CORRECTIONAL SERVICES CANADA
TECHNICAL SERVICES BRANCH
ELECTRONIC SECURITY SYSTEMS

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Revision 2
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ELECTRONICS ENGINEERING STATEMENT OF WORK

STRUCTURED CABLE SYSTEMS FOR ELECTRONIC SECURITY INSTALLATIONS

AUTHORITY

This Specification is approved by the Correctional Service Canada for the procurement and installation of a Security Patrol System in Canadian federal correctional institutions.

Recommended corrections, additions or deletions should be addressed to the Design Authority at the following address:

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TABLE OF REVISIONS

Revision	Paragraph	Comment
0	N/A	Original
1	Cable	Cable upgraded to meet OM3 standards
2	Multiple	Copper cable upgraded to CAT 6

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TABLE OF ABBREVIATIONS

Abbreviation	Expansion
CSC	Correctional Service Canada
ATP	Acceptance Test Plan
CM	Corrective maintenance
COTS	Commercial-off-the-shelf
CSC	Correctional Service Canada
DA	Design Authority
DCR	Design Change Request
DES	Director Engineering Services
DL	Deficiency List
FDR	Final Design Report
MRT	Mean Response Time
MTBF	Mean Time Between Failures
MTTR	Mean Time To Repair
PDR	Preliminary Design Report
PM	Preventative Maintenance
PW&GSC	Public Works & Government Service Canada
QA	Quality Assurance
RFP	Request for Proposal
SOW	Statement of Work
STR	Statement of Technical Requirement
NEXT	Near End Cross Talk

TABLE OF DEFINITIONS

Abbreviation	**Expansion**
CSC	Correctional Service Canada
Design Authority	Director, Engineering Services (DES) - Correctional Service Canada (CSC) is responsible for all technical aspects of the system design and implementation.
Contract Authority	Public Works and Government Services Canada (PW&GSC) is responsible for all contractual matters associated with the system design and implementation.
Contractor	The company selected as the successful bidder.
Project Manager	A CSC employee or a contracted person designated by DES to be responsible for the test and evaluation or feasibility study project.
Project Officer	A CSC employee or a contracted person designated by DES to be responsible for the implementation of the project.
Off-the-shelf	Equipment currently on the market with available field reliability data, manuals, engineering drawings and parts price list.
Custom Equipment	Equipment designed and/or manufactured specifically for a specific contract.

APPLICABLE DOCUMENTS REFERENCES

.1 The following documents of the issue in effect on the date of the Request For Proposal (RFP) shall form a part of the specification to the extent specified herein.

  .1 EIA/TIA Standard EIA/TIA-568BB Commercial Building Telecommunications Wiring Standard
  .2 EIA/TIA Technical Systems Bulletin TSB-36 Additional Cable Specifications for Unshielded Twisted Pair Cables
  .3 EIA/TIA Technical Systems Bulletin TSB-40 Additional Transmission Specifications for Unshielded Twisted Pair Connecting Hardware.
  .4 International standard ISO/IEC 11801-2nd Edition: Information technology — Generic cabling for customer premises.

.2 Any other applicable industrial safety and control standards governing specific aspects for equipment and/or installations.

1 INTRODUCTION

1.1 General

.1 This document defines the quality control requirements for the design, installation, testing and acceptance of structured cable systems for use in security systems installed in all Correctional Service Canada (CSC) facilities.

1.2 Scope

.1 This specification has been developed to ensure high standards for the installation of electronic systems. It defines workmanship standards which may not be fully covered in subsidiary specifications. All contractor's documentation and installation procedures shall meet this specification for equipment reliability, maintainability, longevity, appearance and operational use.

1.3 Off-the-Shelf Equipment

.1 The contractor shall provide commercial off-the-shelf (COTS) equipment. Where provision of COTS equipment is not possible, written approval from the Design Authority is required. COTS equipment shall meet or exceed the manufacturing standards as listed in this specification.

1.4 Manufactured Equipment

.1 Where COTS equipment is unavailable or unsuitable for a specific application, the contractor may manufacture or arrange for the manufacturing of a particular item to suit the requirements. Manufactured equipment shall meet or exceed the best commercial equipment manufacturing standards. The design Authority must approve all custom manufactured components prior to installation or deployment.

1.5 Commonality of Equipment

.1 The contractor shall provide commonality of hardware components within the design parameters ie. switch locks, racks, panels etc. All equipment, if appropriate shall be interchangeable.

2 MATERIAL AND EQUIPMENT REQUIREMENTS

2.1 Environmental conditions

.1 All materials and equipment which is used in CSC installations shall be equal to, or better than the standards established in the original equipment and shall be chosen with due consideration being given to the intended use, safety, retention of appearance, maintainability and durability under rugged operating conditions. These materials shall be suitable to perform over the following environmental ranges:

.1 Indoor Equipment

Temperature:	0° C to 40° C; and
Humidity:	20% to 95% non-condensing.

.2 Outdoor Equipment

Temperature:	-40° C to +50° C; and
Humidity:	0 to 100%, condensing.

.2 Outdoor equipment shall operate reliably and not be damaged by combinations of direct exposure to the sun, wind, rain, lightning, hail, snow and ice as may be expected to occur at each institution location.

.3 Complete assemblies of indoor equipment shall be resistant to liquid spills, airborne contaminants, shock and vibration.

3 TELECOMMUNICATIONS OVERVIEW

3.1 Structured Cabling System

.1 The design objective is a flexible network that is easy to re-configure, easy to manage and capable of incremental growth. The network is based on a structured cabling system conforming to Electric Industry Association/Telecommunications Industry Association Specification 568B (EIA/TIA-568B) and Canadian Standards Association 529 (CSA 529) and using a star wired topology for the horizontal distribution with Category 6 Unshielded Twisted Pair (UTP). All UTP cable will be bright green in colour.

.2 Provided fibre optic cabling will be provided as follows:

- .1 Indoor fibre optic cable runs from cabinet to cabinet will be 50/125µ OM3 Laser Optimized Fibre.
- .2 Outdoor fibre optic cable runs from building to building will be 50/125µ OS2 fibre optic cable.
- .3 All strands of all fibre optic cablings will be fully terminated onto LC dual connectors installed into high density fibre optic patch panels.
- .4 Fibre strands will be organized in patch panels by “fields” of LC dual connectors. Fields will not contain strands from more than one fibre optic cable.
- .5 Fields will be labeled by cable and individual LC connectors will be numbered within each field.
- .6 The design, manufacturer and elements of the fibre cable, connectors, fields and patch panel will conform to a CAT6 certified solution with OEM warranty on the installed cabling infrastructure.
- .7 The design will support Ethernet, Fast Ethernet, and network management.

4 DESCRIPTION OF WORK

4.1 General System Requirements

.1 This section defines the minimum requirements for a structured cabling system to be provided on an engineered, furnished, installed, tested, and commissioned basis. Products and installation practices shall conform with the EIA/TIA documents identified in the **APPLICABLE DOCUMENTS** section of this Statement of Work.

.2 The structured cabling system includes the following basic elements arranged into backbone feeders and horizontal distribution subsystems that are cross connected or patched together in Telecom Closets or Common Equipment Rooms on Intermediate Distribution Frames (IDFs).

- .1 Unshielded Twisted Pair (Horizontal)
- .2 8-pin modular Telecom outlets
- .3 Insulation displacement connector type terminal blocks
- .4 LOF and SM optic cable (Backbone)
- .5 Fibre optic (duplex) Interconnect patch panels
- .6 Patch cords for patch panels
- .7 Line cords for workstation data equipment (Office Cables)

.3 Notes:

- .1 3 meter length is standard for workstation patch cords
- .2 All horizontal cabling shall be GREEN in color and have a FT6 rated jacket.

4.2 Horizontal Data Cable

.1 Cable

- .1 Each cable shall consist of 8 each of 24 AWG thermoplastic insulated solid copper conductors formed into four individually twisted pairs and enclosed by a jacket with the appropriate protection rating determined by National Fire codes.
- .2 The cable shall fully conform with EIA/TIA-568B design requirements for 100 ohm UTP cable and fully conform with EIA/TIA-568B TSB-36 transmission requirements for Category 6 cable.
- .3 Cables shall bear evidence of verified Level 6 or Category 6 and also bear evidence of certification by a recognized standard or testing body.
- .4 The cable bundles will be fed to locations in either a supplied cable tray or conduit system. Outlet cables will then be fed to the user locations via either pac poles or fished down hard wall offices. A pull string will remain in the conduit/cable tray for future installations.
- .5 All cabling in equipment cabinets, termination trays, cable trays, junction boxes, and at edge devices must be neatly dressed using Velcro style “hook and loop” re-useable straps. Cable straps must encircle all the cables in a given bundle. Any cable secured with a tie-wrap will require replacement of the entire cable.
- .6 The cable run length from the IDC to the workstation location shall NOT exceed 90 meters. The combined length for patch cords for data network horizontal distribution connections shall not exceed 10 meters for an overall length from data network hub equipment to workstation equipment not exceeding 100 meters.
- .7 All category 6 6 Ethernet data cables and data jumper cables (minimum 23 gauge), jacks and connector boots installed must be **BRIGHT GREEN** in colour. All cables

must be FT4 rated except where cable in not protected in a conduit or in a plenum ceiling, such cable must meet a FT6 fire rating.

.2 User Termination

.1 Termination at the user end will be made onto a certified Category 6 RJ45 keystone module for data. These keystone modules will then be housed in a certified keystone faceplate. The keystone faceplate to house the keystone modules will have the capability to equip up to six each 8 pin keystone modular jacks. Other configurations to be used will vary with locations: A duplex flush keystone mount faceplate for drywall applications, a duplex surface mount keystone kit for PAC pole applications and duplex single gang keystone outlets mounted into custom furniture with adapter plates. Surface keystone mount kits will not exceed a 6.5 cm. protrusion from the wall. For custom furniture it is assumed that the cable runs will be fed to the outlet via raceways in the legs of furniture. For security reasons, jacks are NOT be installed in exterior walls or walls not totally part of CSC space. All cables must either terminate on a patch panel or on a faceplate, loose or unterminated cables are not acceptable.

.2 The 8 pin keystone modular jack connectors shall comply for termination of 4 wire pairs with 24 ~~A~~AWG solid copper conductors: minimum contact force of 100g and conductors separated by jack comb.

.3 Each keystone modular outlet will be wired per EIA/TIA-568B polarization sequence, designation T568B (reference CAN/CSA T529 Clause 11.2 Figure 11-1 and Table 10-1).

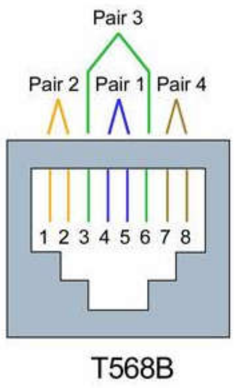
.4 Where the RJ45 is to be provided at the end of a conduit run the conduit will be terminated into a single gang high security electrical box with 21mm (3/4”) threaded ports. The conduit will be threaded into the box. All unused ports on the single gang box shall be sealed with a threaded plug.

.5 Where the conduit is connected directly to a camera enclosure or edge device with internal RJ45 jack the CAT6 cable shall be terminated with a shielded RJ45 IDC plug rated for 24 AWG solid conductor CAT6 cable.

.6 All category 6 structured cabling must be punched onto a high density CAT6 patch field or panel or a CAT6 keystone jack in a single gang box. RJ45 connectors will not be permitted as terminations for CAT6 structured cabling, except where the CAT6 cable is supporting a CCTV camera or the termination is specifically authorized by the project authority in writing. Where CAT6 structured cable is terminated with an RJ45 connector, the connector must be rated specifically for a CAT6 connection directly to a CAT6 premise cable (solid conductor) and the RJ45 jack must be shielded.

.7 In secure office areas where drywall construction is used the contractor must fish associated cabling to support KVM extension devices through the walls. The walls must be finished with an appropriate CAT6 termination plate, labeled to the device. ALL visible CAT6 RJ 45 plugs must be **BRIGHT GREEN**. When fishing cable into a wall the contractor may use flex conduit. Where it is impossible to fish the cable into a hollow wall or the wall is solid (e.g. cinderblock) the contractor may use a decorative wire mold to run the necessary cables to the defined location of the equipment with written permission from the project authority. Wire mold must meet the Canadian Electrical Code when supporting power.

.3 This illustration is a front view of the connector



.1 Figure 11-1 and Table 10-1 outlines the sequencing required to construct line, office, and patch cables.

.2 Each modular outlet will conform with EIA/TIA TSB 40 transmission requirements for Category 6 and will also be compatible with existing standard electrical outlet boxes.

.3 Table 10-2 outlines the correct punch down positioning when using keystone modular -T568B CAT6 Jacks, T568B ISDN QCBIX36DI and T568B ISDN QCBIX46DI Modular Jack Connectors, and T568B CAT6 keystone Modular Patch Panels.

.4 Table 10-1

.1 Colour Codes for horizontal cabling and patch cords

Colour Identification	Colour Code	Abbreviation
Pair 1	White-Blue	(W-BL)
	Blue	(BL)
Pair 2	White-Orange	(W-O)
	Orange	(O)
Pair 3	White-Green	(W-G)
	Green	(G)
Pair 4	White-Brown	(W-BR)
	Brown	(BR)

.5 Table 10-2

.1 Colour Codes for punch down and keystone modular outlets

Position	Colour Code	Abbreviation
1	White-Orange	(W-O)
2	Orange	(O)
3	White-Green	(W-G)

4	White-Blue	(W-BL)
5	Blue	(BL)
6	Green	(G)
7	White-Brown	(W-BR)
8	Brown	(BR)

.6 Closet Termination

.1 Supply and installation of RJ45 Category 6 hardware for system connection in communications closet using 24 port keystone modular patch panels rack mounted with cable organizer panels installed for each patch panel.

.2 Active components will be connected to equipment by 8 conductor patch cords manufactured to CAT 6 compliance. Patch cords shall be stranded conductor and have a “no-snag” boot over the RJ45 connector.

.3 Patch cables shall have a green jacket.

.4 Multi-Level building installations will require individual patch panels be installed for each level of the building. Patch panel(s) for each level of a multi-level building must have at least 15% unused ports. The same holds true for single story, multi ICC buildings.

.5 All cabling in in equipment cabinets must be dressed throughout the cabinet. Cables entering a cabinet from the top must be routed to the base of the cabinet and then return to the designated equipment height, the reverse for cables entering the bottom. Vertical cable runs in the cabinet must be in the side panel areas of the cabinet. Vertical cable runs must be strapped every 12 inches. Cable straps must encircle all the cables in a given bundle. Vertical cable bundles must route from the cable riser across the width of the equipment cabinet and loop back to the termination point on the patch panel. This will provide enough slack to permit any patch panel to be removed, reversed and re-punched.

.6 An installed cable is any cable that is run through a conduit, run from one area in a building to another area, any cable that travels further than the adjacent equipment cabinet in a series of cabinets. Note: Equipment cabinets must be abutting without side panels to open connection to be considered adjacent.

.7 Cable Protection

.1 All ceiling distribution cabling shall be enclosed and protected by 3/4” (21mm) and 1” (27mm) rigid conduit from communications closet(s) room(s) and cabinets to all user outlets located in inmate accessible areas. In areas that CSC designated as non inmate accessible, EMT zone conduit will be permitted. Conduits must have end bushings installed to protect the cable from sharp edges.

.2 Conduit containing Copper backbone cable must be identified with green covers on junction boxes and conduit couplings.

.3 Conduit containing Fibre Optic backbone cable must be identified with green covers on junction boxes and conduit couplings.

.4 The use of flex conduit will only be permitted by written authorization from the project technical authority on a case by case basis; the use of flex conduit is not permitted in inmate accessible areas.

.5 Conduits and junction boxes in inmate areas will not be identified or coloured, all conduit couplings and junction boxes in inmate accessible areas will be secured with high security screws and couplings.

.6 The contractor must avoid, as much as possible, the use of conduit in inmate accessible areas. The contractor must utilize existing pipe chases, existing conduit in the walls, etc., where possible. New lengths of conduit must be of the minimum necessary length. All newly installed conduits carrying video must be identified, except in inmate accessible areas, by prominent labels with **BRIGHT GREEN** wording. The contractor must use only rigid threaded conduit in inmate accessible areas. All junction box covers and conduit joints must be painted bright green except where installed in inmate accessible areas.

.8 Line cord

.1 The cabling company will supply RJ45, 8 pin modular line cords to connect owner provided data equipment to the horizontal distribution outlets at the workstation. They must be consistent with CAT 6 specification and provide end-to-end CAT 6 connectivity. Line cords shall be stranded conductor and have a “no-snag” boot over the RJ45 connector. The cords shall have a green jacket.

.9 Testing

.1 The contractor must test all existing structured cabling to be reused in a project with a certified CAT6 LAN Analyzer and provide detailed analysis and LANCAT readings for all cables. Test results must include:

1.1 Wire Map – pass/fail
1.2 Propagation Delay – pass/fail
1.3 Cable Length – pass/fail – length
1.4 Insertion Loss – pass/fail – dB
1.5 Return Loss – pass/fail
1.6 NEXT – pass/fail
1.7 ELFEXT – pass/fail

.2 Refer to annex A below.
.3 Refer to annex B below.

.10 Labeling

.1 Labels must be located at each end of the conduit run, on both sides of any penetration of a wall, and at 3.5 meter intervals along its length.
.2 Refer to Annex F. Annex F is separate from this document.

.11 Documentation

.1 Customer to supply AutoCAD floor plans when available. If CAD documents are not available, contractor will be responsible to scan (to scale) hard copy of floor plans.
.2 Contractor to supply site plans, individual runs, risers, wire #’s, jack #’s, patch panel #’s in both hard and soft copy.
.3 All test results shall be machine printed, hand written test result sheets are NOT acceptable.

4.3 Fibre Optic Backbone Cable

.1 Cable

Interior – Interior FO cables typically run from node to node within the same building.

4.3.1.1.1. The cable to be supplied and installed for interior backbone purposes shall consist of 12 strands (6 pairs) of Laser Optimized Fibre with nominal 50/125 um OM3 core/cladding diameter formed into a single cable.
4.3.1.1.2. Optical cable shall physically conform with ANSI/ICEA S-110-717 mechanical and environmental specifications for outdoor fibre optic cable.
4.3.1.1.3. Fibre optic cable shall conform with the requirements of OM3 as per the ISO 11801-2nd Edition standards

Exterior – Exterior FO cables typically run from building to building.
4.3.1.1.4. The cable to be supplied and installed for exterior backbone purposes shall consist of 48 strands (24 pairs) of OS2 SM cable with nominal 50/125 um core/cladding diameter formed into a single cable.
4.3.1.1.5. Optical cable shall physically conform with ANSI/ICEA S-110-717 mechanical and environmental specifications for outdoor fibre optic cable.
4.3.1.1.6. Fibre optic cable shall conform with the requirements of OS2 as per the ISO 11801-2nd Edition standards

.2 Terminations

.1 Fibre optic cables shall be terminated to LC Dual connectors. Physical contact Connectors shall be able to sustain a minimum of 200 mating cycles per EIA/TIA-455-21 without violating specifications. These connectors will terminate within interconnect sleeves to facilitate patching in patch panels. The maximum optical attenuation per pair of mated connectors shall not exceed 0.75 db.
.2 All fibre strands, whether used in the project or not, shall be terminated with LC type connectors and installed into a fibre patch panel: generally one duplex patch per cable (i.e. 12 connectors per panel for 12 strand fibre cable).
.3 The patch panel proposed shall provide strain relief for each fibre as an integral part of the panel design. This standard type and size of panel should be uniformly used throughout the project.
.4 Installed fibre panels shall be completed with all guides, brackets and other accessories to facilitate cable cross connect to active components for administration and management, including provisions for labeling that are consistent with EIA/TIA-568B.
.5 Multiple fibre optic cables may populate a patch panel but panel fields must not contain terminated strands from more than one fibre optic cable.

.3 Testing

.1 The contractor must test all existing fibre optic cabling to be reused in a project and provide detailed light budget analysis and OTDR readings for all fibre strands. Test results must include the following:
1.1 Origin and destination of cable
1.2 Light loss in dB over cable – pass/fail – dB
1.3 Length of cable – in meters
1.4 Pass/fail

.2 The contractor must test all new fibre optic cabling installed in a project and provide detailed light budget analysis and OTDR readings for all fibre strands. Test results must include the following:

- 1.1 Origin and destination of cable
- 1.2 Light loss in dB over cable – pass/fail – dB
- 1.3 Length of cable – in meters
- 1.4 Pass/fail

.3 Refer to Annex C below.

.4 Labeling

.1 All Fibre optic cabling and fibre optic patch cords must be labeled at both ends.
.2 Refer to Annex F. Annex F is separate from this document.

4.4 Cross Connect

.1 Data Cross-Connect

.1 Cross connection of the UTP horizontal cables to the tie field will be completed after testing of installed cables has taken place.
.2 Jumper wire shall be provided, if requested, and will conform with EIA/TIA TSB-40 transmission requirements for Category 6.

ANNEX A

REQUIREMENTS FOR TECHNICAL ACCEPTANCE TESTS ON IN-BUILDING TELECOMMUNICATION UTP CABLES

1.0 **GENERAL**

1.1 This Annex outlines the general requirements for the completion of technical acceptance tests on in-building telecommunication UTP cables.

1.2 Technical acceptance tests are made on telecommunication UTP cable pairs to determine whether they meet design specifications. The tests will identify any problems that may exist on the cable due to improper design, manufacturer faults and improper termination or installation errors.

2.0 **PRE-INSTALLATION TESTS**

2.1 Where there is evidence of damage to the cable sheath, the installing agent shall replace the entire length of cable.

3.0 **LENGTH REQUIREMENTS**

3.1 The maximum physical length of the basic link shall be 90 meters (including test equipment cords). The maximum physical length of the channel shall be 100 meters (including equipment cords and patch cords). At least 15 meters of cabling is required to reduce the number of possible FAILS during testing. In other words, do not perform any testing on cable lengths less than 15 meters.

3.2 Never mix cables with different characteristic impedances.

3.3 When untwisting cable pairs to install connectors or make connections at punch-down blocks, make the untwisted sections as short as possible. Maximum acceptable untwist of Category 6 cabling is 13mm. (0.5”)

3.4 All specifications for tests on twisted pair cabling apply to cable with 100 ohm of characteristic impedance.

4.0 CABLE SPECIFICATIONS

4.1 The testing shall involve the following cable category: CAT6. Category 6 is the next generation cabling standard. The Category 6 standard offers major performance improvements over the Category 5e specifications and an available bandwidth of at least 200 MHz, with all transmission parameters specified up to 250 MHz. Each category has required tests that are defined under the TIA 568B.0 specifications.

4.2 Table 1 summarizes the required and optional tests that need to be performed for CAT5, CAT5e and CAT6. A 'yes' in the table means that it is a required test that must be done. It is recommended to perform the optional tests if higher speeds are required in the future.

TABLE 1: SPECIFIC TESTS FOR CABLE TYPES

TESTS	CAT 5	CAT 5e	CAT 6
Wire Map	Yes	Yes	Yes
Length	Yes	Yes	Yes
Insertion Loss/Attenuation	Yes	Yes	Yes
NEXT	Yes	Yes	Yes
PSNEXT	N/A	Yes	Yes
ELFEXT	Optional	Yes	Yes
PSELFEXT	Optional	Yes	Yes
Propagation Delay	Yes	Yes	Yes
ACR	Optional	Optional	Optional
Delay Skew	Yes	Yes	Yes
Return Loss	Optional	Yes	Yes
PSACR	N/A	Optional	Optional
Characteristic Impedance	N/A	Optional	Optional
Resistance	Optional	Optional	Optional

5.0 POST-INSTALLATION TESTS

5.1 Technical acceptance tests shall be performed on all telecommunication cable pairs to confirm their integrity, following installation.

5.2 **TEST CASES:** The following tests shall be carried out for CAT5e and CAT6 cables.

a. **WIRE MAP:** The wire map test is intended to verify pair- to-pin termination at each end in order to check for installation connectivity errors. For each of the 8 conductors in the cable, the wire map indicates:

1. Continuity to the remote end;
2. Shorts between any two or more conductors;
3. Crossed pairs;
4. Reversed pairs;
5. Split pairs; and
6. Any other type of wiring fault.

b. **LENGTH TEST:** The length test measures the length of each cable pair tested. This is a required test forCAT5e and CAT6 cables.

c. **LENGTH-PHYSICAL LENGTH VS ELECTRICAL LENGTH:** The physical length of the basic link/channel is defined as the sum of the physical lengths of the cables between the two end points. Physical length of the basic link/channel may be determined by physically measuring the length(s) of the cable(s). It is determined from the length markings on the cable(s) when present, or estimated from electrical length measurement. The electrical length is derived from the propagation delay of signals and depends on the twist helix and dielectric material.

d. **PROPAGATION DELAY AND DELAY SKEW:** Propagation delays are the times taken in nanoseconds for a test pulse to travel the length of each cable pair. Delay skews are the differences in propagation delays between the shortest delay, which is displayed as 0 ns, and the delays of the other cable pairs. This is required for CAT5e and CAT6.

e. **CHARACTERISTIC IMPEDANCE:** The characteristic impedance is an optional test that determines the approximate characteristic impedance of each cable pair. Characteristic impedance is the impedance that a cable would have if the cable were infinitely long. Impedance measurements require a cable at least 5 m (16 ft) long. This test is optional for all categories.

f. **INSERTION LOSS/ATTENUATION (dB):** Insertion loss was formerly known as attenuation. It is the combined insertion loss of each of the components of the permanent link or channel.

Note: Attenuation is a measure of signal loss in the basic link or channel. Worst-case attenuation of all pairs within a link relative to the maximum attenuation allowed shall be determined. The link attenuation is the sum of:

1. Attenuation of all connecting hardware; and

2. The total attenuation of 10 meters of patch and equipment cord to make connections on each end of the channel configuration, or a total of 4 meters of equipment cord (2 meters each) to make connections on each end of the basic link configuration. This test is required for all categories.

g. **NEAR-END CROSSTALK (NEXT) LOSS:** The NEXT test measures the crosstalk between cable pairs at the near end of the cabling. This crosstalk value is expressed as the difference in amplitude (in dB) between the test signal and the crosstalk signal. This test is required for all categories.

h. **EQUAL LEVEL FAR-END CROSSTALK (ELFEXT):** The ELFEXT (Equal Level Far-End Crosstalk) test calculates the ratio of FEXT to attenuation for each cable pair. To determine ELFEXT, the main unit first measures FEXT by generating a signal at the far end of the cabling and measuring the resulting crosstalk at the near end of the cabling. ELFEXT is calculated as the difference (in dB) between the measured FEXT and attenuation values. This test is only performed for CAT5e and CAT6 cabling.

i. **ATTENUATION-TO-CROSSTALK RATIO (ACR):** The ACR test calculates the ratio of attenuation to crosstalk (ACR) for each combination of cable pairs. ACR is expressed as the difference (in dB) between the measured NEXT and attenuation values. ACR is calculated using values obtained from the NEXT and attenuation tests. The ACR test represents the overall performance of the cable and the results are specified in dB. This test is optional for all categories.

j. **POWER SUM NEAR-END CROSSTALK LOSS (PS NEXT):** The PSNEXT results show how much each cable pair is affected by the combined NEXT from the other pairs. PSNEXT is expressed as the difference in amplitude (in dB) between the crosstalk received on a cable pair and a test signal transmitted on the other pairs. PSNEXT is calculated from NEXT values. This test is only performed for CAT5e and CAT6.

k. **POWER SUM EQUAL LEVEL FAR-END CROSSTALK LOSS (PS ELFEXT):** The PSELFEXT results (dB) show how much each cable pair is affected by the combined FEXT from the other pairs. To calculate PSELFEXT for a cable pair, the test tool subtracts the pair’s attenuation from the combined FEXT of the other pairs. The descriptions of the results are the same as for ELFEXT results, except that they show the sum effect of FEXT on a cable pair. This test is required for CAT5e and CAT6.

l. **POWER SUM ATTENUATION-TO-CROSSTALK RATIO (PSACR):** PSACR results (dB) show the ratio of each wire pair's attenuation to the combined crosstalk received from the other pairs. It calculates PSACR values by subtracting a pair's attenuation from its PSNEXT value. This test is only for CAT5e and CAT6.

m. **RETURN LOSS (dB):** Return loss is the difference between a test signal's amplitude and the amplitude of signal reflections returned by the cabling. The results of the RL test indicate how well the cable's characteristic impedance matches its rated impedance over a range of frequencies. This test is required for CAT5e and CAT6.

n. **RESISTANCE (Ohms):** The resistance test measures the dc loop resistance for each cable pair. This test is optional for all categories.

6.0 INSTALLING AGENT RESPONSIBILITY

6.1 The installing agent is responsible for the identification and correction of all cable faults. The correction of cable faults shall not be assigned to another agency without the concurrence of the CSC project design authority. It is essential that all cable faults be corrected prior to the circuits being energized. In those rare instances where circumstances prevent the correction of all cable faults, a narrative providing justification as to why they could not be corrected is required. The reason for all cable failures shall be recorded on all Cable Acceptance Test Records. See Annex C1 (CAT5e & CAT6) for the tests record templates.

7.0 DOCUMENTATION

7.1 A record of cable pair test results indicating Pass/Fail, cable length, wire map, NEXT, FEXT and cable identification label is required for all UTP cables installed as part of this project. The installer shall provide the CSC with a complete set of test results to be inserted into the as-built documentation.

8.0 TEST EQUIPMENT

8.1 The type of test equipment used to complete the tests shall be shown on the Cable Acceptance Test Records. When testing a Level II tester shall be used for CAT5e and a level III tester for CAT6 shall be used. The higher the level the better is the precision.

8.2 Proof of test equipment calibration (within the past 12 months) must be provided along with test equipment model and serial numbers prior to tests being performed. Test equipment certificate of calibration is to be included in the as-built documentation.

8.3 The type of test equipment used to complete the tests shall be shown on the Cable Acceptance Test Record.

9.0 GROUNDING

9.1 Grounding tests shall be performed as detailed in Annexes D and E . Refer to Annexes D and E below.

10.0 TYPICAL TEST SHEET

CABLE TEST RESULTS, UTP/STP, CAT5E & CAT6

INTERNAL INSTALLATIONS

TESTED BY: _______________ DATE:_____________________

TEST EQUIPMENT USED: ____________________ LOCATION: ________________

CABLE #	FROM	TO	LENGTH (meters)	WIRE MAP	Attenuation (dB)	NEXT (dB)	Resista...	Propagation Delay	Delay Skew	ELFEXT (dB)	ACR (dB) [1]	Return Loss	PSNEXT (dB)	PSELFEX (dB)	PSACR (dB) [1]	Impedance [1]	NOTES

Note [1]: This test is optional

END OF ANNEX A

ANNEX B

REQUIREMENTS FOR TECHNICAL ACCEPTANCE TESTS

ON EXTERNAL / INTERNAL TELECOMMUNICATION CABLES

1.0 **GENERAL**

1.1 This Annex outlines the general requirements for the completion of technical acceptance tests on external telecommunication cables such as telephone lines.

1.2 Technical acceptance tests are made on communication cable pairs to determine whether they meet design specifications. The tests will identify any problems that may exist on the cable due to improper design, manufacturer's faults, splicing and construction errors.

No spliced cables will be accepted.

2.0 **TESTING GUIDELINES**

The common guidelines, which must be followed to promote efficiency and accuracy testing, are:

- Ensure that the test equipment is calibrated to the ambient temperature;
- Repeat the same test three times;
- Shorter runs less than 300 meters should be tested for correct length and integrity but not necessarily documented;
- Ensure that quality test jumpers are used;
- Use a known reference cable and compare tests results with the cable under tests; and
- The installing agent is responsible for the identification and correction of all cable faults. The correction of cable faults shall not be assigned to another agency without the concurrence of the CSC project design authority. It is essential that all cable faults be corrected prior to the circuits being energized. In those rare instances where circumstances prevent the correction of all cable faults, the installing agent is to provide a narrative justifying why the faults could not be corrected.

3.0 PRE-INSTALLATION TESTS

3.1 Where there is evidence of damage to the cable sheath, the installing agent shall replace the cable to be installed.

4.0 POST-INSTALLATION TESTS

4.1 Technical acceptance tests shall be performed on all telecommunication cable pairs to confirm their integrity following installation.

4.2 Cable pair tests shall be made from point-to-point terminations.

5.0 MANDATORY TESTS

5.1 The installing agent shall perform the following mandatory tests on all telephone cables installed as part of this project. The test results will be documented and delivered in a recognized electronic format suitable for analysis to the design authority.

a. **PAIR ASSIGNMENT/POLARITY CHECK TEST:** Confirm that each conductor of a cable pair is terminated on the correct pin at each end of the cable. Split pairs are not acceptable.

b. **SHORTS TEST:** Confirm that no conductor of a cable pair is short-circuited to any other conductor in the cable. Provide a snapshot measurement of the resistances between each leg (TR, TG, and RG) of a pair.

c. **OPENS TEST:** Confirm that each conductor of every cable pair, for all cables installed, forms a complete end-to-end circuit.

d. **AC VOLTAGE TEST (VAC):** The Voltage test gives a snapshot measurement of AC voltages on each leg of a pair. The test is especially useful to identify the presence of unwanted voltages, such as low frequency induction voltages from power lines.

e. **SPLIT TEST:** Checks for the presence of a split and determines its approximate distance. A split condition may exist that is not detected by the Opens Test, due to the length of the split being fairly short. A split pair occurs when a conductor from one pair is punched down in the position normally reserved for a conductor from another pair.

f. **RESISTANCE (OHMS) TEST:** Measures the DC resistance (in ohms) between the Tip and the Ring.

g. **LEAKAGE STRESS TEST:** The Leakage Stress test is a continuous resistance test that uses a higher test voltage than normal, in order to punch through a potential wire fault, such as in the case of a pair that has oxidized over time.

h. **VF LOSS TEST:** Measures the total voice-range losses (in dB) for the entire length of the cable.

i. **LENGTH TEST:** Measures the cable distance from the source to the far-end terminal. Also checks the distance of the TIP side, from the source to the far-end terminal. Finally, it checks the distance of the RING side, from the source to the far-end terminal. If one side is longer than the other, the line may not be well balanced.

j. **LONGITUDINAL BALANCE TEST:** Checks that both wires (Tip & Ring) have the same electrical characteristics. This is a good test that may potentially detect a bad splice. A well-balanced line will offer better transmission characteristics.

k. **NOISE TEST:** This test performs a snapshot measurement of the voice frequency Noise and Power Influence on the pair using a C-MESSAGE filter. Noise is unwanted electrical or electromagnetic energy that degrades the quality of the signal on the line. Normally this noise is of little or no consequence. However, the noise could become very high when it is near a source of noise that can affect communications.

6.0 OPTIONAL TESTS

Optional tests may be performed to ensure a high-quality installation for critical applications. It can also be used for troubleshooting defective cables. Some of these tests are only for active lines.

a. **TDR TRACE TEST:** This optional test performs TDR (Time-Domain Reflectometry) in order to visually see cable problems. It can show potential problems, normally not detected when performing conventional tests. This test shows the pair as a trace on the screen. The TDR measures the distance to the events, based on the input of the pair. It can also be used to measure the length of the cable. In order to get good results, short lengths below 300 meters should be avoided with some TDR testers. This test is recommended for critical applications requiring high-quality lines. It is also recommended for troubleshooting complex problems.

b. **RESISTANCE FAULT LOCATION (RFL) TEST:** The RFL test provides a highly accurate method of locating resistance faults (shorts, grounds, or crosses), including those that are too large for the TDR test to locate. It does this by using cable gauge and temperature values.

c. **LOOP CURRENT TEST**: Measures the loop DC current. This test is only valid for active lines.

7.0 TEST EQUIPMENT

7.1 Ensure that test equipment is capable of measuring the parameters set forth in the loop Technical Specifications. It must have the ability to quickly and accurately analyze and troubleshoot the local loop. It must have an automatic mode to perform an automatic sequence of tests on an inactive or active pair. Finally, the test equipment must withstand more rugged temperatures because the measurements are performed outside.

7.2 The type of test equipment used to complete the tests shall be shown on the Cable Acceptance Test Record.

7.3 Proof of test equipment calibration (within the past 12 months) must be provided along with test equipment model and serial numbers prior to tests being performed.

8.0 DOCUMENTATION

8.1 A record of cable pair test results is required for all telecom cable pairs installed as part of this project. For big cables having a large number of binder groups, only one pair needs to be documented for every 25 pairs. For smaller cables, up to 25% of the pairs shall be documented.

9.0 TEST RESULTS

9.1 The installing agent shall provide the following test results:

a. Test results will be recorded on the test sheets below; and

b. For the TDR test, print a graph and attach to the other records.

10.0 GROUNDING

10.1 Grounding tests shall be performed as detailed in Annexes D and E. Refer to Annexes D and E below.

11.0 TYPICAL TEST SHEET

INTERNAL / EXTERNAL COPPER CABLE ACCEPTANCE TEST RECORD

TESTED BY:
TEST EQUIPMENT USED:
CABLE NO:
GAUGE (AWG):
CABLE TYPE:

DATE TESTED:
LOCATION:
LENGTH (M):
TEMPERATURE (^{0}C):

FROM_________ TO_________

SHEET___OF ___

BINDER GROUP #	PAIR #	SHORTS	OPENS	AC VOLT	SPLIT	RESISTANCE [2]	LEAKAGE	VF LOSS	LENGTH (Distance to terminal) [3]			BALANCE	NOISE		TDR TRACE [1]	CABLE COMPARISON	NOTES
									TIP-TM	RG-TM	T&R-TM		Tip&Ring	Ground			
		P/F	P/F	P/F	Y/N	OHMS	P/F	dB	M	M	M	P/F	P/F	P/F	Y/N	Y/N	

Note [1]: This test is optional. **Note [2]**: Resistance between Tip and Ring. **Note [3]:** Distance (meters) from source (e.g., tip side) to terminal (TM). **Note:** P/F means PASS/FAIL; Y/N means YES/NO.

END OF ANNEX B

ANNEX C

REQUIREMENTS FOR TECHNICAL ACCEPTANCE TESTS

ON FIBRE OPTIC CABLES

1.0 **GENERAL**

1.1 This Annex outlines the general requirements for the completion of technical acceptance tests on external and internal Fibre cables (multimode and single mode). It describes the method used and offers practical guidelines for system testing.

1.2 Fibre optic cable testing is the process of verifying that the optical Fibre cables are installed and terminated correctly. This step checks each optical Fibre cable to confirm that it was terminated correctly. Proper testing maximizes system longevity and minimizes system downtime.

1.3 There are a few different tests required to certify a Fibre optic cabling system. The most important tests include the attenuation test, length test and the OTDR trace test for fault location detection. More stringent tests are recommended for external cabling because of the more severe conditions involved.

2.0 **TESTING STANDARDS** (OM1, OM2, OM3, OM3 and Single Mode)

2.1 Optical Fibre cables must be tested to conform to the specifications defined in all industry standards and optical Fibre testing standards. The standard are for multimode (62.5um) OM1, (50um) OM2, (50um laser optimized) OM3, OM3 and single mode (8.3um) cables. The primary standards for Fibre optic performance specifications are the **TIA-568B-3 (current version), ANNEX A**. The standards that address the performance testing of optical Fibre cables are: TIA-526-7 standard for testing single mode optical Fibre cable systems, TIA-526-14 standard for testing multimode optical Fibre cable systems, TIA-455-171A standard for testing short length multimode and single mode optical Fibre cable assemblies, and the TIA-455-61 standard for testing attenuation using an OTDR tester.

2.2 The TIA TSB-140 bulletin was introduced to clarify optical Fibre testing, in order to ensure overall network integrity and performance. TSB-140 introduces a level 2 (tier 2) testing, which is optional but equally important. TSB-140 is to be used as a complement to the TIA-568B standard.

2.3 There are two levels of testing that can be done on the internal and external Fibre cables. According to the TSB-140 test standard, level 1 testing is required in all Fibre optic cabling links. When conducting level 1 testing, each Fibre link is measured for loss (attenuation) with an optical loss test set. Fibre length is measured optically or calculated via the cable sheath markings. Level 2 testing supplements level 1 (tier 1) testing with the addition of an optional Optical Time Domain Reflectometer (OTDR) trace test. An OTDR trace is a graphical signature of a Fibre's attenuation along its length.

2.4 CSC insist that a mandatory OTDR test for external Fibre cables be completed as it will help better visualize potential problems on the cable, which is not possible with only level 1 testing. For internal installations, the OTDR trace is <u>optional</u>, but it is recommended to perform this test for critical applications.

2.5 All Fibre optic cable runs over 300 feet (91 meters) shall be tested and documented for initial cable acceptance and long-term maintenance. Shorter runs should be tested for correct length and integrity but not necessarily documented. Signature traces of system backbone cables over 300 feet (91 meters) shall be provided for documentation purposes.

3.0 <u>**TESTING GUIDELINES**</u>

3.1 The common guidelines, which must be followed to promote efficiency and accuracy testing, are:

a) Ensure that quality test jumpers are of the same Fibre core size and connector type as the cable system, i.e., 62.5um jumpers for a 62.5um system. The same jumpers will provide consistent results. It is highly recommended that test jumper cables be factory manufactured. This will guarantee that these cables are highly reliable;

b) Ensure that the test equipment is set to the same wavelength for the light source and the power meter;

c) Always clean the Fibre end faces on all optical Fibre jumper cables and the installed optical Fibre cables before making any connections;

d) All cable Fibres shall be tested in both directions for the attenuation test. All tests for multimode cabling shall be performed with both the 850 and 1300 nanometre (nm) wavelengths. Also, the single mode Fibres shall be tested in both directions with both, the 1310 and 1550 nm wavelengths;

e) All Fibre optic cable runs shall be tested and documented for initial cable acceptance and long-term maintenance.

f) An optical Fibre cable must be tested three times. The optical Fibre cable should be tested on the reel for continuity, each Fibre segment should be tested and the entire end-to-end Fibre optic link should be tested;

g) Ensure that the test equipment is calibrated; and

h) Ensure that optical sources are turned on for sufficient time prior to testing.

i) All test results are to be provided in the as-built documentation.

4.0 **TEST CASES: (The following tests shall be carried out)**

4.1 **ATTENUATION & POLARITY TESTING**

4.1.1 The single most important test result is the end-to-end attenuation. This is a measure of the optical power loss between cable termination points. Acceptable loss values are dependent upon the transmission equipment and system design. System loss measurements should always be less than the link loss budget calculated in the design. To verify that the cable meets the loss limit each segment shall be measured.

4.1.2 Attenuation testing of installed optical Fibre cable is measured by the insertion loss method. This method uses a power meter and light source to measure the difference between two optical power levels. Polarity can be verified while performing attenuation tests.

4.1.3 The attenuation test is to be done at both directions, using 850/1300 nm wavelengths for multimode and 1310/1550 nm for single mode cables. Ensure to calibrate the test equipment (a reference may be required) according to the manufacturer’s recommendations.

4.1.4 The standard specifies that multimode optical Fibre cables (50/125 and 62.5/125) shall exhibit the following losses of a maximum of 3.50 dB/km at 850 nm and a maximum of 1.5 dB/km at 1300 nm. The standards specify that single mode optical Fibre cable shall exhibit a maximum of 1.0 dB/km at 1310 and 1550 nm for tight buffer cable and 0.5 dB/km at 1310 and 1550 nm for loose tube cable.

4.2 FIBRE LENGTH TESTING

4.2.1 This test measures the Fibre length (in meters). Fibre length verification may be obtained from cable sheath markings or estimated by the test equipment or by an OTDR.

4.3 OTDR TESTING

4.3.1 OTDR testing can identify the location and causes of losses in a Fibre link. The OTDR is able to detect Fibre optic connectors and splices in a link. The OTDR displays this information on a trace printout.

4.3.2 Fibre Optic Test Sets operate essentially like radar, sending a light pulse through a Fibre, and then measuring the amount reflected. Access is required to only one end of the Fibre. You can gain insight into the performance of the link components (cable, connectors and splices) and the quality of the installation by examining non-uniformities in the trace. An OTDR trace does not replace the insertion loss measurement test, but is used for complementary evaluation of the Fibre link. By incorporating the proposed two-tier testing method, installers have the most complete picture of the Fibre installation and network owners have proof of a quality installation.

4.3.3 It is recommended to perform this test in both directions, using the same wavelengths as that used when measuring attenuation or link loss.

4.3.4 Note that conventional OTDR testers may not work properly for cable lengths less than 300 meters. for cable lengths of less than 300M the contractor will add a 300M test piece to the cable to perform testing. The test piece will utilize LC dual connectors allowing the OTDR to identify the transition from the test length to the installed length.

5.0 TEST EQUIPMENT

5.1 The test equipment must meet the TIA-568B-C.0 specification to be able to perform level 1 testing. The equipment used to perform the OTDR tests should meet ANSI TIA/EIA TSB-140 Tier 1 with Tier 2 (OTDR Trace) specifications.

5.2 Ensure to have the proper setting (type of adapter, number of splices, reference). The reference may be used for power and delay measurements. Setting a reference lets you subtract out the losses due to patch cords.

5.3 Ensure that the proper wavelengths are set on the test equipment.

5.4 Ensure that the test equipment is well calibrated. Also, ensure to follow the manufacturer’s recommendations for specific tests.

6.0 DOCUMENTATION

6.1 Documentation plays a vital role in the long-term continued success of any cabling system reconfiguration. Test results establish the initial integrity and performance of a system. Documentation of work performed on the Fibre plant can be used for liability protection in the event that multiple vendors are involved. Equally important, these records establish "as-built drawings" and can be compared to current conditions when troubleshooting.

6.2 A record of cable pair test results indicating Pass/Fail is required for all inside telecom cables installed as part of this project. The installing agent shall include all test results in the as-built documentation to be provided. The installer shall provide test results for all cables installed into the as-built documentation.

7.0 TEST RESULTS

7.1 The installing agent shall provide the following test results:

a) End-to-end loss (dB);

b) OTDR signal traces;

c) Connector/Splice Loss data; and

d) Length of cable (meters).

7.2 Test results will be recorded on the test sheets. Refer to typical test sheet below One is for single mode cables in an external or external environment. The other is for multimode cables in an external or internal environment.

7.3 For the OTDR test, print a graph and attach to the other records.

8.0 TYPICAL TEST SHEET

8.1 Multimode

FIBRE OPTIC TEST RECORD
MULTIMODE CABLE

DATE:

FIBRE CABLE TYPE (e.g., 62.5/125um, 50/125um):
TEST SET TYPE:
TEST SET MODEL:
TEST SET SERIAL #.:
LENGTH OF CABLE:

FOM	OPTICAL POWER LOSS TEST (dB)				LENGTH TEST	OTDR TRACE [see note 1]	COMMENTS
FIBRE #	FROM (850nm)	TO (1300nm)	FROM (1300nm)	TO (850nm)	FROM (850nm)	YES/NO	
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							

TESTED BY: **ALSO TESTED BY:**

Note 1: Optional for internal installations. Perform in both directions.

8.2 Single Mode

FIBRE OPTIC TEST RECORD SINGLEMODE CABLE 8.3/125um DATE:							
CABLE FIBRE TYPE:							
TEST SET TYPE:							
TEST SET MODEL:							
TEST SET SERIAL NO.:							
LENGTH OF CABLE:							
FOM	**OPTICAL POWER LOSS TEST (dB)**				**LENGTH TEST**	**OTDR TRACE** [see note 1]	**COMMENTS**
FIBRE NO.	**FROM (1310nm)**	**TO (1550nm)**	**FROM (1550nm)**	**TO (1310nm)**	**FROM (1310nm)**	**YES/NO**	
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
TESTED BY:					**ALSO TESTED BY:**		

Note 1: Optional for internal installations. Perform in both directions.

END OF ANNEX C

ANNEX D

INSIDE CABLE PLANT

PROTECTION, BONDING AND GROUNDING REQUIREMENTS

1.0 GENERAL

1.1 This Annex outlines the general requirements for the protection, bonding and grounding of inside plant cabling. This includes all cables and wires running from the Building Entrance to all points of termination within the building.

2.0 BONDING, GROUNDING AND PROTECTION OVERVIEW

2.1 The main purposes of grounding, bonding and protecting the cables are to safeguard: people, property, equipment and continuity of service.

2.2 Proper grounding, bonding and protection have become essential to ensure good cabling and telecommunication system performance. Modern grounding and bonding systems are designed for low impedance to reduce communications and electronic systems noise and provide voltage transient protection. Due to the sensitivity and proliferation of electronic communication equipment, voltage transient levels ranging from 40 to 100 volts have been observed to cause data driver and receiver failures.

2.3 The preventive measures of grounding, bonding and protection are taken to limit potential hazards from foreign electrical voltages and currents, which can originate due to:

a. Lightning;

b. Ground potential rises;

c. Accidental contact with power or lighting cables;

d. Induction from power circuits (electromagnetic interference); and

e. Induction from nearby electrical equipment.

2.4 An inside telecommunication grounding and bonding system defined by TIA-607-C standards includes the following elements and must be used:

a. The Telecommunication Main Grounding Busbar. The TMGB serves as a dedicated extension of the building grounding system. It serves as a dedicated ground for all communication equipment;

b. TBB: Telecommunication Bonding Backbone. A conductor that interconnects all TGB's with the TMGB. It connects the TGB together to the TMGB;

c. TGB: The Telecommunication Grounding Busbar is the single grounding point for all equipment in the telecommunication room; and

d. TBBIBC: Bonds two or more TBB in the same telecommunication room.

3.0 <u>STANDARDS AND CODES</u>

3.1 The information outlined in this document has been written in accordance to specifications on grounding, bonding and protection as noted in:

a. Canadian Electrical Code;

b. Canadian Standards Association and Telecommunications Industry Association requirements document TIA 607;

c. Bell Canada Standards; and

d. National Electrical Code (U.S.A).

4.0 <u>PROTECTION</u>

4.1 These are methods of protecting the cables against transient voltages and currents. It is the separation of telecommunication cables from transient sources. The isolation can be done electrically, physically and mechanically.

4.2 Transient protection must be provided on all exposed cables entering a building. A cable is considered exposed where any portion of the cable is:

a. Subject to accidental contact with electric lighting or power conductors operating at a voltage exceeding 300 V between conductors; and

b.. Subject to lightning strikes.

4.3 A properly protected communication cable plant requires that at least the following conditions be met:

a. All pairs of the cable brought into the building should be equipped with protectors (e.g., gas tubes). A secondary level of protection may be required inside the building to further attenuate the voltage transients that may still be too high for sensitive equipment.

4.3 Installation guidelines for protection:

a. Communication cables must be separated (at least 4in.) from power or lightning conductors. Where practical, a separation of at least 1.83 m or 6 ft. shall be maintained between communication wires and cables on buildings and lightning conductors.

5.0 **BONDING**

5.1 Bonding is the joining together of metallic parts creating a low impedance continuous conductive path to safely carry away foreign or excess currents.

5.2 Effective bonding is required to create a reliable path for such fault currents to the electrical ground system. Bonding must be provided to assure electrical continuity and have the capacity to safely conduct any excess current.

5.3 Installation guidelines for bonding:

a. Ensure that the size of the bonding conductors be of sufficient gauge to carry anticipated fault current;

b. Metal ducts, raceways, racks, cable trays and enclosures must be effectively bonded and grounded to ensure the capacity to conduct any fault current to ground;

c. High strength bolting with joints made with high strength bolts with clean and unpainted surfaces should be considered. All mating surfaces that comprise the bond shall be thoroughly cleaned before joining, to remove oxides and other resistive films from the mating surfaces; and

d. All bonding conductors shall:

1. Be listed for the purpose intended and approved by a Nationally Recognized Testing Laboratory;

2. Conductors shall be insulated and copper; and

3. Be bonded to each end of the conduit with a minimum No. 6 AWG ground wire.

6.0 GROUNDING

6.1 Grounding refers to the electrical connection of telecommunication hardware or cabling to an effective electrical ground. A good ground must provide a low resistance, which will give a good path for current to follow in the event of a fault, permitting the quick operation of the protective devices. The ideal protective ground should have low resistance and be tied into the power company ground. System grounds of twenty-five (25) ohms or less are acceptable for most voice circuits.

6.2 Grounding conductors shall be insulated copper, not smaller in size than the gauge specified and be guarded from mechanical damage. Under no circumstances will aluminium wires, clamps or terminal connectors be used for bonding or grounding.

6.3 The installation guidelines for grounding are:

a. The grounding is most effective if all items to be grounded are connected to a single, common earth connection;

b. All exposed telecommunication cables containing metallic components such as a metallic shield, metallic strength member, or metallic pairs require some form of electrical protection and must be grounded; and

c. Keep the length of the ground wire as short as possible with a minimum of bends.

7.0 TELECOM GROUNDING WIRE SIZE

7.1 Installing agent is to size the ground conductors in accordance with the most current version of TIA-607.

END OF ANNEX D

ANNEX E

OUTSIDE CABLE PLANT

PROTECTION, BONDING AND GROUNDING REQUIREMENTS

1.0 GENERAL

1.1 This Annex outlines the general requirements for the protection, bonding and grounding of outside plant (OSP) cabling. This includes all the outside plant cables and wires running from the Main Distribution Frame to any point of termination.

2.0 BONDING, GROUNDING AND PROTECTION OVERVIEW

2.1 The main purposes of grounding, bonding and protecting the cables are to safeguard: people, property, equipment and continuity of service.

2.2 Proper grounding, bonding and protection have become essential to ensure good cabling and telecommunication system performance. Modern grounding and bonding systems are designed for low impedance to reduce communications and electronic systems noise and provide voltage transient protection.

2.3 The preventive measures of grounding, bonding and protection are taken to limit potential hazards from foreign electrical voltages and currents, which can originate due to:

a. Lightning;

b. Ground potential rises;

c. Accidental contact with power or lighting cables;

d. Induction from power circuits (electromagnetic interference); and

e. Induction from nearby electrical equipment.

3.0 STANDARDS AND CODES

3.1 The information outlined in this document has been written in accordance to specifications on grounding, bonding and protection as noted in:

a. Canadian Electrical Code;

b. Telecommunications Industry Association requirements document TIA 607;

c. Bell Canada Standards; and

d. National Electrical Code (U.S.A).

4.0 PROTECTION

4.1 These are methods of protecting the cables against transient voltages and currents. It is the separation of telecommunication cables from transient sources. The isolation can be done electrically, physically and mechanically.

4.2 Transient protection must be provided on all exposed cable entering a building. A cable is considered exposed where any portion of the cable is:

a. Subject to accidental contact with electric lighting or power conductors operating at a voltage exceeding 300 V between conductors; and

b. Subject to lightning strikes.

4.2.1 A properly protected communications cable plant requires that at least the following conditions be met:

a. All pairs of the cable brought into the building shall be equipped with protectors (e.g., gas tubes);

b. The cable shield to the cable terminal be properly grounded; and

c. Aerial cable shall be bonded to the cable sheath and to the station ground.

4.3 INSTALLATION GUIDELINES FOR PROTECTION

a. A good rule of thumb is to assume that all system components are exposed unless it is absolutely sure that it is not an issue;

b. If the cable has conductive components and is not exposed, bond non-current carrying components to grounding electrode subsystem. If the cable has conductive components and is exposed, protect pairs and separately bond protector and non-current carrying components to grounding electrode subsystem; and

c. Communication cables must be separated (at least 4in.) from power or lightning conductors. Where practical, a separation of at least 1.83 m or 6 ft. shall be maintained between communications wires and cables on buildings and lightning conductors.

5.0 BONDING

5.1 Bonding is the joining together of metallic parts creating a low impedance continuous conductive path to safely carry away foreign or excess currents. In other words, electrical bonding is the process in which components or units of an assembly, equipment, or sub-systems are electrically connected by means of a low impedance conductor.

5.2 Effective bonding is required to create a reliable path for fault currents to the electrical ground system. Bonding must be provided to assure electrical continuity and have the capacity to safely conduct any excess current.

5.3 Installation guidelines for bonding

a. Ensure that the size of the bonding conductors be of sufficient gauge to carry anticipated fault current;

b. Metal ducts, enclosures, or metal cable armouring must be effectively bonded to ensure the capacity to conduct any fault current to ground;

c. Bond all cable shields at all splice locations;

d. High strength bolting with joints made with high strength structural bolts with clean and unpainted surfaces should be considered. Also consider irreversible compression-type connectors, exothermic welding, or equivalent. All mating surfaces that comprise the bond shall be thoroughly cleaned before joining, to remove oxides and other resistive films from the mating surfaces;

e. Consider non-corrosive material and take proper procedures to limit corrosion. There are many methods to combat corrosion (Alloy, inorganic coating, non-metallic material, alteration of environment, cathodic protection, proper design); and

f. All bonding conductors shall:

1. Be listed for the purpose intended and approved by a Nationally Recognized Testing Laboratory;

2. Conductors shall be insulated and copper; and

3. Be bonded to each end of the conduit with a minimum No. 6 AWG ground wire.

6.0 **GROUNDING**

6.1 Grounding refers to the electrical connection of telecommunication hardware or cabling to an effective electrical ground. A good ground must provide a low resistance, which will give a good path for current to follow in the event of a fault, permitting the quick operation of the protective devices. The ideal protective ground should have low resistance and be tied into the power company ground.

6.2 Electrical systems and communication cabling systems are required to be grounded to earth. The grounding mechanism must provide a reliable means to safely conduct the voltages imposed by lightning, line surges, or unintentional contact with high voltage lines.

6.3 Grounding conductors shall be insulated copper, not smaller in size than the gauge specified and be guarded from mechanical damage. Under no circumstances will aluminium wires, clamps or terminal connectors be used for bonding or grounding.

6.4 The installation guidelines for grounding are:

a. The grounding is most effective if all items to be grounded are connected to a single, common earth connection;

b. All exposed telecommunications cables that contain metallic components such as a metallic shield, metallic strength member, or metallic pairs require some form of electrical protection at the building entrance. Improper application of a grounded shield to a wire may cause coupling problems that otherwise would not exist; and

c. Keep the length of the ground wire as short as possible with a minimum of bends. A No.6 AWG is the smallest acceptable ground wire.

END OF ANNEX E