

International Flight Inspection Symposium

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Routine ILS Flight Inspections Conducted From a Remote Location



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History

- Centralized Navigational Aids (NAVAIDS) maintenance began as a standard ILS equipment modernization in 2002
- AFMC leadership decided to exploit the remote maintenance capability of the new system in early 2003
- AFMC established the Customer Support Team (CST) as a centralized maintenance facility

History

- The CST maintains the following NAVAIDS at 7 airfields:
 - 11 Category I Instrument Landing Systems and 2 localizer-only systems
 - 5 Tactical Air Navigation (TACAN) systems
 - 1 Very High Frequency Omnidirectional Range (VOR)
 - 1 Distance Measuring Equipment (DME)
- Current CST manning is 4 technicians, 1 supervisor, and 1 work group manager

History

- All NAVAIDS systems are under a 15-year parts warranty
- Maintenance and certification activities conducted within a \$90K annual budget
- Availability rates exceed 99.6% across the fleet (All single transmitter systems)
- Mean time to repair statistics
 - 15 minutes when no part is required
 - 26 hours when part is required

History

- Centralized ILS Maintenance must address Periodic-with-Monitors flight inspections
- Traveling to perform routine flight inspections defeats the concept
- Procedures, hardware, and software developed to conduct periodic-with-monitors checks currently required in the US Standard Flight Inspection Manual

Software Controls

- All Localizer and Null Reference Glideslope (NRGS) checks/adjustments completed with software controls only
- Some checks and adjustments on Capture Effect (CEGS) and Sideband Reference Glideslopes (SBRGS) are also completed via software controls
- Process begins when the CST initiates a remote maintenance session

Remote Maintenance Session

- Technician contacts Remote Control and Status Unit (RCSU) utilizing the Portable Maintenance Data Terminal (PMDT) program
- RCSU provides:
 - Status to the Remote Status Display Unit (RSDU) in the ATC Operations area
 - Access to the Navigation Aids Remote Maintenance System (RMS) via status lines

Security

- Protocols and Levels:
 - USAF Telephone system that blocks unauthorized modem access
 - Positive control of site dial-in modem numbers
 - RCSU/RMS will only communicate with current PMDT version
 - Software positively controlled

Security

- Protocols and Levels Continued:
 - User Names and Passwords assigned to technicians
 - Highest level required to affect signal-in-space
 - Follow USAF rules for complexity
 - Changed periodically, when employees depart, and when compromises are suspected
 - Passwords and User Names encrypted with a special, proprietary protocol when transmitted

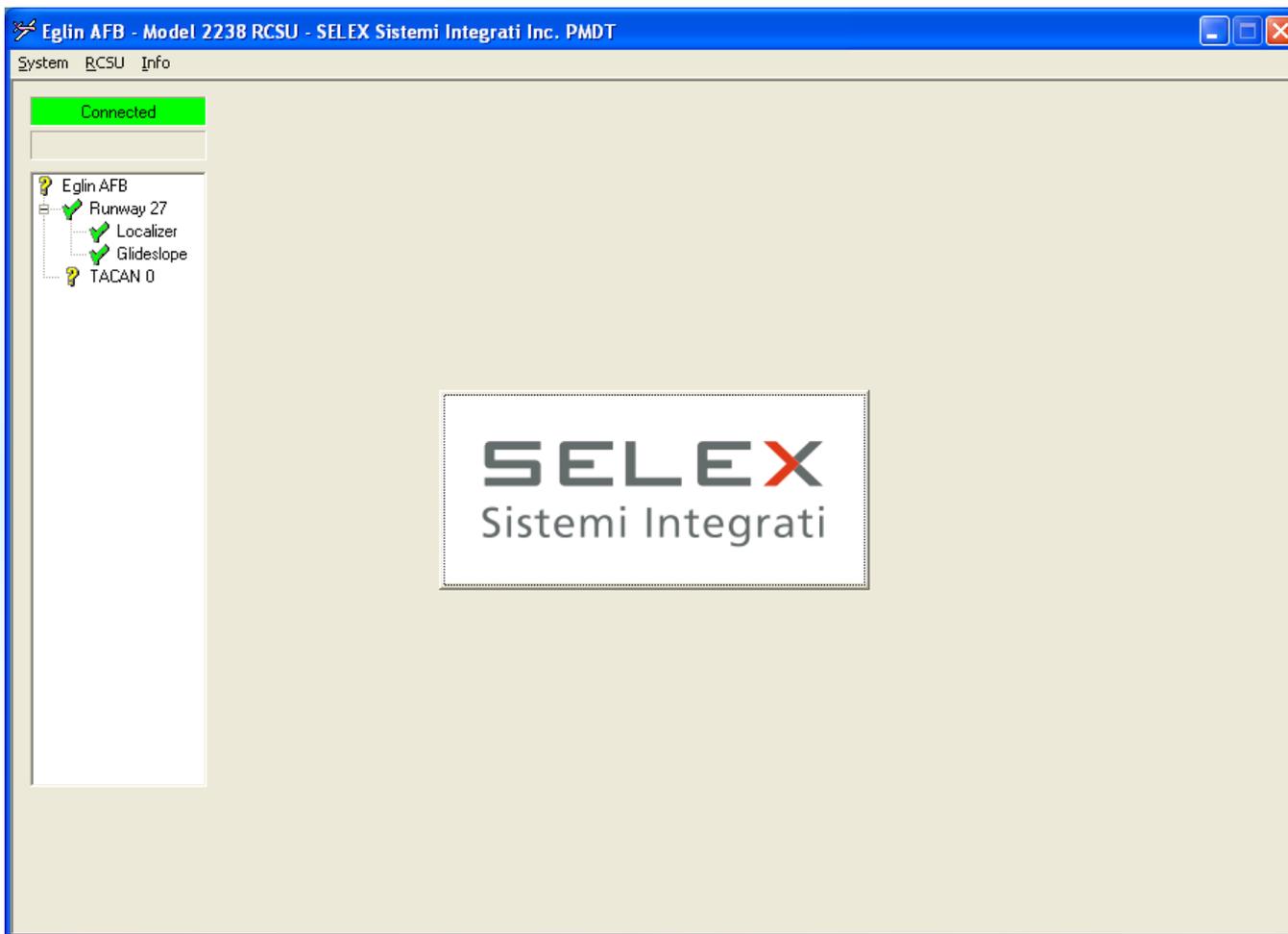
Security

- To affect signal-in-space, the technician must take control of the system
 - Immediate off-air status provided to ATC Operations
 - System removed from service
 - CST notified to begin investigation
- Connection logs are periodically screened to detect unauthorized incursions, none have been detected to date

Remote Maintenance Session

- Upon completion of secure login procedure:
 - Technician right-clicks on desired site
 - PMDT connects to site RMS
 - Pre-flight inspection checks are completed
- Technician can also connect to site directly if there is a line or RCSU failure
 - RCSU connection preferred due to greater transition speed

RCSU System Display



Localizer Flight Inspection

- Normal Alignment , Modulation, and Identity Modulation are adjusted using the PMDT Transmitter Configuration screen
- Normal Width is adjusted using the Transmitter Configuration screen in conjunction with the Wattmeter Data screen

Transmitter Configuration

The screenshot displays the 'Transmitter Configuration' window for 'Transmitter 1'. The window title is 'Eglin CHOT - Model 2100 Single CE Localizer - SELEX Sistemi Integrati Inc. PMDT'. The interface includes a menu bar (System, RMS, Monitors, Monitor 1, Transmitters, Diagnostics, Info) and a toolbar with buttons for 'Next (F5)', 'Close (F6)', 'Apply (F7)', and 'Reset (F8)'. A status bar at the top left indicates 'Connected'. On the left side, there are control panels for 'Alert' (Local), 'Transmitters' (Tx1, Antenna, Off), and 'Monitors' (Integral, Normal, Alarm, Bypass). At the bottom left, there are input fields for 'Int CRS Pos', 'Int CRS Width', 'Int CLR Pos', 'Int CLR Width', and 'Inline Phase'. The main configuration area is divided into 'Course' and 'Clearance' sections, each containing a table of parameters with numerical values and units.

Course		
CSB Modulation Balance Offset	0.000	DDM
CSB Modulation Percent Scale	101.7	%
CSB RF Voltage Level Scale	96.5	%
SBO RF Voltage Level Scale	87.0	%
SBO Phase Offset	-16.0	Degrees
Ident Level Scale	99.5	%

Clearance		
CSB Modulation Balance Offset	0.000	DDM
CSB Modulation Percent Scale	98.0	%
CSB RF Voltage Level Scale	99.0	%
SBO RF Voltage Level Scale	100.0	%
SBO Phase Offset	-18.0	Degrees
Ident Level Scale	102.0	%

Wattmeter Data

The screenshot displays the 'Eglin CHOT - Model 2100 Single CE Localizer - SELEX Sistemi Integrati Inc. PMDT' software interface. The window title bar includes standard OS controls and a menu bar with 'System', 'RMS', 'Monitors', 'Monitor 1', 'Transmitters', 'Diagnostics', and 'Info'. A green 'Connected' status bar is visible at the top left. Below it, there are checkboxes for 'Alert' and 'Local', and a 'Transmitters' section with 'Tx1' selected and 'Antenna' checked. A 'Monitors' section shows 'Integral' checked, 'Normal' selected, and 'Alarm' and 'Bypass' unchecked. At the bottom left, there are several numerical input fields: 'Int CRS Pos' (0.000), 'Int CRS Width' (0.155), 'Int CLR Pos' (0.000), 'Int CLR Width' (0.155), and 'Inline Phase' (0.041). The main area is titled 'Transmitter Data' and contains a 'Wattmeter Data' section for 'Transmitter 1 Synthesizer and PA Data'. This section shows a timestamp of '04/14/08 11:09:39' and two tables of power parameters. The 'Course Transmitter Parameters' table shows CSB Forward Power at 15.100 Watts, CSB Reflected Power at 0.000 Watts, SBO Forward Power at 0.306 Watts, and SBO Reflected Power at 0.000 Watts. The 'Clearance Transmitter Parameters' table shows CSB Forward Power at 12.000 Watts, CSB Reflected Power at 0.108 Watts, SBO Forward Power at 0.400 Watts, and SBO Reflected Power at 0.002 Watts. Navigation buttons for 'Next (F5)', 'Close (F6)', 'Apply (F7)', and 'Reset (F8)' are located at the top right of the main area.

Course Transmitter Parameters		
CSB Forward Power	15.100	Watts
CSB Reflected Power	0.000	Watts
SBO Forward Power	0.306	Watts
SBO Reflected Power	0.000	Watts

Clearance Transmitter Parameters		
CSB Forward Power	12.000	Watts
CSB Reflected Power	0.108	Watts
SBO Forward Power	0.400	Watts
SBO Reflected Power	0.002	Watts

Localizer Flight Inspection

- If normal width, alignment, modulation, or identity modulation adjustments were required, it may be necessary to offset the monitors prior to starting the alarm checks
- This task is accomplished using the Monitor Offsets and Scale Factors screen in conjunction with the Monitor Integral Data screen

Monitor Offsets & Scale Factors

Eglin CHOT - Model 2100 Single CE Localizer - SELEX Sistemi Integrati Inc. PMDT

System RMS Monitors Monitor 1 Transmitters Diagnostics Info

Connected

Monitor 1 Offsets and Scale Factors

Next (F5) Close (F6) Apply (F7) Reset (F8)

Integral Certification

04/14/08 11:14:09

Course

Centerline RF Reference Level	7417	FFT Power
Centerline DDM Offset	0.004	DDM
Centerline SDM Scale	98.9	% Mod
Ident Mod Percent Scale	103.0	% Mod
Width DDM Offset	-0.002	DDM

Clearance

Centerline RF Reference Level	8393	FFT Power
Centerline DDM Offset	0.010	DDM
Centerline SDM Scale	103.5	% Mod
Ident Mod Percent Scale	101.6	% Mod
Width DDM Offset	-0.002	DDM

Alert Local

Transmitters

Tx1

Antenna

Off

Monitors

Integral

Normal

Alarm

Bypass

Int CRS Pos 0.000

Int CRS Width 0.155

Int CLR Pos 0.000

Int CLR Width 0.153

Inline Phase -0.005

Monitor Integral Data

Eglin CHOT - Model 2100 Single CE Localizer - SELEX Sistemi Integrati Inc. PMDT

System RMS Monitors Monitor 1 Transmitters Diagnostics Info

Connected

Alert Local

Transmitters
Tx1

Antenna

Off

Monitors
Integral

Normal

Alarm

Bypass

Int CRS Pos 0.001
Int CRS Width 0.156
Int CLR Pos 0.001
Int CLR Width 0.154
Inline Phase -0.002

Monitor 1 Data

04/14/08 11:15:59

Course Ident Status Normal Clearance Ident Status Normal

Antenna Fault Course Synthesizer Lock Fault Status Clearance Synthesizer Lock Fault Status

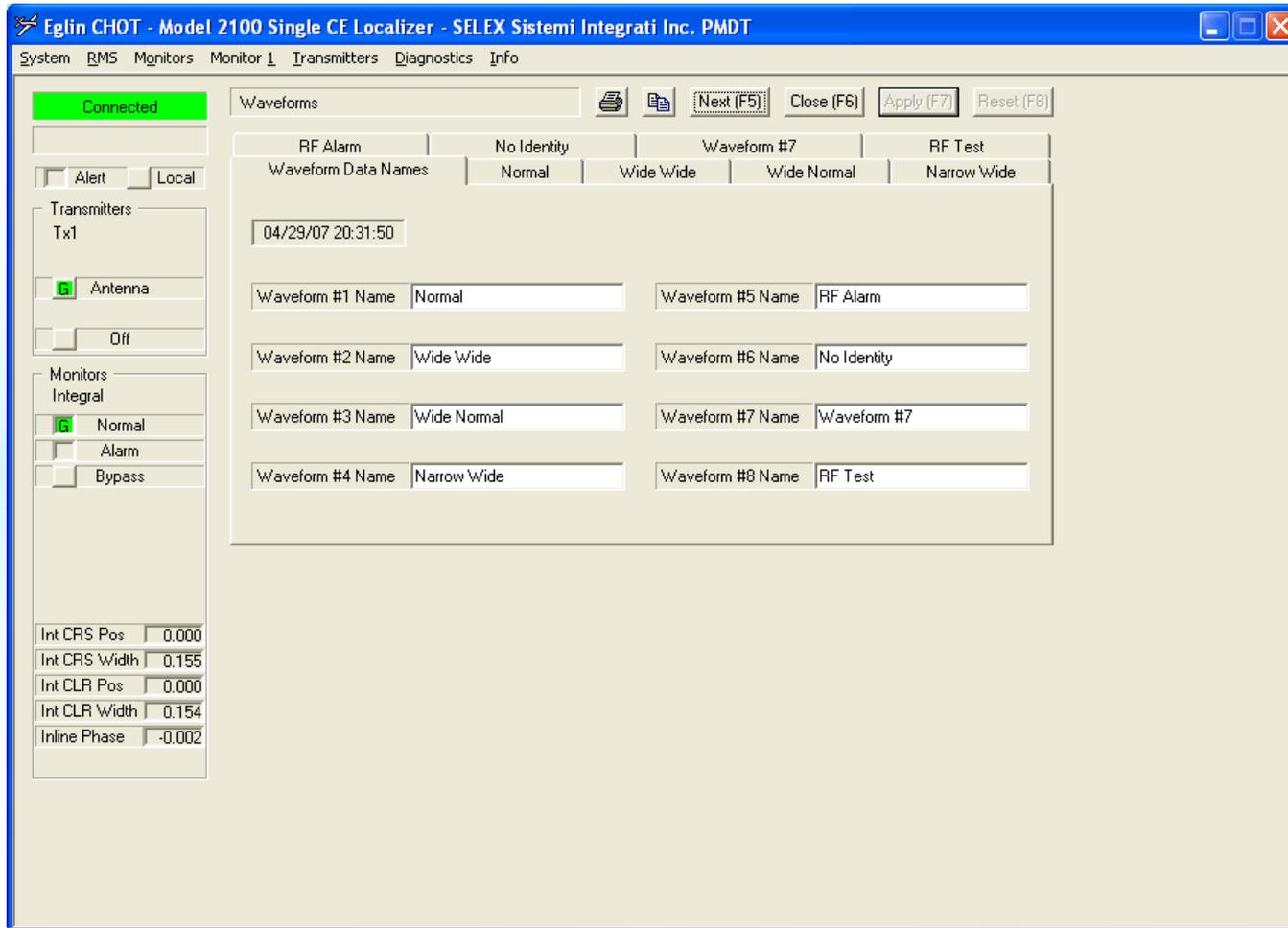
Comm Fault Course Reverse Sense Clearance Reverse Sense

	Alarm Low	PreAlarm Low	Data	PreAlarm High	Alarm High	
Course						
Centerline RF Level	70.0	72.0	97.9	125.0	150.0	%
Centerline DDM	-0.015	-0.011	0.000	0.011	0.015	DDM
Centerline SDM	36.0	38.0	39.5	42.0	44.0	%
Ident Mod Percent	6.0	7.0	8.0	9.0	10.0	%
Width DDM	0.140	0.145	0.156	0.165	0.170	DDM
Clearance						
Centerline RF Level	70.0	72.0	98.7	125.0	150.0	%
Centerline DDM	-0.026	-0.015	0.000	0.015	0.026	DDM
Centerline SDM	36.0	38.0	39.9	42.0	44.0	%
Ident Mod Percent	6.0	7.0	7.9	9.0	10.0	%
Width DDM	0.129	0.141	0.154	0.175	0.181	DDM
RF Freq Difference	7600	7700	7999	8300	8400	Hz

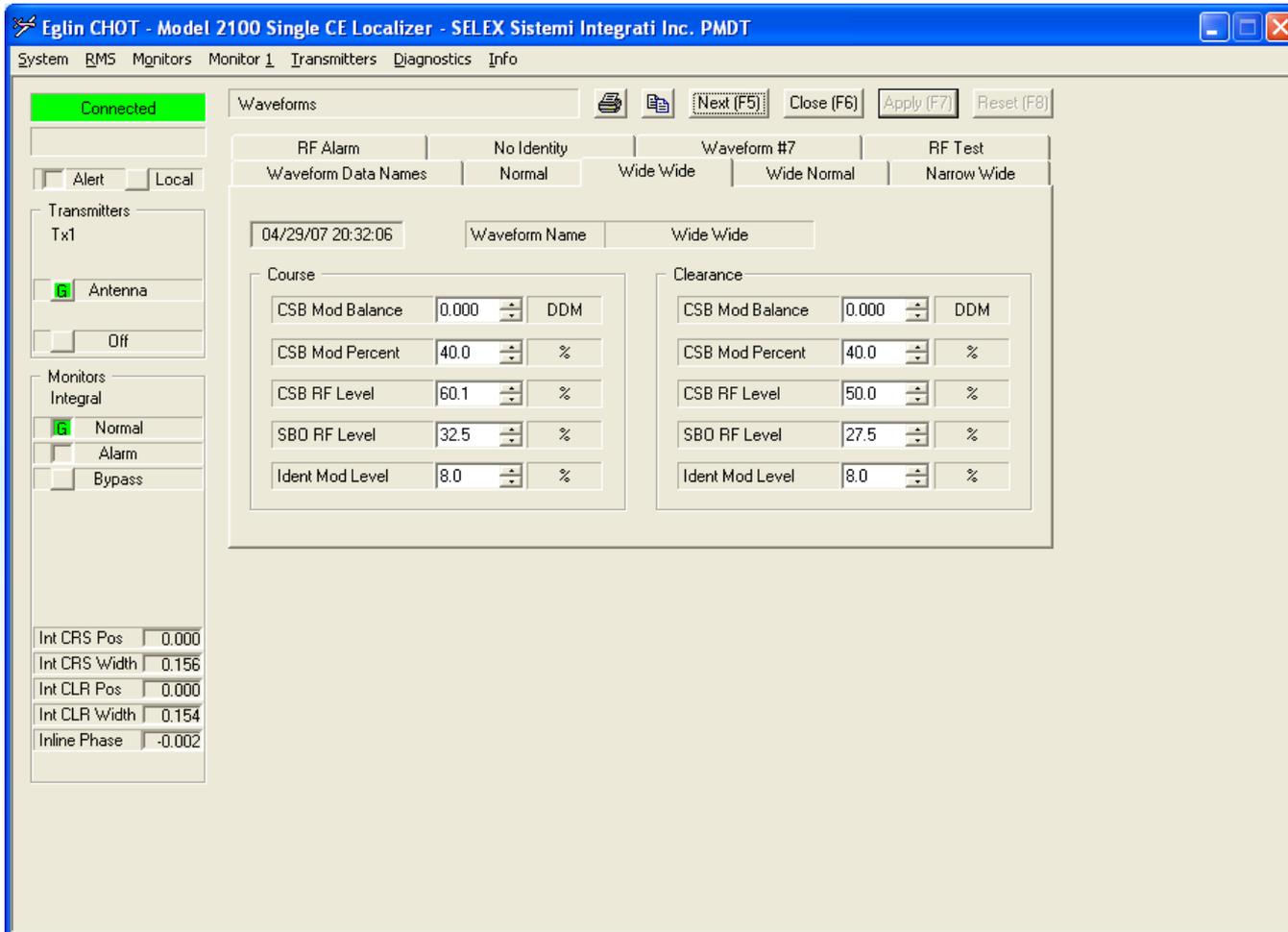
Localizer Flight Inspection

- Alarm conditions are set up prior to flight inspection using the Waveform screens
 - Waveform Data tab
 - Various conditions tab
- Waveform files are named according to function
 - Example “Wide Wide”
- The Waveform screens are individually adjusted to duplicate alarm conditions

Waveform Data Names



Waveform Wide Wide Setup



Localizer Alarm Checks

- Wide Alarm (for Single Frequency) and Course Wide, Clearance Wide (for Dual Frequency) is selected with the appropriate Transmitter Waveform command
- After command is selected, monitor alarm is verified and reported to the panel technician
- At completion of check, the Normal Waveform is selected

Transmitter Commands

The screenshot shows the 'Eglin CHOT - Model 2100 Single CE Localizer - SELEX Sistemi Integrati Inc. PMDT' software interface. The 'Transmitters' menu is open, showing options for 'Transmitter 1' and 'Localizer Ident'. A 'Select Waveform' submenu is also open, listing various waveform options like '1 Normal', '2 Wide Wide', '3 Wide Normal', etc. The main interface displays various parameters for the transmitter, including Course, Clearance, and RF Freq Difference, with numerical values and status indicators.

Parameter	Value 1	Value 2	Value 3	Value 4	Unit
Course					
Centerline RF Level	70.0	70.0	70.0	70.0	
Centerline DDM	-0.015	-0.015	-0.015	-0.015	
Centerline SDM	36.0	38.0	39.6	36.0	
Ident Mod Percent	6.0	7.0	0.0	6.0	%
Width DDM	0.140	0.145	0.155	0.140	
Clearance					
Centerline RF Level	70.0	72.0	98.1	70.0	
Centerline DDM	-0.026	-0.015	0.000	-0.026	
Centerline SDM	36.0	38.0	40.1	36.0	
Ident Mod Percent	6.0	7.0	0.0	6.0	%
Width DDM	0.129	0.141	0.154	0.129	
RF Freq Difference	7600	7700	7999	8300	Hz

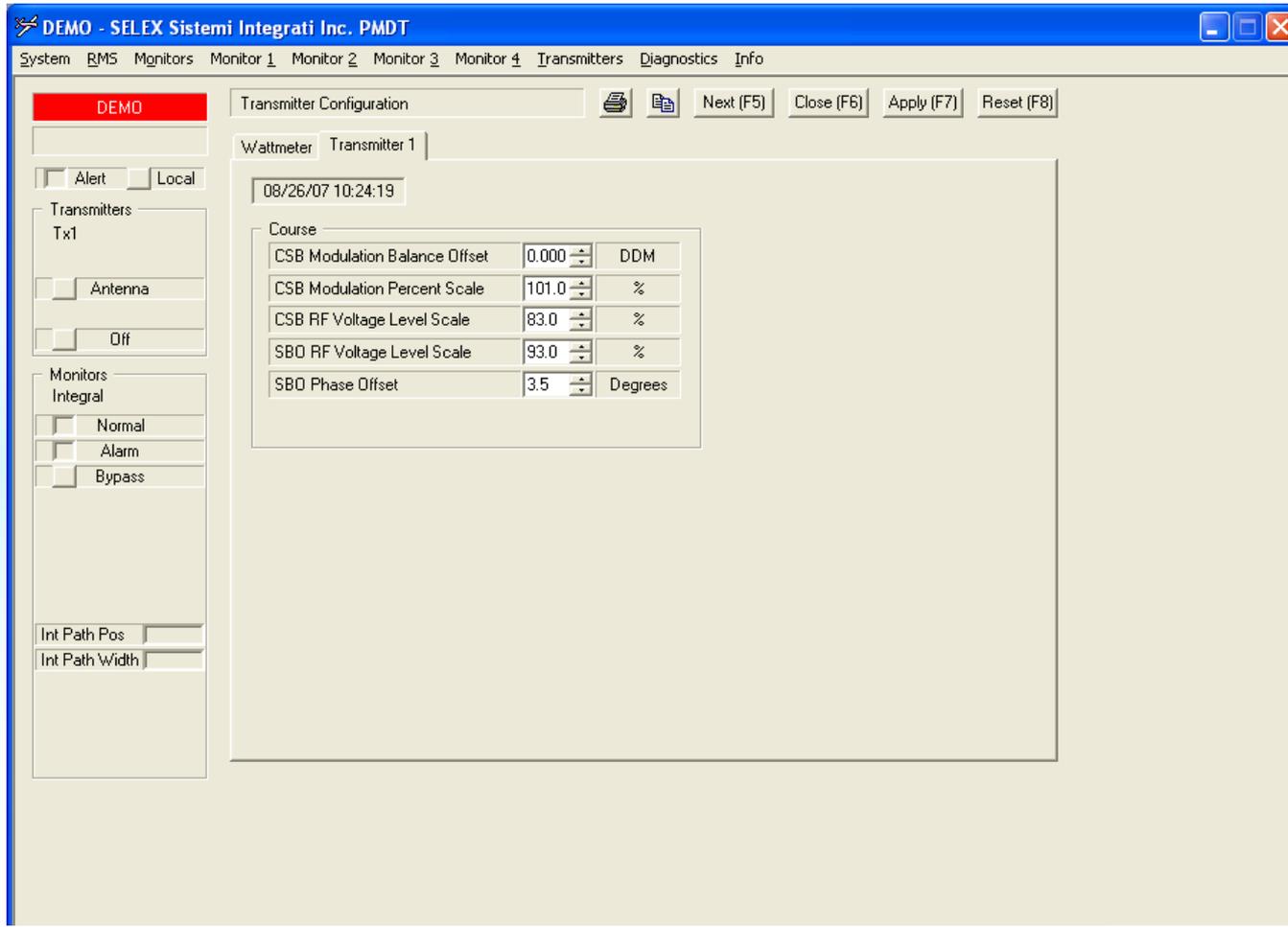
NRGS Flight Inspection

- Most checks/adjustments are the same as the localizer and will not be readdressed
- The exception is advance and delay phase to alarm checks
- This check is accomplished using the Transmitter Configuration screen
- The SBO Phase Offset is recorded, and then the Offset is adjusted in the positive direction until a width alarm occurs

NRGS Flight Inspection

- The technician reports advance to alarm to the panel technician, and how far the Offset was adjusted
- Process is repeated for delay to alarm
- SBO Offset is returned to original value
- Caveat: The initial SBO Offset value must be within $\pm 5^\circ$ of zero in order to have sufficient range to adjust the system to alarm

Transmitter Configuration



SBRGS Flight Inspection

- The following checks required an additional hardware solution:
 - Low Angle Alarm
 - Advance Upper Antenna to Alarm
 - Delay Upper Antenna to Alarm
- The solution is the SBRGS Remote Test Unit (RTU)
- The unit is a special version of the SBRGS Amplitude Phase Control Unit (APCU)

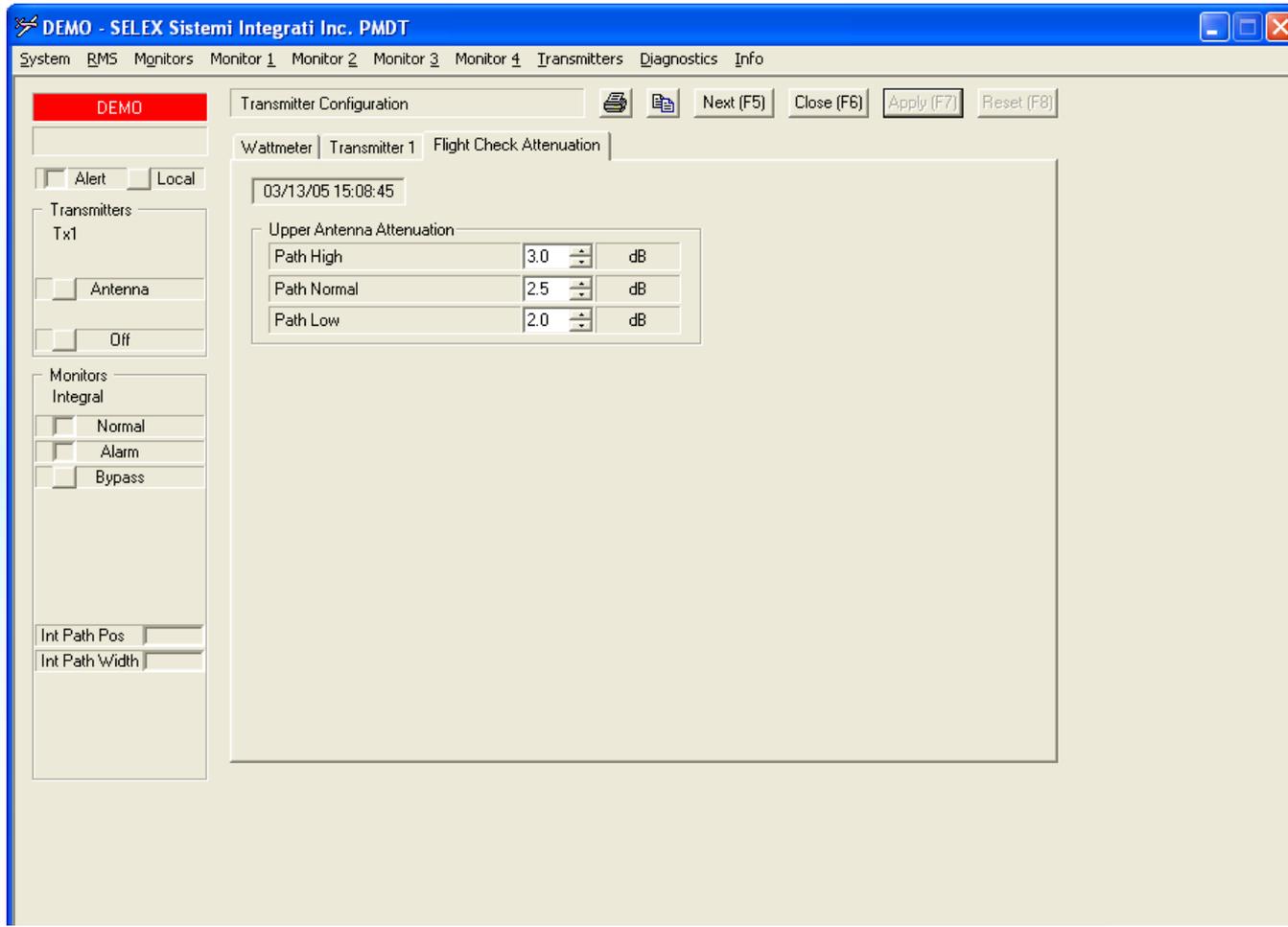
The SBRGS ATU/RTU



SBRGS Flight Inspection

- Low Angle Alarm is set up prior to flight inspection using the Flight Check Attenuation screen in the same manner as the Waveform screens
- The dB difference between Path Normal and Path Low is the value reported to the panel technician
- The Path High option is available for commissioning/special flight inspections

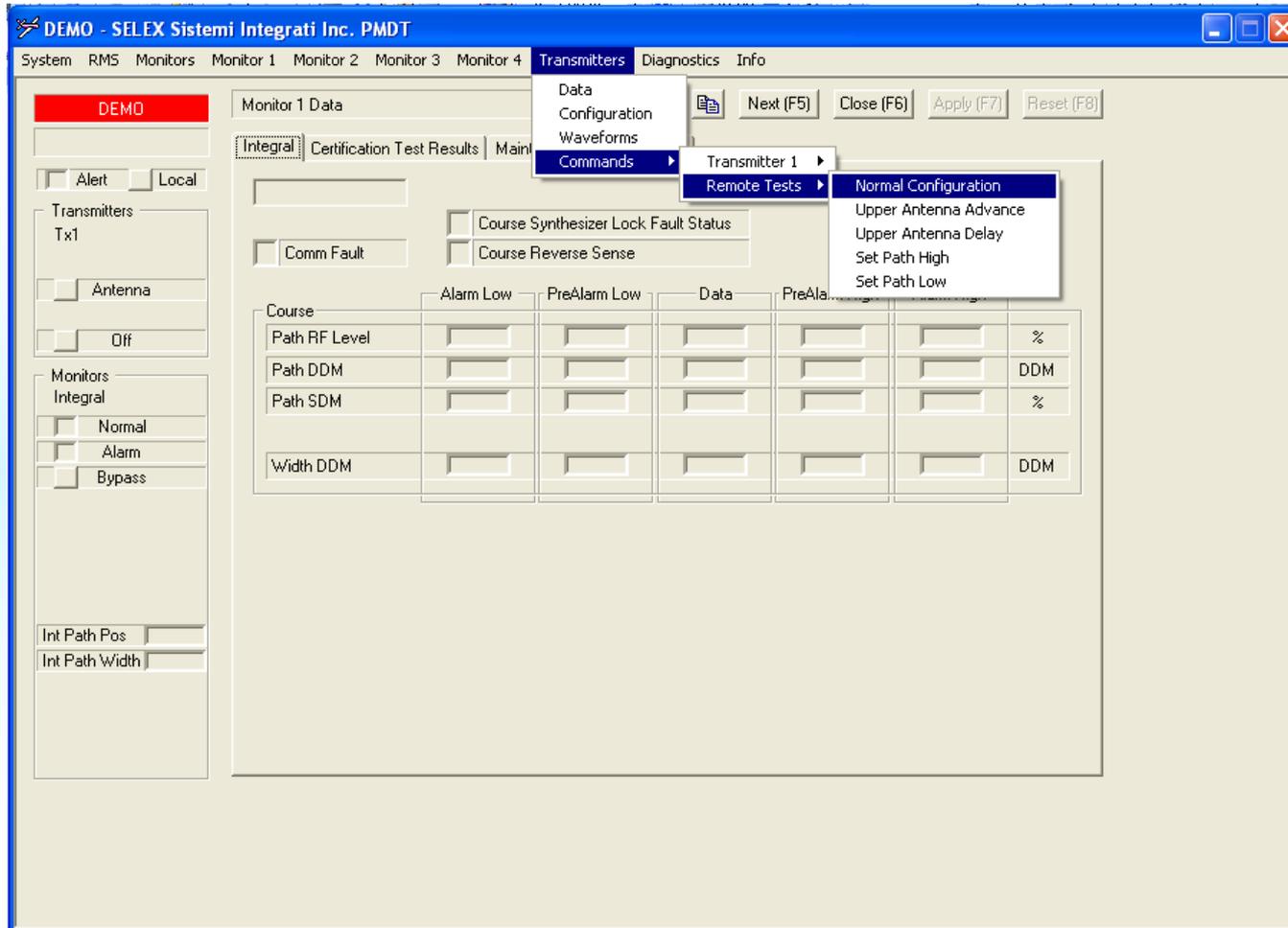
Upper Antenna Attenuation



SBRGS Flight Inspection

- Advance and delay Upper Antenna to alarm switches in a fixed 19 degree phase shift in response to a command from the Remote Test dropdown menu
- That amount of dephase is reported to the panel technician
- The Normal Configuration command is selected at the conclusion of the checks

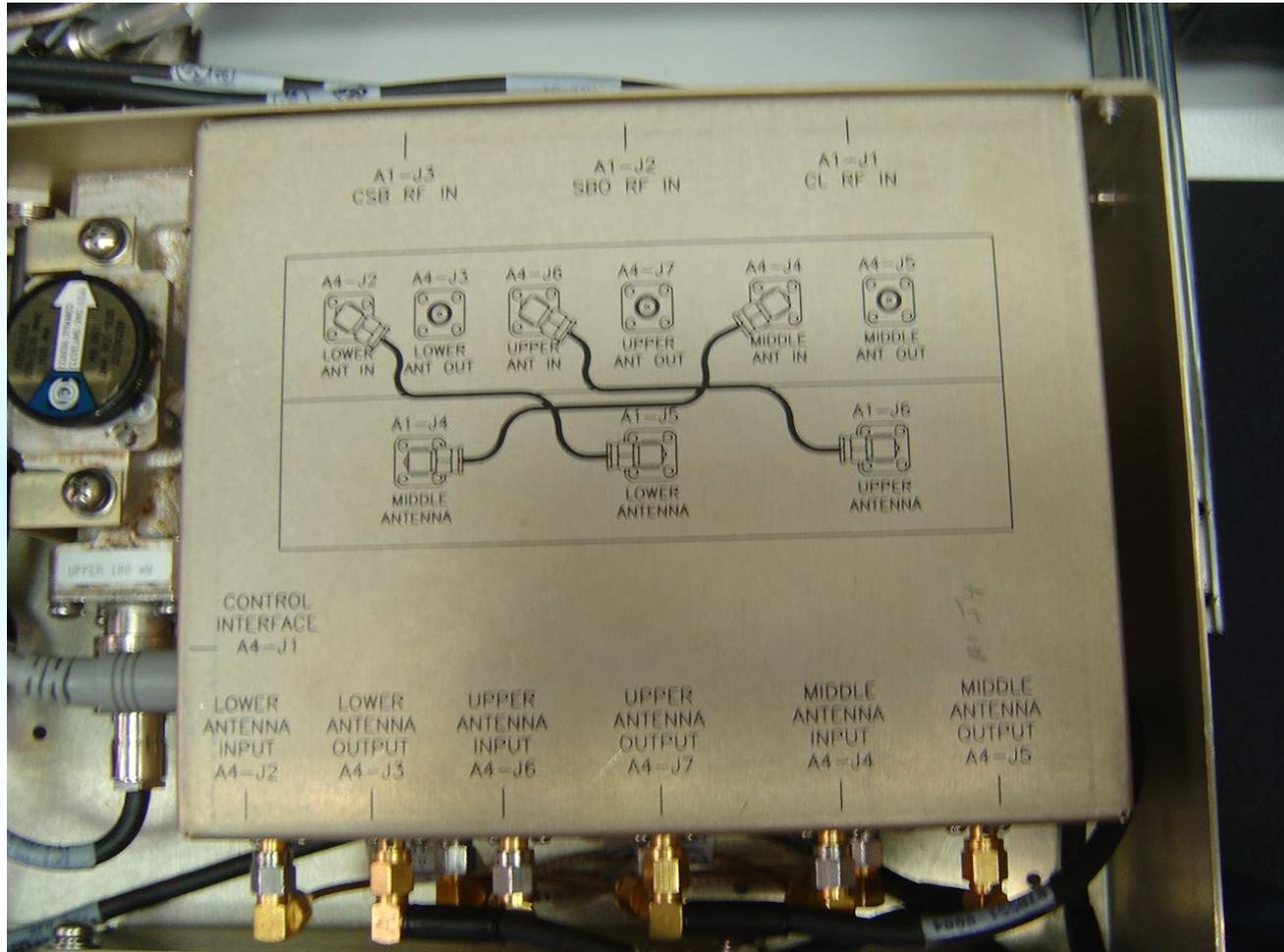
SBRGS Remote Test Dropdown



CEGS Flight Inspection

- The following checks required an additional hardware solution:
 - Attenuate Upper Antenna to Alarm
 - Advance Middle Antenna to Alarm
 - Delay Middle Antenna to Alarm
- The CEGS RTU provides this function
- The unit is mounted atop the CEGS APCU

The CEGS ATU



CEGS Flight Inspection

- The Advance and Delay Middle Antenna commands switches in a fixed 15 degree phase shift in response to a command from the Remote Test dropdown menu
- The Attenuate Upper Antenna command switches in a fixed 1.4 dB of attenuation
- Those amounts of dephase and attenuation are reported to the panel technician

CEGS Remote Test Dropdown

The screenshot shows the Eglin CHOT software interface. The title bar reads "Eglin CHOT - Model 2110 Single CE Glideslope - SELEX Sistemi Integrati Inc. PMDT". The main window has a menu bar with "System", "RMS", "Monitors", "Monitor 1", "Transmitters", "Diagnostics", and "Info". The "Transmitters" menu is open, showing options: "Data", "Configuration", "Waveforms", "Commands", "Alerts", and "Status". The "Commands" sub-menu is open, showing "Transmitter 1" and "Remote Tests". The "Remote Tests" sub-menu is open, showing "Normal Configuration", "Middle Antenna Advance", "Middle Antenna Delay", and "Upper Antenna Attenuate".

The interface also displays a "Connected" status, "Alert" and "Local" indicators, and a "Transmitters" section with "Tx1" and "Antenna" options. A "Monitors" section shows "Integral" with "Normal", "Alarm", and "Bypass" options. A "Data" table is visible, showing various parameters and their values.

	Alarm Low	PreAlarm Low	Data	PreAlarm High	Alarm High	
Course						
Path RF Level	80.0	85.0	100.9	120.0	125.0	%
Path DDM	-0.050	-0.025	-0.001	0.025	0.050	DDM
Path SDM	76.0	78.0	80.4	82.0	84.0	%
Width DDM	0.160	0.165	0.173	0.185	0.195	DDM
Clearance						
RF Level	80.0	85.0	100.9	125.0	150.0	%
150Hz Mod Percent	65.0	75.0	80.1	85.0	95.0	%
RF Freq Difference	7600	7700	8000	8300	8400	Hz

Flight Check Communications

- The CST utilizes a dial-up radio system at each airfield, located at one of the glideslopes
- The radio's are pre-programmed with the four flight check frequencies
- An adapter in the CST facility allows the remote radios to act in the same manner as a push-to-talk radio
- A */# keying method is used as a backup

Dial-up Radio



Dial-up Radio Antenna



Remote Control Adapter



Local Augmentation Personnel

- They are Airfield Systems technicians who maintain the Radar, ATC Radio, and Meteorological systems
- NAVAIDS involvement normally limited to:
 - Remove and replace actions
 - Shelter maintenance
 - Interaction with base agencies for phone, power, and temperature control issues
 - Field readings from the portable ILS receiver

Local Augmentation Personnel

- Have not and will not receive formal Navigational Aids system training; the fully trained personnel are assigned to the CST
- These personnel are not normally required to participate in flight inspections except:
 - A communications line or remote radio failure
 - Collecting new field references if changes were mandated during flight inspection

Benefits Realized

- Time Saved
 - Technicians do not have to travel from localizer-to-glideslope to complete inspections
 - Point and click inspections adjustments decrease the time needed to configure systems for alarm and back to normal checks
- Errors Decreased
 - Advance set-up of alarm conditions decreases errors made in the heat of battle

Benefits Realized

- Flexibility
 - The CST is able to handle last minute schedule changes and unannounced arrivals with ease; since we don't have to pack up and drive to the sites, we can be flight checking within 5 minutes of notification
 - If a flight inspection aircraft is delayed, other work can be performed rather than sitting at a site waiting

Benefits Realized

- Proficiency Maintained
 - Due to the long interval between periodic-with-monitors flight inspections, it is difficult to maintain practical proficiency
 - Small cadre of personnel performing all of the inspections at 7 airfields; we get plenty of practice
 - Added benefit, the flight crew knows they are working with very experienced ground technicians at all of our airfields

Benefits Realized

- Potential Manpower and Monetary Savings
 - Flight inspections can be centralized using remote capability – need for less on-site manning
 - The 5 technicians in the CST can conduct 5 flight inspections simultaneously

Drawbacks and Solutions

- Relatively few problems have occurred implementing remote flight inspection
- Initially, the CST needed local assistance to communicate with flight check
 - Remote radios solved this problem
- Also, the CST could not perform CEGS and SBRGS flight inspections remotely at the outset
 - Adding the remote test units solved this issue

Future Work

- Currently working the process to place the RCSU computers on the base networks with the most current security protocols
- While meant to enhance our remote maintenance and monitoring posture, flight inspection program fallout will be:
 - Quicker response times
 - Less reliance on aging copper in the ground communications infrastructure

Summary

- The CST has successfully performed remote flight inspection since Feb 2003
 - This equates to approximately 40 inspections that did not require on-airfield personnel
 - Saved \$100k in travel costs alone
- Many hours saved utilizing point and click adjustments and not moving site-to-site
- Flexibility and training opportunities contribute to an already stellar program

Questions?

- (Especially the “what if” variety)