

## SECTION 27 10 00 – STRUCTURED CABLING SYSTEMS FOR COMMUNICATIONS INSIDE PLANT

### 1.01 SUMMARY:

- A. <sup>A17</sup>**Scope:** Scope of work shall be in accordance with Paragraph 1.01 D. of Section 01 81 26 (*Communications, Control, Safety, and Security Systems*), as required, for buildings in the Works, including Agua Clara Substation. This Section of the Employer's Requirements shall be read in conjunction with the Sections listed in Table 27 10 00-1.  
<sup>A17</sup>

B. **Related Sections:**

TABLE 27 10 00-1: <sup>A8</sup> Related Sections <sup>A8</sup>			
1.	Section 01 81 26	-	Communications, Control, Safety, and Security Systems.
2.	Section 01 81 36	-	Operations and Maintenance Buildings and Facilities – Program.
3.	Section 07 84 00	-	Firestopping for Inside Plant.
4.	Section 26 43 13	-	Transient Voltage Surge Suppressors (TVSSs).
5.	Section 27 05 28	-	Communications Pathways for Inside Plant.
6.	Section 27 21 00	-	Data Communications Equipment (DCE).
7.	Section 27 31 23	-	IP-based Telephone Systems.
8.	Section 27 53 13	-	Time Synchronization Systems.
9.	Section 28 23 00	-	Closed Circuit Video Systems (CCVSS).
10.	Section 28 23 19	-	Video Recording Systems (VRSs).
11.	Section 40 00 00	-	Process Systems Integration.
12.	Section 40 95 13	-	Process Control Hardware.
13.	Section 40 95 73	-	Control Cables.

### 1.02 REFERENCE:

- A. **Applicable Publications:** Refer to Section 01 81 26 (*Communications, Control, Safety, and Security Systems*), <sup>A8</sup>Paragraph 1.02<sup>A8</sup>.

### 1.03 REQUIREMENTS:

A. **General Requirements:**

- The <sup>A17</sup>Contractor <sup>A17</sup> shall meet all applicable requirements of Section 01 81 26 (*Communications, Control, Safety, and Security Systems*), <sup>A8</sup>Paragraph 1.03<sup>A8</sup>.
- When feasible and cost-effective, use of copper cables for communications and signaling shall be minimized in favor of maximizing the use of fiber optic cables.
- Cables shall be suitable for distribution in horizontal cable trays, plenums, riser shafts, and within conduits.

4. Cables shall be wound in non-returnable reels with lagging.
5. <sup>A19</sup>Items in enclosures shall have key locks. <sup>A19</sup>

**B. Equipment and Materials:**

**1. Connectorized Interconnection Blocks for Outside Plant Copper Cables:**

- a. Blocks shall be suitable for horizontal mounting and wire wrap wiring from the upper part.
- b. Blocks shall have D25 (25-pairs) female connectors with a mechanism to prevent accidental disconnection of male connectors. Pins shall be counted sequentially from the front to the back of the block.
- c. Blocks for front wiring (European style) are unacceptable.

**2. Copper Cables:**

- a. Communications copper cables and hardware shall meet or the requirements of <sup>A10</sup>TIA 568. <sup>A10</sup>
- b. Distance shall be limited to local input/output.
- c. Unless otherwise specified, horizontal copper cables shall be <sup>A10</sup>permanent link type Category 6a UTP or better, with gray (or white) jacket for voice, blue for data, and red for alarms. <sup>A10</sup>

**3. Copper Line Terminating Blocks:**

- a. Units shall have 8 rows depth x 26 pins wide, and shall be suitable for horizontal mounting and wire wrap wiring in the upper and lower part.
- b. Pins shall be counted sequentially from front to back of unit.
- c. Units for front wiring (European style) are unacceptable.

**4. Fiber Optic Cables:**

- a. **General:** Unless otherwise specified,
  - 1) Nucleus shall be 9 and 50/62.5 um for single-mode and multimode fibers, respectively. As to multimode fibers, 50 um fibers shall be for data applications, and 62.5 um fibers shall be for applications that are not strictly data. High grade OM3 type cables are preferable.
  - 2) Multimode and single mode fiber cables shall meet the applicable requirements of ITU-T G.651 and 652, respectively.

- 3) Inside plant fiber optic cables shall be all-dielectric and tight buffer type. Loose tube cables are unacceptable.
- 4) Fiber optic cables shall have a bright differentiating jacket color for easy identification from copper cables. Color coding shall be in accordance with <sup>A10</sup>TIA 568 and 598. <sup>A10</sup>

b. **Backbone and Self-Healing Ring Cables for Process Control Systems (PCSs):**

- 1) Cables shall designed for both indoor and/or outdoor installations (inter and intra-building tight buffer cable), UL listed OFNR rated in accordance with NFPA 70 sections 770-51(b) and 770-53(b), and meeting or exceeding TT GR-409-CORE.
- 2) Multimode fibers shall be 62.5/125 um in 900 um tight buffers and single mode fibers 8 to 9 um cores within the 125 um strands inside 900 um tight buffers.
- 3) Cable construction shall be in sub-cables or sub-units of no more than 12 fibers, grouped around a central strength member. Fibers, tight buffers, and grouping buffer tubes (subcables), shall be organized so that multimode fibers are first and single mode fibers are last.
- 4) The outer sheath shall be extruded under high pressure over the helical core of the individual sub-cables in such a way as to interlock them, protecting them from slippage and friction and preventing axial movement during installation.
- 5) Core shall be protected with a water blocking system designed to prevent entrance of water and humidity.
- 6) Cables shall be labeled in the outside sheath with sequential meter markings, **“CABLE DE FIBRA OPTICA”**, the name **“AUTORIDAD DEL CANAL DE PANAMA”**, a symbol to indicate it is a telecommunications cable and the amount and type of fibers according to the requested cable constructions, eg: **“72 MM 62.5 / 24 SM”**.
- 7) These cables shall have the following or better characteristics:
  - a) Core-locked outer jacket design for installation survivability, long-term, trouble-free service and use in long, vertical installations.

- b) Subcables designed for direct terminations with standard connectors.
- c) Elastomeric jacket encasing each optical fiber, and surrounding aramid strength members to provide a ruggedized sub-cable.
- d) Helically stranded cable core for flexibility, withstand difficult pulls, and mechanical protection for the optical fibers.
- e) High performance tight-buffered coating on each optical fiber for environmental and mechanical protection.
- f) Flame retardant materials and structure.
- g) Fungus-resistant, water-resistant, and UV-resistant for outdoor use.
- h) Suitable for pulling with wire mesh grips.
- i) Suitable for short and moderate distance links between buildings or within a building, where multiple termination points are needed.
- j) Other characteristics:

Average Attenuation	Multimode	3.0 dB/km at 850 nm and 1.0 dB/km at 1,300 nm
	Single Mode	0.4 dB/km at 1,310 nm and 0.3 dB/km at 1,550 nm
Crush Resistance		2,200 N/cm
Flex Resistance		2,000 cycles
Impact Resistance		1,500 impacts
Operating Temperature Range		0 °C to +85 °C
Optical Bandwidth (Multimode Fibers)		160 MHz/km at 850 nm and 500 MHz/km at 1,300 nm

5. **Fiber Optic Connectors:** Shall be in accordance with Section 01 81 26 (*Communications, Control, Safety, and Security Systems*).

6. **Fiber Optic Patch Cords:**

a. **General:**

- 1) Interconnecting patch cords shall be duplex type and adequate for transmission of data, video, and voice over high bandwidth fiber optic networks.

- 2) Patch cords shall meet all applicable requirements of all relevant ANSI, BICSI, EIA, IEC, ITU, NFPA, TIA, TT, and UL standards. Cords shall be classified as OFNR type.
- 3) Overall insertion loss shall be 0.7 dB typically and 1.0 dB maximum, or better, including fibers and connectors.
- 4) All patch cords shall be packed individually with a label containing relevant information, including factory attenuation tests.
- 5) Patch cords shall also have the following or better characteristics:

External Diameter	Jacket	Somewhere between 2.7 and 6 mm
Fiber Height		< 100 nm
Repeatability		> 500 cycles
Service Life		Lifetime against defects
Strain Relief Boots		30 to 50 mm long

**b. Multimode Fiber Optic Patch Cords:**

- 1) Multimode fibers shall have 125 um diameter with  $62.5 \pm 1$  um core diameter. Fibers shall be encapsulated in 900 um tight buffers protected with aramid and an orange jacket. Bandwidth shall be 200 MHz/km at 850 nm and 500 MHz/km at 1,300 nm, or better.
- 2) Patch panel side shall have SC/PC connectors meeting the requirements of <sup>A10</sup>ISO/IEC 11801, TIA 568, and TIA 604-3 (FOCIS). <sup>A10</sup> Connector ferrules shall be 2.5 mm zirconium with return loss of 55 dB, or better.
- 3) Fiber optic equipment side shall have a similar connector unless otherwise allowed by Section 01 81 26 (*Communications, Control, Safety, and Security Systems*).

**c. Single Mode Fiber Optic Patch Cords:**

- 1) Single mode fibers shall have 125 um diameter with  $9 \pm 1$  um core diameter. Fibers shall be encapsulated in 900 um tight buffers protected with aramid and a yellow jacket.
- 2) Patch panel side shall have SC/UPC connectors meeting the requirements of <sup>A10</sup>TIA 568, <sup>A10</sup> ISO/IEC 11801, and EIA 604-3 (FOCIS). Connector ferrules shall be 2.5 mm zirconium with return loss of 55 dB, or better.
- 3) Fiber optic equipment side shall have a similar connector unless otherwise allowed by Section 01 81 26 (*Communications, Control, Safety, and Security Systems*).

7. **Fiber Optic Patch Panels for PCS Backbone and Self-Healing Rings:**

- a. These patch panels shall contain and protect all the Backbone and Self Healing Rings fiber optic slacks, terminations, and patching.
- b. Patch panels shall have the following or better characteristics:
  1. Body made of 16 gauge steel.
  2. Finish with phosphatized steel, coated with corrosion and scratch resistant beige powder paint.
  3. Cable entry/exit with flexible grommet seals.
  4. Flush mount or standard 133 mm (5.25 inch) projection in 483 mm (19 inch) and 584 mm (23 inch) racks.
  5. Front Plexiglas or Lexan, and rear steel doors with ¼ turn latches for easy access.
  6. Cable management spools in the rear of the panel and cable management rings to the front for patching management.
  7. Clear and precise labeling for ports identification.
  8. Design for high density patching applications.
  9. Integral slide rails to permit the panel to travel forward and backward within the rack.
  10. SC multimode UniCam type fiber optic connectors.

8. **Grounding:** Copper communications cables shall be grounded in accordance with the applicable requirements of EIA J-STD-607, IEEE 142, and NFPA 70.

9. **Main Distribution Frames (MDFs):**

- a. MDFs shall be self-supported, flexible, and modular as required for outside plant copper cables and to facilitate future expansion.
- b. Units shall have two distribution sides:
  - 1) A horizontal side, with capacity for the required line terminating blocks plus 25% or larger spare capacity.
  - 2) A vertical side, with capacity for the required number of vertical distribution plus 25% or larger spare capacity.
- c. Each MDF shall consist of the following parts:

	Description
1)	A universal frame with basic structure, sized as required.
2)	Two security guard rails on each distribution side, one in front and one in the back, to protect vertical and horizontal blocks.
3)	One ground bar along the entire frame.

	Description
4)	One lateral safety rail.
5)	Vertical mounting bars, number as required.
6)	Rings to guide interconnecting cables, number and size as required.
7)	Horizontal bars for mounting the above rings, number as required.
8)	Connectorized interconnection blocks as specified above, number as required.

10. **Optical Distribution Frames (ODFs):**

a. **General:**

- 1) ODFs shall be self-supported, flexible, and modular as required for outside plant fiber optic cables and to facilitate future expansion.
- 2) ODFs shall be designed and assembled as an integrated whole, including the following:
- 3) Modules for connectorizing/distribution, splicing, and termination of fiber optic cables.
- 4) Devices for cable distribution, management, patching, positioning, and storing.
- 5) Vertical cable guides to facilitate installation of interconnecting cables.
- 6) Devices to pass cables sideways and between front and back.
- 7) Lateral covers for the exposed side of frames at the beginning and end of each row, and as required for cable protection.
- 8) Interconnecting patch panel modules with capability for various different configurations and options.
- 9) Support for aerial 102 mm (4") or wider aerial raceways for cable distribution in the upper row, with devices connecting to vertical raceways, in accordance with Section 27 05 28 (*Communications Pathways for Inside Plant*). Curvature radii shall be adequate for avoiding inappropriate cable bends and cable pinching.

b. **Patch Panel Modules:**

- 1) Patch panels shall be suitable for the cable configurations. Multimode and single mode fibers shall always be in multiples of six (6).
- 2) Bulkheads shall be interchangeable with type SC connectors suitable for both multimode and single mode fibers. Connector insertion loss shall not exceed 0.5 dB.

- 3) Panels shall have apertures as required to facilitate access and organizers to maintain cable in places and their radius of curvature within manufacturer allowable limits.
- 4) Units shall have front doors made of acrylic or better material, with labeling system adequate for port identification.
- c. **Pigtails for Fiber Optic Cable Connections:** Shall be at least 3,658 mm (12') long.
- d. **Racks:** <sup>A8</sup>Units shall be 2,134 mm (7') high and 483 mm (19") wide, and in accordance with Section 27 11 16 (*Cabinets, Racks, Frames, and Enclosures*).<sup>A8</sup>
- e. **Splice Panel Modules:**
  - 1) Units shall be easily accessible from the front and rear, and have a front cover and cable organizer as required for fibers to be terminated in them.
  - 2) Splice panels shall have ample space for a reasonable length of excess fiber before entering the tray, and inside the splice tray itself. Trays shall be suitable for fusion splices and to identify the different cables and splices.
- f. **Surge Protectors (SPs):** SPs shall be provided in accordance with Section 26 43 13 (*Transient Voltage Surge Suppressors*), as required to protect equipment connected with copper cables.

C. **Installation:**

1. **Cables:**

a. **General:**

- 1) All cables shall be continuous and have no splices, unless otherwise specified.
- 2) Cable route diversity shall be achieved by using different cable trays, or a cable tray and a duct, or different ducts.
- 3) Cables shall be identified in accordance with the requirements Section 40 95 73 (*Control Cables*).
- 4) Individual circuits shall be used for a single service only. Sharing of a circuit for multiple services is strictly prohibited.



- 5) Cables shall be shared between multiple services such as LMCS (PCS), CCVSs, data communications, fire extinguishing, and telephony, if and as required.

- <sup>A10</sup>6) Cables shall be installed by certified installers in accordance with the manufacturer recommendations, including pulling tension and radius of curvature. Installers shall have a valid certification from BICSI or other similar internationally recognized organization.<sup>A10</sup>

b. **Copper Cables:**

- 1) <sup>A19</sup>Cables shall have adequate separation from electromagnetic interference (EMI) and radio-frequency interference (RFI) sources.<sup>A19</sup>
- 2) <sup>A10</sup>In general, communications inside plant horizontal wiring shall be done using UTP cables. UTP cable runs shall not be shorter than 15 m nor longer than 100 m. To help minimize alien crosstalk, the installer shall limit the number of cables in a bundle, and shall avoid bundling several bundles together.<sup>A10</sup>
- 3) Unless otherwise recommended by the designer and reviewed by the Employer's Representative or his authorized representative, STP cables shall be used within MCCs and switchgear.

c. **Fiber Optic Cables:**

- 1) FO cables may have splices only if connectors use a pigtail.
- 2) Splice loss shall not exceed 0.05 dB per fiber optic splice.

2. **Connectors:** Shall be mechanically secured to avoid accidental disconnection.

3. **Main Distribution Frames (MDFs):** Shall be anchored to the floor.

4. **Optical Distribution Frames (ODFs):** Shall be anchored to the floor and aerial raceways above.

5. **Outlets:**

- a. Data and voice (telephone) communications outlets shall be equipped with 51 mm (2") or deeper outlet boxes, and be furnished for the following:
  - 1) Canal Protection Division's guard booths and guard houses.
  - 2) Control rooms.
  - 3) Machinery rooms.

#### 1.04 DESIGN CRITERIA/SYSTEM PERFORMANCE:

A. **General:**

1. **Problem to be Solved:** Inside plant cabling systems shall solve the following business needs:
  - a. Provide means to transport data, video, and voice signals as required for locks and Agua Clara Substation operations.
2. **Restrictions to be Considered:** (reserved)

B. **Design Criteria:** Shall be in accordance with Section 27 05 28 (*Communications Pathways for Inside Plant*), <sup>A8</sup>Subparagraph 1.04 A. <sup>A8 A10</sup>Also, designer(s) shall have a valid certification from BICSI (RCDD or better) or other similar certification from another internationally recognized organization. <sup>A10</sup>

C. **System Performance:** Shall be in accordance with Section 27 05 28 (*Communications Pathways for Inside Plant*), <sup>A8</sup>Subparagraph 1.04 B. <sup>A8</sup>

#### 1.05 SUBMITTALS: The following shall be submitted for substantiation purposes:

A. **Design:** The following shall be in accordance with Section 01 81 26 (*Communications, Control, Safety, and Security Systems*), <sup>A8</sup>Subparagraph 1.05 D. <sup>A8</sup>:

1. CPM diagram, with monthly updates.
2. Descriptive literature.
3. Drawings, including MDFs, ODFs, and wiring plans and details.
4. Specifications.
5. Any other data required for review.

B. **Re-submittals Just Prior to Purchasing Materials:** All items in A. above that have changed from original submittal shall be resubmitted in a Design Conference in accordance with Section 01 81 26 (*Communications, Control, Safety, and Security Systems*), Paragraph 1.05.

C. **Upon Receipt of Shipped Items in Panama:**

1. Packing lists.

D. **Prior to Issuance of Taking Over Certificate:**

1. As-built drawings, including locations of cables, patch panels, and racks.
2. Test reports, including certifications for all horizontal and vertical wiring with data in MS Windows compatible format, such as comma separated value (.csv) or .flw (Fluke Networks LinkWare).

**1.06 QUALITY ASSURANCE:** Shall include the following in accordance with Section 01 81 26 (*Communications, Control, Safety, and Security Systems*), <sup>A8</sup>Paragraph 1.06<sup>A8</sup>:

- A. Factory Quality Control Tests (FQCT).
- B. Final Field Inspection Tests (FFIT).
- C. Warranty.

**END OF SECTION**

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