DERRY LONONDERRY EXIT 4A
13065

May 19, 2020

SPECIAL PROVISION

SECTION 677 – INTELLIGENT TRANSPORTATION SYSTEMS (ITS) EQUIPMENT

FIBER OPTIC COMMUNICATIONS SPECIFICATION

Description

1.1 This work shall consist of furnishing, installing, and testing Single-Mode Fiber Optic Communication Cables, Fiber Optic Splices, and Fiber Optic Splice Enclosures as shown on the plans or as ordered.

Materials

2.1 Technical Submittal. The Design-Build Team shall provide a complete technical submittal as outlined below, and shall not proceed with manufacture, fabrication or construction until the Engineer has approved the submittals in accordance with Section 105.02.

2.1.1 The Design-Build Team shall provide drawings, manufacturer's specifications, and applicable catalog cuts for all materials and components for this work, submitted in accordance with section 105.02.

2.1.2 The Design-Build Team shall provide documentation on the qualifications of personnel involved and responsible for the installation of the fiber optic cable. Personnel shall have at least 3 years of experience with the installation of single-mode fiber optic cable, including splicing, termination, and testing. The installation experience should be applicable to the work required for this project and shall include projects of similar or larger scope, providing mid-span access points and fusion splicing in field conditions.

2.1.3 Along with shop drawings and catalog cuts of all proposed materials and equipment to be installed, the Design-Build Team shall provide the Engineer with a hardcopy of the cable Manufacturer's recommendations and requirements, listed below, for each fiber optic cable type and size:

2.1.3.1 Pulling lubricants recommended by the cable manufacturer for use on the cable. No other lubricants will be permitted.

2.1.3.2 The maximum pulling tensions of the cable, which shall specify both pulling from the cable's strength members and for pulling from the outer jacket.

2.1.3.3 The minimum bending radius of the cable, which shall specify a radius for both the installation and for long-term installation.

2.1.4 Fiber optic loss tests.

2.1.4.1 Fiber loss tests shall be conducted on all strands of the entire length of cable at both 1310 nm and 1550 nm light wavelengths. Three tests shall be conducted as follows:

(a) By the Manufacturer prior to shipping.

(b) By the Design-Build Team upon delivery to the site.

(c) By the Design-Build Team after installation of the cable is complete.

2.1.4.2 The final fiber optic loss tests conducted after installation is complete shall be conducted using an Optical Time Domain Reflectometer (OTDR). The OTDR use and settings shall conform to the requirements described in section 3.15.5 below.

2.1.4.3 An OTDR may also be used for tests specified in 2.1.4.1 (a) and 2.1.4.1 (b) above as well. The OTDR settings for these tests shall conform to the requirements described below for the final fiber optic tests specified in 3.15.5, except that bidirectional OTDR testing is not required; only testing fiber strands in one direction shall be required.

2.1.4.4 Four (4) certified copies of test results, from both tests specified in 2.1.4.1 (a) and 2.1.4.1 (b) above shall be provided to the Engineer for comparison.

2.2 Single Mode Fiber Optic Cable. All fiber optic cable shall be single-mode and shall be supplied by a single manufacturer.

2.2.1 The fiber optic cable shall include an anti-buckling central member, consisting of a dielectric glass reinforced plastic rod. The central member shall prevent the cable from buckling and stretching. The central member expansion and contraction characteristics shall be similar to the optical fibers and the fiber tubes.

2.2.2 The fiber optic cable shall include loose buffered tubes, containing no more than 12 fibers strands in each tube. Buffer tube material shall prevent the fiber from adhering to the inside of the tube.

2.2.2.1 The buffer tube diameter shall not exceed 3.0 mm, and shall be colored in accordance with *TIA/EIA-598, Optical Fiber Cable Color Coding.*

2.2.2.2 Buffer tubes shall be filled with a dry water blocking material to prevent water intrusion. Water blocking material shall be nontoxic, nonirritant to skin contact, and non-nutritive to fungus. The filling shall be electrically non-conductive and readily removable with conventional nontoxic solvents.

2.2.2.3 Fiber optic strands shall be placed loosely inside the buffer tubes to allow for fiber expansion and contraction due to temperature changes.

2.2.3 Fiber optic strands shall consist of a doped-glass cylindrical core, surrounded by a concentric cladding. An acrylate coating shall cover the fiber to add protection and color. Each fiber optic strand shall meet the requirements of Table 1 below.

Table 1: Fiber Optic Strand Requirements

Fiber Optic Strand Characteristic	Requirement
Core Diameter	8.3 µm ± 0.5 µm
Cladding Diameter	125 µm ± 1.0 µm
Core to Cladding Offset	< 0.8 µm
Cladding Non-Circularity	< 1.0%
Total coating diameter	245 ± 10 µm Mechanically strippable
Coating Color	In accordance with TIA/EIA-598, Optical Fiber Cable Color Coding
Attenuation at Water Peak	Not to exceed 2.1 dB/km at 1383 ± 3 nm
Mode-Field Diameter	9.30 ± 0.50 µm at 1310 nm 10.5 ± 1.0 µm at 1550 nm
Zero Dispersion Wavelength	1301.5 nm to 1321.5 nm
Zero Dispersion Slope	<0.092 ps/(nm2 * km)
Cable Loss	<0.4 dB/km when measured at 1310 nm <0.3 dB/km when measured at 1550 nm

2.2.3.1 No point discontinuity along the fiber shall have attenuation greater than 0.10 dB at either 1310 or 1550 nm.

2.2.4 Cable casing shall be composed of high tensile strength dielectric yarns helically stranded evenly around the cable core, surrounded by a polyethylene outer jacket. A ripcord shall be provided between the first and second layer. All casing layers shall be non-nutritive to fungus.

2.2.4.1 The polyethylene outer jacket shall have a minimum thickness of 1.4 mm, and shall be black medium or high density polyethylene in accordance with ASTM D1248, Type II or Type III, Class C, Category 3, 4, or 5 and contain a suitable antioxidant.

2.2.4.2 The polyethylene outer jacket shall contain carbon black to provide ultraviolet light protection.

2.2.4.3 The polyethylene outer jacket shall have permanent affixed markings every two feet or every one meter along the cable. These markings shall contain at a minimum the cable length, manufacturer's name, date of manufacturer, and fiber count.

2.2.5 All fiber optic cable materials shall be non-conductive to electricity. In cases where armored fiber is required, it shall be single jacketed, single armored with a dialectric central element.

2.2.6 The fiber optic cable shall operate over a temperature range of -40°F to 165°F at a relative humidity of 10% to 90% noncondensing. The cable shall be tested in accordance with EIA/TIA-455-3A. The change in attenuation at the extreme operational temperatures shall not exceed 0.2 dB/km at 1550 nm.

2.2.7 The cable shall withstand 25 impact cycles when tested in accordance with *TIA/EIA-455-25, Repeated Impact Testing of Fiber Optic Cables and Cable Assemblies*. The change in attenuation shall not exceed 0.2 dB at 1550 nm.

2.2.8 Using a maximum mandrel and sheave diameter of 560 mm, the cable shall withstand a tensile load of 608 lbs when tested in accordance with *TIA/EIA-455-33, Optical Fiber Cable Tensile Loading and Bending Test*. The change in attenuation shall not exceed 0.2 dB during loading and 0.1 dB after loading at 1550 nm.

2.2.9 The cable shall withstand four full turns around a mandrel of less than 10 times the cable diameter for non-armored cables and less than 20 times the cable diameter for armored cables after conditioning for four hours at test temperatures of -22°F to 140°F. Neither the inner or outer surfaces of the jacket shall exhibit visible cracks, splits, tears or other openings. Optical continuity shall be maintained throughout the test.

2.2.10 The cable shall withstand a minimum compressive load of 250 lbf/in for armored cables and 125 lbf/in for non-armored cables applied uniformly over the length of the sample when tested in accordance with *TIA/EIA-455-41, Compressive Loading Resistance of Fiber Optic Cables.* The load shall be applied at the rate of 3 mm to 20 mm per minute and maintained for ten minutes. The change in attenuation shall not exceed 0.4 dB during loading and 0.2 dB after loading at 1550 nm.

2.2.11 A length of cable no greater than 13’1-½ ” (4 meters) shall withstand 10 cycles of mechanical twisting. The change in attenuation shall not exceed 0.1 dB at 1550 nm.

2.2.12 The cable shall withstand 25 mechanical flexing cycles around a sheave diameter not greater than 20 times the cable diameter when tested in accordance with *TIA/EIA-455-104, Fiber Optic Cable Cyclic Flexing Test.* The change in attenuation shall not exceed 0.1 dB at 1550 nm.

2.3 Fiber optic cable shall be shipped and stored in reels designed to prevent damage to the cable.

2.3.1 Each reel shall contain an identification tag, identifying the cable’s date of manufacture, the Manufacturer’s product code, fiber count, length of cable, and beginning and end length markings.

2.3.2 Both ends of the cable shall be accessible to provide access for testing.

2.3.3 The cable ends shall be securely fastened and shall not protrude beyond any portion of the reel in an unprotected manner to prevent the cable from becoming loose in transport.

2.3.4 Cables ends shall be sealed to prevent the escape of the water blocking material and entry of moisture during shipping, handling, storage, and installation.

2.4 Fiber Optic Splice Enclosure shall be a stand-alone unit, manufactured for installation in an underground storage box and shall meet the following requirements:

2.4.1 Splice enclosures installed in a fiber optic manhole or pull box shall be capable of holding a minimum of 96 splices. Splice enclosures installed in a splice vault shall be capable of holding a minimum of 288 splices.

2.4.2 Splice enclosures shall be manufactured of non-corroding materials and resistant to caustic solutions. Splice enclosures shall be waterproof and airtight.

2.4.3 Splice enclosures shall employ re-usable sealing materials allowing multiple re-entrances without replacing any component.

2.4.4 Splice enclosures shall be large enough to accommodate the number and size of splice trays needed to hold the number of fiber optic cable splices specified in 2.3.1 above.

2.4.5 Each splice enclosure shall contain a splice tray organizer capable of holding the required number of splice trays. Splice trays shall incorporate grooves to hold the fiber optic splice in place, and a system to retain and provide strain relief to the fiber optic buffers tubes. Each splice tray shall incorporate a clear, snap-on lid.

2.4.6 Splice enclosures shall incorporate cable guides that maintain a bending radius for both the fiber strands and buffer tubes greater than the minimum bending radius allowed by the fiber optic cable manufacturer.

2.4.7 The splice enclosures shall incorporate a restraining mechanism to hold each fiber optic cable central member and outside jacket.

2.4.8 Mounting brackets for the splice enclosure shall be provided, as recommended by the manufacturer.

Construction Requirements

3.1 Prior to installation of cable, the Design-Build Team shall clean all conduit and aerial messengers, if applicable, per industry standards.

3.2 The Design-Build Team shall ensure the cable is not damaged during storage, delivery and installation. All cable shall be inspected and approved by the Engineer prior to installation.

3.3 The Design-Build Team shall establish adequate voice communications between the cable feeding location and the cable pulling equipment operators prior to commencing any pulling operation.

3.4 All cables shall be pulled in conduit with a cable grip designed to provide a firm hold on the exterior covering of the cable, with heat shrinkable end caps placed on the cable ends. All fiber optic cables to be installed in a conduit or duct facility shall be pulled as a unit. The cable shall not be pulled along the ground, or over and around obstructions. The cable shall not be stepped on by workmen, or run over by vehicles or equipment.

3.5 Fiber optic cable ends shall be kept sealed at all times during installation, using an approved cable end cap. Tape shall not be permitted to seal the cable end. The cable end shall remain sealed until the Design-Build Team terminates the fiber cables. Cables that are not immediately terminated shall have a minimum of six feet of slack.

3.6 The fiber optic cable shall not be pulled through an intermediate junction box, pull box, or any other opening in the conduit, unless approved by the Engineer. The necessary length of cable to be installed shall be pulled from pull box, or cabinet to the immediate next downstream pull box, or cabinet. The remaining length of cable to be installed in the next conduit or along aerial messenger shall be carefully stacked or stored in a manner that allows that length of cable to be safely pulled into the next conduit.

3.7 The Design-Build Team shall carefully determine the lengths of cable needed to install the cable in a continuous run between termination points as indicated on the plans or directed by the Engineer. Splicing of fiber optic cables at any location other than those shown on the plans shall not be permitted.

3.8 The cable reels shall be placed on the same side of the pull box with the conduit where the cable is being installed. The reel shall be made level and brought into proper alignment with the conduit section, such that the cable will pass from the top of the reel. The cable shall be fed by manually rotating the reel.

3.9 An approved cable feeder guide shall be used between the cable reel or the storage stack and the face of the conduit to protect the cable, and to guide the cable installation. The dimensions and set-up of the feeder guide shall be such that the cable does not bend at any location to a radius less than the cable's minimum allowable bending radius. The cable shall not be pulled over edges or corners, over or around obstructions, or through unnecessary curves or bends. The cable shall be looped in and out to cabinets and pull boxes to provide adequate slack and the least amount of stress on the fibers.

3.10 The maximum pulling tensions and minimum bending radius shall not be exceeded at any time during installation, and shall be monitored at all times.

3.10.1 Allowable pulling tension shall be either the cable manufacturer's recommended pulling tension from the outer jacket for the cable, or eighty percent of the cable manufacturer's maximum pulling tension from the outer jacket, whichever is lesser.

3.10.2 The Design-Build Team shall monitor the tension on the fiber optic cable with the use of an approved tension gauge. The gauge shall be placed sufficient distance from the take up reel, such that the tension can be read throughout the entire pulling operation.

3.11 When using lubricants, the Design-Build Team shall adhere to the cable manufacturer's requirements for the proper amount, application tools and method, and removal of the lubricant from the exposed cable.

3.12 Unless otherwise shown on the Plans or directed by the Engineer, the Design-Build Team shall install a minimum length of spare cable as shown in Table 2 below.

Table 2: Minimum Length of Spare Fiber Optic Cable Installations

Install Location	Length of Spare Cable Required
Underground Splice Vaults and Manholes	200 Feet minimum. If a splice enclosure is present, 100 feet of spare cable shall be installed on each side of the splice enclosure.
Equipment Cabinets	25 feet minimum up to 50 feet maximum. If an underground splice vault or manhole is installed within 50 feet of the cabinet, then 50 feet of spare cable shall be stored in the underground facility in addition to the 200 feet required for the splice vault or manhole.
Aerial Splice Enclosures	Length equal to 2X the distance to the nearest service vehicle parking location, plus 200 feet minimum. Half the length of spare cable shall be installed on each side of the splice enclosure.
All Other Aerial Installations	200 feet minimum for every 1500 feet of installed cable.

3.12.1 Cable storage shall be performed in an industry standard manner that does not violate the manufacturer's minimum bending radius specification of the cable. All spare cable in underground facilities shall be hung on cable racks or hooks to prevent damage or excessive bending of the fiber optic cable.

3.13 The Design-Build Team shall tag each fiber optic cable leaving all splice vaults, manholes, cabinets and enclosures. Each tag shall be constructed of 10 mil thick vinyl, measuring 2 inches by 3.5 inches in size, minimum, with a yellow background color and shall include a 2 mil thick adhesive-backed, clear polyester laminating cover. The tag shall include holes for securing to the fiber optic cable using two nylon cable ties or other method as approved by the Engineer. The tag shall be affixed to the fiber optic cable such that the information on the tag is not obscured. The tag shall permanently state the following information:

(a) "NHDOT FO Cable"

(b) Strand count, e.g., "288F"

(c) Direction of travel of the cable, e.g., "N", "S", "E", "W"

(d) Roadway(s) along which cable is placed

(e) Destination of cable, e.g., "Cabinet 3", "Hub 2", "SV 6"

An example of an acceptable tag is:
NHDOT FO Cable – 288F

3.14 Fiber Optic Splices:

3.14.1 If fiber optic splices are proposed at a location that does not already have an existing splice enclosure installed, the Design-Build Team shall furnish and install a new splice enclosure and splice trays meeting the requirements of 2.4. The Design-Build Team shall provide the fiber optic splice enclosures and splice trays in the numbers and sizes required to fully construct the fiber optic splice location.

3.14.2 All splice installations shall be performed using a fusion splicing technique. Splices shall not exceed the maximum allowable splice insertion loss specified in 3.15.

3.14.3 Each spliced fiber shall be packaged in a protective, waterproof sleeve.

3.14.4 If special tools or kits are required to enter and close splice cases, then these tools or kits shall be provided by the Design-Build Team.

3.14.5 Mounting brackets for the splice enclosure shall be supplied and installed as recommended by the manufacturer.

3.15 Fiber Optic Communications Test.

3.15.1 Except for the two tests specified in 2.1.4.1 (a) and 2.1.4.1 (b) above, all fiber optic communications testing shall be performed after the field installation of all equipment is complete, but before connection with NHDOT's Traffic Management Center (TMC) in Concord. The tests shall validate the functionality of the fiber optic components of the project, relative to the requirements as contained in the contract. Fiber optic communications testing shall be conducted using equipment supplied by the Design-Build Team for this purpose. If a unit fails to pass its communications test, the Design-Build Team shall correct the problem or replace the unit and retest it until satisfactory results are achieved.

3.15.2 Presence of any unexpected optical loss events (optical power loss introduced by unexpected loss events, such as those caused by micro-bending, pinching and sharp bends in fiber) greater than 0.5dB per cause, as documented in the graphic presentation of an Optical Time Domain Reflectometer (OTDR) test, or the total loss introduced by unexpected optical loss events greater than 1dB in an OTDR test, are grounds for rejection of the related fiber installation. All power losses not attributable to planned connectors and splices are considered unexpected loss events.

3.15.3 Splice insertion loss shall not exceed 0.1 dB.

3.15.4 The Design-Build Team shall provide all equipment, materials and labor required to perform each test, including laptop computers, internet connections, software, and maintenance of traffic.

3.15.5 The Design-Build Team shall propose ITS testing plans and procedures, and submit these plans to the Engineer for approval. Test plans shall be developed to provide a mechanism that ensures that all contract requirements have been tested successfully and verified.

3.15.5.1 Each of the test plans shall contain the date, time, and location of the testing, names of the Design-Build Team personnel who will be conducting the testing, descriptive overview of the proposed test procedure, and a list of test equipment required to perform the tests. Test logging forms, presented in tabular format, shall include separate columns for test case, descriptions detailing the test step to be performed, expected results, actual results, pass/fail status, and comments on the test step or result.

3.15.5.2 The Design-Build Team shall supply separate test logging forms at the time of testing for each test plan, and for each device location. The test logging forms shall show the device location, date, and the start and end times of the test. At the end of each test logging form, there shall space to include dated signatures for Design-Build Team personnel conducting the test, NHDOT representative witnesses, NHDOT Project Manager or Contract Administrator. Signatures on the test logging form will signify only that the test was performed and witnessed, not that it passed or failed.

3.15.5.3 The detailed test plans shall be submitted to the Engineer no later than 15 working days prior to the beginning of each test phase for approval. If any deviations or changes to the approved test plans arise, it shall be resubmitted for review and approval prior to any planned test activity. No tests shall be conducted until the test plans have been approved.

3.15.5.4 The Design-Build Team shall have approved test plans prior to submitting a request to schedule the start of any test activities. The Design-Build Team shall notify the Engineer no less than 7 days prior to the beginning of any equipment or systems testing.

3.15.5.5 A summary of all tests shall be produced at the completion of each testing phase of the project to ensure that all requirements defined by the system are satisfied.

3.15.6 Fiber optic loss tests and OTDR settings.

3.15.6.1 Testing shall be conducted on all components of the fiber optic cable plant, including all strands of all fiber cables, all splices, and all terminated patch panel positions, as shown in the Plans.

3.15.6.2 The OTDR testing shall be performed twice on every fiber strand of each fiber segment, once in each direction. The optical loss for all components of the fiber optic cable plant tested shall be the average of the two readings, and shall be the measurement used by the Engineer for comparison against the specification requirements.

3.15.6.3 The OTDR used shall internally store all fiber optic cable signatures, and the signatures shall be downloadable to a computer. Signatures of all cables tested shall be supplied by the Design-Build Team in electronic format. The Design-Build Team shall supply OTDR emulation software manufactured by the OTDR manufacturer which is capable of reading the stored signatures and performing all measurement and analysis on the stored signatures as if the OTDR were

connected live to the fiber optic cable. The analysis shall include, but not be limited to, readout of fiber loss per unit length, splice loss measurement (amount of loss and distance from OTDR), connector loss measurement (amount of loss and distance from OTDR), total fiber optic cable length, and generation of event tables, as well as identification and measurement of any other reflective events or faults.

3.15.6.4 The pulse width setting of the OTDR shall be set to the lowest possible setting while allowing the full length of fiber optic cable to be measured for faults or reflective events. In no case shall the pulse width be set to a value greater than 100 ns. The pulse width shall be set to a value sufficiently small so that the optical dead zone shall not extend any distance into the cable being tested.

3.15.6.5 All OTDR testing shall be performed using a launch cable of 1500 feet in length, or greater.

3.15.6.6 For terminated fiber strands, the OTDR "A" marker shall be placed upstream of the connection between the launch cable and the cable under test. For unterminated fiber strands, the "A" marker shall be placed downstream of the launch cable connection, but it shall not be placed downstream of this point by a distance exceeding two percent of the length of the cable under test.

3.15.6.7 The OTDR "B" marker shall be placed upstream of the end of the cable, but it shall not be placed upstream of this point by a distance exceeding two percent of the length of the cable under test.

3.15.6.8 All OTDR traces shall show the total optical loss between the "A" and "B" markers, in units of decibels per kilometer (dB/km).

3.15.6.9 The Design-Build Team shall document the OTDR readings by supplying hard copies of the OTDR signatures for all fiber optic cables. The Design-Build Team shall also supply hard copies of the reflective event table for all optical fibers which shall be directly printed out from the OTDR.

3.15.6.10 The Design-Build Team shall supply fiber optic cable plant loss calculations for all installed components of the cable plant demonstrating that the total plant losses for each fiber are less than the minimum optical fiber optic modem power budget by a safety margin of at least 4 dB.

3.15.7 The Department reserves the right to examine and test or retest any or all materials furnished by the Design-Build Team for the project to determine if they meet the requirements specified within the Contract Documents.

3.15.8 The Design-Build Team shall conduct all tests in the presence of the Engineer or a representative of the NHDOT Bureau of Transportation Systems Management and Operations (TSMO).

3.15.9 Test results shall be packaged and submitted to NHDOT within one week of test completion. No test phase shall begin until all prior test phases have been completed, and test results have been approved by the NHDOT.

3.15.10 The Design-Build Team shall provide any test specific software for testing, as needed.

3.15.11 If installed equipment utilizing the fiber optic cable communication system is subject to an Operational Acceptance Test period, the fiber optic cable shall also be subject to operational testing for the same period of time. This test period will demonstrate that all fiber optic cable and equipment is properly installed, free from problems, exhibits stable and reliable performance communicates reliably with NHDOT's TMC and complies with the Contract Documents. In the event of a failure, the problem shall be reported to the Design-Build Team. The failure shall be corrected and the operational tests shall then be restarted.

3.16 **Documentation.** Complete and accurate as-built global positioning system (GPS) coordinates for the entire system shall be clearly labeled with the project name, number, marked as ITS As-Builts and forwarded to the NHDOT TSMO – Attn: ITS Project Manager, 110 Smokey Bear Blvd. Concord, NH 03301 (603-271-6862).

3.16.1 The Design-Build Team shall provide as-built GPS coordinates and information for the locations of all splices and connections for each strand of fiber optic cable. This documentation shall show the distance in feet of fiber optic cable from the end of the cable for every splice and connection, the cable length marking as marked on the cable for every splice and connection, and shall also show the total number of fiber strands of the installed cable. Four copies of the documentation shall be furnished to the Engineer prior to testing.

3.16.2 The GPS coordinates shall be accurate to +/- 2 feet.

3.17 Guarantees and Warranties.

3.17.1 Limits of Guaranteed Work. The Design-Build Team shall unconditionally guarantee all system and subsystem modules including all cabinets, equipment, hardware, and software installed to be free of defects. The guarantee shall cover all materials, labor, equipment, transportation, maintenance of traffic, and incidentals required to facilitate responsive maintenance as necessary to repair and replace any defective modules, systems or subsystems of the fiber optic cable installation.

3.17.2 It shall be the Design-Build Team's responsibility to secure all guarantees that are customarily issued by the equipment manufacturers for the specific equipment included in the Contract. The form in which such guarantees are delivered to the Design-Build Team shall include the provision that they are subject to transfer to the Department, and shall be accompanied by proper validation of such fact. Transfer of guarantees shall coincide with the Guarantee Period specified below.

3.17.3 Guarantee Period. The length of guarantee will be 1 year from the date of the system acceptance by the Engineer. Additionally, the Design-Build Team shall guarantee availability of

compatible replacement equipment (to the field replaceable unit level) for a ten-year time period from the same date.

3.17.4 Manufacturer's Warranties. The terms of any equipment warranties stipulated by the equipment manufacturers shall be provided with product data included in the Technical Submittal, specified in Section 2.1 above. The terms of any equipment manufacturer's warranties will not relieve the Design-Build Team from any of the guarantee requirements of this contract.

3.17.5 Guarantee Work (Corrective Action). The Design-Build Team shall be responsible for repairs during the Guarantee Period. Repair is defined as all activities that shall be performed for the system to remain in, or return to, operation as observed at the time of system acceptance. The work consists of the repair of defective devices that fail during the normal course of operation, and does not include repairs or replacements made necessary due to damage resulting from vandalism, traffic accidents, or acts of God. The Design-Build Team shall provide on-site warranty service of the equipment within 24-hours of notification by NHDOT. If the Design-Build Team is unable to affect a repair to the system within 7 days of notification, temporary equipment meeting all the original equipment specifications may be requested by the Department, and shall be provided and installed at no cost to the Department. The Design-Build Team shall then either fix or replace the broken device or equipment at their discretion.

3.17.6 A log of all guarantee work performed by the Design-Build Team during the Guarantee Period shall be maintained by the Design-Build Team. The log shall include, the following information:

(a) Date and time defect reported

(b) Entity reporting the defect

(c) Description of the reported defect

(d) Technician responding to reported defect

(e) Arrival time at the site of the technician

(f) Technician performing defect repair or replacement

(g) Description of observed defect

(h) Corrective actions taken

(i) Model and serial number of any module repaired or replaced

(j) Date and time defect rectified

3.17.7 When a guarantee is available on repaired or replacement components, a written and signed guarantee shall accompany the manufacturer's billing invoice. The Engineer or inspecting agent will sign and retain the original and provide a copy to the maintaining agency and a copy to the manufacturer.