BY THE COMPTROLLER GENERAL

Report To The Chairman, Subcommittee On Transportation, Committee On Appropriations House Of Representatives

OF THE UNITED STATES

Installation Of Automated Weather Observing Systems By FAA At Commercial Airports Is Not Justified

Current surface weather observations at commercial airports made by observers using equipment to measure or estimate nine weather elements meet or exceed the Federal Aviation Administration's (FAA's) operational requirements. These requirements are considered essential to providing airport and area aviation weather forecasts required by law and federal aviation regulations and are important in maintaining aviation safety at commercial airports.

As part of its National Airspace System plan to automate air traffic control facilities in the United States by the year 2000, FAA plans to install 304 automated weather observing systems (AWOSs) costing $60 million at commercial airports across the country. Such systems would collect weather data and distribute this information to pilots, weather observers, and aviation weather forecasters.

GAO found that AWOS performance does not meet FAA's operational requirements for four weather elements and is not cost-effective at commercial airports compared with the existing observer system. Therefore, GAO recommends that the Secretary of Transportation not request funds for installing AWOSs at commercial airports until the system meets these requirements and is more cost-effective than the existing weather observing system.

UNITED STATES GENERAL ACCOUNTING OFFICE

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

B-217700

The Honorable William Lehman
Chairman, Subcommittee
on Transportation
Committee on Appropriations
House of Representatives

Dear Mr. Chairman:

This report is one of a planned series of reports responding to your request that we continuously monitor the Federal Aviation Administration's (FAA's) implementation of its National Airspace System (NAS) plan. It discusses the importance of making automated weather observing systems (AWOSs) as cost-effective as the existing weather observing system and capable of meeting present FAA operational requirements before requesting funds for installing them at commercial airports. We undertook this review to evaluate (1) the performance of AWOS sensors in making weather observations in various FAA tests and demonstrations and (2) the cost-effectiveness of installing 304 AWOSs at commercial airports already having weather observers.

As arranged with your office, we are sending copies of this report to other interested congressional committees, the Director of the Office of Management and Budget, the Secretary of Transportation, and the FAA Administrator. Copies will also be available to other interested parties upon request.

Sincerely yours,

Charles A. Bowsher

Charles A. Bowsher
Comptroller General
of the United States

REPORT TO THE CHAIRMAN
SUBCOMMITTEE ON TRANSPORTATION
COMMITTEE ON APPROPRIATIONS
HOUSE OF REPRESENTATIVES

INSTALLATION OF AUTOMATED WEATHER OBSERVING SYSTEMS BY FAA AT COMMERCIAL AIRPORTS IS NOT JUSTIFIED

DIGEST

Federal Aviation Administration (FAA) weather observers stationed at commercial airports now provide commercial carrier, charter, air taxi, and private aircraft pilots with surface weather observations--information on weather conditions at and near ground level. These observations are standardized measurements of nine different weather elements, such as wind, cloud height, and visibility. These airport weather observations are also provided hourly to the National Weather Service (NWS), which uses them as the basis for aviation weather forecasts required by the Federal Aviation Act of 1958 and federal aviation regulations. (See p. 3.)

Automated weather observing systems (AWOSs) would automatically collect weather observation data and distribute the data to pilots, FAA weather observers, and NWS aviation weather forecasters. According to FAA, AWOS will increase efficiency at commercial airports by reducing the amount of time now required to make weather observations and by reducing or eliminating the higher maintenance costs of obsolete weather observing equipment currently in use. Consequently, FAA plans to install 304 AWOSs costing about $60 million at commercial airports. (See p. 1.)

FAA also plans to install 441 AWOSs costing about $86 million at general aviation airports (those serving private aircraft only), where no weather observations are currently provided. FAA expects that such systems, by providing weather data where none are now available, will reduce the number of private aircraft accidents, thereby enhancing flight safety.

Total procurement cost for 745 AWOSs is about $146 million. Through fiscal year 1985, $18.5 million had been appropriated for AWOS development and installation. For fiscal year 1986, FAA requested an additional $27.2 million to begin installing AWOSs at 126 general aviation airports.

AWOS is part of FAA's National Airspace System plan, a comprehensive $11.7 billion endeavor to consolidate, modernize, and automate air traffic control facilities and services in the United States through the year 2000. In June 1983 the Chairman of the House Appropriations Subcommittee on Transportation requested that GAO monitor and periodically report on aspects of FAA's implmentation of this plan. This report is one of a planned series of GAO reports responding to that request.

GAO did not evaluate whether flight safety would be enhanced by installing 441 AWOSs at general aviation airports. Instead, GAO's objectives were to evaluate (1) the performance in FAA tests and demonstrations of AWOS sensors measuring the various elements of airport surface weather observations and (2) the cost-effectiveness of installing 304 systems at commercial airports, which already have weather observers.

AWOS PERFORMANCE DOES NOT MEET FAA's OPERATIONAL REQUIREMENTS FOR FOUR ELEMENTS OF AIRPORT SERVICE WEATHER OBSERVATIONS

FAA's operational requirements for AWOS established minimum criteria for measuring the nine elements of an airport weather observation; these include the same elements and criteria currently used by FAA and NWS for airport weather observations. FAA air traffic control officials responsible for determining the weather information required by pilots said that these operational requirements for automated weather observations assure that the information provided will be at least as good as that presently provided by weather observers. (See p. 4.)

NWS considers compliance with FAA's operational requirements for automated weather observations essential to providing airport and area aviation weather forecasts required by law and federal aviation regulations. In addition, both FAA weather observers and the Air Line Pilots Association stressed the importance of meeting the operational requirements in maintaining aviation safety at commercial airports. (See p. 10.)

FAA's tests and demonstrations showed, however, that AWOS cannot meet the operational requirements for measuring four of the nine required elements--ceiling (cloud height), visibility, precipitation, and thunderstorms. FAA's testing found that the ceiling measuring sensor was the least reliable of the AWOS sensors; it could measure ceiling only up to half the height required and presently reported by weather observers. (See p. 8.)

Similarly, the visibility sensor measured to 5 miles, whereas the FAA operational requirement specifies more than 7 miles. It also provided only point-specific visibility along a straight line rather than surrounding (prevailing) visibility, as presently measured by weather observers. Further, the error in the visibility sensor's measurement increased during marginal and hazardous weather when, according to FAA,accurate visibility information is most essential to flight safety. (See p. 8.)

The precipitation sensors tested in the AWOS demonstration were to identify precipitation occurrence and amount but were not designed to distinguish among types of precipitation such as rain, hail, sleet, and snow, as required by FAA. As demonstrated, AWOS could not detect precipitation occurrence 62 percent of the time. Further, the performance of the sensor measuring the amount of precipitation was not evaluated in the demonstration because the precipitation occurrence sensor failed. (See p. 9.)

FAA and the Air Force are trying to develop a new sensor measuring both visibility and precipitation.

Finally, AWOS was not designed to detect or measure thunderstorms. Yet FAA requires that thunderstorm conditions be observed and reported. At present, thunderstorms are reported hourly (and more frequently during marginal and hazardous weather). Reports are made whenever a thunderstorm begins, ends, or increases in intensity. Such reports include type, location, direction of movement, and type and frequency of lightning.

FAA has assured NWS and the Air Line Pilots Association that the current requirements for weather observations now met by weather observers will not be reduced at commercial airports. To accomplish this, FAA plans to augment AWOS with weather observers.

AWOS IS NOT COST-EFFECTIVE
AT COMMERCIAL AIRPORTS

Installing AWOS at commercial airports and augmenting it with weather observers to the extent necessary to meet FAA operational requirements is not cost-effective. GAO found that by substituting the most current facilities and equipment costs and adjusting operating costs for augmented AWOS performance, FAA's 1983 cost analysis (1) understated the extent to which AWOS would have to be augmented by weather observers (see p. 14) and the costs of maintaining the system (see p. 16) and (2) overstated the cost of maintaining existing equipment (see p. 15) and making observations using existing weather observers. (See p. 17.) Moreover, AWOS facilities and equipment costs have almost doubled since FAA's 1983 analysis. (See p. 14).

GAO's analysis showed that each AWOS would cost about $343,500, compared with about $239,600 to maintain the existing observer system over the 15-year life cycle of the equipment--a cost increase of about $104,000 per system as measured in 1981 dollars. When multiplied by the 304 commercial airports where AWOS is to be installed, GAO estimates that the system would cost over $31 million more (in 1981 dollars) to buy and operate over its expected life than would use of the existing weather observer network. (See p. 12.)

RECOMMENDATION TO THE
SECRETARY OF TRANSPORTATION

Because AWOS cannot currently meet FAA's operational requirements without being augmented by weather observers, and is not cost-effective compared with the existing observer system, GAO recommends that the Secretary of Transportation not request funds for installing AWOSs at commercial airports until the system meets these requirements and is more cost-effective than the existing weather observing system.

VIEWS OF AGENCY OFFICIALS

GAO requested, but did not receive, written comments on this report from the Department of Transportation. GAO did discuss the report's contents with FAA officials, whose comments were considered in making the report final.

FAA officials agreed with GAO's recommendation. They stated that they believed, however, that the report should also discuss the AWOS system requirements statement, which provided the basis for installing AWOSs at general aviation airports, where no weather observations are currently provided.

GAO did not discuss the AWOS system requirements statement because GAO's objectives were to evaluate the performance and cost-effectiveness of installing AWOS at commercial airports--which already have weather observers. Therefore, GAO used FAA's operational requirements which, according to FAA policy, are the appropriate criteria. (See p. 4.)

Contents

ILLUSTRATIONS

ABBREVIATIONS

AWOS Automated Weather Observing System

FAA Federal Aviation Administration

GAO General Accounting Office

NTSB National Transportation Safety Board

NWS National Weather Service

CHAPTER 1

INTRODUCTION

The Department of Transportation's (DOT's) Federal Aviation Administration (FAA) plans to purchase 745 automated weather observing systems (AWOSs) costing about $146 million. An AWOS is a cluster of atmospheric sensors, a processor, visual displays, voice broadcast, and longline communications outlets arranged in a way to collect weather data and disseminate airport surface weather observations--current weather data obtainable at or near ground level--to aircraft pilots. (See illustration on the following page.)

An AWOS operates with or without the attendance of a human weather observer. Unattended, it can automatically collect, process, format, and report weather observations. When attended, it also accepts information from weather observers, who may add to or modify the automatically generated weather observation and/or add airport, approach, and runway information through a voice recording.

FAA plans to install AWOSs at selected commercial and general aviation airports.[1] General aviation airports are to receive 441 systems costing about $86 million; commercial airports are to receive 304 systems costing about $60 million. Procurement is planned to begin in fiscal year 1986, with installation completed by 1991. Through fiscal year 1985, $18.5 million had been appropriated for development and installation of AWOS. For fiscal year 1986, FAA requested an additional $27.2 million for installing AWOS at 126 general aviation airports.

AWOS is part of FAA's National Airspace System (NAS) plan, a comprehensive $11.7 billion endeavor to consolidate, modernize, and automate air traffic control facilities and services in the United States through the year 2000. In June 1983 the Chairman of the House Appropriations Subcommittee on Transportation asked us to monitor and periodically report on aspects of FAA's implementation of the NAS plan. This report is one of a planned series of reports responding to that request and is the first weather-related report.

THE OBJECTIVES OF AWOS

AWOS is designed to (1) enhance flight safety by providing weather observations at general aviation airports where no observations are currently provided and (2) increase efficiency at commercial airports by reducing the cost of weather observations.

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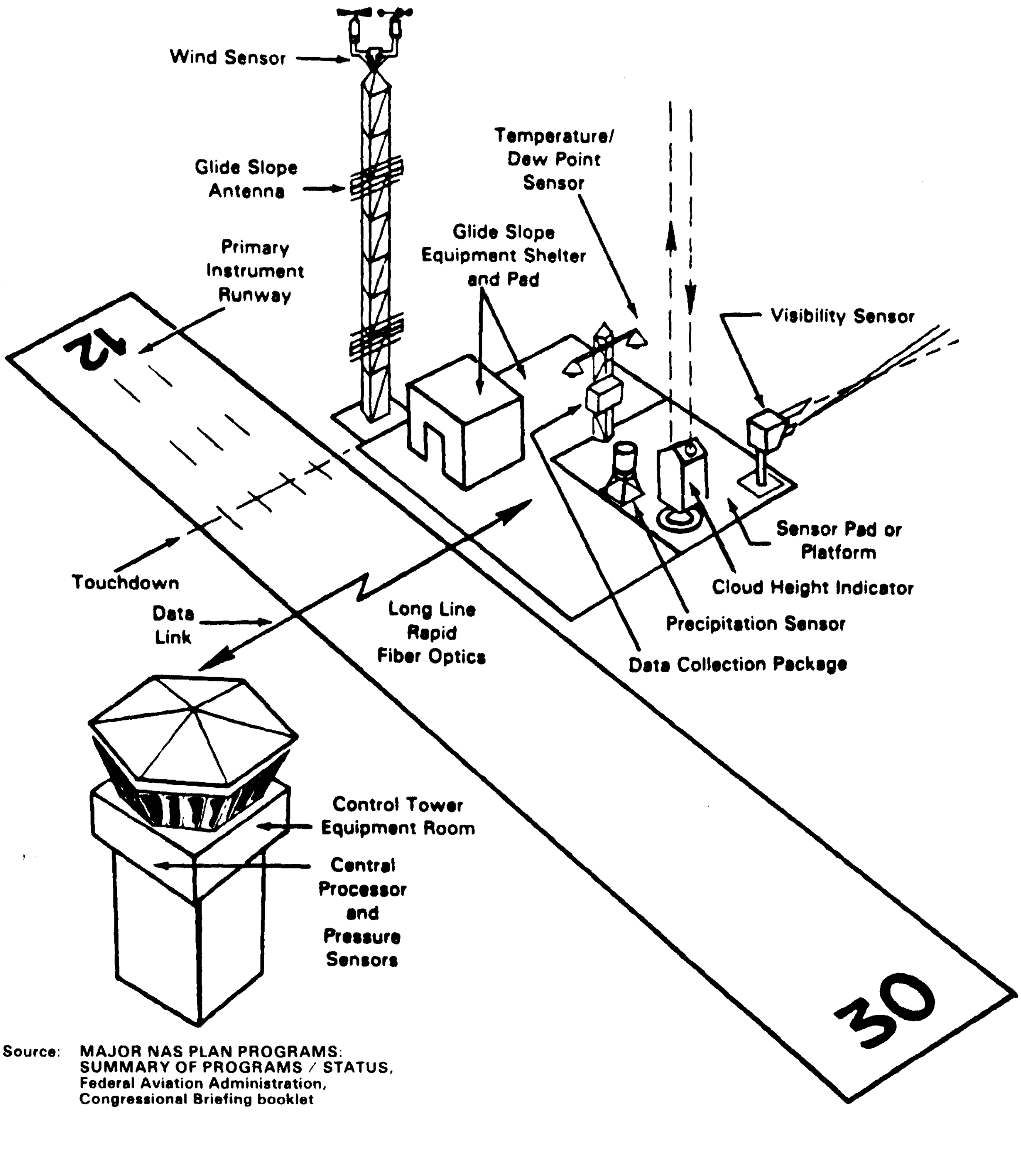
[1]Commercial airports serve commercial aircraft pilots--carrier, charter, and taxi--and private aircraft pilots. General aviation airports serve only private aircraft pilots.

Typical AWOS Installation



Source: MAJOR NAS PLAN PROGRAMS: SUMMARY OF PROGRAMS / STATUS, Federal Aviation Administration, Congressional Briefing booklet

Safety at general aviation airports

The National Transportation Safety Board (NTSB) has identified weather as a cause of general aviation accidents. Weather was a factor in 43 percent of all private aircraft accidents between 1977 and 1981, according to NTSB. Wind, ceiling (cloud height), and visibility (fog) were the elements cited most often. FAA's analysis of NTSB accident reports suggests that providing weather observations of these elements at general aviation aiports could reduce the number of private aircraft accidents attributable to weather.

FAA also expects that adding automated weather observing systems at general aviation airports will improve aviation weather forecasting by providing broader area coverage and weather trends data from which to construct forecasts. In addition, standardized weather observations would be made each minute rather than hourly, thereby providing pilots with more current weather data.

Efficiency at commercial airports

FAA believes that installing AWOS at commercial airports will increase efficiency by reducing the amount of time now required to make and report weather observations and by reducing or eliminating the high maintenance costs of obsolete weather equipment currently in use. Transmittal of AWOS weather observation reports to forecast meteorologists would be automatic, reducing observer reporting time.

FAA AND NWS WEATHER OBSERVATION AND FORECASTING RESPONSIBILITIES

As a result of the Federal Aviation Act of 1958 (Public Law 85-726), the Department of Commerce's National Weather Service (NWS) provides aviation weather forecasts to FAA, which distributes them to pilots. NWS constructs weather forecasts from raw data supplied by FAA and other airport weather observers. The applicable federal aviation regulations require that commercial aircraft pilots--carrier, taxi, and charter--be provided with weather forecasts and observations. Parts 121 and 135 of the regulations stipulate that commercial aircraft pilots be provided with weather forecasts for their destination airports and route of flight prior to departure, as well as weather conditions at their destination airports prior to landing. Both surface weather observations of local conditions and airport weather forecasts must, therefore, be available for commercial flights to use an airport. Unlike commercial airports, these observations and forecasts are not required at non-towered general aviation airports.

Airport surface weather observations are used to construct aviation weather forecasts. FAA weather observers presently supply NWS with hourly surface weather observations from airport weather stations across the country. In addition, NWS weather observers and private contractors provide surface weather observations.

Weather observers use a mixture of weather measuring equipment to assist them in making their observations.

NWS provides airport weather forecasts for a 5-mile radius surrounding each commercial airport and area forecasts for multi-state regions containing major air traffic routes between cities. FAA distributes these forecasts along with airport surface weather observations to pilots at commercial airports in accordance with federal aviation regulations.

FAA OPERATIONAL REQUIREMENTS FOR AWOS WEATHER OBSERVATIONS

In 1984 FAA approved and published operational requirements for AWOS weather observations. The requirements, which establish the minimum criteria for surface weather observations, include nine observation elements and the extent to which each must be measured or estimated.

The requirements include virtually the same observational elements and measurement criteria used by both NWS and FAA in making surface weather observations. NWS says that these observations are essential for weather forecasting to meet both the federal aviation regulations and the aviation weather forecasting requirements of the Federal Aviation Act of 1958. FAA air traffic control officials responsible for determining the weather information required by pilots told us that these operational requirements assure that automated weather observations at commercial airports will be at least as good as those currently being provided.

The table below summarizes the nine elements of a surface weather observation and the extent that each must be measured.

Table 1

Required Weather Observation Elements and Measurements

Elements of surface weather observations	Operational requirements for AWOS
Wind speed	3-125 knots
Wind direction	0-360°
Barometric pressure	28-31" mercury
Temperature	-80° to +130°F
Dewpoint	-35° to +90°F
Ceiling (cloud height)	10,000 ft. measured
Visibility	zero to over 7 miles
Precipitation	
-occurrence	yes/no
-type	liquid/frozen
-amount	actual
Thunderstorms/ convective activity	observe and report

AWOS TESTING AND EVALUATION

In order to equip airports with weather observing devices as early as possible, FAA field-tested and demonstrated currently available sensors in operational systems at 14 airports throughout the United States between September 1983 and June 1984. FAA compared the results of two separate contractor-designed AWOSs with hourly weather data obtained from NWS-certified weather observers. Each contractor installed seven AWOSs using readily available technology.

FAA also initiated additional separate tests and analyses of ceiling sensors by NWS, visibility sensors by DOT's Transportation Systems Center, and precipitation sensors with the Air Force.

AWOS sensors' performance was independently evaluated in an FAA operational readiness test and evaluation required for all major DOT systems acquisitions prior to procurement. A report was issued to FAA's Administrator in May 1984 advising him that ceiling and precipitation sensors were not successfully demonstrated.

OBJECTIVES, SCOPE, AND METHODOLOGY

Of the two AWOS objectives--safety at general aviation airports and efficiency at commercial airports--we limited the scope of our review to the latter. This review, therefore, sought to evaluate (1) AWOS' performance in measuring the elements of an airport surface weather observation and (2) the cost-effectiveness of installing the system at commercial airports that have weather observers using existing equipment.

To meet the first objective, we examined the results of FAA's AWOS tests and demonstrations. We examined AWOS's sensor capabilities and reviewed FAA's assessment of AWOS' operational readiness. We reviewed and discussed the adequacy of AWOS' performance with officials of FAA's AWOS program and air traffic service offices in Washington, D.C., and the test and evaluation group at FAA's Technical Center, Pomona, New Jersey. We also met with weather requirements officials at NWS' headquarters, Silver Spring, Maryland; forecast meteorologists at NWS' Severe Storms Forecast Center, Kansas City, Missouri; and ceiling sensors test officials at NWS' test and demonstration facility, Sterling, Virginia. We visited the Air Force Geophysics Laboratory, Bedford, Massachusetts, overseeing testing of a present-weather (visibility and precipitation) sensor and Hanson Air National Guard Base, Falmouth, Massachusetts, site of visibility sensors tests and demonstrations by DOT's Transportation Systems Center. Further, we obtained the views of the Air Line Pilots Association and the National Association of Air Traffic Specialists on automated weather observations in Washington, D.C., as well as those of the private Air Force contractor developing the present-weather sensor in Needham, Massachusetts.

To meet the second objective, we determined the extent to which AWOS would have to be augmented by weather observers to meet FAA operational requirements and the cost of this augmentation by sending questionnaires to a stratified random sample of 527 FAA air traffic controllers and flight service station[2] specialists at commercial airports of various sizes scheduled to receive AWOS. (See app. III.) We received responses from 487 weather observers. Table 2 shows our universe and sample sizes and the number of respondents from each of the two groups. These questionnaires were designed to identify the amount of time observers normally spend on each element of a surface weather observation. We then used these data to compare estimated personnel and operating costs of AWOS to those of the existing weather-observer system using FAA's operational requirements to identify the extent to which AWOS performance would have to be augmented.

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[2]FAA operates a network of flight service stations that offer a broad range of flight services primarily to general aviation pilots. These services include conducting pre-flight weather briefings for pilots, filing flight plans, and assisting pilots in distress.

Table 2

Questionaire Sample Size and Response

Group	Number in universe	Number in sample	Number that responded	Percent that responded	Number in universe represented by respondents
Air traffic controllers	1,427	203	185	91.1%	1,300
Flight service specialists	1,951	324	302	93.2%	1,819

In addition, we updated and revised the 1981 costs used in FAA's 1983 life-cycle cost comparison of AWOS and the existing weather observer system. This was done to reflect the most current and accurate data available.

Our work was performed primarily from February to November 1984 and is based on the latest information available at that time. The review was performed in accordance with generally accepted government auditing standards.

We requested, but did not receive, written comments on this report from DOT. We did discuss the report's contents with FAA officials and their comments were considered in making the report final.

CHAPTER 2

AWOS PERFORMANCE DOES NOT MEET FAA OPERATIONAL REQUIREMENTS FOR FOUR ELEMENTS OF SURFACE WEATHER OBSERVATIONS

Current surface weather observations at commercial airports made by observers using equipment to measure or estimate weather elements meet or exceed FAA's operational requirements. NWS, FAA, the Air Line Pilots Association, and certified weather observers have all stressed the importance of meeting these requirments. Moreover, NWS has informed FAA that it could not continue to provide aviation weather forecasts for airports where surface weather observation measurements do not meet this standard.

FAA tests and demonstrations have shown that AWOS cannot meet FAA's operational requirements for ceiling, visibility, and precipitation. Moreover, AWOS lacks sensors for detecting thunderstorm activity, another FAA operational requirement. Therefore, FAA intends to augment AWOS with weather observers at commercial airports.

CEILING

FAA found that the ceiling measuring sensor's (ceilometer's) performance was the least reliable of the sensors tested in the AWOS demonstration. Ceiling as measured by AWOS was compared with ceiling as measured by weather observers at six airports; none of the AWOS ceiling measurements satisfied FAA's operational requirements. Further, FAA's operational readiness test and evaluation found that AWOS' reported ceiling was unreliable and was inferior to ceilings estimated and measured by weather observers at the demonstration sites.

FAA has contracted with NWS to test ceiling sensors. NWS has identified a ceilometer capable of measuring cloud height to 3,000 feet with 90 percent reliability and to 5,000 feet with 80 percent reliability; FAA has demonstration tests underway using this ceilometer at three airports. However, because this measurement is still 5,000 feet less than the 10,000-foot ceiling required at commercial airports by FAA's operational requirements (see p. 5), this ceilometer would also have to be augmented by weather observers.

VISIBILITY

Visibility as measured by AWOS did not satisfy FAA's operational requirement for commercial airports. The AWOS demonstration only required measured visibility up to 5 miles, versus a minimum of over 7 miles as stipulated by FAA. The demonstration also did not include any surrounding or prevailing visibility measurements as presently provided by weather observers, but only specific point-to-point visibility along a straight line. Moreover, the error in sensor measurement increased significantly during marginal and hazardous weather when, according to FAA, accurate visibility information is most essential to flight safety.

DOT's Transporation Systems Center reviewed visibility sensor test results and identified several sensors that it said demonstrated accuracies as good as an existing light intensity measuring device (transmissometer) used to compute visibility. However, neither the sensors nor the transmissometer can measure point-to-point visibility beyond 5 miles, as required by FAA's operational requirement, nor provide surrounding visibility presently reported by weather observers at commercial airports. (See p. 5.)

PRECIPITATION

FAA's operational requirements specify that precipitation occurrence, type, and amount be reported. (See p. 5.) However, the precipitation sensors used in the AWOS field test and demonstration were not designed to distinguish among types of precipitation such as rain, sleet, and snow, but only to report "yes" there is precipitation or "no" there is not.

Moreover, FAA field tests and demonstrations showed that AWOS lacked the capability to detect the occurrence of precipitation about 62 percent of the time. FAA's operational readiness test and evaluation confirmed that the precipitation occurrence sensor did not reliably detect precipitation. Further, the sensor measuring amount of precipitation was not evaluated because the precipitation occurrence sensor failed.

FAA has joined in an existing Air Force Geophysics Laboratory contract with a firm developing a single sensor to measure both visibility and precipitation.

THUNDERSTORMS

FAA's operational requirements specify that thunderstorm conditions be observed and reported. (See p. 5.) At present, thunderstorms are reported hourly--and more frequently during marginal and hazardous weather. Reports of thunderstorms are made whenever a thunderstorm begins, ends, or increases in intensity. Such reports include type, location, direction of movement, and type and frequency of lightning. However, AWOS is not designed to detect or measure thunderstorm activity.

AWOS MUST BE AUGMENTED TO MAINTAIN SAFETY AT COMMERCIAL AIRPORTS

General aviation pilots as well as FAA officials have stated their belief that flight safety can be enhanced by providing basic weather data at general aviation airports where none are currently provided. Moreover, AWOS meets FAA's operational requirements for five of the nine surface weather observation elements--wind speed, wind direction, barometric pressure, temperature, and dewpoint.

AWOS cannot, however, measure the other four elements of a surface weather observation to the extent now measured by weather observers and required by FAA at commercial airports. Commercial pilots and NWS have voiced concern that the procurement and installation of AWOS at commercial airports could adversely affect aviation safety. Officials of NWS and the Air Line Pilots Association told us that the measurement of the existing weather observation elements is essential to aviation safety.

NWS' position

A major NWS concern about AWOS' impact on safety involves its limitation in measuring ceiling. NWS has told FAA that it cannot continue to provide all aviation weather forecasts, as required by law and federal aviation regulations, if ceiling measurements are not made to at least 10,000 feet. NWS stated that the observation and reporting of these mid-level clouds are essential to aviation weather forecasting. NWS has told FAA that the measurement of cloud heights to 5,500 feet, as specified for AWOS, is not sufficient to maintain existing forecasting capabilities.[1]

Air Line Pilots Association position

The Air Line Pilots Association has also identified four limitations in the automated system. The association's concerns are directly related to the performance of the ceiling, visibility, and precipitation sensors, and the absence of the thunderstorm measurement capability. The limitations are that AWOS

--has a limited cloud height-detection capability;

--cannot differentiate among obstructions to visibility such as smoke, fog, haze, snow, etc., and cannot determine actual sectoral and prevailing visibility;

--cannot differentiate among types of precipitation; and

--cannot detect either the existence or the intensity of thunderstorm activity.

Weather observers' position

In our questionnaire, we asked FAA air traffic controllers and flight service station specialists certified by NWS as weather observers to identify the degree of hazard to aviation safety of a variety of weather conditions. Their reponses are summarized in the following table.

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[1]This conclusion was contained in a draft report to FAA by NWS. We made subsequent inquiries and confirmed the NWS position. No final report to FAA, however, is planned.

Table 3

Weather Observers' Judgments Regarding Hazards to Aviation Safety

Condition	Little or no hazard	Some hazard	Major hazard
	----------percent---------		
Light rain	71	28	1
Heavy rain	1	62	37
Freezing rain	0	2	98
Hail	0	7	93
Sleet	1	27	72
Snow flurries	29	59	12
Snow squalls	2	45	53
Heavy snow	0	15	85
Fog	1	40	59
Wind	6	67	27
Thunderstorms	0	4	96
Lightning	6	42	52
Tornadoes	2	3	95
Smoke	43	55	2
Haze	35	61	4

Types of precipitation--including freezing rain, hail, sleet, and heavy snow--and thunderstorms and accompanying lightning were conditions considered by most to be major hazards to aviation safety. Yet AWOS cannot distinguish among types of precipitation or detect and measure thunderstorm activity.

FAA has given written assurances to the Air Line Pilots Association and to NWS that aviation weather services will not be reduced at commercial airports. FAA has stated that to accomplish this, AWOS will be augmented by weather observers.

CHAPTER 3

AWOS IS NOT COST-EFFECTIVE AT COMMERCIAL AIRPORTS

FAA's 1983 life-cycle (15-year) cost analysis (using 1981 dollars) showed that AWOS will increase efficiency at commercial airports by reducing the costs of weather observations. However, FAA's analysis underestimated the extent to which AWOS must be augmented by weather observers to maintain safety at commercial airports. Moreover, AWOS facilities and equipment costs have almost doubled since FAA's 1983 analysis. Conversely, the existing weather observer system costs much less than FAA estimated.

We substituted the most current AWOS facilities and equipment costs and data regarding weather observations obtained from questionnaire responses to a sample of FAA weather observers into FAA's 1983 analysis; we found that AWOS is not cost-effective at commercial airports. The installation of AWOS at 304 commercial airports could cost over $31 million more (in 1981 dollars) than the cost of the existing weather observer network over AWOS' expected 15-year life.[1]

REVISIONS TO FAA's 1983 ANALYSIS

The revisions made to FAA's 1983 life-cycle cost analysis are reflected in the table below and are discussed in detail in the remaining sections of this chapter.

We compared the cost of maintaining the existing equipment with the most current AWOS costs. Our analysis (in constant 1981 dollars) shows that AWOS would cost $343,503, compared to $239,589 to maintain an existing system--a cost increase of $103,914 per system. When multiplied by the 304 commercial airports where AWOS is to be installed, the costs for AWOS would likely exceed the costs of maintaining the existing systems by over $31 million (in 1981 dollars) over the 15-year life of the system.

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[1]The $31 million in increased costs is a "net present value" computation reflecting the current value difference of all acquisition and operating expenses for the proposed AWOS and existing weather observing systems over their 15-year expected useful life. The net present value savings is less than the total dollar value savings for all years. This is because net present valuing considers the time value of money by giving greater weight to current dollars than to those spent in future years.

Our economic analysis, presented on page 13, used October 1983 prices for AWOS prepared by the FAA program office. GAO then deflated these prices to October 1980 price levels and used these AWOS cost estimates in evaluating FAA's 1983 economic analysis comparing AWOS costs to those of weather observers. It was necessary to deflate the current costs to October 1980 price levels since FAA did not update the earlier benefit analysis.

Table 4

Comparison of FAA and GAO Cost Estimates for AWOS and for Existing Weather Observation System (1981 dollars)

	Federal Aviation Administration Costs			GAO Revised Costs		
	AWOS Automated	Weather Observers		AWOS Automated	Weather Observers	
Facilities and Equipment	System	ATCT	FSS	System	ATCT	FSS
Total hardware	$ 54,305	$47,480	$47,480	$ 73,950	$ 0	$ 0
Other facilities and equipment	19,007	0	0	74,213	0	0
Initial spares (25% of hardware costs)	13,576	11,870	11,870	18,488	0	0
Total	$86,888	$59,350	$59,350	$166,651	$ 0	$ 0
Operations and Maintenance						
Personnel:						
Observation	$2,162	$52,969	$40,225	$11,446	$16,871	$15,003
Maintenance	712	21,124	21,124	3,185	11,049	11,049
Spares inventory	1,629[a]	5,697	5,697	2,218[a]	0	0
Communications	2,920	0	486	2,920	0	486
Facilities	2,404	2,934	2,934	2,404	2,934	2,934
Total (annual)	$ 9,827	$82,724	$70,466	$ 22,173	$30,854	$29,472
Life-cycle discount	x 7.976	x 7.976	x 7.976	x 7.976	x 7.976	x 7.976
	$ 78,380	$659,807	$562,037	$176,852	$246,092	$235,069
Life-cycle cost	$165,268	719,157	621,387			
Relative percentage		x .41[b]	x .59[b]		x .41	x .59
of observations		$294,854	$366,618		$100,898	$138,691
Total weighted average life-cycle cost	$165,268	$661,472		$343,503	$239,589	

[a]FAA computed spares inventory costs as 3 percent of total hardware costs. Using this percentage, AWOS inventory spares costs increase from $1,629 to $2,218 due to increase in total hardware costs from $54,305 to $73,950.

[b]These percentages have been adjusted from those used in FAA's analysis. FAA's analysis included NWS and contractor weather observer locations on the assumption that NWS and contractors would also procure AWOS. However, all 745 AWOSs are to be installed at FAA Air Traffic Control Towers (ATCT) or Flight Service Stations (FSS). Accordingly, we eliminated NWS and contractor locations from our analysis.

Another approach would be to replace the old equipment in the existing system rather than maintain it. We found that it would cost about $60,000 more in 1981 dollars to install AWOS than to replace the old equipment in an existing system at a commercial airport. (See app. I.) Therefore, in our analysis we used the cost of maintaining the existing equipment rather than replacing the existing equipment because it is the least costly.

AWOS MUST BE AUGMENTED MORE THAN FAA ASSUMES

FAA's published life-cycle cost analysis states that substantial savings will result from AWOS by reducing weather observation duties of controllers and flight service personnel. However, FAA weather observers' responses to our questionnaire showed that the time required by them to determine and report ceiling, visibility, precipitation, and thunderstorms is greater than FAA estimated.

In its comparison of AWOS costs to those of the existing system, FAA estimates that 1.25 percent of a weather observer's time will have to be spent augmenting AWOS. Based on questionnaire responses from FAA's weather observers and data on the percentages of good and bad weather days, we calculated that an average of 8 percent[2] of their time will be required to observe the four weather elements that AWOS cannot adequately measure. As a result, the cost of an observer's time to augment AWOS is $11,446 per year,[3] rather than the $2,162 estimated by FAA. (See p. 13.)

FAA UNDERSTATES AWOS FACILITIES AND EQUIPMENT COSTS

FAA's 1983 analysis estimated procurement costs of AWOS facilities and equipment to be $86,888. However, FAA's AWOS program office now estimates the cost to be $196,014.[4] For use in our comparative analysis, this cost was discounted to $166,651 in 1981 dollars. As shown below, the cost increases are largely attributable to additional requirements, including data processors and communications facilities, installation costs, contractor start-up costs, and the cost of initial spares.

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[2]At 95 percent confidence the sampling error is plus or minus .4 percent.

[3]This figure could vary as much as $458 either way based on sampling error.

[4]FAA AWOS program office estimates were used because they were the most current available.

Table 5

Increase in Facilities And Equipment Costs (1981 dollars)

Facilities and equipment requirements	FAA's 1983 estimate	FAA's 1984 estimate	Increase (decrease)
AWOS sensors	$ 43,145	$ 40,342	$ (2,803)
Towers, guys, anchors	570	0	(570)
Signal conditioning unit	1,620	2,125	505
Data processors	3,440	6,972	3,532
Data acquisition and transmission	5,530	24,511[a]	18,981
Initial spares	13,576	18,488	4,912
Installation, profit, and other costs	19,007	60,632	41,625
Contractor start-up costs	0	13,581	13,581
Total	$ 86,888	$166,651	$ 79,763

[a]About $3,700 of the $24,511 data acquisition and transmission costs is for MODEMs--telephonic computer communication links. The program office assumes that an additional $20,000 of the MODEMs' cost will be shared by other FAA programs. If not, AWOS data acquisition and transmission costs could increase by $20,000.

FAA OVERSTATES COSTS FOR EXISTING EQUIPMENT AND MAINTENANCE

FAA charged the existing observer system $59,350 for new equipment and $5,697 for new equipment spares on the assumption that the existing equipment is outdated and obsolete and would have to be replaced. In addition to these new equipment charges, however, FAA also assigned the existing system an annual cost of $21,124 to maintain the old equipment. The existing observer system, then, was charged for both the cost of the new equipment and the cost for maintaining the older, existing equipment.

Based on available data, it appears to be more cost-effective to maintain rather than to replace the existing equipment. (See app. I.) Therefore, our comparison of AWOS costs with those of the existing system eliminated the $59,350 new equipment cost. It also eliminated the $5,697 new equipment spares cost because new spares are not required unless new equipment is purchased. We also believe this to be more representative of the present situation because the existing system is comprised of old, rather than new, equipment.

In addition, the $21,124 maintenance cost assigned by FAA to the existing equipment is based on data acquired from NWS. Our discussions with an NWS official disclosed that this cost was based on initial engineering estimates rather than on actual repair costs. We found that the actual annual cost to maintain an existing system, using NWS data, is $11,049, which NWS officials said that they believed to be more representative than FAA's estimate. (See p. 13.)

FAA UNDERSTATES AWOS MAINTENANCE COSTS

We found that FAA underestimated AWOS maintenance costs. FAA's estimate of $712 assumes that AWOS will require 8 days of maintenance per 365 days, rather than 8 days per 220 working days per year; this caused FAA to understate personnel maintenance costs per year by 40 percent. The 220 working days available each year recognizes that employees normally work 5 days per week and receive official holidays off, along with vacation,sick leave, and training; this properly represents the base for computing the proportion of personnel costs attributable to 8 days for AWOS maintenance.

FAA also provided no basis for its 8-day maintenance assumption. Automated sensors having the ability to measure wind speed and direction, temperature, dewpoint, and barometric pressure have been in use for several years by NWS, and actual repair costs are available for these sensors. Automated sensors for visibility and ceiling, however, are presently not in use by NWS and, therefore, the maintenance cost available is for existing older equipment. Historically, this older equipment has required more than twice the amount of maintenance than have the automated sensors used by NWS in measuring the other weather elements. The following table illustrates the actual number of staff days spent by NWS in maintaining weather observation equipment.

Table 6

NWS Weather Observation Equipment Maintenance Experience

Weather element	Equipment staff-day maintenance 1981	Equipment staff-day maintenance 1983
Wind speed, direction, temperature, dewpoint, and barometric pressure	10	15
Visibility	12	16
Ceiling	12	16
Total	34	47

NWS believes that the maintenance factor for ceiling and visibility could be cut in half with modernized equipment. By reducing the maintenance requirement for cloud height and visibility by 50 percent and by using the 1981 maintenance data, the base year used in FAA's analysis, we estimate the annual maintenance requirements for an automated system to be 22 staff days (10 + 6 +

6), or $3,185 annually, assuming that an average maintenance staff year of 220 days costs about $33,000. Accordingly, we revised FAA's maintenance cost from $712 to $3,185. (See p. 13.)

EXISTING WEATHER OBSERVATIONS COST LESS THAN FAA ASSUMES

In its analysis of the cost of maintaining the existing observer system, FAA overstates the time required for weather observations, which inflates the cost of weather observers. FAA estimates that existing weather observations require 25 percent of one person's time. Based on our questionnaire results and data on the percentage of good and bad weather, we calculated that observations require 11 percent[5] of one person's time. Therefore, FAA's analysis overstates existing observation costs by 127 percent.[6]

In addition, FAA's analysis overstates the number of hours each day that an observation facility is open. FAA presumes that flight service stations and control towers are open 24 hours per day. In contrast, we found that the facilities identified by FAA as candidates for AWOS are actually open an average of 19 hours per day. Accordingly, FAA's analysis overstates the hours of operation by almost 26 percent.

Further, FAA's analysis overstates weather observers' annual salaries. FAA's estimate presumes that air traffic control tower observations were being made by federal employees at the level of GS-12 (step 5), and that observations made at flight service stations were being made by those at GS-10 (step 5). We found that the average staffing level for locations identified as candidates for AWOS were GS-11 (step 7) at air traffic control towers and GS-10 (step 6) at flight service stations. As a result, FAA's analysis overstates annual salaries by almost 5 percent.

The combined effect of overstating (1) the time required for weather observations, (2) the number of hours each day that an observation facility is open, and (3) weather observers' salaries is that FAA overstated existing system observation costs by $36,098 at air traffic control towers and by $25,222 at flight service stations. Our revised estimates found observation costs to be $16,871 at control towers and $15,003 at flight service stations, rather than FAA's estimates of $52,969 and $40,225, respectively. (See p. 13.)

CONCLUSIONS

To maintain safety at commercial airports, AWOS weather reports for ceiling, visibility, precipitation, and thunderstorms

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[5]At 95 percent confidence the sampling error is plus or minus .5 percent.

[6]Adjusting for sampling error, this percentage could be as high as 129 and as low as 125.

must be augmented by weather observers. Without augmentation AWOS cannot meet FAA's operational requirements for measuring four of nine required elements. The amount of time required to augment AWOS and the cost of procuring AWOS equipment make total life-cycle costs of such observations almost $104,000 more per system (in 1981 dollars) than those made under the existing system. Therefore, over $31 million (in 1981 dollars) could likely be saved over AWOS' expected 15-year life cycle by not installing the 304 AWOSs at commercial airports and continuing to use the weather observer network already in place at those locations.

RECOMMENDATION TO THE SECRETARY OF TRANSPORTATION

We recommend that the Secretary of Transportation not request funds for installing AWOSs at commercial airports until the system meets FAA's operational requirements for weather observations and is more cost-effective than the existing weather observer system.

VIEWS OF AGENCY OFFICIALS

We requested, but did not receive, written comments on this report from DOT. We did, however, discuss the report's contents with FAA officials who agreed with our recommendation not to install AWOSs at commercial airports unless the systems can meet FAA's operational requirements and are proven cost-effective. They stated their belief, however, that our report should also discuss the AWOS system requirements statement, which provided the basis for installing AWOSs at general aviation airports, where no weather observations are currently provided.

We did not discuss the AWOS system requirements statement because our objectives were to evaluate the performance and cost-effectiveness of installing AWOSs at commercial airports, which already have weather observers. Therefore, we used FAA's operational requirements which, according to FAA policy, are the appropriate criteria. (See p. 4.)

FAA's system requirements statement is said to be applicable for weather observations at general aviation airports where AWOS will not have to meet the more stringent criteria for observations that exist at commercial airports. We found, however, that AWOS demonstration testing did not meet the system requirements statement for two observation elements--cloud height and precipitation. Thus, the AWOS system specifications that are to govern subsequent requests for contractor proposals differ from the system requirements statement in the extent to which cloud height and precipitation must be measured.

FAA officials also reasserted their belief that AWOS may be cost-effective relative to the alternatives of replacement or continued use of weather observers at commercial airports. FAA's assessment supporting this belief is based on an assumption that present and future sensor capabilities will meet both the system requirements statement and the operational requirements. To date, AWOS cannot meet two elements of the system requirements statement and four elements of the operational requirements. AWOS, therefore, is not cost-effective at commercial airports.

GAO's COMPARISON OF COSTS OF MAINTAINING/REPLACING EQUIPMENT WITHIN THE EXISTING WEATHER OBSERVATION SYSTEM WITH COSTS OF INSTALLING AWOS (1981 DOLLARS)

	Maintaining existing hardware		Replacing existing hardware		Installing AWOS
Facilities and Equipment	ATCT[a]	FSS[b]	ATCT	FSS	
Total hardware	$ 0	$ 0	$47,480	$ 47,480	$ 73,950
Other facilities and equipment	0	0	0	0	74,213
Initial spares (25% of hardware cost)	0	0	11,870	11,870	18,488
Total	$ 0	$ 0	$59,350	$ 59,350	$166,651
Operations and Maintenance					
Personnel:					
Observation	$ 16,871	$ 15,003	$ 16,871	$ 15,003	$ 11,446
Maintenance	11,049	11,049	3,185	3,185	3,185
Spares inventory	0	0	5,697	5,697	2,218
Communications	0	486	0	486	2,920
Facilities	2,934	2,934	2,934	2,934	2,404
Total (annual)	$ 30,854	$ 29,472	$ 28,687	$ 27,305	$ 22,173
Life cycle discount	x7.976	x7.976	x7.976	x7.976	x7.976
Total (15 years)	$246,092	$235,069	$228,808	$217,785	$176,852
F + E and O + M	246,092	235,069	$288,158	$277,135	343,503
	x .41	x .59	x .41	x .59	
Weighted total	$100,898	$138,691	$118,145	$163,510	
Total life cycle cost	$239,589		$281,655		$343,503

[a]Air Traffic Control Tower
[b]Flight Service Station

Weather Observers' Judgments Regarding Hazards to Aviation Safety[a]

Condition	Little or no hazard	Some hazard	Major hazard
	-----percent-----		
Light rain	71.2 ± 3.7	28.3 ± 3.7	0.4 ± 0.5
Heavy rain	0.6 ± 0.6	62.1 ± 4.0	37.2 ± 4.0
Freezing rain	0	1.6 ± 1.0	98.4 ± 1.0
Hail	0.2 ± 0.3	6.7 ± 2.1	93.1 ± 2.1
Sleet	0.6 ± 0.6	27.4 ± 3.7	72.0 ± 3.7
Snow flurries	29.5 ± 3.8	58.8 ± 4.1	11.7 ± 2.7
Snow squalls	2.1 ± 1.2	44.8 ± 4.1	53.1 ± 4.1
Heavy snow	0	15.5 ± 3.0	84.5 ± 3.0
Fog	0.8 ± 0.7	39.7 ± 4.0	59.6 ± 4.0
Wind	5.9 ± 2.0	66.8 ± 3.9	27.3 ± 3.6
Thunderstorms	0	3.8 ± 1.6	96.2 ± 1.6
Lightning	6.4 ± 2.0	41.8 ± 4.1	51.8 ± 4.1
Tornadoes	1.6 ± 1.0	3.1 ± 1.4	95.2 ± 1.8
Smoke	42.6 ± 4.1	55.0 ± 4.1	2.4 ± 1.2
Haze	34.9 ± 3.9	61.3 ± 4.0	3.8 ± 1.5

[a]Confidence intervals are calculated at 95% levels.

U.S. GENERAL ACCOUNTING OFFICE

SURVEY OF WEATHER OBSERVERS IN FLIGHT SERVICE STATIONS AND AIR TRAFFIC CONTROL TOWERS

GENERAL INSTRUCTIONS

The U.S. General Accounting Office is evaluating the cost effectiveness of the proposed procurement of an FAA automated weather observing system (AWOS). The purpose of this questionnaire, which is being sent to a sample of weather observers, is to determine how much time is required to perform activities that will not be performed by the automated equipment.

All questions can be answered by simply checking a box or writing in a small amount of information. The questionnaire has been written based on our discussions with weather observers at several locations, and we have attempted to provide a format that will be readily adaptable to all individuals. In the event that the format for any question does not fit your situation, however, we would appreciate any additional comments required to properly describe your activities. We have provided room at the end of the questionnaire for additional comments or explanations.

Please complete the questionnaire and return it in the enclosed envelope within 10 days of receipt if possible. If you have questions about any specific items in the questionnaire, please contact Virgil Schroeder on (405) 231-4489 or 736-4489 (FTS). In the event that the envelope is misplaced, please mail your completed questionnaire to:

Mr. Virgil Schroeder
U.S. General Accounting Office
Room 4476
441 G Street, N.W.
Washington, D.C. 20548

Thank you for your cooperation in making our report to the Congress as complete and accurate as possible.

1. How often do you normally conduct weather observations? (CHECK ONE.)

   1. [57%] At least once a day
   2. [35%] Several times a week
   3. [4%] At least once a week
   4. [4%] Less than once a week
   5. [0%] Never (SKIP TO QUESTION 6.)

2. How often, if ever, is the volume of air traffic that you control and/or brief so great that it prevents your routine weather observations? (CHECK ONE.)

   1. [34%] Never
   2. [37%] Less than once a week
   3. [14%] At least once a week
   4. [10%] Several times a week
   5. [5%] At least once a day

3. On average, what percentage of your total work time is spent occupying a weather observing and reporting position? (ENTER PERCENTAGE.)

   16 %

4. About how many minutes per hour does it normally take you to observe and report weather conditions (a) when the weather is good (stable VFR) and (b) when the weather is bad (marginal VFR, IFR, or rapidly changing conditions)? (ENTER MINUTES.)

   a. 5.3 Minutes per hour when weather is good.

   b. 13.0 Minutes per hour when weather is bad.

5. Of the time you spend observing and reporting weather conditions (reported in question 4), approximately what percentage do you spend observing and reporting the following weather conditions (a) when the weather is good (stable VFR) and (b) when the weather is bad (marginal VFR, IFR, or rapidly changing conditions)? (ENTER PERCENTAGES SO THAT EACH COLUMN TOTALS 100%.)

WEATHER CONDITION	(a) PERCENTAGE OF TIME IN GOOD WEATHER	(b) PERCENTAGE OF TIME IN BAD WEATHER
a. Ceiling and cloud height.	33 %	35 %
b. Visibility.	21 %	23 %
c. Barometric pressure, winds, temperature and dew point.	23 %	15 %
d. Precipitation (such as rain, sleet, snow, hail) and obscurations and convective activity (such as haze, fog, thunderstorms).	16 %	21 %
e. Other (SPECIFY). ____________	7 %	6 %
f. TOTAL TIME OBSERVING AND REPORTING WEATHER.	100 %	100 %

6. In your opinion, how hazardous are the following weather and visibility conditions to aviation safety? (CHECK ONE BOX PER LINE.)

	HAZARD TO AVIATION SAFETY		
CONDITION	Little or no hazard 1	Some hazard 2	Major hazard 3
a. Light rain.	71 %	28 %	1 %
b. Heavy rain.	1 %	62 %	37 %
c. Freezing rain.	0 %	2 %	98 %
d. Hail.	0 %	7 %	93 %
e. Sleet.	1 %	27 %	72 %
f. Snow flurries.	29 %	59 %	12 %
g. Snow squalls.	2 %	45 %	53 %
h. Heavy snow.	0 %	15 %	85 %
i. Fog.	1 %	40 %	59 %
j. Wind.	6 %	67 %	27 %
k. Thunderstorms.	0 %	4 %	96 %
l. Lightning.	6 %	42 %	52 %
m. Tornadoes.	2 %	3 %	95 %
n. Smoke.	43 %	55 %	2 %
o. Haze.	35 %	61 %	4 %

7. How important for aviation safety is it to distinguish among types of precipitation, such as rain, hail, sleet, or snow? (CHECK ONE.)

1. [87%] Very important
2. [13%] Somewhat important
3. [0%] Not very important
4. [0%] No basis to judge

8. How important for aviation safety is to determine convective activity, su as thunderstorms, tornadoes, or wind (CHECK ONE.)

1. [98%] Very important
2. [2%] Somewhat important
3. [0%] Not very important
4. [0%] No basis to judge

9. How important for aviation safety is it to distinguish prevailing visibility from sectoral visibility? (CHECK ONE.)

1. [38%] Very important

2. [50%] Somewhat important

3. [12%] Not very important

4. [0%] No basis to judge

10. Does your facility have a rotating beam ceilometer? If so, how long is its baseline (the distance between the receiver and the transmitter) in feet? (CHECK ONE. IF YES, ENTER DISTANCE IN FEET.)

1. [46%] No

[a] 2. [55%] Yes -----> The baseline is 751 feet.

11. To what extent, if at all, do you rely on the following methods to measure ceiling? (CHECK ONE BOX PER LINE.)

	EXTENT RELIED ON				
METHOD	Very great extent 1	Great extent 2	Moderate extent 3	Some extent 4	Little or no extent 5
a. Rotating beam ceilometer.	24 %	22 %	12 %	5 %	37 %
b. Clinometer ("ceiling light," "pop bottle").	8 %	8 %	16 %	20 %	48 %
c. Helium balloons.	5 %	8 %	15 %	21 %	51 %
d. Eye sight.	43 %	34 %	18 %	4 %	1 %
e. Pilot reports.	19 %	32 %	32 %	15 %	2 %
f. Other. Landmarks.	10 %	27 %	15 %	35 %	13 %
Cloud diagrams.	12 %	34 %	11 %	32 %	11 %
Temperature-dewpoint.	23 %	23 %	22 %	32 %	0 %
Other.	9 %	8 %	12 %	37 %	34 %

[a] Totals do not always equal 100 due to rounding.

12. During the past year, approximately what percentage of the time were you unable to use the following equipment at your facility because it was out-of-service? (CHECK ONE BOX PER LINE.)

	PERCENTAGE OF TIME				
	Never or rarely 0-5%	Sometimes 6-10%	Often 11-30%	Very often 31-100%	NOT APPLICABLE, DO NOT HAVE
METHOD	1	2	3	4	5
a. Thermometer.	55 %	18 %	8 %	5 %	14 %
b. Rotating beam ceilometer.	22 %	19 %	12 %	9 %	38 %
c. Anemometer (wind gauge).	75 %	18 %	3 %	3 %	1 %

13. Does the Federal Aviation Administration (FAA), National Weather Service (NWS), or some other group provide maintenance for the following weather observation equipment? (CHECK ONE BOX PER LINE.)

EQUIPMENT	FAA 1	NWS 2	OTHER 3	NOT APPLICABLE, DO NOT HAVE EQUIPMENT 4
a. Thermometer.	[38%]	[46%]	[1%]	[15%]
b. Rotating beam ceilometer.	[39%]	[19%]	[1%]	[41%]
c. Anemometer (wind gauge).	[55%]	[44%]	[0%]	[1%]
d. Runway visual range (RVR).	[28%]	[1%]	[0%]	[71%]
e. Runway visibility value (RVV).	[18%]	[1%]	[0%]	[81%]

14. If organizations other than FAA or NWS provide maintenance for your weather observation equipment, please specify who provides the maintenance and for which pieces of equipment.

15. Are the FAA and NWS maintenance technicians who service your weather observation equipment located at your facility? If not, how many miles away from your facility are they located? (CHECK ONE. IF NO, ENTER NUMBER OF MILES.)

	LOCATED AT FACILITY YES 1	NO 2	IF NOT AT FACILITY, NUMBER OF MILES AWAY
a. FAA equipment maintenance technicians	[78%]	[22%]	35
b. NWS equipment maintenance technicians	[4%]	[96%]	70

16. If you have additional comments on any items in the questionnaire or any related topics, please write them below. Your comments are greatly appreciated.

THANK YOU FOR YOUR COOPERATION.

GAO note:

Responses to the open-ended questions are not reported below due to limited space. For multiple choice questions, we have reported the percentage responding. For the remaining questions, we have reported averages.

GAO's ECONOMIC ANALYSIS PROCEDURES

FAA conducted an economic analysis using 1981 prices to evaluate the feasibility of its proposed AWOS program. FAA used the OMB-approved discount rate of 10 percent. It did not consider real or nominal price level increases. As much as possible, we accepted FAA's methodology and cost data so as to simplify the presentation in this report.

Major Assumptions Used in Study

FAA economists prepared the economic analysis using cost information provided by the AWOS program office. The cost data included initial investment (i.e., facilities and equipment) as well as annual operating expenses. The net present value of total annual costs over the 15-year project life was then calculated. This was done by developing a life-cycle discount factor that assumes a 10-percent discount rate, constant annual real costs for recurring expenditures, and a 15-year analysis period.

FAA estimated costs for the proposed AWOS and for the existing system. We then took these estimates, evaluated them, and developed our own cost estimates.

GAO's Methodology Differs From That Used by FAA

We do not concur with the methodology that FAA used. While FAA considered different cost estimates when evaluating the different systems, it did not analyze the impact of changes in real or nominal prices over time. It is appropriate to measure the impact of changing real and nominal prices over time when evaluating the cost of an investment over time.

We conducted two analyses to determine the impact that real (i.e., constant dollar) changes in prices have on our present value results. Since a real interest rate is used for discounting, estimates concerning inflation changes are unnecessary. We retained use of the 10-percent discount factor. In this sensitivity analysis we assumed that the price levels would change 2 percent yearly. The 2-percent figure is used as an example of what real price changes might be; it is not meant to imply that we expect 2-percent price changes to occur. The impact of the price change on present-value cost calculations shows the stability of the cost differences between the two programs. The first analysis demonstrates the impact that a 2-percent increase in annual costs had on the net present value results. The second analysis demonstrates the impact of a 2-percent decline in prices. Since the facilities and equipment are purchased initially, inflation has no impact on their cost contribution to the net present value evaluation.[1]

Per Unit Cost Using Alternative Net Present Value Analysis

Alternatives	Manual weather observers (current)	AWOS (automated system) (proposed)	Manual costs as percentage of AWOS
FAA Economic Analysis	$633,546	$161,633	392.0%
GAO Revised Costs	$228,566	$335,301	68.2%
2% Real Cost Increase	$254,606	$354,514	71.8%
2% Real Cost Decrease	$206,144	$318,756	64.7%

(341068)

[1]These present values differ slightly from the FAA analysis presented in the report. We used a smaller factor (7.606), which assumes an end-of-year cash flow. FAA's factor (7.976) assumed a mid-year cash flow. (See p. 13.) There is no practical difference between using mid-year and end-of-year discounting. We used end-of-year discounting for ease of computation. This results in about a 3.5-percent difference in the present value of the cost of each weather observing system. Since the change in the calculated costs of the alternative systems is in the same direction, there is no change in their relative costs.

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