC personnel and funding during fiscal year 1975 and anticipated in 1976 are:

	NAFEC staff-years	NAFEC funding		
		In-house	Contract	Total
		(000 omitted)		
1975 (note a)	20	$496	$ 48	$ 544
1976 (note a)	20	503	591	1,094
Total	40	$999	$639	$1,638

a/PAAs 13-251 and 13-265.

14--TERMINAL/TOWER CONTROL PROGRAM

NAFEC's efforts are directed toward reducing the number and difficulty of tasks required of the human controller and making the best use of data available within the terminal/tower facilities.

PAA review results: Automated radar terminal systems enhancement (PAA 14-129)

NAFEC's effort concerns testing and verifying contractor-furnished computer programs by air traffic controllers in a simulated environment at NAFEC and "live" in the field. The computer programs are intended to assist ATC by (1) determining speed and altitude adjustments needed to meter traffic flow and provide optimum spacing for landing aircraft, (2) alerting controllers of predicted conflicts between two or more aircraft when their separation is less than prescribed minimums, and (3) alerting controllers when controlled aircraft are descending below minimum safe altitudes in terminal areas.

NAFEC, along with FAA and contractor personnel, is to assure that the metering and spacing program is acceptable for a field appraisal at the Denver airport. This effort is to be made on simulation equipment located at NAFEC. NAFEC

is to prepare the field appraisal test plan, control the "live" tests by Denver air traffic controllers, and prepare a final test report.

For the conflict alert task, data collection and development of scenario tapes involving various conflict situations are continuing. NAFEC is to conduct simulations to ascertain computer program performance and prepare a report on the results.

Under the minimum safe altitude effort, NAFEC completed verification tests of the contractor's program with both simulated and "live" aircraft traffic. Further simulations are planned on a contractor-furnished program for integrating both metering and spacing and conflict prediction.

Personnel and funding applied by NAFEC during fiscal year 1975 and anticipated in 1976 are:

	NAFEC staff-years	NAFEC funding		
		In-house	Contract	Total
		(000 omitted)		
1975 (note a)	34	$ 833	$ 7	$ 840
1976 (note a)	21	526	60	586
Total	55	$1,359	$67	$1,426

a/PAA 14-129.

15--AVIATION WEATHER PROGRAM

This program is to improve methods of measuring visibility and ceiling information provided to the pilot and controller. Sustaining engineering efforts are to provide more cost-effective measurement systems and equipment. Two meteorological towers have been installed at NAFEC for evaluating slant-range visibility measurement techniques. A test bed has been established to evaluate runway visual range system improvements and international systems of this type.

16--TECHNOLOGY PROGRAM

NAFEC provides the resources for (1) state-of-the-art maintenance in data entry and display technology, (2) evaluation of available and developmental data entry and display devices, techniques, and procedures for specific ATC application, (3) participation in new system design at the man-to-machine interface level, and (4) development of laboratory facilities and specialists to achieve these goals.

17--SATELLITE PROGRAM

NAFEC's objectives in this program are to obtain satellite system design data and to establish a test bed for evaluation and demonstration.

18--AIRCRAFT SAFETY PROGRAM

NAFEC's involvement in this program encompasses many areas, several of which are described below.

1. General aviation flight safety includes determining causal factors of general aviation aircraft accidents and the operational conditions which produce propeller blade fatigue failures.

2. Pilot performance includes determining the acceptability of pilot ground trainers as pilot training and flight check devices.

3. Aircraft airworthiness involves determining optimum locations for the placement of explosive devices encountered on board civil transport aircraft.

4. Modified fuel activities includes effort directed toward developing modified turbine fuels designed to avoid a conflagration on impact and providing a modified fuel specification.

5. General aviation crash safety involves (1) the development and evaluation of methods for improving general aviation crashworthiness with emphasis on test methods for inclusion in regulations and (2) the design and testing of a crash-resistant fuel system.

6. Cabin crash safety activities are described in the following section.

PAA review results:
Minimize airframe crash fire hazards and aircraft systems fire safety
(PAAs 18-443 and 18-471)

NAFEC is concerned with the need to reduce fuel system and cabin fire hazards during flight and crash conditions. Due to priorities and funding levels, we reviewed the center's continuing work in the area of cabin crash safety.

NAFEC has planned and is conducting a series of laboratory and aircraft cabin fire tests to determine (1) the smoke and toxic gas hazards resulting from the burning of cabin materials, (2) the ability of cabin compartmentation concepts to provide protection against fire, smoke, toxic gases, and high temperatures, and (3) the degree of safety provided to the passengers by fire suppression systems.

Preliminary studies have determined methods of measuring toxic gases from burning materials and established initial hazard rankings for the materials. The dispersion effectiveness of a fire suppression system has been demonstrated, and fire suppression tests are planned. NAFEC also demonstrated the feasibility of using a cannister, along with existing oxygen face masks, to chemically filter certain toxic gases. The center plans to prepare reports on these efforts.

Work on toxic gases produced by burning materials and the effects of these gases on experimental animals is divided between NAFEC and the FAA's Civil Aeromedical Institute. Neither organization had the facilities or expertise to individually undertake the total work effort. The National Bureau of Standards is investigating the flashfire propensity of cabin material for NAFEC.

Work on a fire-protective magnetic tape to assure survivability of crew voice recordings was dropped by NAFEC because it was felt the objective was beyond the state of the art.

Personnel and funding resources applied by NAFEC during fiscal year 1975 and anticipated in 1976 are:

	NAFEC staff-years	NAFEC funding		
		In-house	Contract	Total
		(000 omitted)		
1975 (note a)	11	$263	$108	$ 371
1976 (note b)	23	598	220	818
Total	34	$861	$328	$1,189

a/ PAA 18-443.

b/ PAA 18-471.

20-ENVIRONMENTAL PROTECTION PROGRAM

NAFEC's role in this program has been directed into two basic areas: (1) aircraft propulsion system air pollution and (2) evaluation and control of sonic boom. A brief description of these areas and NAFEC's participation is presented below.

1. To comply with the standards of the Environmental Protection Agency, aircraft propulsion systems are being evaluated to determine (a) the cause of variability in exhaust emission requirements and the effects of engine operating time on the emission levels of typical reciprocating engines and (b) the limits of emission level reduction which can safely be achieved by engine operation and design changes.

2. Activities to evaluate and control the sonic boom consist of operating an airborne meteorological sensing and recording system and processing magnetic tapes of sonic boom data recorded on the ground.

21--SUPPORT PROGRAM

NAFEC's role in this program has been related to the FAA effort to minimize or eliminate wake turbulance as an impediment to air traffic.

MAJOR FAA PROGRAMS INVOLVING TSC

03--AIR TRAFFIC CONTROL RADAR BEACON SYSTEM (ATCRBS) PROGRAM

FAA sponsored this project to improve the performance and capacity of ATCRBS. The project director said that system improvements were needed because the original ATCRBS antennas (1940 vintage) produced false targets on aircraft controller equipment and might misdirect aircraft. The incidence of false targets varies, depending on the buildings and terrain at the equipment locations. The Transportation Systems Center R&D approach was to design and test new antennas to alleviate the problem.

As of October 1975, TSC had designed three new antennas. An open array interrogator antenna has been tested at NAFEC and at airport sites in Albuquerque, New Mexico, and Las Vegas, Nevada. It is now being tested at Oakland, California. A phased-array antenna and a reflector-type antenna have been developed by TSC and are scheduled for testing at NAFEC in fiscal year 1976. Other R&D tasks for this project include (1) testing the antenna energy output and (2) developing an antenna that handles both radar and antenna frequencies.

For 1976, TSC plans to (1) complete field testing of interrogator antennas, (2) test and evaluate monopulse techniques, and (3) develop equipment specifications. This project received over $5.7 million and required 47.8 staff years for fiscal years 1971 through 1975. The project director said that over 56 percent of the R&D funds was for out-of-house work. Estimated 1976 project funding is $600,000.

04--NAVIGATION PROGRAM

Short take-off and landing (STOL) navigation and guidance study

FAA concern over how STOL aircraft affect terminal area operations led to this project. The project's objective was to define STOL aircraft performance characteristics, which would affect terminal area operations, by

--gathering data on STOL aircraft performance to provide mathematical and simulation models,

--investigating STOL terminal area navigation and surveillance, and

--evaluating pilot performance.

This project, which was completed in fiscal year 1974, received over $1.8 million and required 23 staff years for fiscal years 1971 through 1974.

05--AIRBORNE SEPARATION ASSURANCE PROGRAM

Airborne proximity warning indicator (APWI)

In 1971, NASA transferred its optical proximity warning indicator development program to TSC. FAA then funded the program in 1972 and broadened it to include a determination of whether an APWI could be used for general aviation. FAA's objective is to have TSC develop data and define system concepts and specifications for an APWI. At June 30, 1974, TSC had (1) developed a visual detection simulation facility and preliminary system specifications, (2) initiated procurement of experimental hardware, and (3) established collision avoidance system performance requirements.

This project received over $2.7 million of FAA funding and required 28.6 staff years for fiscal years 1971 through 1975.

06--COMMUNICATIONS PROGRAM

Air-to-ground data link development

FAA's engineering and development program is concerned with improving air-to-ground communications and thus sponsored an R&D project on Air-Ground Data Link Development to

--evaluate a mobile frequency communications bank for air-to-ground digital data transmission,

--develop and evaluate a data link cockpit display,

--evaluate interfaces needed between controllers and automated data link equipment, and

--develop an experimental data link system for evaluation of systems communications.

TSC has tested and evaluated transmitting and receiving equipment and cockpit displays to be used in the data link system. In 1976, TSC plans to (1) complete data on experimental operation of the system, (2) coordinate the system with experimental ATC facilities at NAFEC and weather service facilities, and (3) operate the system with multiple air-to-ground communications sites. The project manager advised us that FAA will develop computer programs for the data link system after TSC completes its tests and experiments.

This project received over $3.3 million and required 48.8 staff years for fiscal years 1971 through 1975. Estimated funding for 1976 is $90,000.

07--APPROACH AND LANDING SYSTEMS PROGRAM

Instrument landing system (ILS) performance prediction

FAA requested TSC to develop a method of predicting ILS performance when new airport buildings are constructed, facilities are upgraded, different ILS antennas are used, and terrain conditions are less than ideal. The primary objective is to develop a computer model to predict ILS performance and to test alternative equipment locations.

This project received over $1.9 million and required about 25.3 staff years from 1971 through 1975. Estimated funding for 1976 is $170,000. Project completion is scheduled in 1976.

08--AIRPORT/AIRSIDE PROGRAM

Aircraft wake vortex avoidance

One of FAA's broad objectives is to increase capacity at major airports without degradation of safety. An impediment to safe and efficient air traffic flow is the potential hazard due to trailing wake vortices in the terminal area. The separation between arriving aircraft was increased, at the cost of capacity, when wide-bodied aircraft were introduced.

FAA sponsored a wake vortex avoidance R&D project. Its objective is the design and development of a wake vortex avoidance system for high-density aircraft terminals to allow for decreased separations between arriving and departing aircraft and increased capacity while maintaining a high level of safety. At June 12, 1975, the following project tasks were complete.

--Study of current aircraft separations.

--Design and preliminary development of vortex detection and tracking sensors.

--Establish and evaluate vortex detection and tracking sensors at Kennedy Airport, New York.

--Formulate a vortex prediction model.

--Design a meteorological-based vortex advisory system.

Short-term project results are expected to provide for increased capacity and safety at high-density airport terminals. In the long run, efficient use of this system will allow a greater terminal operation capacity at decreased costs.

This project received FAA funding of over $6.4 million and required 53.2 staff years from 1971 through 1975. The estimated 1976 funding is $1.8 million.

In 1976, TSC plans to (1) verify the vortex predictive model, (2) design the avoidance system, (3) evaluate the advisory system, and (4) select a vortex detection and tracking sensor.

The project manager said that the basic systems design work is done in-house but that TSC usually contracts for hardware items when needed.

Airport surface traffic control

FAA sponsored this project in 1972 because the existing control system at airports was experiencing problems with large workloads for airport controllers, delays during peak hours, and poor visibility. Its objectives are (1) to develop and demonstrate traffic control subsystems which would meet individual airport requirements for surface surveillance, control, communications, and guidance for surface traffic and (2) to prepare system design documentation on the various subsystems for use by airport authorities in selecting systems that meet their individual requirements.

At June 17, 1975, TSC had completed several project tasks. Airport surface detection equipment had been modified at 13 airports to decrease maintenance cost and increase reliaoility. A surface detection radar display system has been developed and tested at Kennedy Airport, New York. In 1976, TSC plans to

--design and develop a specification for an advanced tower-automated ground surveillance system,

--field test an automated intersection control system at NAFEC,

--field test ATC radar beacon system sensors for ground location purposes,

--develop a new surface surveillance radar, and

--fabricate controller display systems.

In 1977, development will begin on an engineering model of an advanced surveillance system which will provide a synthetic alphanumeric display for tower controllers. TSC also plans to fabricate and field test a new surface surveillance radar.

This project received over $6.4 million and required 74.2 staff years for 1971 through 1975. Estimated funding for 1976 is $2.5 million.

16--TECHNOLOGY PROGRAM

Future data processing

To upgrade and improve the capacity of the ATC system, FAA sponsored an R&D project in 1971 on data processing. The objective was to explore advanced computer hardware and software designs to meet future ATC requirements. TSC's work consisted mainly of investigations and analyses of large-scale computer systems and resulted in an evaluation of a discrete address beacon system processor and a multiprocessor system using parallel and serial processors.

An FAA project manager said that a principal purpose of the project was to determine if the use of parallel data processing in ATC programing was technically feasible and economically practicable. The project was completed in 1975 and showed that parallel processing was feasible and efficient but not economical. In October 1975, FAA was reviewing the project results.

The project received over $2.1 million in FAA funding and required 32 staff years during 1971-75.

17--SATELLITE PROGRAM

Aeronautical satellite system

This project supports FAA in system design, avionics development, and evaluation of an aeronautical satellite (AEROSAT) system for advanced oceanic ATC. The project evolved from TSC's previous work in satellite communication, navigation, and surveillance concepts. By June 27, 1975, TSC had (1) completed L Band flight experiments, (2) initiated procurement of an L Band Test Avionics System, and (3) completed an AEROSAT laboratory test facility.

In 1976, TSC plans to continue test and development of the L Band Test Avionics System and to provide support to FAA on the AEROSAT ground segment.

This project received over $5.7 million and required about 56.4 staff years for 1971-75. The estimated 1976 funding is about $2.4 million. A TSC project summary, dated June 27, 1975, estimates total project funding at about $19.3 million and anticipates completion beyond 1979.

TRANSPORTATION-SPONSORED PROJECT 1/

Advanced air traffic management system (AATMS)

Transportation sponsored this R&D because of its concern that the ATC system being developed for use in the 1980s might not be able to accommodate demands of the 1990s and beyond. The major purpose of the AATMS was to (1) define future ATC systems requirements, processes, and procedures of air traffic management and (2) conduct comparative evaluations to determine a system which will handle future requirements at minimal cost. The project was undertaken to provide Transportation with a long-range plan for an air management system designed to accommodate air traffic growth projected for the 1990s.

A TSC final report estimated that between 1972 and 1995 the growth in air transportation will result in

--an eight-fold increase in the number of revenue passenger miles,

--a doubling of the air carrier fleet,

--a 150-percent increase in the size of the general aviation fleet,

--a tripling of the number of general aviation operations,

--a 50-percent increase in the number of civil airports, and

--a 150-percent increase in the number of aircraft airborne at peak time.

1/Included in our review because it was the highest dollar cost aviation R&D project at TSC through FY 1975.

APPENDIX IV

The principal features of the air management system are (1) use of satellites for surveillance, navigation, and communications, (2) tactical and strategic control 1/ of aircraft, and (3) increased automation of the system. This R&D project has been completed and it was concluded that the use of satellites would result in centralization and induce savings in system operation costs. An official said that the results of this project would be used by both Transportation and FAA in their long-range R&D planning.

The AATMS project received over $9.4 million and required 80.9 staff-years of effort at TSC during 1971-75. Project officials estimated that about 50 percent of the R&D work was done out of house because of expertise needed, cost, and time for completion.

1/Under tactical control, the flight path is modified through a series of ATC instructions while with strategic control, the aircraft flight path is essentially predetermined.

MAJOR FAA PROGRAMS INVOLVING CAMI

19--AVIATION MEDICINE PROGRAM

Physiology laboratory

1. Survey of intermediate vision problems of senior pilots

This project was initiated at the request of the Federal Air Surgeon to determine how much of a problem intermediate vision is among older pilots in reading instrument panels and the most acceptable and safe means of correcting the problem. The users of the information from the study will be the Office of Aviation Medicine in determining the need for regulatory action.

Start date	Completion date	FY 76 estimates	
		Staff-years	Cost
7/73	6/76	1.6	$33,000

2. Protection of flight attendants from hypoxia following decompression

The project was initiated by the research branch chief as a followup to research done as a result of the 1973 DC-10 airliner decompression over New Mexico. The purpose is to determine how soon supplemental oxygen has to be obtained by working flight attendants in the event of rapid, severe decompression.

The airlines will be the primary users of the information developed, which is anticipated to show that supplemental oxygen for flight attendants will have to be obtained immediately from the passenger-type drop masks rather than a portable oxygen system.

Start date	Completion date	FY 76 estimates	
		Staff-years	Cost
7/75	1/76	2.2	$51,500

3. Development of the aviation stress protocol--simulation and performance physiological and biochemical monitoring system

The project was initiated by the Aviation Physiology Laboratory. The project is to establish a uniform test bed for testing pilots and air traffic controllers in the area of stress workload measuring response. Information obtained may be used in developing a test for identifying accident-prone

people. The users of the information will be Flight Standards Service of FAA, Office of Aviation Medicine (OAM), and pilots in evaluating their flying ability.

Start date	Completion date	FY 76 estimates Staff-years	Cost
7/75	9/76	2.2	$111,200

4. Stress in air traffic controllers

The project was initiated by the Air Traffic Service to test the effect of boredom on low flight density ATC personnel and to determine whether this boredom has an effect on the controllers' ability to handle various situations. The project deals with the biomedical determination of workload and stress in ATC personnel which is considered of high priority. The users of the information developed will be the Air Traffic Service.

Start date	Completion date	FY 76 estimates Staff-years	Cost
1/76	1/77	1.3	$28,300

Toxicology laboratory

1. Toxicological examinations in accident investigations

This project was initiated at the request of the National Transportation Safety Board (NTSB). The project is to collect statistical data on the number of incidents involving the use of toxicological drugs in accidents. The data collected will be provided to NTSB for use in determining probable accident causes.

Start date	Completion date	FY 76 estimates Staff-years	Cost
1/67	Continuing	4	$106,500

2. Pathology in aircraft accident investigations

This project was initiated at CAMI to improve the collection of more accurate autopsy information from victims of fatal aircraft accidents. The ultimate aim for this data is to educate pilots and aviation medical examiners (AME) of conditions which could be dangerous in the operation of an aircraft or the need for improved safety practices and equipment. The ultimate users will be pilots and AME's and, to a lesser degree, the NTSB and aircraft designers and builders.

Start date	Completion date	FY 76 estimates Staff-years	Cost
7/73	Continuing	2.7	$87,000

3. Development of analytical methodology for hydrogen cyanide and determination of tissue concentration

The laboratory chief said this was the highest priority project in toxicology and was initiated at the request of the Federal Air Surgeon and the Systems Research and Development Service.

The purpose of the project is to test and analyze fire hazard aspects on various types of aircraft material including interior paneling and seat covers. As a result of these tests, the toxic substances could be curtailed in production of future aircraft.

The intended users of information will be the Flight Standards Service for developing rules concerning materials acceptable for aircraft use.

Start date	Completion date	FY 76 estimates Staff-years	Cost
7/74	6/76	4.8	$98,400

4. Effects of problem drugs on neural mechanisms in animals and man

This project was initiated at CAMI in response to OAM's policy statement emphasizing medical certification and medical standards development.

The purpose of the project is to look at the medical certification process for pilots with interest on the possible effects and duration of effects that certain drugs have on a pilot's ability to operate an aircraft safely.

The Medical Certification Branch of CAMI, as users of the information developed, might consider the effects of drugs on pilots in their medical certification and education programs. The OAM would also be a potential user.

Start date	Completion date	FY 76 estimates Staff-years	Cost
7/75	6/77	2.7	$68,400

5. Radiobiological safety requirements in the national aerospace program

This project was initiated at the request of OAM for calibrating and determining testing of cosmic radiation measuring instruments for the possible radiation hazards of high-altitude flying by the supersonic transport.

Its purpose has shifted to determining the possible hazards of transporting radioactive materials on passenger aircraft.

The intended users will be the regulatory segment of FAA.

Start date	Completion date	FY 76 estimates Staff-years	Cost
7/75	Continuing	1	$23,100

Psychology laboratory

1. Stimulus parameters of visual approach

This project was initiated by the Systems Research and Development Service and the general aviation community to accumulate information on the use of the Visual Approach Slope Indicator (VASI), a special device to aid the pilot in determining the right approach slope. Pilot organizations had made inquiries regarding vagueness in FAA rules on pilot decisions based on visual approach systems.

The purpose of the project is to evaluate the adequacy of equipment from the pilot's point of view and the possible effect on his flying performance in aircraft approach and landings. The responsible investigator said the study was important for determining under various weather conditions the minimal necessary cues for safe approach and landing and the effectiveness of various visual approach slope indicator systems.

Start date	Completion date	FY 76 estimates Staff-years	Cost
1/73	9/76	2.4	$89,600

2. Comprehensive assessment of air traffic controller selection factors

This project is an ongoing study for the Civil Service Commission and FAA, which are contemplating changes to the air

traffic controller selection process. It was initiated by the Office of Personnel Training.

The purpose of the project is to evaluate the validity of techniques used for selecting and training of controllers. The potential exists for saving FAA money by phasing out people, early in the training program, who aren't suited to be controllers. Also, the project will assess the fairness of certain hiring factors, such as giving point preference to individuals with flying experience when it has been proven that such experience does not have an important bearing on becoming a successful controller.

The users of information developed include the FAA's Air Traffic Control, Civil Service Commission, and general aviation.

Start date	Completion date	FY 76 estimates	
		Staff-years	Cost
8/75	Continuing	2.4	$56,400

3. Effects of congener vs. noncongener alcoholic beverages on performance in stationary and moving environments

This project is a followup of previous research. It was initiated at CAMI in response to a suggestion by OAM personnel that the psychology laboratory determine whether the type of alcoholic beverage will affect the test of impairments in a motion situation vs. stationary condition and to support the research priority for medical standards development as set out by the Federal Air Surgeon.

The purpose of the project is to evaluate the adequacy of the Federal Aviation Regulation (FAR) 91.11; i.e., the "eight-hour rule" that civil air crewmen cannot drink alcoholic beverages within 8 hours of the time they are to be crewmembers in a civil aircraft.

Start date	Completion date	FY 76 estimates	
		Staff-years	Cost
7/75	11/76	2.4	$63,300

4. Development of performance measures for the aviation stress protocol simulation

This project was initiated by CAMI to test the performance and behavior response to various drugs to determine if pilots should be restricted from flying if they take certain

drugs. The psychology laboratory chief said this project was a joint effort with the physiology laboratory which was studying the biomedical aspects, including urine analysis, blood samples, and heart rates.

The users of information developed will be OAM, aeromedical education programs, the general flying population, and air traffic controllers.

Start date	Completion date	FY 76 estimates Staff-years	Cost
7/75	9/76	1.3	$50,500

Protection and Survival Laboratory

1. Testing and evaluation of oxygen masks and systems for high-altitude decompression and respiratory protection in toxic smoke and fire

This project was originally initiated by CAMI and continued at the request of the Flight Standards Service. The purpose of the project is to develop criteria and standards for oxygen masks and systems and to eliminate deficiencies in present systems. The direct users will be the Flight Standards Service, the Department of Defense, U.S. air carriers, FAA's Flight Standard Service for updating FARs, and the NTSB. The indirect users are private airlines, air frame manufacturers and air travelers.

Start date	Completion date	FY 76 estimates Staff-years	Cost
1966	Continuing	3	$101,700

2. Investigation of materials and techniques to reduce aviation crash injury

This project was initiated in-house. Primary users of the information developed will be the Flight Standards Service to update FARs. Other users are the aviation industry, the Department of the Army, the National Aeronautics and Space Administration, and the National Highway Transportation Safety Administration.

Start date	Completion date	FY 76 estimates Staff-years	Cost
7/71	Continuing	2	$62,500

3. Emergency evacuation of disabled travelers

This project was originally initiated in-house and continued at the request of the Flight Standards Service.

The purpose of the project is to develop guidelines for aircrews in handling handicapped passengers in emergency situations and to develop and evaluate related equipment.

The immediate users of data developed will be airframe and equipment manufacturers, and the Flight Standards Service for updating FARs. An advisory circular on this matter has been issued to airlines.

Start date	Completion date	FY 76 estimates	
		Staff-years	Cost
7/73	6/76	1	$31,000

4. Biomedical factors in evacuation systems

This project was initiated at the request of the FAA's Aeronautical Center Flight Standards Technical Division and the Flight Standards Service.

The purpose of the project is to improve aircraft escape procedures and related equipment. Users of the information developed will be the Flight Standards Service for updating FARs, the NTSB, DOD, airlines, and aircraft manufacturers.

Start date	Completion date	FY 76 estimates	
		Staff-years	Cost
7/75	6/77	1.5	$43,550