



Coverage Acceptance Test Plan (CATP) Test Summary Report

CATP Overview and Coverage Guarantees

The Coverage Acceptance Test Plan (CATP) was designed to verify that the Butler County voice radio Simulcast System implemented by Motorola meets or exceeds the required coverage reliabilities within Butler County's two service areas, 1) Butler County's jurisdictional boundaries and 2) Butler County's jurisdictional boundaries plus extended areas).

The Butler County System, Contractual Portable Configuration and Coverage Guarantees and In-Building Testing (for informational purpose) are as follows:

Butler County System Configuration is a fourteen site 800 MHz ASTRO 25 Simulcast System.

Contractual Portable Configuration is an XTS 5000 portable in a swivel case equipped with a public safety speaker microphone with a quarter-wave antenna at shoulder level for transmit (talk-in) and receive (talk-out).

Contractual Coverage Guarantees are:

1. Provide talk-out (simulcast) coverage to 95% of the total Butler County service area (Butler County's jurisdictional boundaries) inside 15 dB loss buildings using above-mentioned system and portable configuration.
2. Provide talk-in (voting) coverage to 95% of the total Butler County service area (Butler County's jurisdictional boundaries) inside 15 dB loss buildings using above-mentioned system and portable configuration.
3. Provide talk-out (simulcast) coverage to 94% of the total Butler County plus extended areas (shown in ITB Appendix G) service area inside 15 dB loss buildings using above-mentioned system and portable configuration.
4. Provide talk-in (voting) coverage to 94% of the total Butler County plus extended areas (shown in ITB Appendix G) service area inside 15 dB loss buildings using above-mentioned system and portable configuration.

In-Building Testing was performed for Informational Purposes Only. DAQ talk/listen tests were performed in each building on the building list in ITB Appendix I titled List of Critical Buildings.

Radio Coverage Evaluation Summary

Summary of Testing Process

In order to verify talk-out coverage within both service areas (Butler County's jurisdictional boundaries and Butler County's jurisdictional boundaries plus extended areas), Bit Error Rate (BER) measurements and Delivered Audio Quality (DAQ) talk/listen tests were taken over a large number of uniformly distributed random test points. BER samples were automatically recorded using the Motorola Voyager test tool for the BER objective portion of the test. DAQ talk/listen test data was recorded electronically using DeLorme XMap software and manually using printed test sheets.

In order to verify talk-in coverage within both service areas (Butler County's jurisdictional boundaries and Butler County's jurisdictional boundaries plus extended areas), DAQ talk/listen tests were taken over a large number of uniformly distributed random test points. DAQ talk/listen test data was recorded electronically using DeLorme XMap software and manually using printed test sheets.

The BER, DAQ, and In Building tests were conducted during the weeks of December first, eighth and fifteenth. The five re-banded frequencies of Butler County's license, WQCD754, were used at all of the Butler County sites operating in the digital simulcast wide area trunking mode of operation for BER and DAQ testing of the ASTRO 25 System.

Established Coverage Criteria

The design objectives for the ASTRO 25 System are:

- ◆ BER level of 2% or better while communicating within 95% of County jurisdictional boundaries and 94% of Butler County jurisdictional boundaries plus extended areas with an XTS 5000 portable in a swivel case equipped with a public safety speaker microphone with a quarter-wave antenna at shoulder level for receive (talk-out) in 15 dB loss building. A BER level of 2% corresponds with a DAQ level of 3.4.
- ◆ DAQ level of 3.4 or better while communicating within 95% of Butler County jurisdictional boundaries and 94% of Butler County jurisdictional boundaries plus extended areas with an XTS 5000 portable in a swivel case equipped with a public



safety speaker microphone with a quarter-wave antenna at shoulder level for transmit (talk-in) and receive (talk-out) in 15 dB loss building.

Table 1: Delivered Audio Quality

DAQ Delivered	Subjective Performance Description
1	Unusable, speech present but unreadable.
2	Understandable with considerable effort. Frequent repetition due to noise / distortion.
3	Speech understandable with slight effort. Occasional repetition required due to noise / distortion.
3.4	Speech understandable with repetition only rarely required. Some noise / distortion.
4	Speech easily understood. Occasional noise / distortion.
4.5	Speech easily understood. Infrequent noise / distortion.
5	Speech easily understood.

Coverage Area Grids

The statistical reliability prediction formulas used to model radio coverage require a minimum number of valid test grids within the coverage area, which dictates the grid dimensions. Butler County’s jurisdictional boundaries plus extended areas were divided into 0.517 mile high by 0.491 mile wide sized grids. The grid overlay for Butler County coverage test was developed using Motorola’s proprietary HYDRA coverage simulation software tool. A map showing the Grid Overlay and Grid Numbers along with the DAQ test results for the entire service area can be seen in Appendix F. This map shows 1943 grids within Butler County’s jurisdictional boundaries and 2428 grids within Butler County plus extended area as shown in ITB Appendix G.

Test grids that are inaccessible by the test vehicles during the coverage test are not included in the coverage guarantee reliability calculations. These inaccessible grids are identified with yellow squares on the maps included in Appendix D. These inaccessible grids are also identified with yellow squares with a red “X” on the map included in Appendix F.



Coverage Test Set-up

The BER and DAQ tests were performed with a de-rated portable attenuated to simulate an XTS 5000 portable in a swivel case equipped with a public safety speaker microphone with a quarter-wave antenna at shoulder level for transmit (talk-in) and receive (talk-out) in a 15 dB building. Appendix B includes a drawing that shows the de-rated portable set up. It also includes a chart that verifies the attenuated values of each test team's de-rated portable.

The de-rated portable test setup includes a fixed attenuator, variable attenuator, co-ax cable and a mag-mount quarter wave 800 MHz antenna. The mag-mount antenna was located on the center of the test vehicle's roof.

For the BER test, a V.52 test pattern was set up to constantly transmit on the 853.0375 MHz frequency (channel 4 in the System).

Summary of Testing Procedure

BER CATP Procedures

A quantitative coverage acceptance test was performed using Motorola's Voyager package to provide objective verification that the ASTRO 25 System provides the faded performance threshold for the specified Channel Performance Criterion (DAQ-3.4) within Butler County's service areas (County jurisdictional boundaries and County jurisdictional boundaries plus extended areas).

The procedure for the objective BER coverage test utilizing Motorola's Voyager was as follows:

- ◆ A calibrated digital voice test receiver connected to an antenna installed on the test vehicle. The test receiver monitored transmissions from the fixed network radio sites.
- ◆ A Global Positioning System (GPS) receiver, that provided the computer with the location and speed of the test vehicle.
- ◆ A laptop computer with Voyager software and a mapping database, which included highways and local streets political boundaries, rivers, and railroads.
- ◆ The Voyager package was installed in a test vehicle. Motorola personnel drove the test vehicles (two field test teams) over a route planned to cover all the accessible grids within the coverage test area. Other Motorola personnel in each team operated the Voyager package.
- ◆ The ASTRO 25 System BER coverage test utilized a de-rated XTS 5000 to resemble an XTS 5000 portable in a swivel case equipped with a public safety



speaker microphone with a quarter-wave antenna at shoulder level for transmit (talk-in) and receive (talk-out) in 15 dB loss building.

- ◆ Signal strength measurements in each grid were also provided for information only as part of the BER test.
- ◆ During the objective coverage test, the laptop computer displayed the vehicle's location on a map of the coverage test area overlaid with the test grids. Voyager automatically initiated BER measurements when the GPS receiver indicated that a test grid has been entered. The computer provided a visual indication that a measurement had been completed in a grid.
- ◆ Voyager managed the coverage test data collection and stored BER results for each grid for later analysis of the ASTRO 25 System. The portable outbound reference signal level measured in each tested grid was stored for information only.
- ◆ At the conclusion of the test, all data was compiled. For each coverage guarantee, the area reliability percentage was calculated by dividing the number of passed grids by the total number of tested grids in the service area. Inaccessible grids were excluded from the calculation.
- ◆ BER coverage acceptance test verifications are:
 - Coverage acceptance based on 95% of the grids in the total Butler County service area (Butler County's jurisdictional boundaries) are measured to provide a mean level of 2% BER or better.
 - Coverage acceptance based on 94% of the grids in the total Butler County plus extended areas shown in ITB Appendix G service area are measured to provide a mean level of 2% BER or better.

DAQ CATP Procedures

Subjective listening tests were performed independently for talk-in and talk-out coverage acceptance testing for ASTRO 25 System to verify Delivered Audio Quality of DAQ-3.4 performance of the system for grids within Butler County's service areas (County jurisdictional boundaries and County jurisdictional boundaries plus extended areas).

The procedure for the subjective DAQ coverage tests was as follows:

- ◆ To perform a statistically valid subjective DAQ test, a large group of people was used to ensure high confidence in the results. The group of personnel participating in the subjective test was calibrated with the sound of radio conversations at DAQ-3.4 level.
- ◆ The test participants were divided into teams, each consisting of personnel from Butler County and Motorola. Each team had members that operated the portable



unit in the field and fixed team members that were stationed at the control point location operating the MCC 7500 consoles.

- ◆ As the field test teams drove through the coverage area, test locations within each grid were randomly selected for the ASTRO 25 System subjective coverage test.
- ◆ The ASTRO 25 System DAQ coverage test utilized a de-rated XTS 5000 to resemble an XTS 5000 portable in a swivel case equipped with a public safety speaker microphone with a quarter-wave antenna at shoulder level for transmit (talk-in) and receive (talk-out) in 15 dB loss building.
- ◆ The test teams evaluated the DAQ value of the test transmission, and recorded the pass / fail rating for each transmission in the grid on the test sheets as well as any pertinent notes for the location.
- ◆ For each test in each grid, each field test team called out which grid number they were in, and gave a test count. The fixed team answered back with the grid number and said the transmission was “loud and clear” or “please repeat last transmission.” Then the field team answered back with the grid number and said the transmission was “loud and clear” or “please repeat last transmission.”
- ◆ At each grid location, each field test team member listened to a talk-out audio transmission and evaluated the DAQ value of the test transmission and recorded the pass / fail rating for each grid. Team members stationed at the control point evaluated talk-in audio quality of transmissions from the test field unit in that grid and recorded the pass / fail rating for that grid. Each team maintained an ASTRO 25 System test log to record subjective pass / fail rating for each test grid. Subjective evaluation was based on the Delivered Audio Quality definition of DAQ-3.4 in Table 1 for the ASTRO 25 System. The pass / fail rating for each test grid was the pass / fail consensus of all team members’ subjective evaluations for that grid.
- ◆ A grid rated below DAQ-3.4 on the first trial was immediately retested. The retest was taken three feet away from the original location. If the rating of the second retest failed, the grid was counted as a fail. If the rating of the second test passed, a third test was taken to prove that the first failure was an anomaly. If the rating of the third test was a pass, the grid was counted as a pass. If the rating of the third test was a fail, the grid was counted as a fail.
- ◆ At the conclusion of the test, all data was compiled. For each coverage guarantee, the area reliability percentage was calculated by dividing the number of grids that passed by the total number of tested grids in the service area. Inaccessible grids were taken out of the calculation.
- ◆ DAQ coverage acceptance test verifications are:
 - Coverage Acceptance based on 95% of the grids in the total Butler County service area (Butler County’s jurisdictional boundaries) meet the minimum DAQ-3.4 requirement in the talk-out direction.



- Coverage Acceptance based on 95% of the grids in the total Butler County service area (Butler County’s jurisdictional boundaries) meet the minimum DAQ-3.4 requirement in the talk-in direction.
- Coverage acceptance based on 94% of the grids in the total Butler County plus extended areas shown in Appendix G service area meet the minimum DAQ-3.4 requirement in the talk-out direction.
- Coverage acceptance based on 94% of the grids in the total Butler County plus extended areas shown in Appendix G service area meet the minimum DAQ-3.4 requirement in the talk-in direction.

In-Building DAQ CATP Procedures (Informational Only)

Over 70 buildings were tested per ITB Appendix I building list (titled List of Critical Buildings) plus additional buildings identified by Butler County.

The procedure for the subjective In-building DAQ coverage tests was as follows:

- ◆ The test participants were divided into teams, each consisting of personnel from Butler County and Motorola. Each team had members that operated the portable unit in the field and fixed team members that were stationed at the control point location.
- ◆ Portable unit was an XTS 5000 portable in a swivel case equipped with a public safety speaker microphone with a quarter-wave antenna at shoulder level for transmit (talk-in) and receive (talk-out).
- ◆ The test teams evaluated the DAQ value of the test transmission in the lobby and several other locations within each building, and recorded the pass / fail rating for each in-building transmission on the test sheets as well as any pertinent notes for the locations.
- ◆ Each field test team called out building name and the test location, and gave a test count. The fixed team answered back with building name and test location and said the transmission was “loud and clear” or “please repeat last transmission.” Then the field team answered back and said the transmission was “loud and clear” or “please repeat last transmission.”
- ◆ At each in-building location, each field test team member listened to a talk-out audio transmission and evaluated the DAQ value of the test transmission and recorded the pass / fail rating for that building location. Team members stationed at the control point evaluated talk-in audio quality of transmissions from the test field unit and recorded the pass / fail rating for that in-building location. Each team maintained an ASTRO 25 System test log to record subjective pass / fail rating for each in-building test. Subjective evaluation was based on the Delivered Audio Quality definition of DAQ-3.4 shown in Table 1 for the ASTRO 25



System. The pass / fail rating for each in-building test location was the pass / fail consensus of all team members' subjective evaluations for that test location.

- ◆ A test location rated below DAQ-3.4 on the first trial was immediately retested. The retest was taken three feet away from the original location. If the rating of the second re-test failed, the test location was counted as a fail. If the rating of the second test passed, a third test was taken to prove that the first failure was an anomaly. If the rating of the third test was a pass, the test location was counted as a pass. If the rating of the third test was a fail, the test location was counted as a fail.
- ◆ In the event that a test location failed the DAQ-3.4 test, the location was retested with an XTS5000 portable unit equipped with a half-wave antenna and remote speaker microphone for informational purpose only.
- ◆ All of in-building test sheets with documented test results and pertinent notes are included in Appendix H.

Customer will conduct City of Oxford's in-building testing at a later date. Upon availability of customer documented test results, City of Oxford's in-building test data sheets will be included in the Appendix I.

Coverage Evaluation Results

A complete listing of the test grid data, BER and DAQ test results are attached to this report, in Appendices C, D and E.

ASTRO 25 System – BER (Talk Out) Test Results (Butler County Only)

Total Grids in Butler County:	1943
Total Grids Inaccessible:	163 (excluded from test)
Total Grids Tested	1780
Number of Passing Grids:	1748
Number of Failed Grids:	32
Coverage Test Scoring:	98.20% = Pass

ASTRO 25 System – BER (Talk Out) Test Results (Butler County plus Extended Areas)

Total Grids in Butler County plus Extended Areas:	2428
Total Grids Inaccessible:	245 (excluded from test)
Total Grids Tested	2183
Number of Passing Grids:	2134
Number of Failed Grids:	49



Coverage Test Scoring: 97.75% = Pass

ASTRO 25 System - DAQ-3.4 (Talk Out) Test Results (Butler County Only)

Total Grids in Butler County:	1943
Total Grids Inaccessible:	85 (excluded from test)
Total Grids Tested	1858
Number of Passing Grids:	1855
Number of Failed Grids:	3
Coverage Test Scoring:	99.84% = Pass

ASTRO 25 System - DAQ-3.4 (Talk In) Test Results (Butler County Only)

Total Grids in Butler County:	1943
Total Grids Inaccessible:	85 (excluded from test)
Total Grids Tested	1858
Number of Passing Grids:	1855
Number of Failed Grids:	3
Coverage Test Scoring:	99.84% = Pass

ASTRO 25 System - DAQ-3.4 (Talk Out) Test Results (Butler County plus Extended Areas)

Total Grids in Butler County plus Extended Areas:	2428
Total Grids Inaccessible:	134 (excluded from test)
Total Grids Tested	2294
Number of Passing Grids:	2286
Number of Failed Grids:	8
Coverage Test Scoring:	99.65% = Pass



ASTRO 25 System - DAQ-3.4 (Talk In) Test Results (Butler County plus Extended Areas)

Total Grids in Butler County plus Extended Areas:	2428
Total Grids Inaccessible:	134 (excluded from test)
Total Grids Tested	2294
Number of Passing Grids:	2286
Number of Failed Grids:	8
Coverage Test Scoring:	99.65% = Pass

The above results demonstrate the ASTRO 25 System has passed the requirements of the ITB and CATP with results greater than 95% and 94% coverage reliabilities within Butler County's service areas (County jurisdictional boundaries and County jurisdictional boundaries plus extended areas), respectively.

ASTRO 25 System - In Building Test Results (for Informational Purpose)

Over 70 buildings were tested per ITB Appendix I, plus additional buildings identified by Butler County. The system passed coverage test in the lobby of all tested buildings. The coverage test results of the additional test locations within each building are included in Appendix H.



Appendices

- A. **Final CATP Document** – Appendix A includes the final Coverage Acceptance Test Plan (CATP) document.
- B. **CATP Test Set-Up** – Appendix B includes CATP Test Set-Up Drawing that shows the de-rated portable set up. It also includes a chart that verifies the attenuated values of each test team’s de-rated portable.
- C. **ASTRO 25 BER Test Results** – Appendix C includes ASTRO 25 Test Results.
 - 1. Butler County Only (West/Blue Team) BER Test Results
 - 2. Butler County Only (East/Red Team) BER Test Results
 - 3. Butler County Plus Extended Areas (West/Blue Team) BER Test Results
 - 4. Butler County Plus Extended Areas (East/Red Team) BER Test Results
- D. **DAQ Summary Maps for ASTRO 25 DAQ Coverage Test** - Appendix D includes Talk In and Talk Out Summary Maps of Pass / Fail Grids for ASTRO 25 DAQ Coverage Test within the Butler County and Butler County plus Extended Areas.
 - 1. Talk In Butler County Only DAQ Summary Map
 - 2. Talk Out Butler County Only DAQ Summary Map
 - 3. Talk In Bulter County Plus Extended Areas DAQ Summary Map
 - 4. Talk Out Bulter County Plus Extended Areas DAQ Summary Map
- E. **Formatted Final Electronic ASTRO 25 DAQ Test Sheets** – Appendix E includes the ASTRO 25 DAQ manual test data from the field and dispatch teams inputted into Microsoft Excel.
 - 1. Red Team Formatted Final Electronic Test Sheets
 - 2. Gray Team Formatted Final Electronic Test Sheets
 - 3. Blue Team Formatted Final Electronic Test Sheets
 - 4. Yellow Team Formatted Final Electronic Test Sheets
- F. **DeLorme XMAP Generated Grid Overlay with DAQ Test Results** – Appendix F includes a DeLorme XMAP® Generated E-size Map. This map shows the Grid Overlay and Grid Numbers along with the DAQ test results for the entire service area. A green dot identifies a passing grid. A red dot identifies a failed grid. A yellow box with red X identifies an inaccessible grid.



G. ASTRO 25 DAQ Test Sheets – Appendix G includes a scanned copy of the manually populated ASTRO 25 DAQ Test Sheets used by Field and Dispatch Teams during testing.

1. Red Field Team Test Sheets
2. Red Dispatch Team Test Sheets
3. Gray Field Team Test Sheets
4. Gray Dispatch Team Test Sheets
5. Blue Field Team Test Sheets
6. Blue Dispatch Team Test Sheets
7. Yellow Field Team Test Sheets
8. Yellow Dispatch Team Test Sheets

H. ASTRO 25 In-Building DAQ Test Sheets – Appendix H includes ASTRO 25, informational only, In-Building DAQ Test Sheets used by Field and Dispatch Teams during In-Building Testing. The list of building locations are per ITB Appendix I, plus additional building locations identified by Butler County.

1. West Field Team (Hamilton)
2. East Field Team (West Chester)
3. West Dispatch Team (Hamilton)
4. East Dispatch Team (West Chester)

I. ASTRO 25 In-Building City of Oxford only DAQ Test Sheets - Appendix I includes ASTRO 25 In-Building City of Oxford only DAQ Test Sheets used by Field and Dispatch Teams during City of Oxford In-Building Testing. These test sheets will be added by the customer upon completion of this test.

1. City of Oxford Field Team
2. City of Oxford Dispatch Team

