INTEGRATED TERMINAL WEATHER SYSTEM: IMPORTANT DECISIONS MUST BE MADE ON THE DEPLOYMENT STRATEGY

Federal Aviation Administration

Report Number: AV-2003-009
Date Issued: December 20, 2002

Memorandum

U.S. Department of
Transportation
Office of the Secretary
of Transportation
Office of Inspector General

Subject: ACTION: Integrated Terminal Weather System: Important Decisions Must Be Made on the Deployment Strategy
Report No. AV-2003-009

Date: December 20, 2002

From: Alexis M. Stefani
Principal Assistant Inspector General for Auditing and Evaluation

Reply to Attn. of: JA-10:x60500

To: Federal Aviation Administrator

This report provides our observations on the Federal Aviation Administration's (FAA) acquisition of the Integrated Terminal Weather System (ITWS). ITWS is a new weather system that is intended to help air traffic managers make safe and efficient air traffic decisions during bad weather conditions. ITWS is also an important part of FAA's Operational Evolution Plan to enhance capacity in the National Airspace System over the next 10 years. In preparing this report, we met with program officials periodically and incorporated their comments, as appropriate.

OBJECTIVE AND SCOPE

Our objective was to evaluate FAA's management of the ITWS program with respect to cost, schedule, and performance. Additionally, we examined how FAA will use ITWS to lessen the impact of adverse weather on airspace capacity. We met with air traffic managers that are using ITWS prototypes to discuss how the new system helps improve the flow of air traffic during periods of severe weather. We performed our review from July through December 2002 in accordance with Government Auditing Standards as prescribed by the Comptroller General of the United States. Exhibit A provides a detailed discussion of our audit scope and methodology. Exhibit B lists the offices we visited or contacted during the audit.

BACKGROUND

According to FAA, bad weather, such as thunderstorms, is the leading cause of flight delays. Bad weather causes rerouting of aircraft and closure of runways, which reduce airport capacity and cause ripple effects nationwide. ITWS is a new technology that integrates data from multiple sensors into a single display. The system provides up to a 20 minute forecast of weather conditions in the terminal area and helps traffic managers use airport and airspace capacity more efficiently. With better forecasting, traffic managers will be able to better predict when to open and close runways, change runway configurations, and reroute arriving and departing air traffic. This is expected to reduce flight delays and avoid unnecessary diversions of aircraft. Exhibit C provides an example of an ITWS display.

In January 1997, FAA awarded a contract to the Raytheon Company for the development and implementation of ITWS. FAA plans to invest $286.1 million through fiscal year (FY) 2008 to acquire and field 38 systems that will support 108 air traffic control towers, terminal approach control facilities, en route centers, and support facilities. This amount also includes funding through FY 2009 for planned system enhancements. Thus far, FAA has committed $179.1 million through FY 2002. Currently, ITWS prototypes (developed by the Massachusetts Institute of Technology – Lincoln Laboratory) are operating in New York, Dallas, Memphis, and Orlando. The first ITWS production system is scheduled to be fully operational in Atlanta by the end of December 2002.

RESULTS IN BRIEF

ITWS is expected to significantly improve FAA's ability to manage the flow of air traffic during poor weather conditions. The prototype systems have been well received by air traffic managers because they provide an accurate display of current and forecasted weather conditions that was previously not available. However, production costs are three times higher than expected, increasing from $360,000 to $1.1 million[1] per system, and FAA cannot execute the program as planned within the existing budget and schedule. As a result, FAA plans to extend the deployment schedule through June 2008, nearly 5 years later than scheduled.

Thus far, FAA has committed $179.1 million to the program, which has gone principally to development and prototyping efforts. The remaining $107 million is insufficient to pay for the production systems, system engineering, testing, contract support, program management support, and more than 50 planned system enhancements.[2] According to ITWS program officials, FAA will need an

[1] The $1.1 million per system represents the unit cost for the initial six systems. The unit cost for future systems is yet to be determined.

[2] ITWS enhancements include hardware and software improvements and new capabilities.

additional $55 million to complete the deployment in June 2008 and add all planned system enhancements by the end of FY 2009. Absent additional funding, FAA intends to defer adding several planned enhancements, and the production systems will be less capable than the prototype systems.

FAA Should Reassess When and Where to Deploy ITWS. FAA will not complete the deployment of ITWS as scheduled because program officials did not update the budget estimate to support the sharp increase in production costs. The cost increase is due primarily to poor cost estimating and new contract requirements—problems that have historically impacted FAA acquisitions. Program officials told us that their initial production cost estimate, in 1997, was never negotiated with Raytheon and that program officials did not have a clear understanding of system performance requirements. The most significant production cost driver was the need to buy a larger computer processor (including all its associated costs for testing and installation) to handle higher processing requirements of the large terminal area control facilities, such as Potomac,[3] as well as planned system enhancements.

Given the cost and schedule impacts resulting from the increase in production costs and the fact that FAA is now beginning to install ITWS, FAA needs to reassess when and where to deploy ITWS. This analysis should be data driven and result in a new deployment strategy that ensures that ITWS is logically deployed to sites that achieve the greatest potential benefits to the flying public as soon as possible. For example, we found that air traffic operations in Phoenix have increased 24 percent from FY 1994 to FY 2001 and the airport ranked ninth among the ITWS sites most affected by weather delays in FY 2001. However, FAA does not plan to install ITWS in Phoenix until near the end of the deployment—in FY 2007. Until FAA completes a thorough analysis, it cannot ensure that ITWS will be deployed in a logical and efficient manner.

FAA Should Accelerate Plans to Provide a Key ITWS Enhancement—a 60 Minute Convective Weather[4] Forecast (CWF) Product. While the production system has a 20 minute forecast, a 60 minute CWF product has been available in the prototypes since 1998. This enhancement provides a quantitative improvement for ITWS. However, since production costs have tripled, FAA plans to defer adding a 60 minute CWF product until at least FY 2006—8 years after this capability was made available in the ITWS prototypes. The main benefit of this enhancement is to improve the flow of air traffic for *departing* aircraft. With more advance notification of when and where bad weather will occur, air traffic

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[3] The ITWS Potomac site includes airports located in one of the most congested air travel areas in the United States. These airports are Baltimore-Washington International, Ronald Reagan Washington National, Washington Dulles International, and Andrews Air Force Base.

[4] Convective weather includes thunderstorms, hail, wind shear, severe icing, and tornadoes.

managers are able to avoid bringing arriving aircraft close to the airport and making diversions that interfere with or close air routes for departing aircraft. Traffic managers we spoke with at New York and Dallas/Ft. Worth felt so strongly about the benefits from a 60 minute CWF product that they asked to keep the prototype systems until this product is available in the production system. As part of revising the ITWS deployment strategy, FAA should also accelerate plans to provide a 60 minute CWF product with the ITWS production system sooner than FY 2006. Further, FAA should update the cost and schedule baseline to reflect the new deployment strategy and the revised plan to integrate a 60 minute CWF product.

RECOMMENDATIONS

At this time, FAA must make several important business decisions on how to move forward with ITWS. In moving forward, FAA needs to complete a data driven analysis to reassess the ITWS deployment strategy and incorporate a key ITWS enhancement. Using the data analysis, we are recommending that FAA:

- revise the deployment strategy, as appropriate, to logically deploy ITWS to sites that achieve the greatest potential benefits as soon as possible,
- integrate a 60 minute CWF product with the ITWS production system to sites that achieve greatest potential benefits sooner than FY 2006, and
- update the ITWS cost and schedule baseline to reflect the new deployment strategy and a revised plan to integrate a 60 minute CWF product.

AGENCY COMMENTS AND OFFICE OF INSPECTOR GENERAL RESPONSE

On December 5, 2002, we provided a discussion draft report to the offices of the Associate Administrator for Research and Acquisitions, Terminal Business Service, and ITWS Product Team to obtain their oral comments. FAA officials from those offices generally agreed with our results and finding. FAA officials stated that revising the deployment strategy and incorporating a 60 minute CWF product would be subject to the results of the data analysis. Further, this data driven analysis may show the need to incorporate a 60 minute CWF product at only a limited number of ITWS sites, depending on the type of convective weather at each site. We are requesting that FAA provide written comments to the final report that address all of our recommendations.

FINDING AND RECOMMENDATIONS

ITWS is expected to significantly improve FAA's ability to manage the flow of air traffic during poor weather conditions. The prototype systems have been well received by air traffic managers because they provide an accurate display of current and forecasted weather conditions that was previously not available. However, production costs are three times higher than expected, increasing from $360,000 to $1.1 million per system, and FAA cannot execute the program as planned within existing cost and schedule parameters. As a result, FAA will defer adding several future enhancements and the production systems will be less capable than the prototype systems. In addition, FAA intends to stretch out the deployment schedule through June 2008, nearly 5 years later than planned.

FAA Did Not Update the Budget Estimate to Account for the Increase in Production Costs

When the ITWS contract was awarded in 1997, FAA intended to complete the deployment of ITWS by July 2003. In August 2001 FAA revised the schedule to complete the deployment by May 2004 because new requirements were added to the ITWS contract. However, FAA will not complete the deployment of ITWS as currently scheduled, because program officials did not update the budget estimate to account for the sharp increase in production costs.

FAA attributes the production cost increase to poor cost estimating, new contract requirements, and greater-than-anticipated computer processing needs. Program officials told us that their initial production cost estimate, in 1997, was never negotiated with Raytheon and that program officials did not have a clear understanding of system performance requirements. Several new requirements were added to the contract that substantially increased the production costs. For example, FAA added a new requirement for a certification tool that will ensure ITWS is properly receiving and displaying weather information. The most significant production cost driver was the need to buy a larger computer processor (including all its associated costs for testing and installation) to handle higher processing requirements of the large terminal area control facilities, such as Potomac, as well as planned system enhancements.

In July 2002, at FAA's request, the Defense Contract Audit Agency audited Raytheon's ITWS production proposal. The audit reviewed labor charges; part and material costs; and overhead costs to ensure that the contract prices were based on accurate, complete, and current cost and pricing data. From the audit, the Defense Contract Audit Agency concluded that proposal costs were fair and

reasonable. However, FAA did not anticipate the sharp increase in the production costs or update the budget estimate to address this cost increase.

Thus far, FAA has committed $179.1 million to the program, which has gone principally to development and prototyping efforts. This also includes the procurement of six ITWS production systems. Table 1 summarizes FAA's estimated funding for ITWS.

Table 1. ITWS Estimated Program Funding

(Facilities and Equipment funding in millions)

Funding	FYs 92-02	FY03	FY04	FYs 05-09	Total
October 2002 (estimate)	$179.1*	$16.3	$20.0	$70.7	**$286.1**

* Actual amount appropriated by Congress.

Assuming the ITWS budget follows this same baseline, FAA will need at least $35 million of the remaining $107 million to procure the final 32 ITWS. The remaining $72 million is insufficient to pay for system engineering, testing, contract support, program management support, and more than 50 planned system enhancements through FY 2009. Some of the key enhancements include providing a longer weather forecast, detecting microbursts in dry air environments, and improving the accuracy of weather detection and forecasts. According to ITWS program officials, FAA will need about $55 million—over and above the $286 million program cost estimate—to complete the deployment and add all planned system enhancements. Absent additional funding, FAA will defer many of these enhancements in order to complete the deployment of ITWS.

FAA Should Reassess When and Where to Deploy ITWS

Given the cost and schedule impacts resulting from the increase in production costs and the fact that FAA is now beginning to install ITWS, FAA needs to reassess when and where to deploy ITWS. This analysis must be data driven and result in a deployment strategy to ensure that ITWS is logically deployed to sites that achieve the greatest potential benefits to the flying public. A data driven analysis should include factors such as production costs, weather delays, air traffic operations, safety benefits, and delay savings to airlines and passengers.

FAA's last data analysis was completed in 1994[5] and has not been updated with current air traffic operations data. Given that 8 years have passed and air traffic

[5] FAA updated this analysis in 2001 to reflect a larger weather area covered at each airport, but it did not account for changes in air traffic data.

operations at many airports have changed, FAA may achieve greater benefits by installing ITWS at some locations earlier than planned. For example, air traffic operations in Phoenix increased 24 percent from FY 1994 to FY 2001, and the airport ranked ninth among the ITWS sites most affected by weather delays in FY 2001. However, FAA does not plan to install a new system in Phoenix until near the end of the ITWS deployment—in FY 2007. Table 2 shows how air traffic operations have changed at ITWS sites since FY 1994.

Table 2. Changes in Air Traffic Operations at Planned ITWS Sites

(By Total Operations in FY 2001)

ITWS Sites	ITWS Operational Dates (Proposed)	FY 1994 Total Operations	FY 2001 Total Operations	Percent Change in Operations from FY 1994 to 2001
New York *	2003	1,321,320	1,474,661	11.61%
Chicago *	2003	1,351,652	1,422,972	5.28%
Potomac *	2003	1,029,646	1,191,561	15.73%
Dallas/Ft. Worth *	2005	1,048,466	1,085,571	3.54%
Miami *	2003	999,718	1,012,237	1.25%
Atlanta	2002	699,400	898,899	28.52%
Houston *	2003	589,068	738,098	25.30%
Detroit/Wayne	2004	589,987	643,479	9.07%
Phoenix	2007	507,698	627,561	23.61%
Orlando *	2005	607,754	613,405	0.93%
Denver	2005	546,305	526,204	-3.68%
Las Vegas	2007	488,347	513,679	5.19%
Minneapolis/St. Paul	2005	454,441	512,102	12.69%
Boston	2004	478,660	499,474	4.35%
St. Louis	2003	466,639	486,503	4.26%
Philadelphia	2004	402,845	475,577	18.05%
Charlotte	2006	471,128	471,731	0.13%
Pittsburgh	2004	435,433	452,696	3.96%
Memphis	2005	345,534	398,451	15.31%
Cincinnati	2004	333,832	390,306	16.92%
Salt Lake City	2007	343,807	363,682	5.78%
Cleveland	2005	260,485	305,300	17.20%
Raleigh-Durham	2006	283,713	293,995	3.62%
Indianapolis	2004	237,937	257,295	8.14%
Columbus	2006	223,633	243,203	8.75%
Nashville	2007	295,558	241,280	-18.36%
Kansas City	2003	198,274	215,833	8.86%
Wichita	2008	167,757	212,995	26.97%
San Juan	2008	174,598	210,050	20.30%
Tulsa	2007	198,332	195,669	-1.34%
Louisville	2006	179,921	177,643	-1.27%
Oklahoma City	2008	146,759	172,241	17.36%
New Orleans	2007	167,375	162,507	-2.91%
Dayton	2006	154,481	135,992	-11.97%

Data Source: FAA's Operations Network

* *Data for these sites include multiple airports supported by one system. For example the Potomac site supports four airports: Baltimore-Washington International, Ronald Reagan Washington National, Washington Dulles International, and Andrews Air Force Base.*

A data driven analysis could result in a change in where and when to deploy ITWS. We performed a limited analysis comparing FAA weather delays and air traffic operations over a 5 year period (FYs 1997 through 2001) to determine the impact of adverse weather at each site where FAA plans to install ITWS. We also met with Massachusetts Institute of Technology - Lincoln Laboratory officials to discuss the types of weather activities that could be expected to benefit from an ITWS. From our analysis, we made the following observations.

- The top 6 ITWS sites affected by weather delays averaged over 21 weather delays per 1,000 operations and more than 10,000 weather delays per year (New York, Chicago, Atlanta, Boston, Philadelphia, and St. Louis). These sites should get significant benefits from ITWS by reducing the number of weather related delays.

- Ten ITWS sites averaged less than 1 weather delay per 1,000 operations and less than 120 weather delays per year (New Orleans, Nashville, Columbus, San Juan, Indianapolis, Dayton, Louisville, Tulsa, Oklahoma City, and Wichita). FAA should reassess when it intends to install ITWS at these sites with the goal of installing units first where the benefits from reducing weather related delays will be the greatest.

- FAA plans to install ITWS at 21 sites that support capacity benchmark airports.[6] We note that FAA is not deploying ITWS at five capacity benchmark airports (Honolulu, Los Angeles, San Diego, Seattle, and San Francisco). This is because west coast airports would not derive many benefits from ITWS since most of their weather delays are caused by non-convective weather such as fog. Further, these sites do not have one of the primary radars, called terminal Doppler weather radar, used to collect terminal weather information.

Table 3 summarizes our analyses of ITWS sites.

[6] The capacity benchmark airports represent 31 of the Nation's busiest and most congested airports.

Table 3. Weather Delays Reported at Planned ITWS Sites

(By ITWS Deployment Year)

ITWS Sites*	ITWS Operational (Proposed)	Capacity Benchmark Airport	Average FAA Reported Weather Delays (FY 1997-2001)	Average Weather Delays Per 1,000 Operations (FY 1997-2001)
Atlanta	2002	Yes	22,657	26.20
Miami **	2003	Yes	3,717	3.73
Kansas City		No	184	0.86
Houston **		Yes	8,841	12.40
St. Louis		Yes	10,894	21.78
Potomac **		Yes	6,378	5.51
Chicago **		Yes	35,051	25.00
New York **		Yes	49,669	34.69
Boston	2004	Yes	13,890	27.55
Pittsburgh		Yes	1,090	2.42
Cincinnati		Yes	2,782	6.35
Detroit/Wayne		Yes	4,453	8.13
Philadelphia		Yes	10,466	22.14
Indianapolis		No	85	0.34
Denver	2005	Yes	1,262	2.52
Cleveland		No	1,217	3.85
Orlando *		Yes	2,450	3.94
Memphis		Yes	223	0.59
Dallas/Ft. Worth **		Yes	12,691	11.20
Minneapolis/St. Paul		Yes	2,851	5.68
Charlotte	2006	Yes	1,551	3.39
Dayton		No	74	0.50
Columbus		No	101	0.44
Louisville		No	69	0.39
Raleigh-Durham		No	295	1.08
Nashville	2007	No	104	0.45
New Orleans		No	111	0.67
Las Vegas		Yes	851	1.70
Phoenix		Yes	4,097	7.15
Salt Lake City		Yes	668	1.82
Tulsa		No	43	0.21
San Juan	2008	No	90	0.43
Wichita		No	17	0.08
Oklahoma City		No	40	0.24

Data Source: FAA's Operations Network

* *Only 34 of 38 ITWS sites are listed. Four systems will be installed at facilities that do not support air traffic operations (FAA Technical Center, FAA Program Support Facility, FAA Academy, and Raytheon Company).*

** *Data for these sites include multiple airports supported by one system.*

Program officials stated that FAA could achieve 80 percent of the system's benefits by installing ITWS at just 14 locations, but without a current data driven analysis, we were unable to verify this statement. However, until FAA completes a thorough analysis, including safety benefits, it cannot ensure that ITWS will be deployed in a logical and efficient manner.

FAA Could Significantly Increase the Benefits of ITWS by Integrating a 60 Minute CWF Product

Improvements in convective weather forecasting can provide traffic managers with the ability to better anticipate the effect of severe weather on the National Airspace System. One of the key planned enhancements for ITWS is to provide a 60 minute CWF product. While the ITWS production system will provide a 20 minute forecast of convective weather conditions, a 60 minute CWF product has been available at the four prototype sites since 1998. Due to the sharp increase in production costs, FAA does not plan to include a 60 minute CWF product with ITWS until at least FY 2006—nearly 8 years after the product became available.

The 60 minute CWF product provides a quantitative improvement over ITWS because it provides a longer weather forecast and more accurately shows the growth and decay of storms. In addition, the 60 minute CWF product displays an animated loop of storm movement that is not available with the production version of ITWS. According to an independent study completed in February 2001 by Management, Consulting, and Research Federal, Incorporated, providing air traffic managers with a 60 minute CWF product could result in delay savings to the airlines and flying public of at least $440 million annually. The main benefit of this enhancement is to improve the flow of air traffic for *departing* aircraft. With more advance notification of when and where bad weather will occur, air traffic managers are able to avoid bringing arriving aircraft close to the airport and making diversions that interfere with and close air routes for departing aircraft.

ITWS program officials estimated they could deliver a 60 minute CWF product within 18 months. Traffic managers we spoke with at New York and Dallas/Ft. Worth felt so strongly about the benefits of having a 60 minute CWF product that they asked to keep the prototype systems and not receive the production system until this product is available. Given the significant benefits of the product and feedback from air traffic users, ITWS program officials should accelerate plans to provide a 60 minute CWF with the ITWS production system in conjunction with revising the deployment strategy. We note that depending on the type of convective weather at each ITWS site, FAA should consider incorporating a 60 minute CWF product to sites that achieve the greatest potential benefits.

FAA Needs to Update the Cost and Schedule Estimates

Since production costs are three times higher than expected, FAA cannot execute the program as planned within existing cost and schedule parameters. According to ITWS program officials, FAA will need about $55 million—over and above the $286 million program cost estimate—to complete the ITWS deployment and add more than 50 planned system enhancements, including a 60 minute CWF product.

At this point, before FAA program officials approve any additional funding for ITWS above the current program cost estimate, they need to make a smart business decision to ensure that they have a benefit driven deployment strategy and a plan to integrate a 60 minute CWF product. In making this decision, FAA needs to complete a data driven analysis to ensure that ITWS and the 60 minute CWF product are deployed to sites that achieve the greatest potential benefits as soon as possible. After revising the deployment strategy and incorporating a plan for a 60 minute CWF product, FAA needs to update the cost and schedule estimates for ITWS.

RECOMMENDATIONS

At this time, FAA must make several important business decisions on how to move forward with ITWS. In moving forward, FAA needs to complete a data driven analysis to reassess the ITWS deployment strategy and incorporate a key ITWS enhancement. Using the results of the analysis, we are recommending that FAA:

1. Revise the deployment strategy, as appropriate, to logically deploy ITWS to sites that achieve the greatest potential benefits as soon as possible.
2. Integrate a 60 minute CWF product with the ITWS production system to sites that achieve greatest potential benefits sooner than FY 2006.
3. Revise the ITWS cost and schedule baseline to reflect the new ITWS deployment strategy and a revised plan to integrate a 60 minute CWF product.

AGENCY COMMENTS AND OFFICE OF INSPECTOR GENERAL RESPONSE

On December 5, 2002, we provided a discussion draft report to the offices of the Associate Administrator for Research and Acquisitions, Terminal Business Service, and ITWS Product Team to obtain their oral comments. FAA officials from those offices generally agreed with our results and finding. FAA officials stated that revising the deployment strategy and incorporating a 60 minute CWF product would be subject to the results of the data analysis. Further, this data

driven analysis may show the need to incorporate a 60 minute CWF product at only a limited number of ITWS sites, depending on the type of convective weather at each site. We revised our recommendations accordingly. We are requesting that FAA provide written comments to the final report that address all of our recommendations.

ACTION REQUIRED

In accordance with Department of Transportation Order 8000.1C, we would appreciate receiving your written comments within 30 days. If you concur with our finding and recommendations, please indicate for each recommendation the specific action taken or planned and the target dates for completion. If you do not concur, please provide your rationale. Furthermore, you may provide alternative courses of action that you believe would resolve the problems presented in this report.

We appreciate the cooperation and assistance provided by your staff during the review. If you have any questions or need further assistance, please contact me at (202) 366-1992, or David A. Dobbs, Assistant Inspector General for Aviation Audits, at (202) 366-0500.

EXHIBIT A. AUDIT SCOPE AND METHODOLOGY

We performed audit work from July through December 2002 and reviewed documentation dated from February 1995 through November 2002 covering all aspects of the ITWS program. This review was performed in accordance with Government Auditing Standards as prescribed by the Comptroller General of the United States.

Since ITWS is in the solution implementation phase of FAA's acquisition process, we concentrated our review on whether FAA was effectively and efficiently preparing to deploy ITWS. To evaluate whether FAA was effectively managing the ITWS program, we assessed program management areas that included system requirements; contracts and contractor performance; financial management; test and evaluation; software development; human factors; and logistic support.

Key program documents we examined included the mission need statement, operational requirements document, acquisition plan, acquisition program baseline, test and evaluation master plan, test reports, logistic support plans, the prime contract, and contract modifications. We also interviewed key personnel responsible for developing and implementing these plans.

We evaluated key program status report documents that included monthly program status reports, team meeting minutes, and Joint Resources Council decisions. These reports were used to identify, track, and evaluate program cost, schedule, and performance risks.

We also completed a limited assessment of the ITWS deployment strategy. We relied on FAA's Operations Network to collect data on air traffic operations and delays for FYs 1994 through 2001 for all ITWS sites. We compared these data to FAA's Capacity Benchmark Report of 2001 and the ITWS deployment strategy to determine the correlation between the ITWS deployment and the airports that are most congested and affected by adverse weather. We also assessed changes in air traffic operations at ITWS sites since 1994.

EXHIBIT B. OFFICES VISITED OR CONTACTED

During the audit, we visited or contacted the following offices.

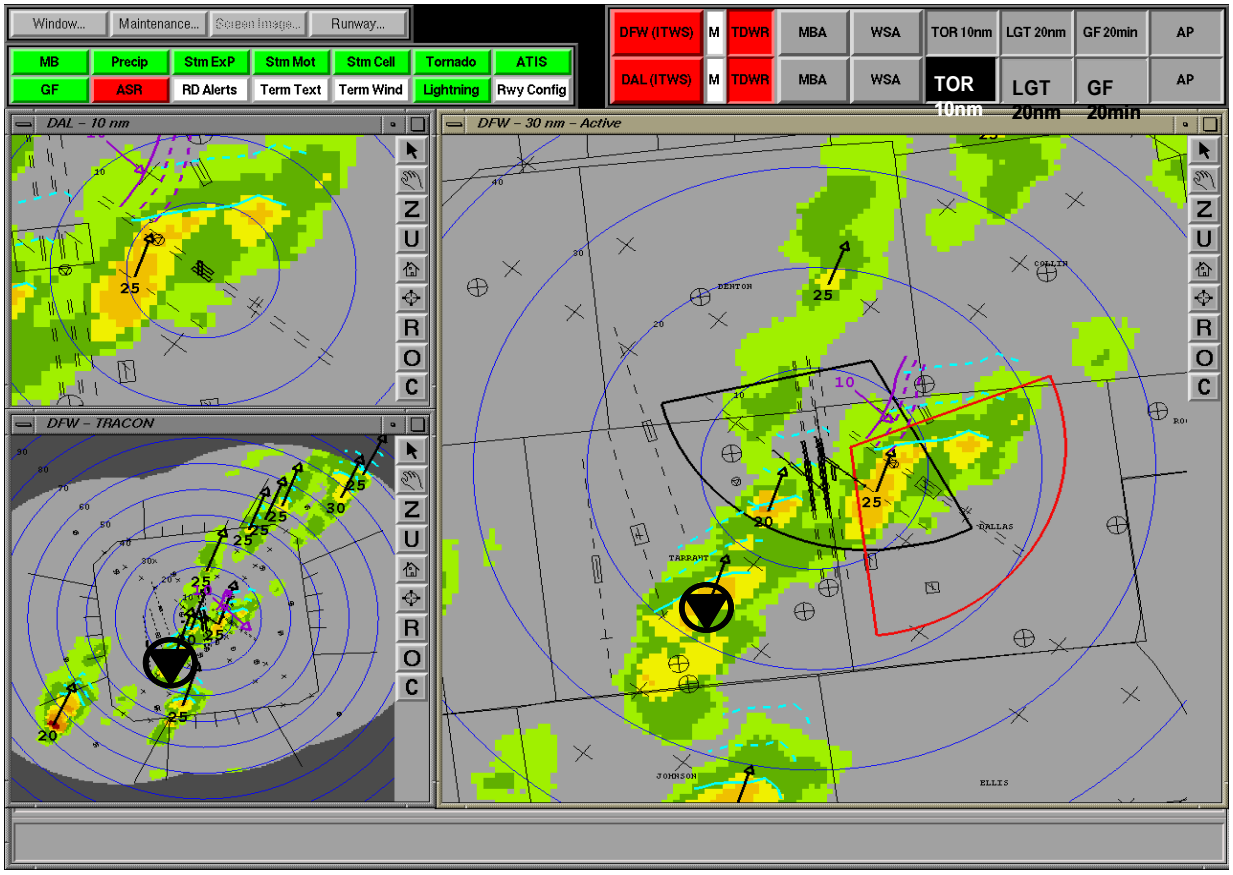
FAA OFFICES

FAA Headquarters, Washington, DC
FAA Eastern Region, Jamaica, NY
FAA Southwest Region, Ft. Worth, TX
FAA William J. Hughes Technical Center, Atlantic City, NJ
Atlanta Air Route Traffic Control Center, Hampton, GA
Atlanta Terminal Radar Approach Control Center, Peachtree City, GA
Dallas/Ft. Worth Air Route Traffic Control Center, Euless, TX
Cleveland Air Route Traffic Control Center, Oberlin, OH
Cleveland Terminal Radar Approach Control Center, Cleveland, OH
LaGuardia International Airport, New York, NY
New York Air Route Traffic Control Center, Ronkonkoma, NY
New York Terminal Radar Approach Control Center, Westbury, NY

NON-FAA OFFICES

Massachusetts Institute of Technology, Lincoln Laboratory, Lexington, MA
TRW, Washington, DC
National Air Traffic Controllers Association, Washington, DC
Professional Airways Systems Specialists, Washington, DC

EXHIBIT C. EXAMPLE OF ITWS DISPLAY



This is a display of the ITWS prototype at Dallas/Ft. Worth. The system provides a multi-window color display showing three views of weather at difference ranges around the Dallas/Ft. Worth airport. The top left picture shows Terminal Doppler Weather Radar precipitation within 10 nautical miles of the airport. The lower left picture shows Airport Surveillance Radar-9 precipitation within the terminal area control boundaries. The right picture shows Airport Surveillance Radar-9 precipitation within 30 nautical miles of the airport. Storm motion arrows and wind speed are indicated on all three views. The black triangle indicates a potential tornado moving in the direction of the airport.

Exhibit C. Example of ITWS Display

EXHIBIT D. MAJOR CONTRIBUTORS TO THIS REPORT

THE FOLLOWING INDIVIDUALS CONTRIBUTED TO THIS REPORT.

Name	Title
Matt Hampton	Program Director
Don Pierro	Project Manager
Sam Vass	Senior Auditor
Catherine Aubrey	Program Analyst
Shirley Murphy	Editor