Add the following Section:

SECTION 663

MULTIMODE FIBER OPTIC CABLE PLANT

Special Provisions

663 1.01 DESCRIPTION. This item consists of the work required to furnish and install multimode fiber optic cable in polyethylene conduit between equipment shown on the Plans along the route indicated. The item includes installing vaults, splicing cable, testing cable, and terminating fibers.

663-1.02 REFERENCED SPECIFICATIONS. Complete the following work according to the subsections referenced.

1. Submit materials for review and approval, prepare as-built plans, and deliver warranties, guarantees, and instruction sheets according to subsection 660-2.01 Materials.

   The fiber optic cable manufacturer shall submit a letter certifying products conform to requirements specified herein.

2. Complete excavation and backfill according to subsection 660-3.01.3 Excavating and Backfilling, except install conduits at the depth specified in the Polyethylene Duct System Construction Requirements.

3. Remove and replace improvements according to the subsection 660-3.01.5 Removing and Replacing Improvements. .

663-1.03 CERTIFIED FIBER OPTIC TECHNICIAN. Employ a Fiber Optic Technician that has successfully completed at least one four day "Installation of Fiber Optic Products School." A major manufacturer of fiber optic products shall conduct this school or an Engineer approved independent generic four-day school that encompasses aspects of fiber optic technician certification.

Only employ those technicians that provide documents proving a minimum two years work experience splicing, terminating, and testing fiber optic cable.

The approved technician shall provide evidence of completed courses within 1 week before the beginning of construction. The Engineer reserves the right to revoke the approval of technicians not demonstrating the skill and knowledge to perform at accepted industry standards or to the quality required in this special provision.

663-1.04 MANUFACTURER WARRANTIES. Manufacturer's support (customary warranties) period shall be provided for all equipment and materials furnished and installed as part of the fiber optic system, including end equipment

(modems, panels, switches etc.). Manufacturer's and Contractor's warranties or guarantees shall be continuous throughout the specified duration; warranties and guarantees are subject to transfer.

663 2.01 POLYETHYLENE DUCT SYSTEM. Install polyethylene conduits and vaults in excavated trenches to form the duct system for the fiber optic cable. The Department will not permit the polyethylene conduits to be plowed into place.

For the polyethylene conduit, furnish a smooth wall, schedule 40 or schedule 80 as shown on the Plans, high-density polyethylene (HDPE) pipe that conforms to UL 651 B and features a controlled outside diameter.

663-2.02 FIBER OPTIC CABLE, GENERAL.

A current ISO9001 certified manufacturer, who is regularly engaged in the production of fiber optic cable according to these specifications, shall produce the fiber optic cable installed on this project. The manufacturer shall not only manufacture the fiber optic cables, but they shall also test and prepare the cables for shipping and provide connectors needed to complete the project.

Conformance Requirement References

Install fiber optic cable approved for use in underground ducts and which conform to:

1. United States Department of Agriculture Rural Utilities Service (RUS) standard 7 CFR 1755.900.
2. Department of Agriculture Rural Electrification Administration (REA) Bulletin 1753f-601 (PE-90) dated August 4, 1994, and these specifications.
3. National Electrical Code (NEC) Article 770; NFPA-National Fire Protection Agency.
4. Telecommunications Industry Association/ Electronic Industries Association (TIA/EIA) FOTP-Fiber Optic Test Procedures.
5. ASTM A615, Grade 60.
6. Bellcore Testing Requirements GR-771-CORE.
7. EIA/TIA-455-82B: Fluid Penetration Test for Fluid-Blocked Fiber Optic Cable (ANSI/EIA/TIA-455-82B-92; Standard Test Procedures for Fiber Optic Fibers.

8. NEC 250-1: National Electric Code Grounding.; Article 770 Optical Fibers and Raceways.

9. Telcordia GR20-CORE: Optical Fiber and Optical Fiber Cable; GR409-Mechanical Requirements for Optical Fiber Cable.

10. Telcordia GR-771: Fiber Optic Splice Enclosure.

11. TIA/EIA-4720000-A: General Specification for Fiber Optic Cable (ANSI/TIA/EIA-4720000-A-93).

12. TIA/EIA-598-A: Optical Fiber Cable Color Coding (ANSI/TIA/EIA-598-A-95).

Use loose tube fiber optic cables with all-dielectric construction (with no metal armor or conductive material). Optical fibers shall be contained in kink resistant buffer tubes. Each cable shall be equipped with 12 buffer tubes stranded around an anti-buckling central strength member using a reverse oscillation or "SZ" stranding process.

Each buffer tube shall contain 6 fibers and shall have an inside diameter much larger than the total diameter of the fiber it supports. Buffer tubes may have up to 12 fibers where specified in the plan.

Fillers are allowed in the cable to achieve cable cross-section symmetry.

All cable fibers shall be usable and shall be sufficiently free of surface imperfections and inclusions to meet or exceed the optical, mechanical and environmental requirements contained in this specification.

Each optical fiber shall consist of a doped silica core surrounded by a concentric silica cladding.

Fibers shall contain no factory splices.

Fiber coating shall be a dual-layered, UV cured acrylate applied by the fiber manufacturer. The coating shall be mechanically or chemically strippable without damaging the fiber.

Repairs to the fiber coatings are not allowed except as determined by the Engineer at designated splice locations.

A water-blocking gel shall displace the voids between the buffer tubes and void areas around the individual buffer tubes to prevent water entry. The gel shall be non-nutritive, electrically non-conductive and homogeneous and shall facilitate free movement of the fibers within the tubes such that mechanically or environmentally induced stress on the cable is not induced in the optical fibers. The gel shall be free

of dirt or foreign matter and shall be readily removable with nontoxic solvents.

Two (polyester or aramid) yarn binders shall be applied contra-helically with sufficient tension to secure each buffer tube layer to the central strength member without crushing the buffer tubes. The binders shall be non-hygroscopic, non-wicking and dielectric with low shrinkage.

Use cables that gain tensile strength by using a combination of high tensile strength yarns helically wrapped around the buffer tubes before the application of the outer jacket (sheath). The fiber optic cable shall withstand a maximum pulling tension of 600 lbs during installation (short term loading) with no damage and 200 lbs (long term loading).

Cable Color Coding

Furnish cables that use the TIA/EIA-598-B, "Optical Fiber Cable Color Coding" to distinguish individual buffer tubes and optical fibers. During temperature cycling, the coloring compounds shall not fade or smear onto each other or into the gel filling material, and not cause fibers to stick together. The color-coding is as follows:

1. Blue	5. Slate	9. Yellow
2. Orange	6. White	10. Violet
3. Green	7. Red	11. Rose
4. Brown	8. Black	12. Aqua

For cables containing more than 12 buffer tubes, use the color code shown above for tubes 1 through 12, and use stripes or tracers in conjunction with the standard color code for tubes 13 through 24.

Cable Outer Jacket

Furnish cables with the outer jacket applied directly over the high tensile strength yarns. The jacket shall be free of holes, splits, or blisters. The minimum nominal jacket thickness shall be 55 mils.

The outer jacket material shall be a medium density polyethylene (MDPE) conforming to ASTM D 1248, Type II, Class C, Category 4 or 5, Grade J4 and contain carbon black to provide ultra-violet light protection. The jacket material shall be fungus inert as described in ASTM G 21.

The cable shall contain at least one ripcord under the jacket for easy jacket removal.

Miscellaneous Requirements

The shipping, storage and operating temperature range of the cable shall be –40° F to +160° F.

In each vault, provide the additional length of cable listed in subsection, Construction Requirements for Communications Vaults.

Cable Identification

Cable markings shall be approximately 1/8-inch (3 mm) nominal height, clearly legible and distinguishable, and made at 2-foot intervals to be used as length markers. If initial markings fail to meet marking criteria, i.e. illegible, incorrect spacing, spelling error, etc., cables may be remarked to meet criteria. Cable markings shall include:

1. Cable ID
2. Sequential numbers in whole foot or meter intervals to determine the length of the cable and amount remaining on the reel.
3. Number of fibers
4. "MM" (for Multimode Fiber)
5. "ADOT Fiber"

Fiber Optic Drop Cable

Drop Cable is defined as the assembly or pigtail consisting of fiber optic cable, connectors, protective tubing and fan-outs (if required) and all incidental materials used for connectivity between a fiber trunk cable and field devices, i.e. signal controller, modems, etc.

Cable design and installation shall meet requirements for outdoor use as described in subsection, Fiber Optic Cable-General.

Optical jackets (3mm), where used, shall be orange for multimode fibers.

No splices are allowed within the cable length.

Drop cables shall be factory assembled.

Non-connectorized ends shall be suitable for heat fusion splicing as described in the subsection, Splices.

The manufacturer shall provide factory-testing information of each fully assembled fiber optic drop cable for each connector/fiber on tags attached to the individual or paired connector/fiber.

Drop cables shall be packaged individually within a plastic package marked clearly with the manufacturer's part number.

Field testing information of each Fiber Optic Drop cable (fully assembled) shall be according to subsection, Field Testing and Performance of Fibers. Documentation of testing shall be according to subsection, Documentation of Testing.

Fiber optic drop cables shall be equipped with:

1. Six optical fibers or number as specified in the plan.
2. Fiber optic connectors that are:
   a. compatible with the equipment being used for fiber strands with preset usage.
   b. in conformance with subsection, Connectors.
   c. factory installed unless otherwise allowed by the Engineer.
3. Drop Cable Fan-out Kits that feature the heavy duty Spider design. Install fan-out kits for connectorized ends to build up to 3 mm jacket.
4. Tubing that is 900 µm or 3 mm fanout as required by the application.
5. Buffer tubes protected by the cable sheath or fan out kit. Exposed buffer tubes are not acceptable.
6. Individual fiber strands protected by aramid fiber tubes.
7. Minimum tubing length: no requirement for this project.

Multimode Optical Fibers

Multimode (MM) fibers utilized in the cable shall be fabricated from 100 kpsi proof stress glass and primarily composed of silica which shall provide a matched clad index of refraction (n) profile and the following physical and performance characteristics:

1. Core Diameter: 62.5µm
2. Maximum Attenuation: 3.0/1.0 dB/Km at 850/1300 nm, respectively.
3. Maximum Dispersion: not applicable.
4. Dispersion Wavelength (ZWD): 1306.5 nm +-9.5 nm
5. Zero Dispersion Slope: < 0.101 ps/[nm2-km]
6. Cladding Diameter: 125 +/- 2.0 µm
7. Core-to-Cladding Offset (concentricity): < 0.8 µm
8. Cladding Non-Circularity: < 1.0%
9. Fiber Coating Diameter: 245 +/- 10 µm

10. Secondary Coating: 900 µm (as specified for breakout cable/kits, distribution cable, pigtails and patch chords only)

11. Fiber Colored Diameter: 250 +/- 10 µm nominal

12. Mode-Field Diameter: not applicable

13. Attenuation Uniformity: No point discontinuity greater than 0.10 dB at either 1310nm or 850nm

14. This criteria number is not used on this project.

15. Cutoff Wavelength: not applicable

16. Maximum End-to-End Attenuation per cable length: 6 db

17. Fiber Light loss: at 1310 nm and at 850 nm, no requirements for this project, respectively.

18. Maximum cable outside diameter: no requirement for this project.

19. Fiber Polarization Mode Dispersion (PMD): not applicable.

20. Fiber Curl: no requirement for this project.

21. Proof Test: All Optical fibers shall be proof tested by fiber manufacturer

22. Attenuation at Water Peak: no requirement for this project
+Numerical Aperture: 0.2+-015.

23. Step Index: no requirement for this project.

24. Index of Refraction: at 1310 nm and 850 nm no requirements for this project, respectively.

Testing and Performance by Manufacturer:

Outdoor cable installations shall meet or exceed the requirements of the Fiber Optic Test Procedure criteria referenced in RUS 7 CFR 1755.9 and Bulletin 1753f-601 (PE-90) and these specifications.

The following requirements apply to the referenced Fiber Optic Test Procedure (FOTP):

1. TIA-455-3-A, FOTP-3, "Procedure to Measure Temperature Cycling Effects on Optical Fibers, Optical Cable, and Other Passive Fiber Optic Components": The average change in attenuation at extreme operational

temperatures (-40° F to +160 ° F) shall not exceed 0.05 dB/km at 1300 nm for multi-mode fiber. The magnitude of the maximum attenuation change of each individual fiber shall not be greater than 0.6 dB/km at 1300 nm.

2. When a one-meter static head or equivalent continuous pressure is applied at one end of one-meter length of unaged cable for 24 hours, no water shall leak through the open cable end. When a one-meter static head or equivalent continuous pressure is applied at one end of one-meter length of aged cable of one hour, no water shall leak through the open cable end. The aging cycle is defined as exposing the cable to 85° C for 168 hours and two cycles of –40 ° C to +70 ° C with cable held at these temperatures for 24 hours. At the end of this cycle, the cable will be decreased to +23 ° C and held for 24 hours. The water penetration test is completed at the end of the 24-hours hold. Testing shall be performed according to the industry standard test, TIA-455-82-B, FOTP-82, "Fluid Penetration Test for Fluid-Blocked Fiber Optic Cable".

3. TIA/EIA-455-81-B, FOTP-81, "Compound Flow (Drip) Test for Filled Fiber Optic Cable": the cable shall exhibit no flow (drip or leak) of filling and/or flooding material at +65 ° C.

4. TIA/EIA-455-41-A, FOTP-41, "Compressive Loading Resistance of Fiber Optic Cables": Ten percent of the fibers shall not experience a magnitude of attenuation change greater than 0.6 dB at 1300 nm (multimode fiber). The magnitude of the attenuation change shall be within the repeatability of the measurement system for the remaining 90% of the test fibers; the repeatability of the measurement system is typically 0.05 dB or less. No fibers shall exhibit a measurable change in attenuation after test load is removed.

5. TIA/EIA-455-104-A, FOTP-104, "Fiber Optic Cable Cyclic Flexing test": Change in attenuation shall not exceed 0.6 dB at 1300 nm for multimode fiber. The magnitude of the attenuation change shall be within the repeatability of the measurement system for 90% of the test fibers; the repeatability of the measurement system is typically 0.05 dB or less. The remaining 10% of the fibers shall not experience an attenuations change greater than 0.6 dB at 1300 nm (multimode fiber). The cable jacket shall not exhibit evidence of cracking or splitting at the completion of the test.

6. TIA/EIA-455-25-C FOTP-25, "Repeated Impact Testing of Fiber Optic Cables and Cable Assemblies": The magnitude of the attenuation change shall be within the repeatability of the measurement of 90% of the test fibers; the repeatability of the measurement system is typically 0.05 dB or less. The remaining 10% of the fibers shall not experience an attenuation change greater than 0.6 dB at 1300 nm (multimode fiber). The cable jacket shall not exhibit evidence of cracking or splitting at the completion of the test.

7. TIA-455-33-A FOTP-33, "Fiber Optic Cable Tensile Loading and Bending Test": While subjected to a minimum load of 600 lbf, the cable sample shall be able to withstand a twist of 360 degrees in less than 3 meters of length. The magnitude of the attenuation change shall be within the repeatability for he measurement system for 90% of the test fibers; the repeatability of the measurement system is typically 0.05 dB or less. The remaining 10% of the fibers shall not experience an attenuation change greater than 0.6 dB at 1300 nm (multimode fiber). The cable shall not experience a measurable increase in attenuation when subjected to the rated residual tensile load, 200 lbf.

8. TIA/EIA-455-85-A FOTP-85, "Fiber Optic Cable Twist Test": The magnitude of the attenuation change shall be within the repeatability for the measurement system for 90% of the test fibers; the repeatability of the measurement system is typically 0.05 dB or less. The remaining 10% of the fibers shall not experience an attenuation change greater than 0.6 dB at 1300 nm (multimode fiber). The average increase in attenuation for the fibers shall be <0.60 dB at 1300 nm. The cable jacket will exhibit no cracking or splitting under a 5x magnification after completion of test.

9. TIA/EIA-455-181 FOTP-181, "Lightning Damage Susceptibility Test for Optic Cables with Metallic Components: no requirement for this project.

10. TIA/EIA-455-37-A FOTP-37, "Low or High Temperature Bend Test for Fiber Optic Cable": no requirement for this project.

11. TIA/EIA-455-98, FOTP-98-A, "Fiber Optic Cable External Freezing Test": no requirement for this project.

Packaging

Fiber optic cables shall be shipped on wooden reels. The diameter of the drum shall be a least 20 times the diameter of the cable.

Packaging Tag

The following information must be either stenciled on the reel, on a weatherproof tag firmly attached to the reel or a combination of both in order to trace the manufacturing history of the cable:

1. Optical Cable
2. Number of Fibers
3. Date cable was tested
4. Non-armored
5. Year of cable manufacture
6. Name of cable manufacturer
7. Gross weight
8. Part Number
9. Handling Instructions
10. Arrow indicating cable wind direction

Cable Data Sheet

Furnish the Engineer, who will provide copies to the MOA Traffic Department, cable

data sheets that contain the following information:

1. Manufacturer Name
2. Cable ID Number and fiber type
3. Factory Order Number
4. Cable Length
5. Factory measured attenuation (each fiber)
6. Index of Refraction
7. Bandwidth Specification (where applicable)

Sufficient cable length, in addition to the quantities shown on the Plans, shall be provided for testing. Both ends of the cable shall be available for testing. Pack one continuous length of fiber optic cable per reel; maximum overage shall not exceed 10% unless approved by the Engineer. Compensation will not be granted for overage or excess cable needed for testing and installation methods.

Package the cable for shipping to prevent the cable from coming loose in transit. Secure the outer and inner end of the cable. Cover the reel with thermal wrap to protect the cable. Apply end seals to each end of the cable to prevent moisture and from entering the cable. Project the inner end of the cable a minimum of 6 ft into a slot in the side of the reel or into a housing on the inner slot of the drum, in such a manner to make it available for testing.

Include the manufacturers test documentation with each reel. This documentation indicates the attenuation of each cable fiber in dB/km (dB/ft), measured at 1300 nm for multimode fiber.

Mark each reel to indicate the direction in which it should be rolled to prevent loosening of the cable on the reel.

Connectors

Connectors: Furnish and install connectors (in-line or terminated ends) or attenuators as required in the Plans or as required to provide a fully operational fiber optic system.

Hybrid adaptors shall not be used to connect two different connectors. Instead, complete the interface using jumper cables with connectors that match the two incompatible connectors.

A Certified Technician, as described in these specifications, shall install connectors.

Connectors shall be ST connectors to assure compatibility with equipment as required for fibers with a preset usage and approved by the Engineer.

Ceramic ferrules shall be provided for fiber optic connector applications. Install connectors according to manufacturer application and recommendations, including proper termination to the outer tubing (900 micron, 3 mm fan-out) as required by the application.

Connectors shall be rated for operating temperatures of -40° F to 160° F.

Connectors shall be factory installed except where approved by the Engineer.

Connectors shall be installed with ceramic ferrules with fibers secured within ferrule with epoxy, heat set or air dried, as specified by the manufacturer; machine polished mating faces shall be provided.

Boots shall be provided for durable cable strain relief.

Dust caps shall be provided and installed at all times when connector is not in use.

If connections are made, connectors shall be cleaned once before the first connection and once every time thereafter before reconnection. Connectors shall be cleaned according to manufacturers recommended practice.

Connector losses shall not exceed limits as described in subsection, Field Testing and Performance of fibers.

Repeatability of keyed connectors shall not exceed 0.2 dB.

Ceramic ferrule color coding for SC connectors, when used, shall be used as follows to identify type of connector polish as follows:

Attenuators

Attenuators shall be provided at no extra payment to the Contractor to achieve the desirable signal losses at the receiving end equipment (modems, etc.). Attenuators shall only be installed on the receiving end closest to the originating transmission.

Connecting ends shall be compatible to connectors described in subsection, Connectors.

Splice Closures

Fiber optic splice closures (FSC) shall be installed in the locations on the Plan at designated splice locations. Closures shall contain splice trays or organizers that contain the splices.

Before installation, the Contractor shall provide certification from the manufacturer that the splice closures conform to the specifications and test procedures.

Splice closures shall be designed for use under the most severe conditions such as moisture, vibration, impact, cable stress and flex temperature extremes as demonstrated by successfully passing factory test procedures and these specifications. The closure shall prevent the intrusion of water without the use of encapsulates.

Closure re-entry and subsequent reassemble shall not require specialized tools or equipment; these operations shall not require the use of additional parts.

Splice closures shall provide housing and storage for splices, stripped cable and undisturbed buffer tubes. Splice enclosures shall provide protection and strain relief to optical fibers.

Splice closures shall be suitable to handle straight, butt or branch splices.

Large Splice Closures

Splice closures greater than 48 splices shall provide for the following requirements:

1. 6-inch diameter by 22-inch length
2. One, six cable entry, end plate.
3. One blank end plate
4. All endplates shall be 3-section, premolded and suitable for use with Coyote closures
5. Required accessories to complete splice.
6. One future cable entry kit for each splice closure.

Closures shall be provided with external valve pressurization ports.

Closure shells shall be glass-filled high-density thermoplastic that effectively withstands corrosion, high impact, and freeze thaw stresses.

Provide enclosure with rubber tape for sealing around cables to provide a seal that compensates for expansion and contraction associated with temperature cycling.

Closure endplates shall be interchangeable with each size of closure available from the closure supplier.

Where additional access is required into an existing splice closure, replace the existing endplate with an endplate suitable for the task.

Use torque bars to secure, support and align end plates.

Splice closures must accept up to six cables in a butt configuration and 12 for in-line configuration without special adaptors.

Closure shall contain a permanent neoprene gasket seal.

All closures, including closing hardware, shall be from the same supplier.

External Shrader valve pressurization port shall be supplied.

The splice case shall be designed and equipped with the necessary mounting hardware to be attached to the side of the, manhole or vault, and to be suspended with sufficient clearance at each end for acceptable cable bends.

Cables shall be properly dressed and affixed to rails or racks within the manhole or vault. No cables or enclosures will be permitted to lie on the floor.

Fiber optic cables shall be restrained within the splice enclosure such that there is no discernible tensile force on the optical fiber.

The splice closure shall have provisions for storing fiber splices in an orderly manner, mountings for splice organizer assemblies, and space for excess or unspliced fiber. Splice organizers shall be re-enterable and re-sealable.

The closure shall be capable of accommodating splice organizer trays that accept mechanical, fusion, or multi-fiber array splices.

Splice cases shall hold a minimum of 2 splice trays with a maximum of number of splice trays to hold up to 96 splices.

One splice tray shall be designed to hold a minimum of 12 mechanical splices. A second splice tray (for Fiber Optic Drop Cable splicing) shall be designed to hold a minimum of 12 fusion splices. All other splice trays provided in the closure shall be designed to hold fusion splices of 12 (typical) up to 36 splices. Total number of splices supported shall be 96 splices.

Splice trays shall allow for optical fiber storage as recommended by the manufacturer

The splice closure shall have provisions for controlling the fiber bend radius (1.5 inches typical) to a minimum as required by the manufacturer.

Splice closure shall contain a basket allowing fiber buffer tube storage of exposed buffer tubes.

The splice case shall be UL listed for use in wet locations.

The closure shall be installed according to the manufacturer's recommended guidelines.

Splice Closures -Factory Testing Requirements: The construction and testing of the fiber optic splices and splice enclosures shall comply with applicable industry standards including: Electronic Industry Standards (EIA/TIA), ANSI and ASTM standards.

Compression Test: The closure shall not deform more than 10% in its largest cross-sectional dimension when subjected to a uniformly distributed load of 300 lbf (1335

N) at a temperatures of 0°F and 100 °F (–18°C and +38 °C). The test shall be performed after stabilizing at the required temperature for a minimum of 2 hours. It shall consist of placing an assembled closure between two flat paralleled surfaces, with the longest closure dimension parallel to the surfaces. The weight shall be placed on the upper surface for a minimum of 15 minutes. The measurement shall then be taken with weight in place.

Impact Test: The assembled closure shall be capable of withstanding an impact of 21 ft-lbf (28 N-m) at temperatures of 10 °F and 100 °F (–12 °C and 38 °C). The test shall be performed after stabilizing the closure at the required temperature for a minimum of 2 hours. The test fixture shall consist of a 20 lb (9 kg) cylindrical steel impacting head with a 2-inch (5 cm) spherical radius at the point where it contacts the closure. It shall be dropped from a height of 12 inches (30 cm). The closure shall not exhibit any cracks or fractures to the housing that would preclude it from passing the water immersion test. There shall be no permanent deformation to the original diameter or characteristic vertical dimension by more than 5%.

Cable Gripping and Sealing Testing: The cable gripping and sealing hardware shall not cause an increase in fiber attenuation in excess of 0.05 dB/fiber @ 1300nm when attached to the cables and the closure assembly. The test shall consist of measurements from six fibers, on from each buffer tube or channel, or randomly selected in the case of a multimode fiber bundle. The measurements shall be taken from the test fibers, before and after assembly to determine the effects of the cable gripping and sealing hardware on the optical transmission of the fibers.

Vibrations Test: The splice organizers shall securely hold the fiber splices and store the excess fiber. The fiber splice organizers and splice retaining hardware shall be tested per EIA standard FOTP-11, Test condition I. The individual fibers shall not show an increase in attenuation in excess of 0.1 dB/fiber.

Water Immersion Test: The closure shall be capable of preventing a 10-foot waterhead from intruding into the splice compartment for a period of 7 days. Testing of splice closure is to be accomplished by the placing of the closure into a pressure vessel and filling the vessel with tap water to cover the closure. Apply continuous pressure to the vessel maintain a hydrostatic head equivalent to 10 ft on the closure and cable. This process shall be continued for 7days. Remove the closure and open to check for the presence of water. Intrusion of water in the compartment containing the splices constitutes a failure.

Certification: It is the responsibility of the Contractor to ensure that either the manufacturer, or an independent testing laboratory has performed the above tests, and the appropriate documentation has been submitted to the Engineer. Manufacturer certification is necessary for the model of closure supplied. It is not necessary to subject each supplied closure to the actual tests described herein.

Fiber Optic Connectors

With the following characteristics:

1. Factory installed or field installed ST or ST compatible connectors.
2. Ceramic ferrules and metallic connector bodies.
3. Maximum insertion loss: 0.50 dB. Maximum insertion loss of 1.0 dB is acceptable with approval of the Engineer.
4. Connector back reflection: greater than 35 dB.

Clean connectors with alcohol wipes and a compressed cleaning gas.

Closet Connector Module

Required in existing closet connection housings and hub shelters entered by fiber optic cables.

Characteristics:

1. Six fibers per module.
2. Six ST connectors.
3. Six strand factory made multimode pigtail.
4. Height equivalent to four rack units high.
5. Mate with existing closet connector housing.
6. Siecor CCH-CM06-61 or equivalent.

Stand Alone Video Optical Transmitter

Physical Characteristics

1. Maximum Size: 8 inch x 4 : inch x 1 2 inch.
2. Maximum Weight: 2.2 lbs.
3. Mounting Holes: 4 minimum.
4. Package: High quality aluminum, complete enclosure.
5. Indicators: LED type, neatly labeled and visible from mounted position.
6. User Settings: No user adjustments or settings.

Electrical Characteristics

1. Application: Single Fiber Uni-Directional RS-250C Medium Haul Video
2. Transmitter with bi-directional RS-232 data.
3. Modulation: Frequency Modulation or digital encoding.
4. Data Connector: DB 9 F.
5. Data Rate: up to 19.2 kbps, suitable for bursty data.
6. Bit Error Rate: 10-9 minimum over full optical range.
7. Video Connector BNC.
8. Power Consumption: 1-Watt maximum.
9. Video Signal to Noise: 50-dB minimum unweighted over full optical range.

Optical Characteristics

1. Physical: ST Type Connector.
2. Optical Range: 13 dB for multi-mode fiber.
3. Operating Wavelength: 1310 nm.
4. Backreflection: Tolerance of -35 dB.
5. Reliability: Mean Time Between Failure 500,000 hours.

Compatibility: directly interchangeable.

Rack Mount Video Optical Receiver

Physical Characteristics

1. Maximum Size: 8 inch x 4 : inch x 1 2 inch.
2. Maximum Weight: 2.2 lbs.
3. Mounting: Sliding Rack Mount Card with retainers.
4. Package: High quality aluminum, complete enclosure, compatible with rack mounting chassis.
5. Indicators: LED type, neatly labeled and visible from mounted position.
6. User Settings: No user adjustments or settings.

Electrical Characteristics

1. Application: Single Fiber Uni-Directional RS-250C Medium Haul Video
2. Receiver with bi-directional RS-232 data.
3. Modulation: Frequency Modulation or digital encoding.
4. Data Connector: DB 9 F.
5. Data Rate: up to 19.2 kbps, suitable for bursty data.
6. Bit Error Rate: 10-9 minimum over full optical range.
7. Video Connector BNC.
8. Power Consumption: 1-Watt maximum.
9. Video Signal to Noise: 50-dB minimum unweighted over full optical range.

Optical Characteristics

1. Physical: ST Type Connector.
2. Optical Range: 13 dB for multi-mode fiber.
3. Operating Wavelength:1310 nm.
4. Backreflection:Tolerance of B35 dB.
5. Reliability: Mean Time Between Failure 500,000 hours.

Compatibility: directly interchangeable.

663-2.03 COMMUNICATIONS VAULTS. Work under this item consists of installing communications vaults with bolt on lids according to the details shown on the Plans and as specified in the following.

Each vault shall consist of two sections that stack one atop the other and a lid that features nominal dimensions of 30-inches by 48-inches. The top and bottom sections shall measure 11 and 48 inches tall, respectively, and with a 3-inch overlap, shall provide an effective height of 56 inches. The vault shall have an open base.

The vault lid shall have a minimum design load of 15,000 pounds and include two pull slots, each 1/2-inch wide by 4-inches long. Furnish lids with a permanently recessed logo that reads "TRAFFIC". The lid surface shall have a coefficient of friction of 0.50 according to ASTM C 1028.

Furnish lids that contain steel rebar or mesh pieces completely encased within the lid to enable locating the vault with a metal detector. Provide lids with a minimum 1-inch of cover over the steel. Lid construction shall preclude the need to ground the lid.

Furnish vaults and lids that are gray in color and constructed of the polymer concrete material, "cosmopolite".

To keep water from entering the vault, install manufacturer-approved gaskets in the two joints in the vault: between sections and between the lid and the top section.

Furnish vaults with lids that can be bolted down with two 3/8-inch 16 UNC stainless steel pentahead bolts. Install the pentahead bolts and stainless steel washers upon acceptance of the completed fiber optic cable interconnect system.

Furnish each vault with brackets that support the length of fiber optic cable and any splice enclosure required in the vault. Furnish brackets recommended by the manufacturers of the fiber optic cable and splice enclosures. Furnish brackets made from corrosion resistant materials and anchor them with stainless steel hardware. These brackets shall be incidental to the communications vault.

The stainless steel hardware used to attach the fiber optic cable support assembly shall not fully penetrate vaults to prevent water intrusion.

Furnish vaults with conduit openings machined at the time of fabrication as shown on the vault detail sheets, or punch-driven at the time of placement. Size each opening to accommodate the 2-inch nominal UL-651B HDPE conduit called for in the Plans.

Furnish vaults with one 5 ¾-inch diameter knockout for future multiduct installation in those walls with one or no conduits. The knockouts shall be aligned across from each other to the extent possible.

663-3.01 CONSTRUCTION REQUIREMENTS FOR POLYETHYLENE DUCT SYSTEM. Install polyethylene conduits at least 36-inches below finished grade in trenches separate from those used to install the traffic signal and highway lighting systems.

Install clean conduits that remain free of water and earthen materials during and after installation. Before removing polyethylene conduits from their reels, install expandable rubber plugs in the conduit ends. When conduits are cut, install

expandable rubber plugs in all exposed conduit ends.

Install one-piece conduits between vaults. Fuse shorter sections together according to the conduit manufacturer's written instructions. The Department will not accept mechanical connectors for joining shorter sections of conduit together.

Install the polyethylene duct system without using elbows. Run the HDPE pipes straight through vault walls as detailed in the attached vault details sheets. After fully backfilling the conduit trenches and backfilling around the vaults, trim the HDPE pipes to protrude 50 mm inside the vault wall. Reinstall the expandable rubber plugs in the conduit ends

Mark underground ducts with a continuous strip of polyethylene marker taped four mils thick and six-inches wide. Furnish orange marker tape with a black legend that reads "CAUTION FIBER OPTIC CABLE BURIED BELOW". Install the tape 24-inches ±three inches below finished grade.

Keep junction boxes and conduit ends covered until starting to pull conductors. After installing the fiber optic cable, install special termination kits, recommended by the conduit manufacturer, to seal the conduits from contamination, rodents and flooding. Kits shall be designed to fit the number and size of cable(s) within the conduit and shall allow cable entry and exit within vaults or manholes without inducing stress on the fiber optic cable or damaging cable jacket.

Install a 12 AWG stranded copper locate wire furnished with green insulation in the HDPE conduit system. The locate wire shall be approximately 4 feet longer than the run of conduit. Locate wires entering vaults shall be electrically connected together to provide a continuous locate signal throughout the conduit system for locating purposes.

Install conduit marker posts on approximate 200 feet centers. Each marker shall consist of a two inch perforated steel tube that supports a one-foot square, four line sign that reads "CAUTION FIBER OPTIC CABLE BURIED BELOW" in one inch tall series B lettering and a double headed arrow.

663-3.02 CONSTRUCTION REQUIREMENTS FOR FIBER OPTIC CABLE. Cable installation in conduit (duct) systems shall conform to Corning Cable Systems procedure SRP-005-011, "Fiber Optic Cable Placing-Duct", or manufacturer approved methods of jetting or pulling.

Submit a detailed construction plan and installation procedure for the Engineer's approval before cable installation.

Cable shall only be spliced in the following fiber optic cable vaults: C4, C7, and C11.

Only a certified technician, meeting the requirements of subsection, Certified Fiber

Optics Technician, shall complete the following work: cutting of fiber optic cable, if required, and all splicing, testing, and terminating of optical fibers.

Fibers should be tested upon receiving cable. The Contractor shall assume full responsibility to cable that is damaged if testing is not performed after receiving cable.

Before removing cable from a reel, remove nails, staples and other materials that might kink or damage the cable when it is unreeled.

Inspect cables before installation to ensure they are free of damage (nail or staple holes, jacket tears, kinks etc.), material and manufacturing defects, and dimensional non-uniformities that would:

1. Interfere with the cable installation using accepted cable installation practices.
2. Degrade the transmission performance and environmental resistance after installation.
3. Inhibit proper connection to interfacing elements.
4. Otherwise yield an inferior product.

Record the physical condition of the cable as outlined in subsection, Documentation of Field Testing.

Take necessary precautions to protect reeled cable from possible damage while unattended.

Cable shall not be kinked or forced abruptly against conduit edge when pulling cable from conduit ends. Cable feed systems (reels, rollers, guide, tubes etc.) must be used to install or retrieve cable from conduit ends in vaults, manholes or junction boxes.

When cable is installed by pulling, use a swivel and woven cable grip designed for fiber optic cable. Materials for lubricating shall be utilized when pulling.

Fiber optic cable lengths greater than 100 ft shall not be coiled in one continuous direction. Lengthy cables requiring multiple pulls shall be coiled in a "figure-eight" pattern at intermediated access points to avoid twisting of cable unless cable is assisted by jetting or winching. The figure-eight patterns shall be approximately 15-feet in length. Cardboard shims shall be installed between cable layers at the crossover of the "figure eight" to relieve pressure on the cable.

Cable shall be pulled in one continuous run. Splices are only allowed at the designated locations.

When a conduit run contains two or more cables, pull each cable individually when 2 or more 90^{o} bends occur in the run. One continuous cable pull shall not contain more than one 90^{o} bend.

When installing cables, monitor the tensile forces in the cable using equipment manufactured for this purpose. Monitoring equipment shall record the maximum tension incurred during each pull.

Required Replacement

The Contractor shall, at the Contractor's expense, replace cable runs subjected to one of the following conditions:

1. Recorded tensions exceeded the maximum tension of 600 lbs during pulling,
2. Cables were bent to a radius less than 20 x diameter of the cable during pulling,
3. Cables were bent to a radius less than 10 x diameter of the cable when they are coiled into the figure-eight pattern or otherwise handled.

Protect exposed cable from damage.

If cable ends are exposed and unattended, cable caps shall be taped onto cable ends to prevent ingress of moisture into the cable. If the duration of the exposed cable end is short, several wraps of tape shall be provided on the cable end.

Temporary aerial installation methods shall be consistent with Corning Cable Systems SRP-005-010, "Fiber Optic Cable Placing-Lashed Aerial" or a manufacturer approved methods.

Required Cable Slack

Furnish the following lengths of slack cable at the locations indicated:

1. 100-feet per splice vault
2. 65-feet per non-splice vault
3. 6-feet per controller/computer cabinet.

Neatly coil slack cable around the inside perimeter of manholes, vaults and junction boxes on cable brackets. Cable slack shall be supported as to not interfere with access into manholes, vaults or junction boxes.

Exceed manufacturer recommended minimum bend radii for loaded and unloaded conditions. If radii information is not available, minimum bend radii shall not be less than 20 times the diameter of the cable when loaded or 10 times the diameter of the cable unloaded (at rest).

Install fiber optic cable with marking tape, copper wire tracer and above ground markers as required in subsection 663-3.01 Construction Requirements For Polyethylene Duct System.

Splices

A Certified Technician as described in these specifications shall perform splicing and termination of optical fibers.

Two weeks before the start of the fiber optic cabling installation, the Contractor shall submit the following: proposed locations of the mainline spliced points for review by the Engineer; the proposed process to be used for splicing including procedure, cleave tool and specific fusion splicer to be used.

Splicing shall only be allowed in areas as designated on the Plans or as approved by the Engineer.

Splices and stripped cable shall be housed in a splice closure.

Mainline splices shall consist of end-to-end fusion splices for fibers (72 fibers typical) within the fiber optic cable where designated in the Plans.

Drop fiber splices (6 fiber typical) and drop cables (6-fibers typical) shall be used for connectivity between a primary mainline fiber optic cable (72-count typical) and field devices (i.e. traffic signal controller cabinet) as identified in the Plans.

Drop fiber splices shall consist of breaking out the required buffer tube(s) from the fiber optic trunk cable (72-count typical) and fusion splicing the appropriate number of fibers to the fiber optic drop cable (6 fibers typical). Remaining undisturbed fibers, if any, shall be protected in the splice tray. End-to-end fusion splicing shall be conducted for any disturbed fibers within the disturbed buffer tube(s). Remaining buffer tube(s) that are not required for splicing shall be undisturbed and protected in the Splice Closure.

Splicing (drop splice) shall be performed for each device location at locations shown on the Plans. Splicing shall be performed according to Corning Cabling Systems Recommended Procedure SRP-004-013, Mid-Span Access of Fiber Optic Cable (Cable Slack Present), or an equivalent manufacturer's recommended procedure approved by the Engineer.

Cable ends involved in splicing shall match colors of the fibers and buffer tubes to the extent possible.

Fiber splices shall be contained within fiber splice closures (FSC) in designated locations shown on the Plans.

Splices shall be fusion splices protected with a heat shrink sealant (RTV fusion splices). Mechanical splices are not allowed.

Fusion splices shall be made with a portable fusion splicer, capable of AC or internal battery-powered operation. The unit must be able to splice fibers specified in these

with 250 micrometer coating and 900 micrometer coating with little or no modification in the field. The fusion splicer shall be capable of full battery recharge in an eight-hour charging period.

End-to-End splicing shall be performed according to written manufacturer instructions for the supplied splice closure units.

No stresses shall be placed on the fibers before or after the splice is completed.

Splice loss shall not exceed the limits described in subsection, Field Testing and Performance of Fibers .

Fan-out kits are required for splices to multiple fibers in the buffer tubes for multimode fiber (NCHRP).

Splices shall be located in the center of the slack cable in junction boxes, manholes or vaults.

Field Testing and Performance of Fiber

A Certified Technician, as described in subsection, Certified Fiber Optic Technician, shall perform all testing of optical fibers.

All fibers should be tested upon receiving cable. The Contractor shall assume full responsibility to cable that is damaged if testing is not performed after receiving cable.

Physical condition of the cable shall be recorded as outlined in subsection, Documentation of Field Testing.

The Contractor shall schedule the date, time and location of tests required by this specification with MOA Traffic Personnel (907-343-8355) 72 hours before performing the tests. MOA Traffic personnel shall be present when the tests are conducted. The certification technician shall demonstrate clearly how the tests are being performed and shall be made available to discuss testing strategies with MOA personnel.

Tests shall be conducted using standard operating procedures as defined by the manufacturer of the test equipment.

The following tests shall be conducted after the cable has been installed, spliced and connectorized. Test results shall be submitted according to subsection, Documentation of Field Testing (NCHRP). Tests shall be preformed before making permanent equipment connections. Fibers shall be tests for continuity, events above 0.05 dB and total attenuation of the cable. If the fiber optic cable installed is connected to an existing fiber optic cable, perform installation tests on the installed cable and all existing fibers to which it is spliced or connected:

1. End-to-end Optical Time Domain Reflectometer (OTDR) testing shall be conducted to identify attenuation associated with each fiber. Traces shall be provided for each operational wavelength for the type of fiber in the system to indicate attenuations and their locations.

   A Certified Technician utilizing an OTDR and Optical Source/Power Meter shall conduct the tests after installation. The Technician shall conduct the test according to the standard operating procedure as defined by the manufacturer of the test equipment.

   To eliminate or shift the "dead zone", either a factory patch chord or "fiber launch box" of length greater than the dead zone shall be used.

   Measurement shall be conducted for 1310 nm for multimode fiber.

   After completing the required work, test every fiber strand passing through splice trays that were opened by the Contractor.

   Conduct traces with a pigtail or fiber box between the OTDR and the fiber under test.

   Do not exceed launch transition of 6 dB.

   Provide traces with the following information:
   Horizontal Axis: Distance in Feet and Kilometers.
   Vertical Axis: attenuation scale in dB.
   Traces showing attenuation versus distance.
   Cursors positioned at cable ends.

   Tabulate for each trace: method, fiber type, wavelength, pulse width, refraction index, range, search threshold, reflection threshold, end threshold, warning threshold, backscatter, jumper length, file date, file time, fiber ID, cable ID, OTDR location, far end location, operator initials.

   Provide an event table showing events having more than 0.05 dB loss, containing event type, position from OTDR end, loss and reflectance.

   For cables less than 3300 ft (1 km) in length, the maximum total allowable attenuation is 1.0 dB.

2. Attenuation Test: Fiber links shall be tested with a standard power-meter test and attenuation shall be documented.

   For every fiber installed or connected to under this Contract, perform end-to-end attenuation test. For the test, use a calibrated optical source and power meter using the standard three-stage procedure. Determine acceptable link

attenuation by the cumulative value of standard losses based on length, number and type of splices and connectors.

3. Post Termination and Splicing Test:

Test every strand in cable segments including connectorized strands of drop cables.
Light Frequency: 1310 nm.
Direction: Bidirectional.
Location of test: Every field location required to obtain access to each cable segment.
Test after terminating and splicing at points shown on the Plans.
Cable Tested by: Certified Contractor Staff.
Department inspector witnesses and approves before final approval by the Engineer.
Acceptance Criteria:
Cable attenuation. 0.4 dB/km at 1310 nm excluding splices shown on the Plans or authorized by the Engineer.
Cable attenuation. 0.25 dB/km at 1550 nm excluding splices shown on the Plans or authorized by the Engineer.
Strand lengths are consistent.
Launch Transition < 6 dB.
No event > 0.30 dB.
Maximum splice attenuation 0.20 dB per splice unless otherwise shown on the Plans.
Trace available for each strand in cable segments.

4. Power Meter Test

Connect the light source to the connectorized fiber at the location identified on the Fiber Optic Test form. Connect a power meter to the other end of the fiber at the location identified on the Fiber Optic Test form.

Turn on the light meter and record the power received at the power meter in the appropriate location on the Fiber Optic Test form.

Specifically indicate the fibers tested on Fiber Optic Test form. Otherwise, test each strand in every cable segment including connectorized strands of drop cables.

Use the light frequencies of 1310 nm, or as indicated in test plans.

Perform the test uni-directional.

Test every field location required to obtain access to each cable segment.

A qualified member of the Contractor staff will perform testing.

A Department inspector witnesses and approves the results before final approval by the Engineer.

Acceptance Criteria:
Cable attenuation as called for in test plans.
Strand lengths are consistent.
Launch Transition less than 6 dB.
No event less than 0.30 dB.
Maximum splice attenuation 0.20 dB per splice unless otherwise shown on the Plans.
Trace is available for each strand indicated in test plans. Otherwise, trace will be available for each strand in each cable segment.

5. Light Source Test

Connect the light source to the connectorized fiber number at the location identified in the Fiber Optic Test Forms. Connect a power meter to the other end of the fiber at the location identified in the Fiber Optic Test Forms.

Testing:

Turn the light source off and on at a rate of approximately once per second for three cycles. Observe the power meter and record the response of the meter in the appropriate location on the Fiber Optic Continuity Test form.
Indicate OK if the Contractor notes the meter responding to each of the three cycles. Indicate BAD for any other responses, such as no cycles, less than three cycles, or more than three cycles.
For each bad response, submit to the Engineer a statement summarizing the response.
A tone modulated light source may be used, in place of the three cycle method, to conduct this test.

Fiber Optic Continuity Test Form

Complete the ATMS Fiber Optic Continuity Test Form included at the end of this Section and submit the completed form to the Engineer. This form identifies the specific set up location for the power meter and light source.

Connect the light source to the connectorized fiber number at the location identified in the Fiber Optic Continuity Test Form.

Connect a power meter to the other end of the fiber at the location identified in the Fiber Optic Continuity Test Form.

Turn on the light meter and record the power received at the power meter in the appropriate location on the Fiber Optic Continuity Test Form.

The Fiber Optic Continuity Test Form identifies the specific set up location for the

power meter and light source.

Fiber Optic Cable Loss Limits

Fiber optic cable loss limits shall be according to the following: The Engineer may elect to allow bi-directional averaging of OTDR testing due to splice loss core alignments.

No event shall exceed 0.10 dB. If any event is above 0.10 dB, repair or replace that event location.

Total dB loss of a cable fiber less events shall not exceed +3% of the factory test or 1% of the manufacturer's published production loss at 1310 nm. Cable fiber loss shall not exceed Maximum Attenuation Limits as defined in subsection, "MultiMode Fiber Optic Cable".

Cable Fiber Loss (dB) = Total Loss (dB) - $\sum$ events (dB)

Cable Fiber Loss (dB/km) = Cable Fiber Loss (dB)
Cable Fiber Length (km)

Where total or event losses exceed these specifications, replace or repair that cable run and assume all expenses, both labor and materials. Elevated attenuation due to exceeding pulling tension during installation will require replacement of cable at no expense to the Department.

Fusion splice losses shall not exceed 0.10 dB per fiber. Mechanical splices, where allowed, shall not exceed 0.30 dB.

Each connector, after factory assembled, shall not exceed the maximum loss of 0.50 dB (typical loss is 0.25dB) and optical return reflective loss of <-0.45dB.

If event losses exceed these specifications, event locations shall be replaced or repaired without additional cost reimbursement for expenses.

If total loss exceeds these specifications, Fiber Optic cable shall be replaced or repaired without reimbursement for expenses.

All fibers within the cable shall be usable.

Contact the Engineer 48 hours before performing acceptance testing (Post Termination and Splicing OTDR and Power Meter).

Perform fiber optic testing with an OTDR capable of producing output files compatible with the Siecor OTDR 383PCW Version 1.21 or higher.

Documentation of Testing

Upon completion of the field tests, the Contractor shall provide three copies of all documentation to the Engineer.

Except for standard bound materials, documentation shall be neatly bound in 8.5" x 11" (size A4) documentation in logical groupings. Bindings shall be of either the 3-ring or plastic slide-ring type. Permanently and appropriately label each such bound grouping of documentation. Electronic submittal to Engineer on floppy disk or CD is also required.

Documentation from manufacturer shall include manufacturer data of cable and fiber including: Optical performance (OTDR) including dB/km loss measured at 1310 nm for multimode, manufacturer's name, date of manufacture, Index of Refraction, cable ID, connector losses and bandwidth/dispersion data.

Documentation of field testing shall include a map of the cable part numbers, manufacturer, cable length markings, as-built cable routing map, location of splice points and hardware at each splice point location (see below under testing also). Documentation shall include the information below for end-to-end testing, splice loss measurements, OTDR traces.

The documentation shall be neatly tabulated for each field test and shall include the following:

1. Cable and Fiber Identification:

Manufacturer	Operator Name
Cable ID	Date and Time
Fiber ID (include tube and fiber color)	Date of installation
Cable Location – begin and end point	Fiber Count
Cable (i.e multimode, loosetube, OSP, OFNG-nonconductive general etc.)	

2. Setup Parameters:

Wavelength	Range (OTDR)
Pulse Width (OTDR)	Scale (OTDR)
Refractory index (OTDR)	
Jumper and/or Launch Box Length	

3. Test Results:

a. OTDR Test:

Total Fiber Trace (mile)	Total Length (OTDR) (mile)
Splice Loss/Gain	Events > 0.05 dB
Measured Length (Cable Marking)	Backscatter

Provide traces on Diskette to Engineer

b. End-to-End Attenuation Test:
Length, number and type of splices and connectors
Link Attenuation

Fiber optic cable test results shall demonstrate that dB/km losses do not exceed limits specified in subsection, Field Testing and Performance of fibers.

Submit to the Department and maintain on file a current calibration certificate for the OTDR being used.

Submit Power Meter/Light Source Test results to the Department for acceptance (Fiber Optic Continuity Test Form).

Submit to the Department and maintain on file a current calibration certificate for the Power Meter/Light Source being used.

663-3.03 CONSTRUCTION REQUIREMENTS FOR COMMUNICATIONS VAULTS. Do not install vaults in or near the ditch bottoms, in areas that collect drainage, or where vehicular traffic is anticipated. If a vault in a broad area that collects drainage cannot be avoided, install the top of the vault one foot higher than the drainage outlet and fill around the vault with Selected Material Type A placed on a 4:1 slope.

To the extent possible, install vaults at the locations shown on the Plans. If a vault needs to be moved, the distance between adjacent vaults shall not exceed 1000 feet (305 meters).

Under all vaults, place a 48-inch by 66-inch sump that is 12-inches thick and consists of coarse aggregate for concrete conforming to subsection 703-2.02 of the Alaska Standard Specifications for Highway Construction.

After installing the conduits, fill the gaps between the conduits and the sides of conduit openings with a self-curing caulking that provides a permanent, flexible rubber that is unaffected by sunlight, water, oils" mild acids and alkali. The cured compound shall be mildew resistant, non-flammable, and gray in color. The material shall provide a permanent bond with the polymer concrete. Allow caulking to fully cure per the manufacturer's written installation instructions before placing backfill around the vault.

Install the fiber optic cable support assemblies according to the vault manufacturer's written instructions.

663 4.01 METHOD OF MEASUREMENT. 663 items will not be measured.

663 5.01 BASIS OF PAYMENT. HDPE conduit shall be incidental to Items 669

(1A) through 669 (1D) and includes furnishing and installing materials, including plugs, locating wire, and marker posts and all excavation, backfilling, and disposal of surplus material; and for all labor, tools, equipment and incidentals necessary to complete the work.

Payment for fiber optic cable shall be incidental to Items 669 (1A) through 669 (1D) and includes furnishing and installing all materials, including drop cables, splice closures; and for all labor, tools, equipment and incidentals necessary to complete field tests and splicing.

Payment for each communications vault shall be incidental to Items 669 (1A) through 669 (1D) and includes furnishing and installing all materials, including, lids, gaskets, pentahead bolts, washers, fiber optic cable support assembly with stainless steel mounting hardware, caulking, and coarse concrete aggregate; for all excavation, backfilling, and disposal of surplus material; and for all labor, tools, equipment and incidentals necessary to complete the work.

Add the following Section:

SECTION 669

COMMERCIAL VEHICLE INFORMATION SYSTEMS AND NETWORKS (CVISN)- AUTOMATIC VEHICLE IDENTIFICATION, REMOTE VIDEO MONITORING CAMERA SYSTEMS, OVER-HEIGHT VEHICLE DETECTION AND WARNING SYSTEM, AND BACKUP DETECTION

Special Provisions

669-1.01 DESCRIPTION. Furnish and install the following systems at the locations indicated and as shown on the Plans. Install physical infrastructure only. Personnel of the State of Alaska Division of Measurement Standards and Commercial Vehicle Enforcement (MSCVE) will provide data collection and processing functionality.

1. Glenn Highway Northbound Weigh Station.

The Automatic Vehicle Identification (AVI) and Unattended Weigh Station Operation (UWSO) systems are expansions of the International Road Dynamics (IRD), Inc Weigh In Motion System that was installed south of the Glenn Highway Northbound Weigh Station.

The main difference between the Glenn Highway Northbound (GNB) and Glenn Highway Southbound (GSB) Weigh Stations is that the GNB Weigh Station facility has a Weigh-In-Motion (WIM) installed for the northbound direction and the GSB Weigh Station has no WIM for the southbound direction. AVI for the GSB will screen vehicles based on safety and credential information and relay safety-related data between individual carriers and weigh station enforcement personnel.

a. System Overview

1. As the vehicle approaches the GNB Weigh Station, and AVI transponder reader reads the in-cab transponder tag and a WIM device collects weight and vehicle data.

2. Weight and vehicle data from the WIM, and AVI transponder tag from the Advanced AVI (1st pole) is sent from the WIM and AVI cabinets to the GNB Weigh Station Roadside Operations Computer.

3. At the Advance AVI location two cameras with video and still frame capture capability, both day and night, will capture the Department of Transportation and Alaska Identification tag information. The first camera is aligned perpendicular to the direction of travel and in line with the first WIM loop detector in the right lane. The second