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UNITED STATES GENERAL ACCOUNTING OFFICE

Costly Requirements For Certain Control Towers, Navigation Aids, And Airport Lights

B 164497

Federal Aviation Administration
Department of Transportation

BY THE COMPTROLLER GENERAL OF THE UNITED STATES

911650

DEC 10,1974

COMPTROLLER GENERAL OF THE UNITED STATES
WASHINGTON D C 20548

B-164497

The Honorable H R Gross
House of Representatives

Dear Mr Gross

Pursuant to your request of March 4, 1974, we have reviewed selected Federal Aviation Administration requirements for airports and facilities which, according to some complaints, unnecessarily result in high costs We also compiled certain statistical data on the Federal Aviation Administration's operations and growth

As your office requested, we have not obtained formal comments from the Department of Transportation on the contents of this report We are also sending similar reports to other Members of Congress who requested reports on this subject

We are not making recommendations in this report because of the technical and safety aspects of the subject matter and the lack of formal agency comments We believe, however, that the information should be useful to the Department officials in their studies of existing requirements, and accordingly we plan to provide it to them We plan no further distribution of this report unless you agree or publicly announce its contents

Sincerely yours,

Comptroller General
of the United States

Contents

ABBREVIATIONS

FAA	Federal Aviation Administration
GAO	General Accounting Office
UHF	ultra high frequency
VHF	very high frequency

COMPTROLLER GENERAL'S REPORT TO THE HONORABLE H R GROSS HOUSE OF REPRESENTATIVES

COSTLY REQUIREMENTS FOR CERTAIN CONTROL TOWERS, NAVIGATION AIDS, AND AIRPORT LIGHTS

Federal Aviation Administration
Department of Transportation
B-164497

DIGEST

WHY THE REVIEW WAS MADE

GAO was asked to examine Federal Aviation Administration (FAA) requirements and costs for selected items of equipment and facilities procured by FAA

GAO primarily reviewed complaints that FAA requirements were too stringent and caused associated costs to be unnecessarily high

At Congressman Gross' request, GAO did not obtain formal written comments from the Department of Transportation on matters discussed in this report

FINDINGS AND CONCLUSIONS

FAA pays the cost of establishing and maintaining control towers and radio navigation aids procured under its facilities and equipment activity It also provides matching grants to local airport sponsors for lighting and other airport development under its Airport Development Aid Program

State and local agencies sometimes pay for these items without Federal assistance to avoid FAA requirements or when Federal funds are not available

Facilities and equipment procured with Federal funds must meet detailed FAA standards, while projects without Federal funds generally are not subject to these standards unless they are radio navigational aids Radio navigational aids established without Federal funds must meet FAA's general performance and maintenance requirements

Airport traffic control towers

The least expensive FAA low-activity airport traffic control tower GAO reviewed cost $189,000 while costs ranged from $32,000 to $128,000 for five non-FAA towers GAO reviewed

Cost differences are due primarily to differences in floorspace and construction material, but--according to FAA and local officials--both towers perform the same basic function satisfactorily

For its own towers, FAA generally requires enough space in the tower cab for three controllers to operate simultaneously--one each for controlling airborne traffic and ground traffic and for coordinating flight data It also requires administrative space in the tower shaft for a chief's office and a training room

These space requirements frequently result in a non-FAA tower being unacceptable for FAA use Non-FAA towers generally operate with only one or two controllers However, an FAA official said flight data may be monitored somewhere other than in the tower cab

GAO observations of the standard FAA tower and several non-FAA towers indicated that although the FAA tower is more spacious, the space in the non-FAA towers appeared to be adequate for controlling air traffic and for administrative functions (See p 3)

Radio air navigation aids

Complaints have been made that FAA radio air navigation aids--omnirange facilities--are unnecessarily costly Omnirange facilities are designed to assist pilots maintain accurate flight courses

One case specifically cited is the proposed facility in the mountains near Salmon, Idaho According to the State's estimate, it could be established for about $152,000 rather than the $600,000 estimated by FAA Both these estimates contained errors

Correction of errors without changing the basis on which estimates were prepared results in an estimated construction cost of $186,000 for the State facility and $471,200 for the FAA facility

Costs of FAA omniranges are high because FAA has achieved availability in excess of 99 percent in its omnirange facilities and is attempting to achieve 100 percent availability To achieve high availability, FAA requires that omniranges always be accessible for maintenance, regardless of weather and other hindrances

Accordingly, FAA plans to spend $75,000 for a road to the Salmon facility and $20,200 for a snow vehicle and garage The State proposed a jeep trail which would probably be impassable at times and proposed using a smaller snow vehicle

FAA also requires that electrical generators and dual electronic components be installed as back-up systems A generator for the Salmon facility will cost an estimated $19,000 and dual electronic components will cost about $56,000 An FAA study shows that dual components result in a 0 5 percent decrease in the number of outages

FAA bases its requirements on the general need for airway safety Although safety is a legitimate overriding concern in designing omnirange facilities, FAA has not adequately considered the need for the 100 percent availability it seeks at each facility

FAA officials advised GAO that certain omnirange facilities are more critical than others Outages of several hours or days cause air traffic to be rerouted to other airways or require closer monitoring on radar by the cognizant FAA air traffic control center

On busy routes, these changes might impair safety because controllers and airways used as alternatives would be overburdened by the additional traffic On less busy routes, however, these changes might not overburden controllers or airways

FAA recently undertook an omnirange project near Sandusky, Ohio, in which it contracted with an equipment manufacturer for a complete facility meeting FAA's major performance requirements The Sandusky project should give FAA some indication of whether the costs of establishing omnirange facilities can be reduced by using this turnkey method (See p 11)

Airport lights

Airport lighting approved by FAA costs substantially more than nonapproved lighting because of FAA's more extensive and demanding equipment and installation requirements FAA requires that (1) more powerful runway lights be installed, (2) they be installed differently, and (3) additional equipment be installed with runway lights

Sponsors of smaller airports frequently have found FAA's requirements excessively costly and rather than seek Federal financing have installed less costly lighting systems at their own expense According to State and local officials, the less costly, nonapproved lighting meets their airports' needs and is inexpensive to maintain

FAA has contracted for studies to review and identify lighting and runway construction needs of small general aviation airports because of the controversy between FAA and the aviation community over costly requirements imposed on sponsors seeking Federal funds These studies are expected to be completed about December 1974

FAA's requirement under its Airport Development Aid Program for installation of visual approach slope indicators on all runway lighting projects results in significant cost increases for runway lighting systems Visual approach slope indicators are precisely aimed beams of red and white light which give pilots a visual indication of whether they are on the proper glideslope on their landing approach These indicators cost from $9,400 to $17,000 per runway

Nebraska and Iowa aviation officials, airport managers, and pilots interviewed by GAO objected to the slope indicator requirement They agreed that slope indicators are very helpful but believed they should be required only when obstructions or safety hazards existed in approaches to an airport

GAO noted that under its facilities and equipment activity, in which FAA pays the full cost of the slope indicator installation, installation of each slope indicator must be justified on the basis of an existing runway approach safety hazard (See p 22)

CHAPTER 1

INTRODUCTION

At the request of Congressman H R Gross, we reviewed Federal Aviation Administration (FAA) requirements and costs for selected equipment and facilities to determine whether the requirements were too stringent and caused associated costs to be unnecessarily high.

On the basis of the Congressman's request and subsequent discussions with his office, we gathered information on the costs resulting from selected FAA requirements for airports, facilities, and equipment and, where possible, evaluated the reasonableness of these requirements and costs The equipment requirements selected for review have been the subject of public complaints that they result in excessive costs to the Federal Government and airport sponsors. We also compiled, at the Congressman's request, various statistical data on the performance and growth of FAA (See apps. I to IV.)

The Federal Aviation Act of 1958 (49 U.S C 1346, 1348, 1421) provides the FAA Administrator with responsibility to

--Encourage and foster the development of civil aeronautics and air commerce in the United States and abroad.

--Acquire, establish, improve, operate, and maintain air navigation facilities

--Provide facilities and personnel for the regulation and protection of air traffic

--Prescribe minimum standards and regulations

FAA funds airport and air navigation facilities under its facilities and equipment activity and the Airport Development Aid Program State and local governments also fund airport facilities and development

Under its facilities and equipment activity, FAA procures, establishes, and improves air navigation facilities. It also operates and maintains these facilities In fiscal year 1974, the facilities and equipment budget was $250 million. The Airport Development Aid Program provides local sponsors with matching grants to build or improve public airports and certain airport facilities Authorized funds for this program totaled $300 million in fiscal year 1974

Facilities and equipment procured with Federal funds are required to meet detailed FAA standards, while projects without Federal funds, unless they are radio navigational aids, generally are not subject to these standards. Radio navigational aids established without Federal funds must meet FAA's general performance and maintenance requirements

SCOPE OF REVIEW

We examined FAA requirements and costs for recent or programed facilities and equipment procurements--radio navigational aids and low-activity airport traffic control towers--and for certain facilities partially funded under FAA's Airport Development Aid program--lighting equipment used at airports. For comparison, we also examined certain non-Federal facilities The locations selected for our review were not chosen on a scientific basis and, accordingly, may not be representative of other locations, especially the non-FAA facilities.

We examined FAA policies, specifications, requirements, standards, research reports, and cost records for the selected facilities and equipment. We visited facilities, equipment, and airport sites and interviewed FAA and local officials and pilots at locations suggested in the request and those we selected in Idaho, Illinois, Indiana, Iowa, Massachusetts, Missouri, Nebraska, Ohio, Texas, and Vermont. We also interviewed responsible FAA headquarters officials, State aviation officials, facility and equipment manufacturers, and FAA officials in the five regional offices having jurisdiction over FAA activities in the above States

CHAPTER 2

AIRPORT TRAFFIC CONTROL TOWERS

FAA standards for designing, building, and equipping its low activity control towers exceed what it suggests for locally financed towers at similar airports As a result, FAA towers are much more costly than those constructed without Federal funds although both structures perform the same basic function. Since 1972 FAA has contracted to install 95 control towers at low-activity airports at a total cost, including engineering and equipment, of about $23 million The least expensive FAA tower we reviewed in detail cost about $189,000, while non-FAA towers ranged in cost from $32,100 to $128,000 at five locally operated towers which we visited.

FAA builds and staffs airport traffic control towers to increase safety and expedite aircraft movement in and around airports Tower controllers monitor and direct local airborne traffic as well as aircraft and vehicular movement on airport surfaces. State and local sponsors sometimes build non-FAA control towers at their own expense at airports where FAA determines that traffic does not warrant an investment FAA does not establish towers at airports with less than 20,000 itinerant flights[1] a year if the airport receives scheduled air carrier service, if it does not receive air carriers, it must have at least 50,000 itinerant flights a year.

Local authorities usually request FAA's advice on tower design and siting, and FAA must certify the controllers If air traffic reaches the minimums for FAA tower service, FAA sometimes assumes the responsibility for operating the tower

FAA defines a low-activity tower as one which does not have radar equipment and which handles less than 500,000 total operations per year under visual flight rules While low-activity FAA towers generally serve more traffic than non-FAA towers, the additional traffic is not enough to

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[1]A flight from or to another airport.

change the type of tower needed Local officials said safety has not been a problem at any of the airports included in our review since the towers were established

REQUIREMENTS

FAA does not prescribe the physical characteristics of non-FAA control towers but it suggests that these towers should be designed and sited to provide controllers with a good view of the airport, approaches, and traffic pattern

In determining whether an existing tower facility is satisfactory for its use, FAA requires that the tower meet the same visibility standards as suggested for nonfederally operated towers and that the tower contain adequate space for a tower chief's office and for training, and utility, and sanitary facilities. Although FAA does not specify the space needed for a chief's office and for a training room it provides 140 square feet for a chief's office and plans to provide 140 square feet for training in its own towers.

FAA generally requires enough space in the tower cab for three controllers to operate simultaneously--one each controlling airborne and ground traffic and one coordinating flight data. These requirements frequently result in a non-FAA tower being unacceptable for FAA use

FAA-built towers must meet the same visibility standards as suggested for locally operated towers Recently built FAA towers consist of a shaft made of prefabricated steel modules 18 feet square and 10 feet high, with a hexagonal cab on top. The tower shafts are erected on a concrete foundation and are from 30 feet to 70 feet high. FAA developed its current tower design after we issued a report in June 1966 criticizing the high costs of FAA towers being constructed for low-activity airports In that report "Savings Available by Use of Conventionally Designed Airport Traffic Control Towers at Low-Activity Airports" (B-133127, June 21, 1966) we recommended that FAA institute procedures to insure economical designs for towers at these airports

In adopting the current design, FAA either did not consider or rejected possible cost-savings alternatives. Only steel or concrete construction was considered, and FAA rejected a proposal for a 12-foot square shaft and square cab because it considered that (1) a shaft of that size would not provide enough administrative space and (2) a square cab receives more reflections in the windows than a six-sided one FAA studies show that increasing the number of sides on the cab from 4 to 6 reduces reflections by 11.6 percent if the space enclosed remains the same. All of the non-FAA towers we visited had square cabs

We observed that, although the FAA tower cab is more spacious, the space in the non-FAA tower cab appeared to be adequate for controlling air traffic Our discussions with local airport officials and controllers showed no safety problems in air traffic control at these airports The non-FAA towers also seemed to contain a reasonable amount of space in the shaft for administrative functions, although they contained less than provided for by FAA standards

FAA is moving in the direction of increasing the cost of its towers. After several 30 foot, three floor towers were put into use, FAA determined that the towers needed training space but did not have it Consequently, FAA plans to construct additions to its existing 30 foot towers, and future low-activity tower shafts will contain at least four floors, not to meet visibility requirements, but to provide 140 additional square feet for training.

The standard 30 foot FAA tower has unused space on the ground floor which might be used for training FAA officials questioned using this space for training because the 140 square foot room contains a janitor's sink, telephone relay equipment, and emergency batteries. The room might be usable by arranging the existing equipment properly and by erecting partitions to separate the equipment from the training space. Three of the five non-FAA towers we visited also had unused space which could be used for training

Equipment

FAA suggests that non-FAA towers should be equipped with (1) a local control very high frequency (VHF) radio transmitter and receiver with microphone, (2) a light gun for signalling air traffic if the radio malfunctions, (3) a wind direction indicator, (4) a wind speed indicator, (5) an altimeter, and (6) an accurate clock. FAA also recommends that an ultra high frequency (UHF) transmitter and receiver be used if military aircraft are based at the airport and that sponsors provide a separate transmitter and receiver for control of ground traffic and aircraft training on the airport

In taking over an existing tower or constructing a new tower, FAA requires the following equipment so that the two persons controlling traffic can operate simultaneously

Number	Equipment
2	VHF transmitters
2	VHF receivers
2	Altimeters
2	Wind speed and direction indicators
3	Clocks
2	Signal light guns

In addition the tower equipment must include control and test devices and, if military operations are conducted at the airport, a UHF transmitter and receiver should also be included All equipment must meet FAA specifications

COSTS

Comparative data on FAA and non-FAA control towers which we visited is shown in the following schedule

Comparison of FAA and Non FAA Airport Traffic Control Towers

	Year commissioned	Total cost	Height of shaft (ft)	Usable floor space (sq ft) cab/shaft	Authorized staff	Control hours per day	Number of control positions	Annual itinerant operations
FAA								
Norwood Mass	1973	$189 220	30	128/520	13	16	2	96,000
Beverly, Mass	1975	199,700	40	128/705	9	8 16	2	53 000
Non FAA								
Jefferson City, Mo	1973	32,090	27	79/285	3	16	2	35,000
Anderson, Ind	1972	128 600	30	50/350	3	16	2	27,000
Marion Ill	1970	67 700	30	45/350	3 4	16	2	31,000
Non FAA (with FAA Controllers)								
Norwood Mass	1970	45 300	(a)	[b]55/180	9	16	2	94 000
Appleton Wisc	1970	37 000	(a)	[b]55/400	7	16	2	33 000

[a]These towers are portable house trailer type control towers which do not have shafts

[b]Shaft space is space other than cab space

Each tower listed in the schedule has three floors plus a cab except for the tower at Beverly which has four floors, and the portable towers at Norwood and Appleton, which are house-trailer-type structures with a cab projecting above the roof on one end A comparison of the costs, by major element for the Norwood FAA tower and the Jefferson City non-FAA tower, follows

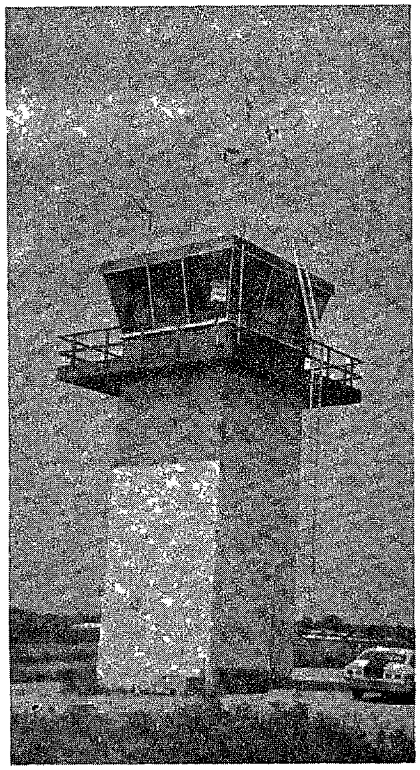
	Norwood FAA	Jefferson City non-FAA
Equipment		
Control equipment	$ 9,830	$ 7,240
Testing devices	6,050	-
Control system	3,150	-
Installation	12,370	(a)
	31,400	7,240
Structure and site preparation	137,290	21,700
Engineering	15,480	2,540
Supplies and miscellaneous	5,050	610
Total	$189,220	$32,090

[a]Included in structure cost

Structure and floor space

The Norwood tower is a standard FAA tower consisting of three prefabricated steel modules and a hexagonal cab The Jefferson City tower has a wooden frame with steel reinforcement and a square cab all constructed at the site The shaft is 12 feet square compared to 18 feet for the FAA tower Photographs of the two towers appear on page 8

Although the FAA cab is more spacious, controllers working in the Jefferson City tower said the cab provided sufficient working space for controlling both air and ground traffic An FAA official said the portable towers contain enough space in the cab for safely controlling the traffic, and the Jefferson City tower cab has more space than the cabs in the portable towers Non-FAA controllers at Anderson and Marion said the cabs were somewhat cramped



JEFFERSON CITY AIR TRAFFIC CONTROL TOWER
(non Federal tower)

STANDARD FAA AIR TRAFFIC CONTROL TOWER

The FAA cab includes a flight data position, not present in the Jefferson City tower No extra equipment is associated with this position and, according to FAA, the extra space is not critical to tower operations since this function need not be performed in the tower cab.

The three-story FAA tower shaft houses electronic equipment, a chief's office, and a lavatory. Telephone equipment and power facilities are on the ground floor but do not fully use the available space The non-FAA tower shaft houses an office, a lavatory, and mechanical equipment on two floors, leaving the ground floor empty. Electronic equipment is in the cab and the air conditioning unit is outside

Equipment

The cost differences in equipment are attributable primarily to FAA's use of more equipment and more sophisticated equipment than is installed in the non-Federal facility The non-Federal tower at Jefferson City had as many radios as the FAA towers, and the Jefferson City radios had been flight tested and found satisfactory by FAA The FAA radio system, however, includes a control system which makes it more convenient for the controllers to change radio frequencies

The Jefferson City tower had two altimeters, as does FAA towers, but had only one wind speed and direction indicator (FAA towers have two), one accurate clock (FAA towers have three), and one signal light gun (FAA towers have two).

Local sponsors are free to select tower equipment to satisfy their needs. FAA tower equipment specifications are, for the most part, very detailed and promote uniformity. FAA adheres to these specifications because they create a standardization that eases supply support and maintenance

Agency officials said FAA has no formal system to solicit other equipment now being manufactured The officials said that, in some cases, they solicit comments from industry on their specifications and evaluate other equipment but their procedures are informal and are not documented

Engineering

FAA tower engineering costs are higher than those associated with non-FAA towers, because FAA has a resident engineer at the site throughout the construction period to provide inspections and advisory services On the Jefferson City tower project, the local sponsor performed periodic inspections One FAA resident engineer may be responsible for more than one project at one time.

CONCLUSIONS

FAA air traffic control towers for low-activity airports are more costly than those constructed by local governments. Although differences exist between FAA towers and non-FAA towers, both apparently perform the same basic functions satisfactorily. Under these circumstances it appears that FAA could save money by reevaluating its low-activity control tower requirements.

CHAPTER 3

AIR NAVIGATION RADIO AIDS

FAA designs certain radio navigation facilities for 100 percent availability on the basis of a general need for aviation safety Although safety is a legitimate overriding concern in designing these facilities, FAA has not adequately considered the need for 100 percent availability in each case This high availability is achieved at a significant cost Also, FAA's use of smaller, prefabricated buildings to house the equipment and delegation of more responsibility to contractors might result in reduced costs

OMNIRANGES

VHF omnidirectional radio range facilities (omniranges) are designed to assist pilots in maintaining accurate courses both in airport approaches and in the airways Some of the facilities are easily accessible, such as those at or near airports, while some are relatively inaccessible, such as those on mountaintops

The facilities consist of buildings on a cleared area, electronic equipment, and access roads At December 31, 1973, FAA had 904 such facilities in operation and it continues to modify and improve the system The fiscal year 1974 budget contained about $6 million to install, relocate, and improve such facilities Each facility includes one or more of the following items

- --Omniranges which transmit radio signals to provide civil aviation pilots with highly accurate horizontal guidance information Omniranges are used extensively by general aviation pilots as well as air carrier pilots as aids for airport approaches and for navigation between airports

- --Distance measuring equipment which tells a pilot how far he is from the transmitting facility Distance measuring equipment is frequently installed with an omnirange

--A counterpoise which is a flat circular surface, either on the top of the building or at a higher nearby location, designed to reflect the radio signals accurately from the accompanying antenna

The general aviation public have complained that FAA omnirange facilities are unnecessarily costly One case is a proposed facility in the mountains near Salmon, Idaho, which reportedly could be established for about $152,000 rather than the $600,000 estimated by FAA We examined the differences in these estimates and FAA's plans for omnirange facilities at Comfort and Welfare, Texas

Salmon facility

Idaho had originally considered constructing an omnirange near Salmon in 1971 and then transferring the facility to FAA for operation and maintenance FAA rejected this proposal, because it did not meet FAA's standards and decided to proceed with its plans to install an FAA en route omnirange in the Salmon vicinity The exact site had not been determined as of September 1974 FAA estimated the facility would cost $600,000, although the estimate is preliminary and not precise since detailed planning had not been performed

When the FAA estimate became known, controversy developed over the facility's high estimated cost and the State estimated that the facility could be established for about $152,000 This estimate was based primarily on an informal price quoted by an equipment manufacturer for a building and equipment, in place

Both estimates contained errors, as discussed in the following pages, and if corrections were made without changing the basis on which they were prepared, the State's estimate would be $186,600 and the FAA's would be $471,200

FAA's requirements for high availability will add an estimated $170,200 to the cost of the Salmon facility, but the State's estimate included $27,400 for features intended to increase the facility's availability The remaining $141,800 difference results from FAA's plan to obtain several items and services separately, which the State assumed were included in the equipment manufacturer's quote

Errors in estimates

The $128,800 deduction from FAA's $600,000 estimate consists of the following

Special study not directly related to the project	$100,000
Miscalculation of grading cost	15,000
Overstatement of generator cost	9,000
Overstatement of garage cost	4,800
	$128,800

The $34,600 addition to the State's estimate consists of the following

Understatement of cost of	
Generator	$ 16,000
Power line	10,000
Garage	2,800
Omission of flight testing	12,800
	41,600
Less overstatement in cost of grading	7,000
	$ 34,600

FAA's estimate for the Salmon facility includes $100,000, which represents a portion of the cost of a special FAA study on air navigation This study does not relate directly to the Salmon facility, and including a portion of its costs for purposes of comparing the FAA and State estimates is not appropriate

By inadvertently using an incorrect factor, FAA estimated that grading the site would cost about $30,000 Use of the correct factor results in an estimate of $15,000 The State included an extra $7,000 for grading the counterpoise, but its $15,000 estimate for site grading sufficiently covered the cost of grading the counterpoise

FAA estimated that an emergency generator and its installation would cost $28,000, while the State estimated it would cost only $3,000 FAA's recent experience indicates that $19,000 is a more accurate figure

FAA estimated that the garage for the snow vehicle would cost about $10,000, while the State estimated it would cost about $2,400 Our independent inquiries indicated that $5,200 is a more accurate estimate

The State estimated that an electrical power line to the facility would cost about $25,000 Our independent inquiries in the Salmon area indicated that FAA's estimate of $35,000 for this item is a more realistic figure The State estimate did not include an amount for flight testing the facility after it is completed, because FAA would perform this service at no cost to the State

Requirements associated with high availability

FAA has achieved availability in excess of 99 percent in its omnirange facilities and is attempting to achieve 100 percent availability FAA officials said certain omniranges are more critical than others For example, the high altitude omniranges mark major high altitude airways used by airlines, and their signals must be accurate and constant at high, as well as low, altitudes About 300 of FAA's 900 omniranges are high altitude facilities

The cost of 100 percent omnirange availability is substantial, especially in the case of the proposed Salmon facility The estimated costs of the high availability features FAA plans to design into the Salmon facility are shown below

Access road	$ 75,000
Dual electronic equipment	56,000
Emergency generator	19,000
Snow vehicle	15,000
Garage for snow vehicle	5,200
	$170,200

The need for the access road, snow vehicle, and garage are unique to mountaintop locations, such as Salmon, but FAA provides dual electronic equipment and generators at all high altitude omnirange facilities Generators are also installed at certain other critical omnirange facilities

To promote its goal of 100 percent availability, FAA requires that omniranges be accessible to maintenance personnel at all times, regardless of weather or other hindrances It also requires that omnirange facilities receive routine inspection and maintenance at least weekly to insure high availability In order to meet these requirements, FAA plans to construct a road up the mountainside to the Salmon facility and to keep a snow vehicle in a garage near the State highway

No documentary support on the development of the maintenance requirements was available, although an FAA official stated it was based on engineering judgment and International Civil Aviation Organization recommendations The State did not agree with FAA's requirement for accessibility at all times and considered that a jeep trail to the facility would be adequate State officials said a bulldozer could clear a jeep trail at very low cost but this cost was not included in their estimate A jeep trail could become impassable, however, due to quick thaws and rainstorms FAA officials pointed out that the maintenance technician who will repair this facility is stationed about 150 miles away and his trip would be wasted if he traveled to the base of the mountain and the trail to the top was impassable

FAA plans to acquire a large tracked snow vehicle for about $15,000, while the State anticipated acquiring a smaller snowmobile-type vehicle for about $3,200 The State and FAA estimates were based on building similar metal garages near the State highway for the snow vehicle Our inquiries of FAA, State, and local power company personnel and forest rangers indicated that the larger vehicle would permit instant responses, as required by FAA, in soft dry snow and in storm conditions that are experienced in the Salmon area during the winter months These inquiries indicated that snowmobile-type vehicles are not satisfactory under these conditions

FAA requires the installation of dual electronic components at all high altitude omnirange facilities so that, if one component fails, another is available to take over Although FAA considers this requirement necessary to minimize unplanned outages, an FAA study showed a 0 5 percent decrease in unplanned outages by installing dual equipment The requirement was applied to the Salmon facility at an additional cost of $56,000

If a high altitude omnirange were to be out of service unexpectedly and to remain out of service for several hours or days, high altitude air traffic would have to be rerouted or more closely monitored on radar by the cognizant FAA air traffic control center On busy routes, these changes might impair safety, because the controllers and airways used as alternatives would be overburdened by the additional traffic

The officials stated, however, that the closer radar control or rerouting of air traffic would not overburden either the controllers or the alternate airways on less busy routes The rerouting of scheduled airline flights could result in delays, but flights receiving close radar monitoring could be expedited, because they might be more direct than originally planned FAA has not determined whether the net results of omnirange outages justify the added expense incurred in attempting to achieve 100 percent availability These effects of an outage in a high altitude omnirange were corroborated by our interviews with several airline pilots According to a local FAA official, the proposed Salmon facility is a high altitude omnirange, the outage of which probably would not overburden controllers or alternate airways

Items included in State-proposed contract

Pursuant to the contract the State had planned with an electronic equipment manufacturer, the State would have relied on the manufacturer to perform several functions and supply several items FAA showed separately in its estimate These items accounted for $141,800 of the differences in the two estimates as shown below

Building	$ 27,600
Freight, provisioning, and factory inspections	33,000
Other inspections and engineering	54,200
Antenna foundation and cable	20,000
Antenna shelter and miscellaneous equipment	7,000
	$141,800

A representative of the manufacturer confirmed that the manufacturer would have supplied most of these items and services, but not necessarily to the same extent as required by FAA For example, FAA performs factory inspection of the electronic equipment in addition to those done by the manufacturer. Also, FAA incurs high engineering and site inspection costs because FAA evaluates proposed sites and otherwise plans omnirange facilities more thoroughly than proposed by the State, and it supervises the facilities' construction more closely

The manufacturer's informal price quote to the State included a circular metal panel building 15-1/2 feet in diameter The State added about $2,400 to its cost estimate to enlarge and insulate the building

FAA estimated it would cost $30,000 to erect a standard 25 foot by 31 foot concrete block building it designed in 1965 to house tube-type electronic equipment and an emergency generator The Salmon facility will use solid state omnirange and distance measuring equipment, however, which takes only about half the space of tube-type equipment The building was also designed to house other equipment which will not be included in the Salmon facility

An FAA Headquarters official said that in developing the 1965 design, FAA determined that it would be less costly to construct a concrete block building than a prefabricated-type building but could not explain how that determination had been made Another headquarters official said he considers it generally known that prefabricated construction is less costly than concrete block construction

FAA is developing a new building design of prefabricated construction to house a solid state, single transmitter omnirange. The design is to be for a building that can be expanded as needed to accommodate additional equipment, such as dual omnirange or distance measuring equipment The new design will not include space for an emergency generator, because FAA plans to use separate trailer-type shelters for emergency generators

The new building design had received a relatively low priority but after we brought this matter to FAA's attention, FAA promised to accelerate the work so that the new design will be available in time for the Salmon project

FAA procurement of omnirange with complete installation by manufacturer

In June 1974 FAA awarded its first contract for a complete package omnirange facility designed and installed by an electronic equipment manufacturer The project will cost about $184,600 consisting of the contract price of $149,700 and about $30,300 for FAA engineering, contract supervision, and flight inspection, and $4,600 for miscellaneous equipment The contract requires the manufacturer to furnish all plant, labor, materials, and equipment necessary for installing a complete terminal omnirange with distance measuring equipment to meet FAA performance and flight test standards The facility is being installed at the Griffing-Sandusky Airport near Sandusky, Ohio

The Sandusky facility will be a terminal omnirange and therefore will not include the features for accessibility and high availability discussed earlier However, the turnkey procurement concept might also be cost advantageous for en route omniranges The same type of eletronic equipment is to be used in this facility and in the high altitude facilities we reviewed with the major difference being that only single electronic components will be used The $30,300 for FAA engineering and inspection is significantly lower than the $52,400 estimated cost for these items at the Comfort, Texas, omnirange facility

FAN MARKERS

FAA generally installs the same makes and models of fan marker equipment as those installed by State and local agencies, and equipment costs have generally been about the same, however, FAA's installation costs are usually higher

A fan marker is an electronic device that identifies an exact location on an airway or on the approach course of a runway It is usually mounted on a standard utility-type pole with the antenna at the top and the electronic equipment and emergency battery pack mounted on the pole near the bottom or in a separate shelter on the ground All fan markers, including those installed by State and local agencies, must be flight tested and approved by FAA before they can be put into operation

We examined the comparative costs of fan markers because Nebraska charged that it could obtain this equipment at an installed price of $3,200, whereas costs under FAA requirements were as much as $26,000 Nebraska had not installed any fan markers in recent years and State officials were unable to substantiate the charge We did find that FAA and a State had recently installed fan markers in New England, and we compared the costs of these installations

Equipment costs of seven FAA fan marker projects completed since 1969 ranged from $950 to $2,500, except for one advanced model which cost $4,100 Equipment costs in three non-Federal projects during this same period ranged from $1,250 to about $2,600

Installation costs for the equipment varied considerably because of unique location features, but non-Federal costs have generally been less than those incurred by FAA FAA's installation costs have ranged from $5,600 to $13,000 compared to costs of $3,500 and $3,900 for two State projects we reviewed The following table summarizes the installation costs for these two projects and two recent FAA projects

	FAA projects		Non-FAA projects	
	Middlesex, Vt	Manchester, N H	Toppsfield, Mass	Canton, Mass
Engineering	(a)	$2,463	$ 400	$ 400
Construction and installation	$9,907	2,919	3,175	2,790
Flight test	(a)	355	300	300
Total	$9,907	$5,737	$3,875	$3,490

[a]Part of a larger project and costs cannot be separately identified Such costs are estimated to be at least as great as those for Manchester

State officials estimated the amounts shown for engineering and flight checking non-Federal projects because the actual costs were not charged to specific projects.

The Middlesex project included several unusual features, which account for about $4,600 of the $9,907 installation cost The fan marker was sited in a marsh and the land owner required FAA to bury the electrical cable and to paint and fence the equipment so it would blend with the natural environment

FAA's Manchester installation involved no complications and the installation costs were about minimum for recent installations Neither State project included any unusual features, and State officials explained that, if possible, difficult or expensive projects are avoided

FAA engineering costs were higher primarily because FAA obtained legal interests in the property by leases, which required land surveys The Manchester land survey took 17 man-days and cost about $1,500

One of the State fan markers is located on State-owned land, the other is located on private land where the owner permitted installation at no cost Under these circumstances the States did not obtain legal descriptions of the property or incur any costs related to such matters

CONCLUSIONS

The design and maintenance of FAA omnirange facilities result in more than 99 percent availability. Although such high availability may be justified by safety considerations in some cases, the associated cost is significant. The three proposed high altitude omniranges included in our review are to be designed for 100 percent availability, but FAA has not adequately considered the need for this degree of availability at these facilities.

On most of its omnirange projects, FAA incurs substantial costs for engineering, inspection, and supervision. On its project for an omnirange near Sandusky, Ohio, however, a contractor, who was responsible for installing a complete facility meeting FAA's major performance requirements, performed many of these and other functions. The Sandusky project should give FAA some indication of whether the costs of establishing omnirange facilities can be reduced by using a turnkey contract.

FAA pays about the same for fan marker equipment as the States, and its higher installation costs are attributable to engineering costs associated with land acquisition.

CHAPTER 4

AIRPORT LIGHTS

FAA-approved airport lighting costs substantially more than nonapproved lighting because of FAA's more extensive and demanding equipment and installation requirements In the past, FAA has not directed its attention to the needs of small general aviation airports but has based requirements on equipment and systems designed for the larger air carrier airports Sponsors of the smaller airports frequently have found FAA's requirements excessively costly and rather than seek Federal financing have installed less costly lighting systems at their own expense According to State and local officials, the less costly nonapproved lighting meets the needs where it is installed and is not expensive to maintain

FAA has contracted for studies to review and identify the needs of small general aviation airports as the result of the controversy between FAA and the aviation community over these costly requirements imposed on sponsors seeking Federal funds These studies emphasize runway construction and airport lighting and are expected to be completed about December 1974

RUNWAY LIGHTS

Runway lighting meeting FAA's minimum requirements cost several times as much as runway lights installed by State and local governments without FAA assistance FAA requires that (1) more powerful lights be installed, (2) they be installed differently from the State and local installation, and (3) additional equipment be installed with the runway lights. The FAA light fixtures are also of a different design The practices followed by State and local governments result in runway lights which are satisfactory to the users of the airports and are not costly to maintain.

Runway edge lights are white lights installed at the sides of runways to make the runway more discernible during darkness or other periods of low visibility Red and green runway lights are installed at the ends of runways

The possible difference in costs is shown in the following table which contains the estimated costs for a State runway lighting project at Tekamah, Nebraska, and FAA's estimate of what it would have cost to complete the same project in accordance with FAA's requirements

	Estimated State costs	Estimated costs to meet FAA requirements
Lights and installation	$5,339	$13,600
Beacon light	1,625	1,675
Visual approach slope indicator	0	13,093
Engineering	700	2,837
Administration and contingencies	300	1,419
	$7,964	$32,624

The actual costs paid by the State for the Tekamah project totaled only about $3,600 The State obtained several items included in the project at no cost including surplus cable, a surplus beacon light, and the use of a State-owned trenching machine for which it estimated costs. The State does not require the installation of a beacon light, although one was included in this project, while FAA requires that an airport have an approved beacon light or agree to install one for a runway lighting project to receive FAA assistance.

We reviewed two recent Federal and six recent non-Federal runway lighting projects in Iowa and Nebraska and found the cost differences generally comparable to the cost differences estimated for the Tekamah, Nebraska, project

Airport beacon lights

FAA-approved beacon lights can be purchased for as little as $625, and installation costs on projects we reviewed ranged from about $1,000 to $7,000 depending on how and where it was installed Our review showed that, where the need for a beacon was agreed upon, the FAA beacon was not unreasonably costly compared to the cost and performance of nonapproved beacons, and FAA's installation requirements were not unduly restrictive or burdensome

Visual approach slope indicators

FAA generally requires the installation of a visual approach slope indicator on each end of each runway on which new runway lighting systems are being installed under the Airport Development Aid Program These indicators cost from about $9,400 to $17,000 per runway State and local runway lighting projects in Iowa and Nebraska did not include slope indicators and, under FAA's facilities and equipment activity, slope indicators must be justified on a case-by-case basis.

Visual approach slope indicators are highly directional and precisely aimed beams of red and white light which give pilots preparing to land a visual indication of whether they are on the proper glideslope or whether they are too high or too low If the approaching pilot sees all red, he is too low, if he sees all white, he is too high, if he sees both colors, he is on the proper glideslope. Visual approach slope indicators help (1) prevent overshoots and undershoots on landings, (2) assist in noise abatement, and (3) insure that aircraft clear hazards along the approach paths

The requirement for slope indicators exists under FAA's Airport Development Aid Program through which FAA provides matching funds to airport sponsors. However, under FAA's facilities and equipment activity, in which FAA pays the full cost of installation and maintenance, installation of a slope indicator must be justified by a specified activity level and by a safety problem in the approach to the runway The latter policy is in accordance with the views expressed by State aviation officials in Nebraska and Iowa who said the installation of a slope indicator should be contingent upon the existence of a hazard and should be evaluated on a case-by-case basis.

FAA began requiring visual approach slope indicators under its matching grant program in 1970, because statistics showed that about 50 percent of general aviation accidents occurred during the approach and landing phases of flight FAA officials said they knew of no documents or studies which would indicate the percentage of the accidents that might have been prevented if a slope indicator had been present

Before establishing the requirement, FAA solicited the views of interested parties Several organizations, especially those representing agencies financially affected by the requirement, objected to it We interviewed airport managers and pilots who stated that slope indicators are very helpful, especially when there are obstructions along the approach path, but they questioned FAA's overall requirement for slope indicators at both ends of all lighted runways, especially in view of their high cost

Light fixtures and installation

Until March 1967 FAA provided financial assistance for the installation of low-intensity runway lighting which used 15 to 25 watt bulbs Since that time it has required a system using medium-intensity runway lights (30 watts) because its regional offices commented that the maintenance cost on the low-intensity systems was so high that it offset the low initial cost of the system FAA rejected improving the low-intensity system to reduce maintenance costs because it believed that this action would result in installed cost of low-intensity systems which would be comparable to the cost of medium-intensity systems

The FAA-approved medium-intensity runway light systems use special bulbs which, in combination with specially designed lenses, concentrate light beams up and down the runway with much less light given off directly toward the runway FAA required that the runway edge lights be installed on a series-wired electrical circuit until August 1974 when parallel circuitry was also permitted. Series circuitry requires the use of an isolation transformer at each lighting fixture so that, if a bulb burns out, the remainder of the lights will stay on FAA required series circuitry because (1) each light receives the same voltage and therefore should be of the same brightness and (2) a short in the electrical cable does not affect the operation of the system

The series circuitry in FAA-approved systems requires the use of a constant current regulator, which also eliminates surges that can shorten bulb life and permits the brightness of the runway lights to be adjusted to different levels Catalog prices of these regulators range from $950 to $1,650 depending on the capacity, contract prices, which include installation, range as high as $4,400

In Iowa and Nebraska, many general aviation airports have low-intensity runway lights These lights use standard household-type light bulbs, usually 15 watt size, and the lenses are not designed to concentrate light in any particular direction

Although these lights are not as bright as those in the FAA-approved medium-intensity system and the light is not concentrated, users of the low-intensity systems in Iowa and Nebraska found them adequate State aviation officials in both States said brighter lights may be necessary in locations with highly lighted residential or commercial areas surrounding the airport, but not at isolated locations The low-intensity light systems in Iowa and Nebraska were somewhat different from the design previously approved by FAA and maintenance was not a problem.

At some airports non-FAA-approved medium-intensity runway lighting systems have been installed which are designed to use 40-watt household-type light bulbs. These systems use lenses designed to concentrate light up and down the runway, but the use of household-type bulbs results in less concentration of light than is required for the FAA-approved system

Iowa and Nebraska installed the low- and nonapproved medium-intensity lighting systems using multiple, or parallel electrical circuits, similar to those used in most homes This results in more electrical cable, but does not require the isolation transformers. Lights near the end of a long parallel circuit receive less voltage than lights near the beginning and therefore are not as bright An FAA spokesman told us, however, that there is no reason why a parallel-wired system could not be used with properly designed fixtures on runways, such as those at most general aviation airports because the voltage loss would be insignificant

The FAA-approved lighting fixture costs about $70 to $77, including the isolation transformer, while the nonapproved fixtures cost from about $12 to $16 For the Tekamah, Nebraska, project, 56 light fixtures were used

Most of the nonapproved runway lighting systems included in our review could not be adjusted to different brightness levels, but local officials said this feature could be obtained easily and economically through use of a rheostat.

One of the airports included in our review had a nonapproved runway lighting system which had an unusually large number of bulbs burn out because of surges in the local electrical power supply We were informed that this problem could be solved through use of a regulator which costs an estimated $200.

The special light bulb required by FAA costs about $2 each, while the light bulbs used in the nonapproved systems cost as little as $0.21 each Although the FAA-approved lighting system is designed to insure uniform brightness among the lights, the FAA-required light bulb dims with use, resulting in differences in brightness among the lights. The nonapproved systems we observed were of uniform brightness FAA recommends that all of the bulbs in an approved system be replaced at one time, after about 1,000 hours of use at maximum brightness, which is the rated life of the FAA-approved bulb The sponsors were not following this practice for the approved systems included in our review.

Electrical cable and installation

FAA requires the use of FAA-approved 5,000 volt electrical cable in the installation of federally assisted runway lighting projects, while 600 volt cable is generally used in the nonapproved systems. The 5,000 volt cable is necessary because of the series circuitry required in the FAA-approved system FAA-approved cable costs about 22 cents a foot while the cable used in Iowa's nonapproved systems cost from 4 to 9 cents a foot

FAA requires that electrical cable be buried 18 to 24 inches deep Nebraska buries cable about 40 inches to reduce damage from frost and rodents Both of these practices involve digging a trench and placing the cable in it Digging and refilling trenches has cost from 20 cents to a dollar a foot on FAA-assisted lighting projects. Nebraska costs were not available because it uses municipal personnel and volunteers and State equipment

Iowa generally plows cable into the ground about 6 inches deep at a cost of from 5 to 8 cents a foot. FAA officials noted that the National Electrical Code requires that buried cable be 18 inches or more under the surface In August 1974, FAA began allowing cable to be plowed into the ground

Neither Iowa nor Nebraska has experienced unusual problems resulting from its method of installing electrical cable An Iowa official noted that installing cable by plowing it into the ground is so inexpensive that it is more economical to install new cable than it is to spend time searching for and repairing an electrical short circuit, if one should occur

Cable markers

Cable markers are slabs of concrete 2 feet square and 5 inches thick marked to show the location of cable Cable markers are required to (1) help prevent someone from digging into the cable by accident and (2) help locate the cable if repairs are necessary. These markers cost $20 to $25 each and about 25 of them are needed on a typical project Markers have not been used with nonapproved systems in Iowa and Nebraska A State engineer said light fixtures and engineer's drawings are adequate for determining the location of cables if the need occurs

Engineering

In FAA-assisted runway lighting projects, the local airport authority usually hires a private consulting engineer to perform engineering on the project Costs for these services varied from $2,200 to $9,800 for the projects included in our review On the non-FAA lighting projects, engineering was performed by State or local employees and, in the two cases where records showed engineering costs, they were $66.50 and $700 FAA noted that Federal procurement policies cause them to perform more engineering than is performed on the non-FAA projects The non-FAA engineering cost of $66 50, for example, did not appear to include preparation of formal plans and specifications.

RUNWAY END IDENTIFIER LIGHTS

Costs for FAA-approved runway end identifier lights varied only slightly from nonapproved lights The installation costs on FAA-approved projects we reviewed were significantly higher than on the local projects, because, in the FAA projects, the runway end identifier lights were not connected to the nearest source of power

Runway end identifier lights consist of a pair of lights at the end of the runway which flash simultaneously to help pilots identify the approach end of the runway They flash high intensity white light about twice a second, which effectively overrides other lighting around the airport

Although FAA does not require the costly use of a more distant power source for runwav end lights, it generally follows this practice under its facilities and equipment activity FAA officials said they follow this practice because the regulators for runway edge lights are not usually adequate to accommodate the additional power requirements of the runway end identifier lights They said that the cost of the larger regulators sometimes exceeds the savings in cable costs.

At the times of our visits, Beatrice, Nebraska, and Forest City, Iowa, were each in the process of installing a pair of runway end identifier lights with an FAA grant under the Airport Development Aid Program The contract price at Beatrice was $10,780, including $2,500 for the lights and $8,280 for installing them on a separate electrical circuit using 8,700 feet of cable The contract price at Forest City was $10,179. The contractor's bid did not break down costs by elements but about 14,000 feet of cable will be required to install a separate circuit.

In comparison with the costs for the installations where FAA is participating, we obtained information on three airports in Nebraska and five in Iowa where non-FAA-approved runway end identifier lights were installed at local cost and found that the average cost for equipment and installation was about $1,525 In each case the identifier lights were connected to the runway edge light circuits rather than being on separate circuits or connected to some other power source further away than the runway edge lights

We talked to pilots and airport managers at four Iowa airports and each said he thought the end lights performed as well as the FAA-approved end lights Airport managers at two of the Nebraska airports said they were satisfied with the performance of the end lights at their airports One said that a regional airline serving the airport had expressed favorable reaction to the end lights installed

FAA plans to install runway end identifier lights at 98 locations under its facilities and equipment activity FAA estimates that equipment costs at each location will amount to about $1,650 and that typical installation costs will be $10,000 to $11,000 We reviewed plans for 12 of these installations and found that in every case FAA planned to use a source of power further away than the runway edge light circuits.

FAA EFFORTS TO DEVELOP LIGHTING FOR SMALL AIRPORTS

FAA officials admit that lighting needs vary according to airport size, type, and location The airport lighting needs of an airport located near an urban area would differ from an airport located apart from surrounding lights There have been only a few isolated efforts to improve visual aids for the smaller airports but these generally involved equipment of the type designed for larger air carrier airports For instance, the runway lighting system required by FAA for general aviation airports was originally designed for airports handling jet traffic Also, the present visual approach slope indicator system required with runway light installations replaced a simpler system that was designed for smaller general aviation airports FAA took this action not for safety reasons but because few of the simpler systems had been installed and because it could not be upgraded

FAA's activities in meeting the equipment needs of smaller airports have been largely confined to evaluating proposals from airport operators and manufacturers with little effort devoted to developing or soliciting ideas for new, less costly equipment

FAA recently evaluated a light system in Cambridge, Ohio, which used parallel circuitry and traffic light bulbs rather than the special FAA bulb The traffic light bulbs cost about 25 cents each and last about twice as long as the FAA-approved bulb Also, the traffic bulb does not dim significantly with use FAA-type lenses were used in the system, but the use of traffic light bulbs resulted in less concentration of light than in the FAA-approved system

This evaluation resulted in FAA's approving the use of parallel circuitry for runway lights, but FAA rejected the use of traffic light bulbs on the basis that the lack of light concentration failed to meet FAA standards Our discussions with responsible FAA officials indicated that FAA did not adequately consider whether traffic light bulbs would meet the needs of small general aviation airports

In June 1973 FAA contracted for a technical report discussing the historical development of airport lighting and other visual aids, secondary airport requirements and needs, and problems associated with existing installations This report was expected to be finalized in late November or early December 1974 Another contract was awarded in April 1974 to survey and assemble all available FAA and State design standards and program procedures applicable to runway and associated construction at general aviation airports serving small aircraft. The study is intended to resolve the controversy between FAA and the aviation community over whether technical and administrative requirements and specifications for local airport projects are so exacting and costly that local interests are not seeking Federal funds. The report is due in December 1974

CONCLUSIONS

Generally, FAA lighting requirements result in substantially more costly lighting systems than small airport sponsors can obtain without Federal financing because of (1) more extensive and demanding equipment requirements, (2) additional equipment requirements, and (3) methods of installation. FAA has not adequately considered the needs of small airports in establishing its requirements and, as a result, these airports frequently install less costly lighting systems, which meet their needs, at their own expense rather than seeking Federal assistance.

FAA APPROPRIATION DATA

Fiscal year	Total appropriations	Contract authority available	Resources available (note a)
	(000 omitted)		
1963	$ 700,882	$ -	$ 700,882
1964	758,341	75,000	833,341
1965	658,792	75,000	733,792
1966	791,910	75,000	866,910
1967	922,026	71,000	993,026
1968	849,650	66,000	915,650
1969	832,174	70,000	902,174
1970	1,207,977	80,000	1,287,977
1971	1,579,529	250,000	1,829,529
1972	1,654,874	280,000	1,934,874
1973	1,682,876	280,000	1,962,876
1974	1,742,495	300,000	2,042,495

[a]Includes contract authority and total appropriation Obligations incurred pursuant to contract authority are liquidated with appropriations made for that purpose, usually in subsequent years

FAA RATIO OF FIELD PERSONNEL TO HEADQUARTERS PERSONNEL

(1963-73)

Date	Number of employees: Headquarters (note a)	Number of employees: Field (note a)	Ratio of field to headquarters personnel
(Dec 31)			
1963	4,159	41,459	9.9 to 1
1964	4,191	40,730	9.7 to 1
1965	4,134	39,780	9.6 to 1
1966	3,862	38,982	10.0 to 1
1967	3,859	40,762	10.5 to 1
1968	3,775	42,497	11.2 to 1
1969	3,778	44,553	11.7 to 1
1970	3,917	49,208	12.5 to 1
1971	3,862	50,396	13.0 to 1
1972	3,598	48,930	13.5 to 1
1973	3,625	49,729	13.7 to 1

[a] Includes full-time, part-time, and temporary civilian employees and military personnel assigned on a reimbursable basis

FAA RATIO OF AIRCRAFT HOURS FLOWN TO AVERAGE NUMBER OF FAA EMPLOYEES (1963-73)

Calendar year	Average number of FAA employees (note a)	Total aircraft hours flown	Ratio of aircraft hours flown to average number of FAA employees
1963	45,804	19,232,399	419 to 1
1964	45,337	20,050,764	442 to 1
1965	44,728	21,423,882	478 to 1
1966	43,438	26,127,984	601 to 1
1967	43,931	28,021,842	637 to 1
1968	45,906	30,457,260	663 to 1
1969	47,903	32,091,199	669 to 1
1970	50,977	32,500,351	637 to 1
1971	53,977	31,894,335	590 to 1
1972	53,372	[b]33,602,160	630 to 1
1973	53,187	[b]34,729,000	653 to 1

[a]Based on number of employees on board January 1, June 30, and December 31 each year

[b]This is an estimated figure.

FAA SAFETY RECORDS OF AIR CARRIER AND GENERAL AVIATION AIRCRAFT (1963-73)

Calendar year	Accidents: Air carrier	Accidents: General aviation	Accident rate per 100,000 hours flown: Air carrier	Accident rate per 100,000 hours flown: General aviation	Accident rate per million miles flown: Air carrier	Accident rate per million miles flown: General aviation
1963	77	4,690	1 866	31 0	0 063	2 29
1964	79	5,069	1 809	32 2	0.058	2 32
1965	83	5,196	1 769	31 1	0 054	2 03
1966	75	5,712	1 469	27.2	0.042	1 71
1967	70	6,115	1 193	27.6	0 032	1 78
1968	71	[a]4,968	1.109	20 6	0 028	1 34
1969	63	[a]4,767	0.935	18 8	0 023	1 21
1970	55	[a]4,712	0 850	18.1	0 020	1 47
1971	48	[a]4,651	0 752	18.2	0 018	1.48
1972	50	[a]4,228	0 793	15 4	0.019	1 24
[b]1973	42	[a]4,180	0 643	14 8	0.015	1 19

[a]Accidents included in this figure are those involving fatal or serious injuries or substantial damage to aircraft From 1963 through 1967 substantial damage for light aircraft was defined as $300 or more of damage. Beginning January 1968 substantial damage has been defined as damage which adversely affects the airworthiness of the aircraft--the same definition that has been applied to air carrier aircraft

[b]Information for this year is preliminary data

PRINCIPAL OFFICIALS OF THE DEPARTMENT OF TRANSPORTATION RESPONSIBLE FOR ADMINISTERING ACTIVITIES DISCUSSED IN THIS REPORT

	Tenure of office			
	From		To	
DEPARTMENT OF TRANSPORTATION				
SECRETARY OF TRANSPORTATION				
Claude S Brinegar	Feb	1973	Present	
John A Volpe	Jan	1969	Feb	1973
Alan S Boyd	Jan	1967	Dec	1968
FEDERAL AVIATION ADMINISTRATION				
ADMINISTRATOR				
Alexander P Butterfield	Mar	1973	Present	
John H Shaffer	Mar	1969	Mar	1973
David D Thomas (acting)	Aug	1968	Mar	1969
Gen William F McKee	July	1965	July	1968
ASSOCIATE ADMINISTRATOR FOR OPERATIONS (note a)				
William M Flener (acting)	July	1973	Apr	1974
George S Moore	May	1967	July	1973
Arvin O Basnight	July	1965	May	1967
ASSOCIATE ADMINISTRATOR FOR AIR TRAFFIC AND AIRWAY FACILITIES				
William M Flener	Apr	1974	Present	
ASSOCIATE ADMINISTRATOR FOR AVIATION SAFETY				
James F Rudolph	June	1974	Present	
Oscar Bakke	Apr	1974	June	1974

	Tenure of office	
	From	To
FEDERAL AVIATION ADMINISTRATION (continued)		
ASSOCIATE ADMINISTRATOR FOR AIRPORTS		
William V Vitale (acting)	Apr 1974	Present

[a] This position was eliminated in April 1974