Integrated Terminal Weather System (ITWS) Operational Test (OT) Final Report Production Version Volume II

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March 2004

DOT/FAA/CT-TN04/15

U.S. Department of Transportation
Federal Aviation Administration

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Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
DOT/FAA/CT-TN04/15		

4. Title and Subtitle INTEGRATED TERMINAL WEATHER SYSTEM (ITWS) OPERATIONAL TEST (OT) FINAL REPORT PRODUCTION VERSION VOLUME II	**5. Report Date** March 2004 **6. Performing Organization Code** ACB-630
7. Author(s) Thomas M. Weiss , William E. Benner, Thomas C. Carty	**8. Performing Organization Report No.** DOT/FAA/CT-TN04/15
9. Performing Organization Name and Address U.S. Department of Transportation Federal Aviation Administration William J. Hughes Technical Center Atlantic City International Airport, NJ 08405	**10. Work Unit No. (TRAIS)** **11. Contract or Grant No.**
12. Sponsoring Agency Name and Address U.S. Department of Transportation Federal Aviation Administration William J. Hughes Technical Center Atlantic City International Airport, NJ 08405	**13. Type of Report and Period Covered** Technical Note **14. Sponsoring Agency Code**

15. Supplementary Notes

16. Abstract

This Integrated Terminal Weather System (ITWS) Operational Test (OT) Final Report Production Version Volume II documents the results of the Production ITWS OT conducted by the William J. Hughes Technical Center (Technical Center) Weather Processors and Sensors Group (ACB-630). Production OT was conducted at Technical Center and Atlanta, GA; Atlanta OT sites included Hartsfield International Airport Air Traffic Control Tower (ATCT) (ATL), Atlanta Terminal Radar Approach Control (TRACON) (A80), and Atlanta Air Route Traffic Control Center (ARTCC) (ZTL). First Article ITWS OT (Phase I, II, and III OT) was conducted from February 6 through November 12, 2001 at Technical Center, Kansas City, and Houston; the results are documented in "ITWS OT Final Report, Volume I."

17. Key Words	18. Distribution Statement
Integrated Terminal Weather System (ITWS) Operational Test (OT) Final Report-Volume II	This document is available to the public through the Technical Center's Full-Text Technical Reports page: http://actlibrary.tc.faa.gov

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	38	

Form DOT F 1700.7 (8-72) Reproduction of completed page authorized

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EXECUTIVE SUMMARY

The Weather Processors and Sensors Group (ACB-630), of the Verification Service Division, William J. Hughes Technical Center (hereafter referred to as Technical Center), successfully conducted Operational Testing (OT) of the Production Integrated Terminal Weather System (ITWS) in accordance with the ITWS OT Test Plan. OT was previously conducted on First Article systems. Volume I of the OT Final Report documents the First Article OT results; Volume II documents the Production OT results.

Production OT took place at Technical Center (Phase IV) and Atlanta (Phase V); Atlanta facilities included the Hartsfield International Airport (ATL), ATL Terminal Radar Approach Control (TRACON), and Atlanta Air Route Traffic Control Center (ARTCC, ZTL).

The most significant differences between the First Article and Production ITWS were the inclusion of Bandwidth Manager (BWM) and Transmission Control Protocol/Internet Protocol (TCP/IP) communications, and a hardware upgrade for the Product Generator (PG) and Situation Display (SD). In addition, Atlanta was the first site with the Low Level Windshear Alert System (LLWAS III) interface to the ITWS, and therefore this interface was tested in the field for the first time. Remote Maintenance Monitoring System (RMMS) and External Users Interfaces were not available, and were not tested during First Article or Production OT.

The objectives of Production ITWS OT were to:

a. Compare the First Article System with the Production System,
b. Verify performance and maintenance improvements,
c. Verify the IP Network performance as well as Network Security, and
d. Evaluate Human Factors.

Airways Facilities user evaluations took place as a part of Phase V OT in Atlanta.

Technical Center Production OT (Phase IV) focused on the integration of the sensors into the production ITWS, product generation and display functionality, and testing the BWM interface. Comparisons were made between the First Article ITWS and the Production ITWS in order to identify any possible degradation in performance or system usability. Production OT testing at ATL (Phase V) focused more on sensor interface and performance verification.

The following Critical Operational Issues (COI) were partially resolved:

a. COI-1: Interoperability
b. COI-2: Regional Effectiveness
c. COI-4: System Resiliency
d. COI-5: Enhanced traffic planning
e. COI-6: ITWS Display
f. COI-7: ITWS Configuration
g. COI-8: Airport Capacity
h. COI-9: ITWS Product Usability

i. COI-10: ITWS Product Suitability
j. COI-12: Controller Workload

The following COIs were not resolved or were deferred:

a. COI-3: Remote maintenance monitoring
b. COI-11: Performance Thresholds

Overall, the Production OT was successful; a record of discrepancies was maintained in the ACB-630 Discrepancy Report (DR) database. A total of 32 DRs were written against the Production ITWS. One critical DR was written against the Production ITWS and has been subsequently closed by virtue of AOS-250 action. The remainder of the DRs were classified as Type II (AF) and Type III (AT), non-critical.

Human Factors data was collected for Airways Facilities (AF) users only. Air Traffic (AT) data collection was deferred because of schedule constraints. The human factors data collected at ATL noted an overall positive reception to ITWS from users, but the sample size was extremely limited. Additional user evaluations for both AF and AT are recommended.

Given the success of Production OT, the ITWS program proceeded to Independent Operational Test and Evaluation (IOT+E) by ATQ.

1. INTRODUCTION.

1.1 PURPOSE.

The purpose of Volume II of the Integrated Terminal Weather System (ITWS) Operational Test (OT) Final Report is to document the results of the Production ITWS OT conducted by the Technical Center Weather Processors and Sensors Group (ACB-630). Production OT was conducted at Technical Center and Atlanta, GA; Atlanta OT sites included Hartsfield International Airport Air Traffic Control Tower (ATCT) (ATL), Atlanta Terminal Radar Approach Control (TRACON) (A80), and Atlanta Air Route Traffic Control Center (ARTCC) (ZTL). First Article ITWS OT (Phase I, II, and III OT) was conducted from February 6 through November 12, 2001 at Technical Center, Kansas City, and Houston; the results are documented in "ITWS OT Final Report, Volume I".

1.2 SCOPE.

This volume of the OT Final Report documents the results of the Production ITWS OT, based upon the data collected during Production OT conducted at Technical Center (Phase IV) and ATL (Phase V). A list of the discrepancy reports (DR) is included as appendix A, and the results of Human Factors data collection are included in appendix B.

2. REFERENCE DOCUMENTS.

a. Operational Test (OT) Plan for the Integrated Terminal Weather System (ITWS), October 2000

b. ITWS Operational Test (OT) Procedures June 2001

c. ITWS Test and Evaluation Master Plan (TEMP), October 1995

d. Operational Requirements Document (ORD) for the Integrated Terminal Weather System (ITWS), February 1995

e. Acquisition Management System, Test & Evaluation Process Guidelines, November 1998

f. ITWS Operational Test (OT) Final Report, Volume I, April 2003

3. SYSTEM DESCRIPTION.

3.1 MISSION REVIEW.

The ITWS is a fully automated, integrated terminal weather information system that is intended to improve the safety, efficiency, and capacity of terminal area aviation operations. ITWS will provide Air Traffic personnel with tactical aviation weather products such as 6 level precipitation out to 200 nm, storm motion, storm extrapolated position, storm cell information, windshear, microburst, and gust front detection and prediction. Products and information will be displayed on ITWS situation displays (SD) installed in the ATCTs, TRACONs, and the Center Weather Service Unit (CWSU) and Traffic Management Unit (TMU) at associated ARTCCs.

To perform its mission, the ITWS acquires information from external systems that provide radar, weather sensor, and National Weather Service (NWS) data. Specified data sets from the NWS are acquired at the ITWS NWS Filter Unit (NFU) located at the FAA Technical Center and then communicated to the ITWS Product Generator (PG) sites via Government Furnished Equipment (GFE). The ITWS merges and processes the acquired data sets and provides weather products on displays for Air Traffic Control (ATC) personnel. The ITWS also provides products via designated output ports for access by aircraft data link processing and transmission systems, as well as for external users. For ITWS operations, interfacility communications are provided as GFE, either via the National Airspace Data Interchange Network II (NADIN-II), a national Packet Switching Network (PSN), or point-to-point terrestrial communications lines. The connection to NWS is provided as GFE via FAA Bulk Weather Telecommunications Gateway (FBWTG) service to the NFU. The NFU extracts portions of the NWS data for each ITWS. The Bandwidth Manager (BWM) was implemented prior to the Production OT. BWM replaces the NADIN connection as the communications link between the PGs and the ARTCC SDs.

3.2 TEST SYSTEM CONFIGURATION.

For the Phase IV OT, the Technical Center Production ITWS was connected to all available Philadelphia (PHL) sensors –Terminal Doppler Weather Radar (TDWR) (PHL), Airport Surveillance Radar-Model 9 (ASR-9) (PHL, ACY). Next Generation Weather Radar (NEXRAD) (KDIX), and Airport Weather Observation System (AWOS) Data Acquisition System (ADAS) (New York ARTCC (ZNY) and Washington ARTCC (ZDC)), just as the First Article ITWS had been configured and tested; the ATL ITWS was connected to the Atlanta NEXRAD (KFCC), the ATL TDWR, the ATL ASR-9, ATL Low Level Windshear Alert System (LLWAS) III, and Atlanta ARTCC ADAS (ZTL), representing the true operational configuration.

The primary difference between the First Article ITWS and the Production ITWS was an upgrade in the **SUN** hardware and changes to the communication infrastructure; there were also some maintenance improvements. The SUN SPARC 5 series machines, used for the First Article SDs and NFU, are no longer supported and therefore, the upgrade was required to ensure future availability of production systems, spare parts, etc. Table 3.2-1 highlights the SUN hardware changes. ITWS product depiction and functionality were not changed.

TABLE 3.2-1 ITWS SUN HARDWARE COMPARISON

ITWS COMPONENT	FIRST ARTICLE VERSION	PRODUCTION VERSION
PRODUCT GENERATOR	SUN Enterprise	SUNFIRE 3800
SITUATION DISPLAY PROCESSOR	SUN SPARC 5	SUN BLADE 100
SITUATION DISPLAY	CRT	FLAT PANEL LCD
NFU	SUN SPARC 5	SUNFIRE 280R

The communication infrastructure of the Production System was upgraded, the UCONX Maintenance Processor System (MPS 600) series units used for the First Article were replaced with the 800 series, and the Cisco router series 2600 was included to handle most of the ITWS interfaces. These infrastructure changes provide for Transmission Control Protocol/Internet Protocol (TCP/IP) connectivity to many of the ITWS interfaces; TCP/IP was not implemented on First Article systems.

Figure 3.2-1 depicts the generic OT Configuration for the Technical Center and ATL. Table 3.2-2 defines the acronyms used in the figure.

3.3 INTERFACES.

The interface descriptions are contained in "ITWS OT Final Report, First Article Version, Volume I", section 3.3.

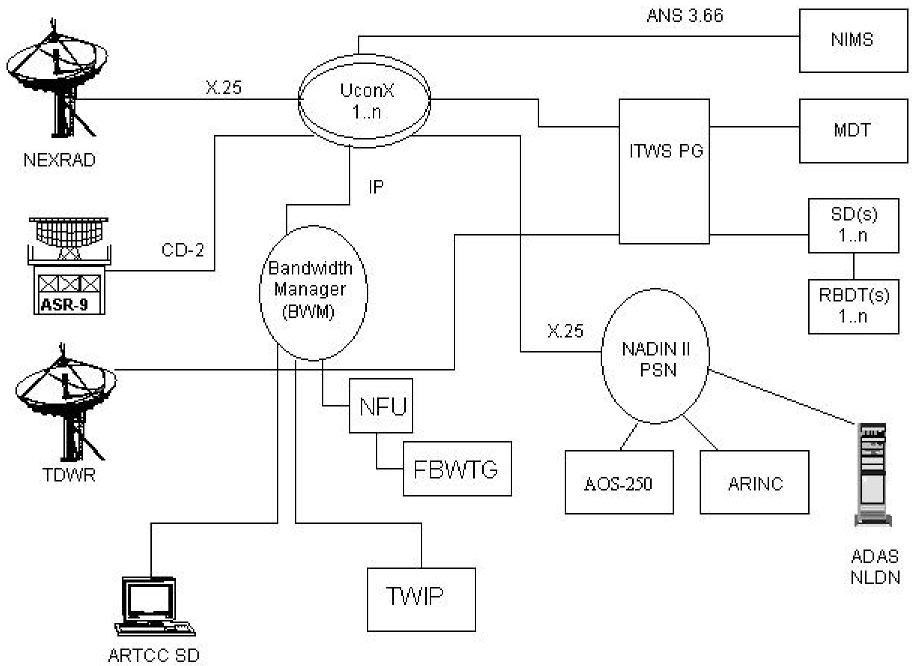

FIGURE 3.2-1 ITWS FUNCTIONAL DIAGRAM

TABLE 3.2-2 ACRONYMS FOR FUNCTIONAL DIAGRAM

ADAS	AWOS Data Acquisition System		NEXRAD	Next-Generation Weather Radar
ARTCC	Air Route Traffic Control Center		NFU	NWS Filter Unit
ASR-9	Airport Surveillance Radar-Model 9		NLDN	National Lightning Detection Network
BWM	Bandwidth Manager		PG	Product Generator
FBWTG	FAA Bulk Weather Telecommunications Gateway		RBDT	Ribbon Display Terminal
ITWS	Integrated Terminal Weather System		SD	Situation Display
MDT	Maintenance Data Terminal		TDWR	Terminal Doppler Weather Radar
NADIN-II	National Airspace Data Interchange Network-II		TWIP	Terminal Weather Information for Pilots

4. TEST DESCRIPTION.

The major Production OT test components were categorized as Comparison Tests, Performance and Maintenance Tests, IP Network Tests, and Human Factors Tests. These tests were further broken down into subtests, as depicted in figure 4-1.

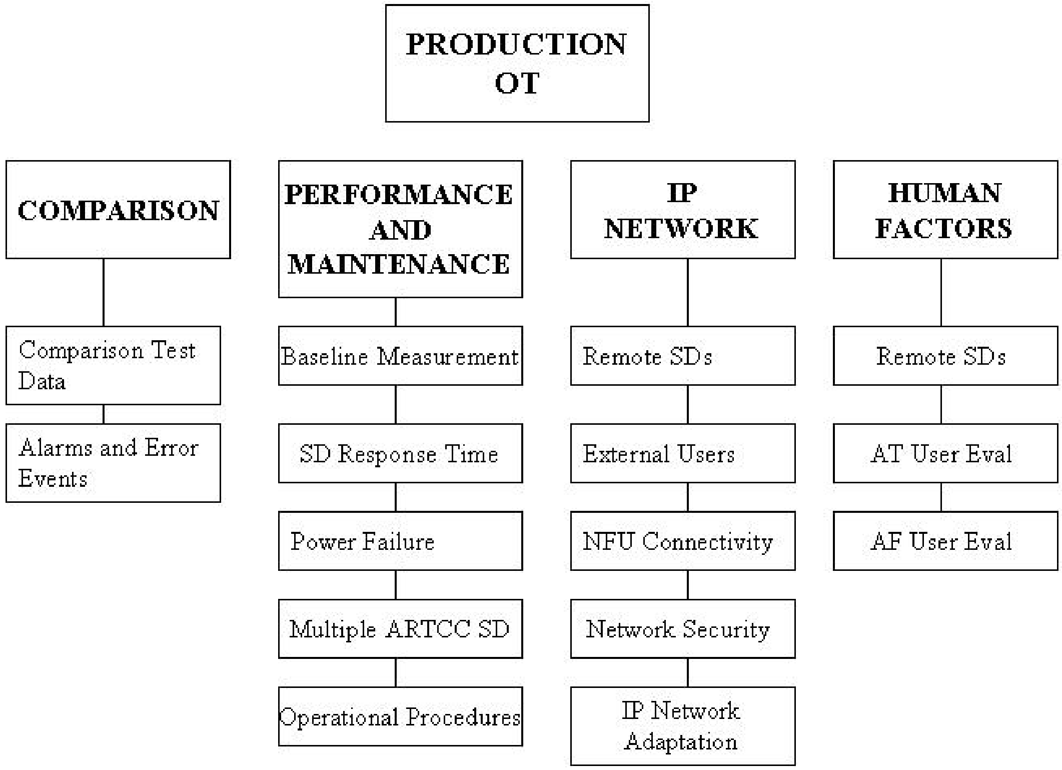

FIGURE 4-1 PRODUCTION OT COMPONENT BREAKDOWN

4.1 TECHNICAL CENTER/ATL TEST OBJECTIVES.

The Production OT was conducted in accordance with the Production ITWS OT Plans and Procedures. The objectives of Production ITWS OT were to:

a. Compare the First Article System with the Production System,
b. Verify performance and maintenance improvements,
c. Verify the IP Network performance and Network Security, and
d. Evaluate Human Factors

The focus of Phase IV OT conducted at the Technical Center was on the integration of the sensors into the production ITWS, and on product generation and display functionality (Comparison Tests and Performance and Maintenance Tests). Phase IV OT also provided the first opportunity to test the BWM interface. Comparisons were made between the First Article ITWS and the Production ITWS in order to identify any possible degradation in performance or system usability (IP Network Tests). Phase V Production OT testing at ATL also focused on sensor interface and performance verification, but in an operational environment; human Factors data collection was also an objective of Phase V OT. Phase V at ATL provided the first opportunity to test the LLWAS III interface.

Both qualitative and quantitative comparisons of the production and First Article ITWS were made. Weather products from both the First Article and Production ITWS systems, as well as input sensor base data where applicable, were compared for consistency.

Performance data such as product response time, system stability, system response to power failure, and loss of sensor input was collected and analyzed with respect to First Article performance and specification compliance.

Comprehensive testing of the IP network was conducted. PG communications to remote SDs, external users, and the NFU were evaluated.

During the functional testing of the ITWS National Airspace System (NAS) interfaces, the test equipment listed in table 4.1-1 was utilized:

TABLE 4.1-1. ITWS OT TEST EQUIPMENT

RAD Protocol Analyzer, Model No. RC-100WFL	ACB-630 Weather Server
NEXRAD Test Pattern Generator*	PHL TDWR DFU
NEXRAD APUP Simulator*	PHL TDWR Base Data Display
NEXRAD Weather Display*	TDWR TWIP Display*
PHL ASR-9 Weather Display	ITWS TWIP Display*
ACY ASR-9 Weather Display	Frontline Test System break-out box

* - developed by ACB-630

4.1.1 Test Limitations.

Phase IV OT was conducted in a laboratory environment; although the Technical Center ITWS interfaced with all available interfaces that will be a part of the eventual Philadelphia ITWS configuration. LLWAS III was available only at Atlanta. NAS Infrastructure Management System (NIMS)/MPS was not implemented at the time of OT, and testing was planned for a later date.

4.2 TEST SCHEDULE AND LOCATIONS.

The Phase IV OT took place at Technical Center from May 21 through July 17, 2002; Phase V OT took place in Atlanta from May 29 through July 17, 2002, which included Airways Facilities (AF) user evaluations. ITWS Program Management (AUA-400) made the decision to defer Air Traffic (AT) user evaluations in order to avoid delaying the In-Service Decision (ISD); this decision was based on the positive feedback received during First Article OT and previous prototype evaluations.

4.2.1 Test Descriptions.

As mentioned previously, the top-level test categories were Comparison, Performance and Maintenance, IP Network, and Human Factors. The tests conducted, along with the number of requirements tested and satisfied, are presented in table 4.2.2-1.

4.2.1.1 Comparison Tests.

The Comparison tests consisted of Data/Product Comparison and Alarms and Error Events subtests. The Data/Product Comparison Test verified functionality (i.e., the detection time, and depicted location, strength and movement of weather phenomena) of the production ITWS products. The Alarms and Error Events subtest verified that the Production ITWS detects and reports faults and alarms with the same level of accuracy as the First Article ITWS.

4.2.1.1.1 Data/ Product Comparison.

4.2.1.1.1.1 Test Objectives.

The objective of the Data/Product Comparison test was to determine if anomalies existed between the First Article and Production ITWS systems when the End-to-End Worst Case Weather Scenario was run through the system. The End-to-End Worst Case Weather Scenario is a test case used throughout much of the previous ITWS testing, particularly Factory Acceptance Tests (FAT) and Site Acceptance Tests (SAT). It is intended to stress the ITWS system with respect to maximum data inputs; it provides known inputs and should produce expected output.

4.2.1.1.1.2 Test Criteria.

The Production ITWS functionality should be equal to or greater than that of the First Article ITWS.

4.2.1.1.1.3 Test Approach.

The End-to-End Worst Case Weather Scenario was played through the First Article and Production ITWS systems, using the ITWS Test Tool, and the SDs for each system were monitored for differences. Based on prior usage of the End-to-End Worst Case Weather Scenario, the First Article ITWS SDs were expected to display specific products at specific times. The First Article performance was used as a baseline to compare the presentation on the Production ITWS SDs.

4.2.1.1.1.4 Data Analysis Methods.

This was a qualitative test, thus analysis was done by observation and direct comparison. ITWS system resource utilization reports (generated by the MDT) from the First Article and Production PG and SD were compared for differences.

4.2.1.1.2 Alarms and Error Events.

4.2.1.1.2.1 Test Objectives.

The objective of the Alarms and Errors Test was to verify that the Production ITWS detected and reported induced faults and alarms with the same level of accuracy as the First Article ITWS.

4.2.1.1.2.2 Test Criteria.

The Production ITWS must detect and report alarms and errors to a degree of accuracy at least that of the First Article.

4.2.1.1.2.3 Test Approach.

A series of faults were induced into the Production ITWS system. The responses to these faults were anticipated and had been previously witnessed on the First Article system. Both the First Article and Productions systems were in the identical state for testing. Because many of the tests required accessibility to the same ITWS sensor interfaces, the tests could not be run simultaneously since redundant interfaces for all sensors were not available. The primary group of tests in this area focused on interface fault reporting. These tests were conducted by disconnecting the specific interfaces and timing the reporting of errors to the ITWS Maintenance Data Terminal (MDT) and SD. The errors were also tracked in the applicable error logs.

4.2.1.1.2.4 Data Analysis Methods.

The MDT at each system was monitored to verify the accuracy and timeliness of the error messages that were generated. The system error logs were printed and analyzed for comparability. Interface Status buttons on the MDTs of both systems were monitored for interface failure alarms. The Product Status buttons at the Situation Displays of both systems were monitored for product unavailability.

4.2.1.2 Performance and Maintenance Tests.

The Performance and Maintenance tests consisted of several subtests: Baseline Measurements, ITWS SD Response Time, Power Failure, Multiple ARTCC SDs, and Operational Procedures. Baseline Measurements were performed to verify the backbone Local Area Network (LAN) traffic between the PG and the SDs and to evaluate the LAN traffic and central processing unit (CPU) utilization. The SD Response Time subtest included performing various command options (zoom, unzoom, pan, re-center, home, storm cell information) and recording the response time for comparison to specification time limits. The Power Failure subtest verified that the PG would power up in the specified time without user intervention. Multiple ARTCC SDs verified that the PG could transmit products to two ARTCC SDs, as well as a single ARTCC SD receiving products from two PGs. As more ITWS systems are installed, this capability will be re-verified, using more PGs and ARTCC SDs.

4.2.1.2.1 Baseline Measurements.

4.2.4.2.1.1 Test Objectives.

The objective of the Baseline Measurements Test was to measure the line utilization levels of the LAN traffic between the PG and the SDs and to evaluate the LAN traffic and CPU utilization with all interfaces operating.

4.2.1.2.1.2 Test Criteria.

CPU utilization under heavy data load was to remain below 50% over a period of 72 hours.

4.2.1.2.1.3 Test Approach.

The test was performed while the Production system was in an operational mode and ingesting data from the full complement of interfaces as well as sending data to a maximum configuration of SDs. A protocol analyzer configured with a LAN module was utilized for this test. The analyzer provided the necessary statistics and error capture logs needed to identify LAN loads and capture data errors. LAN communications were monitored for errors and loading. While the LAN was being monitored, routine actions were conducted at the SDs to ensure that such activity did not interfere with the LAN traffic.

4.2.4.2.1.4 Data Analysis Methods.

LAN and CPU data were examined with the protocol analyzer over a period of time, which included both clear and active weather.

4.2.1.2.2 SD Response Time.

4.2.1.2.2.1 Test Objectives.

The objective of the SD Response Time Test was to verify that the update rate and SD command response time of the Production ITWS met the specification requirements of 3 seconds. It was also expected and desired that the production ITWS show improvement over the First Article ITWS response times. While the First Article response times met the 3 second specification, there were situations where it approached being operationally unsuitable, particularly when multiple commands were given in rapid succession, e.g. ZOOM.

4.2.1.2.2.2 Test Criteria.

The ITWS SD must respond to various SD viewing option commands (zoom, unzoom, pan, re-center, home, storm cell information) within 3 seconds; although not a requirement, a reduction in response time versus the First Article ITWS was also expected.

4.2.1.2.2.3 Test Approach.

The various SD commands were issued multiple times and the response times were recorded for comparison to specification time limits, as well as to prior results from First Article OT.

4.2.1.2.2.4 Data Analysis Methods.

The response times were recorded and data were entered into spreadsheets and graphs, which were analyzed for specification compliance and improvement over First Article performance.

4.2.1.1.3 Power Failure.

4.2.1.1.3.1 Test Objectives.

The objective of the Power Failure Test was to verify that upon reacquiring electrical power after a power failure, the ITWS PG would power up within the specified time frame without user intervention.

4.2.1.1.3.2 Test Criteria.

After experiencing a power failure, the ITWS must power up within 15 minutes without user intervention. In addition, SDs were to restore themselves to the highest priority Product Display Operational Mode available, no more than 5 minutes after power restoration.

4.2.1.1.3.3 Test Approach.

Power failures were induced to the ITWS PG and various subsystems (SD, UCONX, etc.); upon reintroducing electrical power, the PG was observed for automatic restart.

4.2.1.1.3.4 Data Analysis Methods.

The restart times of the ITWS PG upon reintroduction of electrical power were recorded and compared to specification time limits for compliance.

4.2.1.2.4 Multiple ARTCC SD.

4.2.1.2.4.1 Test Objectives.

The objectives of the Multiple ARTCC SD test were to verify that:

a. An ITWS PG could transmit ITWS products to ARTCC SDs at two locations, and

b. A single ARTCC SD could receive and display products from two ITWS PGs

4.2.1.2.4.2 Test Criteria.

The ITWS must have the capability to transmit products to multiple ARTCC locations. An ARTCC SD must be capable of receiving and displaying products from multiple ITWS PGs.

4.2.1.2.4.3 Test Approach.

The Technical Center ITWS transmitted products to an SD configured as an ARTCC SD in the ACB-630 Weather Lab; this ARTCC SD was configured to receive ITWS products from the Technical Center and Atlanta ITWS systems. Once the ATL PG was installed and operational, ATL ITWS products were transmitted to the ARTCC SD at Technical Center.

4.2.1.2.4.4 Data Analysis Methods.

The ARTCC SD in the ACB-630 Lab was observed for products from both the Technical Center and Atlanta ITWS PGs.

4.2.1.2.5 Operational Procedures.

4.2.1.2.5.1 Test Objectives.

The objective of the Operational Procedures Test was to verify that the Maintenance Handbook (supplied by AOS-250) was complete and adequate to perform routine maintenance.

This test was deferred; the Maintenance Handbook was not available at the time of OT.

4.2.1.3 IP Network Tests.

The IP Network Test was further decomposed into five subtests: Remote SDs, External Users, NFU Connectivity, Network Security and IP Network Adaptation. The Remote SDs subtest verified the capability of the ITWS PG to communicate via BWM to multiple SDs. The ITWS Production System provided the first instance of an External User 2 Interface. The External Users subtest functionally verified the output of the External User 2 port via the BWM. The NFU Connectivity subtest verified the distribution of products between the NFU and PGs via BWM. The Network Security subtests evaluated the vulnerability of the ITWS system to unauthorized access. Of particular concern were host passwords, UNIX services configured, TCP ports open, UNIX patches installed, application file permissions, active processes, and physical security. IP Network Adaptation Tests were conducted to verify the capability of a trained AF technician to accurately change and configure new IP adaptation data.

4.2.1.3.1 Remote SDs.

4.2.1.3.2 Test Objectives.

The objective of the Remote SD test was to verify the network capability of the ITWS to communicate with multiple remote SDs via the BWM.

4.2.1.3.1.2 Test Criteria.

The ITWS PG is required to communicate with multiple remote SDs via the BWM.

4.2.1.3.1.3 Test Approach.

To perform this test, remote PGs, SD, and printers were 'pinged' using the IP addresses defined in the adaptation configuration data.

4.2.1.3.1.4 Data Analysis Methods.

The required network capability was verified via observation of receipt and display of ITWS products by remote SDs.

4.2.1.3.2 External Users.

4.2.1.3.2.1 Test Objectives.

The objective of the External Users test was to verify the output of the External User 2 port via BWM. This test was conducted at Technical Center.

4.2.1.3.2.2 Test Criteria.

The following characteristics of the External User 2 interface were verified:

a. Communication protocol implementation,
b. Error condition handling, and
c. Bandwidth measurements.

4.2.1.3.2.3 Test Approach.

The interface was exercised by using the BWM node as the data distribution point for the ITWS PG. The External User 2 product set contains only displayable products.

4.2.1.3.2.4 Data Analysis Methods.

The Protocol analyzer was used to collect message frames transmitted between the ITWS PG and the Bandwidth Manager. The data was then printed or transferred to a PC for offline analysis.

4.2.1.3.3 NFU Connectivity.

4.2.1.3.3.1 Test Objectives.

The objective of the NFU Connectivity test was to verify the distribution of products between the NFU and multiple PGs via the BWM.

4.2.1.3.3.2 Test Criteria.

The following characteristics of the NFU interface were verified:

a. Communication protocol implementation,
b. Error condition handling, and
c. Bandwidth measurements.

4.2.1.3.3.3 Test Approach.

The interface was exercised by using the BWM node as the data distribution point for the ITWS PG to evaluate the NFU product transmission.

4.2.1.3.3.4 Data Analysis Methods.

The Protocol analyzer was used to collect message frames transmitted between the ITWS PG and the Bandwidth Manager. The data was then printed or transferred to a PC for offline analysis.

4.2.1.3.4 IP Network Adaptation.

4.2.1.3.4.1 Test Objectives.

The objective of the IP Network Adaptation Test was to verify the Production ITWS TCP/IP capability and the ability of the PG to accurately maintain, change, and configure new IP adaptation data.

4.2.1.3.4.2 Test Criteria.

This test determined the network capability of the ITWS system to communicate via BWM to multiple users with the same PG as well as other PGs.

4.2.1.3.4.3 Test Approach.

To perform this test, remote PGs, SD, and printers were ‘pinged’ using the IP addresses defined in the adaptation configuration data.

4.2.1.3.4.4 Data Analysis Methods.

The network capability was verified by observation of successful feedback from remote units.

4.2.1.3.5 Network Security.

4.2.1.3.5.1 Test Objectives.

The objective of the Network Security test was to evaluate the vulnerability of the ITWS system to unauthorized access. The security test demonstrated that the necessary operational security features had been implemented into the ITWS system. This included features that restrict access to the workstation by requiring specific user log-ins and passwords, that operators' classes were specified and adaptable, that all security anomalies were noted, and that an audit log of all system access activity was maintained and displayable on the MDT, accessible only by authorized personnel.

4.2.1.3.5.2 Test Criteria.

The Network Security test verified that the required system security features were properly implemented. Tasks included verifying user level authority, system safeguards to prevent unauthorized system entry, and methods for preventing unintentional system shutdown.

An electronic audit log of system activity was generated and was maintained and protected within the ITWS MDT; only authorized users would be allowed to read the audit log.

4.2.1.3.5.3 Test Approach.

To perform this test, authorized and unauthorized user logins and passwords were inserted. System security was verified using the MDT log; the log was checked to ensure that all attempts to enter the system were logged. This verified that unauthorized users were denied access to certain ATC functions and that only a specific user could modify passwords. Also, incorrect IDs, passwords, and combinations were entered, and the functions allowed to an authorized user were verified. The test also verified that all attempts to access the system were recorded.

4.2.1.3.5.4 Data Analysis Methods.

A security checklist was used to collect the aforementioned security data. This checklist was performed on each piece of ITWS equipment (e.g., SD, PG, NFU). The checklists were inspected and failures resulted in Program Trouble Reports (PTRs). The audit log was to determine whether all access attempts were recorded.

4.2.1.4 Human Factors Test.

The Human Factors tests consisted of AF user evaluations (questionnaires and interviews); detailed results are presented in appendix B. Air Traffic evaluations were not conducted in Atlanta, due to schedule constraints. ACB-630 submitted that the AT User Evaluations conducted for the First Article ITWS and the prototypes provided sufficient evidence that AT users were satisfied with the ITWS products and their usability and interpretation. This was the consensus view of ITWS Integrated Product Team members as well. It should also be noted that the generation and display of the ITWS products on the Production SD are identical to that of the First Article. Additional verification data will be collected in Atlanta and other production sites once AT personnel have had ample opportunity to exercise the ITWS. This data will ensure that local situational differences have no negative effect on AT satisfaction with the ITWS.

The purpose of the AF data collection was to capture information regarding the utility and ease of use of the ITWS Maintenance Display Terminal (MDT) for performing maintenance and data display functions. Data collection was performed by administering questionnaires and conducting structured interviews with AF technical personnel. Two users from the ATL TRACON participated in the evaluation; however, it should be noted that although they had received the required maintenance training, they had no substantial hands-on experience with the ITWS prior to the evaluation.

The AF interviewed users rated ITWS MDT products and functions based on utility and ease of use. Although the rating criteria differed for each section, a 5-point Likert scale was implemented. The questionnaire also included open-ended questions that allowed users to comment on specific aspects of ITWS.

Interview questions were designed to obtain user impressions on the ITWS products in terms of task benefit, utility, and other relevant issues. If necessary, impromptu questions were posed in order to obtain more detailed information or to clarify questionnaire responses. Interviews were conducted with individual users on a one-on-one basis.

4.2.1.4.1 AF User Evaluation.

4.2.1.4.1.1 Test Objectives.

The objective of the AF User evaluation was to assess the perceived utility and ease of use of the MDT.

4.2.1.4.1.2 Test Criteria.

There were no formal requirements for this test; however, general user acceptance and operational suitability to AF tasks were desired outcomes. The MDT was expected to provide/display system health, maintenance, and data display functions in a clear and useable manner for trained AF technicians.

4.2.1.4.1.3 Test Approach.

The test was conducted by administering questionnaires to AF users as well as conducting structured interviews. The assessment was based on actual and/or anticipated operational use of the MDT. The consideration of “anticipated” operational use was made necessary by the lack of real ITWS experience presented by the available ITWS AF users.

4.2.1.4.1.4 Data Analysis Methods.

Data from the questionnaires and interview were tabulated and evaluated for users' opinions on the use of the MDT.

4.2.2 Test Results.

Table 4.2.2-1 presents the results of the individual tests and the requirements verified. The operational issues/problems discovered during OT were captured in a DR database which was developed and maintained by ACB-630. The status of the DRs is included as appendix A.

There were 22 DRs written on the Production ITWS system during OT; 10 additional DRs were written post-OT during various maintenance activities. One DR was classified as CRITICAL; this DR was written in response to a problem that was noted when the ITWS was in LLWAS backup mode. This DR has been closed by virtue of AOS-250 action. Ten DRs remain open; they are under investigation by Raytheon, or await ITWS program office disposition.

TABLE 4.2.2-1. PRODUCTION OT TEST PROCEDURE RESULTS

Test Name	Test Site	Total # Reqts	# Reqts Deferred	# Reqts Failed
Data/Product Comparison	Technical Center	4	0	0
Alarms and Error Events	Technical Center/ATL	4	0	0
Baseline measurements	Technical Center	3	0	0
SD Response Time	Technical Center	3	0	0
Power Failure	Technical Center	3	0	0
Multiple ARTCC SDs	Technical Center	3		0
Operational Procedures	Technical Center/ATL		deferred	
Remote SDs	Technical Center	2	0	0
External Users	Technical Center	3	0	0
NFU Connectivity	Technical Center	2	0	0
IP Network Adaptation	Technical Center	4	0	0
Network Security	Technical Center	5	0	0
AT Workload	ATL	5	0	0
AT User Evals	ATL	1	0	0
AF User Evals	ATL	1	0	0
TOTAL		43	0	0

4.2.2.1 Comparison Testing.

Comparison Testing verified that the Production ITWS SDs rendered ITWS products in the same manner and via the same commands as the First Article ITWS. Alarms and error events were detected and reported as expected.

4.2.2.2 Performance and Maintenance Testing.

Performance and Maintenance Testing verified that the speed of product generation and the SD response to commands such as Pan, Zoom, and Storm Cell Information was almost instantaneous. This was a significant improvement over First Article response times which, while meeting the specification requirement of 3 seconds, approached being operationally unsuitable. This was particularly apparent when multiple commands were given in rapid succession (i.e. ZOOM command). Also, SD CPU utilization alerts and alarms were not observed on the Production ITWS, as they were on the First Article. This is likely due to the increase in processor speed and capacity of the Production ITWS. System components responded to loss of electrical power as expected. It was also demonstrated that the PG could transmit products to multiple ARTCC SDs, and an ARTCC SD could receive products from two PGs.

An overall improvement in the general performance of the Production ITWS over the First Article was noted; no degradation in the performance of the Production ITWS was noted, when compared to the First Article ITWS.

4.2.2.3 IP Network Testing.

IP Network tests demonstrated that the BWM implementation was successful; remote SDs were successfully configured and received ITWS products via BWM. IP adaptation data was changed and reconfigured, and the network security capabilities were successfully demonstrated. The NFU, while previously used during First Article OT, was also verified to properly distribute products between the NFU and multiple PGs via BWM. The External User 2 interface via BWM was also functionally verified.

4.2.2.4 AF User Evaluations.

As previously explained, no AT evaluations were conducted, due to schedule constraints. A comprehensive accounting of the AF data collection is contained in appendix B. Four AF technicians were trained in May 2002, and were scheduled to participate in user evaluations. One of the four was unavailable at the time of the evaluation, and one was from ZTL, which has only ITWS SDs – no MDT – therefore had no real input.

The feedback from the two remaining technicians provided that all aspects of the MDT utility were rated at least neutral in terms of its utility in performing AF related tasks (i.e. none were rated as hindering the performance of the tasks) and the majority rated as enhancing the performance of AF related tasks, to some degree. The Ease of Use for the MDT was rated at least reasonably acceptable, except for ratings of the Status Buttons for internal and external links and Viewing the Event Logs. Status Buttons received the only unacceptable rating. However, due to the extremely small sample size and participating user's lack of experience with the MDT in an operational setting, no conclusions should be inferred from the report.

Users made several recommendations to change color-coding and terminology. A user recommendation to alter color-coding on alarm statuses would appear to be substantiated by the fact that some ITWS color coding schemes violate some human factors best practices, and are inconsistent with typical AF coding.

Additional user comments and minor issues and other Human Factor related recommendations are contained in appendix B.

4.2.2.5 COIs.

Resolution of the COIs from the TEMP is as indicated below. Final resolution will be resolved between the ITWS Program Office, ACB-630, and ATQ-3.

COI-1: Interoperability. Will input sensor quality be adequate? PARTIALLY RESOLVED

COI-2: Regional Effectiveness. Can the effectiveness demonstrated at the Demonstration and Validation (DEMVAL) locations be achieved at other ITWS airports given regional climatic differences, diverse airport equipage, and availability of inputs? PARTIALLY RESOLVED

COI-3: Remote maintenance monitoring. Most FAA programs have had difficulty implementing the remote maintenance requirements. Can the Remote Maintenance Monitoring System (RMMS) be successfully implemented? NOT RESOLVED

COI-4: System Resiliency. Is the ITWS system resilient under loss of input from interfaced systems/sensors (TDWR, ASR-9, NEXRAD, RMMS, and ADAS)? PARTIALLY RESOLVED

COI-5: Enhanced traffic planning. Do the ITWS products enhance the effectiveness of traffic planning/management (delays, airport acceptance rate, traffic flow, etc.) during adverse weather conditions in the terminal area? Are terminal airspace and runways used more effectively? PARTIALLY RESOLVED

COI-6: ITWS Display. Is the ITWS display visible under anticipated lighting conditions? PARTIALLY RESOLVED

COI-7: TWS Configuration. Will the algorithm and hardware function properly in a large TRACON environment, with multiple TDWRs, ASR-9s, NEXRADs, and ADASs? PARTIALLY RESOLVED

COI-8: Airport Capacity. Can the ITWS aid in maintaining effective airport capacity during adverse weather conditions? PARTIALLY RESOLVED

COI-9: ITWS Product Usability. Are the ITWS products usable without the need for meteorological interpretation? PARTIALLY RESOLVED

COI-10: ITWS Product Suitability. Are the ITWS products suitable for air traffic use? PARTIALLY RESOLVED

COI-11: Performance Thresholds. Does the ITWS meet the critical performance threshold requirements of the Operational Requirements Document (ORD)? NOT RESOLVED/DEFERRED

COI-12: Controller Workload. Does the ITWS reduce (perceived) controller workload during adverse weather conditions in the terminal area? PARTIALLY RESOLVED

5. SUMMARY OF CONCLUSIONS.

Based on the results of the Production Integrated Terminal Weather System (ITWS) Phase IV and V Operational Test (OT), ACB-630 reached the following conclusions:

a. The Production ITWS functioned comparably to or better than the First Article ITWS. The Product Generator (PG) and Situation Display (SD) hardware upgrades increased the capacity and speed of product generation.

b. A combined thirty-two Discrepancy Reports (DRs) were written against the production ITWS at Technical Center and Atlanta Hartsfield International Airport (ATL); one was assigned a CRITICAL nature of priority, and has been subsequently closed. This DR dealt with a condition that only exists when the Terminal Doppler Weather Radar (TDWR) is unavailable, and Low Level Windshear Alert System (LLWAS) winds are fed directly to the ITWS (this is an unusual condition that will rarely occur).

c. 10 of the other 31 DRs remain open; but are considered to be non-critical.

d. The majority of the open DRs are related to the Maintenance Data Terminal (MDT) and the status of interfacing sensors. The DRs and their status are listed in appendix A.

e. Hardware upgrades improved the SD Response Times (essentially immediate) and Central Processing Unit (CPU) utilization.

f. Production ITWS SDs rendered ITWS products in the same manner and via the same commands as to the First Article SDs.

g. The implementation of Bandwidth Manager (BWM) and Internet Protocol (IP) Networking provided acceptable data transmission performance.

h. Security measures that were implemented into the Production ITWS adequately protected system information and integrity.

i. Air Traffic (AT) and Airway Facilities (AF) users have had insufficient time to effectively evaluate the Production ITWS at this time. Two AF users did provide feedback in response to questionnaires and interviews.

j. The main AF concerns related to color-coding and terminology that is not consistent with other equipment.

k. According to AF users the product and interface status indicators do not provide timely information.

6. RECOMMENDATIONS.

At the conclusion of Production OT, ACB-630 recommended proceeding as planned with the conduct of Independent Operational Test and Evaluation (IOT+E) and installation of the Miami ITWS. IOT+E was completed and subsequent installations of production ITWS systems have taken place at Miami, Kansas City and Houston. The following recommendations are also made:

a. ACB-630 should conduct follow-on AT and AF user evaluations at Atlanta and/or Miami after users have gained adequate operational experience. Changes/ modifications should be made as required to the Production ITWS based on the outcome of these user evaluations.

b. The open DRs should be revisited with the ITWS program office and appropriate users to determine their priority and the feasibility of including solutions in future ITWS builds.

7. ACRONYMS.

ACY	Atlantic City International Airport
ADAS	AWOS Data Acquisition System
AF	Airway Facilities
APUP	Associated Principal User Processor
ARTCC	Air Route Traffic Control System
ASR-9	Airport Surveillance Radar-Model 9
AT	Air Traffic
ATC	Air Traffic Control
ATCT	Air Traffic Control Tower
ATL	Atlanta Hartsfield International Airport
AWOS	Automated Weather Observing System
A80	Atlanta TRACON
BWM	Bandwidth Manager
COI	Critical Operational Issue
CPU	Central Processing Unit
CWSU	Center Weather Service Unit
DEMVAL	Demonstration and Validation
DFU	Display Functional Unit

DR	Discrepancy Report
FAT	Factory Acceptance Tests
FBWTG	FAA Bulk Weather Telecommunications Gateway
GFE	Government Furnished Equipment
IOT+E	Independent Operational Test and Evaluation
IP	Internet Protocol
ISD	In-service Decision
ITWS	Integrated Terminal Weather System
KDIX	NEXRAD, Ft. Dix, NJ
KFCC	NEXRAD, Peachtree City, GA
LAN	Local Area Network
LLWAS	Low Level Windshear Alert System
MDT	Maintenance Data Terminal
MPS	Maintenance Processor System
NADIN II	National Airspace Data Interchange Network II
NAS	National Airspace System
NEXRAD	Next-Generation Weather Radar
NFU	NWS Filter Unit
NIMS	NAS Infrastructure Management System
NLDN	National Lightning Detection Network
NWS	National Weather Service
ORD	Operational Requirements Document
OT	Operational Test
PG	Product Generator
PHL	Philadelphia International Airport
PSN	Packet Switching Network
RBDT	Ribbon Display Terminal
RMMS	Remote Maintenance Monitoring System
SAT	Site Acceptance Test
SD	Situation Display
TCP/IP	Transmission Control Protocol/Internet Protocol
TDWR	Terminal Doppler Weather Radar
TEMP	Test and Evaluation Master Plan
TMU	Traffic Management Unit
TRACON	Terminal Radar Approach Control Facility
TWIP	Terminal Weather Information for Pilots
ZDC	Washington DC ARTCC
ZNY	New York ARTCC
ZTL	Atlanta ARTCC

APPENDIX A

Production ITWS Discrepancy Status

Discrepancy#	Originator	Date Written	Status	Priority	Assigned	Location	Title
Build:	2004/2043						
Production-1	Donne Wedge	5/29/2002	Closed	Type III	ACB-630	FTC	2900D Requirements Allocated to Phase 0
Production-2	Donne Wedge	5/29/2002	Closed STR8004	Type III	Raytheon	FTC	SEM Log Printout does not wrap
Production-3	Gerry DiMassa	5/31/2002	Closed STR-8273	Type III	ACB-630	FTC	IP Addresses not in Adaptation Data
Production-4	Donne Wedge	5/31/2002	Closed	TYPE II	AOS-250	FTC	No instructions to 'Ping" a device
Production-5	Jim Olivo	6/3/2002	Open	TYPE II	ATB-260	ATL	Maintenance Data Terminal
Production-6	Jim Olivo	6/3/2002	Closed	TYPE II	ATB-260	ATL	Use of new NEXRAD products
Production-7	Jim Olivo	6/3/2002	Open	TYPE II	ATB-260	ATL	The Telco Circuit ID's unavailability
Production-8	Jim Olivo	6/3/2002	Closed	TYPE II		ATL	LZU ASR-9 availability
Production-9	Jim Olivo	6/3/2002	Open	TYPE II	ATB-260	FTC	MDT status light colors
Production-10	Jim Olivo	6/3/2002	Closed	TYPE II	ATB-260	FTC	MDT interface reporting
Production-11	Gary Mitchell	6/3/2002	Closed	TYPE II	ACB-630	FTC	External Users Interface Product data incorrect
Production-12	Scott Kirby	6/4/2002	Open	Type III	ATB-260	ATL	Level 0 Precip color too bright
Production-13	Tom Weiss	6/4/2002	Closed	TYPE II		ATL	NEXRAD Status takes too long to turn red on MDT
Production-14	Jim Olivo	6/7/2002	Closed	TYPE II	ATB-260	FAA TC	ASR-9 Range Reduction
Production-15	Tom Weiss	6/12/2002	Open	Type III	AT REQ	FTC	TDWR Hazard Mode indication
Production-16	Gerry DiMassa	6/13/2002	Open	Type III	AT REQ	FTC	NFU status indication
Production-17	Jim Olivo	6/14/2002	Open	TYPE II	Raytheon	FTC	UCONX port failure
Production-18	Jim Olivo	6/14/2002	Closed	TYPE II		FTC	Uconx Port Failure
Production-19	Steve Viveiros	6/19/2002	Closed	TYPE II	ATB-260	ATL	DLU-ARNC NADIN CUG Value
Production-20	Steve Viveiros	6/19/2002	Closed	Type III	ACB-630	ATL	ATL DLU-PSF Subaddress Incorrect

Discrepancy#	Originator	Date Written	Status	Priority	Assigned	Location	Title
Production-21	John Badders	6/20/2002	Closed	TYPE II	ACB-630	FTC	PG Cisco 2600 Router
Production-22	John Badders	6/20/2002	Closed	TYPE II	ACB-630	FTC	UCONX
Production-23	John Badders	6/20/2002	Closed	TYPE II	ACB-630	FTC	MDT Console
Production-24	John Badders	6/20/2002	Closed	TYPE II		FTC	PG restore to operational mode
Production-25	John Badders	6/20/2002	Closed STR-8273	TYPE II	ACB-630	FTC	Display IP Addresses
Production-27	John Badders	6/20/2002	Closed	TYPE II	ACB-630	FTC	Purged products
Production-29	Todd Pattison	10/7/2002	Closed STR-8456	TYPE I	Raytheon	ATL	LLWAS III/ITWS Discrepancy
Production-30	Steve	11/7/2002	Open STR8534	TYPE II	Raytheon	FTC	ITWS PG time out
Production-32	Donne Wedge	2/4/2003	Open	TYPE II	ATB-260	FTC	ASR-9 "Smart Mode"
Production-33	Donne Wedge	2/12/2003	Closed	TYPE II	ATB-260	ATL	Safety Concern with ITWS
Build:	2011/2013						
Production-26	Donne Wedge	8/5/2002	Closed STR8265	Type III	Raytheon	FTC	Storage Directory for FBWTG
Build:	4006/4032						
Production-31	Steve Viveiros	1/7/2003	Open	TYPE II	Raytheon	FTC	NFU Susceptible to Crash

APPENDIX B

Airway Facilities MDT Human Factors Evaluation for the
Integrated Terminal Weather System (ITWS)

1. HUMAN FACTORS APPROACH.

The purpose of the data collection was to capture information regarding the utility and ease of use of the ITWS MDT for performing maintenance and data display functions. Data collection was performed by administering questionnaires and conducting structured interviews with AF technical personnel. Two users from the Atlanta International Airport (ATL) Terminal Radar Approach Control (TRACON) participated in the evaluation.

It should be noted that AF users had only received the required training. Users had not had the opportunity to utilize the MDT in an operational setting due to scheduling difficulties and delays in declaring Initial Operational Capability (IOC).

1.1 DATA COLLECTION TOOLS.

1.1.1 QUESTIONNAIRES.

Airway facility users rated ITWS MDT products and functions based on utility and ease of use. Although the scales differed for each section, a 5-point Likert scale was implemented, with 1 being the best and 5 being the worst. The questionnaire also included open-ended questions that allowed users to comment on specific aspects of ITWS.

1.1.2 INTERVIEWS.

Interview questions were designed to obtain user impressions on the ITWS products in terms of task benefit, utility, and other relevant issues. If necessary, impromptu questions were posed in order to obtain more detailed information or to clarify questionnaire responses. Interviews were conducted with individual users on a one-on-one basis.

1.2 DATA ANALYSIS.

Data was summarized and tabulated. Questionnaire ratings were analyzed using descriptive statistics. Structured interview responses were summarized. Since ranking data was ordinal and a normal distribution could not be assumed, the median was used as the measure of central tendency.

2. RESULTS AND DISCUSSION.

2.1 FACTORS AFFECTING RESULTS.

Small response set: A total of 2 questionnaires and 2 interviews were obtained from AF personnel. This sample size is inadequate to draw any conclusions or to achieve statistical significance. In order to extrapolate results to the airway facilities community further testing would be required using multiple sites and more users.

Lack of use in an operational setting: Users received training but had not had the opportunity to utilize the MDT under operational conditions. Therefore, answers may be subject to change as users gain more operational experience with the system.

2.2 QUESTIONNAIRE RESULTS.

This section will describe general results from the questionnaires derived from the ATL TRACON Airway Facilities personnel. Interview data will be discussed separately. Two users responded to the questionnaire. Three users had completed the ITWS training at the time of the evaluation and were solicited for feedback. However, one user, located at the Atlanta ARTCC, was not comfortable providing feedback on the MDT as it is not intended for use in the ARTCC and because the user lacked adequate familiarity with system functions.

Questionnaire ranking results regarding the ITWS products and functionality are summarized in tables 1 and 2. The following results are broken into 2 sections, one for the Utility of MDT Functionality and one for Ease of Use of MDT Functionality. Data with responses sets of 0 or 1 were not addressed due to lack of feedback.

2.2.1 UTILITY QUESTIONNAIRE RESULTS.

The results of the Utility Questionnaire are presented in table B-1.

The utility of Maintenance Functions received positive ratings (1-1.5) for Playback and Control functions, Status Reports, View Event Log functions, and the Systems Message Box. The remainder of the maintenance functions was not rated as positively. Status buttons for internal and external links received neutral responses indicating that utilizing the system neither led to enhancement nor degradation of job performance. Users cited that the color-coding of the buttons do not adequately reflect the status of the system. These color-coding difficulties will be further discussed in the Structured Interview section of this document.

The Parameters- View Adaptation Data had a minimal response rate (N=1) and will not be commented upon. The declining user reported that airway facilities will not be responsible for utilizing these functions and therefore, did not feel qualified to respond.

TABLE B-1. UTILITY RATINGS FOR MDT FUNCTIONALITY

Product	Median	#
I. Display Support Functions		
1. Change Password	2	2
2. Set Runway Control	2.50	2
3. Edit Alarm Timeouts	3	1
4. View/Edit Runway Configurations	2.50	2
5. Edit Runway Configuration Install Box	3	2
II. Maintenance Functions		
6. System Message Box	2	2
7. Status buttons for external links	3	2
8. Status buttons for internal links	3	2
9. Status reports	1	2
10. Parameters – View/Edit Adaptation Data		
a. Algorithm	3	1
b. PG Control	3	1
c. SD Data for MDT	3	1
d. Thresholds	3	1
11. Messages: View Event Log	1	2
12. Playback		
a. Transfer PG Data	1.50	2
b. Playback PG Data for MDT	1.50	2
c. Playback PF Disk Data	1.50	2
13. Control		
a. Update Time	1.50	2
b. Select UTC Time Source	1	2
c. Shutdown PG	1	2
d. Change PG Mode	1	2
e. Restart PG	1.50	2
f. Run Diagnostics	1	2

Products were rated using the following scale. 0 = Not Used 1 = Consistently Enhances 2 = Frequently Enhances 3 = Neutral 4 = Frequently Hinders 5 = Consistently Hinders
In general, Display Support Functions were in the Neutral to Frequently Enhances Range. The Change Password function received the highest rating indicating this function “Frequently Enhances” job performance, while the Set Runway Control, View/Edit Runway Configurations, Edit Runway Configuration Install Box functions fell in the Neutral to Frequently Enhances range. The Edit Alarm Timeouts response rate (N=1) was not adequate to comment on results.

2.2.2 EASE OF USE QUESTIONNAIRE RESULTS.

The results of the MDT Ease of Use questionnaire are presented in table B-2.

TABLE B-2. EASE OF USE RATINGS FOR MDT FUNCTIONALITY

Product	Median	#
I. Display Support Functions		
14. Change Password	1	2
15. Set Runway Control	2	1
16. Edit Alarm Timeouts	0	0
17. View/Edit Runway Configurations	2	1
18. Edit Runway Configuration Install Box	2	1
II. Maintenance Functions		
19. System Message Box	1.5	2
20. Status buttons for external links	4.5	2
21. Status buttons for internal links	3	2
22. Status reports	2	2
23. Parameters – View/Edit Adaptation Data		
a. Algorithm	0	0
b. PG Control	0	0
c. SD Data for MDT	0	0
d. Thresholds	0	0
24. Messages: View Event Log	2.5	2
25. Playback	1	2
a. Transfer PG Data	1	2
b. Playback PG Tape Data	1	2
c. Playback PG Disk Data	1.5	2
26. Control		
a. Update Time	1.5	2
b. Select UTC Time Source	1.5	2
c. Shutdown PG	1.5	2
d. Change PG Mode	1	2
e. Restart PG	1.5	2
f. Run Diagnostics	1	2

The ease of use for the ITWS MDT was rated using the following scale. 0 = Not Used 1 = Completely Acceptable 2 = Reasonably Acceptable 3 = Borderline 4 = Moderately Unacceptable 5 = Completely Unacceptable

In terms of Ease of Use, Display Support Functions were generally in the Completely Acceptable to Moderately Acceptable range. The Edit Alarms functions had a response rate of N=0 and therefore cannot be commented upon.

The Maintenance Functions on the MDT were fairly positive in terms of the Playback and Control functions. However, the View Events Log rating fell in the Borderline range. This was consistent with attached comments and recommendations for enhancements. Users requested that View Event Log function provide more detailed reports on hardware status. A request was also made to implement a highlight and print selection for the View Event Log. Current functionality requires that the entire 24 hr log be printed. In addition, despite the positive rating for the Restart PG function, users requested that the router be linked to a LAN Minder so that it will automatically cycle during a Restart. The router currently requires manual cycling. Further details on these issues will be provided in the Interview section of this document.

Results for the Internal and External Status Links were not as positive. The external link status button received a median rating of 4.50, indicating a response between moderately and completely unacceptable. Internal links rated at Borderline. Comments confirmed user ratings. Users reported that the color-coding of these states is not meaningful. In the current configuration, disabled links remain green. Users would prefer that degraded links turn yellow, representing a “degraded” status. This topic is investigated more fully in the remainder of this document.

Parameter- View/Edit Adaptation Data cannot not be commented upon due to lack of responses (N=0). During informal discussion, participants commented that Air Traffic personnel would perform these functions. Airway Facilities do not make decisions regarding airport parameters.

2.3 OTHER ISSUES.

A written comment indicated that the ATL ARTCC does not and will not possess a TDWR backup feed. The user reported that the lack of a backup feed would prompt a red alarm to be perpetually displayed on the SD. The user believed that the TDWR backup feed alarm button should be grayed out.

2.4 INTERVIEW RESULTS.

Interviews indicated that the terminology and systems states (Operational, Offline, and Standby) are not intuitive or logical. Users stated that Offline is essentially Standby and vice versa. Furthermore, users stated that these system states are inconsistent with other frequently used equipment, which could easily lead to confusion. Users believed this is counter-intuitive to normal operations and should be rectified, as habit will make personnel less likely to respond to the correct option.

Users believed that current functionality supported their job tasks. The MDT provided the capabilities needed to perform necessary functions. Caution should be exercised in weighting these results too heavily due to the extremely small sample size and participating user’s lack of experience with the MDT in an operational setting.

The users made the following issues and recommendations:

a. The router needs to be manually cycled after a Restart in order for it to locate the server. Users preferred that the router be hooked to the LAN minder so that it will cycle automatically.

b. Users reported that the MDT PG Alarms function currently reports the statuses of the CPU and Memory only. Users preferred that the alarms status message block should display the status of the hardrive failures and LED Failures. They believed this would assist with troubleshooting tasks. Users said that current troubleshooting capabilities are limited to LED lights, and if LED lights are out, there is no alternate method.

c. The ASR9 - LZU is new radar waiting to be commissioned. The status bar on the display for the ASR9 radar will be perpetually red until it is commissioned. Users stated that the status bar button should be yellow for degraded status. Red is alarming to AF and ATC personnel.

d. When disabling internal and external links the status button remains green. There is no indication of degraded link status. Users stated that this button turn yellow.

e. The Viewer Log currently only prints the entire data log from the previous 24 hrs. This is time consuming and results in large amounts of irrelevant data. User requested that an implementation of a highlight and print selection function.

3. CONCLUSIONS.

Due to the extremely small sample size and participating user's lack of experience in an operational with the MDT in an operational setting no conclusions should be inferred from this report.

Color-coding for degraded system states was the most outstanding issue that arose during the evaluation. The system lacks a yellow color-coding, which typically signifies a "degraded" or "disabled" status in an AF and AT environment. Red alarms are normally reserved for only grave malfunctions that require immediate attention. In addition, miscoded alarms raise the potential of system problems going unnoticed. Several recommendations were made by users to adjust counterintuitive color-coding and terminology.

Status Reports, View Event Log, Playback, and Control functions were rated most positively, despite recommendations for changes for several of these functions. Remaining functions largely fell in the neutral range indicating that the equipment neither degrades nor enhances job performance.

Ease of use ratings were somewhat consistent with utility ratings. Change password, Playback, and Control functions were rated most positively while View Event Log, and Status Buttons for External and Internal Links received poorer ratings. Users indicated that the external links (which received a rating of 4.5 or “unacceptable”) and internal link status buttons did not properly reflect system status.

Some functions could not be evaluated due to lack of responses. These functions are especially deserving of further testing. These functions include: Edit Alarm Timeouts, and Parameter-View Adaptation functions.

4. RECOMMENDATIONS.

Due to the extremely small sample size and participating user’s lack of experience in an operational with the MDT in an operational setting no conclusions should be inferred from this report. ACB-630 recommends more intensive follow up testing in order to thoroughly evaluate the ITWS MDT. A comprehensive and thorough evaluation would require a larger response set that have had ample experience utilizing the system under operational constraints.

Despite the small sample set, the user recommendations for altering color-coding on alarm statuses can be considered valid in that they violate basic human factors and are inconsistent with typical AF coding. In addition, perpetually red alarms increase the possibility of valid alerts going unnoticed.

Consideration for color–coding changes should be given to the following user requests:

a. Disabled or degraded internal and external links should be indicated as such via yellow shading.

b. If the ATL ARTCC will not receive a backup feed, the alarm button on the SD should be grayed out.

c. The ASR9 radar awaiting commission should be yellow to indicate a “disabled” status. The red alarm should be eliminated.

The Offline and Standby modes are counterintuitive in that users have been conditioned to operate differently on more frequently used systems. Users reported that if this condition is to remain as is, training is imperative. However, consideration should be given to reversing offline and standby modes, as habit will make personnel less likely to respond to the correct option.

In addition to the above items, the following user recommendations should be considered for follow-up testing with more users who have had ample time to form opinions on the MDT in an operational environment:

a. The automatic recycling of the router after a Restart.
b. The request for a more comprehensive System Status Message box.
c. Implementation a highlight and print selection option on the Viewer Log.