# TENDER DOCUMENTS

# SUBSECTION 6.56
# TELECOMMUNICATION

# TABLE OF CONTENTS

**PAGE**

## SUBSECTION 6.56 TELECOMMUNICATION

### 6.56.1 GENERAL

6.56.1.1 This subsection describes the requirements relating to the work carried out in connection with telecommunication cables and equipment covered by this Contract.

6.56.1.2 Any specific requirements pertaining to the telecommunication work covered by this Contract are indicated on the drawings and in Section 4 *Special Technical Conditions*.

6.56.1.3 The requirements relating to the supply and installation of the conduits are described in subsection 6.51 *Conduits, Junction Boxes and Pull Boxes*.

### 6.56.2 MEASUREMENT UNITS

6.56.2.1 The measurement units and respective symbols thereof used in this subsection are described as follows:

| Measurement Unit | Designation | Symbol |
|---|---|---|
| length | meter | m |
| length | millimeter | mm |
| length | nanometer | nm |
| length | kilometer | km |
| temperature | Celsius degree | °C |
| angle | degree | ° |
| loudness | decibel | dB |
| mitigation | decibel per kilometer | dB/km |
| voltage | volt | V |
| AC voltage | volt | Vca |
| DC voltage | volt | Vcc |
| force | newton | N |
| power | watt | W |
| electric resistance | ohm | Ω |
| frequency | hertz | Hz |
| frequency | megahertz | MHz |

### 6.56.3 REFERENCE STANDARDS

6.56.3.1 The **Contractor** shall carry out all telecommunication work in accordance with the requirements of the following standards and documents, to which the provisions of this Contract are added:

6.56.3.1.1 (ACNOR(CSA)) Canadian Standards Association:

- CAN/CSA-C22.2 NO. 214-02 *Telecommunication Cables*.

6.56.3.1.2 (ANSI/TIA/EIA): American National Standards Institute (ANSI)/Telecommunications Industry Association (TIA)/Electronic Industries Alliance (EIA):

- ANSI/TIA-568.0-D *Generic Telecommunications Cabling for Customer Premises;*
- ANSI/TIA-568.1-D *Commercial Building Telecommunications Cabling Standard;*
- ANSI/TIA-568.3-D *Optical Fiber Cabling Components Standard;*
- ANSI/TIA-568-C.2 *Balanced Twisted-Pair Telecommunication Cabling and Components Standard*;
- ANSI/TIA-568-C.4 *Broadband Coaxial Cabling and Components Standard*;
- ANSI/TIA/EIA-422-B *Electrical Characteristics of Balanced Voltage Digital Interface Circuits*;
- ANSI/TIA/EIA-526-7 *Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant*;
- ANSI/TIA/EIA-568-B.2-1 *Transmission Performance Specifications for 4-pair 100 Category 6 Cabling*;
- ANSI/TIA/EIA-606-B *Administration Standard for Commercial Telecommunications Infrastructure*;
- ANSI/TIA/EIA-607-B-2 *Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises;*
- TIA/EIA-455-61A *Measurement of Fiber or Cable Attenuation Using an OTDR*;
- TIA/EIA-485-A *Electrical Characteristics of Generators and Receivers for Use in Balanced Digital Multipoint Systems*;
- TIA/EIA-758-B *Customer-Owned Outside Plant Telecommunications Infrastructure Standard;*
- EIA/ECA-310 *Cabinets, Racks, Panels, and Associated Equipment*.

6.56.3.1.3 (IEC) International Electrotechnical Commission:

- IEC 60297 *Mechanical Structures for Electronic Equipment – Dimensions of Mechanical Structures of the 482,6 mm (19 inch) series*;
- IEC 60603-7 *Connectors for Electronic Equipment* – Part 7: *Detail Specification for 8-way, Unshielded, Free and Fixed Connectors*;
- ISO/IEC *Information Technology – Generic Cabling for Customer Premises*.

6.56.3.1.4 (IEEE) Institute of Electrical and Electronics Engineers:

- IEEE 802.1D *MAC Bridges Standard*;
- IEEE 802.1Q *Virtual LANs* (VLANs);
- IEEE 802.1w *Rapid Reconfiguration of Spanning Tree*;
- IEEE 802.1X *Port Based Network Access Control*;
- IEEE 802.3 *Standard for Ethernet*;
- IEEE 802.3at *Power Over Ethernet Plus* (POE+).

## 6.56.4 MATERIALS

6.56.4.1 FIBRE OPTIC CONNECTION BOX, FUSION ENCLOSURE, FUSION PLATES AND CONNECTORS

6.56.4.1.1 The passive fibre optic equipment shall come from the same manufacturer in order to provide a complete solution and ensure full compatibility of the elements. The passive fibre optic equipment shall be operational at temperatures ranging between -40°C and +60°C.

6.56.4.2 FIBRE OPTIC CABLE

6.56.4.2.1 The fibre optic cable shall have, without however being limited to, the following characteristics:

6.56.4.2.1.1 single-mode for outdoor use;

6.56.4.2.1.2 unarmoured;

6.56.4.2.1.3 consisting of dielectric material only, without gel;

6.56.4.2.1.4 maximum long-term voltage of 890 N and maximum short-term voltage of 2700 N;

6.56.4.2.1.5 maximum attenuation of 0.4 dB/km at 1310 nm and of 0.3 dB/km at 1550 nm;

6.56.4.2.1.6 operating temperature of -40˚C to +70˚C.

6.56.4.3 TRACER WIRE

6.56.4.3.1 The **Contractor** shall install a tracer wire in the conduits containing new installed fibre optic cables. Such tracer wire shall have, without however being limited to, the following characteristics:

6.56.4.3.1.1 be lubricated and flat, in order to reduce friction in the conduits;

6.56.4.3.1.2 have a sequential meter marking to identify the length of the conduit;

6.56.4.3.1.3 be made of tinned copper with a minimum size of 22 AWG;

6.56.4.3.1.4 be flat with a core containing an insulated metallic conductor;

6.56.4.3.1.5 be made of abrasion-resistant polyester or aramid woven fibres;

6.56.4.3.1.6 enable the detection of fully dielectric cables and empty conduits;

6.56.4.3.1.7 the metal conductor included in the strip tracer shall be an insulated conductor, resistant to corrosion, shall operate over a wide range of detection frequencies and shall be compatible with any transmission or reception equipment.

6.56.4.4 FIBRE OPTIC PATCH CABLES

6.56.4.4.1 The fibre optic patch cables shall have, without however being limited to, the following characteristics:

6.56.4.4.1.1 have sufficient length so as not to exert tension on the connector;

6.56.4.4.1.2 equipped, at each end, with connectors suitable for the equipment;

6.56.4.4.1.3 manufactured, tested and certified at the manufacturer's factory;

6.56.4.4.1.4 insertion loss and attenuation, in accordance with standard ANSI/TIA-568.3-D;

6.56.4.4.1.5 be operational at temperatures ranging from -40°C to +70°C.

6.56.4.5 PRIMARY ROUTER SWITCH

6.56.4.5.1 The primary router switch shall be the product *Cisco IE-5000 Series*, or equivalent authorized by the Engineer.

6.56.4.5.2 The primary router switch shall have, without however being limited to, the following characteristics:

6.56.4.5.2.1 be a Level 2 or Level 3;

6.56.4.5.2.2 be equipped with a minimum of twelve (12) Gigabit-Ethernet "Small Form-Factor Pluggable" (SFP) ports;

6.56.4.5.2.3 be equipped with a minimum of twelve (12) Gigabit Ethernet RJ45 ports;

6.56.4.5.2.4 be equipped with a minimum of four (4) 10-Gigabit Ethernet SFP ports;

6.56.4.5.2.5 be equipped with a minimum of two (2) PoE+ ports providing 30 W each;

6.56.4.5.2.6 enable remote configuration via Telnet and SSH (Secure Shell) sessions;

6.56.4.5.2.7 enable access to "Simple Network Management Protocol" (SNMP) v1/2/3;

6.56.4.5.2.8 be equipped with “Internet Group Management Protocol” (IGMP) v1/2/3 and IGMP “snooping;

6.56.4.5.2.9 enable the deactivation of “Traffic Storm Control”;

6.56.4.5.2.10 be equipped with two (2) 120 Vca (50 to 60 Hz) power supply units;

6.56.4.5.2.11 be designed for “Industrial design and compliance” hostile environment;

6.56.4.5.2.12 be operational at temperatures ranging from -40°C to +70°C;

6.56.4.5.2.13 be operational at humidity levels ranging from 10% to 95%;

6.56.4.5.2.14 be designed to be installed in an equipment rack.

6.56.4.6 INDOOR SECONDARY SWITCH

6.56.4.6.1 The secondary switch intended to be installed inside a building shall be the product *Cisco Catalyst 2960-X Series*, or equivalent authorized by the Engineer.

6.56.4.6.2 The indoor secondary switch shall have, without however being limited to, the following characteristics:

6.56.4.6.2.1 be a Level 2;

6.56.4.6.2.2 be equipped with a minimum of two (2) Gigabit-Ethernet SFP ports;

6.56.4.6.2.3 be equipped with a minimum of twenty-four (24) Gigabit Ethernet RJ45 ports;

6.56.4.6.2.4 be equipped with a minimum of two (2) PoE+ ports providing 30 W each;

6.56.4.6.2.5 enable remote configuration via Telnet and SSH sessions;

6.56.4.6.2.6 enable access to SNMP v1/2/3;

6.56.4.6.2.7 be equipped with (IGMP) v1/2/3 and IGMP “snooping”;

6.56.4.6.2.8 enable the deactivation of “Traffic Storm Control”;

6.56.4.6.2.9 be equipped with two (2) 120 Vca (50 à 60 Hz) power supply units;

6.56.4.6.2.10 be designed to be installed in an equipment rack.

6.56.4.7 OUTDOOR SECONDARY SWITCH

6.56.4.7.1 The secondary switch intended to be installed in an outdoor cabinet shall be the product *Cisco IE-3000 Series*, or equivalent authorized by the Engineer.

6.56.4.7.2 The outdoor secondary switch shall have, without however being limited to, the following characteristics:

6.56.4.7.2.1 be a Level 2;

6.56.4.7.2.2 be equipped with a minimum of two (2) Gigabit-Ethernet SFP ports;

6.56.4.7.2.3 be equipped with a minimum of twelve (12) RJ45 10/100Base-TX ports;

6.56.4.7.2.4 be equipped with a minimum of two (2) PoE+ ports providing 30 W each;

6.56.4.7.2.5 enable remote configuration via Telnet and SSH sessions;

6.56.4.7.2.6 enable access to SNMP v1/2/3;

6.56.4.7.2.7 be equipped with IGMP v1/2/3 and IGMP “snooping”;

6.56.4.7.2.8 enable the deactivation of “Traffic Storm Control”;

6.56.4.7.2.9 be equipped with one (1) 24 Vcc or 24 Vca or 120 Vca (50 à 60 Hz) power supply unit;

6.56.4.7.2.10 be designed to be mounted on DIN (Deutsches Institut für Normung) rail;

6.56.4.7.2.11 be designed for “Industrial design and compliance” hostile environment;

6.56.4.7.2.12 be operational at temperatures ranging from -40°C to +70°C;

6.56.4.7.2.13 be operational at humidity levels ranging from 10% to 95%.

6.56.4.8 1-GIGABIT SFP MODULE

6.56.4.8.1 The SPF module shall have, without however being limited to, the following characteristics:

6.56.4.8.1.1 be equipped with a least one (1) Gigabit Ethernet interface module: the product *1000BASE-LX*;

6.56.4.8.1.2 be equipped with a least one (1) single-mode optical module;

6.56.4.8.1.3 be equipped with a least two (2) LC connectors;

6.56.4.8.1.4 enable communication over a distance of 10 km;

6.56.4.8.1.5 be operational at temperatures ranging from -40°C to +70°C;

6.56.4.8.1.6 be certified and recognized as compatible by the manufacturer of the primary router switch, the indoor secondary switch and the outdoor secondary switch.

6.56.4.9 10-GIGABIT SFP MODULE

6.56.4.9.1 The SPF module shall have, without however being limited to, the following characteristics:

6.56.4.9.1.1 be equipped with a least one (1) ten (10) Gigabit Ethernet interface module: the product *10GBASE-LR*;

6.56.4.9.1.2 be equipped with a least one (1) single-mode optical module;

6.56.4.9.1.3 be equipped with a least two (2) LC connectors;

6.56.4.9.1.4 enable communication over a distance of 10 km;

6.56.4.9.1.5 be operational at temperatures ranging from -40°C to +70°C;

6.56.4.9.1.6 be certified and recognized as compatible by the manufacturer of the primary router switch, the indoor secondary switch and the outdoor secondary switch.

6.56.4.10 EIA RS-422/RS-485 CONTROL CABLE

6.56.4.10.1 The EIA RS-422/RS-485 control cable shall have, without however being limited to, the following characteristics:

6.56.4.10.1.1 be a low capacitance cable in accordance with standards ANSI/TIA/EIA-422 or TIA/EIA-485-A;

6.56.4.10.1.2 be equipped with two (2) twisted-pair stranded copper conductors with a minimum size of 24 AWG;

6.56.4.10.1.3 have a nominal impedance of 100 Ω;

6.56.4.10.1.4 have a shielding to completely block 100% of the emissions;

6.56.4.10.1.5 have a manufactured sheath designed for outdoor installation and direct burial and be UV resistant, for the outdoor cable installations;

6.56.4.10.1.6 have either an FT-4 sheath, equivalent to the USA CMR (Riser) or an FT-6 sheath, equivalent to the USA CMP (Plenum) according to the type of installation, for indoor cable installations;

6.56.4.10.1.7 be operational at temperatures ranging from -40°C to +70°C.

6.56.4.11 COAXIAL CABLE FOR VIDEO SURVEILLANCE

6.56.4.11.1 The coaxial cable for video surveillance shall have, without however being limited to, the following characteristics:

6.56.4.11.1.1 be an RG-59/U type product;

6.56.4.11.1.2 be equipped with one (1) solid copper strand with a minimum size of 20 AWG;

6.56.4.11.1.3 have a nominal impedance of 75 Ω;

6.56.4.11.1.4 have a shielding made of braided copper to block at least 95% of the emissions;

6.56.4.11.1.5 have insultation made of high density polyethylene (HDPE) foam;

6.56.4.11.1.6 have a manufactured sheath designed for outdoor installation and direct burial and be UV resistant, for outdoor cable installations;

6.56.4.11.1.7 have either an FT-4 sheath, equivalent to the USA CMR (Riser) or an FT-6 sheath, equivalent to the USA CMP (Plenum) according to the type of installation, for indoor cable installations;

6.56.4.11.1.8 be operational at temperatures ranging from -30°C to +60°C;

6.56.4.11.1.9 the connectors at each end that shall be compression connectors.

6.56.4.12 ETHERNET CABLE FOR OUTDOOR INSTALLATION

6.56.4.12.1 The Ethernet cable for outdoor installation shall have, without however being limited to, the following characteristics:

6.56.4.12.1.1 be a Category 6 cable;

6.56.4.12.1.2 be equipped with four (4) twisted-pair solid copper conductors with a minimum size of 24 AWG;

6.56.4.12.1.3 have a manufactured sheath designed for outdoor installation and direct burial and be UV resistant, for outdoor cable installations;

6.56.4.12.1.4 be operational at temperatures ranging from -30°C to +60°C;

6.56.4.13 ETHERNET CABLE FOR INDOOR INSTALLATION

6.56.4.13.1 The Ethernet cable for indoor installation shall have, without however being limited to, the following characteristics:

6.56.4.13.1.1 be a Category 6 cable;

6.56.4.13.1.2 be equipped with four (4) twisted-pair solid copper conductors with a minimum size of 24 AWG;

6.56.4.13.1.3 have either an FT-4 sheath equivalent to the USA CMR (Riser), or an FT-6 sheath equivalent to the USA CMP (Plenum), according to the type of installation for indoor cable installations.

6.56.4.14 ETHERNET PATCH CABLES

6.56.4.14.1 The Ethernet patch cable shall have, without however being limited to, the following characteristics:

6.56.4.14.1.1 be a Category 6 cable;

6.56.4.14.1.2 be equipped with four (4) twisted-pair solid copper conductors with a minimum size of 24 AWG;

6.56.4.14.1.3 be equipped with one (1) male RJ45 (8P8C) connector with a pre-installed snagless boot protection at each end;

6.56.4.14.1.4 be factory tested and certified;

6.56.4.14.1.5 have either an FT-4 sheath equivalent to the USA CMR (Riser), or an FT-6 sheath equivalent to the USA CMP (Plenum), according to the type of installation for indoor cable installations;

6.56.4.14.1.6 be of a length in accordance with the current TIA certification.

6.56.4.15 ETHERNET CABLE CONNECTOR

6.56.4.15.1 The Ethernet cable connector shall have, without however being limited to, the following characteristics:

6.56.4.15.1.1 be a RJ45 (8P8C) type product;

6.56.4.15.1.2 be compatible with a cable of Category 6 or higher;

6.56.4.15.1.3 have a terminating resistance of 0.0025 Ω;

6.56.4.15.1.4 have a T568B termination;

6.56.4.15.1.5 comply to standards TIA-EIA-568-B.2-1, IEC 60603-7 and ISO/IEC 11801 – Parts 1 to 6;

6.56.4.15.1.6 be combined with a “plug latch guard” retainer device.

6.56.4.16 IDENTIFICATION

6.56.4.16.1 The conductors shall be identified with white heatshrink polyolefin tubing with black lettering. The product for the identification of the conductors shall be the *LS8E-H000X034H1C*, manufactured by Panduit, printed mechanically, or equivalent authorized by the Engineer. The tube diameter shall allow it to properly adjust to each conductor as well as to the number of conductors to identify.

6.56.4.16.2 The cables shall be identified with a *SMK* label, manufactured by Thomas & Betts, or equivalent authorized by the Engineer. The diameter shall be appropriate for the cable to be identified.

6.56.4.16.3 All other materials shall be identified using lamicoid type identification plates. The identification plates shall be UV resistant and black with white core. The text and images shall be engraved on the front side of the plates. The reverse side shall have a self-adhesive tape on 100% of the surface of the plate.

## 6.56.5 EXECUTION OF WORK

6.56.5.1 CONTRACTOR'S QUALIFICATION

6.56.5.1.1 The **Contractor** shall provide to the Engineer, for review, all certificates and documents related to the qualifications requested for the telecommunication work required under this Contract.

6.56.5.1.2 Telecommunication network

6.56.5.1.2.1 The **Contractor** and the workers assigned to the programming and configuration of the telecommunication network shall have, without however being limited to, the following qualifications:

6.56.5.1.2.1.1 have at least five (5) years of recent relevant experience in the development of telecommunication networks and the commissioning of telecommunication equipment;

6.56.5.1.2.1.2 be accredited by the manufacturers of the telecommunication network equipment used under this Contract;

6.56.5.1.2.1.3 have a minimum of one (1) worker with an industry-recognized networking certification such as Cisco Certified Network Associate (CCNA) and Cisco Certified Design Professional (CCDP) or equivalent authorized by the Engineer.

6.56.5.1.3 Fibre optic

6.56.5.1.3.1 The **Contractor** and the workers assigned to the work pertaining to the connection and fusion of fibre optic shall have, without however being limited to, the following qualifications:

6.56.5.1.3.1.1 have a minimum of five (5) years of relevant experience in telecommunication, fiber optics, CCTV systems and work of similar scale and complexity as that under this Contract.

6.56.5.1.3.2 The **Contractor** shall be a supplier/installer authorized by the manufacturers of telecommunication products provided and installed under this Contract.

6.56.5.1.3.3 The **Contractor** shall have its own mobile qualified service shop to perform installation service on worksite.

6.56.5.1.3.4 The fiber optic technicians shall have a Fiber Optic Association (FOA) certification, a minimum of five (5) years of relevant experience in fiber optic works and provide proof.

6.56.5.1.4 Structured cabling

6.56.5.1.4.1 The **Contractor** and the workers assigned to the work pertaining to structured cabling shall have, without however being limited to, the following qualifications:

6.56.5.1.4.1.1 have at least five (5) years of relevant experience in structured cabling work.

6.56.5.1.4.2 The installers/integrators shall have successfully completed a training program in structured cabling and cable installation and hold a training certificate.

6.56.5.2 SUPPLY AND INSTALLATION

6.56.5.2.1 At least fourteen (14) days prior to the commencement of the work, the **Contractor** shall submit to the Engineer, for review, shop drawings and technical data sheets for all components indicated on the drawings and described in this subsection.

6.56.5.2.2 The **Contractor** shall supply and install the cables, equipment and accessories in accordance with the drawings and this subsection.

6.56.5.2.3 The **Contractor** is responsible for validating the lengths and quantities indicated on the drawings before ordering the equipment.

6.56.5.2.4 The **Contractor** shall ensure that the new equipment and materials are properly adapted to the existing equipment.

6.56.5.2.5 The **Contractor** shall provide the skilled labour and supply the installation hardware, tools and all that is required for the complete installation, including testing and commissioning.

6.56.5.2.6 The **Contractor** shall supply, at its expense, any accessories or materials that are not mentioned, but are necessary for a complete installation of the telecommunication network.

6.56.5.3 SERVICE CONTINUITY

6.56.5.3.1 The **Contractor** shall maintain the existing network in function at all times. The **Contractor** shall provide for the phasing of all its work in regard to this constraint and in regard to a list of priorities provided by the Engineer.

6.56.5.3.2 Service interruptions on the network shall be coordinated and authorized by the Engineer at least seventy-two (72) hours prior to any interruption.

6.56.5.4 EQUIPMENT COMPATIBILITY

6.56.5.4.1 The **Contractor** shall ensure that all equipment is compatible to one another. In case of incompatibility, the **Contractor** shall immediately notify the Engineer thereof.

6.56.5.5 SEQUENCE OF WORK WITH RESPECT TO TELECOMMUNICATION NETWORKS

6.56.5.5.1 At least fourteen (14) days prior to the commencement of the work, the **Contractor** shall propose and submit to the Engineer, for review, the sequence of execution of the work pertaining to the telecommunication networks. The sequence of the work shall aim at limiting the operational impacts. Furthermore, the sequence of the work shall clearly identify the work requiring a service interruption.

6.56.5.5.2 The sequence of the work pertaining to the telecommunication networks shall be carried out in accordance with the following order, without however being limited to the following steps:

6.56.5.5.2.1 dismantling of the existing cabling and the structured cabling works;

6.56.5.5.2.2 relocation of the electric power systems;

6.56.5.5.2.3 installation of the new equipment and the commissioning;

6.56.5.5.2.4 dismantling or relocating of the equipment;

6.56.5.5.2.5 installation of the new equipment and the commissioning;

6.56.5.5.2.6 certification testing of the telecommunication cabling;

6.56.5.5.2.7 electrical tests.

6.56.5.6 IDENTIFICATION OF EQUIPMENT, CABLES AND CONDUCTORS

6.56.5.6.1 The **Contractor** shall supply and install all the identification required for the operation and maintenance of the work carried out. Such identification shall be written both in French and English.

6.56.5.6.2 All equipment shall be identified with waterproof and indelible labels.

6.56.5.6.3 The identification shall correspond both to the information and to the nomenclature of the equipment indicated on the drawings. The **Contractor** shall allow the Engineer at least fifteen (15) working days to validate the proposed nomenclature. The **Contractor** is not authorized to install identifications that have not been validated. The **Contractor** shall submit to the Engineer, for review, all identifications.

6.56.5.6.4 All equipment cabinets shall be identified.

6.56.5.6.5 The **Contractor** shall ensure that all conductors are identified at their ends with permanent marking. The identification shall remain legible once the connection of the conductor is completed.

6.56.5.6.6 The **Contractor** shall also label the cables at each end, as well as in the pull boxes, fusion boxes, junction boxes, manholes, work cages and any other location requiring identification for operation and maintenance purposes. Labels shall be secured with "tie-rap" type fasteners.

6.56.5.6.7 All materials shall be identified by means of an identification plate in accordance with paragraph 6.56.4.16.3. The label shall be affixed directly to the materials. In addition, the plates installed on outdoor materials shall be securely fastened with a minimum of two (2) stainless steel fasteners that enable to maintain integrity and watertightness.

6.56.5.7 INSTALLATION METHOD, HANDLING AND TRANSPORTATION OF CABLES

6.56.5.7.1 The **Contractor** shall take all necessary precautions to avoid damaging the fibre optics, conductors and cable sheaths during handling, storing and installation of the cables.

6.56.5.7.2 The **Contractor** shall respect the minimum bending radius of the cables recommended by the manufacturer, when installing and pulling the cables.

6.56.5.7.3 The **Contractor** shall observe the ultimate tensile strength, recommended by the manufacturer, that can be applied to the cables. To do so, the **Contractor** shall use a cable lifter.

6.56.5.7.4 The **Contractor** shall plan the installation of the cables in accordance with the drawings and with the physical constraints on the site, in order to minimize the number of splices. The cables shall be continuous and without fusion/junction between the connection points.

6.56.5.7.5 The **Contractor** shall, in the same conduit, install one (1) tracer wire with the fibre optic cable, in order to make it possible to locate the cable above the ground via the induction method.

6.56.5.7.6 The **Contractor** shall use a lubricant authorized by the manufacturers of the cables to be installed to facilitate the pulling of the cables. The lubricant used shall be compatible with all cables and conductors in the conduit.

6.56.5.7.7 The **Contractor** shall leave an excess of 5 m of fibre optic cables and tracer wires in all manholes and equipment cabinets.

6.56.5.7.8 The **Contractor** shall leave an excess of Ethernet cables, coaxial cables and control cables in all access shafts and equipment cabinets. The excess length of the cables shall be equivalent to the perimeter of the access shaft or cabinet but not less than 1 m.

6.56.5.8 TRACER WIRE INSTALLATION METHOD

6.56.5.8.1 The tracer wire shall be installed in the conduit at the same time as the cables.

6.56.5.8.2 The tracer wire shall not be used for the initial pulling of the cable.

6.56.5.8.3 Inside the conduits, the tracer wire shall be continuous and without splices.

6.56.5.8.4 The sequential metering printed on the tracer wire shall be readable once installed in the pull boxes and junction boxes to allow the Engineer to confirm the measurement.

6.56.5.8.5 Once installed, the **Contractor** shall carry out a verification of the continuity of the tracer wire in the presence of the Engineer. The points of discontinuity, if any, shall be repaired to the satisfaction of the Engineer.

6.56.5.9 FIBRE OPTIC FUSION AND CONNECTION

6.56.5.9.1 The **Contractor** shall terminate and fusion the fibre optic cables in the fusion and optical connection panels, taking care to leave an additional 5 m loop at each optical connection cabinet and at the manholes.

6.56.5.9.2 The **Contractor** shall supply and install the fusion panels and the optical connection panels, the patch cables and fusion plates necessary for the fusion and termination of the fibre optic cables. The **Contractor** shall adequately protect the loose tubes.

6.56.5.9.3 All splices made on fibre optic cables shall be made by fusion. All bonding and mechanical connections are prohibited. The net loss of a fusion shall be equal to or less than 0.2 dB.

6.56.5.9.4 The **Contractor** shall arrange the fused fibre optics inside the plates in accordance with the fusion plate manufacturer's recommendations.

6.56.5.9.5 For each fusion carried out, the **Contractor** shall, without however being limited to, perform the following:

6.56.5.9.5.1 verify the adjustment of the times and the accuracy and fusion level on the fusion machine;

6.56.5.9.5.2 verify that the cut is straight and that the edge has an inclination of less than one 1°;

6.56.5.9.5.3 align the fibre optic using the "Profile Alignment System (PAS)" alignment technique or equivalent authorized by the Engineer. Each fusion shall be protected with a heat-shrinkable protective sleeve. Fused fibres, as well as fusions, shall be labeled.

6.56.5.9.6 Any fusion deemed unacceptable by the Engineer shall be corrected immediately by the **Contractor**, at its expense.

6.56.5.10 TELECOMMUNICATION EQUIPMENT

6.56.5.10.1 The **Contractor** shall install the telecommunication equipment in accordance with the drawings and with the manufacturer's recommendations.

6.56.5.10.2 Equipment configuration

6.56.5.10.2.1 The equipment configuration shall comply with the physical and logical topologies as directed by the Engineer and shall allow the proper functioning of all the services on the telecommunication network.

6.56.5.10.2.2 The **Contractor** shall submit to the Engineer, for review, all projected configurations. The **Contractor** shall allow twenty (20) working days for the Engineer to validate the proposed configurations.

6.56.5.10.2.3 The **Contractor** shall perform the configurations of all functions of the following network equipment, without however being limited thereto:

6.56.5.10.2.3.1 remote access for the administrative management on each switch;

6.56.5.10.2.3.2 local “VLAN” virtual networks;

6.56.5.10.2.3.3 network interfaces on switches such as VLAN, "trunk/access" mode, speed and description;

6.56.5.10.2.3.4 IGMP "snooping" feature on all switches;

6.56.5.10.2.3.5 “Broadcast Storm Control” feature on all switches;

6.56.5.10.2.3.6 SNMP "Read-Only" Community;

6.56.5.10.2.3.7 SNMP traps to the network monitoring system. The list of traps to be activated will be provided by the Engineer;

6.56.5.10.2.3.8 security mechanisms and rules in accordance with the **Owner**’s policies. Such policies will be provided by the Engineer;

6.56.5.10.2.3.9 any other configurations required for the proper functioning of the network.

6.56.5.11 REGROUPING AND FASTENING OF TELECOMMUNICATION CABLES

6.56.5.11.1 The fibre optic shall be bundled and covered with a protective sheath.

6.56.5.11.2 The twisted pair and coaxial cables shall be tied, every meter, with *Velcro* ties, or equivalent authorized by the Engineer. Such ties shall be installed parallel to each other.

6.56.5.11.3 No *Ty-Rap* type fasteners shall be installed or maintained.

## 6.56.6 QUALITY CONTROL

6.56.6.1 The **Contractor** is responsible for conducting all tests and taking all readings and measurements required to ensure the quality control of its telecommunication work.

6.56.6.2 For all verification and measurement for testing and quality control purposes, the **Contractor** shall only use test equipment with valid calibration certificates that include NIST traceability.

6.56.6.3 TESTING OF CATEGORY 6 COPPER CABLES

6.56.6.3.1 The **Contractor** shall perform tests on a significant sample of cables prior to installation.

6.56.6.3.2 Following the installation of the telecommunication cabling including end-to-end plugs and connectors, the **Contractor** shall check all Category 6 cables, connections, jumpers, RJ-45 plugs and connectors from end-to-end, in the two (2) directions, for a test of Category 6 cables in permanent link configuration "permanent link", up to a minimum of 250 MHz.

6.56.6.3.2.1 Following the installation of Category 6 Cables, the following checks shall be made, without however being limited thereto:

6.56.6.3.2.1.1 continuity;

6.56.6.3.2.1.2 short circuit;

6.56.6.3.2.1.3 open circuit;

6.56.6.3.2.1.4 reversal of conductor;

6.56.6.3.2.1.5 resistance;

6.56.6.3.2.1.6 impedance;

6.56.6.3.2.1.7 Near-End Crosstalk (NEXT) and Power Sum Near-End Crosstalk (PSNEXT);

6.56.6.3.2.1.8 ACR-F and PSACR-F attenuation to crosstalk ratio;

6.56.6.3.2.1.9 attenuation;

6.56.6.3.2.1.10 reflection attenuation "return loss";

6.56.6.3.2.1.11 cable length in meters;

6.56.6.3.2.1.12 conformity of identification;

6.56.6.3.2.1.13 propagation delay;

6.56.6.3.2.1.14 difference in propagation delay "delay skew".

6.56.6.3.2.2 All tests shall be conducted in the presence of the Engineer.

6.56.6.3.2.3 The parameters encountered for each test on the distribution cables shall be greater than those specified in standard ANSI/TIA-568-C for a test on Category 6A cables.

6.56.6.3.3 The **Contractor** shall submit the test results in a report in PDF format and in the proprietary "viewer" format produced by the testing apparatus. The **Contractor** shall provide the software required to view the results in the proprietary format.

6.56.6.3.4 The report shall include, without however being limited to, the following information and documents:

6.56.6.3.4.1 test standard used;

6.56.6.3.4.2 Contract identification;

6.56.6.3.4.3 cable number;

6.56.6.3.4.4 date and time when the test was performed in YYYY/MM/DD (24H) format;

6.56.6.3.4.5 name of the operator of the testing apparatus;

6.56.6.3.4.6 model and serial number of the testing apparatus;

6.56.6.3.4.7 software version;

6.56.6.3.4.8 calibration certificate of the testing apparatus in accordance with paragraph 6.56.6.2;

6.56.6.3.4.9 results of all tests conducted on the cables;

6.56.6.3.4.10 "PASS" or "FAIL" mention, as applicable.

6.56.6.4 TESTING OF THE FIBRE OPTIC CABLES

6.56.6.4.1 Pre-installation tests

6.56.6.4.1.1 Each fibre of each cable shall be checked using a reflectometer prior to installation in order to ensure that there is no breakage or discontinuity, either due to the handling of the cable or to a manufacturing defect.

6.56.6.4.2 Pre-fusion tests

6.56.6.4.2.1 Each fibre of each cable shall be checked using a reflectometer prior to being connected by fusion to ensure there is no breakage or discontinuity due to the cable installation.

6.56.6.4.3 Post-fusion tests

6.56.6.4.3.1 The **Contractor** shall, when performing the cable fusions, check the continuity and connections of the fibre optics. The test shall be configured and conducted in accordance with standard ANSI/TIA/EIA-526-7, as well as the application guides of the manufacturer of the testing apparatus.

6.56.6.4.3.2 The **Contractor** shall submit the results to the Engineer, for review, immediately following the fusions. All tests shall be conducted on all fibre optics installated by the **Contractor**, end-to-end.

6.56.6.4.3.3 Two (2) optical tests shall be conducted on all fibre optics. For single-mode fibres, a total of four (4) tests/fibre shall be conducted for each device. The **Contractor** shall then calculate the average of the fibre results in the two (2) directions to eliminate the variable length backscattering effects.

6.56.6.4.3.4 Reflectometer test

6.56.6.4.3.4.1 The “Optical Time Domain Reflectometer” (OTDR) testing shall be used to determine the adequacy of the cable installation by showing any irregularities, such as discontinuities, microbends and inaccurate splices.

6.56.6.4.3.4.2 The OTDR traces shall be obtained from the reflectometer for each fibre and included in the test report.

6.56.6.4.3.4.3 The OTDR tests shall be measured in both directions and at two (2) wavelengths, 1310 nm and 1550 nm. A launch cable of at least 300 m in length and a receiver cable shall be used to connect the OTDR reflectometer to the end located nearest to the link under test and to terminate at the end furthest from the link under test. Such cables shall be long enough to allow the OTDR reflectometer to measure the loss of the first and last connections.

6.56.6.4.3.5 Attenuation test using the optical power meter

6.56.6.4.3.5.1 End to end attenuation measurements shall be taken on all fibres, in both directions and with two (2) wavelengths, 1310 nm and 1550 nm, using a light source at one end and the optical power meter at the other end, to ensure that the cable system attenuation requirements are met. The attenuation tests shall be conducted using two-meter (2 m) cords for connecting the test equipment to the cable.

6.56.6.4.3.5.2 The attenuation measurement method shall comply with standard EIA/TIA-455-53A. The attenuation tests shall be conducted following the reflectometer tests.

6.56.6.4.3.6 The link attenuation value obtained shall not exceed the value calculated in accordance with the following formula:

Link attenuation = Cable Attenuation + Insertion loss of connectors + Loss of fusion joints

Where:

- Cable attenuation in dB = attenuation coefficient in dB/km x length in km, obtained from the OTDR
- Attenuation coefficient for a single-mode fibre:
  - 0.5 dB/km at 1310 nm
  - 0.5 dB/km at 1550 nm
- Insertion loss of connectors in dB = number of pairs of connectors x loss of pairs of connectors in dB = 2 x 0.75 dB = 1.5 dB
- Loss of fusion joints in dB = number of joints x loss of a joint in dB = 1 x 0.2 dB = 0.2 dB (where applicable)

6.56.6.4.3.7 In case of failure, the **Contractor** shall repeat the OTDR test and correct any defects. The **Contractor** shall then resume the attenuation test. Once the results have been obtained with the OTDR tests and with the optical power meter, the **Contractor** shall document them in an Excel file.

6.56.6.4.3.8 Following the installation of the fibres and connectors, the **Contractor** shall provide an audit report comprising the files of the OTDR test traces in native format (.trc), Bellcore format (.sor) or equivalent format, as well as in PDF format, which shall comprise, without however being limited to, the following information for each fibre:

6.56.6.4.3.8.1 OTDR test trace;

6.56.6.4.3.8.2 length;

6.56.6.4.3.8.3 total fibre attenuation;

6.56.6.4.3.8.4 attenuation of the pairs of connectors;

6.56.6.4.3.8.5 fusion attenuation obtained using the reflectometer;

6.56.6.4.3.8.6 value of the total attenuation obtained using the optical power meter.

6.56.6.4.3.9 The **Contractor** shall submit the test reports to the Engineer, for review, and the **Contractor** shall resume, at its expense, the fusions that do not meet the requirements. The final reports shall subsequently be provided to the **Owner**.

6.56.6.4.3.10 The **Contractor** shall submit the test results on PDF file and in the proprietary format produced by the testing apparatus and provide the software required to view the results in proprietary format.

6.56.6.4.3.11 The report shall include, without however being limited to, the following information:

6.56.6.4.3.11.1 test standard used;

6.56.6.4.3.11.2 Contract identification;

6.56.6.4.3.11.3 cable number;

6.56.6.4.3.11.4 date and time when the test was performed in YYYY/MM/DD (24H) format;

6.56.6.4.3.11.5 name of the operator of the testing apparatus;

6.56.6.4.3.11.6 model and serial number of the testing apparatus;

6.56.6.4.3.11.7 software version;

6.56.6.4.3.11.8 calibration certificate of the testing apparatus in accordance with paragraphe 6.56.6.2;

6.56.6.4.3.11.9 results of all tests conducted on the cables;

6.56.6.4.3.11.10 “PASS” or “FAIL” mention, as applicable.

**END OF SUBSECTION**