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# Mode S Beacon System Enroute Configuration Interim Beacon Initiative (IBI) Mode Operational Test and Evaluation (OT&E) Test Report

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September 1997

DOT/FAA/CT-TN95/61

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16. Abstract <p>This document reports the findings of the operational evaluation tests conducted on the Interim Beacon Initiative (IBI) mode, enroute configuration of the Mode Select Beacon System (Mode S). The tests were conducted at the Parker radar facility in Denver, Colorado, site of the first enroute Mode S system delivery. The Mode S system under test was a fully configured, dual-channel sensor having all required external interfaces connected to actual National Airspace System (NAS) equipment. A combination of system optimization, surveillance performance evaluation, and operational suitability testing were performed as part of this Operational Test and Evaluation (OT&amp;E) effort. Test goals were to ensure proper operation of the Mode S sensor in IBI mode for an enroute configuration, while integrated with appropriate NAS equipment.</p> <p>The tests were conducted in accordance with procedures for OT&amp;E stated in FAA Order 1810.4B. The format of this test report is in accordance with FAA-STD-024b.</p>					
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## EXECUTIVE SUMMARY

An Operational Test and Evaluation (OT&E) was performed on the Mode Select Beacon System (Mode S), Enroute Interim Beacon Initiative (IBI) mode configuration as required by FAA Order 1810.4B. The Mode S is a secondary surveillance radar which provides aircraft surveillance to air traffic control (ATC) systems. This OT&E was performed at an enroute radar site in Parker, Colorado, and at the Denver Air Route Traffic Control Center (ARTCC) in Longmont, Colorado. The Parker radar site was chosen as the location for the OT&E effort because of the availability of the National Aviation Facilities Experimental Center (NAFEC) Dipole Feed (NADIF) antenna, the predominant field configuration. Testing was conducted from July 20 to August 11, 1994; September 12 to September 22, 1994; and November 28 to December 9, 1994.

The test objectives for this OT&E were to prove that the Mode S, operating in IBI mode for an enroute configuration, can provide accurate surveillance data to other National Airspace System (NAS) systems, and has user interfaces acceptable to Air Traffic (AT) and Airway Facilities (AF) personnel. To meet these basic objectives, the OT&E was divided into three phases. Phase 1 optimized the Mode S sensor for enroute IBI operations, and verified that its surveillance performance equaled or exceeded that of the existing Air Traffic Control Beacon Interrogator (ATCBI)-3 beacon system it was replacing. Phase 2 of the OT&E was performed to acquire a baseline of Mode S surveillance data in an operational environment. Phase 3 was an operational evaluation of the Mode S in IBI mode by AT and AF personnel, while the Mode S was fully integrated to appropriate NAS systems.

The phase 1 optimization results were successful. Mode S receiver sensitivity and directional transmit power were matched to a close approximation of the ATCBI-3. Mode S omnidirectional (omni) transmit power was optimized to be 100 watts less than that of the ATCBI-3, because surveillance statistics indicated adequate Side-Lobe Suppression (SLS) and fewer Identity (ID) code 0000s than with a higher omni power.

Superior Mode S surveillance performance was proven during the phase 2 surveillance baseline portion of the OT&E effort. IBI exhibited a higher percentage of beacon detection, ID reliability and validity, and altitude reliability and validity. IBI had a lower false target percentage, and a significantly lower ID 0000 percentage than the ATCBI-3. IBI exhibited run lengths, search collimation, and radar reinforcement comparable to that of the ATCBI-3.

Phase 3 testing demonstrated a successful user interface in the performance of maintenance and air traffic control functions on the

Mode S. Air traffic controllers at the Denver ARTCC did not report any abnormalities in utilizing Mode S data.

ACT-310 recommends deployment of the Mode S in IBI mode in an enroute configuration with an NADIF antenna. The Mode S in IBI mode outperforms the ATCBI-3 in most surveillance performance and false target categories, and is comparable to the ATCBI-3 in all others. The Mode S also provides superior reliability and maintainability as compared to the ATCBI-3 equipment.

## 1. INTRODUCTION.

As required by FAA Order 1810.4B, the Mode Select Beacon System (Mode S) must undergo Operational Test and Evaluation (OT&E). There are two operational configurations (terminal and enroute) which utilize Mode S functionality. In a terminal configuration, the Mode S can provide beacon coverage out to 60 nautical miles (nmi) in range. In an enroute configuration, the Mode S can provide up to 255 nmi of beacon coverage, depending on the requirements of the particular radar site. OT&E testing in a terminal environment has already been completed. The Mode S operating in an enroute environment was the configuration for this OT&E test.

In addition to the terminal and enroute configurations, the Mode S has two specific modes of operation; the Mode S mode and the Interim Beacon Initiative (IBI) mode. In Mode S mode, the Mode S sensor utilizes monopulse techniques for enhanced azimuth accuracy, performs tracking functions on Mode S or Air Traffic Control Radar Beacon System (ATCRBS) transponder equipped aircraft, and provides digitized beacon data to an air traffic control (ATC) facility. In IBI mode, the sensor generates interrogations and receives replies in the same manner as existing Air Traffic Control Beacon Interrogator (ATCBI) beacon systems. The reply video is quantized and, together with interrogation mode pairs, is sent to users which have a beacon target detector or tracker. Mode S monopulse capabilities are not utilized in this mode.

The aging beacon systems at a majority of enroute radar sites are scheduled to be replaced by Mode S systems. Most of these radar sites operate through National Aviation Facilities Experimental Center (NAFEC) Dipole Feed (NADIF) antennas, which do not possess monopulse capabilities. A separate deployment of monopulse antennas and accompanying larger radomes is required to allow for full Mode S mode operations. Due to an offset in deployment schedules, initial deployment of Mode S sensors at many enroute sites will occur prior to the antenna replacements. With the NADIF antennas still in place, the Mode S sensors will operate in IBI mode. Consequently, the configuration for this enroute OT&E test required a Mode S sensor in IBI mode connected to an NADIF antenna. The test site selected was the enroute radar facility at Parker, Colorado. This site, the first Mode S enroute system delivery, had the NADIF antenna and proper equipment configuration needed to support the OT&E effort.

As an enroute radar site serving the Denver Air Route Traffic Control Center (ARTCC), Parker is required to provide radar/beacon surveillance coverage out to 200 nmi in range. Parker also has the special responsibility of serving as the Center Radar Arts Presentation (CENRAP) beacon in the event that feed from the beacon at Stapleton Airport became unavailable. Parker is the primary enroute beacon site for providing CENRAP coverage because of its close

proximity to the Stapleton Airport and Denver International Airport (DIA). This allows Parker to provide the low altitude coverage needed for controlling terminal airspace. This report presents data to show that the Mode S was optimized for both enroute and CENRAP operations.

The OT&E of the Mode S system operating in IBI mode for an enroute configuration was divided into three phases. The first phase optimized the Mode S for enroute IBI operations, and verified that Mode S surveillance performance equaled or exceeded that of the existing beacon system upon completion of the optimization. Phase 2 consisted of lengthy surveillance data collections during peak traffic load intervals, to verify that Mode S performance was comparable to that of the existing beacon system, and compliant with field enroute requirements. Phase 3 allowed air traffic controllers and Airway Facilities (AF) maintenance personnel to evaluate system performance at the radar site, ARTCC, and user interfaces.

### 1.1 PURPOSE OF REPORT.

The purpose of this OT&E test report is to document results and conclusions of the test effort, and to present to the Mode S program a recommendation on the suitability of the Mode S in an IBI enroute configuration. The report describes the system configuration under test, defines test objectives, and provides an overview of how the tests were conducted. The report documents test results for the three test phases, draws conclusions based on analysis of the data, and makes a recommendation on deployment of the Mode S in this particular operational configuration.

### 1.2 SCOPE OF REPORT.

The scope of this report is limited to the test activities conducted at the Parker, Colorado, radar site and the Denver ARTCC, and those analysis efforts relevant to proving test objectives. The report does not discuss outstanding Mode S issues, nor does it present results from other Mode S OT&E tests. It also does not address logistics and field support of the Mode S in an IBI enroute configuration.

The report describes the system configuration in section 3, and states test objectives in section 4. Section 5 presents test descriptions, test results, and data analysis for each subsection of the three test phases. Sections 6 and 7 conclude whether objectives were met, summarize overall system performance, and present a recommendation on deployment. Appendices A and B contain test data sheets for phase 1 and phase 2 testing. An executive summary precedes the body of this document.

## 2. REFERENCE DOCUMENTS.

The following documents were used as reference in the development of the test plan and test report.

- a. Preliminary Report for the Mode S Terminal IBI Operational Test and Evaluation Performance and Operational Test Results
- b. Test Report for the IBI Terminal Performance Regression Test
- c. FAA-E-2716 Mode S Specification
- d. ATC-42 Mode S Functional Description
- e. Mode S Performance Test Procedures
- f. Mode S OT&E/Integration Test Procedures
- g. Order 1010.51A US. National Aviation Standard for the Mark X Air Traffic Control Radar Beacon System (ATCRBS) Characteristics
- h. FAA-E-2679a CD-2 Specification
- I. Mode S ATCBI Backup Mode Functional Specification Revisions 10 and 11
- j. Site Enroute Acceptance Test Procedure for the Mode S Sensor
- k. Radar Beacon Analysis Tool (RBAT) Users Manual
- l. Operational Test and Evaluation Test Plan for Mode S IBI Operations at the Parker Enroute Site
- m. Order 6365.00 Airway Facilities Mode S Maintenance Handbook
- n. FAA-STD-024b, Federal Aviation Administration Standard, Content and Format Requirements for the Preparation of Test and Evaluation Documentation
- o. FAA Order 1810.4B, FAA NAS Test and Evaluation Policy

## 3. SYSTEM DESCRIPTION.

### 3.1 MISSION REVIEW.

The Mode S is a secondary surveillance radar which provides aircraft surveillance to ATC systems. The Mode S sensor interrogates through a beacon antenna, and receives replies from the transponders on-board aircraft. When operating in its IBI enroute mode, the Mode S demodulates, and then quantizes the pulses of the replies. It sends

this quantized beacon video to a Common Digitizer (CD)-2. The CD-2 processes the video into digital beacon reports, and disseminates them via modems and telephone lines to the ARTCC. After correlation is performed by various systems at the ARTCC, the aircraft beacon reports are displayed as targets on the enroute air traffic controllers' scopes.

### 3.2 TEST SYSTEM CONFIGURATION.

There were two systems configured under test for this OT&E. The first system consisted of the existing two channel ATCBI-3, commissioned at the Parker radar site and collocated with an Air Route Surveillance Radar (ARSR)-1E surveillance radar. This system served as the performance reference for the Mode S OT&E. The second system under test was a two-channel Mode S sensor operating in IBI mode. Both systems were cabled to receive and transmit through an NADIF antenna, via a manually switched radio frequency (RF) network known as a site change-over switch. The NADIF antenna is a reflector type of nominally 29-decibel (dB) gain. It utilizes a four-dipole feed radiating into the radar reflector. The beacon systems (ATCBI-3 and Mode S) and radar system (ARSR-1E) feed their data to a CD-2 for radar/beacon correlation, message formatting, and dissemination. Figure 3.2-1 shows the interconnection of the three systems.

#### 3.2.1 ATCBI-3.

The ATCBI-3 employs a linear receiver which sends raw reply video to a stagger/destagger unit, where it is quantized and sent to the CD-2. Sensitivity Timing Control (STC) is performed at RF, and a nonstandard STC curve is employed at this site. Typically STC curves roll off at a rate of 6 dB per octave. The Parker ATCBI-3 was aligned for a nominal rolloff of 8 dB per octave between the ranges of 4 and 128 nmi. This was implemented via a special field change for this site. After processing, the data is disseminated by the CD-2 to the ARTCC from a three-channel modem rack at 2400 bits per second (bps). The CD-2 receives mode pairs from the ATCBI-3 and Azimuth Change Pulses (ACP) and the Azimuth Reference Pulse (ARP) from an Azimuth Pulse Generator (APG) unit located at the rotary joint.

#### 3.2.2 Mode S.

The second system under test was the Mode S operating in IBI mode. This system consists of two Mode S channels, each composed of an interrogator and a Data Processing Subsystem (DPS). Each interrogator consists of a transmitter and receiver. The Mode S operates in conjunction with the same surveillance radar (ARSR-1E) as the ATCBI-3, with both providing data to the CD-2. The Mode S receiver employs a logarithmic detector. The on-line channel sends quantized video to the Mode S Junction Box (MSJB) where it interfaces to the CD-2. STC is performed at baseband and employs a curve with a nominal 6-dB

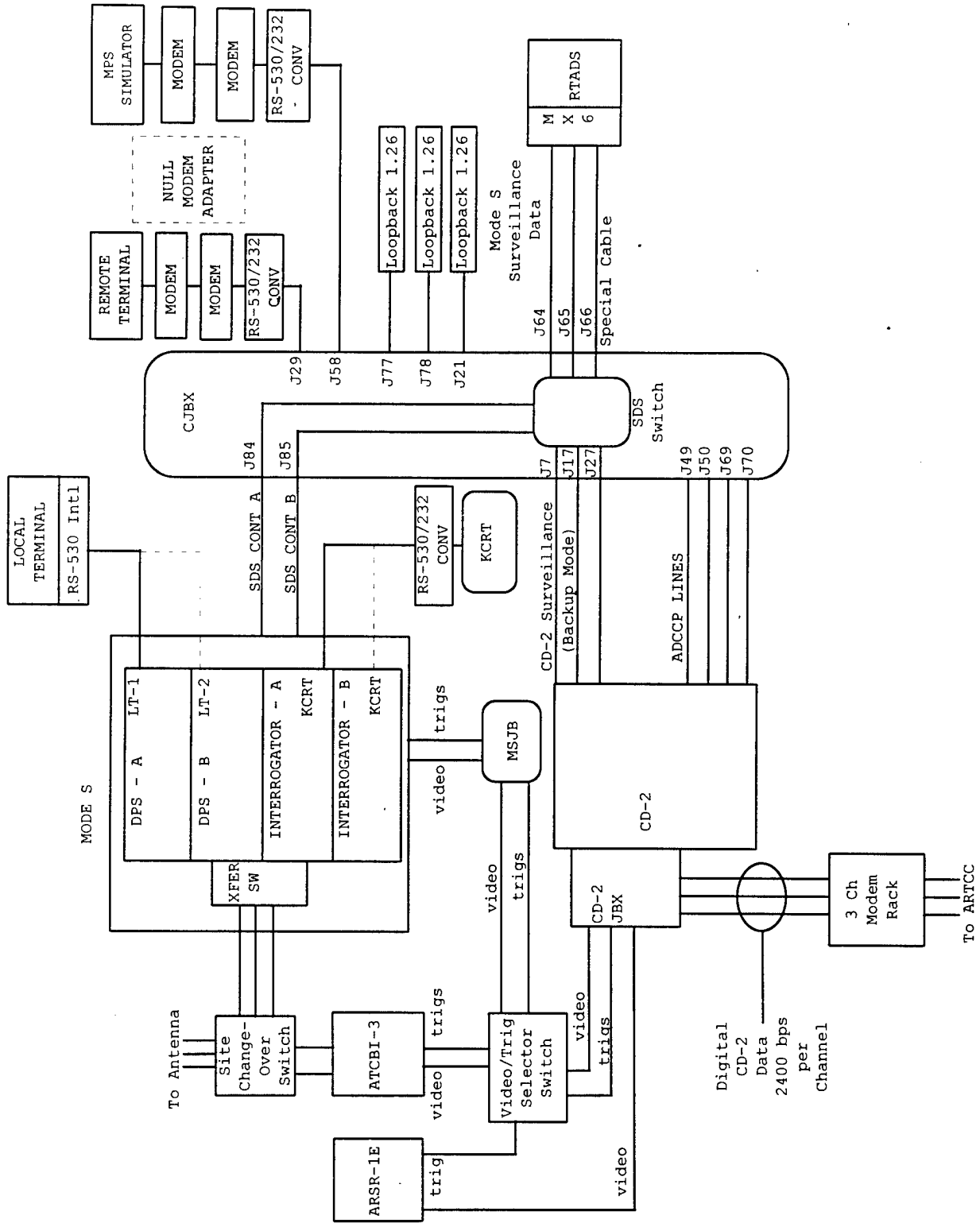


FIGURE 3.2-1. TEST SYSTEM CONFIGURATION

rolloff per octave. In this case STC values are read out of Random Access Memories (RAM) every 8 microseconds ( $\mu\text{sec}$ ), converted from digital to analog, and then applied as the threshold at a comparator. In addition, the CD-2 receives mode pairs from the on-line interrogator and ACPs from the APG located at the rotary joint. The CD-2 accepts video from the ARSR-1E, which it uses for radar/beacon correlation. It also performs the message formatting, and disseminates the data to the ARTCC via the same modem rack as with ATCBI-3 operations. The DPS performs limited status and fault monitoring, providing this data to users by way of either a Local Terminal (LT) or through a Remote Maintenance Monitoring System (RMMS) port to a Mode S Interim Monitoring and Control Terminal (MSIMC). A Remote Terminal (RT) is deployed at the ARTCC and provides overall system status to System Engineers (SE). As with the MSIMC and the LT, the RT provides manual channel switching capability. Finally, independent control and monitoring of either interrogator is provided by a Keyboard Cathode Ray Tube (KCRT) monitor.

### 3.3 INTERFACES.

#### 3.3.1 ATCBI-3.

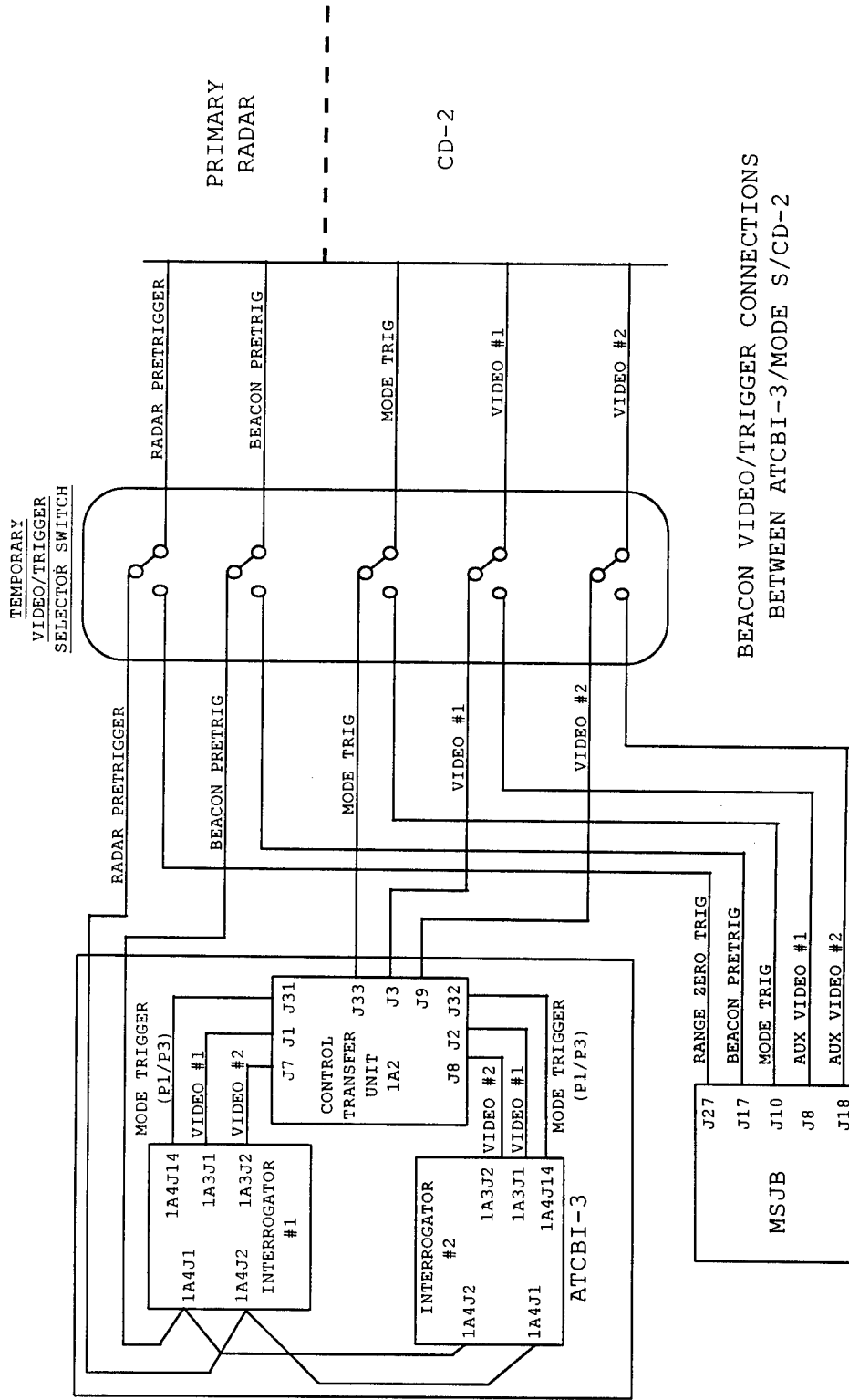
For the configuration under test utilizing the ATCBI-3, the interfaces are:

a. Antenna Interface. The ATCBI-3 interfaces to the NADIF through a pair of 100-foot cables, one for the directional (or sum) channel and one for the omnidirectional (omni) (or Side-Lobe Suppression (SLS)) channel. The ATCBI-3 accesses these cables by way of a site change-over switch, which switches it between the antenna and a dummy load. The site change-over switch was added as part of the Mode S installation to allow either beacon system access to the same antenna.

b. CD-2 Interface. The ATCBI-3 provides mode pairs, beacon sync, and video to the CD-2 through a video/trigger selector switch, which interfaces to the CD-2 by way of the CD-2 junction box. This switch selects between the Mode S video and triggers, and those from the ATCBI-3. The video and trigger switch was also added as part of the Mode S installation to allow either beacon system to operate. The configuration of the switch is shown in figure 3.3.1-1.

c. Radar Interface. The ATCBI-3 receives the radar pre-trigger, which initiates the beacon interrogations, by way of the selector switch.

d. ARTCC Modem Interface. The CD-2 sends three channels of digital surveillance data to the CD-2 junction box. These digital lines interface to the CD-2 modem rack for dissemination to the ARTCC. The three modem channels operate at 2400 bps.



BEACON VIDEO/TRIGGER CONNECTIONS  
BETWEEN ATCBI-3/MODE S/CD-2

FIGURE 3.3.1-1. VIDEO/TRIGGER SELECTOR SWITCH

### 3.3.2 Mode S.

For the configuration utilizing the Mode S, the interfaces are:

a. Antenna Interface. The Mode S IBI interfaces to the NADIF through the same pair of cables that the ATCBI-3 uses, one for the sum channel and one for the omni channel. It accesses these cables by way of two switches. The first is the RF transfer switch, which switches either Mode S channel between the site change-over switch and a local dummy load. The second is the site change-over switch, which switches the Mode S system between the antenna cables and a dummy load located at that switch. The configuration of the switch is shown in figure 3.2-1.

b. Control Point/Monitoring Interfaces. The Mode S had three control points configured for this test, which provided status and fault information. These points include:

1. Local Terminal
2. Remote Terminal
3. MSIMC Terminal

The LT interfaces to the sensor through a 25-pin connector at the DPS cabinet. The Remote and MSIMC terminals interface to the Mode S by way of the communications junction box (CJBX).

A KCRT terminal was also used for limited transmitter/receiver setup and calibration. The KCRT interfaces to either interrogator by way of a 25-pin connector jack located above the door of each interrogator.

## 4. TEST AND EVALUATION DESCRIPTION.

### 4.1 TEST SCHEDULE AND LOCATIONS.

The testing was performed at two locations. The phase 1 testing was executed at the Parker, Colorado, enroute radar site located southeast of the Denver, Colorado, city limits. During phase 2 testing, data was collected at the Parker radar site and Denver ARTCC, while the Mode S was used to control air traffic in an Interim Operational Capability (IOC) state. Phase 3 testing was performed at both the radar site and the Denver ARTCC located in Longmont, Colorado.

### 4.2 PARTICIPANTS.

This test was conducted in joint cooperation and participation of the following organizations: ACT-310, ANM-462, AOS-510, the Denver ARTCC, and the Parker radar site. ACT-310 engineers worked closely with ANM-462 Northwest Mountain region and Parker radar site personnel in accomplishing the phase 1 optimization. AOS-510 aided ACT-310 in collecting and analyzing the phase 2 surveillance data. All the

aforementioned organizations participated in the phase 3 operational suitability and maintenance tests, which required various test locations to be staffed simultaneously.

#### 4.3 TEST AND SPECIALIZED EQUIPMENT.

Tools used in this OT&E test included standard electronics laboratory test equipment and Federal Aviation Administration (FAA) special purpose test tools. The lab equipment used were the following:

- a. Hewlett Packard Spectrum Analyzer Model No. 8568A
- b. Hewlett Packard Network Analyzer Model No. 8753C and 85046A Test Set
- c. Hewlett Packard Peak Power Analyzer Model No. 8990A
- d. Tektronix TDS 544A Digitizing Oscilloscope

FAA special purpose test tools included:

- a. ATCRBS Beacon Test Set. This device generated the ATCRBS replies required to perform the Overall System Sensitivity (OSS) and STC tests. It was triggered by ACPs and provided several variations of target distributions. It was configured for an F1 pulse only to verify STC settings and video performance parameters.
- b. Real-Time Aircraft Display System (RTADS) Program. This test tool obtained surveillance messages disseminated from the CD-2 by way of an MX-6 card installed in a Radar Intelligence Tool (RIT) computer. The RTADS program displayed real-time the beacon and search targets as a function of their range and azimuth. It also simultaneously recorded this target data to a file on the RIT computer's hard drive. The files were transferred to a Compaq portable PC to be analyzed by data reduction programs.
- c. RBAT Software. This software suite of data reduction programs was used to reduce and analyze the RTADS data collections in a variety of ways. Results were presented in user-requested formats (i.e., listings, summaries, totals) to aid in the type of analysis required. The relevant programs used for the data analysis were:
  1. Surveillance Analysis (SA). This program provided statistics on the following beacon performance parameters:
    - (a) Probability of Detection (POD) (Beacon, Search, Total)
    - (b) Identity (ID) Reliability and Validity
    - (c) Altitude Reliability and Validity
    - (d) Run Length

- (e) Radar Reinforcement
- (f) Search Collimation
- (g) Range Errors
- (h) Azimuth Errors

2. Beacon False Target Summary (BFTS). This program provided statistics on the following false target parameters:

- (a) False Target Reports
- (b) Splits
- (c) Ringaround
- (d) Downlink Reflections
- (e) Pulse Repetition Frequency (PRF) False Targets
- (f) Uplink Reflections
- (g) Others
- (h) 3/A Code 0000 percentage

3. Permanent Echo Accuracy. This program calculated range and azimuth errors of target reports originating from a fixed transponder. The range and azimuth information contained in these reports were statistically compared to the surveyed range and azimuth of the fixed transponder.

#### 4.4 TEST OBJECTIVES/CRITERIA.

##### 4.4.1 Phase 1 Test Objectives/Criteria.

Phase 1 of this OT&E test was intended to demonstrate that the Mode S IBI performance for enroute operations is equivalent or superior to the ATCBI-3. An optimized ATCBI-3 operating in conjunction with an ARSR-1E and CD-2 provided the baseline operation that the Mode S had to meet or exceed. In phase 1, the operating parameters of each of the two Mode S channels were adjusted so that they were as close to an optimized ATCBI-3 as possible. These parameters included:

- a. Directional (Sum) and SLS (Auxiliary) Channel Transmit Powers,
- b. Directional (Sum) and SLS (Auxiliary) Channel Voltage Standing Wave Ratio (VSWR),
- c. STC Receiver Settings,
- d. Overall System Sensitivity,
- e. Receiver Video Input to the CD-2.

After the operating parameters of both systems were determined to be equivalent or close to equivalent, both systems underwent a performance evaluation in a live-world environment. Data extractions

were performed on each system, and were reduced using the RBAT SA and BFTS programs. The statistics to be evaluated are listed in section 4.3 under each program's heading. The goal of the optimization was to maximize surveillance detection and reliability while minimizing false targets, 3/A code 0000 targets, and reflections. The statistical results were used to determine if any additional adjustments in the Mode S sensor's operating parameters were required. The parameters could then be adjusted to different values than that of the ATCBI-3, provided that this improved Mode S surveillance performance statistically. The phase 1 optimization was considered successful when all Mode S surveillance performance statistics met or surpassed those of the optimized and certified ATCBI-3. This constituted the exit criteria for phase 1. Once this criteria was met, the Mode S operating parameters could not be changed in phases 2 and 3 of OT&E testing.

#### 4.4.2 Phase 2 Test Objectives/Criteria.

The test objectives of phase 2 were to establish a surveillance performance baseline for Mode S enroute IBI operation, and to ensure stable sensor operation so that phase 3 Operational Suitability could commence. To accomplish this, numerous RTADS data collections were performed on each Mode S channel, with the Mode S system being used to control air traffic in an IOC state. For consistency with daily traffic patterns, a.m. and p.m. data collections were taken around the same time each day. RBAT data reduction programs, as described earlier, were run on each of the data collections and the output statistics analyzed. Results had to meet or exceed the limits specified in the Mode S Enroute Site Acceptance Test Procedure and be congruent with previous Mode S OT&E results.

#### 4.4.3 Phase 3 Test Objectives/Criteria.

The third and final phase of the OT&E effort was to ensure that the Mode S had user interfaces acceptable to Air Traffic (AT) and AF personnel. An operational evaluation of Mode S IBI operation was performed with the Mode S fully configured to the appropriate National Airspace System (NAS) equipment. Both AT and AF personnel participated in evaluating the system's performance and suitability in an operational environment. This was accomplished by the use of structured evaluation periods where target coverage and quality were recorded and compared to the existing ATCBI-3 beacon system. Scripts were also performed to simulate maintenance type actions to assess the Mode S's compatibility and stability with other NAS equipment.

## 5. TEST DESCRIPTIONS, RESULTS, AND ANALYSIS.

### 5.1 PHASE 1 SYSTEM OPTIMIZATION.

The phase 1 System Optimization was performed in order to meet the test objectives outlined in section 4.4.1 of this test report. The STC curve of the Mode S in IBI mode was set up to approximate that of the ATCBI-3. An OSS determination was made on each system to verify that the established level of STC sensitivity provided a similar level of target detection. Directional and omni transmit powers were adjusted on the Mode S to mirror the commissioned operating levels of the ATCBI-3. A qualification of each system's output beacon video was made to ensure proper input to the CD-2. After these optimizations had been completed on the Mode S sensor operating in IBI mode, a surveillance performance evaluation was conducted. Results of this evaluation necessitated the IBI STC curve be further adjusted, as well as IBI transmit power. This was in concert with the test philosophy that surveillance performance had to be at least equivalent between the systems, not just the operating parameters.

Test data sheets for phase 1 preliminary calibrations and measurements can be found in appendix A at the back of this report. Test data for the rest of the phase 1 optimization has been incorporated into tables and figures, and is presented in the test results section. Data statistics necessary to support conclusions are discussed in the body of the text.

#### 5.1.1 Test Description.

Before the Mode S IBI optimization commenced, preliminary calibrations and measurements were performed on equipment that was to be used in testing. These procedures included:

- a. Beacon test set checkout,
- b. Attenuator and cable calibrations,
- c. Directional Coupler (DC) calibrations for the Mode S and ATCBI-3,
- d. Insertion losses between the Aircraft Reply Interference Environment Simulator (ARIES) direction coupler input and the receiver input,
- e. Sum channel insertion loss from the transfer switch to the receiver input.

The beacon test set was characterized by measuring the accuracy of the power attenuators used to control the RF unit input, and measuring the pulse fidelity of the RF output. The insertion losses of the test

cables and test attenuators which were used to measure the power transmitted by each system were determined using the Network Analyzer. Mode S DC calibrations were performed using the Network Analyzer and its associated S-parameter Test Set. The calibration consisted of a series of insertion loss measurements yielding the coupling ratio, the isolation, and the coupler insertion loss. The directivity was determined from the difference between the isolation and coupling ratio. ATCBI-3 DC data was not measured, as it would have impacted ATC operations to have removed the couplers from the system. Their data was taken from labels on the couplers which were the result of previous calibrations. Insertion loss between the ARIES DC and the input to the RF receiver, and between the sum channel of the Mode S transfer switch and the input to the receiver were also performed with the Network Analyzer and S-parameter Test Set.

The ATCBI-3 STC optimization procedure was performed to accomplish two objectives. The first was to verify that the ATCBI-3 was certified for ATC operations. The second was to use this data to align the Mode S STC for similar detection. Through discussions with radar site personnel, it was learned that the ATCBI-3 utilized a nonstandard STC curve with a rolloff of 8 dB/octave nominal for ranges between 4 and 128 nmi. However, the measurement intervals required by certification procedures were not exactly in octaves for the closer ranges, so the rolloff was closer to 7 dB in those regions. In addition, it had been assumed that the CD-2 processes targets at 1 nmi, when in fact it was configured to begin processing at 5 nmi. Therefore, the determinations of STC thresholds at 1, 2, and 4 nmi, for example, were not relevant to target detection.

ATCBI-3 STC certification procedures from the AF Maintenance Handbook called for the measurement of sensitivity up to the quantizer input using a 1- $\mu$ sec, 1090-megahertz (MHz) pulse generated by the ATCRBS Beacon Test Set. Raw video from the receiver detector was displayed on an analog scope. The RF power output of the test set was varied to give a 1-volt level out of the detector. This level was derived in the following way. The video had ringing on the leading edge (LE) of the pulse. With the scope set for a long sweep time, this ringing appeared averaged into an intensified dot on the display. This dot was then adjusted for the 1-volt display with the Beacon Test Set attenuators. The effective noise level of the waveform increased as the range of the pulse was incremented, so it became exceedingly difficult to measure this level.

In addition to this ATCBI-3 STC certification procedure, another ATCBI-3 STC procedure was performed to obtain more appropriate results. This procedure significantly improved measurement stability at ranges where signal to noise ratios were low. It also accounted for the radically different target detection schemes employed by the ATCBI-3 and Mode S systems. Detection (thresholding) is performed at RF for the ATCBI-3 system and at baseband for the Mode S. The new

procedure used a measuring point at the quantizer output for each system. Measuring the pulse at this point compared the same type of output, without being influenced by the different detection methods employed by each system. The new procedure also utilized a digital storage oscilloscope with averaging employed. This had the effect of filtering noise at ranges of low signal-to-noise ratio, to allow for a better estimate of the video (and therefore the threshold) than in the analog case. There was, however, still some inaccuracy ( $\pm 1$  dB) in measurements at the far ranges.

The IBI STC optimization procedure was executed similarly to this second STC procedure used on the ATCBI-3. Quantized video was measured on the digital oscilloscope connected to the coax beacon video output of the MSJB. The beacon sync output of the junction box was used to trigger the scope. A single test pulse was generated at RF using the Beacon Test Set, and input into the Mode S sensor via the DC connected to the RF transfer switch. The power of the test pulse was varied until the pulse video measured 1 volt on the oscilloscope, and that power was recorded as the STC threshold value for that target range. Range was varied by introducing delay in the test pulse being output from the Beacon Test Set.

An objective of optimizing IBI STC was to adjust the Mode S Auxiliary receive channel STC Site Adaptable Parameter (SAP) to give the same value of STC at 1 nmi as the ATCBI-3. Because only auxiliary (Aux) video is output by the Mode S when in IBI mode, only the Aux STC parameters are of interest. A second objective of the optimization was to have the IBI STC curve fall within a  $\pm 1$ -dB window of the ATCBI-3 STC curve for the preferred ATCBI-3 on-line channel. Given that the two STC curves roll off at a different rate, this objective was not likely to be met. The third objective was to verify that each IBI STC curve measurement did not deviate from its theoretical curve value by  $\pm 3$  dB. This is the tolerance delimited in the Mode S specification.

To meet the third objective, SAP parameters for the Mode S Aux receive channel had to be optimized. The Aux STC SAP value (in dB) when added to a nominal -93 decibels above 1 milliwatt (dBm) Hardware Sensitivity Reference should equal the power of the test pulse delayed at 1 nmi when the pulse output video was 1 volt. Whenever this is not the case, the Hardware Sensitivity Reference needs to be fine tuned. This reference can be adjusted automatically by executing an interrogator subroutine known as POD, and then installing the resulting value as the POD offset SAP. When POD is invoked, an internal Test Target Generator (TTG) generates a reply pulse train which is input to the receiver and detected in the quantizer. The type of reply input pulse train injected is dependent on the quantizer for which the POD is being run. For the Mode S quantizer, the Mode S POD would be selected and the TTG would generate preambles. For the ATCRBS quantizer bracket pairs would be injected. For the Aux quantizer however,

although it too detects brackets, it is not capable of detecting them from the TTG because of timing delays in the quantizer due to post design circuit additions. As a result, the POD function for this quantizer has to utilize a train consisting of simple pulses. This type of input produces a POD value, that when installed into the system as the POD offset SAP, tends to leave the STC incorrectly calibrated. Although pulse detection theoretically results in a lower threshold than bracket detection, it is unclear why the thresholds generated from the two detection schemes are often so different (sometimes as high as six counts or 3 dB). Factory alignment may account for part of this discrepancy. The Aux quantizer is supposed to be aligned for unity gain, but checks on some receivers have shown that this is not always the case. Another factor is log amp noise. These devices are inherently noisy, particularly at low levels where the gain is high. Furthermore, they have an offset which needs to be aligned to cancel any DC bias. All of these factors could effect POD threshold. Consequently, the ATCRBS POD offset SAP value was substituted into the Aux receiver channel POD offset SAP. This resulted in a measured STC curve more correctly aligned with the calculated thresholds for the STC.

The procedure of determining OSS was common for both the ATCBI-3 and Mode S systems. It consisted of injecting a ring of 16 test targets from the Beacon Test Set, delayed a predetermined amount in range. The output target ring was viewed on the CD-2 maintenance display. Power was decreased on the Beacon Test Set until approximately half the test targets disappeared from the maintenance display. This power level was recorded as the OSS curve threshold for that particular range. For this OSS determination, the Beacon Test Set was triggered directly from the CD-2, as opposed to being directly triggered from the APG (as called out in the OT&E procedures). This deviation was necessary to stay consistent with field certification practices for OSS. The CD-2 trigger was adjusted so that the Beacon Test Set synchronization delay could be adjusted to provide the same target ranges that were measured in the STC optimization. The trigger was moved far out in range so that the replies would appear on the second time around. This was done because the inherent delay in the CD-2 triggering precluded setting a target at the 5-nmi range, the start of CD-2 detection. The time from P3 to F1 was measured at each range setting to verify that the range was correct.

ATCBI-3 and IBI transmitter performance was qualified by measuring directional and omni (SLS) transmit power levels, and by determining the VSWR of each system. The ATCBI-3 and Mode S were configured to operate with a Mode 3A/Mode C interlace pattern, the normal interrogation pattern of the ATCBI-3. Because the systems had different line losses to the antenna, the input to the NADIF antenna was chosen as the reference point for the power measurements. Transmit powers for the ATCBI-3 on-line directional channel and the on-line SLS channel were measured at the output of the ATCBI-3 sum DC

and omni DC, respectively. Once line losses to the antenna feed had been measured, these losses were subtracted from the measured powers to compute the power input to the antenna. Power measurements were not physically performed at the input to the NADIF feed due to restrictions in obtaining downtime for the Parker site. Similarly, IBI directional and omni powers were measured at the DCs above the RF transfer switch. Line losses to the antenna feed were subtracted from these measurements in aligning to the ATCBI-3 transmit powers. Power measurements were made with a Peak Power Meter, in both "Peak" and "Top" modes. The Peak mode averages the signal peak throughout the measurement interval. The Top mode performs statistics on the sampled data and chooses the most prevalent level based on the statistics.

The determination of VSWR for each system was referenced to the NADIF antenna input. Sum and omni reverse powers were measured at the reverse power ports of the respective DCs for each system. Line losses from the DCs to the antenna were added to the reverse power values. These values (in dBm) were subtracted from the forward power values (referenced to the antenna) to create a Return Loss parameter. Return Loss was used as an index in the VSWR look-up table of the Mode S Maintenance Handbook to provide the VSWR ratio. The Peak Power Meter measurements made in Top mode were used in computing VSWR.

A video performance evaluation was performed on the ATCBI-3 and Mode S systems, to ensure that beacon video for both systems complied with CD-2 requirements. This characterization was important in ensuring that any degradation in surveillance performance could not be attributed to the quality of the pulses sent to the CD-2 target detector. Both receiver video and quantized video were characterized for the ATCBI-3 and Mode S systems. In the ATCBI-3 the receiver video is linearly detected, and in the Mode S receiver video is logarithmically detected. Using a digital oscilloscope, the following pulse parameters were measured: amplitude, rise time, fall time, pulse width, and video noise. The pulse video was generated at RF by the Beacon Test Set, which was configured to produce an approximately 0 dBm, 485 nanoseconds (ns) wide, F2 pulse at 100 nmi. This range was chosen simply to give a representative sample of the video. Each pulse measurement was made at three different attenuation settings (15 dB, 30 dB, and threshold at the 100-nmi range) to characterize pulse parameters over a range of power levels.

At the completion of the matching IBI STC, OSS, transit powers, and pulse video characteristics to the ATCBI-3, IBI surveillance performance was evaluated and compared to ATCBI-3 surveillance characteristics. RTADS data was collected on the RIT, which received beacon reports output from the CD-2 junction box. Data was reduced using the RBAT SA and BFTS programs. Before lengthy IBI data extractions were performed, shorter extractions were made and analyzed succinctly to obtain a general characterization of IBI surveillance performance. If performance was obviously lacking in one area, IBI

parameters would be further adjusted to remedy the deficiencies. Once the short period RTADS extractions produced favorable surveillance results compared to the ATCBI-3, more lengthy (2 hours) IBI and ATCBI-3 RTADS extractions were performed to establish a phase 1 surveillance baseline. IBI RTADS collections were also performed with the Mode S sum and omni transmit powers lowered 1 dB from the optimized values, in preparation for the scheduled flight check prior to the start of phase 2.

RBAT SA, BFTS, Permanent Echo Accuracy, and Filter programs were used to reduce the RTADS data. False target listings were generated from BFTS, so that each false target could be examined. False targets were tracked using the playback feature of the RTADS program, filtering on individual 3/A codes and displaying a continuous target history. A determination was made whether each false target was really a 3/A code-in-transition, or two distinct aircraft assigned the same 3/A code. This was frequently found to be the case with false targets classified in the "other" category. The wrongly classified 3/A codes were then filtered out of the Beacon False Target program, and new totals were calculated. Calibration and Performance Monitoring Equipment (CPME) and parrots were filtered out of the SA program, to better reflect true radar reinforcement in the Parker coverage area. The filter program was used to provide range filtering of the RTADS data, prior to rerunning the BFTS and SA programs.

#### 5.1.2 Test Results.

The preliminary calibrations and measurements revealed adequate results to allow phase 1 testing to proceed. Numerical results can be found in appendix A of this document. DC calibrations and insertion loss measurements were recorded for use later in the optimization. Variations in the ATCRBS Beacon Test Set's course and fine attenuator adjustments were measured. All subsequent calculations performed with the test set were done utilizing these measured attenuator readings. Beacon test set output pulse parameters were characterized in terms of the ATCRBS National Standard specifications pertaining to transponder performance. The test set met the Standard requirements except for pulse rise and fall times, which were faster than required. This was not a critical departure from the Standard, since the rise and fall times are specified to keep the radiated sidebands at a minimum for over the air transmissions. These sidebands would have had a minimal effect on the OSS and STC measurements that the test set was used for in phase 1.

Results of the ATCBI-3 STC certification procedure showed that the measured STC curve did not have the 50-dB range required (for either channel), nor did it meet the expected sensitivity at the far ranges. As shown in table 5.1.2-1, the STC measurements were made in octaves of range delay (in  $\mu$ sec) as per the certification procedure, not in octaves of nmi. The two-way range delay of a target at 1 nmi is 12.36

μsec. Since the STC certification procedure referenced range delay to the leading edge of the P3 pulse instead of the F1 pulse, 3 μsec (nominal ATCRBS transponder and Beacon Test Set delay) was added to 12.36 μsec in computing the range delay at 1 nmi.

TABLE 5.1.2-1. SENSITIVITY TIMING CONTROL (STC)  
(Measured Using Site STC Certification Procedure)

Range (μsec after P3)	Range (nmi)	ATCBI-3 Ch 1 (dBm)	ATCBI-3 Ch 2 (dBm)	Expected Level (dBm)
15.35	1	-32.46	-34.00	-33
30	2.18	-38.53	-39.66	-39
50	3.80	-44.67	-45.22	-45
100	7.85	-53.21	-53.75	-53
200	15.94	-60.72	-61.54	-61
400	32.12	-67.73	-66.79	-69
800	64.48	-75.46	-75.46	-77
1600	129.2	-80.00	-80.00	-85
2473	199.84	N/A	N/A	-85 to -87
3162	256	N/A	N/A	N/A
Notes: Beacon Test Set Input Power				Peak: -1.20 dBm
				Top: -1.38 dBm
Synchronization Delay (Pre-trigger to P3 LE)				34 μsec
Beacon Sync to F1 LE				N/A

Results of the second ATCBI-3 STC procedure (performed at the quantizer output) are shown in table 5.1.2-2. The table shows an STC rolloff at a rate of 7 to 8 dB/octave in the 4- to 64-nmi region. Channel (Ch) 1 was seen to be the more sensitive of the two channels, but because of transmitter problems on that channel, Ch 2 was maintained as the preferred on-line channel. Measuring through the quantizer revealed a sensitivity threshold 6 to 7 dB lower at the far ranges than in the data obtained from the STC certification procedure. Sensitivity was also 8 to 13 dB lower in the 1- to 64-nmi range. Despite this improvement in sensitivity, the range of the STC curve generated from this new procedure still did not meet the certification limit of 50 dB.

Optimizing the IBI STC curves to exactly match the STC curves of the ATCBI-3 could not be realized. The sole STC adjustment in the Mode S system is a SAP which represents the starting point of the STC curve at 1 nmi. The amount of STC attenuation rolls off at 6 dB per octave, and continues until the fixed threshold is reached. On the other hand, the ATCBI-3 STC curve rolls off initially at 6 dB per octave,

then rolls off nominally at 8 dB per octave from 4- to 128-nmi. Therefore, matching Mode S to ATCBI-3 STC values at 1 nmi would leave the Mode S with greatly reduced sensitivity at ranges from 64 to 128 nmi. If the Mode S STC was lowered to match the ATCBI-3 sensitivity at these far ranges, then the reduced thresholding at the close-in ranges would likely result in a greater number of replies being processed. These replies would either expand the hit count of the target report, or increase the likelihood that the report would be split into two reports (one of which being false). Side-lobe replies would also be more likely to be processed, which would cause ringaround. An engineering compromise was thus reached to best approximate ATCBI-3 STC performance, without dramatically affecting sensitivity at either the close or far ranges. As depicted in table 5.1.2-2, IBI STC values for each channel were optimized to provide 1 to 3 more dB of sensitivity from 1 to 16 nmi, while being 2 to 3 dB less sensitive out at 128 nmi. A comparison between the STC curves of the two systems is illustrated graphically in figure 5.1.2-1.

TABLE 5.1.2-2. SENSITIVITY TIMING CONTROL (STC)  
(Measured at Quantizer Output Using OT&E Procedure)

Range (nmi)	ATCBI-3 Ch 1 (dBm)	ATCBI-3 Ch 2 (dBm)	IBI Ch A (dBm)	IBI Ch B (dBm)
1	-42.74	-41.15	-44.94	-45.91
2	-49.41	-47.85	-50.81	-51.88
4	-57.4	-55.44	-56.97	-58.97
5.2	-60.44	-57.93	-59.20	-61.25
8	-65.38	-62.22	-62.86	-63.91
16	-73.5	-69.42	-68.91	-69.88
32	-80.6	-75.6	-75.18	-75.66
64	-85.47	-82.85	-80.84	-82.45
128	-86.52	-87.02	-84	-85.05
200	-86.52	-87.02	-84	-85.05

Notes: ATCBI-3				
Sync Delay (Radar pre-trigger to P3 LE)				<u>67.7 μsec</u>
Radar pre-trigger to F1 LE				<u>70.7 μsec</u>
IBI				
Aux POD value measured at KCRT Ch A, Ch B				<u>33, 34</u>
ATCRBS POD value measured at KCRT Ch A, Ch B				<u>36, 37</u>
Value used for Aux POD offset SAP Ch A, Ch B				<u>36, 37</u>
Aux STC Value Ch A, Ch B				<u>48, 48 dB</u>
Synchronization Delay (Pre-trigger to P3 LE)				<u>37 μsec</u>
Pre-trigger to F1 LE				<u>40 μsec</u>

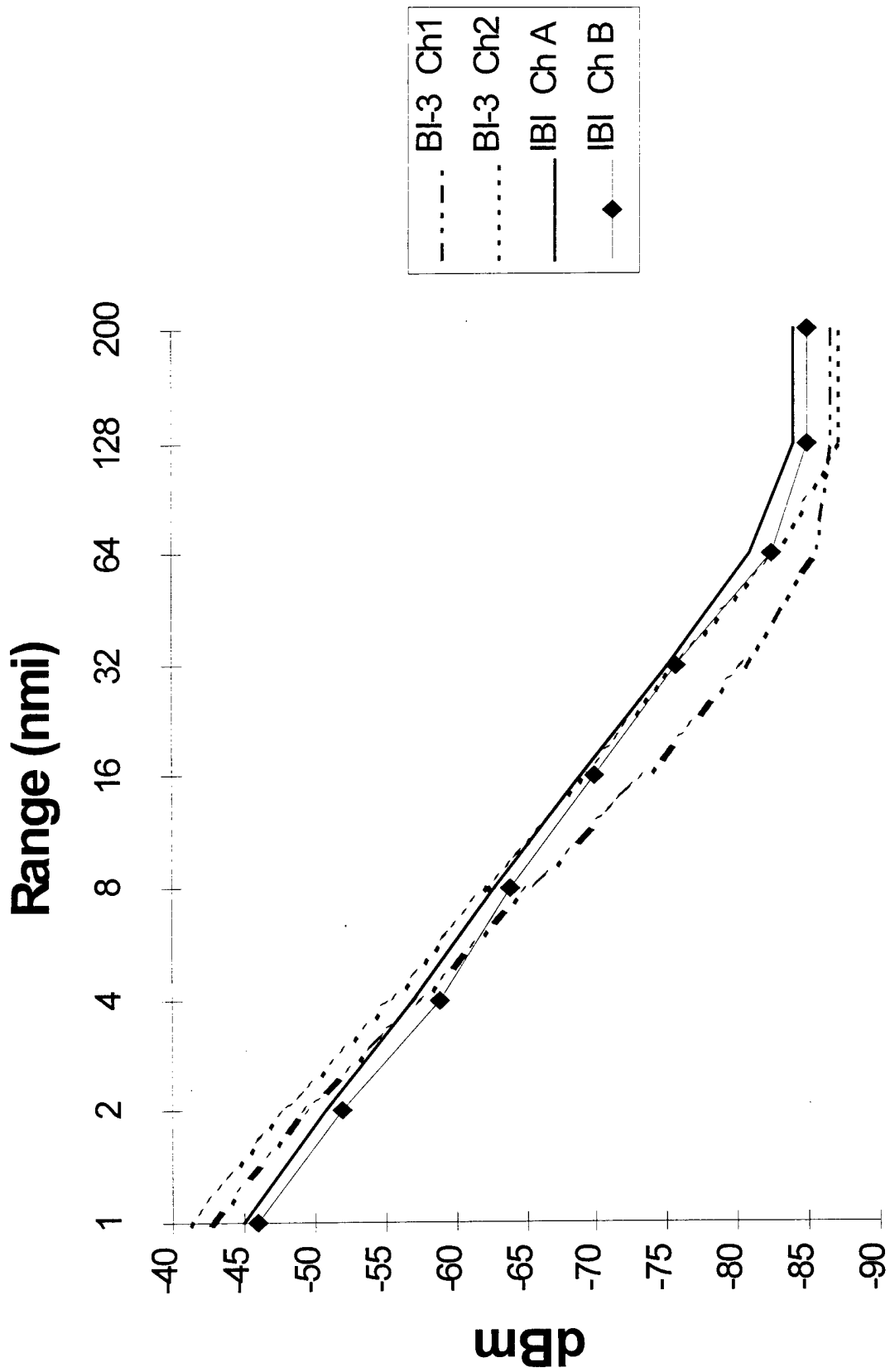


FIGURE 5.1.2-1. SENSITIVITY TIMING CONTROL (STC)

The objective of verifying measured IBI STC curve values to within +3 dB of the theoretical curve values was realized by fine tuning the sensor's Hardware Sensitivity Reference. This was done by changing the Aux POD offset in SAPs to be the ATCRBS POD value. This allowed the theoretical STC curve starting point at 1 nmi to approximately equal the measured value. Deviations between measured IBI STC values and theoretical curve values are listed in table 5.1.2-3. Measured curve values deviated from theoretical values by less than +1 dB (excluding the value at 128 nmi) for Ch A and +2 dB for Ch B. The 3-dB deviation at 128 nmi was still within objective limits.

TABLE 5.1.2-3. SENSITIVITY TIMING CONTROL (STC)  
(IBI Values Compared to Theoretical Curve Values)

Range (μsec)	Range (nmi)	IBI Ch A (dBm)	IBI Ch B (dBm)	Expected Level (dBm)	IBI Ch A Deviation	IBI Ch B Deviation	
12.35	1	-44.94	-45.91	-45	+0.06	-.91	
25	2	-50.81	-51.88	-51	+0.19	-.88	
50	4	-56.97	-58.97	-57	+0.03	-1.97	
65	5.2	-59.20	-61.25	N/A	N/A	N/A	
99	8	-62.86	-63.91	-63	+0.14	-.91	
198	16	-68.91	-69.88	-69	+0.09	-.88	
395	32	-75.18	-75.66	-75	-.18	-.66	
790	64	-80.84	-82.45	-81	+0.16	-1.45	
1581	128	-84	-85.05	-87	+3	+1.95	
2473	200	-84	-85.05	N/A	N/A	N/A	
3162	256	N/A	N/A	-93	N/A	N/A	
Notes:		Aux POD value measured at KCRT Ch A, Ch B				33, 34	
		ATCRBS POD value measured at KCRT Ch A, Ch B				36, 37	
		Value used for Aux POD offset SAP Ch A, Ch B				36, 37	
		Aux STC Value Ch A, Ch B				48, 48 dB	
		Synchronization Delay (Pre-trigger to P3 LE)				37 μsec	
		Pre-trigger to F1 LE				40 μsec	

The OSS determination for the ATCBI-3 resulted in an OSS threshold curve generally higher (less sensitive) than the ATCBI-3 STC curve. This result was expected, since OSS was based on reply bracket detection whereas STC was determined by pulse detection. The rolloff of each curve, however, was basically the same. The OSS data for Mode S IBI mode was also consistent with the IBI STC data. In fact, it was more closely aligned than in the ATCBI-3 case. The IBI OSS curve for either channel was only slightly higher (less than 0.5 dB) than the IBI STC curve out to 128 nmi in range. Table 5.1.2-4

provides OSS threshold values for each system. Note that curve values did not begin at 1 nmi, because the CD-2 starts detection at around 5 nmi. A graphical comparison between the systems' OSS curves is illustrated in figure 5.1.2-2.

TABLE 5.1.2-4. OVERALL SYSTEM SENSITIVITY (OSS)  
(50 Percent of Test Target Ring Detected)

Range (nmi)	ATCBI-3 Ch 1 (dBm)	ATCBI-3 Ch 2 (dBm)	IBI Ch A (dBm)	IBI Ch B (dBm)
5.2	-59.37	-57.35	-59.73	-60.63
8	-64.72	-61.16	-62.79	-63.79
16	-72.33	-68.25	-68.84	-69.76
32	-79.53	-74.44	-75.11	-76.03
64	-84.81	-82.2	-80.77	-81.8
128	-86.41	-84.81	-82.88	-83.88
200	-86.41	-84.81	-83.38	-84.43

Table 5.1.2-5 provides the coupling coefficients, attenuation values, line loss measurements, and transmit power measurements used in the ATCBI-3 transmit power computations. Reverse power measurements were not included in the table, because a reliable measurement could not be performed with the Peak Power Meter. Approximate return loss calculations for ATCBI-3 Ch 2 were made using reverse powers measured with an average power meter. VSWR and return loss calculations were unavailable for ATCBI-3 Ch 1, because this channel could not be switched to the antenna during operational use due to transmitter problems. The ATCBI-3 directional and omni transmit powers were measured to be approximately 100 watts and 400 watts at the input to the NADIF antenna. The ATCBI-3 had been operating at these power levels for a long time, though a justification of these operating parameters and the associated SLS-to-directional difference could not be provided. Nevertheless, IBI transmit powers were adjusted to match the ATCBI-3 output.

Mode S sum and omni transmitter performance data is presented in table 5.1.2-6. The "Note" at the bottom of the table shows the computation methodology. The sum and omni VSWR ratios (referenced to the NADIF feed) for both Mode S channels were higher than the VSWR ratios for the ATCBI-3 channels. The Mode S VSWRs averaged around 1.4:1, while the ATCBI-3 VSWRs averaged about 1.3:1. The higher VSWR tended to decrease the Mode S effective forward power. The VSWR values translated into a 5-watt decrease in Mode S directional effective forward power compared to ATCBI-3 directional effective forward power. The Mode S was also 25 watts lower in omni effective forward power.

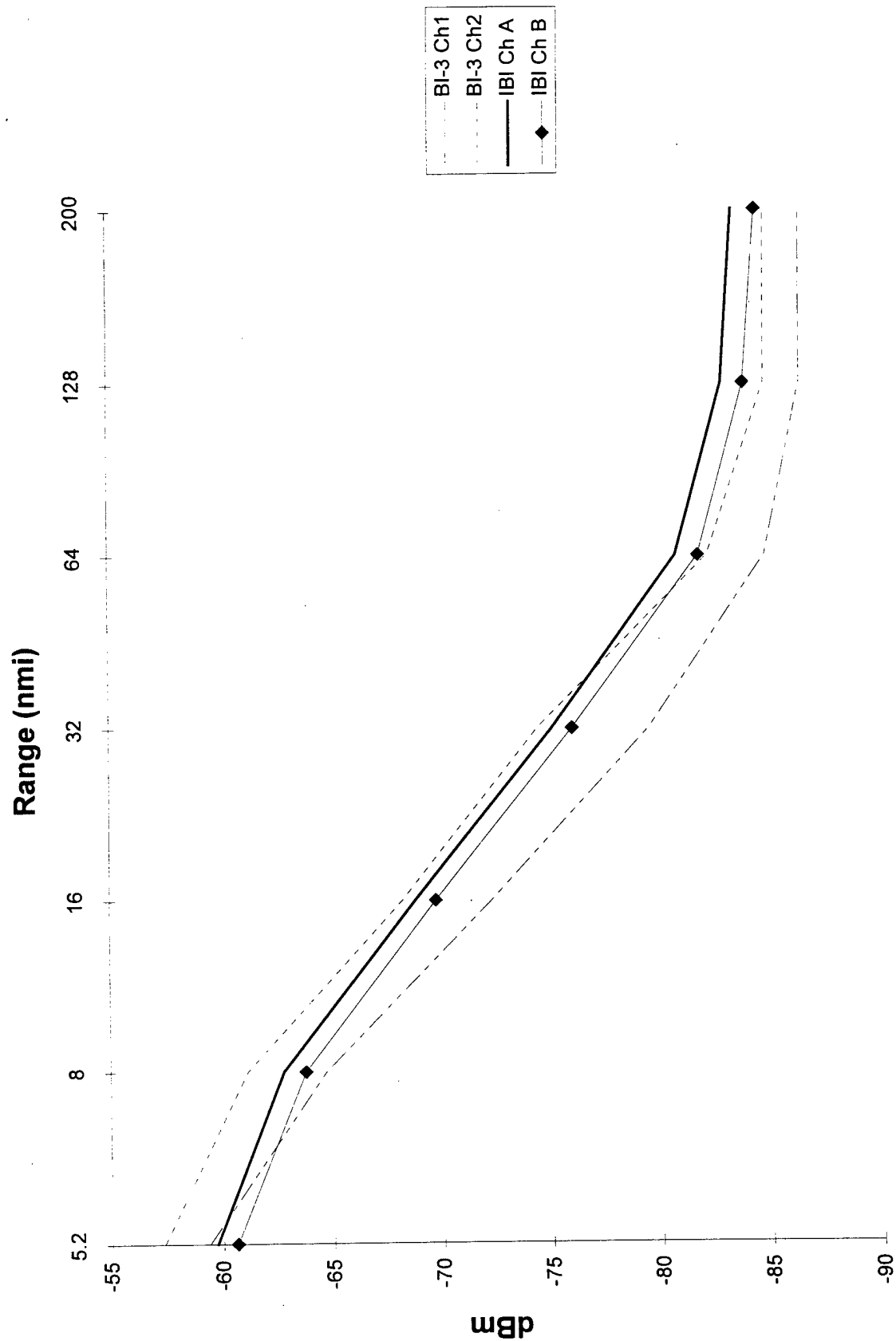


FIGURE 5.1.2-2. OVERALL SYSTEM SENSITIVITY (OSS)

TABLE 5.1.2-5. ATCBI-3 TRANSMITTER PERFORMANCE DATA

Measurement Description	ATCBI-3 Ch 1 Directional Channel	ATCBI-3 Ch 1 Omni Channel	ATCBI-3 Ch 2 Directional Channel	ATCBI-3 Ch 2 Omni Channel
Coupling Coefficient (A)	19.7 dB	19.9 dB	19.7 dB	19.9 dB
Power Meter Cable Attenuation & Attenuator (B)	30.53 dB	30.53 dB	30.53 dB	30.53 dB
Measured Power at the Forward Port of the DC (C)	Peak: 5.88 dBm Top: 5.47 dBm	Peak: 7.81 dBm Top: 7.59 dBm	Peak: 5.67 dBm Top: 5.42 dBm	Peak: 8.71 dBm Top: 8.56 dBm
Line losses from DC to NADIF Feed (D)	6.21 dB	3.11 dB	6.21 dB	3.11 dB
Computed Forward Power at the NADIF Feed (value in A + value in B + value in C - value in D)	Peak: 49.9 dBm Top: 49.49 dBm	Peak: 55.13 dBm Top: 54.91 dBm	Peak: 49.69 dBm Top: 49.44 dBm	Peak: 56.03 dBm Top: 55.88 dBm
Return loss	not measured	not measured	-18 dB (approx.)	-19 dB (approx.)
VSWR referenced to the NADIF Feed	not measured	not measured	1.3 : 1	1.25 : 1

TABLE 5.1.2-6. MODE S TRANSMITTER PERFORMANCE DATA

Measurement Descriptions	Mode S Sum Channel Forward Power		Mode S Sum Channel Reverse Power		Mode S Omni Channel Forward Power		Mode S Omni Channel Reverse Power	
	Ch A	Ch B	Ch A	Ch B	Ch A	Ch B	Ch A	Ch B
Coupling Coefficient (A) Power Meter Cable Attenuation + Attenuator (B)	20.32 dB	20.32 dB	20.33 dB	20.33 dB	20.35 dB	20.35 dB	20.34 dB	20.34 dB
Measured Power at the Forward or Reverse Port of the DC (C)	30.64 dB	30.64 dB	.76 dB	.76 dB	30.64 dB	30.64 dB	.76 dB	.76 dB
Line losses from the Sum or Omni DC to the NADIF Feed (D)	6.93 dBm Peak 6.64 dBm Top	6.84 dBm Peak 6.65 dBm Top	5.00 dBm Peak 5.00 dBm Top	4.05 dBm Peak 4.05 dBm Top	9.80 dBm Peak 9.74 dBm Top	10.17 dBm Peak 9.73 dBm Top	15.06 dBm Peak 15.06 dBm Top	15.86 dBm Peak 15.83 dBm Top
Computed Forward or Reverse Power at the NADIF Feed (E or F)	8.15 dB	8.15 dB	8.15 dB	8.15 dB	5.06 dB	5.06 dB	5.06 dB	5.06 dB
Return Loss referenced to the NADIF Feed (G)	49.74 dBm Peak 49.45 dBm Top	49.65 dBm Peak 49.46 dBm Top	34.24 dBm Peak 34.24 dBm Top	33.29 dBm Peak 33.29 dBm Top	55.73 dBm Peak 55.67 dBm Top	56.1 dBm Peak 55.66 dBm Top	41.22 dBm Peak 41.22 dBm Top	42.02 dBm Peak 41.99 dBm Top
Return Loss referenced to the DC (H)	15.50 dB Peak 15.21 dB Top	16.36 dB Peak 16.17 dB Top	N/A	N/A	14.51 dB Peak 14.43 dB Top	14.08 dB Peak 13.67 dB Top	N/A	N/A
VSWR referenced to the NADIF Feed (I)	31.80 dB Peak 31.51 dB Top	32.66 dB Peak 32.47 dB Top	N/A	N/A	24.63 dB Peak 24.57 dB Top	24.20 dB Peak 23.79 dB Top	N/A	N/A
VSWR referenced to the DC (J)	1.42 : 1	1.37 : 1	N/A	N/A	1.47 : 1	1.52 : 1	N/A	N/A
KCRT data	57.7 dBm Sum Power 1.05 : 1 VSWR	57.4 dBm Sum Power 1.05 : 1 VSWR	N/A	N/A	60.7 dBm Omni Power 1.15 : 1 VSWR	60.6 dBm Omni Power 1.2 : 1 VSWR	N/A	N/A

NOTE:  
 (E): Forward Power = value in A + value in B + value in C - value in D  
 (F): Reverse Power = value in A + value in B + value in C + value in D  
 (G): Return Loss referenced to NADIF Feed = value in E - value in F  
 (H): Return Loss referenced to DC = (value in E + value in D) - (value in F - value in D)  
 (I): VSWR referenced to the NADIF Feed = value of G looked up in VSWR conversion table  
 (J): VSWR referenced to the DC = value of H looked up in VSWR conversion table

Mode S VSWR ratios also had been recorded from the interrogator KCRT for comparison to the measured values. This data can be seen in the last row of table 5.1.2-6. Internal interrogator performance monitoring produced the values at the KCRT, but these values are referenced to the top of the interrogator cabinet. Therefore, these values could only be compared to Mode S VSWR measurements made at the DC above the RF transfer switch, not measurements referenced to the antenna. When the appropriate VSWR comparisons were made between the last two rows of table 5.1.2-6, three of the four measured values agreed with the KCRT results. The fourth, Mode S Ch B omni VSWR, indicated a measured VSWR of 1.13:1, while the KCRT displayed 1.2:1. With a forward power of over 60 dB and a VSWR translating into a return loss of almost 24 dB, the KCRT reverse power was at such a low level that it was only 3 watts higher than the measured reverse power. This small difference did not necessitate making a change to the sensor power detector offsets.

In the configuration at Parker there was a stagger/destagger/quantizer unit that was separate from the CD-2. Beacon video was sent first to this unit, whose output provided the CD-2 with beacon data. No specification limits on pulse parameters input to the stagger/destagger/quantizer unit were available, so CD-2 specification limits were applied as a plausible set of parameters for this test. The limits are shown in the left-most column of tables 5.1.2-7 and 5.1.2-8. When compared to these limits, the rise and fall times of both system's quantized video pulses were too steep. All other parameters were within tolerances. Mode S log video pulse width was commensurate with ATCBI-3 receiver video pulse width, and did not exhibit any significant pulse stretching commonly affiliated with logarithmic detection.

Initial surveillance results indicated poor IBI sensitivity, caused by the excessive cable losses from the Mode S RF transfer switch to the antenna. The cabling and antenna configuration between a typical terminal Mode S sensor and this particular enroute Mode S at Parker were substantially different. The cabling configuration for Parker is shown in figure 5.1.2-3. The STC in the enroute configuration was expected to be higher than the terminal STC because of the higher gain antenna (29 dB for the NADIF at Parker), but the cable losses in the Sum path at Parker were considerably higher as well. The 1.71 dB loss from the transfer switch to the Mode S receiver input (1.73 dB for Ch B) added to the cabling loss up to the input to the antenna totals to 9.86 dB for Ch A and 9.88 dB for Ch B. Assuming a 1-dB rotary joint loss and 0.5-dB rotary joint to beam-former cable loss for both systems resulted in this enroute site having 8.36 dB (8.38 Ch B) of loss up to the input of the rotary joint. Terminal Mode S has typically 21 dB of antenna gain and 3 dB of loss to the rotary joint input. This suggests that the STC at Parker should only have had to increase 3 dB over nominal terminal settings (43-dB STC), when in fact

TABLE 5.1.2-7. ATCBI-3 VIDEO PERFORMANCE DATA

Measurement, nominal value (limits)	ATCBI-3 Ch 1			ATCBI-3 Ch 2		
	At 15 dB on the Power Attenuator	At 30 dB on the Power Attenuator	At 36-37 dB on the Power Attenuator	At 15 dB on the Power Attenuator	At 30 dB on the Power Attenuator	At 32-33 dB on the Power Attenuator
Receiver Video						
Amplitude	2.16 v	640 mv	152 mv	2.12 v	744 mv	576 mv
Rise Time, 100 ns (50 to 200 ns)	73 ns	70 ns	98 ns	98 ns	80.4 ns	70-80 ns
Fall Time, 200 ns (50 to 300 ns)	55.6 ns	92 ns	97 ns	57.6 ns	27.2 ns	126 ns
Pulse Width, 450 ns (50 ns to 2 μsec)	469 ns	460 ns	448 ns	492 ns	483 ns	481 ns
Baseline, 0.0 v (-1 v to +1 v)	-40 mv	-40 mv	20 mv	-50 mv	-60 mv	100 mv
Video Noise, +.5 v (0.0 to 1.0 v)	< .5 v	20 mv	20 mv	15 mv	20 mv	20 mv
Quantized Video						
Amplitude, 4.0 v (+1 v to +8 v)	2.56 v	2.5 v	2.44 v	2.66 v	2.68 v	2.68 v
Rise Time, 80 ns (50 ns to 200 ns)	30 ns	32.2 ns	40 ns	24.8 ns	5.6 ns	20.8 ns
Fall Time, 150 ns (50 ns to 300 ns)	26.4 ns	28.4 ns	55 ns	24.8 ns	25.6 ns	20 ns
Pulse Width, 450 ns (100 ns to 2 μsec)	488 ns	473 ns	253 ns	554 ns	547 ns	325 ns
Baseline, 0.0 v (-1 v to +1 v)	50 mv	50 mv	50 mv	75 mv	100 mv	75 mv
Video Noise, +.1 v (.2 v max)	< 1.0 mv	< 10 mv	10 mv	5 mv	10 mv	10 mv

Note: Test Pulse Characteristics:  
 Range = 100 nmi, 124 μsec  
 Input = -1.28 dBm top, -.83 dBm peak  
 Pulsewidth = 485 ns

TABLE 5.1.2-8. MODE S VIDEO PERFORMANCE DATA

Measurement, nominal value (limits)	Mode S Ch A			Mode S Ch B		
	At 15 dB on the Power Attenuator	At 30 dB on the Power Attenuator	At 35-36 dB on the Power Attenuator	At 15 dB on the Power Attenuator	At 30 dB on the Power Attenuator	At 36-37 dB on the Power Attenuator
Amplitude	1.52 v	1.12 v	.97 v	1.120 v	960	960 mv
Rise Time, 100 ns (50 to 200 ns)	124 ns	116 ns	116 ns	118 ns	112 ns	112 ns
Fall Time, 200 ns (50 to 300 ns)	212 ns	151 ns	147 ns	155 ns	151 ns	151 ns
Pulse Width, 450 ns (50 ns to 2 μsec)	472 ns	476 ns	484 ns	496 ns	476 ns	476 ns
Baseline, 0.0 v (-1 v to +1 v)	8 mv	12 mv	6 mv	10 mv	10 mv	10 mv
Video Noise, +.5 v (0.0 to 1.0 v)	56 mv	57 mv	57 mv	80 mv	82 mv	82 mv
Amplitude, 4.0 v (+1 v to +8 v)	1.84 v	1.84 v	1.8 v	1.84 v	1.84 v	1.84 v
Rise Time, 80 ns (50 ns to 200 ns)	6.4 ns	6.8 ns	6 ns	6.8 ns	7.2 ns	7.2 ns
Fall Time, 150 ns (50 ns to 300 ns)	34.4 ns	35.6 ns	34 ns	34 ns	36 ns	36 ns
Pulse Width, 450 ns (100 ns to 2 μsec)	559 ns	555 ns	496 ns	496 ns	372 ns	372 ns
Baseline, 0.0 v (-1 v to +1 v)	< 5 mv	2 mv	1 mv	1 mv	1 mv	1 mv
Video Noise, +.1 v (.2 v max)	1 mv	2 mv	1 mv	1 mv	1 mv	1 mv

Receiver Video

Quantized Video

Note: Test Pulse Characteristics:  
 Range = 100 nmi, 124 μsec  
 Input = -1.28 dBm top, -.83 dBm peak  
 Pulsewidth = 485 ns

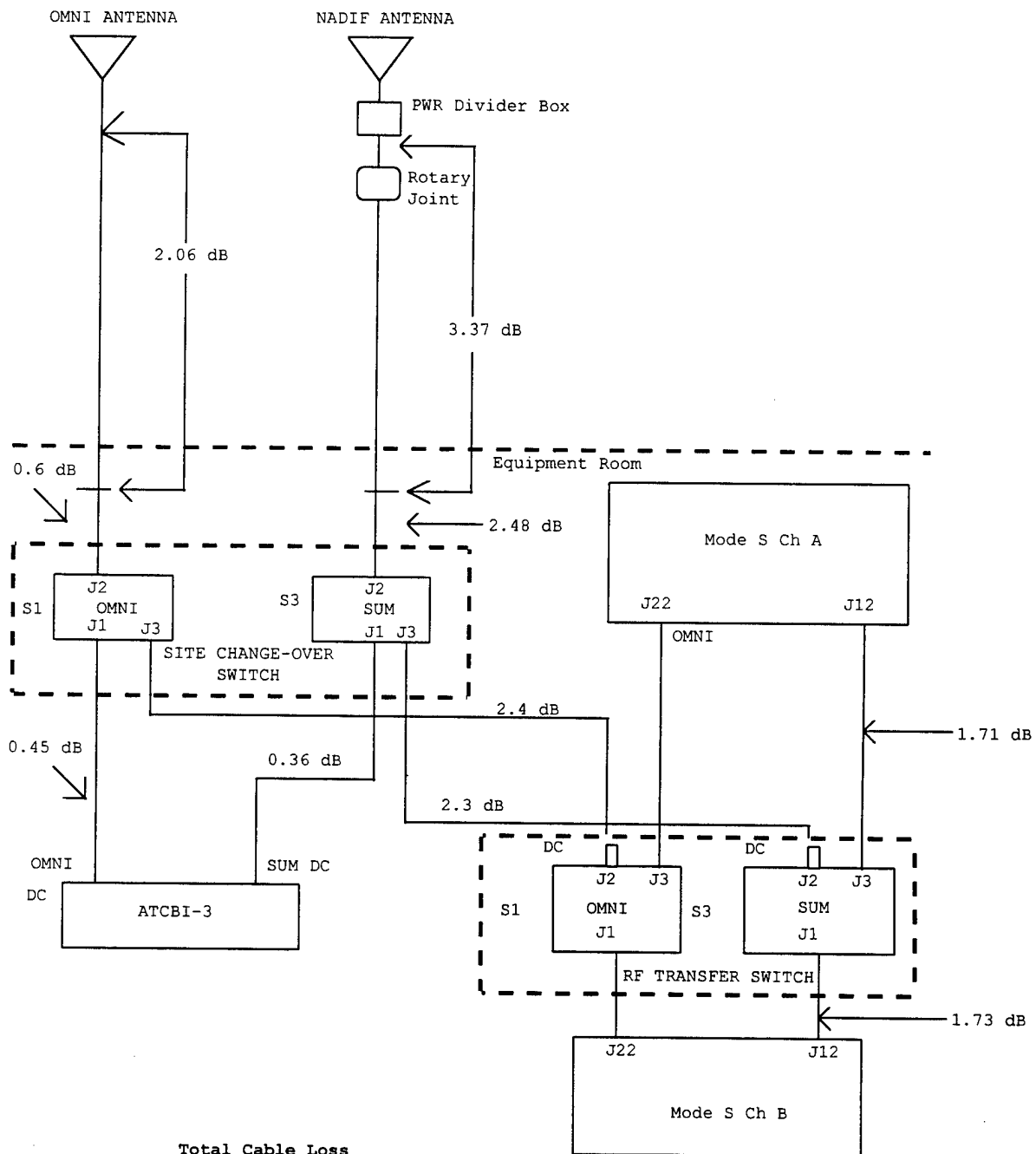


FIGURE 5.1.2-3. CABLING LOSS AT PARKER RADAR SITE

it had to be increased 5 dB (48-dB STC) to approximate that of the ATCBI-3. The Mode S had 1.94 dB more loss in the Sum path than the ATCBI-3. The Mode S also had additional loss from its RF transfer switch to the receiver input, equaling a total of 3.65 dB more loss in the Mode S path referenced to the receiver input. This loss tended to negate the differences between the systems' STC curves at the close-in ranges. At the far ranges, however, especially with the effect of the extra Mode S cable loss, the ATCBI-3 was significantly more sensitive. To remedy this, the Mode S sensor's Aux fixed threshold SAP was lowered 1.5 dB from its default value of -79 dBm to -80.5 dBm. This provided a sensitivity of -84 dBm for IBI Ch A and -85 dBm for Ch B at the 200-nmi limit referenced to the receiver input.

The IBI STC value was varied to ensure that it was not set too low. Data for individual runs made with STC values of 48.5 and 49 dB are available in appendix B. Surveillance performance at the optimized STC curve reference of 48 dB was better than at STC values of 48.5 and 49. At 48 dB, the false target and ID 0000 rates were lower, and the POD, reliabilities and validities were greater.

The very narrow azimuth angle of the NADIF antenna caused sharp rolloffs at the beam edges, which resulted in missed replies when the STC was set higher. The underside of the antenna beam below the 3 dB point exhibited a sharp rolloff as well. Targets that typically show up in this low part of the beam, general aviation aircraft or beacon parrots and CPMEs, had their run lengths increase when the STC was lowered back to 48 dB. The lower STC, however, had the misleading effect of lowering the radar reinforcement percentage. This was not a fault of the beacon. The Parker ARSR-1E radar was not detecting close range, low altitude targets as well as the Mode S was detecting them.

IBI sum and omni transmit powers were varied to try to produce the best detection, lowest code 0000 percentage, and smallest false target rates. When the omni power was lowered 400 to 300 watts at the antenna feed, beacon detection, code and ID reliabilities and validities, and code 0000 percentages improved while not causing an increase in ringaround or other false targets. Hence, the final IBI optimized parameters were determined to be:

Transmit power into antenna	sum -	100 watts
	omni -	300 watts
STC curve reference		48 dB
Aux fixed threshold		-80.5 dBm
Aux POD offset		36 Ch A, 37 Ch B

IBI surveillance performance at these optimized transmit power and receive sensitivity levels met or exceeded that of the ATCBI-3. Table 5.1.2-9 shows a comparison of optimized IBI surveillance statistics versus the average of seven ATCBI-3 Ch 2 baseline runs. IBI exhibited

TABLE 5.1.2-9. PHASE 1 IBI/ATCBI-3 SURVEILLANCE PERFORMANCE COMPARISON

Recording Parameters	Beacon Source		IBI Ch A	IBI Ch A (low 1 dB)	ATCBI-3 Ch 2				
	Directional/Omni Power into Antenna		100/300 w 50/54.77 dBm	79.4/238.3 w 49/53.77 dBm	100/400 w 50/56 dBm				
	STC Value		48 dB	48 dB	46 dB				
	Data Reduction Filtering: BFTS - Filtered codes assigned to multiple aircraft. SA - Filtered CPMEs & Parrot		filtered	filtered	filtered				
Beacon False Target Summary (BFTS)									
Note: Goal is <u>not</u> pass/fail			>Goal<						
(BFTS) Beacon False Target Summary	Total Number of Discrete Code Target Reports			34,849	26,667	738,770			
	False Target Report %		< 1.5	0.07	0.10	.186			
	Split %		< 0.5	0.05	0.03	.067			
	Ringaround %		< 0.2	0.01	0.05	.051			
	Downlink Reflection %		< 0.2	0.00	0.00	.003			
	PRF Interference %		< 0.2	0.01	0.00	.009			
	Uplink Reflection %		< 0.2	0.00	0.01	.014			
	Other %		< 0.2	0.00	0.01	.042			
	ATCRBS ID 0000 Report %		< 0.5	.23	.4	.531			
Surveillance Analysis (SA)									
(SA) Surveillance Analysis	Percent Detection Beacon %		> 97	98.87	98.20	98.798			
	Percent Detection Search %		> 70	78.13	71.87	77.876			
	Percent Detection Total (%)		> 97	99.52	99.26	99.423			
	Identity Reliability (%)		> 95	99.71	99.41	98.952			
	Identity Validity (%)		> 95	99.31	98.52	98.019			
	Altitude Reliability (%)		> 95	99.78	99.55	99.174			
	Altitude Validity (%)		> 95	99.33	98.53	98.143			
	Run Length		> 29	30.5	29.7	31.11			
	Radar Reinforcement (%)		> 70	78.34	72.07	78.112			
	Search Collimation (%)		> 95	99.97	99.94	99.959			
	Range Error (nmi)		< 0.2	0.073	0.077	.076			
	Azimuth Error (deg)		< 0.35	0.173	0.191	.231			
	Number of Tracks in Statistics			356	353	6263			
Permanent Echo Accuracy									
(PE) Permanent Echo	CPME Mode 3/A Code			1273	1274	1273	1274		
	Single Rpt. ATCRBS Update %		> 97	100	99.7	99.667	99.668	99.71	99.687
	Range Error Mean (nmi)		< 0.13	0.012	0.002	0.012	0.01	.012	.001
	Range Error Std-Dev (nmi)		±0.13	0.00	0.010	0.00	0.000	.00	.001
	Azimuth Error Mean (deg)		< 0.2	0.007	0.074	-0.002	0.070	.032	.094
	Azimuth Error Std-Dev (deg)		±0.2	0.061	0.060	0.055	0.065	.061	.064

Note: The ATCBI-3 data in this table is an average of 7 ATCBI-3 Ch 2 data files.

higher beacon percent detection (Pd), ID reliability and validity, and altitude reliability and validity. Beacon Pd was in the high 98th percentile, and reliabilities and validities are in the 99th percentile. IBI had a lower false target percentage and a significantly lower ID 0000 percentage than the ATCBI-3. IBI exhibited run lengths, search collimation, and radar reinforcement comparable to that of the ATCBI-3. Beyond 130 nmi in range, IBI surveillance performance was still comparable. Inside 40 nmi IBI significantly outperformed the ATCBI-3 by having a lower false target percentage, no ringaround, and fewer ID 0000s. IBI detection of nondiscretes at all ranges also appeared comparable. This was important, since Parker surveillance data is used to provide quality CENRAP coverage to the Denver Terminal Radar Approach Control (TRACON) (i.e., detection of low altitude, close range Visual Flight Rules (VFR) aircraft). When the transmit power was lowered 1 dB in anticipation of the flight check, the surveillance performance decreased. The beacon Pd decreased almost 1 percent, while the ID and altitude validities fell below 99 percent. These results were still deemed sufficiently adequate to ensure a successful flight check.

### 5.1.3 Analysis.

Measuring ATCBI-3 STC values at RF as called out in ATCBI-3 maintenance certification procedures did not make sense for this OT&E. Mode S maintenance certification and OT&E procedures called for the STC measurement to be made on quantized pulses, which provided a more accurate representation of detection. The ATCBI-3 STC procedure was performed a second time with quantized pulses, to provide a common baseline for matching up the IBI STC curve.

Regardless of which technique was employed for ATCBI-3 STC measurement (detection at RF or at the quantized level), the overall STC range fell short of the certification requirement of 50 dB. The ATCBI-3 STC curve could not be expanded, because the system lacked the gain to achieve the minimum discernible signal (MDS) required. The ATCBI-3 STC curve was not optimal at the far ranges also because of this reduced system gain. This had little bearing on the IBI optimization effort, however, the purpose of which was to best approximate the ATCBI-3's STC performance as currently commissioned.

The IBI STC curve could not be optimized to closely approximate the ATCBI-3 STC curve, because the ATCBI-3 curve rolled off at a steeper rate. If the IBI curve was set to match the ATCBI-3 at the top end, then there would not be enough sensitivity at the low end. If the curve was set to match the low end, then there would not be enough thresholding at the top end to eliminate false targets. A reasonable engineering compromise was to split the difference halfway, with the IBI STC curve a little lower at the top and a little higher at the bottom.

The OSS curves for the ATCBI-3 and Mode S IBI systems closely approximated each system's respective STC curve. This proved that the power threshold for reply (target) detection versus range was very similar to the threshold for pulse detection. This conclusion provided assurance that further optimizing the STC and fixed thresholds would have a commensurate effect on target detection.

Measurements performed under the two Peak Power Meter modes of operation (Top mode and Peak mode) produced congruent results for the transmit power optimization. Top mode can be superior to Peak mode in some instances, since it filters large variations such as spikes or overshoot, provided they occur infrequently. In most cases with Mode S power, the differences were slight because the pulses were reasonably flat.

The higher Mode S VSWR translated into reduced effective directional and omni output power, but the directional decrease of only several watts had little impact on beacon coverage. An effective omni transmit power reduced 25 watts by the reflected power at the antenna feed may have had an impact on SLS. However, this operating parameter was likely to be further optimized once IBI surveillance performance characteristics were determined. Thus, it was not necessary to readjust IBI omni power at this time. The discrepancy in VSWR between the two systems was likely caused by the additional RG-214 cable loss from the Mode S DC to the site change-over switch.

The quality of beacon video pulses sent to the CD-2 was adequate for both the ATCBI-3 and Mode S systems. The pulse rise and fall times were too steep for specifications, but this type of discrepancy was not likely to cause processing problems at the CD-2. Excessive pulse stretching of Mode S video pulses was not observed, because an interrogator hardware change had already been implemented to correct the problem. On each interrogator Video Processor Monitor board, the log sigma signal had been strapped to the input of the 6-dB threshold generator of the Aux video path. Log sigma filter characteristics tend to minimize pulse stretching, as opposed to the log Aux filters. This wire strapping change has been implemented in all Mode S sensors, after the problem was first identified in Terminal IBI OT&E. In concert with the 6-dB threshold applied in Aux log detection, the pulse width measurement had been made at half the peak voltage of the waveform. This equates to 1/4 of the pulse power, or 6 dB down.

Further optimization of the transmit power and receive sensitivity parameters was necessary to achieve optimal IBI surveillance performance. The Aux fixed threshold was lowered 1.5 dB from its default setting to improve receive sensitivity. This was necessary to compensate for the significantly higher (about 3.65 dB) line losses from the Mode S receiver to the antenna feed. Even with the fixed threshold decreased, the Mode S did not achieve the specification required sensitivity of -79 dBm at the rotary joint. In comparison,

the ATCBI-3 achieved -79 dBm sensitivity at the rotary joint at approximately 80 nmi.

The fixed threshold of -80.5 dBm could probably have been dropped several more dB to improve sensitivity at the far ranges, and attain the required sensitivity at the rotary joint. Calculations showed that the received level for a transponder at 200 nmi would be -65 dBm nominal at the receiver input. Mode S STC at 200 nmi was -84 dBm worse case. The power calculation assumed maximum gain at the NADIF. On the horizon where aircraft at the furthest ranges would likely be, the gain is 6 dB lower. The received signal strength would be -71 dBm, leaving a gain margin of 13 dB. Dropping the fixed threshold 6 dB would therefore have provided three advantages. It would have overcome some of the line loss. Secondly, it would have made up for lost gain on the horizon. Thirdly, it would have brought the STC curves for the ATCBI-3 and Mode S systems closer together at the far ranges.

Lowering the IBI fixed threshold, these six additional dBs were not attempted due to a general reluctance to deviate too far from the default fixed threshold of -79 dBm. Moreover, the Mode S cable loss problem would likely be alleviated to some extent when the Mode S became reconfigured for permanent ATC operations. At the time of Mode S commissioning, the site change-over switch was scheduled for removal, eliminating at least 2.3 dB loss from the Mode S path to the antenna.

Even without the additional 6-dB reduction in IBI fixed threshold, the optimized IBI parameters resulted in surveillance performance which met the phase 1 test objectives. IBI surveillance and false target statistics met or surpassed those of the certified ATCBI-3.

## 5.2 PHASE 2 SURVEILLANCE PERFORMANCE.

### 5.2.1 Test Description.

The Mode S sensor at Parker, Colorado, was operating in IBI and connected to a CD-2. RTADS data was collected on the RIT, which received beacon reports output from the CD-2 junction box. Eleven Mode S IBI mode data files were recorded during the period of December 1 through December 6, 1994.

The original test criteria for phase 2 called for ATCBI-3 data collections to be made in close time proximity with IBI data extractions. However, Parker radar site personnel made an agreement with the Denver ARTCC not to switch back and forth between beacon systems, while the Mode S was operating in an IOC state. Each morning during the week of phase 2 execution, the Parker radar supervisor switched the Mode S to the antenna in the morning, then switched back to the ATCBI-3 when the radar site was closed at night. Hence, test

personnel were unable to capture any ATCBI-3 runs during this IOC period.

RBAT BFTS, Permanent Echo Accuracy, and SA programs were used to reduce the RTADS data. False target listings were generated from BFTS reports, so that each false target could be examined. False targets were tracked using the playback feature of the RTADS program, filtering on individual 3/A codes and displaying a continuous target history. A determination was made whether each false target was really a 3/A code-in-transition, or two distinct aircraft assigned the same 3/A code. This was frequently found to be the case with false targets classified in the "Other" category. The duplicate 3/A codes were then filtered out of the Beacon False Target program and new totals were calculated.

#### 5.2.2 Test Results.

SA test results indicated favorable Mode S IBI performance. Beacon Pd, ID reliabilities and validities, and altitude reliabilities and validities averaged in the 98th and 99th percentile for IBI. Run lengths averaged between 30 and 31, typical of enroute beacon systems. Only one IBI surveillance parameter failed to meet the goal. The radar reinforcement rate for IBI Ch A was suspiciously low, averaging below 70 percent.

False target results for the Mode S were good. Once duplicate targets were filtered out (i.e., two aircraft assigned the same 3/A code), false targets in the "Other" category fell sharply. Average percentages were within acceptable limits for all false target categories except the ATCRBS code 0000 percentage for IBI Ch B.

Permanent echo accuracy results showed IBI range and azimuth jitters comparable to those of the ATCBI-3. This result was expected, since the great benefit of Mode S azimuth accuracy (monopulse) is not available in IBI mode.

Table 5.2.2-1 contains the averages of statistics for IBI Ch A and Ch B, and ATCBI-3 Ch 2. Statistics for each individual IBI run, filtered and unfiltered, are located in appendix B. The ATCBI-3 data runs were collected during the time period of phase 1 testing. The statistics of each ATCBI-3 run are also located in appendix B.

TABLE 5.2.2-1. PHASE 2 IBI/ATCBI-3 SURVEILLANCE PERFORMANCE COMPARISON

Recording Parameters	Beacon Source	IBI Ch A	IBI Ch B	ATCBI-3 Ch 2				
	Directional/Omni Power into Antenna	100/300 w 50/54.77 dBm	100/300 w 50/54.77 dBm	100/400 w 50/56 dBm				
	STC Value	48 dB	48 dB	46 dB				
	Data Reduction Filtering: BFTS - Filtered codes assigned to multiple aircraft. SA - Filtered CPMEs & Parrot	filtered	filtered	filtered				
<b>Beacon False Target Summary (BFTS)</b>								
Note: Goal is <u>not</u> pass/fail		>Goal<						
(BFTS) Beacon False Target Summary	Total Number of Discrete Code Target Reports		561,506	95,110	738,770			
	False Target Report %	< 1.5	.40	.34	.186			
	Split %	< 0.5	.308	.147	.067			
	Ringaround %	< 0.2	.05	.13	.051			
	Downlink Reflection %	< 0.2	.00	.005	.003			
	PRF Interference %	< 0.2	.011	.01	.009			
	Uplink Reflection %	< 0.2	.012	.01	.014			
	Other %	< 0.2	.024	.052	.042			
ATCRBS ID 0000 Report %	< 0.5	.454	.57	.531				
<b>Surveillance Analysis (SA)</b>								
(SA) Surveillance Analysis	Percent Detection Beacon %	> 97	98.502	98.50	98.798			
	Percent Detection Search %	> 70	65.645	72.027	77.876			
	Percent Detection Total (%)	> 97	99.197	99.281	99.423			
	Identity Reliability (%)	> 95	99.362	99.185	98.952			
	Identity Validity (%)	> 95	98.498	98.103	98.019			
	Altitude Reliability (%)	> 95	99.417	99.33	99.174			
	Altitude Validity (%)	> 95	98.603	98.23	98.143			
	Run Length	> 29	30.55	30.8	31.11			
	Radar Reinforcement (%)	> 70	65.568	72.417	78.112			
	Search Collimation (%)	> 95	99.973	99.98	99.959			
	Range Error (nmi)	< 0.2	.077	.077	.076			
	Azimuth Error (deg)	< 0.35	.209	.209	.231			
Number of Tracks in Statistics		5751	1164	6263				
<b>Permanent Echo Accuracy</b>								
(PE) Permanent Echo	CPME Mode 3/A Code		1273	1274	1273	1274	1273	1274
	Single Rpt. ATCRBS Update %	> 97	99.097	99.445	99.585	99.863	99.71	99.687
	Range Error Mean (nmi)	< 0.13	.012	.001	.012	.001	.012	.001
	Range Error Std-Dev (nmi)	±0.13	.00	.001	.00	.00	.00	.001
	Azimuth Error Mean (deg)	< 0.2	.02	.065	.024	.079	.032	.094
Azimuth Error Std-Dev (deg)	±0.2	.067	.065	.054	.06	.061	.064	

Note: The data in this table is the average of statistics from the following: 9 IBI Ch A data files, 2 IBI Ch B data files, and 7 ATCBI-3 Ch 2 data files.

### 5.2.3 Analysis.

Radar reinforcement averaged in the low seventies for IBI Ch B. It averaged in the middle sixties for IBI Ch A, because the ARSR-1E was operating without its amplifitron on one of the extraction days (December 4, 1994). Thus, it could not detect targets further out in range. The radar reinforcement percentages for the two IBI Ch A runs on December 4, 1994, were 42.69 percent and 46.49 percent, respectively. When these runs were filtered out of IBI Ch A data, the radar reinforcement rises to 71.54 percent, more commensurate to the radar reinforcement on IBI Ch B. The ATCBI-3 exhibited a higher average radar reinforcement (78.1 percent). This may have been due to the Mode S detecting more lower power, fringe targets than the ATCBI-3, or because of environmental differences during collection time. The ATCBI-3 data was collected over 2 months prior to the IBI data. The fringe targets were also undetected by the ARSR-1E, causing the Mode S radar reinforcement percentage to be lower.

The code 0000 percentage for IBI Ch B averaged .57 percent. This average was inflated by a high code 0000 count from the December 1, 1994, p.m. data run. RTADS playback revealed numerous conflict targets in the 0 to 60 nmi range, whose codes were garbling and creating the code 0000 reports.

The overall IBI false target percentage was higher than that of the ATCBI-3, attributable to a fairly high split percentage. The December 3, 1994, p.m. run and the December 4, 1994, p.m. run contributed heavily to this average. When these runs were filtered, the average split percentage drops impressively down to 0.12 percent. It was determined that there was heavy traffic in the 0 to 60 nmi range during the December 2, 1994, and December 3, 1994, p.m. recording periods. In this range, the Mode S STC curve was more sensitive than that of the ATCBI-3. This was implemented as a tradeoff to allow the Mode S curve to still be sensitive enough further out in range. With the STC curve lower, the Mode S tended to process more side-lobe replies. Hence, it was more susceptible than the ATCBI-3 in producing split targets.

## 5.3 PHASE 3 MAINTENANCE AND OPERATIONAL EVALUATION.

### 5.3.1 Test Description.

The phase 3 Maintenance and Operational Evaluation consisted of eight scripts executed at the Parker radar site and the Denver ARTCC. The test was conducted at four manned monitoring positions. Three were located at the Parker site: the Mode S LT and RTADS, the MSIMC, and the CD-2. The fourth position was the Mode S RT located in the System Maintenance Monitoring and Control (SMMC) position at the Denver Center. The eight scripts were run in order. A four-way telephone link between positions was established to execute the tests. The test

coordinator, located at the LT and RTADS, established timing marks for execution of test events. After each test event, personnel at the four positions monitored Mode S and CD-2 system status, alarms, and target loss, recording results in the data blanks for that position. At the completion of the eight scripts, master data sheets were compiled from the four positions' data.

Script #1 Mode S Channel Switches manually switched Mode S channels controlled from the LT, MSIMC, and RT. Times for the channel switch to appear on the terminals, target loss, and effect on the CD-2 were recorded.

Script #2 CD-2 Channel Switches manually switched CD-2 channels with Mode S Ch A on-line, then Mode S Ch B on-line. Effects on Mode S system status, target loss, and any CD-2 faults were recorded.

Script #3 Mode S Onsite Maintenance simulated a Mode S onsite maintenance action after a yellow status fault occurred on the on-line channel. After the fault occurred, a manual channel switch to the green standby Mode S channel was executed from the RT. Then the faulted channel was powered off for simulated maintenance. The channel was then powered on and restored to service. The test was repeated for a red status fault occurring on the on-line Mode S channel. Target loss and effects on CD-2 operation were recorded.

Script #4 CD-2 Maintenance simulated a fault occurring on the on-line CD-2 channel causing an automatic switch to the standby channel. The faulted CD-2 module was powered off, and then back on after a simulated maintenance period. This test was repeated with each Mode S channel on-line. Effects on Mode S system status and target loss were recorded.

Script #5 Mode S Remote Maintenance simulated a Mode S maintenance action at the MSIMC after the occurrence of a red status fault on the on-line channel. After the fault was received, a manual channel switch to the green standby Mode S channel was executed from the RT. Sensor control was then relinquished to the MSIMC. A Mode S channel initialization was performed at the MSIMC to clear the fault and return the channel to service. Target loss and effects on CD-2 system status were recorded.

In Script #6 SMMC Maintenance for the CD-2, the standby CD-2 channel was reset with each Mode S channel on-line. Target loss and effects on Mode S system status were recorded.

Script #7 Mode S Cold Starts required a switch to ATCBI-3 operation, so that the Mode S system could be powered off. The antenna, beacon video, and mode triggers were switched to the ATCBI-3. An ATCBI-3 channel was on-line and transmitting. Both Mode S channels were then powered off, and left to cool for 10 minutes. The antenna, video, and

triggers were then switched back to the Mode S. Service from Mode S Ch A was restored by powering up first the interrogator, then the DPS. The other Mode S channel was later powered on. Special attention was paid in recording Mode S and CD-2 system states during this cold start.

Script #8 Mode S/CD-2 Short Power Failures enacted 5-second short power failures on the Mode S only, CD-2 only, and both the Mode S and CD-2 simultaneously. Target loss durations were carefully recorded. Times to return to proper system status on both the Mode S and CD-2 were also observed.

### 5.3.2 Test Results.

A quick reference guide to the test results of this section is provided in table 5.3.2-1, Phase 3 Maintenance Script Summaries.

In Script #1 Mode S Channel Switches, manual Mode S channel switches generally caused minimal target loss on the RTADS and CD-2, and had no effect on the Random Access Plan Position Indicator (RAPPI) at the ARTCC. There was, however, excessive target loss (ranging from 1/3 to 3/4 scans) observed on the site RTADS and CD-2 for two out of four manual channel switches from Ch B to Ch A. The channel switches did intermittently cause CD-2 beacon range alarms, which put both CD-2 channels' Beacon Target Extractor (BTE) and Channel (CHAN) indicators into fault. The excessive target loss could not be definitively linked to the occurrence of CD-2 beacon range alarms, however, as the target loss also occurred when the beacon range alarms were not present. The Parker radar supervisor advised that beacon range alarms on the CD-2 are commonly experienced when switching ATCBI-3 beacon channels, and seem to be caused by a momentary interruption of beacon mode triggers to the CD-2. Thus, beacon range alarms do not appear to be an anomaly uniquely caused by the Mode S.

After a Mode S channel switch, the new on-line channel stayed yellow for up to 3 minutes before turning green, because the channel was waiting for the omni VSWR to be measured. The fact that the omni VSWR took significantly longer to be measured in an enroute Mode S configuration than in a terminal configuration was a function of the slower scan rate at the enroute site.

In Script #2 CD-2 Channel Switches, manual CD-2 channel switches caused no target loss on the RAPPI at the ARTCC, or on the site RTADS or CD-2 displays. Switching CD-2 channels caused absolutely no effect on Mode S system status, nor did it cause any CD-2 faults.

Script #3 Modes Onsite Maintenance successfully demonstrated that when a yellow or red fault occurred on the on-line channel, a channel switch to the green standby channel can be executed from the RT with a

TABLE 5.3.2-1. PHASE 3 MAINTENANCE SCRIPT SUMMARIES

Script #	Description	Results	Anomalies
1	Mode S Manual Channel Switches	Minimal target loss was observed on the RTADS and CD-2 for most switches. No effect was seen on the RAPPI at the ARTCC.	Excessive target loss (ranging from 1/3 to 3/4 scans) resulted for two out of four channel switches from Ch B to Ch A.
2	CD-2 Manual Channel Switches	There was no effect on Mode S system status. No target loss was observed at any test position.	None.
3	Mode S Onsite Maintenance	Minimal interruption of service occurred. No target loss was observed when switching to standby channel.	Excessive time (up to 2 minutes) was required for a newly on-line Mode S channel to turn green.
4	CD-2 Maintenance	Automatic CD-2 channel switches had no effect on Mode S system status, and caused only a slight target loss on the RTADS.	None.
5	Mode S Remote Maintenance	A system initialization of a red Mode S channel was performed from the MSIMC with no interruption of beacon service.	An RT statusing anomaly occurred, in which a faulted red Mode S channel turned yellow for 30 seconds before turning red again.
6	SMMC Maintenance for the CD-2	A reset of the standby CD-2 channel had no effect on Mode S operation.	None.
7	Mode S Cold Starts	The Mode S system was successfully powered up one cabinet at a time.	Excessive 2 1/2 scan target loss resulted when a DPS cabinet was powered on, while the other Mode S channel was still powered off.
8	Mode S/CD-2 Short Power Failures	For a Mode S power failure, targets were lost only for the time that the power was actually off (5 seconds). The CD-2 power failure caused a 55-second target loss, the duration of a normal CD-2 reset.	None.

minimal interruption of service. In fact, no target loss was observed in switching to the standby channel during this test. When the faulted channel was powered off for simulated maintenance, and then powered back on minutes later, the channel returned standby green inside 2 minutes and did not adversely impact the on-line channel.

The only target loss experienced during this script (1/8 to 1/4 scans on the site RTADS and CD-2) was caused by one out of two temporary SAP installations that were performed in order to intentionally induce the yellow and red sensor faults. This SAP installation occurred concurrently with a CD-2 beacon range alarm, which likely contributed to the target loss. When the actual yellow and red faults were detected by sensor fault detection testing, no target loss resulted as the sensor status changed.

Faulting the on-line CD-2 channel in Script #4, CD-2 Maintenance resulted in an automatic CD-2 channel switch. This caused only a slight loss of beacon data on the RTADS (approximately 1/32 of a scan), and had no effect on Mode S system status. No target loss was observed on the RAPPI at the ARTCC.

Script #5 Mode S Remote Maintenance successfully demonstrated that when a red fault occurred on the on-line channel, a channel switch to the green standby channel could be executed from the RT. Then a system initialization of the red channel was performed from the MSIMC with no interruption of beacon service.

One RT status anomaly was observed during this script. When the RT switched to the standby channel, the faulted red channel turned yellow for 30 seconds before turning red again. In reality, the status of the faulted channel had not been upgraded to yellow. The incorrect channel status indication occurred because the RT requires two consecutive status updates after a channel switch to correctly update channel status. The SEs at the ARTCC did not believe that this would pose a problem operationally.

As experienced in Script #1, target loss from a Mode S channel switch from Ch B to Ch A was again excessive (1/3 to 3/4 scans). The 3/4 of a scan loss was observed on the ARTCC RAPPI, which represented the first target loss seen at the ARTCC during execution of these scripts. No target loss resulted from the remote maintenance action, however.

During Script #6 SMMC Maintenance for the CD-2, the Remote Control Interface Unit (RCIU) located in the SMMC position at the ARTCC was used to reset the standby CD-2 channel as a simulated maintenance action. This had no effect on Mode S operation, and caused no target loss.

Script #7 Mode S Cold Starts demonstrated the Mode S system states and target losses that result when the Mode S is powered up one cabinet at

a time. To execute the test, first the site was switched to ATCBI-3 operation. The ATCBI-3 transmitter was turned on; the site changeover switch was switched to the ATCBI-3; and the video/trigger switch was switched to the ATCBI-3. These transitions of switching to the ATCBI-3 were executed as close to simultaneously as possible, and no beacon target loss was observed. All four Mode S cabinets were then powered off and left to cool for 10 minutes. A switch was then made back to the Mode S, and the interrogator that had the transfer switch was powered up. About 1/3 scan target loss was witnessed on the RTADS and CD-2. This is attributable partly to fire-up time for the interrogator, and partly to a human delay in the time between switching the antenna to the Mode S and powering up the interrogator.

With one interrogator now on-line, the DPS cabinet for the on-line channel was now powered up. This brought an unexpected result. Almost 2 minutes after the DPS was powered on, beacon targets were lost for 2 1/2 scans at the RTADS, CD-2, and RAPPI. The timing of the target loss coincided with the time the sensor normally experiences reset. However, the duration of the target loss was excessive, apparently caused by the DPS looking for the other channel's DPS which was still powered off. Further research revealed that this is a known system problem for IBI mode sensors, existing at over 30 commissioned IBI terminal sites.

Meanwhile, the powered-off channel's status was falsely reported as yellow standby for almost 4 minutes before returning off-line red. The newly powered on Mode S channel was reported to be standby instead of on-line, because the channel-to-channel link was still down with the other powered-off channel. Therefore, the RT had to switch to the standby channel in order to force it to update itself to an on-line status. When this occurred, the powered-off channel again falsely reported its status to be standby yellow for over 2 1/2 minutes before returning off-line red.

To complete the cold start script, the powered-off channel was powered on with the alternate channel on-line. There was no change in the on-line channel's status, and there was no target loss.

In Script #8 Mode S/CD-2 Short Power Failures, the Mode S and CD-2 systems were subjected to 5-second short power failures, individually and together. Power was cycled on the main breaker of the Mode S power distribution panel and on the main power switch atop the CD-2 cabinet. During the power failure of just the Mode S system, with either Mode S Ch A or Mode S Ch B on-line, the system resumed proper operation immediately and experienced no alarms. Targets were lost for one-half scan, the duration the sensor was actually powered off. Additional loss of targets caused by a DPS reset (due to the power cycling) was almost negligible.

When power was cycled on the CD-2 only, targets were lost for 55 seconds, the normal time for a CD-2 reset. This had no effect on the Mode S system. When power was cycled on both the Mode S and CD-2, targets were again lost for 55 seconds. Thus, the Mode S interfacing to the CD-2 introduced no additional target loss during a short power fail of both systems.

### 5.3.3 Analysis.

The excessive target losses (ranging from 1/3 to 3/4 of a scan) caused occasionally by Mode S channel switches from Ch B to Ch A did not pose a problem operationally, because these losses were seldom observed on the RAPPI at the Denver ARTCC. Moreover, the mosaic of beacon coverage provided by the Host tends to mask any target losses less than several scans.

The excessive time (up to 2 minutes) required for a newly on-line Mode S channel to transition from yellow to green has been addressed in an enroute Program Technical Report (PTR) submitted against Mode S software. A proposed solution to this discrepancy is to compute the omni VSWR as soon as the forward power and reverse power readings are available. This solution will be implemented in a future version of Mode S software.

The RT statusing anomaly observed in Script #5 posed no operational inconvenience. After a manual Mode S channel switch to a standby channel, the faulted red channel was improperly displayed as yellow for 30 seconds before turning red again. This was caused by the RT requiring two consecutive status updates to show proper status. This problem will be alleviated by a new version of RT software, in which the color of the channel mode does not reflect status (i.e., on-line is always green; standby is always yellow; off-line is always red, etc.).

The 2 1/2 scan target loss experienced during Script #7 Mode S Cold Starts was a concern to AF personnel. Powering on a DPS cabinet while the other sensor channel still powered off apparently reset the on-line interrogator, causing an outage for about 25 seconds. The duration of the reset was prolonged because the newly powered on DPS was searching for its partner DPS which was still powered off. Further investigation of this anomaly revealed that this is a known system problem for IBI mode sensors, existing at over 30 commissioned IBI terminal sites. A new PTR has been issued to further document the problem.

After execution of the eight Maintenance Scripts, the only user concern from SEs at the ARTCC focused on a control point issue with the RT. The SEs would like sensor control to be automatically passed to the RT upon request and a timeout (no response) at the LT. The SEs were concerned that if the radar site was unmanned and the LT still

had control, the RT could not gain control of the sensor to switch to the standby channel in the case of an on-line channel failure. In this situation, a site outage would have to be taken. An enroute PTR has been written to address this issue.

During the 2-day timeframe that phase 3 Maintenance Scripts were being executed at the Parker radar site, the Mode S sensor was the beacon system providing data to ATC at the Denver ARTCC. Careful coordination was done between the test team and AT to ensure that the execution of certain scripts (e.g., Script #8 Mode S/CD-2 Short Power Failures) were timed to have minimal impact on AT operations. Air traffic controllers monitoring airspace covered by the Parker radar facility experienced no difficulties or abnormalities in utilizing Mode S beacon data.

## 6. CONCLUSIONS.

Phase 1 of this Mode Select Beacon System (Mode S) Interim Beacon Initiative (IBI) enroute Operational Test and Evaluation (OT&E) demonstrated that Mode S IBI performance for enroute operations was superior to that of the Air Traffic Control Beacon Interrogator (ATCBI)-3.

The phase 1 test effort optimized Sensitivity Timing Control (STC) on both Mode S IBI channels to best approximate the detection versus range performance of the ATCBI-3. This resulted in an Overall System Sensitivity (OSS) of the Mode S which was slightly more sensitive than the ATCBI-3 at target ranges closer than 64 nautical miles (nmi), and slightly less sensitive at ranges beyond 64 nmi. The Mode S optimized transmit power was the same value as the ATCBI-3 in the directional channel (100 watts into the antenna). However, surveillance statistics suggested that 300 watts Mode S omnidirectional (omni) channel power (into the antenna) provided adequate Side-Lobe Suppression (SLS) and fewer Identity (ID) code 0000 reports. The ATCBI-3 omni power had been operating at approximately 400 watts into the antenna.

Despite these operating differences, the Mode S provided superior surveillance coverage. Phase 1 results indicated that IBI outperformed the ATCBI-3 in surveillance performance categories such as Beacon Probability of Detection (POD), ID reliability and validity, and altitude reliability and validity. IBI exhibited run lengths, search collimation, and radar reinforcement comparable to that of the ATCBI-3. For beacon targets inside 40 nmi, IBI significantly outperformed the ATCBI-3 by having a lower false target percentage, little or no ringaround, and fewer ID 0000s. IBI's detection of nondiscrete targets at all ranges was comparable to that of the ATCBI-3.

OT&E phase 2 results showed that successful IBI surveillance performance was maintained after completion of the flight check. Beacon Percent Detection (Pd), ID and altitude reliabilities, and ID and altitude validities averaged in the 98th and 99th percentiles over the 11 data collections. False target and 3/A code 0000 results also proved favorable. Due to the urgency to commission the Mode S in IBI mode at Parker, a full slate of matching ATCBI-3 data collections could not be attained during this phase, as originally planned. However, comparison of phase 2 IBI data to ATCBI-3 data obtained during the phase 1 Exit Criteria stage indicated that IBI maintained superior performance.

Phase 3 of this OT&E demonstrated a successful user interface in the performance of maintenance functions on the Mode S and Common Digitizer (CD)-2 systems. The test also demonstrated that the Mode S interfacing with the CD-2 can effectively handle short power failures without experiencing system errors and without unreasonable target loss.

Airway Facilities (AF) personnel at the Parker radar site and System Engineers (SE) at the Denver Air Route Traffic Control Center (ARTCC) were very pleased with the user friendliness that the Mode S system in IBI mode demonstrated throughout this testing. The only user concern from SEs at the ARTCC focused on the control point issue with the Remote Terminal (RT). The SEs would prefer sensor control to be automatically passed to the RT upon request, in the event that the radar site was unmanned and the Local Terminal (LT) still had control. The Parker radar site manager's only concern as a result of testing was the 2 1/2 scan target loss experienced during the Mode S cold start script. During the script three of the four Mode S cabinets were powered off, with only an on-line interrogator available. The Data Processing Subsystem (DPS) cabinet from the same sensor channel as the on-line interrogator was then powered on. This resulted in an unexpected 25-second target loss, caused by the newly on-line DPS searching for its partner DPS, which was still powered off. This problem has also occurred in IBI mode in a terminal configuration, and will be fixed in a future release of Mode S software.

Air traffic controllers at the Denver ARTCC experienced no problems and had no complaints while controlling air traffic with beacon feed from the Mode S. The change in source of beacon data appeared transparent to the air traffic controllers monitoring sectors fed from the Parker radar site.

## 7. RECOMMENDATIONS.

The ACT-310 test team recommends deployment of the Mode Select Beacon System (Mode S) in Interim Beacon Initiative (IBI) mode in an enroute configuration with a National Aviation Facilities Experimental Center (NAFEC) Dipole Feed (NADIF) antenna.

Inequalities between the sensitivities of the Mode S and Air Traffic Control Beacon Interrogator (ATCBI)-3's Sensitivity Timing Control (STC) and Overall System Sensitivity (OSS) curves prove to have a minimal impact in overall surveillance performance. In fact, the Mode S in IBI mode outperforms the ATCBI-3 in most surveillance performance and false target categories, and is comparable to the ATCBI-3 in all others.

The Mode S performs admirably during power fail conditions while interfacing with the Common Digitizer (CD)-2. The Mode S user interface terminals function reliably and provide accurate status and command functionality to the end users. The System Engineers' (SE's) concern over sensor control defaulting to the Remote Terminal (RT) is not a threat as long as control is yielded from the Local Terminal (LT) before radar site personnel leave the site. This is the mandated practice.

Airway Facilities (AF) personnel's concern about the 2 1/2 scan target loss caused by powering on a Data Processing Subsystem (DPS) should not affect normal system maintenance. The target loss will not be experienced when a sensor channel is powered off for maintenance, as long as the other channel remains on-line and operational. Moreover, as short a target loss as 2 1/2 scans is usually transparent to controllers because of the mosaic of other beacon feeds processed by the Host system at the Air Route Traffic Control Center (ARTCC).

## 8. ACRONYMS AND ABBREVIATIONS.

ACP	Azimuth Change Pulse
ADCCP	Advanced Data Communication Control Procedure
AF	Airway Facilities
APG	Azimuth Pulse Generator
ARIES	Aircraft Reply Interference Environment Simulator
ARP	Azimuth Reference Pulse
ARSR	Air Route Surveillance Radar
ARTCC	Air Route Traffic Control Center
AT	Air Traffic
ATC	Air Traffic Control
ATCBI	Air Traffic Control Beacon Interrogator
ATCRBS	Air Traffic Control Radar Beacon System
Aux	Auxiliary
BFTS	Beacon False Target Summary
bps	bits per second

BTE	Beacon Target Extractor
CD	Common Digitizer
CENRAP	Center Radar Arts Presentation
Ch	Channel
CHAN	Channel
CJBX	Communications Junction Box
CONV	Converter
CPME	Calibration and Performance Monitoring Equipment
dB	decibel
dBm	decibel above 1 milliwatt
DC	Directional Coupler
deg	Degree
DIA	Denver International Airport
DPS	Data Processing Subsystem
FAA	Federal Aviation Administration
IBI	Interim Beacon Initiative
ID	Identity
IOC	Interim Operational Capability
ISLS	Improved Side-Lobe Suppression
JBX	Junction Box
KCRT	Keyboard Cathode Ray Tube
LE	Lead Edge
LT	Local Terminal
MDS	Minimum Discernible Signal
MHz	megahertz
Mode S	Mode Select Beacon System
μsec	microseconds
MSIMC	Mode S Interim Monitoring and Control Terminal
MSJB	Mode S Junction Box
mv	millivolt
N/A	Not Applicable
NADIF	NAFEC Dipole Feed
NAFEC	National Aviation Facilities Experimental Center
NAS	National Airspace System
nmi	nautical mile
ns	nanosecond
omni	Omnidirectional
OSS	Overall System Sensitivity
OT&E	Operational Test and Evaluation
Pd	Percent Detection
POD	Probability of Detection
PRF	Pulse Repetition Frequency
PTR	Program Technical Report
RAM	Random Access Memories
RAPPI	Random Access Plan Position Indicator
RBAT	Radar Beacon Analysis Tool
RCIU	Remote Control Interface Unit
RF	Radio Frequency
RIT	Radar Intelligence Tool
RMMS	Remote Maintenance Monitoring System

Rpt	Report
RT	Remote Terminal
RTADS	Real-Time Aircraft Display System
SA	Surveillance Analysis
SAP	Site Adaptable Parameter
SDS	Surveillance Data Selector
SE	System Engineer
SLS	Side-Lobe Suppression
SMMC	System Maintenance Monitoring and Control
STC	Sensitivity Timing Control
Std-Dev	Standard Deviation
SW	Switch
TGT	Target
TRACON	Terminal Radar Approach Control
TTG	Test Target Generator
v	volt
VFR	Visual Flight Rules
VSWR	Voltage Standing Wave Ratio
w	watt
XFER	Transfer

**APPENDIX A**  
**PHASE 1 PRELIMINARY CALIBRATIONS AND MEASUREMENTS**  
**DATA SHEETS**

### BEACON TEST SET CHECKOUT

N/A indicates data not available.

	dB Setting	dB Measured
1. Test Set course attenuator	00	<u>00</u>
	10	<u>10.14</u>
	20	<u>20.22</u>
	30	<u>30.16</u>
	40	<u>40.38</u>
	50	<u>50.25</u>
	60	<u>60.26</u>
	70	<u>70.24</u>
	80	<u>80.00</u>
	90	<u>88.54</u>
2. Fine adjust attenuator	Setting	Measured
	1	<u>1.08</u>
	2	<u>2.15</u>
	3	<u>3.15</u>
	4	<u>4.25</u>
	5	<u>5.25</u>
	6	<u>6.19</u>
	7	<u>7.20</u>
	8	<u>8.28</u>
	9	<u>9.12</u>

3.	Beacon Test Set Pulse Parameters	
a.	Peak Power out at 00 dB attenuator Setting with Test cable	<u>-1.11 dBm</u>
b.	Pulse Width (450 ns ±100 ns)	<u>447.06 ns</u>
c.	Rise Time (50 ns to 100 ns)	<u>31.1 ns</u>
d.	Fall Time (50 ns to 200 ns)	<u>42.9 ns</u>
e.	Overshoot	<u>13.2%</u>
f.	Undershoot	<u>N/A</u>
g.	Max. Amplitude Deviation through a Pulse Train ( 1 dB) Peak: Top:	<u>.04 dB</u> <u>.01 dB</u>
h.	Modulator Isolation	<u>&gt;70 dB</u>

### Mode S/ATCBI-3 Pre-Phase 1 Measurements

1.	Mode S Sum Channel Directional Coupler Calibration	
a.	Forward Coupling	<u>-20.32 dB</u>
b.	Reverse Coupling	<u>-20.33 dB</u>
c.	Isolation at Forward Port	<u>&gt;60 dB</u>
d.	Isolation at the Reverse Port	<u>60.8 dB</u>
e.	Insertion loss	<u>.12 dB</u>
f.	Forward Directivity	<u>&gt;40 dB</u>
g.	Reverse Directivity	<u>&gt;40 dB</u>
2.	Mode S Auxiliary Channel Directional Coupler Calibration	
a.	Forward Coupling	<u>-20.35 dB</u>
b.	Reverse Coupling	<u>-20.34 dB</u>
c.	Isolation at Forward Port	<u>-65 dB</u>
d.	Isolation at the Reverse Port	<u>-60.8 dB</u>
e.	Insertion loss	<u>-.14 dB</u>
f.	Forward Directivity	<u>&gt;40 dB</u>
g.	Reverse Directivity	<u>&gt;40 dB</u>
3.	ATCBI-3 Directional Channel Directional Coupler Calibration	
a.	Forward Coupling	<u>-19.7 dB</u>
b.	Reverse Coupling	<u>-19.6 dB</u>
c.	Isolation at Forward Port	<u>N/A</u>
d.	Isolation at the Reverse Port	<u>N/A</u>
e.	Insertion loss	<u>N/A</u>
f.	Forward Directivity	<u>N/A</u>
g.	Reverse Directivity	<u>N/A</u>

4.	ATCBI-3 SLS Channel Directional Coupler Calibration	
a.	Forward Coupling	<u>-19.9 dB</u>
b.	Reverse Coupling	<u>-19.9 dB</u>
c.	Isolation at Forward Port	<u>N/A</u>
d.	Isolation at the Reverse Port	<u>N/A</u>
e.	Insertion Loss	<u>N/A</u>
f.	Forward Directivity	<u>N/A</u>
g.	Reverse Directivity	<u>N/A</u>
5.	a. Loss from the ARIES input port to the Receiver Input Mode S Ch A	<u>-28.57 dB</u>
	b. Loss from the ARIES input port to the Receiver Input Mode S Ch B	<u>-28.52 dB</u>
6.	a. Loss from the RF input at the Mode S interrogator to the Receiver input Ch A	<u>-1.71 dB</u>
	b. Loss from the RF input at the Mode S interrogator to the Receiver input Ch B	<u>-1.73 dB</u>
7.	a. Loss from the RF input at the ATCBI-3 to the Receiver input Ch A	<u>-30 dB</u>
	b. Loss from the RF input at the ATCBI-3 to the Receiver input Ch B	<u>-30 dB</u>

**APPENDIX B**  
**SURVEILLANCE PERFORMANCE CHARTS**  
**FOR**  
**INDIVIDUAL ATCBI-3/IBI DATA COLLECTIONS**

Surveillance Performance Charts for  
Individual IBI Phase 1 Data Collections

Recording Parameters	File Name (filename.ext)	sal_3485.912	sal_3485.912					
	File Date (mm/dd/yy)	09/12/94	09/12/94					
	Beacon Source	IBI	IBI					
	Beacon Antenna Tilt (deg)	2.0	2.0					
	Search Antenna Tilt (deg)	2.0	2.0					
	SLS/ISLS	SLS	SLS					
	Directional/Omni Power into Antenna (peak watts)	100 w/300 w						
	STC Value (dB)	48.5 dB	48.5 dB					
Comments: BFTS: Filtered codes assigned to multiple aircraft SA: Filtered CPMEs & Parrot		not filtered	filtered					
<b>Beacon False Target Summary (BFTS)</b>								
Note: Goal is <u>not</u> pass/fail		>Goal<						
(BFTS) Beacon False Target Summary	Total Number of Discrete Code Target Reports		27,519	27,279				
	False Target Report %	< 1.5	0.19	0.09				
	Split %	< 0.5	0.03	0.03				
	Ringaround %	< 0.2	0.01	0.01				
	Downlink Reflection %	< 0.2	0.01	0.01				
	PRF %	< 0.2	0.01	0.01				
	Uplink Reflection %	< 0.2	0.01	0.01				
	Other %	< 0.2	0.11	0.01				
ATCRBS ID 0000 TGT RPT %		< 0.5	0.39	0.39				
<b>Surveillance Analysis (SA)</b>								
(SA) Surveillance Analysis	Percent Detection Beacon %	> 97	98.46	98.42				
	Percent Detection Search %	> 70	72.96	74.97				
	Percent Detection Total (%)	> 97	99.37	99.35				
	Identity Reliability (%)	> 95	99.35	99.34				
	Identity Validity (%)	> 95	98.61	98.59				
	Altitude Reliability (%)	> 95	99.56	99.55				
	Altitude Validity (%)	> 95	98.77	98.75				
	Beacon Hits	> 29	30.1	30.1				
	Radar Reinforcement (%)	> 70	73.14	75.19				
	Search Collimation (%)	> 95	99.95	99.95				
	Range Error (nmi)	< 0.2	0.073	0.075				
	Azimuth Error (deg)	< 0.35	0.0180	0.182				
	Number of Tracks in Statistics		305	302				
<b>Permanent Echo Accuracy</b>								
(PE) Permanent Echo	Mode 3/A Code		1273	1274	1275	0306	1273	1274
	Single Rpt ATCRBS Update %	> 97	100	99.340	99.669	99.340		
	Range Error Mean (nmi)	< 0.13	0.012	0.003	-0.261	-0.161		
	Range Error Std-Dev (nmi)	±0.13	0.000	0.014	0.000	0.063		
	Azimuth Error Mean (deg)	< 0.2	0.009	0.075	0.173	0.065		
Azimuth Error Std-Dev (deg)	±0.2	0.060	0.062	0.051	0.055			

Recording Parameters	File Name (filename.ext)	sal_3490.911	sal_3490.911					
	File Date (mm/dd/yy)	09/11/94	09/11/94					
	Beacon Source	IBI	IBI					
	Beacon Antenna Tilt (deg)	2.0	2.0					
	Search Antenna Tilt (deg)	2.0	2.0					
	SLS/ISLS	SLS	SLS					
	Directional/Omni Power into Antenna (peak watts)	100 w/300 w	50 dB/54.77 dB					
	STC Value (dB)	49 dB	49 dB					
Comments: BFTS: Filtered codes assigned to multiple aircraft SA: Filtered CPMEs & Parrot		not filtered	filtered					
<b>Beacon False Target Summary (BFTS)</b>								
Note: Goal is <u>not</u> pass/fail		>Goal<						
(BFTS) Beacon False Target Summary	Total Number of Discrete Code Target Reports		19,652	none				
	False Target Report %	< 1.5	0.07					
	Split %	< 0.5	0.04					
	Ringaround %	< 0.2	0.01					
	Downlink Reflection %	< 0.2	0.00					
	PRF %	< 0.2	0.00					
	Uplink Reflection %	< 0.2	0.01					
	Other %	< 0.2	0.01					
ATCRBS ID 0000 TGT RPT %		< 0.5	0.35					
<b>Surveillance Analysis (SA)</b>								
(SA) Surveillance Analysis	Percent Detection Beacon %	> 97	98.59	98.55				
	Percent Detection Search %	> 70	77.82	79.84				
	Percent Detection Total (%)	> 97	99.43	99.42				
	Identity Reliability (%)	> 95	99.39	99.37				
	Identity Validity (%)	> 95	98.85	98.84				
	Altitude Reliability (%)	> 95	99.51	99.49				
	Altitude Validity (%)	> 95	98.88	98.86				
	Beacon Hits	> 29	30.2	30.2				
	Radar Reinforcement (%)	> 70	78.04	80.10				
	Search Collimation (%)	> 95	99.96	99.96				
	Range Error (nmi)	< 0.2	0.075	0.076				
	Azimuth Error (deg)	< 0.35	0.172	0.176				
Number of Tracks in Statistics			294	290				
<b>Permanent Echo Accuracy</b>								
(PE) Permanent Echo	Mode 3/A Code		1273	1274	1275	0306	1273	1274
	Single Rpt ATCRBS Update %	> 97	100	100	100	100		
	Range Error Mean (nmi)	< 0.13	0.012	0.003	-0.261	-0.148		
	Range Error Std-Dev (nmi)	±0.13	0.000	0.014	0.000	0.062		
	Azimuth Error Mean (deg)	< 0.2	0.015	0.078	0.168	0.059		
Azimuth Error Std-Dev (deg)		±0.2	0.059	0.057	0.058	0.050		

Surveillance Performance Charts for  
Individual ATCBI-3 Phase 1 Data Collections

Recording Parameters	File Name (filename.ext)		bi3ch2am.916	bi3ch2am.916				
	File Date (mm/dd/yy)		09/16/94	09/16/94				
	Beacon Source		BI3	BI3				
	Beacon Antenna Tilt (deg)		2.0	2.0				
	Search Antenna Tilt (deg)		2.0	2.0				
	SLS/ISLS		SLS	SLS				
	Directional/Omni Power into Antenna (peak watts)		100 w/400 w	100 w/400 w				
	STC Value (dB)		48 dB	48 dB				
	Comments: BFTS: Filtered codes assigned to multiple aircraft SA: Filtered CPMEs & Parrot		not filtered	filtered				
<b>Beacon False Target Summary (BFTS)</b>								
Note: Goal is <u>not</u> pass/fail		>Goal<						
(BFTS) Beacon False Target Summary	Total Number of Discrete Code Target Reports		97,566	97,050				
	False Target Report %	< 1.5	0.33	0.14				
	Split %	< 0.5	0.06	0.06				
	Ringaround %	< 0.2	0.06	0.01				
	Downlink Reflection %	< 0.2	0.01	0.01				
	PRF %	< 0.2	0.01	0.01				
	Uplink Reflection %	< 0.2	0.02	0.02				
	Other %	< 0.2	0.18	0.03				
ATCRBS ID 0000 TGT RPT %	< 0.5	0.84	0.77					
<b>Surveillance Analysis (SA)</b>								
(SA) Surveillance Analysis	Percent Detection Beacon %	> 97	98.63	98.61				
	Percent Detection Search %	> 70	76.01	77.17				
	Percent Detection Total (%)	> 97	99.39	99.38				
	Identity Reliability (%)	> 95	98.50	98.49				
	Identity Validity (%)	> 95	97.15	97.12				
	Altitude Reliability (%)	> 95	98.80	98.78				
	Altitude Validity (%)	> 95	97.34	97.31				
	Beacon Hits	> 29	30.9	31.0				
	Radar Reinforcement (%)	> 70	76.26	77.44				
	Search Collimation (%)	> 95	99.95	99.95				
	Range Error (nmi)	< 0.2	0.077	0.078				
	Azimuth Error (deg)	< 0.35	0.235	0.237				
	Number of Tracks in Statistics		1031	1027				
<b>Permanent Echo Accuracy</b>								
(PE) Permanent Echo	Mode 3/A Code		1273	1274	1275	0306	1273	1274
	Single Rpt ATCRBS Update %	> 97	99.559	99.559	99.706	99.412		
	Range Error Mean (nmi)	< 0.13	0.012	0.001	-0.261	-0.218		
	Range Error Std-Dev (nmi)	±0.13	0.000	0.000	0.000	0.018		
	Azimuth Error Mean (deg)	< 0.2	0.036	0.104	0.182	0.092		
	Azimuth Error Std-Dev (deg)	±0.2	0.065	0.059	0.052	0.064		

Recording Parameters	File Name (filename.ext)		bi3ch2pm.916	bi3ch2pm.916				
	File Date (mm/dd/yy)		09/16/94	09/16/94				
	Beacon Source		BI3	BI3				
	Beacon Antenna Tilt (deg)		2.0	2.0				
	Search Antenna Tilt (deg)		2.0	2.0				
	SLS/ISLS		SLS	SLS				
	Directional/Omni Power into Antenna (peak watts)		100 w/400 w	100 w/400 w				
	STC Value (dB)							
Comments: BFTS: Filtered codes assigned to multiple aircraft SA: Filtered CPMEs & Parrot			not filtered	filtered				
<b>Beacon False Target Summary (BFTS)</b>								
Note: Goal is <u>not</u> pass/fail			>Goal<					
(BFTS) Beacon False Target Summary	Total Number of Discrete Code Target Reports		73,250	73,094				
	False Target Report %	< 1.5	0.18	0.16				
	Split %	< 0.5	0.02	0.02				
	Ringaround %	< 0.2	0.07	0.07				
	Downlink Reflection %	< 0.2	0.00	0.00				
	PRF %	< 0.2	0.01	0.01				
	Uplink Reflection %	< 0.2	0.02	0.02				
	Other %	< 0.2	0.06	0.04				
ATCRBS ID 0000 TGT RPT %	< 0.5	0.52	0.52					
<b>Surveillance Analysis (SA)</b>								
(SA) Surveillance Analysis	Percent Detection Beacon %	> 97	98.74	98.71				
	Percent Detection Search %	> 70	75.54	77.63				
	Percent Detection Total (%)	> 97	99.56	99.54				
	Identity Reliability (%)	> 95	99.06	99.04				
	Identity Validity (%)	> 95	98.08	98.06				
	Altitude Reliability (%)	> 95	99.26	99.25				
	Altitude Validity (%)	> 95	98.23	98.23				
	Beacon Hits	> 29	30.8	30.9				
	Radar Reinforcement (%)	> 70	75.64	77.76				
	Search Collimation (%)	> 95	99.95	99.95				
	Range Error (nmi)	< 0.2	0.074	0.076				
	Azimuth Error (deg)	< 0.35	0.216	0.220				
Number of Tracks in Statistics		813	809					
<b>Permanent Echo Accuracy</b>								
(PE) Permanent Echo	Mode 3/A Code		1273	1274	1275	0306	1273	1274
	Single Rpt ATCRBS Update %	> 97	99.701	99.701	99.552	99.103		
	Range Error Mean (nmi)	< 0.13	0.012	0.001	-0.260	-0.218		
	Range Error Std-Dev (nmi)	±0.13	0.00	0.000	0.008	0.019		
	Azimuth Error Mean (deg)	< 0.2	0.039	0.102	0.188	0.103		
	Azimuth Error Std-Dev (deg)	±0.2	0.060	0.062	0.048	0.058		

Recording Parameters	File Name (filename.ext)		bi3ch2pm.922	bi3ch2pm.922				
	File Date (mm/dd/yy)		09/22/94	09/22/94				
	Beacon Source		BI3	BI3				
	Beacon Antenna Tilt (deg)		2.0	2.0				
	Search Antenna Tilt (deg)		2.0	2.0				
	SLS/ISLS		SLS	SLS				
	Directional/Omni Power into Antenna (peak watts)		100 w/300 w	100 w/300 w				
	STC Value (dB)							
Comments: BFTS: Filtered codes assigned to multiple aircraft SA: Filtered CPMEs & Parrot			not filtered	filtered				
Beacon False Target Summary (BFTS)								
Note: Goal is <u>not</u> pass/fail		>Goal<						
(BFTS) Beacon False Target Summary	Total Number of Discrete Code Target Reports		117,857	117,416				
	False Target Report %	< 1.5	0.17	0.16				
	Split %	< 0.5	0.06	0.06				
	Ringaround %	< 0.2	0.04	0.04				
	Downlink Reflection %	< 0.2	0.00	0.00				
	PRF %	< 0.2	0.01	0.01				
	Uplink Reflection %	< 0.2	0.01	0.01				
	Other %	< 0.2	0.06	0.04				
ATCRBS ID 0000 TGT RPT %	< 0.5	0.60	0.60					
Surveillance Analysis (SA)								
(SA) Surveillance Analysis	Percent Detection Beacon %	> 97	98.76	98.73				
	Percent Detection Search %	> 70	76.83	78.66				
	Percent Detection Total (%)	> 97	99.50	99.49				
	Identity Reliability (%)	> 95	98.88	98.86				
	Identity Validity (%)	> 95	97.85	97.81				
	Altitude Reliability (%)	> 95	99.04	99.02				
	Altitude Validity (%)	> 95	97.80	97.76				
	Beacon Hits	> 29	31.1	31.2				
	Radar Reinforcement (%)	> 70	77.02	78.88				
	Search Collimation (%)	> 95	99.97	99.97				
	Range Error (nmi)	< 0.2	0.075	0.076				
	Azimuth Error (deg)	< 0.35	0.223	0.226				
Number of Tracks in Statistics		1088	1084					
Permanent Echo Accuracy								
(PE) Permanent Echo	Mode 3/A Code		1273	1274	1275	0306	1273	1274
	Single Rpt ATCRBS Update %	> 97	100	99.442	99.54	99.554		
	Range Error Mean (nmi)	< 0.13	0.012	0.001	-0.261	-0.215		
	Range Error Std-Dev (nmi)	±0.13	0.000	0.000	0.000	0.026		
	Azimuth Error Mean (deg)	< 0.2	0.049	0.108	0.188	0.095		
	Azimuth Error Std-Dev (deg)	±0.2	0.057	0.059	0.055	0.052		

Recording Parameters	File Name (filename.ext)		bi3ch2pm.919	bi3ch2pm.919				
	File Date (mm/dd/yy)		09/19/94	09/19/94				
	Beacon Source		BI3	BI3				
	Beacon Antenna Tilt (deg)		2.0	2.0				
	Search Antenna Tilt (deg)		2.0	2.0				
	SLS/ISLS		SLS	SLS				
	Directional/Omni Power into Antenna (peak watts)		100 w/400 w	100 w/400 w				
	STC Value (dB)							
Comments: BFTS: Filtered codes assigned to multiple aircraft SA: Filtered CPMEs & Parrot			not filtered	filtered				
Beacon False Target Summary (BFTS)								
Note: Goal is <u>not</u> pass/fail			>Goal<					
(BFTS) Beacon False Target Summary	Total Number of Discrete Code Target Reports		83,351	82,782				
	False Target Report %	< 1.5	0.22	0.15				
	Split %	< 0.5	0.03	0.03				
	Ringaround %	< 0.2	0.07	0.07				
	Downlink Reflection %	< 0.2	0.00	0.00				
	PRF %	< 0.2	0.01	0.01				
	Uplink Reflection %	< 0.2	0.01	0.00				
	Other %	< 0.2	0.11	0.04				
ATCRBS ID 0000 TGT RPT %	< 0.5	0.47	0.47					
Surveillance Analysis (SA)								
(SA) Surveillance Analysis	Percent Detection Beacon %	> 97	99.23	99.21				
	Percent Detection Search %	> 70	76.52	78.70				
	Percent Detection Total (%)	> 97	99.60	99.59				
	Identity Reliability (%)	> 95	99.08	99.06				
	Identity Validity (%)	> 95	98.21	98.19				
	Altitude Reliability (%)	> 95	99.24	99.23				
	Altitude Validity (%)	> 95	98.42	98.41				
	Beacon Hits	> 29	31.1	31.2				
	Radar Reinforcement (%)	> 70	76.71	78.92				
	Search Collimation (%)	> 95	99.96	99.96				
	Range Error (nmi)	< 0.2	0.071	0.073				
	Azimuth Error (deg)	< 0.35	0.217	0.220				
Number of Tracks in Statistics		659	655					
Permanent Echo Accuracy								
(PE) Permanent Echo	Mode 3/A Code		1273	1274	1275	0306	1273	1274
	Single Rpt ATCRBS Update %	> 97	99.846	99.692	99.846	99.231		
	Range Error Mean (nmi)	< 0.13	.012	.001	.00	-0.217		
	Range Error Std-Dev (nmi)	±0.13	.00	.007	.005	.023		
	Azimuth Error Mean (deg)	< 0.2	.014	.079	.016	.076		
	Azimuth Error Std-Dev (deg)	±0.2	.061	.075	.052	.051		

Recording Parameters	File Name (filename.ext)		bi3ch2pm.920	bi3ch2pm.920				
	File Date (mm/dd/yy)		09/20/94	09/20/94				
	Beacon Source		BI3	BI3				
	Beacon Antenna Tilt (deg)		2.0	2.0				
	Search Antenna Tilt (deg)		2.0	2.0				
	SLS/ISLS		SLS	SLS				
	Directional/Omni Power into Antenna (peak watts)		100 w/400 w	100 w/400 w				
	STC Value (dB)							
Comments: BFTS: Filtered codes assigned to multiple aircraft SA: Filtered CPMEs & Parrot			not filtered	filtered				
Beacon False Target Summary (BFTS)								
Note: Goal is <u>not</u> pass/fail		>Goal<						
(BFTS) Beacon False Target Summary	Total Number of Discrete Code Target Reports		89,853	89,137				
	False Target Report %	< 1.5	0.30	0.17				
	Split %	< 0.5	0.05	0.05				
	Ringaround %	< 0.2	0.06	0.06				
	Downlink Reflection %	< 0.2	0.00	0.00				
	PRF %	< 0.2	0.00	0.00				
	Uplink Reflection %	< 0.2	0.02	0.02				
	Other %	< 0.2	0.17	0.04				
ATCRBS ID 0000 TGT RPT %	< 0.5	0.37	0.38					
Surveillance Analysis (SA)								
(SA) Surveillance Analysis	Percent Detection Beacon %	> 97	99.07	99.05				
	Percent Detection Search %	> 70	75.42	77.44				
	Percent Detection Total (%)	> 97	99.53	99.52				
	Identity Reliability (%)	> 95	99.19	99.18				
	Identity Validity (%)	> 95	98.43	98.41				
	Altitude Reliability (%)	> 95	99.35	99.34				
	Altitude Validity (%)	> 95	98.50	98.49				
	Beacon Hits	> 29	31.1	31.1				
	Radar Reinforcement (%)	> 70	75.63	77.68				
	Search Collimation (%)	> 95	99.96	99.96				
	Range Error (nmi)	< 0.2	0.073	0.075				
	Azimuth Error (deg)	< 0.35	0.22	0.224				
Number of Tracks in Statistics		755	751					
Permanent Echo Accuracy								
(PE) Permanent Echo	Mode 3/A Code		1273	1274	1275	0306	1273	1274
	Single Rpt ATCRBS Update %	> 97	99.413	99.853	99.853	99.120		
	Range Error Mean (nmi)	< 0.13	.012	.001	.00	-0.213		
	Range Error Std-Dev (nmi)	±0.13	.00	.00	.00	.030		
	Azimuth Error Mean (deg)	< 0.2	.015	.088	.017	.078		
Azimuth Error Std-Dev (deg)	±0.2	.069	.060	.049	.049			

Recording Parameters	File Name (filename.ext)		bi3ch2am.921	bi3ch2am.921				
	File Date (mm/dd/yy)		09/21/94	09/21/94				
	Beacon Source		BI3	BI3				
	Beacon Antenna Tilt (deg)		2.0	2.0				
	Search Antenna Tilt (deg)		2.0	2.0				
	SLS/ISLS		SLS	SLS				
	Directional/Omni Power into Antenna (peak watts)		100 w/400 w	100 w/400 w				
	STC Value (dB)							
Comments: BFTS: Filtered codes assigned to multiple aircraft SA: Filtered CPMEs & Parrot			not filtered	filtered				
Beacon False Target Summary (BFTS)								
Note: Goal is <u>not</u> pass/fail			>Goal<					
(BFTS) Beacon False Target Summary	Total Number of Discrete Code Target Reports		112,344	109,690				
	False Target Report %	< 1.5	0.23	0.21				
	Split %	< 0.5	0.06	0.06				
	Ringaround %	< 0.2	0.06	0.06				
	Downlink Reflection %	< 0.2	0.00	0.00				
	PRF %	< 0.2	0.01	0.01				
	Uplink Reflection %	< 0.2	0.01	0.01				
	Other %	< 0.2	0.09	0.07				
ATCRBS ID 0000 TGT RPT %	< 0.5	0.52	0.53					
Surveillance Analysis (SA)								
(SA) Surveillance Analysis	Percent Detection Beacon %	> 97	98.82	98.79				
	Percent Detection Search %	> 70	78.56	80.23				
	Percent Detection Total (%)	> 97	99.49	99.48				
	Identity Reliability (%)	> 95	98.91	98.90				
	Identity Validity (%)	> 95	97.77	97.75				
	Altitude Reliability (%)	> 95	99.24	99.24				
	Altitude Validity (%)	> 95	98.00	97.99				
	Beacon Hits	> 29	31.1	31.1				
	Radar Reinforcement (%)	> 70	79.79	80.48				
	Search Collimation (%)	> 95	99.96	99.96				
	Range Error (nmi)	< 0.2	0.074	0.076				
	Azimuth Error (deg)	< 0.35	.23	0.233				
Number of Tracks in Statistics		991	987					
Permanent Echo Accuracy								
(PE) Permanent Echo	Mode 3/A Code		1273	1274	1275	0306	1273	1274
	Single Rpt ATCRBS Update %	> 97	99.586	99.724	99.448	98.483		
	Range Error Mean (nmi)	< 0.13	.012	.001	.00	-0.211		
	Range Error Std-Dev (nmi)	±0.13	.00	.00	.00	.033		
	Azimuth Error Mean (deg)	< 0.2	.036	.096	.045	.095		
	Azimuth Error Std-Dev (deg)	±0.2	.059	.072	.051	.069		

Recording Parameters	File Name (filename.ext)		bi3ch2pm.921	bi3ch2pm.921				
	File Date (mm/dd/yy)		09/21/94	09/21/94				
	Beacon Source		BI3	BI3				
	Beacon Antenna Tilt (deg)		2.0	2.0				
	Search Antenna Tilt (deg)		2.0	2.0				
	SLS/ISLS		SLS	SLS				
	Directional/Omni Power into Antenna (peak watts)		100 w/400 w	100 w/400 w				
	STC Value (dB)							
Comments: BFTS: Filtered codes assigned to multiple aircraft SA: Filtered CPMEs & Parrot			not filtered	filtered				
Beacon False Target Summary (BFTS)								
Note: Goal is <u>not</u> pass/fail		>Goal<						
(BFTS) Beacon False Target Summary	Total Number of Discrete Code Target Reports		170,602	169,160				
	False Target Report %	< 1.5	0.39	0.30				
	Split %	< 0.5	0.19	0.19				
	Ringaround %	< 0.2	0.05	0.05				
	Downlink Reflection %	< 0.2	0.00	0.00				
	PRF %	< 0.2	0.01	0.01				
	Uplink Reflection %	< 0.2	0.02	0.02				
	Other %	< 0.2	0.13	0.03				
ATCRBS ID 0000 TGT RPT %	< 0.5	0.43	0.43					
Surveillance Analysis (SA)								
(SA) Surveillance Analysis	Percent Detection Beacon %	> 97	99.37	99.35				
	Percent Detection Search %	> 70	73.05	75.38				
	Percent Detection Total (%)	> 97	99.66	99.65				
	Identity Reliability (%)	> 95	99.21	99.21				
	Identity Validity (%)	> 95	98.24	98.25				
	Altitude Reliability (%)	> 95	99.43	99.44				
	Altitude Validity (%)	> 95	98.50	98.52				
	Beacon Hits	> 29	31.7	31.8				
	Radar Reinforcement (%)	> 70	73.20	75.55				
	Search Collimation (%)	> 95	99.98	99.98				
	Range Error (nmi)	< 0.2	0.071	0.073				
	Azimuth Error (deg)	< 0.35	0.237	0.241				
	Number of Tracks in Statistics		954	950				
Permanent Echo Accuracy								
(PE) Permanent Echo	Mode 3/A Code		1273	1274	1275	0306	1273	1274
	Single Rpt ATCRBS Update %	> 97	99.927	99.854	98.611	99.049		
	Range Error Mean (nmi)	< 0.13	.012	.001	.00	-0.21		
	Range Error Std-Dev (nmi)	±0.13	.00	.00	.00	.035		
	Azimuth Error Mean (deg)	< 0.2	.033	.083	.017	.076		
Azimuth Error Std-Dev (deg)	±0.2	.058	.062	.060	.069			

Phase 2 IBI Operation  
Surveillance Performance Baseline Charts

Recording Parameters	File Name (filename.ext)		ib1201.ibi	ib1201.ibi				
	File Date (mm/dd/yy)		12/01/94	12/01/94				
	Beacon Source		IBIB	IBIB				
	Beacon Antenna Tilt (deg)		2.0	2.0				
	Search Antenna Tilt (deg)		2.0	2.0				
	SLS/ISLS		SLS	SLS				
	Directional/Omni Power into Antenna (peak watts)							
	STC Value (dB)							
Comments: BFTS: Filtered codes assigned to multiple aircraft SA: Filtered CPMEs & Parrot			not filtered	filtered				
Beacon False Target Summary (BFTS)								
Note: Goal is not pass/fail		>Goal<						
(BFTS) Beacon False Target Summary	Total Number of Discrete Code Target Reports		51533	51310				
	False Target Report %	< 1.5	0.37	0.33				
	Split %	< 0.5	0.05	0.05				
	Ringaround %	< 0.2	0.19	0.19				
	Downlink Reflection %	< 0.2	0.01	0.01				
	PRF %	< 0.2	0.01	0.01				
	Uplink Reflection %	< 0.2	0.02	0.02				
	Other %	< 0.2	0.11	0.07				
ATCRBS ID 0000 TGT RPT %	< 0.5	0.44	0.45					
Surveillance Analysis (SA)								
(SA) Surveillance Analysis	Percent Detection Beacon %	> 97	98.57	98.54				
	Percent Detection Search %	> 70	67.64	69.15				
	Percent Detection Total (%)	> 97	99.21	99.19				
	Identity Reliability (%)	> 95	99.32	99.32				
	Identity Validity (%)	> 95	98.42	98.41				
	Altitude Reliability (%)	> 95	99.39	99.39				
	Altitude Validity (%)	> 95	98.51	98.51				
	Beacon Hits	> 29	312	31.2				
	Radar Reinforcement (%)	> 70	67.95	69.49				
	Search Collimation (%)	> 95	99.98	99.98				
	Range Error (nmi)	< 0.2	0.076	0.077				
	Azimuth Error (deg)	< 0.35	0.217	0.220				
Number of Tracks in Statistics		612	608					
Permanent Echo Accuracy								
(PE) Permanent Echo	Mode 3/A Code		1273	1274	1275	0306	1273	1274
	Single Rpt ATCRBS Update %	> 97	99.449	99.725	99.725	99.89		
	Range Error Mean (nmi)	< 0.13	0.012	0.001	0.001	-0.21		
	Range Error Std-Dev (nmi)	±0.13	0.000	0.000	0.011	0.058		
	Azimuth Error Mean (deg)	< 0.2	0.013	0.065	0.002	0.076		
Azimuth Error Std-Dev (deg)	±0.2	0.053	0.059	0.051	0.054			

Recording Parameters	File Name (filename.ext)	ib1201ct.ibi	ib1201ct.ibi					
	File Date (mm/dd/yy)	12/01/94	12/01/94					
	Beacon Source	IBIB	IBIB					
	Beacon Antenna Tilt (deg)	2.0	2.0					
	Search Antenna Tilt (deg)	2.0	2.0					
	SLS/ISLS	SLS	SLS					
	Directional/Omni Power into Antenna (peak watts)							
	STC Value (dB)							
Comments: BFTS: Filtered codes assigned to multiple aircraft SA: Filtered CPMEs & Parrot		not filtered	filtered					
Beacon False Target Summary (BFTS)								
Note: Goal is <u>not</u> pass/fail		>Goal<						
(BFTS) Beacon False Target Summary	Total Number of Discrete Code Target Reports		45285	43800				
	False Target Report %	< 1.5	0.90	0.35				
	Split %	< 0.5	0.25	0.26				
	Ringaround %	< 0.2	0.09	0.06				
	Downlink Reflection %	< 0.2	0.00	0.00				
	PRF %	< 0.2	0.01	0.01				
	Uplink Reflection %	< 0.2	0.00	0.00				
	Other %	< 0.2	0.54	0.03				
ATCRBS ID 0000 TGT RPT %	< 0.5	0.69	0.71					
Surveillance Analysis (SA)								
(SA) Surveillance Analysis	Percent Detection Beacon %	> 97	98.48	98.46				
	Percent Detection Search %	> 70	73.89	75.16				
	Percent Detection Total (%)	> 97	99.39	99.38				
	Identity Reliability (%)	> 95	99.02	99.01				
	Identity Validity (%)	> 95	97.79	97.78				
	Altitude Reliability (%)	> 95	99.23	99.23				
	Altitude Validity (%)	> 95	97.91	97.91				
	Beacon Hits	> 29	30.2	30.2				
	Radar Reinforcement (%)	> 70	74.07	75.38				
	Search Collimation (%)	> 95	99.97	99.97				
	Range Error (nmi)	< 0.2	0.077	0.077				
	Azimuth Error (deg)	< 0.35	0.195	0.196				
Number of Tracks in Statistics		560	556					
Permanent Echo Accuracy								
(PE) Permanent Echo	Mode 3/A Code		1273	1274	1275	0306	1273	1274
	Single Rpt ATCRBS Update %	> 97	99.721	100.00	99.721	99.162		
	Range Error Mean (nmi)	< 0.13	0.012	0.001	0.001	-0.169		
	Range Error Std-Dev (nmi)	±0.13	0.000	0.000	0.009	0.062		
	Azimuth Error Mean (deg)	< 0.2	0.034	0.093	0.035	0.092		
	Azimuth Error Std-Dev (deg)	±0.2	0.054	0.061	0.066	0.071		

Recording Parameters	File Name (filename.ext)		ial202am.ibi	ial202am.ibi				
	File Date (mm/dd/yy)		12/02/94	12/02/94				
	Beacon Source		IBIA	IBIA				
	Beacon Antenna Tilt (deg)		2.0	2.0				
	Search Antenna Tilt (deg)		2.0	2.0				
	SLS/ISLS		SLS	SLS				
	Directional/Omni Power into Antenna (peak watts)							
	STC Value (dB)							
Comments: BFTS: Filtered codes assigned to multiple aircraft SA: Filtered CPMEs & Parrot			not filtered	filtered				
Beacon False Target Summary (BFTS)								
Note: Goal is <u>not</u> pass/fail			>Goal<					
(BFTS) Beacon False Target Summary	Total Number of Discrete Code Target Reports		39461	37084				
	False Target Report %	< 1.5	0.61	0.53				
	Split %	< 0.5	0.47	0.46				
	Ringaround %	< 0.2	0.03	0.03				
	Downlink Reflection %	< 0.2	0.00	0.00				
	PRF %	< 0.2	0.01	0.01				
	Uplink Reflection %	< 0.2	0.00	0.00				
	Other %	< 0.2	0.10	0.02				
ATCRBS ID 0000 TGT RPT %	< 0.5	0.48	0.50					
Surveillance Analysis (SA)								
(SA) Surveillance Analysis	Percent Detection Beacon %	> 97	98.79	98.77				
	Percent Detection Search %	> 70	75.99	77.11				
	Percent Detection Total (%)	> 97	99.53	99.52				
	Identity Reliability (%)	> 95	99.31	99.31				
	Identity Validity (%)	> 95	98.17	98.18				
	Altitude Reliability (%)	> 95	99.33	99.32				
	Altitude Validity (%)	> 95	98.33	98.33				
	Beacon Hits	> 29	30.9	30.9				
	Radar Reinforcement (%)	> 70	76.15	77.29				
	Search Collimation (%)	> 95	99.97	99.97				
	Range Error (nmi)	< 0.2	0.075	0.075				
	Azimuth Error (deg)	< 0.35	0.211	0.213				
Number of Tracks in Statistics		503	499					
Permanent Echo Accuracy								
(PE) Permanent Echo	Mode 3/A Code		1273	1274	1275	0306	1273	1274
	Single Rpt ATCRBS Update %	> 97	99.617	98.084	100.00	99.617		
	Range Error Mean (nmi)	< 0.13	0.012	0.001	0.001	-0.171		
	Range Error Std-Dev (nmi)	±0.13	0.000	0.008	0.011	0.061		
	Azimuth Error Mean (deg)	< 0.2	0.050	0.092	0.035	0.095		
Azimuth Error Std-Dev (deg)	±0.2	0.054	0.071	0.054	0.066			

Recording Parameters	File Name (filename.ext)		ibia_pm.c02	ibia_pm.c02				
	File Date (mm/dd/yy)		12/02/94	12/02/94				
	Beacon Source		IBIA	IBIA				
	Beacon Antenna Tilt (deg)		2.0	2.0				
	Search Antenna Tilt (deg)		2.0	2.0				
	SLS/ISLS		SLS	SLS				
	Directional/Omni Power into Antenna (peak watts)							
	STC Value (dB)							
Comments: BFTS: Filtered codes assigned to multiple aircraft SA: Filtered CPMEs & Parrot			not filtered	filtered				
Beacon False Target Summary (BFTS)								
Note: Goal is <u>not</u> pass/fail		>Goal<						
(BFTS) Beacon False Target Summary	Total Number of Discrete Code Target Reports		73800	72803				
	False Target Report %	< 1.5	1.06	0.65				
	Split %	< 0.5	0.59	0.59				
	Ringaround %	< 0.2	0.02	0.02				
	Downlink Reflection %	< 0.2	0.00	0.00				
	PRF %	< 0.2	0.01	0.00				
	Uplink Reflection %	< 0.2	0.01	0.01				
	Other %	< 0.2	0.44	0.03				
ATCRBS ID 0000 TGT RPT %	< 0.5	0.53	0.54					
Surveillance Analysis (SA)								
(SA) Surveillance Analysis	Percent Detection Beacon %	> 97	98.11	98.05				
	Percent Detection Search %	> 70	72.55	74.42				
	Percent Detection Total (%)	> 97	99.28	99.27				
	Identity Reliability (%)	> 95	99.19	99.18				
	Identity Validity (%)	> 95	98.27	98.24				
	Altitude Reliability (%)	> 95	99.39	99.39				
	Altitude Validity (%)	> 95	98.34	98.34				
	Beacon Hits	> 29	29.8	29.8				
	Radar Reinforcement (%)	> 70	72.73	74.63				
	Search Collimation (%)	> 95	99.96	99.96				
	Range Error (nmi)	< 0.2	0.077	0.078				
	Azimuth Error (deg)	< 0.35	0.195	0.197				
Number of Tracks in Statistics		820	816					
Permanent Echo Accuracy								
(PE) Permanent Echo	Mode 3/A Code		1273	1274	1275	0306	1273	1274
	Single Rpt ATCRBS Update %	> 97	99.845	99.226	99.381	98.916		
	Range Error Mean (nmi)	< 0.13	0.012	0.001	0.001	-0.175		
	Range Error Std-Dev (nmi)	±0.13	0.000	0.000	0.009	0.060		
	Azimuth Error Mean (deg)	< 0.2	0.050	0.083	0.035	0.087		
	Azimuth Error Std-Dev (deg)	±0.2	0.063	0.061	0.054	0.063		

Recording Parameters	File Name (filename.ext)		ial203am.ibi	ial203am.ibi				
	File Date (mm/dd/yy)		12/03/94	12/03/94				
	Beacon Source		IBIA	IBIA				
	Beacon Antenna Tilt (deg)		2.0	2.0				
	Search Antenna Tilt (deg)		2.0	2.0				
	SLS/ISLS		SLS	SLS				
	Directional/Omni Power into Antenna (peak watts)							
	STC Value (dB)							
Comments: BFTS: Filtered codes assigned to multiple aircraft SA: Filtered CPMEs & Parrot			not filtered	filtered				
Beacon False Target Summary (BFTS)								
Note: Goal is <u>not</u> pass/fail		>Goal<						
(BFTS) Beacon False Target Summary	Total Number of Discrete Code Target Reports		75593	73281				
	False Target Report %	< 1.5	0.30	0.18				
	Split %	< 0.5	0.07	0.07				
	Ringaround %	< 0.2	0.04	0.05				
	Downlink Reflection %	< 0.2	0.00	0.00				
	PRF %	< 0.2	0.01	0.01				
	Uplink Reflection %	< 0.2	0.01	0.01				
	Other %	< 0.2	0.16	0.04				
ATCRBS ID 0000 TGT RPT %	< 0.5	0.73	0.75					
Surveillance Analysis (SA)								
(SA) Surveillance Analysis	Percent Detection Beacon %	> 97	97.90	97.86				
	Percent Detection Search %	> 70	62.30	63.55				
	Percent Detection Total (%)	> 97	98.82	98.79				
	Identity Reliability (%)	> 95	98.87	98.86				
	Identity Validity (%)	> 95	97.57	97.55				
	Altitude Reliability (%)	> 95	99.06	99.06				
	Altitude Validity (%)	> 95	97.78	97.78				
	Beacon Hits	> 29	29.6	29.6				
	Radar Reinforcement (%)	> 70	62.67	63.96				
	Search Collimation (%)	> 95	99.96	99.96				
	Range Error (nmi)	< 0.2	0.079	0.080				
	Azimuth Error (deg)	< 0.35	0.207	0.209				
Number of Tracks in Statistics		1028	1024					
Permanent Echo Accuracy								
(PE) Permanent Echo	Mode 3/A Code		1273	1274	1275	0306	1273	1274
	Single Rpt ATCRBS Update %	> 97	99.650	99.301	99.650	97.552		
	Range Error Mean (nmi)	< 0.13	0.012	0.001	0.001	-0.0171		
	Range Error Std-Dev (nmi)	±0.13	0.000	0.000	0.010	0.061		
	Azimuth Error Mean (deg)	< 0.2	0.019	0.063	0.006	0.061		
Azimuth Error Std-Dev (deg)	±0.2	0.058	0.062	0.062	0.066			

Recording Parameters	File Name (filename.ext)		ial203pm.ibi	ial203pm.ibi				
	File Date (mm/dd/yy)		12/03/94	12/03/94				
	Beacon Source		IBIA	IBIA				
	Beacon Antenna Tilt (deg)		2.0	2.0				
	Search Antenna Tilt (deg)		2.0	2.0				
	SLS/ISLS		SLS	SLS				
	Directional/Omni Power into Antenna (peak watts)							
	STC Value (dB)							
Comments: BFTS: Filtered codes assigned to multiple aircraft SA: Filtered CPMEs & Parrot			not filtered	filtered				
Beacon False Target Summary (BFTS)								
Note: Goal is <u>not</u> pass/fail		>Goal<						
(BFTS) Beacon False Target Summary	Total Number of Discrete Code Target Reports		65748	65462				
	False Target Report %	< 1.5 %	1.48	1.45				
	Split %	< 0.5	1.36	1.36				
	Ringaround %	< 0.2	0.03	0.04				
	Downlink Reflection %	< 0.2	0.00	0.00				
	PRF %	< 0.2	0.01	0.01				
	Uplink Reflection %	< 0.2	0.01	0.01				
	Other %	< 0.2	0.07	0.04				
ATCRBS ID 0000 TGT RPT %	< 0.5	1.11	1.11					
Surveillance Analysis (SA)								
(SA) Surveillance Analysis	Percent Detection Beacon %	> 97	97.32	97.25				
	Percent Detection Search %	> 70	68.78	70.53				
	Percent Detection Total (%)	> 97	98.93	98.90				
	Identity Reliability (%)	> 95	98.59	98.56				
	Identity Validity (%)	> 95	96.80	96.74				
	Altitude Reliability (%)	> 95	98.73	98.72				
	Altitude Validity (%)	> 95	96.84	96.83				
	Beacon Hits	> 29	29.1	29.1				
	Radar Reinforcement (%)	> 70	68.99	70.79				
	Search Collimation (%)	> 95	99.95	99.95				
	Range Error (nmi)	< 0.2	0.083	0.085				
	Azimuth Error (deg)	< 0.35	0.215	0.217				
Number of Tracks in Statistics		1093	1089					
Permanent Echo Accuracy								
(PE) Permanent Echo	Mode 3/A Code		1273	1274	1275	0306	1273	1274
	Single Rpt ATCRBS Update %	> 97	99.181	100.00	99.727	99.319		
	Range Error Mean (nmi)	< 0.13	0.012	0.001	0.001	-0.178		
	Range Error Std-Dev (nmi)	±0.13	0.000	0.000	0.008	0.059		
	Azimuth Error Mean (deg)	< 0.2	0.047	0.086	0.032	0.093		
	Azimuth Error Std-Dev (deg)	±0.2	0.059	0.064	0.075	0.059		

Recording Parameters	File Name (filename.ext)		ia1204ct.ibi	ia1204ct.ibi				
	File Date (mm/dd/yy)		12/04/94	12/04/94				
	Beacon Source		IBIA	IBIA				
	Beacon Antenna Tilt (deg)		2.0	2.0				
	Search Antenna Tilt (deg)		2.0	2.0				
	SLS/ISLS		SLS	SLS				
	Directional/Omni Power into Antenna (peak watts)							
	STC Value (dB)							
Comments: BFTS: Filtered codes assigned to multiple aircraft SA: Filtered CPMEs & Parrot			not filtered	filtered				
Beacon False Target Summary (BFTS)								
Note: Goal is <u>not</u> pass/fail		>Goal<						
(BFTS) Beacon False Target Summary	Total Number of Discrete Code Target Reports		50913	49838				
	False Target Report %	< 1.5	0.27	0.27				
	Split %	< 0.5	0.15	0.15				
	Ringaround %	< 0.2	0.06	0.07				
	Downlink Reflection %	< 0.2	0.00	0.00				
	PRF %	< 0.2	0.01	0.01				
	Uplink Reflection %	< 0.2	0.01	0.01				
	Other %	< 0.2	0.03	0.03				
ATCRBS ID 0000 TGT RPT %	< 0.5	0.43	0.44					
Surveillance Analysis (SA)								
(SA) Surveillance Analysis	Percent Detection Beacon %	> 97	98.23	98.19				
	Percent Detection Search %	> 70	41.21	42.40				
	Percent Detection Total (%)	> 97	98.68	98.65				
	Identity Reliability (%)	> 95	99.35	99.35				
	Identity Validity (%)	> 95	98.51	98.50				
	Altitude Reliability (%)	> 95	99.40	99.41				
	Altitude Validity (%)	> 95	98.71	98.71				
	Beacon Hits	> 29	30.1	30.1				
	Radar Reinforcement (%)	> 70	41.48	42.69				
	Search Collimation (%)	> 95	99.97	99.97				
	Range Error (nmi)	< 0.2	0.078	0.079				
	Azimuth Error (deg)	< 0.35	0.218	0.222				
Number of Tracks in Statistics		553	549					
Permanent Echo Accuracy								
(PE) Permanent Echo	Mode 3/A Code		1273	1274	1275	0306	1273	1274
	Single Rpt ATCRBS Update %	> 97	99.443	99.444	99.443	99.167		
	Range Error Mean (nmi)	< 0.13	0.012	0.001	0.001	-0.181		
	Range Error Std-Dev (nmi)	±0.13	0.000	0.000	0.009	0.059		
	Azimuth Error Mean (deg)	< 0.2	0.016	0.050	-0.008	0.050		
Azimuth Error Std-Dev (deg)	±0.2	0.052	0.072	0.063	0.061			

Recording Parameters	File Name (filename.ext)		ial204pm.ibi	ial204pm.ibi				
	File Date (mm/dd/yy)		12/04/94	12/04/94				
	Beacon Source		IBIA	IBIA				
	Beacon Antenna Tilt (deg)		2.0	2.0				
	Search Antenna Tilt (deg)		2.0	2.0				
	SLS/ISLS		SLS	SLS				
	Directional/Omni Power into Antenna (peak watts)							
	STC Value (dB)							
Comments: BFTS: Filtered codes assigned to multiple aircraft SA: Filtered CPMEs & Parrot			not filtered	filtered				
Beacon False Target Summary, (BFTS)								
Note: Goal is <u>not</u> pass/fail			>Goal<					
(BFTS) Beacon False Target Summary	Total Number of Discrete Code Target Reports		39655	39415				
	False Target Report %	< 1.5	0.19	0.09				
	Split %	< 0.5	0.04	0.04				
	Ringaround %	< 0.2	0.03	0.03				
	Downlink Reflection %	< 0.2	0.00	0.00				
	PRF %	< 0.2	0.02	0.01				
	Uplink Reflection %	< 0.2	0.01	0.01				
	Other %	< 0.2	0.09	0.01				
ATCRBS ID 0000 TGT RPT %	< 0.5	0.23	0.23					
Surveillance Analysis (SA)								
(SA) Surveillance Analysis	Percent Detection Beacon %	> 97	98.58	98.53				
	Percent Detection Search %	> 70	44.80	46.20				
	Percent Detection Total (%)	> 97	98.93	98.90				
	Identity Reliability (%)	> 95	99.65	99.66				
	Identity Validity (%)	> 95	99.13	99.14				
	Altitude Reliability (%)	> 95	99.60	99.60				
	Altitude Validity (%)	> 95	99.05	99.07				
	Beacon Hits	> 29	30.4	30.5				
	Radar Reinforcement (%)	> 70	45.07	46.49				
	Search Collimation (%)	> 95	99.95	99.95				
	Range Error (nmi)	< 0.2	0.075	0.077				
	Azimuth Error (deg)	< 0.35	0.193	0.195				
Number of Tracks in Statistics		443	439					
Permanent Echo Accuracy								
(PE) Permanent Echo	Mode 3/A Code		1273	1274	1275	0306	1273	1274
	Single Rpt ATCRBS Update %	> 97	99.187	99.459	99.459	99.189		
	Range Error Mean (nmi)	< 0.13	0.012	0.001	0.001	-0.168		
	Range Error Std-Dev (nmi)	±0.13	0.000	0.000	0.009	0.062		
	Azimuth Error Mean (deg)	< 0.2	0.011	0.060	-0.013	0.054		
Azimuth Error Std-Dev (deg)	±0.2	0.063	0.060	0.064	0.052			

Recording Parameters	File Name (filename.ext)		ial205am.ibi	ial205am.ibi				
	File Date (mm/dd/yy)		12/05/94	12/05/94				
	Beacon Source		IBIA	IBIA				
	Beacon Antenna Tilt (deg)		2.0	2.0				
	Search Antenna Tilt (deg)		2.0	2.0				
	SLS/ISLS		SLS	SLS				
	Directional/Omni Power into Antenna (peak watts)							
	STC Value (dB)							
Comments: BFTS: Filtered codes assigned to multiple aircraft SA: Filtered CPMEs & Parrot			not filtered	filtered				
Beacon False Target Summary (BFTS)								
Note: Goal is <u>not</u> pass/fail		>Goal<						
(BFTS) Beacon False Target Summary	Total Number of Discrete Code Target Reports		33591	NONE				
	False Target Report %	< 1.5	0.10					
	Split %	< 0.5	0.02					
	Ringaround %	< 0.2	0.01					
	Downlink Reflection %	< 0.2	0.00					
	PRF %	< 0.2	0.02					
	Uplink Reflection %	< 0.2	0.01					
	Other %	< 0.2	0.02					
ATCRBS ID 0000 TGT RPT %	< 0.5	0.32						
Surveillance Analysis (SA)								
(SA) Surveillance Analysis	Percent Detection Beacon %	> 97	98.94	98.94				
	Percent Detection Search %	> 70	67.20	69.06				
	Percent Detection Total (%)	> 97	99.34	99.34				
	Identity Reliability (%)	> 95	99.63	99.63				
	Identity Validity (%)	> 95	99.09	99.08				
	Altitude Reliability (%)	> 95	99.58	99.58				
	Altitude Validity (%)	> 95	99.26	99.26				
	Beacon Hits	> 29	30.6	30.6				
	Radar Reinforcement (%)	> 70	67.48	69.36				
	Search Collimation (%)	> 95	99.95	99.95				
	Range Error (nmi)	< 0.2	0.075	0.076				
	Azimuth Error (deg)	< 0.35	0.217	0.220				
Number of Tracks in Statistics		342	338					
Permanent Echo Accuracy								
(PE) Permanent Echo	Mode 3/A Code		1273	1274	1275	0306	1273	1274
	Single Rpt ATCRBS Update %	> 97	95.066	100.00	100.00	99.344		
	Range Error Mean (nmi)	< 0.13	0.012	0.001	0.000	-0.163		
	Range Error Std-Dev (nmi)	±0.13	0.000	0.000	0.000	0.062		
	Azimuth Error Mean (deg)	< 0.2	-0.024	0.063	-0.012	0.052		
	Azimuth Error Std-Dev (deg)	±0.2	0.137	0.072	0.062	0.062		

Recording Parameters	File Name (filename.ext)		ibia_am.c06	ibia_am.c06				
	File Date (mm/dd/yy)		12/06/94	12/06/94				
	Beacon Source		IBIA	IBIA				
	Beacon Antenna Tilt (deg)		2.0	2.0				
	Search Antenna Tilt (deg)		2.0	2.0				
	SLS/ISLS		SLS	SLS				
	Directional/Omni Power into Antenna (peak watts)							
	STC Value (dB)							
Comments: BFTS: Filtered codes assigned to multiple aircraft SA: Filtered CPMEs & Parrot			not filtered	filtered				
Beacon False Target Summary (BFTS)								
Note: Goal is <u>not</u> pass/fail		>Goal<						
(BFTS) Beacon False Target Summary	Total Number of Discrete Code Target Reports		90530	90336				
	False Target Report %	< 1.5	0.18	0.17				
	Split %	< 0.5	0.06	0.06				
	Ringaround %	< 0.2	0.04	0.04				
	Downlink Reflection %	< 0.2	0.00	0.00				
	PRF %	< 0.2	0.03	0.03				
	Uplink Reflection %	< 0.2	0.01	0.01				
	Other %	< 0.2	0.04	0.02				
ATCRBS ID 0000 TGT RPT %	< 0.5	0.20	0.20					
Surveillance Analysis (SA)								
(SA) Surveillance Analysis	Percent Detection Beacon %	> 97	99.42	99.40				
	Percent Detection Search %	> 70	70.06	72.42				
	Percent Detection Total (%)	> 97	99.61	99.60				
	Identity Reliability (%)	> 95	99.73	99.74				
	Identity Validity (%)	> 95	99.31	99.32				
	Altitude Reliability (%)	> 95	99.76	99.76				
	Altitude Validity (%)	> 95	99.37	99.38				
	Beacon Hits	> 29	31.4	31.4				
	Radar Reinforcement (%)	> 70	70.26	72.65				
	Search Collimation (%)	> 95	99.98	99.98				
	Range Error (nmi)	< 0.2	0.071	0.072				
	Azimuth Error (deg)	< 0.35	0.198	0.201				
Number of Tracks in Statistics		551	547					
Permanent Echo Accuracy								
(PE) Permanent Echo	Mode 3/A Code		1273	1274	1275	0306	1273	1274
	Single Rpt ATCRBS Update %	> 97	100.00	99.474	99.341	99.079		
	Range Error Mean (nmi)	< 0.13	0.012	0.001	0.001	-0.167		
	Range Error Std-Dev (nmi)	± 0.13	0.000	0.000	0.009	0.062		
	Azimuth Error Mean (deg)	< 0.2	0.005	0.043	-0.025	0.054		
Azimuth Error Std-Dev (deg)	± 0.2	0.058	0.061	0.064	0.053			

Recording Parameters	File Name (filename.ext)		ibia_pm.c06	ibia_pm.c06				
	File Date (mm/dd/yy)		12/06/94	12/06/94				
	Beacon Source		IBIA	IBIA				
	Beacon Antenna Tilt (deg)		2.0	2.0				
	Search Antenna Tilt (deg)		2.0	2.0				
	SLS/ISLS		SLS	SLS				
	Directional/Omni Power into Antenna (peak watts)							
	STC Value (dB)							
Comments: BFTS: Filtered codes assigned to multiple aircraft SA: Filtered CPMEs & Parrot			not filtered	filtered				
Beacon False Target Summary (BFTS)								
Note: Goal is <u>not</u> pass/fail			>Goal<					
(BFTS) Beacon False Target Summary	Total Number of Discrete Code Target Reports		69889	69696				
	False Target Report %	< 1.5	0.25	0.20				
	Split %	< 0.5	0.05	0.05				
	Ringaround %	< 0.2	0.08	0.08				
	Downlink Reflection %	< 0.2	0.00	0.00				
	PRF %	< 0.2	0.02	0.02				
	Uplink Reflection %	< 0.2	0.04	0.04				
	Other %	< 0.2	0.06	0.01				
ATCRBS ID 0000 TGT RPT %	< 0.5	0.10	0.10					
Surveillance Analysis (SA)								
(SA) Surveillance Analysis	Percent Detection Beacon %	> 97	99.46	99.44				
	Percent Detection Search %	> 70	68.76	71.97				
	Percent Detection Total (%)	> 97	99.69	99.68				
	Identity Reliability (%)	> 95	99.82	99.83				
	Identity Validity (%)	> 95	99.61	99.63				
	Altitude Reliability (%)	> 95	99.83	99.84				
	Altitude Validity (%)	> 95	99.66	99.66				
	Beacon Hits	> 29	32.7	32.9				
	Radar Reinforcement (%)	> 70	68.88	72.11				
	Search Collimation (%)	> 95	99.96	99.96				
	Range Error (nmi)	< 0.2	0.070	0.072				
	Azimuth Error (deg)	< 0.35	0.206	0.211				
Number of Tracks in Statistics		454	450					
Permanent Echo Accuracy								
(PE) Permanent Echo	Mode 3/A Code		1273	1274	1275	0306	1273	1274
	Single Rpt ATCRBS Update %	> 97	99.876	100.00	99.377	99.128		
	Range Error Mean (nmi)	< 0.13	0.012	0.001	0.000	-0.171		
	Range Error Std-Dev (nmi)	±0.13	0.000	0.000	0.000	0.061		
	Azimuth Error Mean (deg)	< 0.2	0.004	0.047	-0.017	0.051		
Azimuth Error Std-Dev (deg)	±0.2	0.059	0.064	0.067	0.061			