

SECTION 647 – FIBER OPTIC CABLE

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3 **647.01 Description.** This section applies to the installation of fiber optic
4 cable in accordance with the contract documents.

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6 There shall be a Fiber Optic Cable Contractor or Subcontractor
7 (hereinafter referred to as an Installer), who shall have at least three years
8 experience in installing fiber optic systems over \$250,000, specifically for outdoor
9 overhead joint-pole and underground in traffic-highway applications.

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11 The Contractor and Installer shall be responsible for testing all fiber optic
12 cables to provide a documented optical budget loss analysis for each link to and
13 from a hub station. Only the Installer shall perform this work.

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15 The Contractor and Installer shall be responsible for all hookup,
16 assignments, dedication, testing, matching, and splicing of the fiber optic
17 cables, unless otherwise indicated. Only the Installer shall perform this work.

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19 All fiber optic splice points shall be spliced color-for-color whenever
20 matching pairs are available. The Contractor and Installer shall be fully
21 responsible for all splices, budget loss, attenuators, appropriate fiber hardware,
22 accessories, and pigtail connections for a fully operational system. Only the
23 Installer shall perform this work.

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25 **647.02 Material.** The fiber optic cables will consist of single-mode fibers.
26 Cables will be installed in existing conduits and overhead in the gain area
27 reserved for the traffic signal systems under joint pole agreements. The
28 Installer shall furnish and install fiber optic cable suitable, and meeting standards,
29 for underground and aerial lashing installations. The fiber optic cables shall
30 meet the requirements of the United States Department of Agriculture (USDA)
31 Rural Utilities Service (RUS) 7 CFR 1755.900 and shall be included in the most
32 current 'USDA List Of Acceptable Materials For Use On Telecommunications
33 Systems Of RUS Borrowers'.

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35 **(A) Single-mode Fiber.** The single-mode fiber utilized in the cable
36 specified herein shall be dispersion unshifted and conform to the following
37 specifications:
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Cladding Diameter	125 $\mu\text{m} \pm 1.0 \mu\text{m}$
Core-to-Cladding Offset	Less than 0.6 μm
Cladding Non-Circularity	Less than 1.0%
Coating Diameter	245 $\mu\text{m} \pm 10 \mu\text{m}$
Colored Fiber Diameter	Nominal 250 μm
Attenuation Uniformity	No point discontinuity greater than 0.10 dB at either 1310 nm or 1550 nm
Attenuation at the Water Peak	The attenuation at $1383 \pm 3 \text{ nm}$ shall not exceed 2.1 dB/kM.
Cutoff Wavelength	The cabled fiber cutoff wavelength shall be less than 1260 nm
Mode-Field Diameter	9.30 $\pm 0.50 \mu\text{m}$ at 1310 nm 10.50 $\pm 1.00 \mu\text{m}$ at 1550 nm
Zero Dispersion Wavelength	Less than 1301.5 nm
Zero Dispersion Slope	Less than 0.092 ps/(nm ² kM)
Fiber Polarization Mode Dispersion	Less than 0.5ps/kM

The coating shall be a dual layered, UV cured acrylate applied by the fiber manufacturer. The coating shall be mechanically strippable.

(B) Fiber Specification Parameters.

Required Fiber Grade	Maximum individual fiber attenuation
Single Mode	The maximum dispersion shall be less than or equal to 3.2 ps/nmkm from 1285 to 1330 nm and shall be less than 18 ps/nm-kM at 1550 nm

The fiber manufacturer shall proof test all optical fibers to a minimum load of 0.7 GN/m² (100 kpsi).

(C) Specifications for Outdoor Cable Construction. Optical fibers shall be inside a loose buffer tube in groups of 12. Optical fibers shall be mechanically strippable. Do not use gel filled. The fiber shall be colored with ultraviolet (UV) curable links. Each fiber shall be distinguishable by means of color coding in accordance with TIA/EIA-598-A, "Optical Fiber Cable Color Coding."

Loose buffer tubes shall also be colored with distinct and recognizable colors in accordance with TIA/EIA-598-A, "Optical Fiber Cable Color Coding" and shall be marked Single mode. Fillers may be included in the cable core to lend symmetry to the cable cross section where needed. Cable construction shall utilize dielectric strength members.

65 Cable jacket shall be a PVC material that is fungus, water and UV
66 resistant. The jacket shall be marked with the manufacturer's name,
67 sequential meter or foot marking, month and year of manufacture,.
68

69 The maximum pulling tension shall be 2700 N (608 lbft) during
70 installation (short term) and 890 N (200 lbft) long term installed.
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72 The shipping, storage, and operating temperature range of the
73 cable shall be -40C to +70C.
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75 **(D) Quality Assurance Provision.** All cabled optical fibers > 1000
76 meters in length shall be 100% attenuation tested. Attenuation of each
77 fiber shall be provided with each cable reel.
78

79 The cable manufacturer shall be ISO 9001 registered.
80

81 **(E) Packaging.** Top and bottom ends of the cable shall be available
82 for testing.
83

84 Both ends of the cable shall be sealed to prevent the ingress of
85 moisture. Each reel shall have a weather resistant reel tag attached
86 identifying the reel and cable.
87

88 The reel tag shall include the following information:
89

90	Cable number	Gross Weight
91	Shipped length in meters	Job order number
92	Product Number	Date cable tested

93
94 A cable data sheet shall accompany each cable. Cable data shall
95 include manufacturer number, billable length, bandwidth specs and
96 measured attenuation of each fiber.
97

98 **647.03 Construction Requirements.**
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100 **(A) Drawings.** The Contractor shall submit a fiber optic cable-pulling
101 drawings for review and acceptance by the Engineer prior to beginning
102 fiber optic cable installation. Do not install fiber optic cable without the
103 Engineer's acceptance of the pulling drawings. The fiber optic cable-
104 pulling drawings shall include:
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- 106 (1) Location of start and end of pulls,
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- 108 (2) Location of cable reel trailers during installation,
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- 110 (3) Location of any "figure-eight" of fiber optic cable, and
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- 112 (4) Location of staged equipment.

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Upon completion of the work, submit an 'As Built' in accordance with Subsection 108.13(B) – Pre-Final Inspection and Section 648 – Field-Posted Drawings including in detail the following:

- (1) Location and attenuation of every event along the installed fiber optic cable,
- (2) Index of refraction of installed fiber,
- (3) Fiber optic cable index of refraction, and
- (4) Sequential fiber optic cable markings at each pullbox, cabinet, and splice closure.

(B) Excavation and Backfill. Excavation and backfill shall conform to Section 206A - Excavation and Backfill for Miscellaneous Facilities.

The Contractor and Installer shall be responsible for the repair of any damage to pavements, sidewalks and other improvements. Place the material from the excavation to prevent damage and obstruction to vehicular and pedestrian traffic and interference with surface drainage.

(C) Fiber Optic Cable. The Installer shall install the new fiber optic cable overhead on existing power poles and underground in conduits as shown in the contract documents. The Contractor and Installer will be responsible for all work and equipment required to install the messenger cable (when there is not already existing messenger cable) on existing joint poles for the overhead portion of the fiber installation. For the underground portion, the Installer will be responsible for furnishing and pulling the new fiber in ductlines using a breakaway swivel to prevent exceeding the tensile load during installation.

All fiber optic splices shall be fusion splices. Do not use mechanical splices. Fiber optic splice locations are permitted only at splice points where splice cabinets are shown on the plans. Fiber optic fibers shall be spliced in every splice cabinet location, and it is the responsibility of the Contractor and Installer to maintain a continuous run throughout the system. The Installer shall leave a minimum of 20-feet of cable service loops at every cabinet or splice location, or utilize aerial cable snowshoes for overhead storage.

Provide documented historical cable pulling data indicating tensile forces exerted on the cable during the installation. Any tension measurements, which exceed the manufacturer's recommendation, will be considered means for the cable rejection. The Contractor and Installer shall be fully responsible for the quality and integrity of the installed cable and the operability of the final fiber optic cable product.

161 All fibers shall be spliced at camera cabinets, hubs, and splice cabinets
162 and shall have no more than 0.07 dB loss per splice based on the
163 appropriate system operating wavelength.
164

165 The Installer shall complete all required fiber optic splices prior to
166 final testing and acceptance. As part of the final testing and acceptance,
167 submit optical time domain reflectometer (OTDR) readings in both
168 hardcopy and electronic formats (such that it can be examined using the
169 manufacturer's OTDR software) to the Engineer for review. Testing
170 shall be conducted on all single mode fibers at 1310nm and 1550nm.
171 Power meter attenuation testing should be performed at dual wavelength,
172 bi-directionally.
173

174 All necessary equipment and plug-in, fiber optic pigtails, fittings,
175 enclosures, and work to complete an operational system shall be
176 furnished and installed by the Installer, unless otherwise indicated, at no
177 increase in contract price or contract time.
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179 **(D) Services Provided By The County.** The City and County of
180 Honolulu, Department of Transportation Services (DTS) will be
181 responsible for all splices and connections in DTS pullboxes and DTS
182 cabinet locations where indicated in the contract documents.
183

184 The Contractor and Installer shall be responsible for the following:
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186 **(1)** Arrange for phases of work with DTS or as specified by the
187 Engineer.
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189 **(2)** Give at least seven calendar days of advance notice to DTS
190 when phases of the work require its services.
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192 **(E) Restoring Pavements and Other Improvements.** Restore the
193 existing pavements and other improvements such as driveways,
194 sidewalks, curbs and gutters disturbed by excavation to their original
195 condition in accordance with the contract documents. Materials used for
196 restoration work shall be equal to or better in quality than the materials the
197 Contractor will replace, and matching in thickness, texture, and color
198 whenever applicable. The grades of the restored surfaces shall conform
199 to the existing grades.
200

201 **(F) Warranty.** Materials and equipment installed for permanent
202 construction shall be new. The contract contemplates the use of first-
203 class material and equipment throughout the performance of the contract.
204

205 Secure from the manufacturer(s), a warranty or warranties
206 guaranteeing equipment from defects in materials, design and
207 workmanship for not less than 12 months from the date of acceptance.
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209 When requiring adjustments or repairs during the warranty period,
210 adjust or repair the existing unit within 24 hours from the time of
211 notification.
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213 When requiring repairs during the warranty period that cannot be
214 repaired within the initial 24 hours, replace the existing unit with an
215 accepted temporary operational replacement unit within 24 hours from the
216 time of notification. The accepted temporary operational replacement
217 shall remain in operation satisfactorily until the Installer can correct the
218 problem in a manner acceptable to the Engineer or install a new unit.
219 However, installation of the new, identical non-defective unit shall be
220 completed within 30 days from the time of notification.
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222 **647.04 Method of Measurement.** Fiber optic cables will be paid on a
223 lump sum basis. Measurement for payment will not apply.
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225 **647.05 Basis of Payment.** The Engineer will pay for the accepted fiber
226 optic cables on a contract lump sum basis. Payment will be full compensation
227 for the work prescribed in this section and the contract documents.
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229 The Engineer will pay for the following pay item when included in the
230 proposal schedule:

Pay Item	Pay Unit
Fiber Optic Cable	Lump Sum

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