technical note

A FAA Technical Center Project Transition Plan; Mode S

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September 1990

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16. Abstract

The provision for two-way communications with aircraft, via a digital data link, has long been considered a means of providing significant enhancements for safe and efficient flight operations. The Mode Select Beacon System (Mode S) system currently under development will provide the mechanism to allow a digital data link function. The Mode S also offers improvements in surveillance processing, and range and azimuth accuracy.

The Mode S Project Transition Plan presents those activities and the organizations that are responsible to effect the transition of the Mode S into the Federal Aviation Administration (FAA) Technical Center.

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1. INTRODUCTION.

1.1 PURPOSE.

The purpose of this document is to provide the necessary information required to support facility modifications at the Federal Aviation Administration (FAA) Technical Center for implementation of the Mode S Beacon System (Mode S) project. This information is used to ensure that the Mode S implementation at the FAA Technical Center is successful.

1.2 SCOPE.

The Project Transition Plans (PTP) present the planning methodology required to assure the orderly and integrated transition of the FAA Technical Center facility for the implementation of individual National Airspace System (NAS) projects.

The FAA NAS Plan for Facilities, Equipment, and Associated Development presents a comprehensive approach to the modernization and improvement of air traffic control (ATC) equipment and Airway Facilities (AF) services through the 1990s. Project No. 3-05, Aeronautical Data Link (ADL) includes the Data Link Processor (DLP) project. The DLP project will provide pilots with unrestricted access to current weather information.

This plan encompasses the transition of the Mode S hardware into the FAA Technical Center laboratory. It is intended to provide critical information necessary to support this transition, with a minimum of extraneous or redundant information found in other documentation. Project specific information is addressed in the areas of management responsibilities, equipment description, environmental requirements, system interfaces, scheduling, site preparation, testing, training, logistics support, and project transition issues.

1.3 PROJECT MANAGEMENT.

This section defines the organizational roles and responsibilities for implementation of the Mode S project at the FAA Technical Center. The overall program management of the Mode S is under the auspices of ANR-130. Other major responsibilities are as follows:

a. Program Manager. Carey Weigel, ANR-130, is the Mode S Program Manager.

b. Technical Officer. Byron Johnson is the Contracting Officer Technical Representative (COTR).

c. Contracting Officer (CO). The ALG-320 designated CO will perform all contract administration and management activities.

d. Quality Reliability Officer (QRO). The QRO designated by ALG-400 is responsible for quality assurance on the hardware contract.

e. Contract Officer Technical Representative (COTR). The COTR will coordinate all contract activities and are responsible for acceptance of all contract activities and are responsible for acceptance of all contract deliverables.

ANR-130 Responsibilities:

The ANR-130 Program Office has overall project management, service procurement, configuration management, system engineering, Integrated Logistics Support (ILS), and hardware/software design.

ACN-220 Responsibilities:

Responsibilities of ACN-220 are to:

a. Monitor development of Mode S software and hardware.

b. Appoint a test director.

c. Direct the Development Test and Evaluation (DT&E) activities for the program office.

d. Develop the NAS Integration Test Plan (ITP) and Test Procedures.

e. Conduct NAS Integration Test and Evaluation (IT&E) at the FAA Technical Center and first operational site.

f. Conduct Operational Test and Evaluation (OT&E).

ASM-400 Responsibilities:

Responsibilities of ASM-400 are to:

a. Appoint a test lead for Shakedown Test and Evaluation (ST&E)

b. Develop the ST&E Plans and Procedures (PP) in coordination with the appropriate AF/Air Traffic (AT) elements.

c. Validate the ST&E PP at the FAA Technical Center and the first operational site.

d. Conduct ST&E at the FAA Technical Center and first operational site.

e. Provide approved ST&E PP to all sites for their ST&E.

f. Support the regions during ST&E of DLP sites.

g. Process daily downtime and maintenance action information through National Airspace Performance Reporting System (NAPRS).

h. Maintain the Mode S software and hardware site documentation after acceptance by the government.

A list of personnel assigned to the Mode S project is provided in table 1.3-1.

TABLE 1.3-1. MODE S PROJECT PERSONNEL

Organization	Name	Telephone	Function
FAA:			
Technical Center:			
ACN-220	William C. Swanseen	482-5392	Test Director
ACN-220	Len Baker	482-5353	Supervisor-Test Tools
ACN-220	Phil Barbagallo	482-4453	Supervisor-Factory Tests
ACN-220	Jeff Livings	482-5342	Supervisor-FAATC Tests
ASM-162	Don Shawver	482-6503	Shakedown Test Lead
Headquarters:			
ANR-130	Carey Weigel	267-8227	Program Manager
ANR-130	William Collins	267-8440	Deputy Program Manager
ANR-130	Byron Johnson	267-8451	Technical Officer
ANR-130	Jim Moe	267-8453	Implementation
ANR-130	Charlie Sloan	267-8458	System Engineer
ANR-130	Larry Taubenkibel	267-8449	ILS
SEIC:			
FAA Technical Center:			
	Dave Van Nostrand	482-5054	System Test
Washington, DC:			
	Larry Hanes	202-646-2364	Program Administration

2. PROJECT CHARACTERISTICS.

2.1 BACKGROUND.

The Mode S Secondary Surveillance Radar Beacon system is being developed to improve the overall capability of the NAS ATC system. The Mode S combines the selective mode addressing of compatible aircraft transponders with monopulse radar techniques to reduce the number of interrogations of aircraft transponders required to positively establish a target. This reduction in interrogations minimizes the interference caused by overlapped transponder replies in high aircraft density environments.

The Mode S program is an outgrowth of research performed at the FAA Technical Center in the late 1970's on a Discrete Address Beacon System (DABS). The DABS was shown to reduce interference in the high aircraft load environments projected for many areas of the country within the next decade. An additional feature of the system was that the selective addressing of aircraft could permit a Digital Data Link to be established between the pilot and the ATC facility.

The current Mode S system consists of a Beacon Interrogator manufactured by Westinghouse and a Data Processing system manufactured by Unisys under a joint venture (JV) agreement between the two companies. The system design is such that a Mode S radar can service either terminal or en route radar facilities with only small changes to hardware and software.

At present, five Mode S sensors are being developed by the JV with the first unit to be completed and delivered to the FAA Technical Center in the third quarter of 1990. The FAA Technical Center is currently evaluating the procedures and witnessing the tests being used to formally prove the hardware and software of the system against FAA-E-2716, the FAA Mode S specification. Once this unit is installed and accepted, a FAA Technical Center team will begin a 6-month evaluation of its performance and its integration into the NAS system for applications involving a terminal sensor. Sensor operation will be validated against NAS operational requirements to determine that the overall system response is not degraded by the introduction of Mode S. During this time, the sensor will also undergo system shakedown prior to its introduction to the first field site at the Baltimore-Washington International Airport.

A second Mode S sensor will be delivered to the FAA Technical Center in 1991. This unit will be installed at the Elwood radar site. This unit will be used to evaluate sensor performance and verify NAS Integration requirements for sensors used in an en route radar environment.

The end result of this effort will be 137 Mode S sensors installed throughout the United States by 1993, with enhanced surveillance detection in high aircraft density environments and with digital data link communications capabilities.

2.2 FUNCTIONAL DESCRIPTION.

The Mode S is a combined secondary surveillance radar (beacon) and ground-air-ground data link system capable of providing the aircraft surveillance and communications necessary to support ATC automation in the dense traffic environments expected in the future. It is capable of common-channel operation with the current Air Traffic Control Beacon System (ATCRBS) and thus, can be implemented at low user cost over an extended ATCRBS-to-Mode S transition period. The fundamental difference between Mode S and ATCRBS is the manner of addressing, or selecting, which aircraft will respond to an interrogation. In ATCRBS, the selection is spatial; all aircraft within the mainbeam of the interrogator respond. As the mainbeam sweeps through the sky, all angles are interrogated, and all aircraft within line-of-sight of the radar antenna respond. In Mode S, each aircraft is assigned a unique address code. Selection of which aircraft is to respond to an interrogation is accomplished by including the aircraft's address code in the interrogation. Therefore, each interrogation is directed to a particular aircraft. The use of the selective address in the Mode S interrogations and replies permits the inclusion of messages to or from a particular aircraft, thereby providing the basis for a ground-air and air-ground digital data link.

2.3 EQUIPMENT DESCRIPTION.

Mechanical Characteristics of Equipment

Description	W (in)	D (in)	H (in)	Location	Weight (lbs)	Power (watts)	BTU/hr
Interrogator	48	34	80	Floor	1100	4800	16500
Mode S J Box	24	17	36	Wall	130	200	700
Power Dist Panel	20	8	48	Wall	30		
RF Switch	36	4	14	Cabinet	20		
TOY Antenna	13	10	30	Roof	10		
TOY Preamps	13	3	10	Wall	6		
DPS	48	34	80	Floor	1200	6600	22700
Comm J Box	33	15	8	Wall	60		
PSF (FAA Technical Center only)							
Powernode 6055	23	33	71	Floor	650	3900	13350
Peripheral Cab	23	33	71	Floor	350		0
Mag Tape 9578	19	12	25	Floor	85	580	2000
Mag Tape 9364	19	12	25	Floor	85	580	2000
Disk 8840	26	36	36	Floor	550	1200	4200
Disk 9346	26	36	36	Floor	550	1200	4200
Printer 600-73	30	34	44	Floor	181	710	2430
Video Console 921	13	13	15	Floor	40	420	1450
Plotter 1042	54	27	47	Floor	130	300	1050
Calcomp CPU (x2)	11.5	30.1	26.7	Floor	390	2150	7350
Force Micro C	20.5	24	22.2	Floor	50	480	1650
(outside location)							
CPME	29	29	52	Floor	100	223	770
CPME Battery	32	26	23	Floor	75		
CPME Antenna	23	30	18	Tower	21		

The FAA Technical Center Terminal Mode S system will be installed at building 269. The FAA Technical Center En Route Mode S system will be installed at the Elwood, NJ, long-range radar facility.

The Program Support Facility (PSF) occupies 259 square feet. For further information, reference the PSF Installation and Checkout Plan, document TM-PA-0018/777/02, Mode S Contract Line Item 14A2.

Two PSF systems will be installed at the FAA Technical Center. One system, at the FAA Technical Center, will be installed in building 269A; the second system will be installed in building 270. A third system will be installed at the FAA Academy in Oklahoma City.

2.4 MODE S INTERFACES.

2.4.1 Mode S/ATC Interface.

The Mode S interfaces with the ATC facilities through the Surveillance Line Adapter. The Mode S/ATC interface is particularly simple in the case of an isolated Mode S sensor interacting with a single control facility, such as the sensor at an airport interconnected only with the local TRACON. In this situation, the sensor provides surveillance data to the TRACON and operates as a relay point for data link messages between the aircraft and ATC.

In general, each sensor is capable of providing surveillance and communication service for more than one facility, and in turn, each control facility may receive data from more than one sensor. This capability of greater connectivity permits control facilities to take advantage of multiple coverage to maintain surveillance and data link service in the event of an equipment or link failure at a particular sensor. Surveillance boundaries between adjacent sensors are determined on a site-by-site basis by coverage maps which are individually generated for each site.

The communication link between the Mode S sensor and the ATC facility is a two-way link. The messages and their formats transmitted and received on this link are specified in FAA-RD-80-14A.

2.4.2 Mode S/Data Link Processor Interface.

The Mode S interfaces with the DLP through the Communications Link Adapter. The DLP will use the Mode S sensor as a communications modem and will, therefore, use a communications interface similar to those used by the ATC facilities. Such processors will communicate with the Mode S sensors via the NAS Interfacility Communications system (NICS).

2.4.3 Mode S/Primary Radar.

Digitized radar data will be input to the Mode S sensor via the radar line adapter. Provision is made to interface with any of the primary radars planned for use with the Mode S system. The Mode S receives radar reports and radar status reports from the primary radar through this interface and transmits surveillance reports generated by Mode S Surveillance Processing to the Airport Surveillance Radar (ASR)-9 radar or the Common Digitizer (CD)-2 digitizer through this interface.

2.4.4 Mode S/RMMS.

The Mode S/RMMS interface is carried through the Mode S Maintenance Line Adapter. This interface is a full duplex RS-ABC interface permitting two-way communications between the Mode S and the MPS, Portable Terminal, and Remote Terminal, as well as the channel-to-channel data communications of the Mode S system.

2.4.5 Mode S/PSF.

This interface is provided to permit the Mode S system to interchange data with the PSF. The interface consists of a manual dial-up, two-way 4800-bits per second (bps) communications link. EIA-STD-RS-ABC is used. The Mode S sensor is implemented as the Data Terminal Equipment (DTE).

2.4.6 Mode S/Local Terminal.

The Local Terminal is supported through a Maintenance Line Adapter. The Local Terminal interfaces with the Mode S data processing subsystem to provide sensor startup functions, data extraction, and diagnostic programs. The Local Terminal interfaces to the Mode S Maintenance Line Adapter through an EIA-STD-RS-ABC interface. Data exchange is asynchronous using the requirements of American National Standards Institute (ANSI) X3.44-1977. Data rates of 1200, 2400, 9600, and 19,200 bps are supported.

2.4.7 Magnetic Tape Interface.

The Magnetic Tape Line Adapter provides the data path for interface with a government furnished magnetic tape unit.

2.4.8 Mode S Antenna.

The Mode S sensor employs a rotating fan-beam antenna having a sum pattern and a difference pattern. The Mode S interrogation is transmitted on the sum pattern. The corresponding reply is received on the sum and difference patterns and an estimate of off-boresight angle of the target is computed in the Mode S system.

The Mode S antenna system may either stand alone, mounted on its own pedestal, or it may share a pedestal with a collocated radar sensor. When sharing a pedestal, the Mode S antenna employs a completely separate radiating structure located above the radar antenna. For en route radar system, the Mode S employs back-to-back antennas to realize a data update rate twice that of the host radar system.

3. PROJECT SCHEDULE AND STATUS.

3.1 GENERAL: MODE S TERMINAL SENSOR.

Within 6 months of receiving the Terminal Sensor, the FAA/Contractor Acceptance tests are to be completed. The tentative date for equipment delivery is August. The following paragraphs outline the integrated schedule of key Mode S Test and Evaluation (T&E) activities upon satisfactory completion of FAA Technical Center Acceptance testing.

3.1.1 Mode S Terminal Sensor (Baseline Only).

Performance tests will be completed within 1 month with baseline data documented and recorded. A Quick Look Test report is required within 15 working days after the tests are completed, and a Final Test report is due within 30 working days.

3.1.2 Terminal Integration/Operational T&E Testing.

Operational testing is comprised of System Integration testing and Shakedown testing of the Mode S configured with:

a. Mode S/ASR-9/ARTS-3A
b. Mode S/ASR-9/ARTS-2A
c. Mode S/ASR-7 or 8/ARTS-2A.

A Quick Look Test report is required within 15 days after each test is completed, and a Final Test report is due within 30 working days after the completion of each major configuration's tests. The time schedule of these tests after acceptance is as follows:

a. Mode S/ASR-9/ARTS-3A

1. Integration T&E.....4 months
2. Shakedown T&E .....6 months

b. Mode S/ASR-9/ARTS-2A

1. Integration T&E.....7 months
2. Shakedown T&E.....9 months

c. Mode S/ASR-7 or 8/ARTS-2A

1. Integration T&E.....10 months
2. Shakedown T&E.....12 months

3.2 GENERAL: MODE S EN ROUTE SENSOR.

Within 6 months of receiving the En Route Sensor, the FAA/Contractor Acceptance tests will be completed. Delivery is expected sometime in 1990. The following paragraphs outline the integrated schedule of key Mode S T&E activities upon satisfactory completion of the FAA Technical Center Acceptance testing.

3.2.1 Mode S En Route Sensor (Baseline Only).

Performance tests will be completed within 1 month with baseline data documented and recorded. A Quick Look Test report is required within 15 working days after the tests are completed, and a Final Test report is due in 30 working days.

3.2.2 En Route Integration/Operational T&E.

As in Terminal testing, En Route Operational testing is comprised of System Integration testing and Shakedown testing. The two configurations are:

a. Mode S/ARSR-2/CD2/Host
b. Mode S/Host (stand-alone)

A Quick Look Test report is required within 15 working days after each test is completed, and a Final Test report is required within 30 working days at the end of each configuration test. The schedule for these tests is as follows:

a. Mode S/ARSR-2/CD2/Host.

1. Integration Testing..... 3.5 months

b. Mode S/Host (stand-alone)

1. Integration Testing.....4.5 months
2. Shakedown Testing (ASM-400).....6.5 months

4. PROJECT INSTALLATION.

4.1 GENERAL.

4.1.1 Site Preparation.

Site preparation activities are planned and scheduled to support the overall implementation of the Mode S Sensors and associated Calibration Performance Monitoring Equipment (CPME) while avoiding interference with ongoing support activities. The WEC/UNISYS Joint Venture Mode S contractor has submitted a Site Preparation Report, CLIN NO. 14b-1. This report was used by the FAA to prepare the sites for installation of the Mode S equipment and to perform necessary services not required of the Mode S contractor.

Requirements to prepare the site for installation of the Mode S equipment is in accordance with paragraph 3.15.2.2 of FAA-E-2716.

4.1.2 Delivery (Shipping and Receiving).

Equipment to be installed, and associated materials and supplies, will be shipped to the site coinciding with times detailed in the approved master deployment schedules.

4.1.3 Site Installation and Checkout.

The Mode S site installation and checkout efforts required shall be accomplished with absolute minimum disruption to ongoing facility operations. Once started, installation work will proceed on a regularly scheduled basis, normally 5 days per week, without lapse, through completion. All activities from delivery of the equipment through installation, checkout, and acceptance will be coordinated with the on-site FAA Technical Officer's Representative (TOR).

The contractor has submitted to the FAA a Site Installation Plan, CLIN No. 14A1. This plan contains all the necessary information required to correctly install the equipment and initiate its operation. Included in the plan are a step-by-step procedure for off-loading, unpacking, and placing the Mode S sensor and its supporting equipment.

4.2 SITE PREPARATION RESPONSIBILITIES.

The Secondary Surveillance Systems Branch, ACN-220, has the responsibility to prepare the sites for installation of the Mode S equipment. This will be accomplished in accordance with paragraph 3.15.2.2 of FAA-E-2716. ACN-220 has the responsibility to review all contractor submitted documentation related to site preparation, installation, and checkout.

4.2.1 FAA Technical Center Furnished Equipment and Services.

The FAA Technical Center will provide or install, or both, where applicable.

a. All existing equipment at ATC/NAS facilities needed to accomplish integration.

b. Appropriate space at the ATC facility, or equivalent, to accommodate contractor engineers during the installation and integration period. This will include desks, chairs, typewriters, filing cabinets, and telephones.

c. Appropriate cable, cable runs, and supports between the contractor-provided wall-mounted interconnection junction boxes and the ASR or NAS facilities interface and communications link.

d. All grounding wires to appropriately tie together the Mode S sensor grounding system and the grounding system within the ATC facility. The grounding system shall be installed in accordance with the government-approved installation plan.

e. Drawings of the radar site, ATC facilities, and interface data for those facilities necessary for development of the installation plan.

f. Any test equipment, monitors, or simulators not supplied by the contractor, but deemed necessary for routine maintenance of the system, as mutually agreed to by the government and the contractor.

g. Necessary space, power, lighting, heating, and air conditioning, including power panels, grounding, and cable supports.

h. Modems to implement interfaces with other facilities (including modems needed at existing ATC/NAS facilities). The government shall also provide all cables needed between the Mode S sensor and those modems located at the Mode S sensor and those modems located at the Mode S site, and between other systems or equipment and those modems to be located at existing facilities.

i. Interconnecting telephone lines and/or land lines to interface the Mode S sensor and other facilities.

j. Site between one-half mile and 20 miles from the radar site which is suitable for installation of CPME based on the contractor's documented requirements.

k. Technical data and drawings required to permit the contractor to fabricate or purchase cables needed between other systems or equipment to be located at existing facilities.

l. Mode S site coordinates to 0.1 second of latitude and longitude.

4.2.2 Delivery (Shipping and Receiving) Responsibilities.

The contractor will package, pack, and ship each Mode S sensor and associated equipment in order that it arrives in operable condition at its destination. The responsibility for meeting this requirement remains fully with the contractor until final acceptance of the equipment by the FAA Technical Center. The contractor will transport, offload, set in place, and install all Mode S equipment. Equipment to be installed and associated materials and supplies will be shipped to the site coinciding with times detailed in the approved master deployment schedules. The contractor's installation teams will be responsible for final receipt of shipments made in support of site installation.

4.2.3 Site Installation and Checkout Responsibilities.

Site installation and checkout is the responsibility of the Mode S contractor on a partial turnkey contract. The Mode S contractor will schedule, coordinate, and staff the efforts required for the expeditious completion of the installation. All activities of the contractor, from delivery of the equipment through installation, checkout, and acceptance, will be coordinated with the on-site TOR.

The installation and checkout process will take 4 months. Contractor installation teams will be required to meet the schedule. Where the facilities serve a common automation system, it has been determined to be advantageous to schedule these facilities in advance.

The entire installation and checkout effort will be under the management control of ACN-220 and ANR-130. The on-site TOR will witness and certify the acceptability of the installation. Procedures for routine progress reporting will be established by input from the TOR and item managers.

The contractor is required to prepare an On-Site Acceptance Test Plan in accordance with paragraph 3.15.3.2.1 of FAA-E-2716. The plan provides an overview of all test activities for the first installation to be performed.

4.2.4 Contractor Furnished Equipment and Services.

The contractor will provide or install, or both, where applicable:

a. Software required for system checkout, test, and integration.

b. Modules and system testing as specified in FAA-E-2716.

c. Special tools, system monitors, simulators, alignments, and test equipment, not supplied as government furnished equipment (GFE).

d. Cables, cable runs, bridging and isolation equipment, conduit and/or other cable supports necessary for interconnecting Mode S sensor equipment to other systems located at the Mode S site, except the government furnished cables specified in FAA-E-2716.

e. Required power cables and alternating current (AC) power duct, conduit, or other appropriate cable supports between the Mode S equipment cabinets and the Mode S power panel.

f. Installation, test, and integration documentation as specified in FAA-E-2716.

g. Inspection of site preparation work prior to shipment of equipment.

h. Temporary radio frequency (RF) switches to permit switching between the Mode S sensor antenna interface and the Air Traffic Control Beacon Interrogator (ATCBI)/antenna interface, as needed to accomplish the installation, site acceptance, and the integration of the Mode S sensor.

i. A Remote Monitoring Subsystem (RMS) with Mode S application software (part of the Remote Maintenance Monitoring System (RMMS) described in FAA-E-2716, paragraph 3.4.10.6) at all installation sites. RMMS application software is required at all sites.

j. CPME specified in FAA-E-2716, appendix VIII, as required by the contract schedule.

k. Aircraft Reply Interference Environment Simulator (ARIES) specified in FAA-E-2716, appendix IX, as required by the contract schedule.

l. Mode S System Support Facility (SSF) and Mode S PSF.

m. Communications Interface Driver (CID) as required by the contract schedule.

5. PROJECT TESTING.

5.1 GENERAL.

The following are the four major tests to be conducted in the Mode S program:

a. Mode S System Technical Center Site Acceptance Testing (SITEAT)
b. Mode S Performance Testing
c. Mode S Integration/Operational Testing
d. Mode S Shakedown Testing

5.1.1 Mode S System Technical Center SITEAT.

The objective of these tests is to prove the accuracy of the output data and the correct functioning of the sensor with its associated ATC equipment.

Mode S System Testing is conducted from a contractor deliverable Test Plan (CLIN 16D, TM-PA-0018/045/xx) which documents the contractor responsibilities for preparing and conducting specific test procedures. These tests are performed by the contractor during the SITEAT and are witnessed by FAA. Further review and analysis of these tests will be conducted by FAA and presented at contractor status and review meetings.

5.1.2 Mode S Performance Testing.

There are three major objectives of the FAA Technical Center Performance tests which will determine the following:

a. Mode S Sensor baseline performance target and communication loading as per sensor design specifications.

b. Mode S Multisensor performance by providing live and simulated targets to a two-sensor netted system and a two-sensor non-netted configuration.

c. Mode S Sensor Adaptation performance as a function of (1) varying selected site adaptation parameter (i.e., theta-half, delta/sum ratio, PRF, etc.), and (2) target and communications loading beyond the limits of the sensor specifications.

5.1.3 Mode S Integration/Operational Testing.

There are four major objectives of the FAA Technical Center Integration/Operational tests which will determine the following:

a. Adequacy of the Mode S Functional Interfaces to the intended NAS entity.

b. Adequacy in Mode S meeting operational requirements.

c. Operational impact of Mode S Sensor degraded operations on NAS.

d. Sensor accuracy and resolution by conducting precision tracked flight tests and timing studies.

5.1.4 Mode S Shakedown Testing.

The goal of the FAA Technical Center Shakedown tests is to determine that the system is capable of operating as part of the NAS. Shakedown testing should reflect the successful integration of people, procedures, and the Mode S system to assume operational readiness in the field.

Operational suitability of the FAA Technical Center Mode S will be determined in the following broad areas: (1) validate system interfaces, (2) identify operational deficiencies, (3) adequacy of test equipment, (4) personnel safety, and (5) environmental needs. Testing will also include the optimization of the Mode S system.

The documentation gathered from the above tests will be repeated at the first field installation and then handed off to the regions to serve as the basis at each Mode S site.

5.2 TESTING RESPONSIBILITIES.

5.2.1 Contractor Testing.

The Mode S system contractor is responsible for the successful completion of system testing at the FAA Technical Center. The FAA Test Support Group will witness contractor testing and provide analysis of test data. The contractor will report directly to ACN-220.

5.2.2 ACN-220 Performance Testing.

The FAA Technical Center Performance testing will be conducted by ACN-220 in accordance with the FAA Technical Center guidelines and the Performance Test Plan and Test Procedures.

5.2.3 ACN-220 IT&E and OT&E.

The FAA Technical Center Integration/Operational testing will be conducted by ACN-220 as per the Integration/Operational Test and Evaluation Plan and Test Procedures.

5.2.4 ASM-400 Shakedown Testing.

The FAA Technical Center Shakedown tests are the responsibility of ASM-400. They will perform Shakedown tests on the sensor at the FAA Technical Center and then repeat it at the first operational site. The Shakedown Plan/Procedures will be handed off to the regions for use as the basis at each Mode S field site.

5.3 SYSTEM ACCEPTANCE.

5.3.1 FAA Management.

5.3.1.1 Management Organization (ACN-220).

The Management Organization is under the direction of ACN-220 as delegated by the Mode S Program Office (ANR-130). Personnel include representatives from the FAA technical/operating services and their designated supporting contractors.

a. The Mode S Test and Evaluation (T&E) Management Organization is responsible for assuring all requirements are verified and accounted for during DT&E and the PAT&E test periods. It will be divided into two groups consisting of the Management Group and the Test Support Group.

1. The Mode S Management Group has the responsibility to direct, control, and monitor all test efforts relative to system acceptance.

2. The Mode S Test Support Group will review contractor test plans and procedures, witness tests, and prepare reports on witnessed tests for analysis and review.

5.3.2 Contractor Site Acceptance Testing.

Site testing is comprised of a mutual contractor/FAA process that begins with a working draft of a Contractor's Test Plan (CLIN 15a/109a), and culminates in the FAA Technical Center acceptance of the delivered Mode S system. The general guidelines include contractor installation of equipment followed by the contractor performing SITEAT for FAA on-site representatives for Installation Checkout, Sensor Operational Tests, and System Operational Tests.

Prior to beginning any of the SITEAT, a Contractor's Preliminary Test (CPT) will be conducted. These tests constitute a dry run of the formal tests outlined in CLIN 15b/109b Test Procedures.

5.3.2.1 Installation Checkout.

These tests will demonstrate that the sensor and the CPME are properly installed. They will also demonstrate that the initial settings, alignments, etc., are ready for acceptance testing.

5.3.2.2 Sensor Operational Tests.

These tests will demonstrate that the Mode S can be operated with the site's beacon antenna, the sensor and CPME can be calibrated, and that the sensor can correctly process data for live targets-of-opportunity within the coverage area.

5.3.2.3 System Operational Tests.

These tests will demonstrate that the sensor and the CPME are operational with the site ATC equipment. The sensor can operate and process targets using triggers, video, and azimuth data from the collocated radar, and the sensor correctly provides and interprets system interface signals.

5.4 SITE TEST REPORT.

The contractor submits an On-Site Acceptance Data Package consisting of the following:

a. Site Test Data Records - CLIN 15c/109c (preliminary)
b. Site As-Built Drawings - CLIN 14c/108c (preliminary)
c. As Delivered Configuration Record

5.5 FAA ACCEPTANCE.

FAA Technical Center ACN-220, accepts the Mode S system from the contractor on the basis of successful completion of the data package in section 5.4.

6. SYSTEM MAINTENANCE AND SUSTAINED OPERATION.

6.1 GENERAL.

Mode S equipment maintenance at the FAA Technical Center is the responsibility of the contractor until final acceptance of the system by the FAA. Final acceptance is based on successful completion of on-site acceptance tests.

The National Automation Engineering Field Support Sector, ASM-400, will provide system support of field operations and maintenance of software and hardware.

The National Airspace Integrated Logistics Support (NAILS) Master Plan and the Integrated Logistics Support Plan (ILSP) for Mode S provide additional maintenance information. See section 3.0, Maintenance Planning in the ILSP for Mode S.

6.2 HARDWARE MAINTENANCE.

ACN-300 will be responsible for hardware maintenance of the Mode S equipment once the system has been accepted by the FAA. Hardware maintenance will be performed under a technical support contract. ASM-400 will assist ACN-300 in developing and implementing a Mode S system maintenance program.

6.3 SOFTWARE MAINTENANCE.

ASM-400 will be responsible for all software maintenance and configuration control of all software programs.

7. TRAINING.

7.1 GENERAL.

Mode S training will be conducted by the contractor at their facilities. The following lists the courses and their lengths:

a.	Mode S System Maintenance Lecture Lab course	6 weeks
b.	PSF Lecture Lab course	*24 weeks
c.	Mode S On-the-Job Training course	4 weeks

* The PSF course consists of the following 3 subcourses:

a.	Mode S Overview course	1 week
b.	PSF Hardware Maintenance course	4 weeks
c.	Software Maintenance course	19 weeks

7.1.1 Mode S System Maintenance.

The contractor will conduct the Mode S System Maintenance course using Mode S Sensor No. 3 at the contractor's training facilities. All instructor and student materials for a class of 12 students will be provided by the contractor. There will be five classes of 6-weeks duration.

7.1.2 Program Support Facilities (PSF).

The contractor will conduct two complete PSF courses. The third PSF course will consist only of the Mode S Sensor Overview course.

7.1.3 Mode S On-the Job Training.

The contractor will conduct On-the-Job Training (OJT) courses that provide technical direction in the areas of operation and maintenance of the Mode S system and the PSF. This training is required by the FAA Technical Center in order to support FAA test and evaluation activities at the FAA Technical Center. OJT will start at the conclusion of system installation and checkout (I&C/O) of system No. 1 at the FAA Technical Center.

Detailed descriptions of the training courses can be found in the "Training Plan for the Program Support Facility and System Software OJT," Clin No. 125A-2; the "Training Materials Mode S Overview Course," Clin No. 129A-1; and the "Training Materials PSF Hardware Maintenance Course," Clin No. 129A-2.

The Secondary Surveillance Systems Branch, ACN-220, will require the following number of slots:

- Mode S System Maintenance Lecture Lab course	0 slots
- Mode S OJT course	4 slots

PSF Course consists of the following three subcourses:

- Mode S Overview course	6 slots
- PSF Hardware Maintenance course	0 slots
- Software Maintenance course	4 slots

The Hardware Engineering Branch, ACN-320, will require two slots in the Mode S Overview Course.

8. LOGISTICS SUPPORT.

8.1 GENERAL.

The general philosophy for logistics support is defined in the "NAILS Master Plan." This plan identifies specific requirements and tasks, as well as roles and responsibilities. The policies outlined in the NAILS Master Plan are applied to the Mode S project by the ILSP. The Mode S support resource requirements are documented in the Logistics Support Analysis (LSA). The LSA is a series of analyses used to determine the logistics requirements.

The NAILS ILSP for the Mode S Beacon System, dated February 25, 1987, describes the detailed approach for integrating logistics considerations and logistics planning into the engineering and design process for the Mode S project. It provides support criteria and concepts for the NAILS program.

8.1.1 Levels of Support.

Hardware maintenance is performed at three levels: (1) Site, (2) Intermediate, and (3) Depot. The characteristics of the maintenance performed at these levels are outlined in the NAILS Master Plan. Software does not fit into the three-level pattern.

Software support is identified through the software development plan and through direct coordination with the software manager. Software support is provided through NAILS elements, including (1) Training and Training Support, (2) Technical Data, (3) Support Equipment, and (4) Maintenance Support Facilities.

8.2 LOGISTICS SUPPORT RESPONSIBILITIES.

8.2.1 On-Site.

On-site maintenance will consist of all maintenance activities performed on equipment installed in its operating environment. Site maintenance will include removal and replacement of faulty Least Replaceable Unit (LRU's), operational verification, preventive maintenance actions (cleaning, lubrication, etc.) and system test and troubleshooting as required to isolate faults.

The contractor is responsible for supplying all repair parts and spares during testing. The FAA will be responsible for hardware and software on-site maintenance after site acceptance. ACN-300 will be responsible for on-site hardware maintenance; ASM-400 will be responsible for on-site software maintenance.

The contractor is responsible for providing the required special test tools and test equipment. The contractor will identify the required common tools and test equipment currently in FAA inventory.

8.2.2 Intermediate.

Intermediate level maintenance tasks are performed in designated work centers. Maintenance will consist of LRU repair, when cost effective, and maintenance of support equipment assigned to the intermediate level. Maintenance tasks to be accomplished at this level will be determined by Repair Level Analysis (RLA). Intermediate level maintenance may also include calibration of test equipment and verification of LRUs repaired at this level.

8.2.3 Depot.

The level of maintenance will consist of those maintenance activities performed on repairable LRUs and system support/test equipment requiring specialized skills and equipment. The tasks performed at this level are those that exceed the capabilities of lower maintenance levels. Depot level maintenance may be conducted at the FAA Depot, at contractor facilities, or in the field by government or contractor teams.

8.3.4 Supply Support.

The FAA Depot has the responsibility for providing supply support to the Mode S system. The depot has the responsibility for maintaining inventory records, the master FAA catalog, and providing an interface with the Federal cataloging system.

8.3.5 Integrated Logistics Support.

The Joint Venture (JV) (Westinghouse and UNISYS) is responsible for both the management and technical execution of the Integrated ILSP. The contractor's logistics manager will interface with the FAA project manager and the System Engineering and Integration Contractor (SEIC) logistician. The logistics manager coordinates all logistics functions. The JV has set up a logistics and training support structure headquartered at Westinghouse Baltimore facility.

9. ABBREVIATIONS AND ACRONYMS.

AC	alternating current
ADL	Aeronautical Data Link
AF	Airway Facilities
ANSI	American National Standards Institute
ARIES	Aircraft Reply Interference Environment Simulator
ARTCC	Air Route Traffic Control Center
ASR	Airport Surveillance Radar
AT	Air Traffic
ATC	Air Traffic Control
ATCBI	Air Traffic Control Beacon Interrogator
ATCRBS	Air Traffic Control Beacon System
bps	bits per second
CD	Common Digitizer
CID	Communications Interface Driver
CO	Contracting Officer

COTR	Contracting Officer Technical Representative
CPME	Calibration Performing Monitoring Equipment
CPT	Contractor's Preliminary Test
DABS	Discrete Address Beacon System
DLP	Data Link Processor
DT&E	Development Test and Evaluation
DTE	Data Terminal Equipment
FAA	Federal Aviation Administration
GFE	government furnished equipment
I&C/O	installation and checkout
ILS	Integrated Logistics Support
ILSP	Integrated Logistics Support Plan
IT&E	Integration Test and Evaluation
ITP	Integration Test Plan
JV	Joint Venture
LRU	Line Replaceable Unit
LSA	Logistics Support Analysis
MODE S	Mode Select Beacon System
NAILS	National Airspace Integrated Logistics Support
NAPRS	National Airspace Performance Reporting System
NAS	NAtional Airspace System
NICS	NAS Interfacility Communications System
OJT	On-the-Job Training
OT&E	Operational Test and Evaluation
PAT&E	Production Acceptance Test and Evaluation
PP	Plans and Procedures
PSF	Program Support Facility
PTP	Project Transition Plan
QRO	Quality Reliability Officer
RF	radio frequency
RLA	Repair Level Analysis
RMMS	Remote Maintenance Monitoring System
RMS	Remote Monitoring Subsystem
SEIC	System Engineering and Integration Contractor
SITEAT	Site Acceptance Testing
SSF	System Support Facility
ST&E	Shakedown Test and Evaluation
T&E	Test and Evaluation
TOR	Technical Officer's Representative
TRACON	Terminal Radar Approach Control Facility