

## SPECIAL PROVISIONS FOR SECTION 750-H: ITS SYSTEM ACCEPTANCE TESTING

The 2014 Edition of the New Mexico Department of Transportation Standard Specifications for Highway and Bridge Construction shall apply in addition to the following:

### 1.0 DESCRIPTION.

This section describes the testing procedures the Contractor must perform to ensure that the ITS system elements installed and integrated under this contract meet the contract specifications, and are properly integrated in the existing systems at the NMDOT Traffic Management Center (TMC) located at 809 Copper Avenue NW in Albuquerque, NM.

Acceptance of the system and related integration shall be achieved through satisfactory completions of the acceptance testing as listed below and formal acceptance of all related reports. The Department retains the right to witness and/or assign a representative to witness any or all of the tests described in this section.

This specification is in addition to any testing requirements identified in specifications for each ITS device. Other testing requirements including, but not limited to, manufacturer testing and certification prior to shipment or any other testing prior to equipment arrival on-site is still applicable. Should test acceptance criteria differ between this special provision and specific device special provisions, the more conservative requirements shall be met.

Contractor will be required to coordinate with the NMDOT and or its designee (i.e., On-call provider of ITS Network Administration, Maintenance, Support and Operations). All such required coordination is considered incidental to the costs of ITS Systems Installation and Acceptance.

1. On-Site Stand-Alone Acceptance Tests (SAATs). On-site SAATs shall be conducted at each CCTV, DMS, RIWS, and Vehicle Detector deployment location, and are intended to verify that each individual field subsystem can function as specified, as a complete assembly. These tests shall be conducted after the installation of the related subsystem is completed and the CCTV, DMS, and Vehicle Detector are powered up in the field, but prior to the device being connected via the telecommunications system(s) to the TMC.

2. TMC Stand-Alone Acceptance Tests (SAATs). TMC SAATs shall be conducted at each CCTV, DMS, and Vehicle Detector deployment location and at the TMC, and are intended to verify that each individual field subsystem can communicate with the intended remote site properly, and support the type of communication(s) expected for the related field deployment. These tests shall be conducted after the installation of the related subsystem is completed, and after the related communication means is installed and terminated, but before the related communication circuit is integrated with the existing systems at the TMC. The field elements and related communication circuit shall be tested as complete assemblies.

3. Integrated System Acceptance Test (ISAT). Integrated System Acceptance Test shall be conducted at the TMC, and at field locations as required, to verify that communication between each field device and the

related processing system in the TMC (as specified by the NMDOT and contract documents), and between field deployments where applicable, can be performed properly when all related deployments are in full operation. These tests shall be after the installation of the whole system included in the contract is completed and all new systems (CCTV, DMS, Vehicle Detector and Telecommunications) are integrated with existing systems both in the field (as applicable) and at the TMC.

4. 30-Day Operational Test (30DOT). The 30DOT shall be conducted at the TMC, and at field locations as required, to verify that the system elements as integrated into the existing system, together with the rest of the existing system, can function as specified as a single system continuously, 24 hours per day for an extended period of time. The choice of 30 days for the test duration is designed to predict the sustained performance of the system over the longer term. This test shall be conducted following the successful completion of all other acceptance tests for all systems under this contract and after the Department begins to use the new systems installed under this contract.

Conduct these tests in the order indicated above. Do not begin a later stage of testing until earlier stage(s) of testing have been successfully completed and approved by the Department. All work done for the testing shall adhere to applicable standards.

Complete stage testing as outlined at key points in time at the developmental, production, or installation stage in order to isolate unforeseen problems. The acceptance of each stage of testing should not imply that problems found at a later date or stage of testing will not require the contractor to return to an earlier stage of testing for a component or subsystem. Retesting may be required to the level necessary to isolate any problem and establish a course of action to remedy the situation. Retesting, if performed, shall be at no additional cost to the Department.

The Contractor shall prepare and submit a report to the Department for approval if a unit has been modified as a result of a system test failure. The report shall describe the nature of the failure and the corrective actions taken. If a failure pattern develops, the Department may direct that design and construction modifications be made to all similar units without additional cost to the Department.

All test tools used in the acceptance testing must have been calibrated by the tool manufacturer or a testing entity not directly affiliated with the Contractor and acceptable by the Department. The calibration validity time must include the dates the testing is performed, and the calibration must be traceable to the National Bureau of Standards.

For all new systems that interface with existing systems, equipment, hardware or software at the TMC, testing of the existing systems should be performed to ensure that full functionality of the existing systems has not been compromised unintentionally by the new modifications. The contractor shall include the costs of integrating new additions and the costs of related modifications to the existing system in the contract price. The contractor shall be required to repair, to the satisfaction of the Department and at no additional cost to the Department, any damage caused by the contractor to the existing systems, hardware, or software at the TMC.

## **2.0 GENERAL.**

Unless a specific waiver is given by the Department, adhere to the following requirements for all acceptance tests:

1. Conduct the tests during regular daytime working hours, on weekdays.
2. Complete testing for each equipment unit in as few consecutive days as practical.
3. Ensure that the tests are well prepared and rehearsed.
4. Provide and submit test documentation for approval by the Department. Any testing, request for related payment, or acceptance performed before approval of the submitted test documentation shall not be considered by the Department.
5. Resubmit all test documentation that does not receive approval by the Department after relevant corrective measures are completed.
6. Schedule testing and notify the Department of the testing dates after the related test documentation is approved. The notification shall be provided at least 10 working days prior to all tests to allow ample time for the Department to respond and to make arrangements to witness the tests. Schedule testing with ample additional time allotted for the Department to request that certain portions of a test be repeated if necessary.
7. Provide the means for two-way wireless voice communications, portable computers, applicable test device(s) and tools, applicable test software packages, consumables, utilities, all appurtenances, and qualified personnel necessary to perform the testing. Any devices included in the scope of supply of the contract shall not be used as tools for such tests.
8. Provide the name of the manufacturer, model number, and calibration date of each piece of test equipment calibrated to industry standards or the Bureau of Standards. Calibration must be certified within two months prior to the actual time of use by a recognized testing facility.
9. At a minimum, perform tests on supplied equipment and systems in accordance with approved test procedures. Record and submit to the Department within three weeks after each test all pertinent quantitative and qualitative test results on data summary sheets for each piece of equipment tested. The test report shall be arranged so that all commands, stimuli, and responses are correlated to allow logical interpretation.
10. Analyze and categorize all defects as to whether they are limited to the specific unit being tested or could be potential problems in all such units. If a unit has been modified as a result of a system test failure, prepare and submit a report to the Department for approval. Describe in the report the nature of the failure and the corrective action taken. If a failure pattern is detected, the Department may direct that design and construction modifications be made to all similar units, without additional cost to the Department.
11. If any of the test results fail to conform to the requirements of the special provisions, the equipment, subsystem or system failing shall be considered a defective item, and be subject to rejection by the Department. Rejected equipment, subsystems, or systems may be offered again for a re-test, provided all the defects have been rectified by the Contractor and the required documentation thereof is submitted to the Department. Repeat the test until successful at no additional cost to the Department.

## **2.01 TEST PROCEDURES AND PLANS**

It is the responsibility of the Contractor to develop the detailed test procedures/plans based on all of the requirements set forth in the contract documents (plans and specifications). The Contractor shall design the test procedures and plans to confirm that the system elements and related systems meet all requirements specified in the contract documents, and specified in the approved design documents and shop drawings.

The results of each test will be compared with these requirements. Failure to conform to the requirements at any test will be considered a system defect, and related equipment will be subject to rejection by the Department.

1. Test documentation shall include, at a minimum, test procedures (identifying applicable correlated test standards), checklists, test forms, and data summary sheets for each item. The contractor shall tailor test documentation for each test and for each item, designed specifically for the project. Reference test procedures, test forms, and checklists to these special provisions, listing each requirement to be tested for each item. All test documentation shall be prepared by the contractor and submitted to the Department for review and approval prior to initiating any testing. All tests shall utilize approved test documentation only.
2. The results of each test shall be compared with the requirements specified in the project contract, and the requirements contained in the approved design documents. Failure to conform to the requirements of any test shall be considered a system defect, and equipment will be subject to rejection by the Department.
3. The contractor shall provide test forms which clearly describe the procedures for tests identified in the test plan. Use of test forms for individual components or units of equipment is subject to approval of the Department on a case-by-case basis.
4. At a minimum, the test procedures shall include the following:
  - a. Test title, requirements to be tested, and procedure description.
  - b. Test date and the signature of the tester.
  - c. The purpose of the tests, including reference to the corresponding test plan, requirements and functions covered by the procedures, specified design and performance requirements, and cases and conditions tested by the procedures.
  - d. Space to record the serial numbers of the equipment tested and the version numbers of the software tested for each procedure.
  - e. The test and measurement equipment to be used, identified by manufacturer and model number. Include space to record test equipment serial numbers and calibration status and date.
  - f. Individual functions to be tested, individual readings to be taken, and actual values measured or determined. Corresponding pass/fail records must be included for each test or reading.
  - g. Description of the required test configuration setup, including target equipment and software, test equipment and software, measurement/monitoring tools, and diagrams illustrating configuration and test equipment connections.
  - h. Enumerated step-by-step instructions for performing the procedure, identifying the points where data is to be recorded, the expected test results, and the limits for acceptable data.
  - i. Provisions for recording pertinent test conditions and environment at time of test, and space to record the unique identifier of the defect problem as a result of faults/problems/variances detected during the test.

## 2.01 TEST REPORTS

After the testing is completed, it is the responsibility of the Contractor to provide test documentation for each of the acceptance tests that are completed, including, at a minimum, performance requirements, test procedures, checklists, test forms for each item tested, and reference to the related specification and/or requirement from the contract documents. Tailor test documentation for each test and for each item.

Acceptance by the Department for all tests will be made upon the basis of both the testing witnessed in the field by the Department and/or its representative and the test reports that are submitted following the testing.

At a minimum, provide testing procedures and test forms that meet the following requirements:

- a. The reports and records of each test and each inspection.
- b. The original records containing the original forms filled out by the persons performing the inspection/tests, and original signatures.
- c. A summary of the inspection/test. For inspection/test of components, equipment, and assemblies, include quantities inspected/tested, quantities that failed the inspection/test, and quantities that failed one or more individual procedures. A summary table shall be included showing the serial number or lot number of each unit inspected/tested and the outcome for that unit to be included.
- d. All required data and reference drawing explanations to permit evaluation of test report without the necessity of securing this information from other sources.

### **3.0 ON-SITE STAND-ALONE TEST**

On-Site Stand-Alone Acceptance Tests (On-Site SAATs) shall be conducted at each field deployment location, and are intended to verify that each individual field subsystem can function as specified, and communicate with the intended remote site (the TMC) properly, and support the type(s) of communication methods expected for the related field deployment.

On-site SAAT for a subsystem shall be conducted only after the installation of the related subsystem is completed.

The On-site SAAT shall include the following entities and aspects, at a minimum:

- Conformance with the approved shop drawings, including bills of material, component layouts, general appearance of the assembled systems, measures for surge protection and system grounding, and measures for abatement against environmental challenges (shock, vibration, extreme temperatures, and protection against ingress of water and small animals).
- Explicit tests to demonstrate that the communication enclosures and communication subsystems contained as part of a larger subsystem, where applicable, are capable of re-establishing normal operation upon power up without human intervention.
- Testing of automated response to remote inquiries, and, if applicable, initiation of communication for automated reporting by the communication subsystems.
- Demonstration of repeatable communication performance, in terms of establishing communication and supported bandwidth, at least three consecutive times (three separate sessions) for each applicable communication mode.
- Demonstration that the communication system is fully functional, including network management, malfunction isolation/diagnosis of failed equipment, and performance monitoring.

The following test aspects and requirements are specific for each device type.

### 3.01 Fiber-Optic Communication Circuit

- Prior to shipment to the project site, all fibers in the FO cables shall be tested and certified at the factory prior to shipment using an Optical Time Domain Reflectometer, based on test method as per EIA/TIA-455-61 or EIA/TIA-455-78. Compile and store all test data on a CD or similar data storage medium, in a format compatible for viewing and printing using a personal computer. Compile and print the test data also on paper medium. Submit the CD and the printouts to the Department. This must occur prior to shipment.

The On-site SAAT for the fiber-optic communication circuit deployment shall be designed and conducted to verify that all required fiber-optic communication circuits, as installed, meet the specified requirements, and that all splice closures installed in manholes, hand holes, and other outdoor installations meet the mechanical requirements. These tests shall be conducted after the installation of the related subsystem is completed.

#### Fiber-Assignment Tests.

A Fiber-Assignment test shall be required at each splice closure, FO patch panel, and where applicable un-terminated ends of each FO cable. The test shall include verification of complete and correct documentation of usage assignment of all fibers at the test points. The records shall include, as minimum grouping of fibers by color-coded buffer tubing, color of fiber coating, circuit description at the remote and local ends.

#### Electro-Optical Tests.

Conduct OTDR and optical power measurements, after installation of the fibers, based on EIA/TIA-455-59, EIA/TIA-455-60, EIA/TIA-455-61, and EIA/TIA-455-34, and submit related reports to the Department, for:

1. each spliced optical fiber, or
2. each optical fiber section longer than 200 feet.

Optical Time Domain Reflectometer (OTDR) tests shall involve tests using OTDR on the fiber-optic circuits, excluding any attenuators, and electronic devices. Perform all tests at 1310 and 1550 nm wavelengths.

Optical Power (Loss) tests shall involve tests using Optical Power meter on the fiber-optic circuits, excluding any attenuators, and electronic devices.

An optical fiber is considered acceptable if all of the following requirements are met:

- Individual splice loss is less than 0.03dB per splice for single-mode fiber, and less than 0.02dB per splice for multi-mode fiber.
- Connector loss is less than 0.5 dB per mated connector pair. Where the installed FO connector assembly terminates onto a connector at a FO device, and the said mating device connector is not separable from the device, then the insertion loss of the single installed FO connector assembly shall be less than 0.35dB.
- Connector return loss (connector reflectance loss) is less than -0.55dB per mated connector pair.
- Optical power loss introduced by unexpected loss events, such as those caused by micro-bending, pinching and sharp bends in fiber, is less than 0.5dB per cause, and the total loss introduced by such causes, combined, is less than 1dB. All power losses not attributable to planned connectors and splices are considered unexpected loss events.

For optical power tests, the test document shall list the expected range of power losses; measured power losses shall be compared to the related range for pass/fail criteria.

Optical Time Domain Reflectometer (OTDR), where used, shall meet the following requirements:

- a. Light source and detector: specific unit for each applicable wavelength
- b. Fiber type: 50/125  $\mu\text{m}$  and 60/125  $\mu\text{m}$  multi-mode, 9/125  $\mu\text{m}$  single-mode fiber.
- c. Minimum Event dead zone: 0.5m at 850nm, 1m at 1300nm and 1550nm
- d. Minimum attenuation dead zone: 4.5m at 850nm, 8m at 1300nm and 1550nm.
- e. Fiber length: minimum 3km at 850nm, 60km at 1300nm and 1550nm
- f. Dynamic range: typical 15dB at 850nm, 24dB at 1300nm and 1550nm
- g. Distance accuracy: 1.1m
- h. Reporting: include reporting software and interface to a personal computer.

Optical Power (Loss) meter, where used, shall meet the following requirements:

- a. Light source and detector: specific unit for each applicable wavelength
- b. Fiber type: 50/125  $\mu\text{m}$  and 60/125  $\mu\text{m}$  multi-mode, 9/125  $\mu\text{m}$  single-mode fiber.
- c. Measurement range 0 to -52dBm at 850nm, 0 to -60dBm at 1300nm and 1550nm.

Identified causes of excessive power losses, such as bad splices, may be corrected where feasible. If the excessive losses cannot be improved to acceptable levels after three attempts, the related fiber is considered not usable.

Submit test reports on all required optical fibers. OTDR tests shall include a graphical plot of the measurements, and distances and signal level at the detected loss and reflective events.

### 3.02 CCTV Camera System

On-site SAAT for a CCTV camera deployment shall include:

- Where camera lowering system is involved, lowering and raising the camera assembly using the electric drive. Verify that the power and electronic connections between the camera assembly and the plug-receptacle block are re-established correctly after dis-engagement and re-engagement. Repeat this test three consecutive times to ensure that proper re-establishment of connections is repeatable.
- Where camera lowering system is involved, lowering and raising the camera assembly using manual winch. Verify that the power and electronic connections between the camera assembly and the plug-receptacle block can be re-established correctly after dis-engagement and re-engagement. Repeat this test three consecutive times to ensure that proper re-establishment of connections is repeatable.
- Where redundant means of communication (CDMA cellular data service, and fiber-optic communication system) are involved, verify system ability for automatic failover to the redundant path.
- Test quality of video image transmitted from the camera communication enclosure.
- For the CCTV camera assembly with Pan-Tilt-Zoom (PTZ) functions only, test camera response to the PTZ signals and video image quality using controller and viewing tools at the related camera communication enclosure in the field at each CCTV site. Tests shall confirm correct focusing and other responses to Pan changes, Tilt changes, Zoom changes, Preset changes for all required preset positions, and ability to transition automatically between presets in the correct sequence

when "Tour" mode activated. Specific minimum PTZ functionality is detailed in the CCTV specifications under separate cover.

- Confirm that the video output from the camera, prior to further connection to encoder, modem, router or other transmission device, is of a full NTSC frame and streamed at a frame rate of 30 frames per second (FPS).
- For the CCTV camera system with digital video encoders only: verify the encoder functions using controller and viewing tools at the related camera communication enclosure. Verify that the encoder is capable of transmitting MPEG2 coded video stream with image size of 4CIF and at a frame rate of 15 frames per second (FPS); where applicable, verify that the encoder is capable of simultaneously transmit the MPEG2 stream stated above, and MJPEG coded images with image size of 1CIF and at a frame rate of 1 FPS.
- Verify for each camera that the produced video image is visible with the following lighting levels at the camera site: at the minimum lighting level as specified for monochrome video, and at the minimum lighting level as specified for color video.

### **3.03 Dynamic Message Sign**

On-site SAAT for a dynamic message sign deployment shall include:

- All functional and performance tests as specified in the Testing section of the related pay item.
- Where redundant means of communication (CDMA cellular data service, and fiber-optic communication system) are involved, verify system ability for automatic failover to the redundant path.
- Test stimuli and response between the related control/communication system and a testing tool (at the deployment site) over a fiber-optic based Ethernet communication medium.
- Test stimuli and response between the related control/communication system and a testing tool (at the deployment site) over an RF (EVDO cellular) based Ethernet communication medium.

### **3.04 Vehicle Detectors**

On-site SAAT for a vehicle detector deployment shall include:

- Verification of speed detection through use of calibrated radar gun and comparison to detector reading outputs. Readings should be within 5% over a sample of ten for each lane within the detection zone.
- Verification of lane occupancy through visual comparison of field conditions and detector reading outputs.
- Verification of volume through use of a manual counter and comparison to detector reading outputs. Readings should be within 5% over a sample of 100 vehicles for each lane within the detection zone.

## **4.0 TMC STAND-ALONE TEST**

TMC Stand-Alone Acceptance Tests (TMC SAATs) shall be conducted at each deployment location and the TMC in Albuquerque, and are intended to verify that each individual field subsystem can function as specified, and communicate with the intended remote site (TMC) properly, and support the types of communication expected for the related field deployment. These tests shall be conducted after the installation of the related subsystem is completed, and after the related communication means is installed and terminated, but before the related communication circuit is integrated with the related processing units

in the TMC. The tested field element and related communication circuit shall be tested as complete assemblies.

The TMC SAAT for a subsystem shall be conducted only after the successful completion and Department acceptance of the On-Site SAAT.

The TMC SAAT shall include the following entities and aspects, at a minimum:

- Conformance with the approved shop drawings, including bills of material, component layouts, general appearance of the assembled systems, measures for surge protection and system grounding, and measures for abatement against environmental challenges (shock, vibration, extreme temperatures, and protection against ingress of water and small animals).
- Explicit tests to demonstrate that the tested subsystem, related communication enclosures and communication subsystem contained as part of a larger subsystem, where applicable, are capable of re-establishing normal operation upon power up without human intervention.
- Testing of automated response to remote inquiries, and, if applicable, initiation of communication for automated reporting by the communication subsystems.
- Demonstration of repeatable communication performance, in terms of establishing communication and supported bandwidth, at least three consecutive times (three separate sessions) for each applicable communication mode.
- Demonstration that the communication system is fully functional, including network management, malfunction isolation/diagnosis of failed equipment, and performance monitoring.

The following test aspects and requirements are specific for each device type.

#### **4.01 Fiber-Optic Communication Circuit**

TMC SAAT for a fiber-optic communication circuit deployment shall include

- Where the FO communication circuit is intended as one of the redundant means of communication, verify system ability for automatic failover to the redundant path, and measure failover speed, on the complete FO communication circuits, including any applicable patch assembly, splitters, attenuators, amplifiers, and transceivers.
- Where Ethernet is involved, verify switch provisioning, VLAN provisioning, Ethernet re-convergence, on the complete fiber-optic circuits, including any applicable patch assembly, splitters, attenuators, amplifiers, and transceivers.
- Where self-healing networking topology is involved, verify system ability for automatic failover to redundant path, and measure failover speed, on the complete fiber-optic circuits, including any applicable patch assembly, splitters, attenuators, amplifiers, and transceivers.
- Testing on VLAN throughput, packet loss, and packet latency, on the complete fiber-optic circuits, including any applicable patch assembly, splitters, attenuators, amplifiers, and transceivers.

#### **4.02 CCTV Camera System**

TMC SAAT for a CCTV camera deployment shall include:

- All functional and performance tests as specified in the Testing section of related pay item.
- Where redundant means of communication (CDMA cellular data service, and fiber-optic communication system) are involved, verify system ability for automatic failover to the redundant path.
- Test stimuli and response between the related control/communication system and a testing tool (at the deployment site) over a fiber-optic based Ethernet communication medium.

- Test stimuli and response between the related control/communication system and a testing tool (at the deployment site) over an RF (cellular) based Ethernet communication medium.
- Test quality of video image transmitted to the TMC.
- For the CCTV camera assembly with Pan-Tilt-Zoom (PTZ) functions only, test camera response to the PTZ signals and video image quality using controller and viewing tools at the related remote site (TMC). Tests shall confirm correct focusing and other responses to Pan changes, Tilt changes, Zoom changes, Preset changes for all required preset positions, and ability to transition automatically between presets in the correct sequence when "Tour" mode activated. Specific minimum PTZ functionality is detailed in the CCTV specifications under separate cover.
- For the CCTV camera system with digital video encoders only: verify the encoder functions using controller and viewing tools at the related remote site (TMC). Verify that the encoder is capable of transmitting MPEG2 coded video stream with image size of 4CIF and at a frame rate of 15 frames per second (FPS); where applicable, verify that the encoder is capable of simultaneously transmit the MPEG2 stream stated above, and MJPEG coded images with image size of 1CIF and at a frame rate of 1 FPS.

#### 4.03 Dynamic Message Sign

TMC SAAT for a dynamic message sign deployment shall include

- All functional and performance tests as specified in the Testing section of related pay item.
- Where redundant means of communication (EVDO based cellular data service, and fiber-optic communication system) are involved, verify system ability for automatic failover to the redundant path.
- Test stimuli and response between the related control/communication system and related workstation in TMC over the installed fiber-optic based Ethernet communication medium.
- Test stimuli and response between the related control/communication system and related workstation in TMC over the installed RF (cellular) based Ethernet communication medium.

#### 4.04 Vehicle Detectors

TMC SAAT for a vehicle detector deployment shall include

- Verification of speed detection outputs at the TMC for each lane in the detection zone. If CCTV coverage is available at the detector a 'reasonability' check should be performed to ensure the detectors are providing accurate outputs.
- Verification of lane occupancy outputs at the TMC for each lane in the detection zone. If CCTV coverage is available at the detector a 'reasonability' check should be performed to ensure the detectors are providing accurate outputs.
- Verification of volume outputs at the TMC for each lane in the detection zone. If CCTV coverage is available at the detector, readings should be verified to be within 5% over a sample of 100 vehicles for each lane within the detection zone.

### 5.0 INTEGRATED SYSTEM ACCEPTANCE TEST

The Integrated System Acceptance Test (ISAT) shall be conducted at the TMC and field deployment locations, as required, to verify that all individual field subsystems can function as specified, and that communication, stimuli and responses between system components integrated in the system meet the specifications, when all related deployments are in full operation.

Conduct Integrated System Acceptance Tests only after all equipment for a particular system is installed and interconnected for a particular phase of work, and only after the related On-Site and TMC SAATs have been completed and accepted by the Department.

The tests shall include the following entities and aspects, at a minimum:

- Explicit tests to demonstrate that the subsystems contained as part of a larger subsystem, where applicable, are capable of re-establishing normal operation upon power up without human intervention.
- Testing of automated response to remote inquiries, and, if applicable, initiation of communication for automated reporting by the communication subsystems.
- Demonstration of repeatable communication performance, in terms of establishing communication and supported bandwidth, at least three consecutive times (three separate sessions) for each applicable communication mode.
- Demonstration that the communication system is fully functional, including network management, malfunction isolation/diagnosis of failed equipment, and performance monitoring.

The following test aspects and requirements are specific for each device type.

### **5.01 Fiber-Optic Communication Circuit**

ISAT for a fiber-optic communication circuit deployment shall include

- Where the FO communication circuit is intended as one of the redundant means of communication, verify system ability for automatic failover to the redundant path, and measure failover speed, on the complete FO communication circuits, including any applicable patch assembly, splitters, attenuators, amplifiers, and transceivers
- Tests shall be conducted to verify that communication between transmission electronic units, through each fiber set, can be performed properly when all related deployments are in full operation.
- Design the test to demonstrate that the transmission devices connected directly to each fiber is able to support OC-192 or 10-Gigabit Ethernet (as applicable) communication networking platform, or the highest communication bandwidth used in the project, without exceeding the bit-error rate of  $10E-9$ .

### **5.02 Individual CCTV Camera System**

ISAT for a CCTV camera deployment shall include:

- All functional and performance tests as specified in the Testing section of related pay item.
- Where redundant means of communication (EVDO based cellular data service, and fiber-optic communication system) are involved, verify system ability for automatic failover to the redundant path.
- Test stimuli and response between the related control/communication system and related workstation in TMC over the installed fiber-optic based Ethernet communication medium.
- Test stimuli and response between the related control/communication system and related workstation in TMC over the installed RF (cellular) based Ethernet communication medium.
- Test quality of video image transmitted to the TMC.
- For the CCTV camera assembly with Pan-Tilt-Zoom (PTZ) functions only, test camera response to the PTZ signals and video image quality using controller and viewing tools at the related remote site (TMC). Tests shall confirm correct focusing and other responses to Pan changes, Tilt changes, Zoom changes, Preset changes for all required preset positions, and ability to transition

automatically between presets in the correct sequence when "Tour" mode activated. Specific minimum PTZ functionality is detailed in the CCTV specifications under separate cover.

- For the CCTV camera system with digital video encoders only: verify the encoder functions using controller and viewing tools at the related remote site (TMC). Verify that the encoder is capable of transmitting MPEG2 coded video stream with image size of 4CIF and at a frame rate of 15 frames per second (FPS); where applicable, verify that the encoder is capable of simultaneously transmit the MPEG2 stream stated above, and MJPEG coded images with image size of 1CIF and at a frame rate of 1 FPS.
- For the CCTV camera system with digital video encoders only: verify that each incoming video stream is routed to a digital video decoder dedicated to the video stream. Verify that the digital video decoder is of model matching the related encoder, and that the PTZ control signal and analog video image generated by the decoder is integrated into the existing analog video matrix switch system. Verify that the matrix switch system is configured to integrate the PTZ control signal and video signal from the new CCTV cameras. Demonstrate that the new cameras can be controlled via any PTZ control interface device of the matrix switch system, and that the video image of the new cameras can be displayed on any of the video monitors connected to the matrix switch.

### 5.03 Integrated CCTV Video System

Tests on the video system shall include the existing video-management (VM) system, all existing and newly installed CCTV cameras and systems, and related communication arrangements, which are added to and integrated into the existing system.

Verify the following performance aspects at a video monitor connected to the VM system:

- Verify that video image from each CCTV camera is received and displayed properly.
- Verify for each camera that the video image is visible with the following lighting levels at the camera site: at the minimum lighting level as specified for monochrome video, and at the minimum lighting level as specified for color video.
- Using the PTZ controller in the TMC, verify that each CCTV camera with PTZ functions respond properly for the following commands: Pan changes, Tilt changes, Zoom changes, Preset changes for all required preset positions, and ability to transition automatically between presets in the correct sequence when "Tour" mode activated. Specific minimum PTZ functionality is detailed in the CCTV specifications under separate cover.

Verify that the VM system, using a workstation in the TMC, can generate the following video patterns on one display involving the added video images:

- Live video image from any attached camera
- Play back of recorded video image from any attached camera
- Combination of live and recorded video image from any attached camera
- Sequencing of full-screen, 4, 7, 9, 10, 13 or 16 cameras of combinations of any attached cameras, and back.

Verify that the VM system respond as specified to the following conditions, involving the added video images:

- "Loss of image" detection in any of the attached camera: activation of related alarm contact output.

- Restoration of power after power down: automatic resumption of video recording and other configured operations.
- System freeze up: automatic reboot of the system.
- Sensor alarm input: automatically issue PTZ command for related camera to move to the related camera preset position.
- Arrange for tests to demonstrate setting and changing of PTZ presets, to adjust (retune) established PTZ presets.
- Arrange for tests to demonstrate the scheduling features of different scanning pattern of detection coverage (sets of PTZ presets) for each camera.

#### 5.04 Individual Dynamic Message Sign

ISAT for a dynamic message sign deployment shall include

- All functional and performance tests as specified in the Testing section of related pay item.
- Where redundant means of communication (CDMA cellular data service, and fiber-optic communication system) are involved, verify system ability for automatic failover to the redundant path.
- Test stimuli and response between the related control/communication system and related workstation in TMC over the installed fiber-optic based Ethernet communication medium.
- Test stimuli and response between the related control/communication system and related workstation in TMC over the installed RF (cellular) based Ethernet communication medium.

#### 5.05 Integrated Dynamic Message Sign System

Tests on the DMS master control system at the TMC shall include the existing DMS control system, DMSs, and related communication arrangements, which are added to and integrated into the existing system.

Verify the following performance aspects of the DMS master control system, using a related workstation in the TMC, involving the added DMSs:

- Verify that DMS responses to stimuli generated from the control system are as specified.
- "Loss of Communication" detection with the attached DMS: activation of related alarm contact output.
- Restoration of power after power down: automatic resumption of video recording and other configured operations.
- System freeze up: automatic reboot of the system.
- DMS alarms: process and annunciate unusual signal status at the DMS, which may include controller door open, controller over-temperature, loss of primary power source at DMS site, DMS UPS battery charge level low, etc.

#### 5.06 Individual Vehicle Detectors

ISAT for a dynamic message sign deployment shall include

- All functional and performance tests as specified in the Testing section of related pay item.
- Where redundant means of communication (CDMA cellular data service, and fiber-optic communication system) are involved, verify system ability for automatic failover to the redundant path.

- Test stimuli and response between the related control/communication system and related workstation in TMC over the installed fiber-optic based Ethernet communication medium.
- Test stimuli and response between the related control/communication system and related workstation in TMC over the installed RF (cellular) based Ethernet communication medium.

### 5.07 Integrated Vehicle Detection System

Tests on the VD system at the TMC shall include the existing VD system, and related communication arrangements, which are added to and integrated into the existing system.

Verify the following performance aspects of the VD system, using a related workstation in the TMC, involving the added VDs:

- "Loss of Communication" detection with the VD: activation of related alarm contact output.
- Restoration of power after power down: automatic resumption of video recording and other configured operations.
- System freeze up: automatic reboot of the system.
- Alarms: process and annunciate unusual signal status at the device, which may include controller door open, controller over-temperature, loss of primary power source, etc.

### 6.0 30-DAY OPERATIONAL TEST

The 30-Day Operational Test (30DOT) shall be conducted at the TMC, and at and field locations as required, to verify that the system elements as integrated into the existing system, together with the rest of the existing system, can function as specified as a single system continuously, 24 hours a day over long periods. This test shall be conducted following the successful completion of all other acceptance tests for all systems under this contract

Provide the communications service to the Department by means of a local telephone number or by means of an answering service. Provide at least one local telephone number at which the Contractor can be reached at all times. Maintain records of stoppages and resumptions of the 30DOT. The records shall be verified against the records maintained by the Department for accuracy.

Maintain event/activity log for all related events taking place during the test period. The event log shall include the identity of equipment related to the malfunction, identified cause of malfunction (if any), description of the work performed, description of used labor, materials, and special equipment, time and date the malfunction is reported, and time and date the malfunction is resolved.

In the event that any equipment malfunctions at any point during the test period, the contractor is to correct the failures within a) 48 hours when repair personnel are located within New Mexico; or b) 72 hours when repair personnel must travel from out of state. The 30-day period is suspended for the whole hours between the time the defect is reported, and the time the defect is resolved. The Contractor will be notified by the Department following the occurrence of the equipment malfunction. The Contractor's receipt of notification is defined as when the Contractor's personnel or the Contractor's answering service receives the call.

In addition to the suspension of the test period, the Department shall deduct one percent (1%) of the unit bid price for ITS Acceptance Testing per day from the payment due to the Contractor as a liquidated damage, for each malfunction lasting beyond the 48 or 72 hour notification period listed above.

During the test period, a system defect may also be declared as specified in the article for "SYSTEM DEFECTS". If a system defect is declared, the ongoing 30DOT shall be discontinued, and a new 30DOT shall be restarted for the entire system after the cause of the system defect is fully resolved, and related acceptance testing (On-Site SAAT, TMC SAAT, and ISAT) are completed satisfactorily and formally accepted by the Department.

### **6.01 On-Site Operational Support**

The Contractor shall provide for the first 5 working days of the 30-day test period, personnel who are fully knowledgeable and capable of operating the ITS and communications subsystems installed under the contract, and who can exercise all functions in a normal working environment. These personnel shall be required to be on site from 8:00 a.m. to 5:00 p.m. every day except Saturdays and Sundays during this period. The personnel shall provide operating support for the installed system, training and guidance for the operators, exercise the system, and perform operational tests on the complete system on a day-to-day basis.

Operational support for all installed communication subsystems shall include troubleshooting, diagnostics, and component replacement of system elements not operating as specified.

### **6.02 On-Call Operational Support**

During the 30-day test, Contractor shall provide on-call operational support for the supplied systems, including troubleshooting and diagnostics, and component replacement of system elements found not operating as specified. Provide telephone number(s) at which the on-call support personnel can be reached 24 hours a day.

The on-call support personnel are expected to respond to a call for the service, to be at the TMC or equipment site within four (4) hours after a call for the service is made, and to record all service calls on a maintenance form provided by the Department. The service record shall be submitted to the Department within one working day from the time the service call is received. The Department shall impose a liquidated damage at the rate of one percent (1%) of the unit bid price for ITS Acceptance Testing per day (or portion thereof) per event, for each 24-hour period beyond the indicated response that this requirement is not met.

### **6.03 Close Out of Acceptance Testing**

After the completion of 30-day operational test, conduct complete system diagnostics for field and TMC equipment as follows:

- Equipment testing and adjustment of settings and parameter
- Check component operations with respect to these specifications
- Conduct all preventative maintenance activities for systems provided under this contract, as per each manufacturer's standard recommendations.
- Submit a record of all events taking place in the 30DOT period.

## 7.0 SYSTEM DEFECTS

The Department retains the right to declare a system defect in the event that

- 20% of similar equipment malfunctions during the test period, or
- less than 20% of similar equipment malfunctions at any point during any test period, but one or more devices experiences a total of three failures of the same component, subsystem, or system.

When a system defect is declared on a particular item or system, the Contractor shall replace all affected equipment at no additional cost, in which case, all replaced equipment shall be retested starting with the phase that was most recently completed prior to the malfunction.

Delays caused by a System Defect will not absolve the Contractor from the obligation of completing the contracted scopes of work by the stated deadline.

## 8.0 GEOGRAPHICAL INFORMATION SYSTEM (GIS) DATA

The Contractor shall provide ESRI Shape Files with GPS coordinates of each installed ITS element to the NMDOT ITS Bureau. GPS data shall be collected in WGS84 and decimal degrees format. Contractor shall contact the ITS Engineer, (505)222-6552 prior to any data collection. The following elements include, but are not limited to: ITS manholes, ITS pullboxes, ITS poles, cameras, sensors, dynamic message signs, HAR stations, RWIS stations, power meters, transformers, conduit, and any infrastructure between the utility drop and the associated ITS items. Data shall be logged in Excel files provided to the Contractor by the ITS Engineer. Data shall be submitted to the ITS Engineer prior to the end of the 30DOT. Photographs shall be taken of all ITS infrastructure, including the inside of all cabinets and manholes. Photographs of meter pedestals shall show the meter face and number.

## 9.0 MEASUREMENT AND PAYMENT

Payment shall be made on a Lump Sum basis in accordance with the itemized list of unit costs submitted for bid item 750000 – Intelligent Transportation System.

### Pay Item

### Pay Unit

ITS Acceptance Testing

Lump Sum

**NOTE:** The Contractor shall make reference to the lump sum item, **INTELLIGENT TRANSPORTATION SYSTEMS (ITS)**, and shall enter the unit cost and total amount bid for the above-described item in the table under the appropriate description.

Payment for ITS Acceptance Testing shall include satisfactory completion of the related acceptance testing, and shall be according to the follow schedule:

- Fifty percent (50%) of the lump sum bid price for this item will be paid upon successful installation and completion of the approved on-site stand alone tests for all systems (CCTV, DMS, Vehicle Detectors and Telecommunications).
- Twenty percent (20%) of the bid price will be paid upon successful installation and completion of the approved TMC stand alone test
- Twenty percent (20%) of the bid price will be paid upon successful installation and integration and completion of the integrated system acceptance tests for all systems.
- Ten percent (10%) of the bid price will be paid upon successful completion of the 30 calendar day operational test period and approved delivery of GIS data.