ABSTRACT

MI Technologies was selected by the United States Air Force to design and install a complete turn-key test facility for depot maintenance support of the F-16 fighter aircraft. These facilities have been installed at Hill Air Force Base, Utah.

Four complete facilities have been supplied, each consisting of a Series 2020 Antenna Analyzer and a Series 5750 Compact Antenna Range. Two facilities are configured for antenna testing and two for radome testing.

This paper describes the equipment furnished for this program. The hardware is discussed as well as the special software designed to perform specific radome and antenna tests.

INTRODUCTION

Current techniques used to test aircraft antennas and radomes are on large outdoor ranges subjected to varying environment and weather conditions. Some antenna testing has been brought inside with the acceptance of the compact antenna range or where very large anechoic chambers are available. It is very desirable to locate all equipment indoors in a controlled environment.

The original concept of these systems was to design and configure special hardware/software to provide depot maintenance of the F-16 antenna and radome. This would have involved an expensive design, fabrication and maintenance program, since special hardware and software would have to be developed. MI Technologies proposed a system using its basic 2020 Automatic Antenna Analyzer and 5751 Compact Antenna Range as the prime equipment. The hardware and software was modified as required to meet the specific test requirement. This allowed standard available equipment to be used and in turn reduced the design effort.

Two basic systems were required: one for testing the fire control radar antenna and another for testing the electrical characteristic of the aircraft nose radome. Both systems use the same equipment wherever possible. This provided even additional commonality of equipment between systems, reducing operator training, spares, etc. Each system is enclosed in a shielded chamber lined with absorber. The compact range reflector and associated positioning equipment are mounted on a monolithic pad to isolate the systems from the environment for boresight measurements.

To best present the test facilities the antenna and radome system are discussed separately.

ANTENNA TEST SYSTEM

General

The compact antenna test range is an integrated depot level maintenance test tool that provides:

- Automatic/Manual Test Procedures
- Antenna Parameter Test Measurements
- Test Data Recording And Storage
- Electromechanical Boresight Measurements
The system is a combination and expansion of two very successful commercial product items manufactured by MI Technologies:

- Series 2020 Antenna Analyzer
- Series 5750 Compact Range

These products were tailored by providing the required mechanical/electrical interfaces, antenna control, range interconnect and special F-16 software.

**Facilities**

Refer to Figure 1 for an outline of an individual antenna test system installation module. This module is divided into two separate rooms by a wall and large viewing window. One room is an anechoic chamber in which the compact range is located. The other room contains the antenna analyzer mounted in a console. The complete module is shielded from the outside environment. The compact range reflector, feed positioner, antenna positioner and boresight system are mounted on a large mechanically isolated concrete "T" pad. The basic specifications for the module are:

<table>
<thead>
<tr>
<th>Specification</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Floor Space Chamber</td>
<td>20' x 36'</td>
</tr>
<tr>
<td>Control Room</td>
<td>10' x 15'</td>
</tr>
<tr>
<td>Shielding</td>
<td>100 dB (at operating freq.)</td>
</tr>
<tr>
<td>Absorber Chamber Room</td>
<td></td>
</tr>
<tr>
<td>Humidity Control</td>
<td>40% ±10% R.H.</td>
</tr>
<tr>
<td>Temperature Control</td>
<td>70 °F ±4°F</td>
</tr>
<tr>
<td>Stable Platform</td>
<td>Monolith Pad isolated from environment</td>
</tr>
</tbody>
</table>
Figure 1 Antenna Test System (Sh 1)

1. VSWR TEST SUBSYSTEM
2. ANTENNA ANALYZER SUBSYSTEM
3. ARRAY CONTROL UNIT SUBSYSTEM
4. COMPACT RANGE SUBSYSTEM
5. RF SIGNAL SWITCHING SUBSYSTEM
6. MANUAL BORESIGHT SUBSYSTEM
SYSTEM DESCRIPTION

The antenna test system is a completely integrated measurement system providing manual, semi-automatic and automatic modes of test capability for depot level testing of the F-16 Fire Control Radar Antenna assemblies. Fault isolation test capability provides for isolation of a malfunction in an unserviceable assembly to the spared level part/subassembly. Depot level tests include documentation of the following antenna parameters, as well as fault isolation routines:

a. Beamwidth
b. Beam Separation
c. Sidelobe Level
d. Gain
e. Boresight
f. VSWR

The five function subsystems which make up the antenna test system include:

a. Compact Range Subsystem
b. Antenna Analyzer Subsystem
c. VSWR Test Subsystem
d. Manual Boresight Subsystem
e. RF Signal Switching and Array Control Unit Subsystem
Control and RF interconnections among these subsystems are shown in Figure 2. The Compact Range creates the required electromagnetic environment and positioning capability to allow pattern testing, gain documentation and boresighting of the antenna under test. Selection of the appropriate RF paths and test assembly uniphasor drive signals for the various test modes involves operator input to the array control unit. This selection set the RF signal switching subsystem, the test/standard select switch functions, and the phase shifters. Specific frequencies, test orientations, signal processing and data analysis are controlled via the antenna analyzer for all pattern testing. The boresight subsystem includes optical devices and a boresight meter. The boresight test and alignment routines are manual. VSWR testing is also a manual operation, performed on the self-contained VSWR test subsystem in the control room. Test routines other than the specific antenna test menu (listed above) are possible with appropriate operator interactions with the antenna analyzer. This more general test capability is inherent in the system due to the complete instrumentation package and the operating software of the MI Technologies Model 2021C subsystem.
FIGURE 2 Antenna Test System Block Diagram
Compact Range Group

This section refers to Figure 3, Compact Range Subsystem Diagram. The compact range is composed of the equipment needed to radiate, collimate, and detect the RF signals; to position or polarize the RF source; to position the antenna; to facilitate fault isolation, and to measure the position of the antenna. The compact range provides the ability to test, in relatively small indoor chambers, antennas which normally require outdoor antenna ranges hundreds or even thousands of feet long. The compact range provides all the advantages of indoor testing, including reduced test time, elimination of large outdoor range facilities and real estate, improved security and immunity to adverse environmental factors.

In the test-on-receive mode, the point-source compact range feed radiates diverging rays from its location at the focal point of the range reflector. The range reflector collimates this primary radiation, producing a planar illuminating field over the test region which is centered on and normal to the longitudinal axis of the test zone. The incident wave has a very flat phase front and a small amplitude taper across the test zone.

In the test-on-transmit mode, the reflector converges the rays radiated in the direction of the reflector by the unit under test (UUT) to its focal point where the feed is located.

The test positioner is comprised of an upper polarization (roll) positioner mounted via a welded mast section to the azimuth turntable of an azimuth-over-elevation positioner, which is in turn mounted on the carriage platform of a longitudinal slide mechanism. The turntable of the upper positioner is fitted with precision mounting studs for direct interface with the UUT.

All test positioner axes may be automatically or manually controlled from the antenna analyzer console. Position data from each axis is provided to the antenna analyzer console for control, display, and recording functions. Typical pattern testing of the UUT employs the elevation axis as the step axis, the azimuth axis as the scan axis, and the roll axis as a polarization or elevation—plane/azimuth—plane switch axis. The elevation and azimuth axes are fitted with handcranks for use in manual boresighting procedures.

The standard gain horn antenna and the TEST ANT/STD HORN selection switch are employed in gain—comparison tests of the UUT. These items are mounted on the test positioner assembly with the horn axis aligned on the positioner roll axis diametrically opposite from the UUT. For reception through the horn, the azimuth axis is rotated 180 from the normal UUT test orientation, and the selection switch is changed from TEST ANT to STD HORN via remote control from the antenna analyzer console.
Antenna Analyzer Subsystem

This subsystem is comprised of four functional groups plus the basic enclosures or console racks, mounting hardware, cabling, and prime power interface/control units:

- Signal Source Subsystem
- Receiving and Recording Subsystem
- Positioner Control Subsystem
- Digital Processing Subsystem

Special data acquisition and analysis software was generated to provide:

a. Beamwidth Data
b. Beam Separation Data
c. Sidelobe Level Data
d. Gain Data
A final test summary record of the pass/fail condition of the UUT was provided with individual summary of each test also available. Samples of these tests are shown in Figures 4 through 7.

**FINAL TEST SUMMARY**

DATA CARTRIDGE: WORK3  
DATE: 7/18/82  
TIME: 19:20  
RESULT FILE: R02088  
OPERATOR: RHB

<table>
<thead>
<tr>
<th>TEST</th>
<th>PASS/FAIL</th>
</tr>
</thead>
<tbody>
<tr>
<td>BEAMWIDTH</td>
<td>PASS</td>
</tr>
<tr>
<td>BEAM SEPARATION</td>
<td>FAIL</td>
</tr>
<tr>
<td>SIDELOUGE LEVEL</td>
<td>PASS</td>
</tr>
<tr>
<td>GAIN</td>
<td>FAIL</td>
</tr>
<tr>
<td>BORESIGHT</td>
<td>N.E.</td>
</tr>
<tr>
<td>VSWR</td>
<td>N.E.</td>
</tr>
</tbody>
</table>

**FIGURE 4: Antenna Test Summary**

**BEAMWIDTH TEST SUMMARY**

ANTENNA NO.: R02088  
DATE: 7/18/82  
TIME: 19:20  
RESULT FILE: R02088  
DATA CARTRIDGE: WORK3  
DATA FILE: D08801

<table>
<thead>
<tr>
<th>TEST PARAMETER</th>
<th>MEASUREMENT</th>
<th>SPEC.</th>
<th>IN/OUT SPEC.</th>
</tr>
</thead>
<tbody>
<tr>
<td>EL. BEAMWIDTH @ F0-100MHZ</td>
<td></td>
<td></td>
<td>IN</td>
</tr>
<tr>
<td>EL. BEAMWIDTH @ F0</td>
<td></td>
<td></td>
<td>IN</td>
</tr>
<tr>
<td>EL. BEAMWIDTH @ F0+100MHZ</td>
<td></td>
<td></td>
<td>IN</td>
</tr>
<tr>
<td>AZ. BEAMWIDTH @ F0-490MHZ</td>
<td></td>
<td></td>
<td>IN</td>
</tr>
<tr>
<td>AZ. BEAMWIDTH @ F0-100MHZ</td>
<td></td>
<td></td>
<td>IN</td>
</tr>
<tr>
<td>AZ. BEAMWIDTH @ F0</td>
<td></td>
<td></td>
<td>IN</td>
</tr>
<tr>
<td>AZ. BEAMWIDTH @ F0+100MHZ</td>
<td></td>
<td></td>
<td>IN</td>
</tr>
</tbody>
</table>

**FIGURE 5: Antenna Beamwidth Test Summary**
SIDELOBE LEVEL TEST SUMMARY

ANTENNA NO.: R02299
DATE: 7/18/82
RESULT FILE: R02299

DATA CARTRIDGE: WORK3
TIME: 19:20
OPERATOR: RHB
DATA FILES: D00606-D02999

1ST SIDELOBE AZ(F0): -37.70DB @ 4.94DEG.
SPEC.: <=-30.60DB IN/OUT SPEC.: IN

1ST SIDELOBE EL(F0): -27.20DB @ 6.73DEG.
SPEC.: <=-25.60DB IN/OUT SPEC.: IN

HIGHEST SIDELOBE LEVEL(F0) +12 TO +90 DEG.: -36.60DB @ 42.37DEG.
HIGHEST SIDELOBE LEVEL(F0) -12 TO -90 DEG.: -35.90DB @ -61.51DEG.

FIGURE 6: Antenna Sidelobe Test Summary

GAIN TEST SUMMARY

ANTENNA NO.: R02299
DATE: 7/10/82
RESULT FILE: R02299

DATA CARTRIDGE: WORK3
TIME: 19:20
OPERATOR: RHB
DATA FILES: D00810-D00811

<table>
<thead>
<tr>
<th>TEST PARAMETER</th>
<th>MEASUREMENT</th>
<th>SPEC.</th>
<th>IN/OUT SPEC.</th>
</tr>
</thead>
<tbody>
<tr>
<td>TX+RX GAIN @ F0=180MHz</td>
<td></td>
<td></td>
<td>OUT</td>
</tr>
<tr>
<td>TX+RX GAIN @ F0</td>
<td></td>
<td></td>
<td>OUT</td>
</tr>
<tr>
<td>TX+RX GAIN @ F0=180MHz</td>
<td></td>
<td></td>
<td>IN</td>
</tr>
<tr>
<td>TX GAIN @ F0=425MHz</td>
<td></td>
<td></td>
<td>OUT</td>
</tr>
<tr>
<td>TX GAIN @ F0=308MHz</td>
<td></td>
<td></td>
<td>IN</td>
</tr>
<tr>
<td>TX GAIN @ F0=365MHz</td>
<td></td>
<td></td>
<td>IN</td>
</tr>
<tr>
<td>RX GAIN @ F0=490MHz</td>
<td></td>
<td></td>
<td>IN</td>
</tr>
</tbody>
</table>

FIGURE 7: Antenna Gain Test Summary
**VSWR Test Subsystem**

This subsystem is a microwave reflectometer that measures the return loss from the UUT. The subsystem includes a sweep oscillator, directional coupler, detectors, swept amplitude analyzer, and an open-end enclosure lined with microwave absorber to terminate the wave radiated from the UUT during test.

A swept frequency is generated by the sweep oscillator. The dual-directional coupler separates the incident (reference) signal and the reflected signal. Diode detectors are used to detect these signals.

The reflectometer is calibrated by placing a short at the test port and inserting a fixed attenuator (calibration reference) at the reflected signal port of the coupler. With the calibration reference attenuator removed and the short replaced by the UUT, the actual return loss of the UUT is displayed and the largest value is manually recorded for input to the digital processing unit.

**Manual Boresight Subsystem (Figure 8)**

This subsystem is employed during boresight alignment, pinning of the UUT and in boresight error checks of previously aligned assemblies. In either case, the boresight reference is established by specific settings of the test positioner in azimuth and elevation, for which the interface plane on the test positioner polarization axis is exactly parallel to the illuminating plane phase front. Due to the close tolerance requirements for these tests, the boresight angle readout is by means of an autocollimator within 0.5 arc second of measurement accuracy.

A boresight calibration procedure is followed to establish the boresight reference settings of the test positioner and autocollimator. This procedure requires the use of a null-forming antenna which operates at the frequency of interest.

The calibration antenna is electrically boresighted by observing null readings for each axis on the boresight meter. Repetition of this electrical boresight condition before and after a 180 roll of the antenna assembly about the polarization axis defines two sets of azimuth and elevation angles. Positioning to the average angle value for each axis establishes the mechanical boresight reference orientation.
With the positioner oriented to the calibration reference, the autocollimator and the positioner-mounted mirror are adjusted for auto reflection conditions. The autocollimator is then adjusted to a reference setting in the horizontal (azimuth) and vertical (elevation) planes. The calibration antenna, if other than the UUT, is then removed and replaced by the UUT to be tested. The UUT is reoriented in azimuth and elevation to establish electrical boresight. The resulting displacements of the azimuth and elevation axes are read with the autocollimator, and the differences in the test assembly boresight angles and the reference boresight angles are determined as boresight error values.

**RF Signal Switching and Array Control Subsystem**

Since the UUT requires gain measurements to be made in both the transmit mode and receive mode, a range reversal switching matrix was provided. A sample of the RF input is coupled off for phase locking the receiver.

The array control provides the beam steering drive/control for the UUT and provides synchronous detection of the IF modulated signal for azimuth and elevation boresight error signals.

**Antenna Test System Summary**

The special test and analysis modifications removed none of the basic compact range/antenna analyzer capability. All of the standard antenna analyzer software which provides for any generalized antenna measurement is available.

The final antenna system performance specifications are shown below.
RADOME TEST SYSTEM

General

This was the first known attempt to integrate a 2020 Antenna Analyzer system into an automated radome test system and one of the first to utilize a compact range for radome testing.

The basic requirement was to provide an indoor, self—contained automated test facility to electrically test the F-16 nose radome for:

- Transmission Efficiency (TE)
- Boresight Error (BSE)
- Boresight Error Rate (BSER)
- Pattern Distortion/Image Lobe Measurements

The facility requirement is the same as that for the antenna test system. Figure 9 depicts the nose radome test system.

System Description

Refer to Figure 10 for the overall radome system functional block diagram. Figure 11 is the functional diagram of that portion which is considered the compact range.

The compact range is used for radiating and collimating the radio frequency (RF) signals, positioning the RF source and radome, and detecting and measuring boresight shifts. The compact range consists of six primary assemblies; they are:

- Angle Measurement
- Test Positioner
- Source Positioner and Feed
- Parabolic Reflector
- Radome Carriage Assembly
- Laser Boresight Illuminator

The angle measurement assembly is a laser, mirror, and detector system which is used to make precise measurements of the pitch and yaw angles of the antenna. This assembly is used with the test positioner to provide these angles. The lower three axes of the five axis test positioner are designated as the radome axes. They are, from bottom to top, the azimuth axis, the elevation axis, and the roll axis. The radome, henceforth called the unit under test (UUT), is mounted to the roll axis. The antenna, which is an F-16 aircraft type phased array, is mounted on an azimuth and elevation gimbal which constitutes the upper two axes of the test positioner. The source positioner is mounted in front of the parabolic reflector. This assembly is a one axis positioner and controls the polarization of the source feed horn either to a vertical or horizontal position. The feed horn transmits the RF signal to the parabolic reflector. The parabolic reflector is designed in such a manner as to simulate a compact range. The reflector does this by

<table>
<thead>
<tr>
<th>Test</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beamwidth</td>
<td>± 0.15º</td>
</tr>
<tr>
<td>Beam Separation</td>
<td>± 0.15º</td>
</tr>
<tr>
<td>Sidelobe Levels</td>
<td>± 0.4 dB</td>
</tr>
<tr>
<td>One-Way Gain</td>
<td>± 0.5 dB</td>
</tr>
<tr>
<td>Two-Way Gain</td>
<td>± 0.7 dB</td>
</tr>
<tr>
<td>VSWR (at 1.4 to 1)</td>
<td>± 0.03</td>
</tr>
<tr>
<td>Boresight</td>
<td>± 0.44 MRAD</td>
</tr>
</tbody>
</table>
producing a collimated plane wave back to the receiving antenna through the UUT. The radome or UUT is mounted onto the test positioner using the facilities of the radome carriage control. The radome carriage control is used to facilitate the transporting and mounting of the UUT. The laser boresight illuminator is used to indicate which part of the UUT is pointed toward the laser boresight by reflecting the laser from a mirror, mounted on the parabolic reflector, onto the UUT which produces a visible spot on the radome. The laser boresight illuminator is mounted on the source positioner.

Figure 9 Radome Test Range
FIGURE 10 Radome System Function Block Diagram
Figure 11 Compact Range Functional Diagram
**Antenna Analyzer**

Refer to Figure 12 for the antenna analyzer functional block diagram. The antenna analyzer controls the operation of the compact range. It positions the radome, antenna, and source; then monitors and analyzes the received RF signal. The antenna analyzer consists of five functional subsystems; they are:

a. Microwave Signal Source Subsystem  
b. Receiving Subsystem  
c. Position Control Subsystem  
d. Digital Processing Subsystem  
e. Gimbal Controller Subsystem  

The microwave signal source and receiving subsystems generate and detect the RF signals respectively. The position control subsystem controls the radome axis of the test positioner and the polarization axis of the source positioner. The digital processing subsystem controls all the subsystems of the antenna analyzer. Interaction with the operator and the output of the test results are also controlled by this subsystem. The gimbal controller subsystem controls the position of the antenna array by controlling the gimbal axes of the test positioner. The gimbal controller subsystem can position the antenna array by either manual selection, automatically, or by autotracking the received RF signal. The multiprogramming interface is a multichannel analog-to-digital converter. Analog data from the angle measurement system and the gimbal controller subsystem are digitized by the multiprogramming interface and then sent to the computer. The computer and the multiprogramming interface are both a part of the digital processing subsystem.

![Figure 12 Antenna Analyzer Functional Block Diagram](image-url)
**Test Description**

The software controlled tests which the system executes are:

a. Image Sidelobe Levels  
b. Transmission Efficiency  
c. Beam Deflections

These tests perform measurements on the UUT and then determine if the results are within the allowable specifications. In general, the sidelobes of the antenna are changed by the reflections of the RF energy from the dielectric radome surface to create image lobes. The image sidelobes level test measures these antenna image lobe levels within the UUT. During this test, the antenna is held in a fixed position relative to the UUT while the lower radome axis makes principle plane scans of the antenna.

The transmission efficiency test measures the received RF power as a function of the radome position while the radome axis scans the UUT. Power transmission efficiency is a measure of the RF energy losses in passing through the dielectric radome surface. The antenna within the UUT autotacks the RF axis of the compact range. The transmission efficiency is automatically calculated by comparing the received RF power with the UUT, and the RF power without the UUT.

The beam deflection test is the refraction of the RF signal in passing through the dielectric radome. The beam deflection test calculates the beam deflection by measuring the angle between the compact range RF axis and the apparent RF axis sensed by the antenna within the UUT. The antenna autotacks the apparent RF axis within the UUT. As the radome axis scans the UUT, the beam deflection is calculated using data from the angle measurement system and the servo controller subsystem.

The software of the antenna analyzer provides the following data analysis and printout in addition to the standard 2020 software:

- Radome Certification Report (complete summary)  
- Seven Complete Test Parameter Results  
- Boresight Error vs. Radome Positioner Plot  
- Transmission Efficiency vs. Radome Positioner Plot  
- Out-of-Spec Boresight vs. Look Angle Plot

Samples of the printouts are shown in Figures 13 through 17.
RADOME CERTIFICATION REPORT

SERIAL NO. R0139
RESULT: FAIL

DATE: 3/31/82
START: 12:00
CART NAME: W0R1
RESULT FILE: R0139
OPERATOR: RHB

IMAGE LEVEL TESTS

TEST NO. 1 RIGHT SIDE PASS
TEST NO. 2 LEFT SIDE PASS
TEST NO. 3 TOTAL RADOME PASS
TEST NO. 4 NOSE SECTION PASS
TEST NO. 5 TOP HEMISPHERE PASS

BEAM DEFLECTION AND TRANSMISSION EFFICIENCY

TEST NO. 6 NOSE SECTION PASS
TRANS. EFF. PASS
RATE OF CHANGE PASS
TEST NO. 7 TOTAL RADOME FAIL
TRANS. EFF. INSIDE CONE PASS
OUTSIDE CONE PASS
BEAM DEFLECTION PERF.CURVES FAIL
RATE OF CHANGE PASS

FIGURE 13 Radome Certification Report

IMAGE LEVEL TEST NO. 1

SERIAL NO. R0139
TEST RESULT: PASS

DATE: 3/31/82
START: 12:00
CART NAME: W0R1
RESULT FILE: R0139
OPERATOR: RHB
LOWEST DATA FILE: 13923
HIGHEST DATA FILE: 13934

RIGHT SIDE

<table>
<thead>
<tr>
<th>TF NO.</th>
<th>FREQ.</th>
<th>LOOK ANGLE</th>
<th>PEAK LEVEL</th>
<th>THRSH. LEVEL</th>
<th>FREQ. BALANCE</th>
<th>SCAN RESULT</th>
</tr>
</thead>
<tbody>
<tr>
<td>23</td>
<td>FØ</td>
<td>28.8</td>
<td>-3.5</td>
<td>-47.5</td>
<td>-15.0</td>
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<tr>
<td>24</td>
<td>FØ</td>
<td>38.8</td>
<td>-3.5</td>
<td>-51.4</td>
<td>-16.4</td>
<td>PASS</td>
</tr>
<tr>
<td>25</td>
<td>FØ</td>
<td>48.8</td>
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<td>-55.1</td>
<td>-20.1</td>
<td>PASS</td>
</tr>
<tr>
<td>26</td>
<td>FØ</td>
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<td>FL</td>
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<td>29</td>
<td>FL</td>
<td>43.8</td>
<td>-3.5</td>
<td>-53.1</td>
<td>-18.1</td>
<td>YES PASS</td>
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<tr>
<td>30</td>
<td>FL</td>
<td>53.8</td>
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<td>-48.9</td>
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<td>NO PASS</td>
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<td>FH</td>
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<td>-45.9</td>
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<td>32</td>
<td>FH</td>
<td>33.8</td>
<td>-3.5</td>
<td>-55.5</td>
<td>-28.5</td>
<td>YES PASS</td>
</tr>
<tr>
<td>33</td>
<td>FH</td>
<td>43.8</td>
<td>-3.5</td>
<td>-55.8</td>
<td>-28.8</td>
<td>YES PASS</td>
</tr>
<tr>
<td>34</td>
<td>FH</td>
<td>53.8</td>
<td>-3.5</td>
<td>-52.6</td>
<td>-17.6</td>
<td>NO PASS</td>
</tr>
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</table>

FIGURE 14 Radome Image Level Test
BEAM DEFLECTION TEST NO. 7
STANDARD SEQUENCE NO. 1
DATE: 3/31/82 START: 12:58
CART NAME: W0RK1 RESULT FILE: B0139
TRANSMISSION EFFICIENCY

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<tr>
<th>AVERAGE %</th>
<th>SPEC %</th>
<th>SCAN RESULT</th>
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</thead>
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<tr>
<td>INSIDE CONE</td>
<td>95</td>
<td>75</td>
</tr>
<tr>
<td>OUTSIDE CONE</td>
<td>94</td>
<td>85</td>
</tr>
</tbody>
</table>

BEAM DEFLECTION

<table>
<thead>
<tr>
<th>VALUE</th>
<th>SPEC</th>
<th>SCAN RESULT</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAX. DEVIATION FROM PERFORMANCE CURVES (MR)</td>
<td>4.2</td>
<td>2.8</td>
</tr>
<tr>
<td>MAX. RATE OF CHANGE (MR/DEGREE)</td>
<td>.2</td>
<td>1.4</td>
</tr>
</tbody>
</table>

FIGURE 15  Radome Beam Deflection

FIGURE 16  Radome Beam Deflection vs. Look Angle
SUMMARY

Radome systems are usually tailored for single radome/antenna types. This is especially true for this system due to the large scan angles required resulting in a unique positioner design. To expand the radome system to be used for other radomes, each case would have to be reviewed closely.

The compact radome test system meets all of the original design goals and specifications. The final system performance is as follows:

<table>
<thead>
<tr>
<th>Test</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boresight Error</td>
<td>±0.24 MRAD</td>
</tr>
<tr>
<td>Transmission Efficiency</td>
<td>±2.0%</td>
</tr>
<tr>
<td>Image Lobe Level (-36 dB)</td>
<td>±1.0 dB</td>
</tr>
</tbody>
</table>