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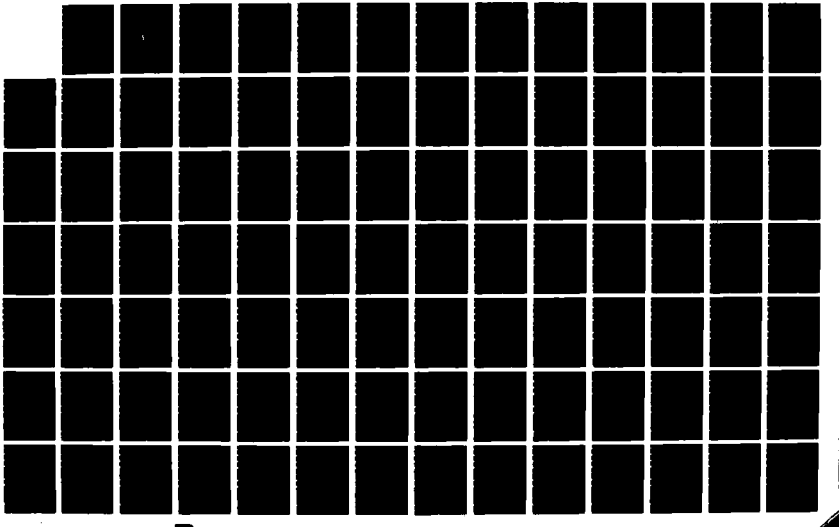

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Airport and Airway Costs Allocated to the Public Sector 1985-1997

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16 Abstract

This document was prepared under the supervision of the Office of Aviation Policy and Plans of the Federal Aviation Administration (FAA). It provides technical documentation for the FAA's report, "Airport and Airway Costs: Allocation and Recovery in the 1980s," (FAA-APO-87-7).

This volume describes how the FAA meets its legislated responsibilities through performing functions which benefit both the aviation community and public-at-large. It defines and estimates the costs incurred in performing public interest services and providing services to public aviation users. The volume also reports 1985, historical, and projected cost allocation estimates for the public sector.

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Section 1.0

INTRODUCTION

1.1 Purpose

In the course of meeting its legislated responsibilities, the FAA performs a certain number of tasks which benefit not only the aviation community, but also the public-at-large. The costs incurred in performing such tasks should not be allocated to any particular private sector aviation user group, but rather should be assigned to the public sector. The analysis of these costs in the FY1985 FAA budget, as well as in projected budgets through FY1997, is the subject of this volume.

1.2 Overview of Public Sector Analysis

In order to distinguish elements of the FAA budget which should be allocated to private sector aviation users from those which should be allocated to the public sector, it is necessary to be clear as to the nature of the activities which the FAA performs. A useful theoretical way of describing these activities is to consider the major "output" of the FAA to be organized, safe airspace for civilian aviation. Most FAA activities contribute directly or indirectly to providing this service.

Organized, safe airspace is a good which must be provided by a single entity or "firm." The reason is that it requires a

level of coordination that cannot be reached if there are competing entities; for example, two or more towers at a single airport would be confusing and unsafe. Thus, a single entity is best suited to provide organized airspace. It may be a government agency or a regulated private producer; in the United States, it is the FAA.

If the FAA were a firm producing organized airspace, its "customers" would be aviators and those whom they carry in their aircraft. Such users would pay, either directly or indirectly, the costs of providing an organized civilian air system. However, if in performing its primary task, the firm also provided services which benefit non-civilian aviation, and non-aviators, as the FAA does, its customers would not pay the costs of these services. Therefore, these costs should be assigned to the general public.

There are three arguments which can be employed to allocate portions of the FAA budget to the public sector. These arguments are:

- Some services provided by the FAA are used by government agencies which provide public goods.
- Certain FAA programs redress externalities associated with the production and consumption of aviation services.
- Some parts of the FAA system primarily benefit non-aviators.

Each of these arguments is discussed briefly below.

In order to be considered a "pure public good," a commodity or service must meet two criteria:[1]

1) If at least one person can consume some of the good, it must not be possible to exclude others from consuming it.

2) The consumption of a unit of the good by one person must not prevent others from consuming the exact same unit.

The classic example of a pure public good is national defense. If the military protects a nation's boundaries and thereby at least one individual, then it is not possible to exclude others living within those boundaries from the same protection. Furthermore, one individual's protection does not preclude others from being equally protected.

An example of a pure private good is aviation fuel. Even though at least one aviator can consume fuel, it is certainly possible to exclude some individuals from consuming this commodity. In addition, the consumption of a particular gallon of fuel by one aviator obviously precludes the consumption of that same gallon by another.

It is difficult to imagine organized, safe airspace as a pure private good. However, it is not a pure public good. It fails the first criterion because the technology exists to prevent unauthorized flights. Organized, safe airspace fails the second criterion as well because, for a given level of technology, it is an exhaustible service during times of congestion.

Even though the FAA does not directly produce a public good, some of its services are indirectly linked to public good

production because government agencies which do provide public goods use the airport and airway system. The most significant example of such an agency is the Department of Defense.

The production and consumption of aviation services also generate certain external costs that are borne by non-aviators; air pollution is an example. Some FAA programs are designed to redress these externalities. The existence of negative externalities, however, does not necessarily mean that the costs of related FAA programs should be allocated to the public sector rather than to users of the system. Rather, the issue of who should pay for these programs can be viewed as a question of property rights. If aviators are considered to have the "right" to create externalities, the costs of redressing them should be allocated to the public sector. However, if those members of society affected by negative externalities have the "right" to clean air, quiet, etc., aviators should bear the costs of related FAA programs.

Finally, some facilities and services provided by the FAA benefit members of society other than aviators. For example, some weather observations made by FAA personnel are used to make forecasts for non-aviators; in those cases where observations would have to be replaced in the absence of the FAA, the costs which the FAA incurs in providing benefits to non-aviators should be allocated to the public sector.

The 1978 study of FAA costs[2] identified five categories of expenditures that should be allocated to the public sector. These categories were:

1) the provision of ATCTs at low-activity airports,

2) the use of FAA services by the military,

3) the use by non-aviators of weather data collected by the FAA,

4) the benefits received by the public from the FAA's safety, medical and environmental regulatory programs,

5) the costs of operating Washington National and Dulles International Airports.

In this study, costs in the first three categories are shown unambiguously to belong in the public sector (although their definition and measurement differ from the 1978 report). Regulatory costs (category four), however, present a more difficult problem. There exist arguments for allocating these costs either to users or to the public sector. Consequently, alternative numerical estimates of public sector costs have been developed.

The costs of operating the Washington, DC metropolitan airports (category five) are included in the FAA budget as an accounting convention. As will be shown below, these airports actually operate at a profit, so that the cost of operating them is excluded from the FAA cost base in the FY1985 budget, as well as all projected budgets. A sixth category of FAA expenditures contains costs associated with civilian, government use of the airport and airway system. Such costs are allocated to the public interest.

Table 1.1 compares costs allocated to the public sector in the 1978 study with the FY1985 allocations in the present study.[3] The cost attributed to the operation of the metropolitan

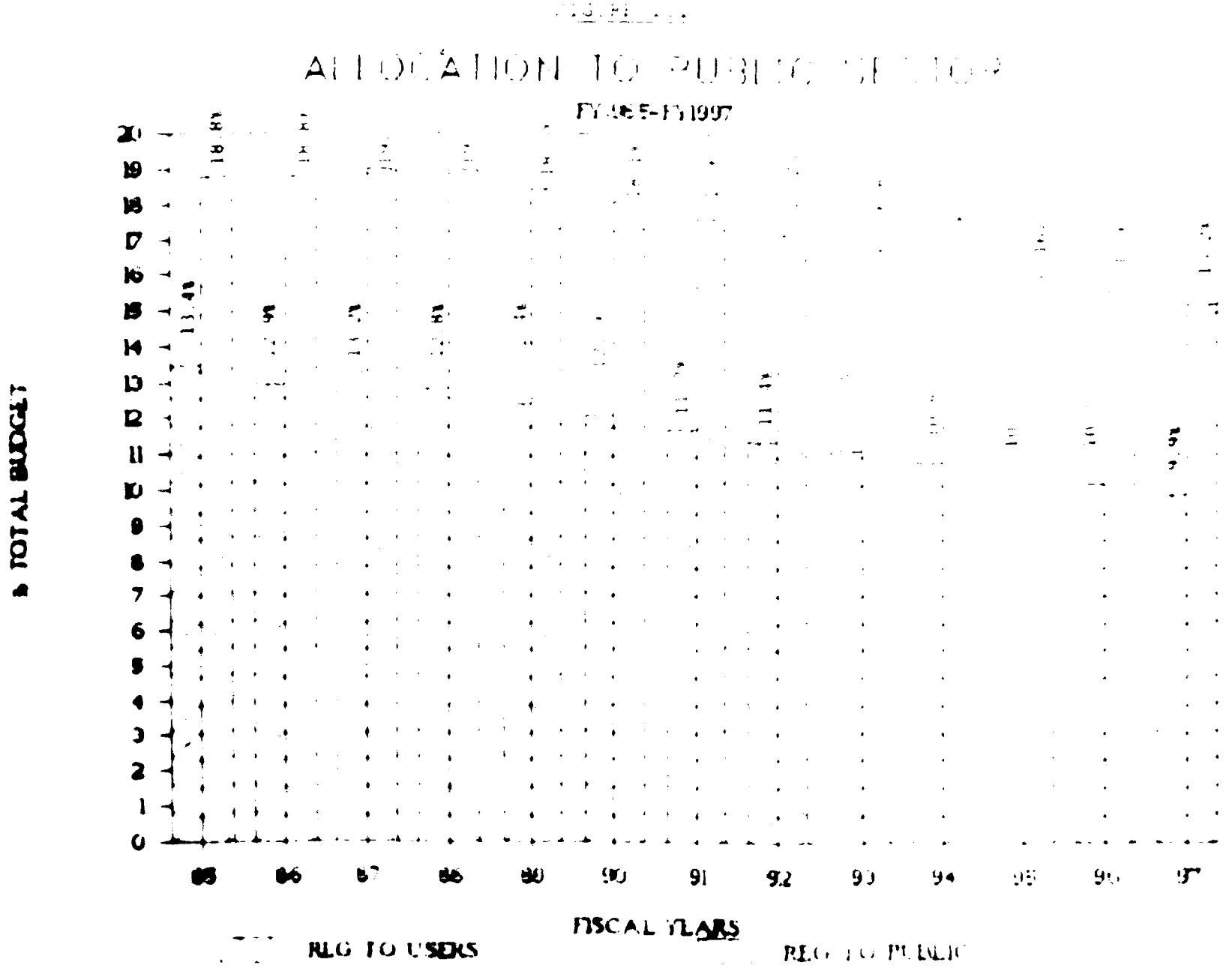
Washington DC airports has been subtracted from the 1978 number in order to make it comparable to the FY1985 numbers. The two figures for FY1985 public sector costs correspond to the alternative arguments which can be made regarding the proper allocation of regulatory costs.

Table 1.1

COMPARISON OF COSTS ALLOCATED TO PUBLIC SECTOR IN 1978 STUDY AND IN PRESENT STUDY

		Present Study	
	1978 Study (DC Airport costs omitted	Reg. Costs Allocated to Users	Reg. Costs Allocated to Public
Current Year Dollars	$ 398,800,000	$ 703,591,771	$ 983,162,801
% of Total FAA Budget	14.5%	13.4%	18.8%

Figure 1.1 depicts the percentage of each FAA budget from FY1985-FY1997 which is allocated to the public sector. Under the assumption that regulatory costs should be assigned to users, this number falls from 13.4 percent in FY1985 to 9.9 percent in FY1982, while under the alternative assumption that regulatory costs should be allocated to the public, the number rises slightly from its value of 18.8 percent in FY1985 and then falls to 15.2 percent by FY1997. The percentage falls under both assumptions because FAA projections of military aviation activity remain constant from the present through FY1987, while the activity of other groups is projected to rise.


ALLOCATION TO PUBLIC
FY 85-FY 1997
% TOTAL BUDGET
0
1
2
3
4
5
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8
9
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11
12
13
14
15
16
17
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85
86
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90
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92
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94
95
96
97
FISCAL YEARS
REG TO USERS
REG TO PUBLIC

1.4 Organization of the Remainder of This Volume

Sections 2.0 - 7.0 of this volume detail the analysis of the direct costs in the FY1985 FAA budget associated with each of the [illegible] categories listed above. The flowchart in Figure 1.2 may be [illegible] reference as the analyses are described. Tables 1.2 and [illegible] provide a summary of the numerical results of the analysis of [illegible] budget, including the attribution of indirect (or [illegible] costs. In Table 1.2 it is assumed that the costs of [illegible] safety, security, and environmental regulatory programs are [illegible] to users, while in Table 1.3 the assumption is that [illegible] are allocated to the public. The most obvious [illegible] between the two allocations is in the fourth row of [illegible]. There are also minor differences between the tables [illegible] direct costs allocated to military use, and to non-[illegible] government use of FAA services. The direct military [illegible] higher in Table 1.2 than in Table 1.3 because of [illegible] and safety regulation costs allocated to the military [illegible]. For a similar reason, the direct cost of non-[illegible] government use is higher in Table 1.2.

[illegible] costs are higher for all categories under the [illegible] that regulatory costs are allocated to users, because [illegible] indirect costs to be distributed is higher under that [illegible]. The method used to calculate indirect costs is [illegible] in Section [illegible] of Volume I of this report.

[illegible] 8.0 describes the methodology for allocating costs [illegible] the public sector in projected FAA budgets for fiscal years [illegible]. Section 9.0 contains the numerical allocations to the

public sector for the years 1985 through 1997. Two scenarios are shown for each year: one where regulatory costs are borne by users, and one where they are allocated to the public sector.

There are also four appendices to this volume. Appendix A provides more detail in the benefit cost ratios of low activity towers discussed in Section 2.0. Appendix B is a table of calculations used to determine which FAA weather observation stations are properly assigned to the public sector, as discussed in Section 4.0. Appendix C provides a more detailed discussion of catastrophe avoidance which relates to the allocation of regulatory costs in Section 5.0. Finally, Appendix D details the costs of operating low activity towers discussed in Section 2.0.

1.4 References to Other Volumes

The estimates derived in this volume provide the numbers for the "public interest" category of the full-cost allocations in Volumes 1 and 2. The analysis reported in this volume supports these estimates.

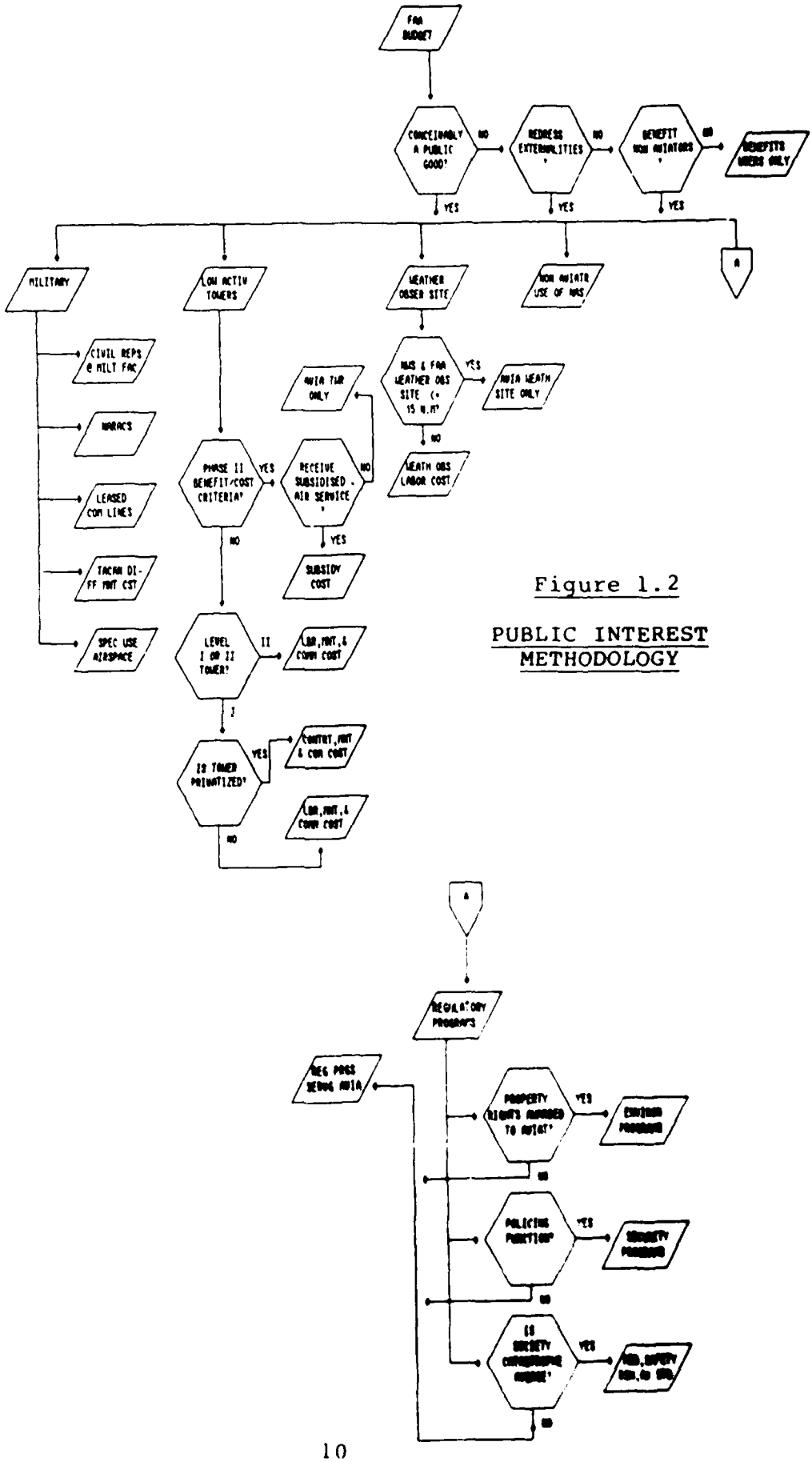


Figure 1.2

PUBLIC INTEREST METHODOLOGY

Volume 3

Table 1.2

COSTS INCURRED BY THE PUBLIC SECTOR
IF REGULATORY COSTS ARE ALLOCATED TO USERS
1985 FISCAL YEAR

	Direct Costs	Indirect Costs	Total Costs
ATCTs at Low Activity Airports	$7,856,422	$1,744,545	$9,600,967
Military Use of FAA	$522,012,328	$125,822,386	$647,834,714
FAA Weather Data Used by Non-Aviators	$11,215,788	$4,400,550	$15,616,338
Regulatory Activities—Safety, Medicine and Environment	$0	$0	$0
Non-Military, Government Use of FAA	$25,070,464	$5,653,441	$30,723,905
TOTAL	$566,155,002	$137,620,922	$703,775,924

* Numbers may not add due to rounding.

Volume 3

Table 1.3

COSTS INCURRED BY THE PUBLIC SECTOR
IF REGULATORY COSTS ARE ALLOCATED TO PUBLIC
1985 FISCAL YEAR

	Direct Costs	Indirect Costs	Total Costs
AICTs at Low Activity Airports	$7,856,422	$1,318,097	$9,174,519
Military Use of FAA	$511,083,522	$97,159,495	$608,243,017
FAA Weather Data Used by Non-Aviators	$11,215,788	$3,324,851	$14,540,639
Regulatory Activities—Safety, Medicine and Environment	$280,467,939	$42,555,736	$323,023,675
Non Military, Government Use of FAA	$23,947,132	$4,226,130	$28,173,263
TOTAL	$834,570,803	$148,584,310	$983,155,113

* Numbers may not add due to rounding.

Section 2.0

PROVISION OF ATCTs AT LOW-ACTIVITY AIRPORTS

The FAA employs a comprehensive mechanism to measure the costs and benefits of both existing and proposed ATCTs which is outlined in FAA Report Number APO-83-2.[4] If the ratio of benefits to costs exceeds one, the existence of a tower is justified by cost and safety considerations, while if it is less than one, the tower is not justified , having failed to meet the "discontinuance criteria."

However, there exist a number of towers which fail the cost-benefit test. Since these towers are not necessary for the safe operation of the airport and airway system, by the FAA's standards, but remain open by congressional direction,[5] the inference drawn in this study is that the full cost of operating them should be allocated to the public sector. At least theoretically, the towers would be closed were it not for some public interest in their existence as determined by Congress.[6]

A working paper for the 1978 study treated this point differently.[7] It was argued that in cases where an existing tower fails discontinuance criteria, the fraction by which its cost-benefit ratio falls short of one should determine the percentage of the tower's cost allocated to the public sector. For example, "if a group of small community airports falls, on the average, 30 percent short of meeting present tower establishment criteria, that fraction of traffic control costs

will be borne by the public and the remainder by users."[8] The 30 percent in this example was termed the "percentage deficiency" for that group of towers. One difficulty with this view is that only a few aviators would benefit from the tower, while all aviators as a group would be allocated the cost. Unlike the case of towers which meet the benefit-cost test and, therefore, are needed for safety reasons, users in general would probably be unwilling to pay for a facility that is not needed.

The multi-level nature of the decisionmaking process for the establishment or discontinuance of a tower may provide some justification for the "percentage deficiency" approach to allocating low-activity ATCT costs. For example, since the full process may take several years to complete, a tower with a cost-benefit ratio close to one may have its ratio fluctuate above and below this number during the process. In addition, although Congress has prohibited the closing of towers, it is not clear that each existing tower has been evaluated by Congress with regard to its public benefits.

Nevertheless, in the light of the avoidable-cost reasoning used throughout this study (see, for example, Vol. 2, Sec. 3.0, "The Minimum General Aviation Allocation"), it is clear that towers which fail discontinuance criteria pose costs that are in excess of quantifiable benefits. Since towers are not divisible, they must either be decommissioned or retained; Congress has decided that they should be retained.

The towers which fail discontinuance criteria, but which remain open, fall into three categories:

- o Level I towers with cost benefit ratios less than one which were operated by the FAA in FY1984,[9]
- o Level I towers with cost benefit ratios less than one at which labor for air traffic control was provided by private companies in FY1984, and
- o Level II towers with cost benefit ratios less than one.

In addition, two towers were identified which met discontinuance criteria due only to scheduled service provided under subsidy. Towers in all of these categories, and their operating costs, are listed in Appendix A. The total direct cost of low-activity ATCT allocated to the public sector for FY1985 was $7,856,422.

Section 3.0

MILITARY USE OF FAA SERVICES

Any expenditure by the FAA for equipment or operations which would be unnecessary in the absence of military aviation should be allocated to the public sector. Essentially, the military obtains from the FAA an input which it uses to provide the public good of national defense. Expenditures by the FAA to accommodate military users can serve as a proxy for the "shadow prices" which the FAA would charge the military in a theoretically perfect world.

The direct costs which must be assigned to the public sector because they are due to military use of FAA services are delineated in Table 3.1. The largest category is that of costs associated with the military as a user group. In allocating costs to the various groups which use organized airspace, the military was analyzed in fundamentally the same manner as other user groups. It should be noted, however, that the military reimburses the FAA directly for certain services, the cost of which were subtracted from the FAA budget before the allocations reported in this volume were made. A more detailed breakdown of this category is shown in Tables 3.2 and 3.3.

In the calculations depicted in Table 3.2, a suitable measure for the operations conducted at a given type of facility (e.g., "handles" at an ARTCC) was chosen, and the marginal cost

Table 3.1

DIRECT COSTS OF MILITARY USE
OF FAA SERVICES--FY1985

	Assuming Regulatory Costs Allocated To Users	Assuming Regulatory Costs Allocated To Public
Costs Allocated to the Military as a User Group	$504,940,421	$494,011,615
Civilian ATC Representative at Military Facilities	2,009,255	2,009,255
Additional Cost of Maintaining NAVAIDs Due to Military Requirements	1,925,677	1,925,677
NARACs Installation (Amortized)	11,407,200	11,407,200
Military Communications	1,729,775	1,729,775
TOTALS	$522,012,328	$511,083,522

Table 3.2

CALCULATION OF DIRECT COSTS OF MILITARY USE OF FAA OPERATING FACILITIES--FY1985

Facility	Measure of Operations	Number of Operations	MC per Operation	MC x OPS.= VC of Operations	Joint Fate Costs	Total Direct Costs
ARTCC	"Handles"	4,873,478	$ 21.30	$ 103,805,087	$ 20,017,040	$ 123,822,126
Tower	"Operations"	842,013	$ 4.45	$ 3,746,959	$ 12,820,224	$ 16,567,183
TRACON	"TSOs"	4,302,317	$ 12.80	$ 55,064,063	$ 28,004,076	$ 83,073,739
FSS	"Services"	3,546,941	$ 6.47	$ 22,940,676	$ 4,319,855	$ 27,260,532
TOTAL						$ 250,723,580

Table 3.3

DIRECT COSTS FOR MILITARY AS A USER GROUP NOT ATTRIBUTABLE TO USE OF FAA OPERATING FACILITIES

FY1985

Case 1: Regulatory Costs Allocated to Users

Facilities and Equipment (Excluding NARACS)	$	150,812,469
Research and Development	$	11,267,357
NAVAID Maintenance	$	76,094,048
AIP Grants	$	9,458,392
Safety Regulation	$	6,584,576
	$	254,216,842

Case 2: Regulatory Costs Allocated to Public

Facilities and Equipment (Excluding NARACS)	$	150,812,469
Research and Development	$	6,923,128
NAVAID Maintenance	$	76,094,048
AIP Grants	$	9,458,392
	$	243,288,037

of such an operation by a military aircraft was estimated econometrically. This marginal cost, multiplied by the number of operations conducted at all such facilities gave the total variable cost allocated to the military for that type of facility. Adding this number to the share of joint costs of the given type of facility allocated to the military yielded the total direct costs attributable to the military for that type of facility.

Table 3.3 gives a detailed breakdown of the allocation of direct military-related costs that were not attributable to the use of FAA operating facilities. These allocations differ depending on which assumption is made as to the appropriate assignment of regulatory costs. Therefore, allocations under each assumption are presented. Programs in the Facilities and Equipment, and Research and Development budgets were allocated to the military if they served primarily military purposes. NAVAID maintenance, Airport Improvement Grants and Safety Regulation are all joint system costs. Their allocation among users, including the military, was based on marginal costs, activity and relative demand elasticities.

The estimated marginal costs in Table 3.2 appear relatively larger for the military than for most other groups. There are two factors which may contribute to this result:

- The marginal costs for towers and TRACONs reflect establishment criteria and staffing standards. Each of these, in turn, reflect extra resources to meet military requirements, which would not be needed in a strictly civilian system.[10]

The existence of [illegible] Airspace [illegible] SUA for military purposes imposes additional costs on ANTC. These costs are [illegible] three [illegible] The [illegible] that air traffic [illegible] [illegible] air traffic [illegible] [illegible] familiarizing [illegible] made easier by the [illegible] representatives at military facilities mentioned below and disseminating information about SUAs to pilots. None of these activities would be required in the absence of the military.

The other four items shown in Table 4.1 are

1) the cost of stationing civilian representatives from the FAA Air Traffic Control System at various military facilities to enhance coordination between military and civilian use of airspace -- $2,009,255,[11]

2) the additional maintenance costs which the FAA must bear in order to provide TACAN rather than DME equipment as NAVAIDS in many locations -- $1,925,677,[12]

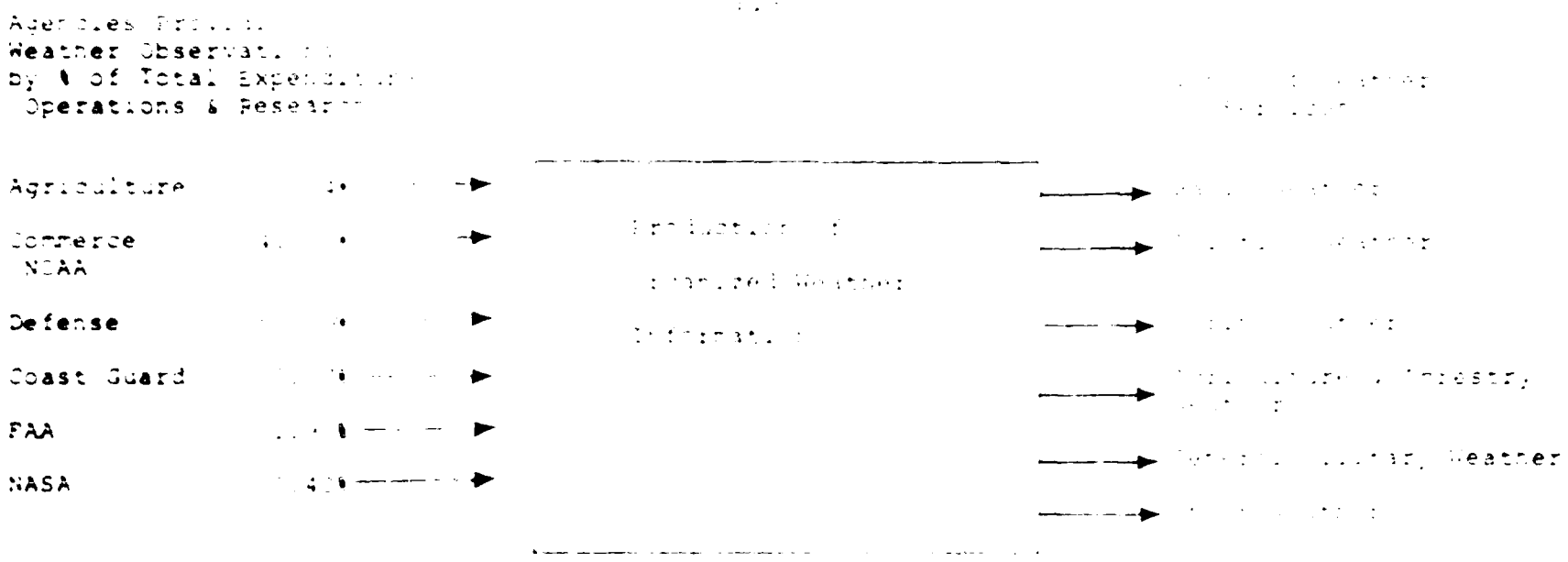
3) FY1985 expenditure on the establishment of the National Radio Communications System, which would facilitate military use of the airport and airway system in the event of either a military attack or catastrophic natural disaster--$11,407,200, and[13]

Section 4.0

USE BY NON AVIATORS OF WEATHER DATA COLLECTED BY THE FAA

The collection and analysis of weather information and the [illegible] weather forecasts is a complex process to which [illegible] government agencies contribute. This process is described [illegible] Federal Plan for Meteorological Services and Supporting [illegible] Fiscal Year 1985.[15] Figure 4.1 illustrates the basic [illegible] in which organized weather information is produced. The weather at any particular location is part of a complicated [illegible] pattern. Therefore, a large number of observations, provided by many governmental agencies, is useful in producing both descriptions and forecasts of weather conditions. On the left side of the exhibit, the various agencies which make weather observations are shown, along with the percentage of total expenditure on observation which each provides. The FAA plays a relatively minor role; its expenditure for weather observations, as estimated in the Federal Plan, is only 1.9 percent of the [illegible] in FY1985.[16]

The box in the center of Figure 4.1 represents the complex process of organizing and analyzing weather observations. This process is carried out through the interrelated efforts of several agencies. However, for the purposes of determining the role of the FAA in providing weather information which is of use to non-aviators, it is best thought of as a process to which many agencies contribute.



Definitions of Weather Services

1. **Basic:** Common needs of all users, needed by general public or most [illegible]

2. **Aviation:** General, commercial and military aviation.

3. **Marine:** General, commercial and defense on high seas, inland [illegible]

4. **Agricultural & Forestry:** Forests, large-crop inventory, fruit-[illegible]

5. **General Military:** Defense programs not part of other services.

6. **Other:** Space operations, urban air pollution program.

Source: Federal Coordinator for Meteorological Services [illegible]
The Federal Plan for Meteorological Services and [illegible] Fiscal Year 1985, U.S. Department of Commerce National [illegible] Administration, March 1984, Chapter [illegible]

The column at the right of Figure 4.1 lists the various specialized outputs of organized weather information. These outputs, known as "services," are defined at the bottom of the figure. Aviation Weather is one of these specialized outputs.

In terms of providing benefits to the general public, the [illegible] of the FAA is to provide weather observations. These observations are part of the raw material from which weather [illegible] are derived. Because of the interrelated nature of [illegible] conditions, information provided by the FAA is of use in providing forecasts used by many other groups.

FAA observations are also crucial in providing pilots with weather conditions at the specific points at which they take off and land.[17] Thus, some FAA observations are taken at points which are very near to observation sites of other agencies, primarily the National Weather Service (NWS). In addition, the FAA pays the National Oceanographic and Atmospheric Administration (NOAA), which is the parent administration for NWS, an annual sum for [illegible] and the use of research facilities which benefit aviation. This amount was $27,000,000 in FY1985.[18] Finally, NOAA bills the FAA for occasional services. However, since these expenditures are for aviation-related services, none of them can be [illegible] to the public sector.[19]

In order to determine the cost incurred by the FAA in its collection of weather observations which benefit the general public, it was necessary to identify those FAA observations which another agency would need to make if the FAA did not exist. Based on the cost-benefit formula found in the FAA's Airway Planning Standard Number One, any FAA weather observation site

within 15 nautical miles of an observation site manned by another government agency (usually NWS) or by a private contractor on behalf of a government agency was considered to provide no significant contribution to the production of [illegible]. These 41 sites are listed in Appendix B.

[illegible] of the remaining sites at which the FAA takes [illegible] the total number of observations for which the FAA is responsible was determined. For sites where the FAA is the only agency taking weather observations, this information was available directly. At some sites, however, the FAA shares responsibility for observing weather with other agencies. For example, a FAWRS and National Weather Service office may both exist at the same airport. In such cases, it was assumed that the FAA observations benefited the general public only during times when the other agency was not collecting weather data.[21]

Using the above analysis, the total number of observations for which the FAA is responsible was calculated for each site. It was assumed that an FAA employee at an observation site spends one-tenth of an hour taking each observation.[22] In addition, that employee was assumed to spend 312 hours maintaining the observation equipment each year.[23] The total number of person-hours spent for weather observation and maintenance at all FAA [illegible]

The hourly fully burdened labor cost for an employee performing the above tasks in FY1985 was assumed to be $29.37 per hour, based on an annual fully-burdened labor cost of $61,094.40.

Thus the total direct cost incurred by the FAA to take weather observations which benefited the general public in FY1985 was $11,215,788.[24]

Section 5.0

REGULATORY ACTIVITIES RELATED TO SAFETY, MEDICINE AND THE ENVIRONMENT

The FAA makes direct expenditures on a variety of regulatory programs related to safety, medicine, and the environment. In addition to the safety inspections and certifications provided by the Office of Aviation Standards, the FAA is involved in research involving medical, environmental and safety issues. The total amount allocated directly to such programs in FY1985 by this study was $280,467,939. As noted in the introduction, arguments can be made for allocating these costs either to users or to the public sector. The alternatives are described below, and summarized in Table 5.1.

5.1 Allocation to Users

If the FAA is viewed as a "firm" which provides safe, organized airspace, all of the programs related to safety or medicine can be allocated to users because these activities make aviation safer, but have little impact on those who do not fly. Those who do fly, whether on scheduled flights or as general aviators, have an interest in safety for which they would be willing to pay directly if markets were perfect. In a theoretical world, for example, suppose carrier A employs a reputable "aircraft inspection firm" to certify that its aircraft are safe, while carrier B does not. Carrier A will make this

Table 5.1

ALTERNATIVE ALLOCATION OF REGULATORY COSTS

Program Category	Argument(s) for Allocation to Users	Argument for Allocation to the Public Interest
Medical	Affects only those who fly	Catastrophe Avoidance
Environment	Property rights awarded to those affected by aviation pollution	Property rights awarded to aviation
Safety	Affects only those who fly	Catastrophe Avoidance
Inspection	Affects only those who fly	Catastrophe Avoidance
Certification	Affects only those who fly Economic rent earned by holder of certificate	Catastrophe Avoidance
Aviation Security	Affects only those who fly	Police Precedent

fact known in its advertising and will be able to charge a higher fare since it will attract customers through its reputation as a "safe" airline.[25] A similar argument can be made for all of the programs under the categories of medicine, safety, inspection, and certification. The extra amount which holders of certificates could earn in a theoretically perfect world can be classified as "economic rent." Even though no one can operate in the real world without a certificate, it is still reasonable to assume that aviation customers place a premium on buying FAA-certified goods and services, and that sellers, therefore, derive value from holding certificates.

The argument justifying the allocation of the costs of environmental programs is more complex.[26] The presence of civil aviation causes environmental damage in the form of noise and exhaust emissions. An analogy can be made to the case of a private firm which produces a negative externality, such as toxic smoke. Aviation users stand in the same position relative to those who live near runways or breathe airplane exhaust fumes as does the polluting firm relative to those who must breathe its smoke. However, as in all cases of a negative externality, there is a question: does the firm have the "right" to pollute or do those affected by the pollution have a "right" to clean air, quiet, etc.[27]

This question may be seen as one of property rights, and illustrated by an example. Suppose that an airport has recently been surrounded by neighbors who complain about the noise of aircraft operations. The airport operator or aircraft operator can take steps to reduce the noise, but they are costly. Who

should pay? The answer depends on whether society gives the neighbors the right to quiet or the airport operator the right to use his property unfettered. In the first case the airport operator should pay and in the second case it should be the neighbors.

Making an analogy to the FAA, regulatory programs which reduce exhaust emissions, noise, etc., should be paid for by aviation users if it is determined that those affected have the right to clean air and quiet. On the other hand, if civil aviation is considered sufficiently important to the welfare of the nation, it can be argued that the costs of environmental regulation are in the public interest, and should be shared by everyone. It is worth noting that in many cases where there is a clearly identified source of a negative externality, public policy has been to award property rights to those affected. Examples are: automobile emission controls, mandatory installation of effluent and particulate controls by industry, and the toxic waste "Superfund."

5.2 Allocation to the Public Sector

Using the reasoning of the above argument, the cost of environmental programs can be allocated to the public sector if property rights are awarded to aviation. It is possible that legislation providing for large tax-credits to defray the expense of installing industrial pollution control equipment indicates an award of property rights to polluters. A detailed analysis would be required to sort out the economic effects of the legislation.

Aviation security also can be allocated to the public sector using the argument that the prevention of hijackings and other crimes aboard aircraft is a police function. Since police protection usually is provided by a public agency, a precedent exists for allocating aviation security to the public sector.

The remaining regulatory programs can be allocated to the public sector by considering their purpose to be a reduction in the probability that a fatal aviation accident will occur. In recent operations research literature, the concept of social "catastrophe avoidance" has been explored.[28] There is some theoretical justification for allocating the cost of these programs to the public at large on the grounds that there is a public interest in avoiding catastrophic loss of life.

The theoretical argument and supporting evidence for this view are presented in Appendix C. The basic idea, however, can be stated simply: society desires to lessen the chance of a major (or "catastrophic") aviation accident, even though the chance that any particular individual will die in such an accident is very small, (infinitesimal for those who do not fly). If this is, indeed, society's attitude, then FAA programs which decrease the chance that such an accident will occur will benefit everyone, not only those who fly, and the costs of such programs should be allocated to the public sector.

Evidence to support this argument can be found in the history of the FAA. Although the forces which brought the agency into being were already in motion, a major accident in which two airliners collided over the Grand Canyon on June 30, 1956 provided substantial impetus for the formation of the FAA.[29] The Federal

Aviation Act of 1958 gives the FAA a congressional mandate to pursue aviation safety.[30]

The choice of whether regulatory costs should be allocated to users or to the public sector has a substantial impact on the amount of the total public sector allocation. The sum of direct and indirect costs in this category, as shown in Table 1.3, is $322,335,075, which is 4.3 percent of the total FAA budget.

Section 6.0

COSTS OF OPERATING WASHINGTON NATIONAL AND DULLES INTERNATIONAL AIRPORTS

According to the 1986 FAA budget:[31]

> The operation of the [Washington National and Dulles] airports is conducted on a commercial basis with revenues derived from landing fees, concession activity, and lease arrangements being deposited as receipts in the general fund of the Treasury. The direct operating costs and capital investment are financed by direct appropriation.

The expenditures for operation and improvement of Washington National and Dulles International Airports are included in the FAA budget. Receipts from user fees are paid directly to the general fund. Thus, to allocate FAA budget costs of this activity to users would count the users' cost responsibility twice. To assign these costs to the public sector as was done in a working paper for the the 1978 study[32] also would be misleading because they are paid for by users even though the user payments do not flow through the FAA budget. In fact:[33]

> The rate structures and concession arrangements are established so as to assure the recovery of operating costs, interest expenses, and an appropriate return on the Government's investment during the useful life of the airports. (emphasis added)

The profits earned by the Washington, DC metropolitan airports in FY1985 are shown in Table 6.1. Projects categorized as "Construction" are amortized and account for the "Depreciation and Interest" shown in the table.

Table 6.1

FINANCIAL RESULTS OF COMBINED OPERATIONS
OF WASHINGTON D.C. METROPOLITAN AIRPORTS

FISCAL YEAR 1985

Revenues	$ [illegible],363,000
Less: Operating Expense	35,690,000
Operating Profit	19,673,000
Less: Depreciation and Interest	7,514,000
New Program Profit	$ 12,159,000

Source: FAA Budget, FY1986, p. 149.

Section 7.0

CIVILIAN, GOVERNMENT USE OF NATIONAL AIRSPACE

In the same way that the military uses organized, safe airspace to provide the public good of national defense, other government agencies also use the airport and airway system. Based on data provided by the FAA on costs and activity, the econometric model developed for the overall cost allocation study was used to estimate the direct cost of such use by all levels of government to be $10,696,596. Table 7.1 details this calculation.

As with other user groups, the incremental cost of civilian, government use of each type of facility was estimated econometrically. These users were allocated a share of F&E, R&D and airport grants based on avoidable costs, activity and relative demand elasticities.

Facility	Measure of Operations	Number of Operations	M[illegible] per Operation	M[illegible] x OPS.[illegible] of Operations	[illegible]	[illegible] Costs
ARTCC	"Handles"	204,875	$ 12.63	$ 2,587,083	[illegible]	[illegible]
Tower	"Operations"	379,002	$ 1.44	$ 545,762	[illegible]	[illegible]
TRACON	"TSOs"	470,433	$ 4.44	$ 2,377,631		[illegible]
FSS	"Services"	405,089	$ 4.47	$ 1,623,891	[illegible]	[illegible]
TOTAL						[illegible]

Section 8.0

METHODOLOGY FOR ALLOCATING COSTS TO THE PUBLIC SECTOR IN PROJECTED FAA BUDGETS FOR FISCAL YEARS 1986-1997

Introduction

As described in Volume 2, the fundamental methodology used to allocate FAA costs in the fiscal years 1986-1997 was to construct a detailed projected budget for FY1992, compare it with the FY1985 budget, and make inferences from this comparison regarding budgets for the intervening years, as well as for the years from 1993-1997. Since the analysis of public sector allocations is essentially based on the analysis of the budget as a whole, the fundamental assumptions about the future stated in Sections 1.0 and 1.2 of Volume 2 also underly the analysis described in this section. Of particular importance is the assumption that FAA labor costs rise by 3.5 percent over the two year period 1984-1985, by 3 percent annually from 1986 through 1990, and by 4.64% for the period 1991-1997. However, several of the public sector cost categories require further assumptions. In addition, while the methods used to project future expenditures were based on the methods described in Sections 2.0-7.0 of this volume, they were not always identical to those methods. The following subsections explain the particular techniques used for each projection. A summary of results for FY1992 is given in Tables 8.1.1 and 8.1.2.

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Table 8.1.2

COSTS INCURRED BY THE PUBLIC SECTOR
IF REGULATORY COSTS ARE ALLOCATED TO PUBLIC
1992 FISCAL YEAR

	Direct Costs	Indirect Costs	Total Costs
ATCTs at Low Activity Airports	$9,175,634	$1,234,168	$10,409,802
Military Use of FAA	$462,297,811	$66,773,242	$529,071,053
FAA Weather Data Used by Non-Aviators	$16,604,043	$3,931,844	$20,535,887
Regulatory Activities—Safety, Medicine and Environment	$312,619,154	$39,062,558	$351,681,712
Non-Military, Government Use of FAA	$27,429,342	$3,923,272	$31,352,614
TOTAL	$828,125,984	$114,925,084	$943,051,068

* Numbers may not add due to rounding.

8.2 Provision of ATCTs at Low-Activity Airports

The analysis of Section 2.0 depended on calculations of the Phase II cost benefit ratios for low-activity towers. However, the Phase II ratio is not a reliable measure of the worth of a tower in future years, because there is a large margin for error in predicting both costs and benefits.[34]

As an alternative to using the Phase II criteria, three assumptions were made regarding the status of low-activity towers during the fiscal years 1986-1997. These assumptions, shown below, are specific manifestations of the more general assumption that the status of low-activity towers will not change significantly over this period. The assumptions are:

1) Congress will continue to require that some low-activity towers remain open.

2) The number of both Level I and Level II towers failing discontinuance criteria in each year will remain the same as in FY1984, (four and 16 respectively), although the locations of these towers may vary over time as costs and benefits at particular sites vary.

3) Five of the 16 Level I towers will be contracted to non-FAA operators. The cost of a contract tower, including costs incurred both by the contractor and by the FAA will average $251,775 (measured in 1992 dollars). This number, adjusted for inflation, is used for all contract towers in each year, even though it represents an average, over both time and location, of costs which can reasonably be expected to be incurred.

Based on these assumptions the direct cost of providing ATCTs at airports which would otherwise not merit them in 1992 was estimated to be $9,175,634..

8.3 Military Use of FAA Services

Table 8.3.1 shows the categories of costs which the FAA is expected to incur on behalf of the military in FY1992. The costs for the military as a user group were allocated by the econometric model using 1992 data as shown in Table 8.3.2. The number and GS grade of civilian representatives at military facilities are expected to remain constant, so that the increase in cost for these personnel to $2,551,358 is due solely to inflation. According to the Facility Master File, by FY1992 it will be less expensive to maintain a TACAN than a DME. Therefore, the "additional" cost borne by the FAA in order to maintain military NAVAIDS in FY1992 is zero. The amortized cost of NARACS F&E in 1992 is $4,533,000. Finally, the cost of military communications is assumed to grow, due only to inflation, to $4,084,752 by FY1992.

Table 8.3.3 shows the direct costs assigned to the military as a user group which cannot be attributed to the use of FAA operating facilities. As with the FY1985 allocation, alternative cases are presented for the two possible assignments of regulatory costs.

8.4 Use by Non-Aviators of Weather Data

The collection of weather data will change during the 1985-1997 period due to the planned implementation of Automatic

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Table 8.3.1

DIRECT COSTS OF MILITARY USE
OF FAA SERVICES
1992

	Assuming Regulatory Costs Allocated to Users	Assuming Regula Costs Alocat to Public
Costs Allocated to the Military as a User Group	$461,160,935	$451,117,198
Civilian ATC Representatives at Military Facilities	$2,562,861	$2,562,861
Additional Cost of Maintaining NAVAIDs Due to Military Requirements	$0	$0
NARACs Installation (Amortized)	$4,533,000	$4,533,000
Military Communications	$4,884,752	$4,884,752
TOTAL	$472,341,548	$462,297,811

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Table 8.3.2

CALCULATION OF DIRECT COSTS OF MILITARY
USE OF FAA OPERATING FACILITIES
1992 FISCAL YEAR

Facility	Measure of Operations	Number of Operations	MC per Operation	MC x OPS=VC of Operations	Joint Site Costs	Total Direct Costs
ARTCC	"Handles"	5,057,163	$21.31	$107,758,504	$30,420,085	$138,178,588
Tower	"Operations"	903,658	$3.76	$3,396,672	$12,950,681	$16,347,353
TRACON	"TSOs"	3,953,017	$15.47	$61,139,522	$40,719,026	$101,858,548
FSS	"Services"	3,223,303	$5.26	$16,962,860	$4,703,659	$21,665,719
TOTAL						$278,050,208

* Numbers may not add due to rounding.

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Table 8.3.3

DIRECT COSTS FOR MILITARY AS A USER GROUP NOT ATTRIBUTABLE TO USE OF FAA OPERATING FACILITIES

FISCAL YEAR 1992

Case 1: Regulatory Costs Allocated to Users

Facilities and Equipment (Excluding NARACs)	$114,904,770
Research and Development	$16,346,848
NAVAID Maintenance	$37,798,817
AIP Grants	$6,805,674
Safety Regulation	$7,254,618
	$183,110,727

Case 2: Regulatory Costs Allocated to Public

Facilities and Equipment (Excluding NARACs)	$114,904,770
Research and Development	$13,557,729
NAVAID Maintenance	$37,798,817
AIP Grants	$6,805,674
	$173,066,990

* Numbers may not add due to rounding.

Weather Observation Stations (AWOS) at a large number of observation sites. The Facility Master File, which was used as the basis for facilities and equipment installation and upgrading throughout the study, shows major AWOS implementation beginning in FY1986. However, a variety of sources within the FAA confirm that the equipment has not yet been developed to the point where it can be used reliably. While it is expected that implementation will take place during the period covered by this study, there is no consensus as to a schedule. In order to capture the expectation that AWOS will become a major factor in collecting weather data during the 1985-1997 period, while remaining consistent with other parts of the study, it was assumed that AWOS implementation will begin in 1988. All sites scheduled to receive AWOS in 1986 or 1987 were assumed to receive it instead in 1988. In all other respects, the FMF schedule was assumed to hold.

Table 8.4.1 shows the direct annual costs for weather observations which can be allocated to the public sector. The entries in the first column show the costs of collecting weather data at sites which are more than 15 nautical miles from other weather data collection locations. The second column gives the cost incurred by the FAA at sites where it shares the responsibility for collecting weather data with another agency. These two types of observation sites are the ones described in Section 4.0. For the period 1986-1987, the only changes in the total weather observation costs allocated to the public sector are due to inflation.

Table 8.4.1

DIRECT COSTS OF WEATHER OBSERVATIONS ALLOCATED TO THE PUBLIC SECTOR IN FISCAL YEARS 1984-1997

Year	Manual Observation Sites More Than 15 N.M. From Other Sites	Manual Observation Sites Where FAA Shares Observation Responsibility	AWOS Sites	Total Cost
1985	8,417,951	2,797,837	0	11,215,788
1986	8,712,579	2,895,762	0	11,608,341
1987	8,973,956	2,982,635	0	11,956,591
1988	4,276,530	1,983,695	7,189,553	13,449,778
1989	4,143,703	1,721,867	8,724,207	14,589,777
1990	4,161,558	1,773,524	9,119,926	15,055,008
1991	4,343,196	1,850,934	9,435,200	15,629,330
1992	4,536,315	1,933,232	10,059,973	16,529,520
1993	4,746,800	2,022,934	10,526,756	17,296,490
1994	4,967,051	2,116,798	11,015,198	18,099,047
1995	5,197,522	2,215,017	11,526,303	18,938,843
1996	5,438,687	2,317,794	12,061,124	19,817,605
1997	5,691,043	2,425,339	12,620,760	20,737,142

From 1988 through 1992, AWOS equipment was assumed to come into use. The costs for AWOS, shown in the third column of Table 8.4.1, were calculated based on estimated labor hours for maintenance, as given by the Facility Master File.[35] These costs rise in real terms from 1988 through 1992 as the AWOS stations are installed. From 1993-1997, all cost changes are due to inflation.

8.5 Regulatory Activities and Civilian, Government Use of FAA Services

The allocations for these expenditures were determined by the model which was used to predict FAA budgets through FY1997. Regulatory programs related to safety, medicine and the environment were projected to receive a direct allocation of $14,778,110 in FY1992, as shown in Table 8.1.2 at the beginning of this section.

The direct costs for civilian, government use of FAA operating facilities were calculated in the same manner as in FY1985. The details of this calculation for FY1992 are shown in Table 8.5.1. The costs totaled $16,109,861 for FY1992.

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Table B-[illegible]

ALLOCATION OF DIRECT COSTS TO CIVILIAN, [illegible]
USE OF [illegible] FACILITIES
1992 [illegible] Value

[illegible]	[illegible] Operations	[illegible] Operations	[illegible] Operation	[illegible] of Operations	[illegible]	[illegible] Direct Costs
[illegible]	"Maneuver"	[illegible]	$13.38	$1,358,679	$[illegible]	$[illegible]
[illegible]	"Operations"	[illegible]	$1.63	$738,298	$2,784,442	$3,514,740
[illegible]	"Fires"	[illegible]	$5.87	$1,086,359	$2,055,542	$3,141,901
[illegible]	"Operations"	[illegible]	$5.26	$2,528,857	$[illegible]	$3,229,899
[illegible]						$16,102,343

* Numbers may not add due to rounding

Section 9.0

SUMMARY AND YEAR-BY-YEAR RESULTS

Not all FAA costs can be attributed to specific user groups. In particular, the FAA:

- provides some services used by government agencies (at all levels) to provide public goods,
- conducts programs to redress externalities associated with the production and consumption of aviation services, and
- includes in its system some functions and facilities which primarily benefit non-aviators.

This volume has analyzed the FAA budgets for the fiscal years 1985-1977 and has shown the portion of FAA costs which should be allocated to the general public in each year. Five categories of costs have been considered:

- The cost of providing ATCTs at airports which do not meet the criteria for establishing such facilities based on safety considerations,
- The costs incurred by the FAA due to military use of the airport and airway system,
- The costs associated with the collection of weather data which is not of direct use to aviators,
- The costs of regulatory programs related to safety medicine and the environment, and

- The costs incurred by the FAA due to non-military, government use of FAA services, by all levels of government.

Tables 9.1 through 9.13 present summaries of the allocation of FAA costs to the public interest for the fiscal years 1985-1997. Two allocations have been calculated for each year. The first assumes that users are allocated the cost of regulatory activities, while the second assumes that these costs should be assigned to the public at large. The total public sector allocations for each year, under each assumption, have been shown as a percentage of the total FAA budget in Figure 1.1. As noted in Section 1, under the assumption that regulatory costs should be borne by users, the public sector is allocated 13.5 percent of the budget in FY1985. This number falls to 9.9 percent in FY1997. If regulatory costs are assigned to the public sector, 18.8 percent of the FY1985 budget is allocated to the public sector. By 1997, this number falls to 15.2 percent.

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Table 9.1.1

ALLOCATION TO PUBLIC SECTOR
1985 FISCAL YEAR

13 Aug 86	REGULATORY COSTS ALLOCATED TO USERS Total Costs	REGULATORY COST ALLOCATED TO PUBLIC Total Costs
ATCTs at Low Activity Airports	$9,600,967	$9,174,519
Military Use of FAA		
ARTCCs	$162,883,221	$156,160,656
Towers	$21,857,042	$20,775,988
FARCOMs	$109,527,161	$104,702,391
FSSs	$38,857,979	$36,332,823
F&E + R&D	$178,895,364	$172,623,961
Naval Maintenance	$109,598,743	$101,445,698
Other	$27,823,204	$16,197,561
FAA Weather Data Used by Non-Aviators	$15,616,338	$14,548,639
Regulatory Activities—Safety, Medicine and Environment	$0	$323,823,675
Non Military, Government Use of FAA	$30,723,985	$28,171,263
TOTAL (Current Dollars)	$783,775,924	$983,155,113

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Table 9.1.2

ALLOCATION TO PUBLIC SECTOR
1986 FISCAL YEAR

Using Sector	REGULATORY COSTS ALLOCATED TO USERS Total Costs	REGULATORY COSTS ALLOCATED TO PUBLIC Total Costs
[illegible] at Non-Contract Airports	$9,991,527	$9,582,265
Military Use of FAA		
ARTCCs	$166,766,259	$159,227,399
Towers	$22,130,111	$20,932,868
TRACONs	$113,885,415	$108,277,713
FSSs	$38,295,987	$35,542,550
F&E + R&D	$141,235,337	$137,188,526
Navaid Maintenance	$95,766,063	$87,979,573
Other	$26,831,270	$15,550,981
FAA Weather Data Used by Non-Aviators	$16,485,090	$15,166,994
Regulatory Activities - Safety, Medicine and Environment	$0	$343,241,072
Non-Military, Government Use of FAA	$29,534,000	$26,793,979
TOTAL (Current Dollars)	$668,761,779	$959,611,120

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Table 9.1.3

ALLOCATION TO PUBLIC SECTOR
1987 FISCAL YEAR

13-Aug-86	REGULATORY COSTS ALLOCATED TO USERS Total Costs	REGULATORY COST ALLOCATED TO PUBLIC Total Costs
AICIs at Low Activity Airports	$10,083,864	$9,635,340
Military Use of FAA		
ARTCCs	$164,311,120	$157,549,498
Towers	$21,486,698	$20,373,292
TRACONs	$113,614,629	$108,576,669
FSSs	$35,739,120	$33,401,311
F&E + R&D	$146,610,835	$143,727,631
Navaid Maintenance	$98,854,809	$91,438,251
Other	$24,346,738	$13,549,357
FAA Weather Data Used by Non-Aviators	$16,349,516	$15,215,194
Regulatory Activities--Safety, Medicine and Environment	$0	$329,663,830
Non-Military, Government Use of FAA	$29,763,369	$27,133,087
TOTAL (Current Dollars)	$661,080,698	$958,255,459

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Table 9.1.4

ALLOCATION TO PUBLIC SECTOR
1988 FISCAL YEAR

13-Aug-86	REGULATORY COSTS ALLOCATED TO USERS Total Costs	REGULATORY COST ALLOCATED TO PUBLIC Total Costs
ATCTs at Low Activity Airports	$10,850,760	$10,271,198
Military Use of FAA		
ARTCCs	$175,449,733	$166,817,882
Towers	$22,670,891	$21,320,254
TRACONs	$123,133,368	$116,568,412
FSSs	$37,142,666	$34,223,881
F&E + R&D	$156,228,548	$151,888,778
Navaid Maintenance	$93,940,325	$85,756,417
Other	$26,355,441	$14,512,994
FAA Weather Data Used by Non-Aviators	$19,638,635	$18,848,282
Regulatory Activities--Safety, Medicine and Environment	$0	$389,188,786
Non-Military, Government Use of FAA	$32,873,787	$29,714,841
TOTAL (Current Dollars)	$698,284,154	$1,838,135,716

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Table 9.1.5

ALLOCATION TO PUBLIC SECTOR
1989 FISCAL YEAR

13-Aug-86	REGULATORY COSTS ALLOCATED TO USERS Total Costs	REGULATORY COST ALLOCATED TO PUBLIC Total Costs
ATCTs at Low Activity Airports	$10,022,515	$9,521,635
Military Use of FAA		
ARTCCs	$172,976,348	$164,989,649
Towers	$21,869,056	$20,666,949
TRACONs	$123,041,579	$116,866,795
FSSs	$34,685,156	$32,130,835
F&E + R&D	$152,526,916	$148,199,973
Navaid Maintenance	$80,884,288	$74,201,936
Other	$25,584,998	$14,282,407
FAA Weather Data Used by Non-Aviators	$20,767,564	$19,173,355
Regulatory Activities--Safety, Medicine and Environment	$0	$376,916,047
Non-Military, Government Use of FAA	$32,958,189	$29,895,463
TOTAL (Current Dollars)	$675,316,610	$1,006,844,245

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Table 9.1.6

ALLOCATION TO PUBLIC SECTOR
1990 FISCAL YEAR

13-Aug-86	REGULATORY COSTS ALLOCATED TO USERS Total Costs	REGULATORY COST ALLOCATED TO PUBLIC Total Costs
ATCTs at Low Activity Airports	$10,275,541	$9,782,047
Military Use of FAA		
ARTCCs	$172,122,436	$164,467,686
Towers	$21,270,200	$20,165,134
TRACONs	$124,095,366	$118,077,680
FSSs	$32,719,539	$30,399,984
F&E + R&D	$140,917,840	$144,661,979
Navaid Maintenance	$70,441,590	$64,805,498
Other	$25,135,153	$14,152,171
FAA Weather Data Used by Non-Aviators	$21,125,206	$19,559,535
Regulatory Activities—Safety, Medicine and Environment	$0	$373,529,289
Non-Military, Government Use of FAA	$33,388,001	$30,343,334
TOTAL (Current Dollars)	$659,490,952	$989,944,337

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Table 9.1.7

ALLOCATION TO PUBLIC SECTOR
1991 FISCAL YEAR

13-Aug-86	REGULATORY COSTS ALLOCATED TO USERS Total Costs	REGULATORY COST ALLOCATED TO PUBLIC Total Costs
ATCTs at Low Activity Airports	$10,557,193	$10,092,639
Military Use of FAA		
ARTCCs	$171,685,618	$164,672,245
Towers	$20,671,685	$19,699,833
TRACONs	$125,414,933	$119,814,358
FSSs	$30,738,894	$28,733,328
F&E + R&D	$145,285,821	$141,860,829
Navaid Maintenance	$60,294,913	$55,885,509
Other	$24,690,256	$14,878,410
FAA Weather Data Used by Non-Aviators	$21,349,908	$19,885,391
Regulatory Activities—Safety, Medicine and Environment	$0	$364,894,385
Non-Military, Government Use of FAA	$33,868,219	$30,894,618
TOTAL (Current Dollars)	$644,468,559	$969,630,745

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Table 9.1.8

ALLOCATION TO PUBLIC SECTOR
1992 FISCAL YEAR

13-Aug-86	REGULATORY COSTS ALLOCATED TO USERS Total Costs	REGULATORY COST ALLOCATED TO PUBLIC Total Costs
ATCTs at Low Activity Airports	$10,838,677	$10,409,882
Military Use of FAA		
AWTCCs	$170,832,568	$164,542,390
Towers	$19,981,982	$19,156,766
TRACONs	$126,399,793	$121,301,806
FSSs	$28,696,093	$27,021,177
F&E + R&D	$138,574,972	$135,065,974
Navaid Maintenance	$51,414,834	$47,914,083
Other	$24,299,922	$14,068,855
FAA Weather Data Used by Non-Aviators	$21,982,218	$20,535,887
Regulatory Activities--Safety, Medicine and Environment	$0	$351,681,712
Non-Military, Government Use of FAA	$34,215,099	$31,352,614
TOTAL (Current Dollars)	$627,156,078	$943,051,068

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Table 9.1.9

ALLOCATION TO PUBLIC SECTOR
1992 FISCAL YEAR

14-Aug-86	REGULATORY COSTS ALLOCATED TO USERS Total Costs	REGULATORY COST ALLOCATED TO PUBLIC Total Costs
ATCTs at Low Activity Airports	$11,264,281	$10,835,391
Military Use of FAA		
ARTCCs	$174,573,504	$168,385,669
Towers	$20,297,076	$19,493,381
TRACONs	$127,428,039	$122,485,736
FSSs	$29,381,969	$27,729,692
F&E + R&D	$140,860,689	$137,334,555
Navaid Maintenance	$51,523,126	$48,128,267
Other	$24,789,178	$14,525,392
FAA Weather Data Used by Non-Aviators	$22,672,173	$21,385,083
Regulatory Activities—Safety, Medicine and Environment	$0	$361,451,321
Non-Military, Government Use of FAA	$35,516,957	$32,596,754
TOTAL (Current Dollars)	$638,306,991	$964,271,962

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Table 9.1.10

ALLOCATION TO PUBLIC SECTOR
1994 FISCAL YEAR

14-Aug-86	REGULATORY COSTS ALLOCATED TO USERS Total Costs	REGULATORY COST ALLOCATED TO PUBLIC Total Costs
ATCTs at Low Activity Airports	$11,703,204	$11,275,949
Military Use of FAP		
ARTCCs	$176,345,245	$172,281,401
Towers	$20,609,583	$19,838,097
TRACONs	$128,451,047	$123,677,282
FSSs	$30,871,542	$28,448,176
F&E + R&D	$143,136,053	$139,595,465
Navaid Maintenance	$51,583,059	$46,304,837
Other	$25,262,872	$14,995,922
FAA Weather Data Used by Non-Aviators	$23,457,382	$22,096,223
Regulatory Activities—Safety, Medicine and Environment	$0	$371,040,107
Non-Military, Government Use of FAA	$36,857,477	$33,882,871
TOTAL (Current Dollars)	$649,497,383	$985,428,331

[illegible]

[illegible]

ALLOCATION TO PUBLIC SECTOR
1995 FISCAL YEAR

[illegible]	REGULATORY COSTS ALLOCATED TO USERS Total Costs	REGULATORY COSTS ALLOCATED TO PUBLIC Total Costs
ATCT, at non-Activity Airports	$[illegible]	$[illegible]
Military Use of FAA		
ARTCCs	$162,143,617	$176,228,983
Towers	$28,919,116	$28,166,915
TRACONs	$129,469,543	$124,877,676
FSSs	$30,764,822	$29,176,281
F&E + O&D	$145,399,415	$141,847,138
Navaid Maintenance	$51,593,624	$48,642,795
Other	$25,781,187	$15,488,917
FAA Weather Data Used by Non-Aviators	$24,257,174	$22,987,083
Regulatory Activities -Safety, Medicine and Environment	$0	$288,283,159
Non-Military, Government Use of FAA	$38,237,318	$35,212,115
TOTAL (Current Dollars)	$668,722,641	$1,086,454,829

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Table 9.1.12

ALLOCATION TO PUBLIC SECTOR
1998 FISCAL YEAR

[illegible]	REGULATORY COSTS ALLOCATED TO USER FEES (Millions)	REGULATORY COSTS ALLOCATED TO [illegible] (Millions)
[illegible] Activity Airport	$16,661,74	$1[illegible]
Military Use of FAA		
Airli[illegible]	$185,972,33[illegible]	$18[illegible]
Tower[illegible]	$21,225,874	$2[illegible]
TRACON[illegible]	$138,484,191	$1[illegible]
FSS[illegible]	$31,456,58[illegible]	$[illegible]
F&E + R&E	$147,649,139	$144,[illegible]
Naval[illegible] Maintenance	$51,553,189	$4[illegible]
Other	$26,284,352	$15,960,87[illegible]
FAA Weather Data Used by Non-Aviation	$25,870,786	$2[illegible]
Regulatory Activities Safety Medicine and Environment	$0	$389,427,60[illegible]
Non-Military, Government Use of FAA	$39,657,097	$3[illegible]
TOTAL (Current Dollars)	$671,977,206	$1,027,278,15[illegible]

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Table 9.1.13

ALLOCATION TO PUBLIC SECTOR
1997 FISCAL YEAR

[illegible]	REGULATORY COSTS ALLOCATED TO USERS Total Costs	REGULATORY COSTS ALLOCATED TO PUBLIC Total Costs
[illegible] Activity Airports	$13,101,76[illegible]	$[illegible],69[illegible],211
[illegible] Use of FAA		
AWOSs	$109,822,908	$184 [illegible],289
Towers	$21,529,761	$28,[illegible]48,941
[illegible]RCOMs	$131,495,587	$127,[illegible]89,884
FSSs	$32,154,356	$38,659,842
FAA - ARTCC	$149,883,607	$146,366,477
Aviation Maintenance	$51,461,186	$48,599,285
Other	$26,792,638	$16,496,323
Use Weather Data Used by Non-Aviators	$25,897,348	$24,589,597
Regulatory Activities Safety, Medicine and Environment	$0	$396,831,790
Non-Military Government Use of FAA	$4[illegible],777,466	$36,[illegible]04,719
TOTAL (Current Dollars)	$683,256,560	$1,047,816,247

NOTES

[1] For brief discussions of the nature of public goods, see: Eric J. Solberg, Intermediate Microeconomics, (Plano, TX, Business Publications, Inc., 1982), pp. 546-47, and Richard Just, Darrell Hueth, and Andrew Schmitz, Applied Welfare Economics and Public Policy, (Englewood Cliffs, NJ, Prentice-Hall, Inc., 1982), pp. 283-86.

A more technical treatment can be found in Richard W. Tresch, Public Finance: A Normative Theory, (Plano, TX, Business Publications, Inc., 1981), Chapter 6. This chapter presents a broad definition of externalities, of which "nonexclusive goods" are examples (p. 108).

[2] Results from several working papers were condensed in: Financing the Airport and Airway System: Cost Allocation and Recovery, U.S. Department of Transportation, Federal Aviation Administration, Office of Aviation Policy, Washington, DC, 1978. The paper which dealt specifically with costs allocated to the public interest was: D.S. Garvett, S.E. Koenig, J.C. Scalea, and A.N. Sinha, Airport and Airway Costs Incurred in the Public Interest, (McLean, VA, The MITRE Corporation, METREK Division, September 1977).

[3] Financing the Airport and Airway System: Cost Allocation and Recovery, Op. Cit., pp.. 20, 30. The numbers reported in this 1978 summary volume differ slightly from those found in the 1977 working paper by Garvett, et. al. cited above.

[4] Susan Helzer, Establishment and Discontinuance Criteria for Airport Traffic Control towers, U.S. Department of Transportation, Federal Aviation Administration, Office of Aviation Policy and Plans, Washington, DC, August 1983, pp. 4-5. The cost-benefit ratio is often referred to as the "Phase II Ratio." There is a less comprehensive measure of the value of a tower, based on annual operations at the candidate airport, which is called the "Phase I Criteria" (p. 5).

[5] U.S. Congress, Senate. Committee on Appropriations, Report to Accompany Department of Transportation and Related Agencies Appropriations Bill, 1985. 94th Congress, 2nd Session, S. Rept. 98-561 to accompany S.2852. Washington: GPO, 1984, p. 76.

[6] It should be kept in mind that closing a tower does not imply closing an airport.

[7] Henry L. Eskew, Airport and Airway Costs Incurred in Servicing Small Communities, Final Report, prepared for Office of Aviation Policy, Federal Aviation Administration by Administrative Sciences Corp., Alexandria, VA, September 1977, pp.6, 8.

[8] Ibid, p. 8.

[9] Although FY1985 is the base year for this study, the analysis in this section was based on FY1984 data and extrapolated to FY1985.

[10] See, for example, Air Traffic Terminal Staffing Standards, Federal Aviation Administration, Office of Management Systems, AMS-560, January 1986.

[11] Costs for these civilian representatives were identified from data provided by the FAA Office of Management Systems (AMS-560).

[12] These costs were calculated using data from the FAA Facility Master File under the assumption that in any location where a TACAN now exists, whether colocated with a VOR or not, a DME would exist instead, in the hypothetical situation in which the military made absolutely no use of FAA services.

[13] This is an average of the expenditures over the period 1985-1992. See: FAA Budget, FY1986, p. 231.

[14] The leased communications costs attributable to the military were estimated by identifying the FAA circuits that serve military facilities. Cost data were obtained from the FAACIS database maintained by Transportation Systems Center. If there were n drops on a given circuit, 1/n of the circuit cost was assigned to each military drop.

[15] Federal Coordinator for Meteorological Services and Supporting Research, The Federal Plan for Meteorological Services and Supporting Research: Fiscal Year 1985, U.S. Department of Commerce/National Oceanic and Atmospheric Administration, March 1984.

[16] The estimate of the expenditures for weather observation contained in the Federal Plans are based on data available in 1983 (p. 3-1 of that document). They are intended only to illustrate the relative position of the FAA in the system of weather observation. It should also be noted that the amount spent by the FAA in making weather observations, which is 1.9% of all the money spent by government agencies to make weather observations, is not the same as the amount which benefits the general public by making weather observations. As the analysis of this section shows, not all FAA weather observations benefit the general public.

[17] In fact, some types of weather observations, such as those provided by the Low Level Windshear Alert System, have little value except at a specific airport.

[18] FAA Budget, FY1986, p. 166.

[19] The FAA is also part of a joint effort (with the Departments of Defense and Commerce) to develop an advanced "Next Generation dWeather Radar" (NEXRAD), which will use doppler radar to improve detection of severe weather. (FAA Budget FY1986, p. 313.) In this study, it has been assumed that the FAA's contribution to the research and development costs for NEXRAD is proportional to the benefits to aviation which this system will provide. No NEXRAD costs have been allocated to the public sector.

[20] Airway Planning Standard Number One--Terminal Air Navigation Facilities and Air Traffic Control Services, Order No. 7031.2C, Department of Transportation, Federal Aviation Administration, November 15, 1984. This document assigns a "proximity penalty" to any site within 10 nautical miles of another site. Fifteen nautical miles was chosen as the standard for the present analysis in order to account for possible errors in measuring distance.

Latitude and longitude of weather observation sites were obtained from National Weather Service Offices and Stations, 22nd ed., U.S. Department of Commerce/National Oceanic and Atmospheric Administration, February 1984.

[21] Two sites, Talkeetna, AK (TKA) and Marquete, MI (MQT), performed observations irregularly, so that it was not possible to determine the total number of oservations taken annually at these sites.

[22] These assumptions were based on time study statistics collected by the FAA in the course of preparing automation evaluation studies for various FSS locations in 1979.

[23] Weather equipment maintenance labor data were obtained from the Facility Master File, System 7, provided by APM-130.

[24] The FAA is developing an Automated Weather Observing System (AWOS). Although no money was spent on this system in FY1985, AWOS has been funded in subsequent years and is expected to be funded in the future. (FAA Budget, FY1986, p. 222.) To the extent that AWOS provides observations at sites greater than 15 nautical miles from existing NWS sites, its cost should be allocated to the public sector. See Section 8.0 for an explanation of the treatment of AWOS in the projected budgets.

[25] In actual practice, airlines are reluctant to cite safety in their advertising because even a single accident would destroy their credibility. However, it is worth noting that when on-board radar first became available, airlines which had acquired it labeled their aircraft "radar equipped" in such a way that passengers were sure to notice.

[26] The only environmental programs considered in the analysis involved research and development. Grants to airports for environmental purposes were not considered because they were not part of the sample used to analyze airport grants, as described in Section 2.6 of Volume 1 of this study.

[27] This question was first explored in: Ronald H. Coase, "The Problem of Social Cost", Journal of Law and Economics, October 1960. Although the "Coase Theorem" which developed from his original analysis has seen much technical refinement, this reference remains the best available for grasping the basic issues. It should be noted that this is not a direct application of the Coase Theorem because one of the "parties" in the present case may be the public-at-large. Coase's article dealt with two private parties in conflict over an externality.

[28] Ralph Keeney, "Equity and Public Risk," Operations Research, Volume 28 (May-June 1980): pp. 527-34. See also: Ralph Keeney, "Utility Functions for Equity and Public Risk," Management Science, Volume 26 (April 1980), pp. 345-53.

[29] Stuart Rochester, Takeoff at Mid-Century: Federal Civil Aviation Policy in the Eisenhower Years, 1953-1961, (Washington, DC, U.S. Department of Transportation, Federal Aviation Administration, 1976), pp. 125-31, 146-48, 215.

[30] Federal Aviation Act of 1958, Revised December 1984, Title Vi, Section 601, Washington, GPO.

[31] FAA Budget, FY1986, p. 137.

[32] D.S. Garvett, et al, op. cit., Chapter 7, p. 1.

[33] FAA Budget, FY1986, p. 137.

[34] When these ratios were calculated for FY1992, using projected cost data, nearly four times as many towers failed the criteria as had failed in FY1984. In addition, when Phase I ratios were calculated, the number of towers failing because of the Phase I criteria was substantially smaller than the number failing because of the Phase II criteria. The opposite was the case with ratios calculated using the FY1984 data.

[35]The costs associated with AWOS were considered to be in the public interest if:

1) The AWOS replaced a current observation site that is more than 15 nautical miles from any other observation station,
2) The AWOS replaced another agency's observation station that is more than 15 nautical miles from any other observation site, or

3) The AWOS replaced an FAA observation station at a site where the FAA shared observation responsibility with another agency.

In the third case, it was assumed that the AWOS performed all observations so that the total cost of the AWOS was incurred by the FAA to benefit the general public.

APPENDIX A

LOW ACTIVITY TOWERS

Towers which fail the cost-benefit test, but remain open, fall into three categories. Table A.1 lists 11 Level-I towers with cost-benefit ratios less than one, along with their total costs of operation for FY1984.[1] These costs include air traffic control labor, airway facilities maintenance, and leased communications.[2] Table A.2 gives the same information for five Level-I towers at which labor for air traffic control was provided by private companies in FY1984.[3] These companies performed under subcontract to municipalities which, in turn, had entered contracts with the FAA for the operation of the towers. The FAA continued to pay for airway facility maintenance and leased communications at these towers in FY1984. Table A.3 lists four Level-II towers with cost-benefit ratios less than one.

In addition to towers which fail to meet the cost-benefit test, two towers were identified which pass the test due only to scheduled service provided under subsidy. These towers, and their operating costs are shown in Table A.4. Since subsidized service is mandated by Congress, it can be inferred that the costs of these towers also are in the public interest. The total direct cost of operating ATCTs at low-activity airports which remained open in FY1984 due to the public interest, as expressed by Congress, was $7,856,422.[4] The costs calculated in this appendix were assumed to carry over unchanged to FY1985.

Table A.1

LEVEL-I TOWERS WHICH FAIL COST-BENEFIT TEST

LOCID	Airport	Cost-Benefit Ratio	Total Cost
ISO	Kinston, NC	.97	$424,159
BMG	Bloomington, IN	.65	$299,540
HLG	Wheeling, WV	.61	$459,645
ALW	Walla Walla, WA	.97	$482,361
STJ	St. Joseph, MO	.95	$282,593
MIE	Muncie, IN	.94	$406,124
MVY	Martha's Vineyard, MA	.94	$224,152
GRI	Grand Island, NE	.91	$363,945
FLO	Florence, SC	.89	$457,802
TUT	Pago Pago	.73	$348,413
LWB	Lewisburg Gbr., WV	.63	$224,466
	TOTAL		$3,973,200

Table A.2

LEVEL-I TOWERS WHICH ARE UNDER CONTRACT AND FAIL COST-BENEFIT TEST

LOCID	Airport	Cost-Benefit Ratio	Total Cost
ADM	Ardmore, OK	.18	$111,503
FLG	Flagstaff, AZ	.89	$180,473
OWB	Owensboro, KY	.59	$250,089
PDT	Pendleton, OR	.47	$298,240
WDG	Enid, OK	.87	$203,789
	TOTAL		$1,044,094

Table A.3

LEVEL-II TOWERS WHICH FAIL COST-BENEFIT TEST

LOCID	Airport	Cost-Benefit Ratio	Total Cost
CSM	Clinton-Sherman, OK	.69	$432,001
MWC	Milwaukee, WI	.99	$539,900
HUT	Hutchinson, KS	.98	$546,257
JXN	Jackson, MI	.62	$525,718
	TOTAL		$2,043,876

Table A.4

LEVEL-I TOWERS WHICH PASS COST-BENEFIT TEST DUE TO SUBSIDIZED SERVICE

LOCID	Airport	Cost-Benefit Ratio	Total Cost
CIC	Chico, CA	1.39	$258,901
SLE	Salem, OR	1.30	$536,351
	TOTAL		$795,252

Total Cost Allocated to Public Interest for ATCTs at Low-Activity Airports: $7,856,422

NOTES

[1] Cost-benefit ratios could not be obtained for two towers: Atlantic City--Baeder Field, NJ (AIY) and Anchorage--Lake Hood, AK (LHD). In the absence of better information, it was assumed that the cost of these towers should not be allocated to the public interest.

[2] The numbers in the exhibit were obtained from the database used to estimate the marginal costs of various operations associated with each type of user. For a detailed description of the compilation of this database, see Volume 6.

[3] Costs for contract labor were obtained directly from the FAA office responsible for the contract-tower program (ATR-130).

[4] Although no money was actually spent, the FY1984 FAA budget included a request for $1,752,700 to establish an ATCT at Obyan, Saipan, even though this airport does not meet the cost-benefit criteria. A similar request, this time for $2,992,100, was included in the FY1986 budget.

APPENDIX B

FAA SURFACE OBSERVATION SITES WITHIN 15 NAUTICAL MILES OF OBSERVATION STATIONS MANNED BY OTHER GOVERNMENT AGENCIES

FAA LOCID	NON-FAA LOCID	DISTANCE nm
MRI, AK	ANC, AK	6.86
SCC, AK	PUO, AK	8.80
PAQ, AK	SWO, AK	3.97
BHM, AL	BIRAI, AL	9.36
LIT, AR	1M1, AR	8.04
DVT, AZ	SDL, AZ	11.15
ACV, CA	96Q, CA	6.07
BUR, CA	LAXC1, CA	12.93
CNO, CA	ONT, CA	6.72
CCR, CA	99Q, CA	4.10
EMT, CA	MWS, CA	10.81
FUL, CA	LGB, CA	11.49
HHR, CA	LAX, CA	4.14
HWD, CA	OAK, CA	8.87
POC, CA	ONT, CA	10.58
WJF, CA	PMD, CA	11.18
MRY, CA	95Q, CA	10.58
ONT, CA	RAL, CA	12.63
PAO, CA	RDWC1, CA	5.07
RAL, CA	UCR, CA	6.98
SAC, CA	SACC1, CA	5.32
SMF, CA	SACC1, CA	11.01
SQL, CA	RDWC1, CA	3.96
SEE, CA	MVF, CA	9.79
SJC, CA	RHV, CA	7.35
TOA, CA	L82, CA	6.60
GON, CT	18N, CT	3.30
HVN, CT	N11, CT	0.98
FXE, FL	HWD, FL	7.23
FLL, FL	PMP, FL	14.76
HWO, FL	MIA, FL	14.92
MLB, FL	MEBF1, FL	6.32
OPF, FL	MIA, FL	14.62
TMB, FL	MIAF1, FL	10.30
ORL, FL	MCO, FL	9.36
PNS, FL	NPA, FL	12.15
SPG, FL	PIE, FL	12.30
PIE, FL	TPA, FL	9.68
FTY, GA	ATL, FL	12.16
SSI, GA	BQK, GA	9.36
KOA, HI	K53, HI	8.21
MDW, IL	DUK, IL	12.70

CGX, IL	DUK, IL	8.26
LAF, IN	LFYI3, FN	5.59
KCK, KS	MCIM7, MO	3.98
FOE, KS	TOP, KS	9.76
LOU, KY	SDF, KY	5.59
PAH, KY	KY29, KY	14.21
NEW, LA	MSY, LA	13.35
DTN, LA	SHV, LA	5.59
BVY, MA	34B, MA	9.68
FMH, MA	30B, MA	10.68
HAY, MA	FMH, MA	13.78
ACK, MA	45B, MA	2.83
DET, MI	31G, MI	7.27
YIP, MI	DTW, MI	12.74
CMX, MI	32Y, MI	9.47
FCM, MN	MSP, MN	14.28
STP, MN	MSP, MN	9.68
SUS, MO	SJOM7, MO	11.71
MKC, MO	MCIM7, MO	1.65
OMA, NE	3NO, NE	8.68
MHT, NJ	ASH, NH	12.93
CDW, NJ	TEB, NJ	13.87
TTN, NJ	TRTN4, NJ	6.07
EKO, NV	EKLN2, NV	0.98
AKR, OH	CAK, OH	9.51
LUK, OH	C1N01, OH	5.01
OSU, OH	CMH, OH	12.66
PWA, OK	OKC, OK	10.81
RVS, OK	TULO2, OK	9.36
OTH, OR	835, OR	7.23
CXY, PA	HRBP1, PA	4.40
MDT, PA	HRBP, PA	9.47
PSB, PA	N36, PA	13.98
GMU, SC	GSP, SC	8.79
ADS, TX	DFW, TX	12.90
RBD, TX	DAL, TX	13.33
DAL, TX	ADS, TX	9.36
FTW, TX	FTWT2, TX	5.41
HOU, TX	CLC, TX	11.89
DWH, TX	IAH, TX	14.21
STT, VI	X70, VI	3.22
STX, VI	MISX, VI	8.50
PAE, WA	98S, WA	2.83
RNT, WA	SEA, WA	6.31
BFI, WA	SEA, WA	6.65
ALW, WA	WLAW1, WA	6.07
EAT, WA	EATW1, WA	9.21
LSE, WI	LCRW3, WI	3.99
MWC, WI	15C, WI	9.91

APPENDIX C

Catastrophe Avoidance As An Argument for Allocating Regulatory Costs to The Public Sector

This Appendix provides both an informal and a formal treatment of the argument that if society exhibits "catastrophe avoidance," FAA regulatory costs should be allocated to the public sector.

Informal Argument

In order to illustrate the idea of social catastrophe avoidance, it is first necessary to define a probablistic "lottery." A lottery consists of two events, each of which has an associated probability that it will occur. The two probabilities must sum to one. An example would be a probability of .01 that 100 people die (perhaps in an aviation accident) and a probability of .99 that no one dies.

Society can be considered to have preferences regarding lotteries. Table C.1 shows three examples of lotteries. The examples have been chosen to meet three special restrictions:

1) The number of deaths in the second event is zero for each lottery,
2) the mathematical expected value (or "weighted average") of each lottery is equal to one, (e.g., for lottery (1), .01 x 100 + .99 x 0 = 1),
3) the third lottery is identical to knowing for certain that one person will die.

Table C.1

SPECIAL EXAMPLES OF PROBABILISTIC LOTTERIES

Lottery	Event 1		Event 2		Expected Value
	Prob.	No. of Deaths	Prob.	No. of Deaths	
(1)	.01	100	.99	0	1
(2)	.1	10	.9	0	1
(3) (Certainty)	1	1	0	0	1

Society is said to be "risk averse" if it prefers the third lottery to either the second or the first, i.e., if it prefers to know for sure that one person will die rather than accept a lottery in which some people might die or no one might die. The essential idea is that society dislikes uncertainty if it is risk averse. Notice that this definition does not permit a comparison between lotteries (1) and (2).

In the special case of a comparison between two lotteries with the same expected value, a stronger form of risk aversion, denoted "catastrophe avoidance," can also be applied. A society exhibits catastrophe avoidance if, in such comparisons, it always prefers the lottery in which the largest number of deaths which might occur is smallest. In the special examples shown in Table C.1, the potential number of deaths in the second event is smaller than the potential number of deaths in the first event. Thus, a society which exhibits catastrophe avoidance would prefer lottery (3) to either of the others, and would prefer lottery (2) to lottery (1).[1]

If society does, in fact, wish to avoid catastrophe, actions taken to lessen the likelihood of aviation fatalities benefit not only those who fly, but the public in general. Keeney has shown that if society is risk averse, then it also exhibits catastrophe avoidance.[2] Hammerton, Jones-Lee, and Abbot[3] have reported experimental data regarding human attitudes toward risk which provide support for the hypothesis that if society has preferences over lotteries, then those preferences show risk aversion. Thus, indirectly, these authors' results give credence

to the proposition that society wishes to avoid the catastrophic loss of life. FAA programs which lessen the likelihood of a fatal aviation accident, therefore can be seen as serving the public interest.

Formal Argument

Let a lottery be defined as a pair of events (x, y) such that x occurs with probability p, and y occurs with probability (1-p). Kenney considers only the subset of such lotteries in which y=0. His definition of the catastrophe avoidance assumption is then:

> Def.: Catastrophe avoidance holds if a probability, p of having x fatalities is preferred [by society] to a probability p' of having x' fatalities for any x<x', given that px=p'x'.

Based on this definition, Kenney states and proves the following result regarding social expected utility functions.

> Theorem: Catastrophe avoidance holds if and only if the utility function over the number of fatalities is risk averse.

The experimental evidence collected by Hammerton, Jones-Lee, and Abbott supports the proposition that:

> ...if social decisionmaking criteria are fundamentallly individualistic and utilitarian, reflecting the interests and preferences of individual members of the society, then the N.M. utility function over the number of fatalities should be decreasing and concave, at least over an initial interval of its domain.[4]

Recalling that an expected utility function is risk averse if and only if it is concave, and noting that a function defined

over the number of fatalities is the same as a function defined over lotteries in which no fatalities occur with probability (1-p), one can apply the theorem to infer that society does, indeed, exhibit catastrophe avoidance.

NOTES

[1] For a textbook treatment of economic behavior under uncertainty, see: Walter Nicholson, Microeconomic Theory: Basic Principles and Extensions, Second Edition, (Hinsdale, IL, The Dryden Press, 1978), Chapter 6. It should be noted that there is disagreement as to whether a meaningful set of social preferences can be constructed. See Nicholson, op. cit., pp. 549-51.

[2] Ralph Keeney, "Equity and Public Risk," Operations Research, Volume 28 (May-June 1980), p. 532.

[3] M. Hammerton, M.W. Jones-Lee, and V. Abbott, "Equity and Public Risk: Some Empirical Results," Operations Research, Volume 30 (Jan.-Feb. 1982), pp. 203-207.

[4] Ibid, p. 205.

APPENDIX D

CALCULATION OF LOW-ACTIVITY TOWER ACTC COSTS BY THE PUBLIC SECTOR FY1986-FY1997

This appendix details the calculation of the costs of providing air traffic control towers at low-activity airports in the fiscal years 1986-1997. The calculations rest on the assumptions stated in the text. They were based on 1984 data and then extrapolated.

Table D.1 breaks down assumed costs for contract towers. Of particular note is the category "Expected Cost Increases Above 1984 Level." This category addresses the belief by administrators of the contract-tower program that there will be a real increase in contract costs over the 15-year contracting period for each tower, primarily due to rising insurance costs. Since it is not possible to predict exactly what these increases will be, an alternative method was adopted. It was assumed that there is a cost above which the FAA would find it less expensive to run a tower itself, than to continue with a contract. The major cost for the FAA in making a transition from a contract back to FAA operation of a tower is the personnel change of station (PCS) cost. It was assumed that PCS costs for five controllers, totaling $200,003 plus the training cost for one controller of $34,456 (all in 1992 dollars) would be incurred if the FAA took over the operation of a contract tower. This cost was amortized over the 15 years of the contracting period, giving

Table D.1

ASSUMED COSTS FOR CONTRACT TOWERS (1992 Dollars)
FY 1985 - FY 1997

Costs to Contractor

Controllers: 1 G.S. 11 - Step 5, fully burdened	$ 57,734
4 G.S. 10 - Step 5, fully burdened	132,648
Administrative Equipment - 3.5% of total labor	8,074
	$203,457

Costs to FAA

Maintenance: 1 G.S. 7 - Step 5, burdened for .45 person years	$ 13,583
Leased Communications and Utilities	19,105
Expected Cost Increases Above 1984 Levels	15,630
	$ 48,318

Total Cost	$251,775

an annual cost of $15,630. The assumption, therefore, was that if annual costs (measured in 1992 dollars) were to rise by more than $15,630, the FAA would reassume responsibility for operating the [illegible].

The calculation of estimated costs for towers failing to [illegible] FAA discontinuance criteria in 1992 is shown in Table D.2. The annual site costs of $450,917 for Level I towers and [illegible] for Level II towers are the arithmetic means of the 1992 [illegible] for the sets of these two types of towers which fail Phase [illegible] criteria using 1992 traffic data.

For the years 1985-1992, a linear interpolation was used to find the mean tower costs for the Level I and Level II towers assumed to fail discontinuance criteria. In addition, for each of the fiscal years 1985-1987, $823,085 ($1986) was included as the cost of the two towers (Chico, CA and Salem, OR) which pass Phase II only because they receive subsidized service. The subsidies will end in FY1988, and it was assumed that if these towers then fail discontinuance criteria, they will be among the 16 Level I towers assumed to fail in each year through FY1997.

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Table D.2

ESTIMATED COSTS FOR TOWERS FAILING DISCONTINUANCE CRITERIA IN FY1992

Level I:	11 x 450,917 =	4,960,087
Level II:	4 x 735,802 =	2,943,208
Contract Towers:	5 x 251,775 =	1,258,875
		9,167,170

NOTES

[1] This assumption is optimistic in the sense that it says that the FAA will not be forced to raise its contract payments significantly. However, it represents a compromise, given that the factors which may affect contract negotiations over the next 13 years are virtually impossible to predict.

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