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Time Code Display (TCD) Test and Evaluation Master Plan (TEMP)

Michael R. Melillo

July 1996

DOT/FAA/CT-TN95/68

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16. Abstract

This technical note contains the Time Code Display (TCD) Test and Evaluation Master Plan (TEMP). This TEMP was used to define the overall planning, coordination, and testing associated with the preparation and conduct of the OT&E effort for the TCD project. In addition, this TEMP was utilized to serve as a basis for the development of the OT&E Test Plan .

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1. INTRODUCTION.

1.1 BACKGROUND.

The Time Code Display (TCD) has been in the field since 1979. This is the sixth hardware procurement and will be identical in form, fit, and function to the approximately 6000 TCDs in operation now.

1.2 PURPOSE.

This Test and Evaluation Master Plan (TEMP) describes the Test and Evaluation (T&E) program for the TCD project. The TCD project is not delineated in the National Airspace System (NAS) System Specification (NAS-SS-1000). Therefore, this T&E will ensure the TCD program meets the Statement of Work (SOW) technical salient characteristics and integrates properly with the NAS. This TEMP describes all T&E phases, and includes the Development Test and Evaluation (DT&E), Operational Test and Evaluation (OT&E) Integration and Operational, and OT&E Shakedown testing.

Roles and responsibilities for the Federal Aviation Administration (FAA) organizations involved in the TCD T&E activities are presented. A Test Verification Requirements Traceability Matrix (TVRTM), which integrates the TCD physical, functional, operational effectiveness, and the NAS operational suitability requirements, is also provided.

1.3 SCOPE.

The Development Phase, the OT&E phase, and Shakedown phase are the prime focus of this TEMP. The First Article buy will consist of 130 units which will be tested at the contractor's facility. Subsequently, OT&E will be conducted at the Air Route Traffic Control Center (ARTCC), Boston, Massachusetts, the Terminal Approach Control Facility (TRACON), Philadelphia International Airport, the Air Traffic Control Tower (ATCT), Atlantic City International Airport, and the Automatic Flight Service Station (AFSS), Millville, New Jersey. This TEMP provides a summary of T&E activities, issues, and requirements.

2. REFERENCE DOCUMENTS.

The following specifications, standards, and other documents form a part of this TEMP.

2.1 FAA DOCUMENTS.

2.1.1 FAA Specifications

FAA-G-2100F	Electronic Equipment, General Requirements, November 15, 1993.
FAA-E-2306	Coded Time Source and Auxiliaries, June 23, 1967.

2.1.2 FAA Standards.

FAA-STD-024b	Content and Format Requirements for the Preparation of Test and Evaluation Documentation, August 22, 1994.
FAA-STD-013b	Quality Control Program Requirements, September 28, 1989.
FAA-STD-021a	Configuration Management, August 17, 1987.

2.1.3 Other FAA Publications.

FAA ORDER 1810.4B	FAA NAS Test and Evaluation Policy, October 22, 1992.
FAA ORDER 6950.2C	Electrical Power Policy Implementation at National Airspace Facilities.

2.2 MILITARY AND FEDERAL PUBLICATIONS.

2.2.1 Military Handbook.

MIL-HDBK-781	Reliability Test Methods, Plans, and Environments for Engineering Development, Qualification, and Production, July 14, 1987.

2.2.2 Military Standards.

MIL-STD-781D	Reliability Testing for Engineering Development, Qualification, and Production, October 17, 1986.

3. NAS SUBSYSTEM DESCRIPTION.

3.1 NAS SUBSYSTEM IMPLEMENTATION.

The TCD will be implemented using a Research, Engineering, and Development program. One hundred and thirty TCDs will initially be produced and utilized for specification compliance testing and OT&E testing. Upon completion of the testing, these TCDs will be sent to the Logistics Center in Oklahoma. Three additional buys are contained under the contract. The buy for the first option is 600 units; for the second is 500 units; and, for the third and final option is 500 units.

3.2 NAS SUBSYSTEM.

The TCDs are located in ARTCCs, ATCTs, TRACONs, and AFSSs.

The TCD will accept as its input one of three modulated serial time codes: Inter-Range Instrumentation Group-E (IRIG-E) or modified IRIG-E (FAA-E) from a Time Code Generator (TCG), or IRIG-B from a Global Positioning System (GPS) or a WWV Broadcast Receiver. The input time code signal is decoded and reformatted to drive a six-digit display, representing the time in hours, minutes, and seconds.

In the event of loss of the input time code signal, the TCD will switch to the Alternating Current (AC) line clock mode. In this mode, the update of the display will be derived from 60 hertz (Hz) line power. Upon return of the time code signal, the display will automatically reconnect to the input code. If the TCD loses power while operating in the AC line clock mode, upon return of AC power, the display will flash at a 1-Hz rate.

Controls for adjustment/setting of the display are provided on the front panel to allow for selection of operating mode (modulated time code or AC line mode),manually presetting the time of day, adjusting the display intensity, and display test.

The switch selectable inputs are as follows:

a. Coded Time Signal.

b. AC line clock synchronized to the 60-Hz power line, and used in event of the serial time code failure or those facilities that have no TCG.

3.3 INTERFACES.

The TCD interfaces with the following:

a. TCG, FAA IRIG-E, or Standard IRIG-E.

b. IRIG-B output devices such as a Global Positioning Satellite Receiver output or a WWVB receiver.

c. 115 VAC 60-Hz power.

3.4 CRITICAL PERFORMANCE PARAMETERS (CPP) AND CRITICAL SYSTEM CHARACTERISTICS.

The TCD's CPPs are as follows:

a. ability to display the correct time of day;
b. ability to be adjustable to the proper intensity; and
c. ability to satisfy the criteria for connecting to the critical power bus.

3.5 CRITICAL OPERATIONAL ISSUES (COI).

The most critical issue related to the TCD is its reliability performance. It is highly important that the TCD under test not only performs satisfactorily, but equals or exceeds its designed intended useful life.

3.6 MINIMUM OPERATIONAL PERFORMANCE (MOP).

The TCD shall display correct time of day at the appropriate intensity setting for its environment (bright light to almost total darkness).

4. T&E PROGRAM MANAGEMENT.

4.1 MANAGEMENT.

Organization Primary Roles and Functions

AND-430	The Terminal Products Lead (TPL) directs and manages all FAA activities for the TCD acquisition and implementation. The TPL is responsible for the design, development, integrated logistic support, test and evaluation, full-scale production, installation, and development of the TCD TEMP. The TPL is the program spokes-person in behalf of the FAA. The TPL develops program budget justification documentation, and controls program funds within the approved appropriation.
AND-430	The TCD Associate Program Manager for Engineering (APME) directs, manages, and accomplishes engineering activities delineated in TCD program directives. The APME provides assistance and support to the implementation of this TEMP through the review of related test plans, procedures, test data, and test reports. In conjunction with the ACT-320 Associate Program Manager for Test (APMT), the APME presents reviews to the Test Policy Review Committee (TPRC) as required.
ASU-425	The TCD Associate Program Manager for Quality (APMQ) directs, manages, and accomplishes quality activities delineated in TCD program directives.
ALM-800	The TCD Associate Program Manager for Logistics (APML) directs, manages, and accomplishes logistics and training activities delineated in TCD program directives.
ACT-320	The TCD APMT is the focal point for testing. He ensures that preparation of test plans and procedures are in accordance with FAA-STD-024b and consistent with FAA Order 1810.4B. Further, he is responsible for all aspects of OT&E Integration and Operational testing and the witnessing of TCD OT&E Shakedown, Reliability, and DT&E testing. He provides recommendations based on test results in support of the Deployment Readiness Review (DRR) Executive Committee (EXCOM) process.
AOS-220	This organization is responsible for the development and execution of the OT&E Shakedown Test Plan, Test Procedures, Maintenance Handbook, and conducts OT&E Shakedown.

Contractor	The contractor, Condor Reliability Services, devebps the Test Plans, Test Procedures and Test Reports in accordance with the SOW. Upon approval of the plans and procedures, the contractor proceeds into DT&E testing. The contractor provides the FAA with DT&E and Reliability Test Reports at the conclusion of DT&E and Reliability Testing. The contractor provides OT&E test support, as requested, and is responsible for resolving any deficiences related to testing.
Region AEA	The Eastern Region will provide both Air Traffic (AT) andAirway Facilities(AF) support activities as described in the TCD Program Implementation Plan which lead to site acceptance and field Shakedown testing.
TPRC	The TPRC is responsible for approving the TEMP and test policy waivers. The TPRC is also responsible for resolution of disagreements on T&E issues when agreements cannot be reached at lower levels of FAA management.

4.2 INTEGRATED SCHEDULE.

The TCD program's T&E integrated schedule includes major program office Key Decision Points (KDP), milestones, test and evaluation activities, and production dates as indicated in figure 4.2-1.

4.3 TEST AND EVALUATION FUNDING.

Funding for the TCD test program covers the following:

a. FAA Technical Center Personnel	12/1/95 - 2/15/96	20 hrs/wk
b. Contractor Support	12/1/95 - 2/15/96	20 hrs/wk
c. Test Equipment	$10,000.00	
d. Travel	$10,000.00	

Phase	Concept Phase 1	Demonstration Phase 2	Development Phase 3	Production Phase 4
Key Decision Points	• KDP 1	• KDP 2	• KDP 3	• KDP 4
Time Line			12/1/95 - 2/14/96	2/15/96
Contract Milestones			• Contract Award 12/1/94 • Critical Design Review 2/13/95 • Production of 130 TCDs for Test and then Field use 2/1/95 - 8/28/95	Production • 600 Units 7/15/95 - 11/15/95 • 500 Units As required • 500 Units As required
TEMP Schedule			12/1/94 - 6/21/95	
Test Plans Development			• Contractor's Master Test Plan 1/15/95 - 5/01/95 • First Article Test Plan 3/15/95 - 5/26/95 • Factory Acceptance Test Plan 3/15/95 - 5/08/95 • Factory Acceptance Test Proc. 3/15/95 - 5/22/95 • 1st Article Test Procedures 3/15/95 - 5/31/95 • Corrective Action Plan 4/1/95 - 6/01/95 • Rel Demo & Growth Test Plan 4/1/95 - 5/04/95 • Rel Demo & Growth Test Proc. 4/01/95 - 6/19/95	

FIGURE 4.2-1. TCD INTEGRATED SCHEDULE

Phase	Concept Phase 1	Demonstration Phase 2	Development Phase 3	Production Phase 4
Test Plans Development (continued)			• OT&E Plan 6/21/95 - 7/20/95 • OT&E Procedures 7/20/95 - 8/29/95 • Factory Acceptance Test Report 7/01/95 - 9/29/95 • 1st Article Test Report 8/15/95 - 9/29/95 • Reliability Demo Test Report 8/15/95 - 9/29/95 • Reliability Growth Test Report 10/05/95 - 6/22/96	
Scheduled Testing			• Factory Acceptance Test (First 30 units) 5/26/95 - 6/5/95 • Factory Acceptance Test (Additional 100 units) 8/28/95 - 9/14/95 • First Article Test 6/6/95 - 8/15/95 • Reliability Demo Test 8/1/95 - 9/15/95 • Reliability Growth Test 9/15/95 - 5/15/96 • FAA OT&E Integration and Operational Testing 10/02/95 - 1/15/96	
Test Support Equipment				

FIGURE 4.2-1 TCD INTEGRATED SCHEDULE (CONTINUED)

4.4 TEST PLANS.

The following contractor-provided test plans are required during the DT&E phase of the TCD program:

Plan	Delivery Date
Contractor's Master Test Plan	5/01/95
First Article Test Plan	5/26/95
Reliability Demonstration and Growth Test Plan	6/19/95
Factory Acceptance Test Plan	5/08/95

The following test plan is required for the OT&E test phase of the TCD program and will be provided by ACT-320:

Plan	Delivery Date
OT&E Operation and Integration Test Plan	7/20/95

The following test plan is required for the OT&E Shakedown test phase of the TCD program and will be provided by AOS-220:

Plan	Delivery Date
OT&E Shakedown Test Plan	6/30/95

4.5 TEST PROGRAM RESOURCES.

The following resources are required to support testing of the TCD:

a. Time Code Generators:

1. IRIG-E.
2. Modified IRIG-E.
3. IRIG-B.

b. Test Sites:

1. Air Route Traffic Control Center (ARTCC).
2. Air Traffic Control Tower (ATCT).
3. Terminal Radar Approach Control (TRACON).
4. Automated Flight Service Station (AFSS).

4.5.1 Manpower and Training.

Training will be acquired through the review and evaluation of the TCD instruction manuals, test documentation, design reviews, and witnessing of the prime contractor T&E activities.

4.5.2 Test Articles.

The current contract calls for 130 TCDs to be initially procured from Condor, Inc., 120 of which will be utilized for First Article testing. This testing will be held at Condor Reliability Services, Santa Clara, CA.

4.5.3 Test Sites.

First Article testing and Reliability Demonstration and Growth testing will take place at Condor Reliability Services' facility: 2921 Copper Road, Santa Clara, CA 95051.

It is currently planned that the OT&E Integration, Operational, and Shakedown testing will be held at the ARTCC in Boston, Massachussetts.. In addition, to test the TCD with a variety of Time Code Generators, OT&E testing also will be conducted at the Terminal Radar Approach Control Facility (TRACON), Philadelphia International Airport, Philadelphia, Pennsylvania; the Air Traffic Control Tower (ATCT), Atlantic City International Airport, New Jersey; and the Automated Flight Service Station, Millville, New Jersey.

4.5.4 Test Support Equipment.

The OT&E Integration and Operational Testing will require the following test support equipment:

a. Photometer,
b. AC power analyzer,
c. Oscilloscope - storage,
d. Current probe, and
e. TCGs.

4.6 TEST CONFIGURATION MANAGEMENT.

The TCD Prime Contractor's Configuration Management program will be implemented in accordance with FAA-STD-021a. (Note: The SOW does not call for the prime contractor to perform a Functional Configuration Audit (FCA) or a Physical Configuration Audit (PCA).)

5. T&E PROGRAM DESCRIPTION.

5.1 COMPLETED DT&E/PRODUCTION ACCEPTANCE TEST AND EVALUATION (PAT&E).

Since 1979, production contracts have been awarded to five contractors. To date, all five contractors have completed the DT&E testing. The most recent contractor, C&G Associates, Limited, completed DT&E testing in January 1990. The current contractor has successfully completed 10 of 11 PAT&E tests and 10 of 12 DT&E tests as of June 21, 1995.

5.2 COMPLETED OT&E.

No OT&E testing has been performed to date.

5.3 DT&E TESTING.

DT&E testing will be conducted at the Condor Reliability Services facility and will consist of hardware, software, system testing, and a test report. DT&E testing will be conducted using the FAA approved/prime contractor developed test plan and procedure. Testing will be witnessed by the FAA. The prime contractor is responsible for timely and satisfactory completion of testing in accordance with the schedule.

The prime contractor shall develop and provide test procedures to ensure that each engineering, integration, and performance requirement delineated in the SOW is verified. Test procedures will describe the step-by-step approach required to verify such requirements (including personnel, equipment, schedule, and location). No formal testing shall commence until the procedures have been reviewed and approved by the FAA.

The prime contractor shall provide a test report for all completed tests. The test report shall describe evaluation criteria, results (pass/fail), and all related supporting material. Each report prepared by the prime contractor will be approved by the FAA before the next test begins.

The objectives of the DT&E Testing are:

a. To verify all design, engineering, integration, and performance requirements delineated in the SOW, and

b. To demonstrate logistic support to show, as an example, that test equipment and manuals are technically compatible.

Once the prime contractor successfully completes DT&E, 20 TCDs will be delivered to the FAA Technical Center for OT&E testing.

5.4 PAT&E TESTING.

Production Acceptance tests will be the same as the Factory Acceptance Tests (FAT).

5.5 OT&E Testing.

OT&E testing usually consists of verifying that the system or device being tested meets the operational requirements contained in the NAS-SS-1000. Since the TCD is not contained in the NAS-SS-1000 requirements, OT&E testing will consist of verifying that the TCD meets the requirements contained in the TCD SOW TVRTM, table 7-1. If the contractor, as witnessed by a FAA representative, has successfully passed the requirements contained in this TVRTM during FAT or First Article test, the test results will fulfill the requirements of this TVRTM. In addition to the SOW requirements, the TCD will be tested to the requirements contained in the FAA TVRTM, table 7-2.

5.5.1 OT&E Integration Testing.

ACT-320 has developed OT&E Integration Test Procedures which will be used to perform integration testing on the TCD. It is currently planned that testing for the TCD system will be conducted at four different facilities: an ARTCC, an ATCT, an AFSS, and a TRACON. The OT&E Integration test schedule is provided in figure 4.2-1.

OT&E Integration testing is to ensure the successful integration of the TCD system into the FAA NAS. Test cases will be employed to verify that all integration and end-to-end performance criteria are successfully completed. Considerations included in the Integration testing are:

a. Interfacing the TCD with different TCGs that have IRIG-E outputs;
b. Interfacing the TCD with different TCGs that have FAA IRIG-E outputs;
c. Interfacing the TCD with different TCGs that have IRIG-B outputs; and
d. Interfacing the TCD with the Critical Bus Power System.

5.5.2 OT&E Operational Testing.

ACT-320 has developed OT&E Operational Test procedures in order to perform operational testing on the TCD. It is currently planned that testing for the TCD system will be conducted at four sites, the ARTCC in Boston, MA; the ATCT facility at the Philadelphia International Airport, Philadelphia, Pennsylvania; the AFSS in Millville, NJ; and the ATCT at the Atlantic City International Airport, NJ. The OT&E Operatioanl test schedule is provided in figure 4.2-1.

The objectives of the OT&E Operational testing are to verify the operational effectiveness and suitability of the equipment while including user participation during testing. Aspects of this testing are as follows:

a. Reliability This test will determine if the TCD meets the requirements contained in the SOW. Since a complete reliability test would take several months, this test will be performed by analysis on the data that Condor collects during DT&E testing. If for any reason ACT-320 does not agree with the collected data or any circumstances surrounding the collection of the data, ACT-320 will perform additional reliability testing as outlined in the FAA's OT&E Test Plan.

b. Corrective Maintenance. This evaluation will determine if the system can be maintained safely and correctly by means of the Maintenance Manuals. This evaluation will verify the Mean Time to Repair (MTTR) requirement and will also determine if corrective maintenance guidance is effective.

c. Usability and Safety This evaluation will determine if the display and operation of the TCD is usable to Air Traffic Control (ATC), and the field technician can accomplish periodic maintenance activities in an efficient, realistic, and safe manner.

d. Tools and Test Equipment. This evaluation will determine if the field technician has the necessary support tools and diagnostic capabilities toperform maintenance tasks effectively.

e. Operational Accuracy. This test evaluates the system's capability to accurately present time code data and system status to the maintenance technician and ATC.

f. Human Factors. This test will assess the "man/machine" interface to ensure system useability and suitability in an automated operational environment.

g. Electromagnetic Environment This test will determine that no detrimental Electromagnetic Interference (EMI) occurs between the TCD and other existing airport facility equipment.

h. Physical Environment This inspection ensures that the grounding, wiring, cable installation, and lightning protection circuits are adequate and meet all requirements.

ACT-320 will carry out and conduct operational and functional testing of the following TCD items at the four test locations:

a. The display lamp test control;

b. The system components to demonstrate interchangeability with any other system component of the same type;

c. The LED display readout;

d. The display intensity of the readout to enable readability of the hours and minutes under ambient illumination conditions ranging from almost total darkness like in a TRACON to very bright conditions like in an ATCT and at any viewing angle of 120° from in front of the display;

e. The intensity control on the display;

f. The basic unit control panel; and

g. The accuracy in the display of the TCG data.

5.5.3 OT&E Shakedown Testing.

OT&E Shakedown testing will determine the overall readiness of the TCD. This will be accomplished by means of the analysis of procedures, documentation, logistics support, and technical training.

AOS-220 will develop a series of test scenarios that verify and/or validate effectiveness, suitability, maintainability, supportability, and integration requirements.

AOS-220 is an independent testing organization that reserves the right to verify/reverify any OT&E Integration or OT&E Operational requirement.

OT&E Shakedown testing will be conducted at one of the three selected test sites. These tests shall demonstrate that the logistics, training, documentation, environment, and other operational requirements have been met and that the TCD is a supportable system.

OT&E Shakedown testing is to be accomplished by the user organizations for the purpose of independently evaluating the following objectives:

a. Ensure operational effectiveness and suitability,
b. Supportability and maintainability,

c. Identification of any possible operational deficiencies,
d. Ensure that operational procedures are available.

6. ACRONYMS and ABBREVIATIONS.

AC	Alternating Current
AF	Air Facilities
AFSS	Automated Flight Service Station
APME	Associate Program Manager for Engineering
APML	Associate Program Manager for Logistics
APMQ	Associate Program Manager for Quality
APMT	Associate Program Manager for Test
ARTCC	Air Route Traffic Control Center
AT	Air Traffic
ATCT	Airport Traffic Control Towers
COI	Critical Operational Issues
CMTP	Contractor Master Test Plan
CPP	Critical Performance Parameters
DRR	Deployment Readiness Review
DT&E	Development Test and Evaluation
EMI	Electromagnetic Interference
EXCOM	Executive Committee
FAA	Federal Aviation Administration
FAT	Factory Acceptance Test
FCA	Functional Configuration Audit
GPS	Global Positioning System
Hz	Hertz
IRIG	Inter-Range Instrumentation Group
KDP	Key Decision Point
MOP	Minimum Operating Performance
MTTR	Mean Time to Repair
NAS	National Airspace System
OT&E	Operational Test and Evaluation
PAT&E	Production Acceptance Test and Evaluation
PCA	Physical Configuration Audit
SOW	Statement of Work
T&E	Test and Evaluation
TCD	Time Code Display
TCG	Time Code Generator
TEMP	Test and Evaluation Master Plan
TPL	Terminal Products Lead
TPRC	Test Policy Review Committee
TRACON	Terminal Radar Approach Control
TVRTM	Test Verification Requirements Traceability Matrix

Appendix A

Test Verification Requirements Traceability Matrix (TVRTM)

TEST VERIFICATION REQUIREMENTS TRACEABILITY MATRIX (TVRTM)

Column Definitions and Utilization.

The following are TVRTM column definitions:

a. TEST REQUIREMENT NUMBER - identification number produced by the FAA Technical Center to reference requirements throughout the series of test documents;

b. SOW REFERENCE NUMBER - shows the TCD SOW paragraph reference number;

c. SOW REQUIREMENT - describes or restates the SOW requirement;

d. TEST LEVELS:

FAT - Subsystem level (First Article Test)

OT&E - Operational Test and Evaluation

e. VERIFICATION METHODS:

A - Analysis

I - Inspection

D - Demonstration

T - Test

X - Not Applicable

L - Verified By Lower Layer Requirements

TCD SOW Verification Requirements Trace-ability Matrix (VRTM)

TEST REQUIREMENT NUMBER	REFERENCE NUMBER	SOW REQUIREMENT	FAT	OT&E	COMMENT
0001	2.A	POWER REQUIREMENTS			TITLE
0002	2.A.1	Power Requirements shall be: AC -120v +/- 15%; 60 Hz, +/- 5 Hertz; 20 Watts (max.).	I	I	
0003	2.B	SERIAL TIME CODE INPUT REQUIREMENTS			TITLE
0004	2.B.1	Input Requirements shall be: IRIG-E, standard format, 100-Hz, 1000-Hz carrier frequencies.	T	I	
0005	2.B.2	Input Requirements shall be: IRIG-E, modified format (FAA IRIG-E) 600-Hz carrier frequency. See Appendix D of FAA-E-2306, Attachment 3 for description of modified IRIG-E code.	T	I	
0006	2.B.3	Input Requirements shall be: IRIG-B, standard format (See Attachment 5 to DTFA01-94-R-28858 for the description of the modified IRIG-B code).	T	I	
0007	2.B.4	SELF-GENERATING, ALTERNATING CURRENT (AC) LINE CLOCK SYNCHRONIZED TO THE 60 HZ POWER LINE			TITLE
0008	2.B.4.a	Time Code Display shall have a front panel indicator lamp to indicate when display is operating in the AC line clock mode.	D	I	

TCD SOW Verification Requirements Trace-ability Matrix (VRTM)

TEST REQUIREMENT NUMBER	REFERENCE NUMBER	SOW REQUIREMENT	FAT	OT&E	COMMENT
0009	2.B.4.b (1)	Time Code Display shall be capable of automatically switching to the AC line clock mode if either the FAA IRIG-E, standard IRIG-E, or the IRIG-B time code signal to the time code display is lost, without losing more than 1 second in the transition from the time code signal mode to AC line clock mode.	T	X	
0010	2.B.4.b (2)	Upon return of the time code signal, the display shall automatically reconnect to the input code.	T	X	
0011	2.B.4.c	If an AC power failure occurs while the display is in the AC clock mode, the display shall, upon return of AC power, cause all six digits to blink at a rate of approximately one pulse per second until display is manually reset.	T	D	
0012	2.B.4.d	If an AC power failure occurs while the display is operating in either of the time code input modes, the display shall automatically resume operation from the time code input as soon as AC power is restored.	T	X	

TCD SOW Verification Requirements Trace-ability Matrix (VRTM)

TEST REQUIREMENT NUMBER	REFERENCE NUMBER	SOW REQUIREMENT	FAT	OT&E	COMMENT
0013	2.B.4.e (1)	The time shall be able to be set to the exact second.	D	D	
0014	2.B.4.e (2)	To preset time, the seconds digit shall, upon activation of the preset mechanism, go to "00" and the hours and the minutes digits shall be able to be set to the exact hour and minute desired.	D	D	
0015	2.B.4.e (3)	The preset mechanism(s) shall be located on the front of the Time Code Display and be accessible through mounting plate opening(s).	I	X	
0016	2.B.4.f	The time code display shall have a 5-foot long 3 conductor number 18 power cord attached to it.	I	X	
0017	2.B.4.g	The TCD shall be capable of determining which time signal has been connected and display the correct time.	D	D	
0018	2.B.4.h	The Operator shall be able to select between the connected time signal or AC-line operation by means of a toggle switch.	D	D	

TCD SOW Verification Requirements Trace-ability Matrix (VRTM)

TEST REQUIREMENT NUMBER	REFERENCE NUMBER	SOW REQUIREMENT	FAT	OT&E	COMMENT
0019	2.2.4.i	If the Operator determines that the incoming time signal is not correct, the operator shall have the capability on the front of the TCD to select the AC mode and make the appropriate changes to the display digits to initialize the correct time.	D	D	
0020	2.C	PHYSICAL REQUIREMENTS			TITLE
0021	2.C.1	DIGITS, LED TYPE:			TITLE
0022	2.C.1.a	Number of digits: six each (two each for hours, two each for minutes, and two each for seconds).	I	I	
0023	2.C.1.b	HEIGHT OF DIGITS:			TITLE
0024	2.C.1.b (1)	Height of hours and minutes shall be 0.50 inch (minimum).	I	I	
0025	2.C.1.b (2)	Height of seconds shall be 0.25 inch (minimum).	I	I	
0026	2.C.1.b (3)	The seconds digits shall be approx. 50%-80% of the size of the hours and the minutes digits.	I	I	
0027	2.C.1.c	BRIGHTNESS:			TITLE

TCD SOW Verification Requirements Trace-ability Matrix (VRTM)

TEST REQUIREMENT NUMBER	REFERENCE NUMBER	SOW REQUIREMENT	FAT	OT&E	COMMENT
0028	2.C.1.c (1)	Hours and minutes digits shall be clearly discernible in all ambient light conditions from total darkness to 10000 FT L brightness from a distance of 12 feet.	D	D	
0029	2.C.1.c (2)	Seconds digits shall be clearly discernible in all ambient light conditions from total darkness to 6000 FT L brightness from a distance of 6 feet.	D	D	
0030	2.C.1.c (3)	The brightness control switch shall be located on the front panel to vary the brightness of digits from minimum discernible to full brightness.	D	D	
0031	2.C.1.d	The operator shall have the ability to turn the "seconds" digits off via the front panel.	D	D	
0032	2.C.2	OVERALL SIZE OF DISPLAY (SHALL NOT EXCEED):			TITLE
0033	2.C.2.a	The Height shall be 2.0 inches (max.).	I	I	
0034	2.C.2.b	The Width shall be 9.0 inches (max.).	I	I	
0035	2.C.2.c	The Depth shall be 12.5 inches (max.).	I	I	

TCD SOW Verification Requirements Trace-ability Matrix (VRTM)

TEST REQUIREMENT NUMBER	REFERENCE NUMBER	SOW REQUIREMENT	FAT	OT&E	COMMENT
0036	2.C.3	VIEWING ANGLE:			TITLE
0037	2.C.3.a	The Vertical plane shall be 120 degrees.	D	D	
0038	2.C.3.b	The Horizontal plane shall be 120 degrees.	D	D	
0039	2.C.4(1)	The hours, minutes and seconds display shall be in red color.	I	I	
0040	2.C.4(2)	Design of the digits shall be such that hours and minutes are separated by a colon.	I	I	
0041	2.C.5	A switch shall be provided on the front panel to test lamp segments to see if they are burned out.	I	I	
0042	2.C.6(1)	Each and every Time Code Display delivered under this contract shall be identical in design and comprised completely of identical and interchangeable components.	I	X	

TCD SOW Verification Requirements Trace-ability Matrix (VRTM)

TEST REQUIREMENT NUMBER	REFERENCE NUMBER	SOW REQUIREMENT	FAT	OT&E	COMMENT
0043	2.C.6(2)	If a change is proposed by the Contractor on any one system or component as a result of Contractor induced redesigns or replacements, all systems or components whether delivered or undelivered shall be modified and refitted to assure unity of design and complete interchangeability, all at no additional cost to the Government.	I	X	
0044	2.C.7(1)	If jumper wires are used, they shall be terminated in holes, standoffs, or terminals, and be considered as components.	I	X	
0045	2.C.7(2)	The jumpers shall be as short as practical and shall not be applied over or under other parts.	I	X	
0046	2.C.7(3)	Jumper wires shall be insulated.	I	X	
0047	2.C.8	Each and every Time Code Display shall operate within a temperature range of 55° - 120° Fahrenheit.	D	X	
0048	2.C.9	Each and every Time Code Display shall have a reliability of at least 65,700 hours mean time between failures.	D	X	

TCD SOW Verification Requirements Trace-ability Matrix (VRTM)

TEST REQUIREMENT NUMBER	REFERENCE NUMBER	SOW REQUIREMENT	FAT	OT&E	COMMENT
0049	2.C.10	LED indicator intensity shall be capable of being controlled by the operator via the front panel.	D	D	
0050	2.D	ELECTRICAL LOAD REQUIREMENTS			TITLE
0051	2.D.1	The display shall be designed so that up to 100 displays with single ended input can operate directly off of one time code generator.	D	D	
0052	2.D.2	The output impedance of the different types of time code generators used by the FAA varies from 50-2,000 ohms.	I	X	COMMENT
0053	2.D.3(1)	The connector design shall be of a type that will allow interconnection of the input cable to the output cable, without adapters, to allow the by-passing of an individual display.	I	X	
0054	2.D.3(2)	The time code input connector shall be Molex number 03-06-1031 or equal and the time code signal output connector shall be Molex 03-06-2031 or equal.	I	I	
0055	2.D.3(3)	The Contractor shall provide mating input and mating output connectors with each Time Code Display.	I	X	

TCD SOW Verification Requirements Trace-ability Matrix (VRTM)

TEST REQUIREMENT NUMBER	REFERENCE NUMBER	SOW REQUIREMENT	FAT	OT&E	COMMENT
0056	2.D.3(4)	The time code signal shall be input on pin #1 (IRIG-E, FAA IRIG-E) and returned on pin #2 (signal ground).	I	X	
0057	2.D.4	Over voltage protection shall be provided for protection of digital circuits and display elements.	I	I	
0058	2.D.5	Short circuit protection of the power supply shall be provided.	I	I	
0059	2.D.6(1)	Equipment radiated and conducted emissions requirements shall be in accordance with MIL-STD-461 for class A3 (Table 4-1, MIL-STD-461, Visual Displays) equipment.	D	X	
0060	2.D.6(2)	The generation of, and susceptibility to, electromagnetic interference shall be controlled such that the equipment complies with the requirements of MIL-STD-461 for the test methods listed below: a. CE01 AC/DC Leads b. CE03 AC/DC Leads c. CS01 AC/DC Leads d. CS02 AC/DC Leads and grounds e. CS06 AC/DC Leads and grounds f. RE01 Magnetic Field emissions g. RS01 Magnetic Field emissions	D	X	

TCD SOW Verification Requirements Trace-ability Matrix (VRTM)

Test Requirement Number	Reference	Requirement	OT&E	Comment
0061	6950.2c 8.C.3.c	The total harmonic content of the input current caused by the system/equipment being connected to the critical bus shall not exceed 5 percent of the fundamental (60Hz) and, no single harmonic shall be greater than 3 percent of the fundamental.	T	
0062	6950.2c 8.C.3.d	The peak total inrush current during start-up shall not exceed five times the normal peak operating current. The duration of the inrush current shall not exceed 8 milliseconds (return to 110% of normal).	T	
0063	6950.2c 8.C.3.e	The equipment shall be designed so that it presents a power factor not less than .85 lagging when operating under steady state conditions.	T	
0064	N/A	The TCD shall be capable of operating with a IRIG-E TCG which has an output that falls within the tolerances allowed for the TCG.	T	
0065	N/A	The TCD shall be capable of operating with a FAA-IRIG-E (modified IRIG-E) TCG which has an output that falls within the tolerances allowed for the TCG.	T	
0066	N/A	The TCD shall be capable of operating with a IRIG-B TCG which has an output that falls within the tolerances allowed for the TCG.	T	

TCD SOW Verification Requirements Trace-ability Matrix (VRTM)

Test Requirement Number	Reference	Requirement	OT&E	Comment
0067	N/A	Reliability Test - This test will verify that the TCD can meet the reliability requirements contained in the Statement of Work.	A/T	See Note 1 below.
0068	N/A	Physical Environment - Ensure that the grounding, wiring, and cable installation requirements are met.	D	
0069	N/A	Usability and Safety - Check to see that the TCD is usable to the Air Traffic Controller.	D	
0070	N/A	Tools and Test Equipment - Check to see that the technician has the correct tools and test equipment to perform corrective action on the TCDs.	I	
0071	N/A	Operational Accuracy - Check to see that the system accurately presents the data to the Air Traffic Controller.	D	
0072	N/A	Human Factors - Check to see that man/machine interface is useable and suitable in the NAS environment.	D	
0073	N/A	Electromagnetic Environment - This test will check that operational equipment located at the test sites do not interfere with the TCD.	D	
0074	N/A	Corrective Maintenance - Check if the System can be maintained safely and correctly by means of the instruction manual. Verify mean time to repair.	I	

Note 1: Testing will only be performed if the analysis of the data collected during DT&E proves to be inconclusive.