



CABLE PLANT SPECIFICATIONS

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SECTION A: DESIGN PARAMETERS

A.1 OVERVIEW

A.2 INSIDE PLANT

A.2.1 HORIZONTAL WIRING

A.2.1.1 OVERVIEW

Horizontal cabling is that portion of the telecommunications cabling that provides connectivity between the horizontal cross-connect and the work-area telecommunications outlet. The horizontal cabling consists of the transmission media, the outlet, terminations of the horizontal cables and horizontal cross-connect at the IDF.

A.2.1.2 DATA OUTLETS

All 100 Ohm UTP shall be wired to eight position modular jacks using T568B pin-out unless otherwise specified. All data outlet and patch panel jacks shall be Panduit Mini-Com TX6™ PLUS UTP Jack Module part# CJ688TGRD unless signed off by TMCC Project Manager. All data outlet and patch panel Jacks must be red in color.

Surface mounted boxes for data and voice outlets will be parallel-type, with built-in knockouts for mounting to raceway and number of RJ-45 compatible ports. All wiring devices and RJ-45 jacks should follow the TIA 568B configuration standard. Each data/voice outlet box will contain one spare port labeled spare.

All data outlet faceplates shall be Panduit Mini-Com Sloped Executive Faceplates, single gang part # CFPSE4EIY, double gang CBEEI-2GY, and Electric Ivory in color unless otherwise signed off by TMCC Project Manager.

A.2.1.3 VOICE OUTLETS

All voice outlets should be the same as the data outlets with the following exception: voice outlets should be white in color, Panduit Mini-Com TX6™ PLUS UTP Jack Module part# CJ688TGWH.

A.2.1.4 MEDIA TYPE

The media required for voice and data horizontal cabling is four pair 100 Ohm UTP Category 6 CMP rated. Approved vendors are Berk-Tek LANmark-1000, Belden DataTwist 3600 or ADC/Krone TrueNet AirES. See Addendum [Section D.1](#).

A.2.2 VERTICAL WIRING

A.2.2.1 OVERVIEW

The purpose of the vertical wiring is to provide connectivity between IDFs, MDFs and entrance facilities. The following transmission media types may be used in the backbone cabling as noted on drawings or approved by TMCC Project Manager. See Addendum [Section D.1](#).

A.2.2.2 MEDIA TYPE

- 100 Ohm Category 6 cable (Berk-Tek LANmark-1000, Belden DataTwist 3600, ADC/Krone TrueNet® AirES®)
- 50/125 um optical fiber Multi-mode fiber Corning
- Single-mode Optical Fiber shall be 8.3/125 micron Corning

A.2.2.3 CABLE ROUTING

The following is a chart of minimum distances that UTP must be run from common sources of EMI (Electromagnetic interference):

EMI SOURCE	MINIMUM DISTANCE
Fluorescent lighting	24 inches
Neon lighting	24 inches
Unshielded power cable 2 KVA or less	15 inches
Unshielded power cable over 2 KVA	39 inches
Transformers and Motors	39 inches

Voice and data cabling should not be run parallel and adjacent to power cabling even at short distances unless one or both cable types are shielded and grounded. For current recommendations, refer to NEC/NFPA 70, Article 800-52.

All data and voice cabling is to be routed throughout buildings in surface raceways in exposed locations and on bridal rings, J-hooks, D-rings, or approved equal in concealed locations. D-rings are to be securely mounted to structure (wall, joists, etc.) and no more than five to six feet apart. Bridal rings and J-hooks no more than three feet apart and are to be securely mounted to structure (wall, joists, etc.).

Cable slack is to be in Telecommunication Rooms only, with no cable sags more than 6-inches anywhere between bridal rings, J-hooks, or D-rings. Install mounting hardware 2 feet above ceiling tiles.

Exposed non CMP rated fiber optic cabling will be placed in 1-inch CMP rated flexible innerduct for protection. Flexible innerduct must be fastened to a structure, by approved methods, above lay-in ceilings, with no sags laying on ceiling tiles. Fiber optic cabling runs in protected conduit will be run in a MaxCell type plenum rated flexible multi cell textile innerduct system.

Plenum rated armored, or other similar type CMP rated backbone fiber optic cable, can be run parallel with data cable in the plenum returns. If exposed, the cable must be clearly labeled with a self laminating cable ID tag every 20 feet, the tag must note the cable type and termination locations and be orange or red in color, yellow for single mode cable. Cable must also be clearly labeled on each end no more than two feet from termination box.

No cable ties are to be used for either copper or fiber bundles. Velcro strips are the approved method for tying and securing cable bundles.

All cable, conduit and wire mold routings shall utilize the path of least obstructions and shall be run parallel or perpendicular to existing walls. Hang multiple horizontal conduits in tight, vertically organized arrays and run vertical riser similarly. Avoid creating obstructions to future mechanical/electrical work.

Fiber optic cabling shall have no bends with a radius smaller than 20 times the outside diameter of the enclosing sheath. The minimum bend radius, under no-load conditions for four-pair unshielded twisted pair (UTP) cable, shall not be less than four times the cable diameter or that which is recommended by the cable manufacturer.

From all individual data and voice outlets, run the appropriate cabling to the nearest Telecommunication Room. Voice lines should be homerun to the MDF or Entrance Facility.

The quantity and uses of cables needed at each receptacle location are as indicated on the drawings. No UTP link shall exceed 295 feet. Terminate each cable at the faceplate and in the appropriate patch panel in the Telecommunication Room. All exposed tag ends of cable terminations must be flush cut to factory specifications. Follow TIA 568B configuration for terminations.

Cabling shall meet or exceed the electrical specifications of ANSI/TIA/EIA 568-B.

A.2.3 MAIN & INTERMEDIATE DISTRIBUTION FACILITIES (MDF & IDF)

A.2.3.1 OVERVIEW

The Main Distribution Facility is a centralized space for all telecommunications equipment (voice, data & video). All requirements of entrance facility apply to MDF as well (see [A.3.3](#)). Main Distribution Facilities should be designed to incorporate UPS systems, power backup circuits to diesel generators, and HVAC systems.

The primary function of an IDF is to terminate horizontal cabling. All requirements of an entrance facility are required in an IDF as well. The IDF's may be used to cross connect horizontal as well as backbone cabling together. UPS systems and generated backup circuits are required for every IDF. The Contractor may be required to provide a TMCC approved UPS system depending on the contract.

A.2.3.2 ENVIRONMENT

Environmental control equipment, such as power distribution/conditioner, Large scale UPS systems, and HVAC must be provided. See section [A.5](#).

A.2.4 PATCH PANELS, CROSS CONNECTS, AND OUTLETS

Patch panels for data are to be Panduit CP48BL or CP24BL on approval. Patch cables shall be Panduit #UTPSP7Y and #UTPSP10Y, white in color, level 6 UTP with snagless RJ-45 connectors or Corning ClearCurve Pretium Low-loss OM3 Ultra-Bend fiber cables with SC connectors. A 7 foot white patch cable shall be provided for each connector in the patch panels. Each data outlet requires a 10 foot white drop cable to be provided. All straight thru data cables will be white in color. Crossover data cables will be purple in color. See Addendum Section [D.1](#).

Fiber termination enclosures must contain an appropriate number of fiber cross connect SC type connectors for interconnection of fibers between wiring closets. Enclosures must be able to be mounted in a 19-inch equipment rack. Enclosures are to contain a front accessible, hinged, slide-out tray with SC connectors on front and strain relief ring for excess fiber cabling in back of tray. Rack mounted fiber enclosures shall be manufactured by Corning or Panduit/Opticom.

Telecommunication Standards ANSI/TIA/EIA-568-B, TIA/EIA-568-B.1, T568B must be followed unless otherwise noted.

A.2.5 EQUIPMENT RACKS, CABLE MANAGEMENT AND RACEWAYS

A.2.5.1 EQUIPMENT RACKS

All telecommunication rooms must be equipped with a minimum of two (2) 19" black aluminum relay racks which are anchored to the floor. Each rack is to be supported from the wall with a standard 12" black cable runway ladder rack. The ladder rack is to be anchored to the wall and the rack using industry standard mounting hardware.

The ladder will be used to support the racks and also to transition the cables to the rack space. No cable will free span from the wall to the racks.

A.2.5.2 CABLE MANAGEMENT

Cable management panels are to be utilized to organize excess slack cable lengths at rack locations. Furnish one (1) 2U cable management panel per 48 port patch panel, plus one (1) additional 2U management panel. Management panels must be able to be mounted in an EIA 356 standard 19-inch rack, and provide both horizontal and vertical wire management. Panduit is the TMCC approved vendor for wire management.

A.2.5.3 RACEWAYS

All new wiring devices, data and voice outlets, etc., that are shown to be installed on existing walls and surfaces are to be installed in metallic raceways. Raceways to be UL and CSA listed for electrical wiring up to 300V, and furnished with all boxes, faceplates, connectors, corners, angles, tees, etc., as required to install all devices as shown on drawings.

Raceways are to be securely mounted to walls with screws anchored into walls. Screws must be drilled into base of raceway 12 inches apart on center.

A.2.6 TELCO WIRING

Termination panels for Telco are to be 66-type punch down blocks.

All exterior runs of voice backbone cabling to be lightning protected. Lightning protection units to utilize 66-type connection system and must be UL certified and UL 497B listed. Lightning protectors shall utilize gas-discharge modules with over-voltage protection. Lightning protectors shall be as manufactured by Lucent Technologies, or approved equal.

A.3 OUTSIDE PLANT

A.3.1 CONDUITS AND PULL BOXES

A.3.1.1 CONDUIT SPECIFICATIONS

In general, conduit shall be zinc-coated, rigid steel conduit and shall meet in all respects, the UL Standards for Rigid Steel Conduit. The conduit shall be metallized, galvanized, or approved equal. No flexible conduit shall be used unless specifically approved by the TMCC Project Manager.

All conduit shall be installed concealed unless otherwise noted or shown on the drawings. All horizontal runs of conduit shall contain a junction box every 100 feet, and every 180 degrees of bend unless otherwise stipulated by the TMCC Project Manager.

No conduit smaller than 1" inch shall be used. All conduit required under this specification shall be provided with a 14-gauge galvanized steel fish wire or approved nylon pull string. All exposed conduit ends are to be covered with a plastic rim cap.

Holes through walls and ceilings, chases, shafts, or other architectural assemblies, for the passage of cable or conduit shall be made so as to substantially preserve the integrity of the fire rating of such surfaces or passages in accordance with NEC 300-21. All exposed conduit or through floor riser openings are to be sealed with fire stop caulking unless an approved rated mechanical device of EZ-Path type is installed.

A.3.1.2 ENVIRONMENT

Whenever possible, avoid running UTP in locations where temperature will be below 40 degrees Fahrenheit or above 115 degrees Fahrenheit. Humidity should normally be in the range of 8-80%. See [A.5](#).

All exposed exterior cabling to be in EMT conduit, sized as noted on drawings.

A.3.2 FIBER SPECIFICATIONS

A.3.2.1 OVERVIEW

Fiber Optic terminations shall be consistent with existing fiber terminations in an area. If fiber is being terminated in a location where no fiber exists, it should be termination in a 19" rack mounted fiber enclosure. See [A.2.4](#). All fibers must be terminated and tested unless otherwise approved by TMCC Project Manager. Terminations shall be of type SC.

A.3.2.2 MULTIMODE

Multimode Optical Fiber shall be Corning 50/125 µm OM3 Multimode Fiber.

A.3.2.3 SINGLE MODE

Single-mode Optical Fiber shall be Corning 8.3/125 micron.

A.3.3 ENTRANCE FACILITY & DEMARCATION POINTS

A.3.3.1 OVERVIEW

An Entrance Facility includes all telecommunication and service connections that enter and leave a building. An Entrance Facility may include Wide Area Network connections, Telco demarcations, inter-building connectivity entrances, antenna entrances. An Entrance Facility may reside in an MDF, IDF or a mechanical room.

A.3.3.2 WALL MOUNTED BOARD

Mechanically fasten 3/4 inch X 8 foot X 4 foot flame retardant A-C plywood on all walls of each Telecommunication Room from 6-inch AFF to 8-foot 6-inch AFF. Treat all plywood with two coats of white, flame retardant paint. The printed rating on each sheet of plywood must remain unpainted and visible in no less than two locations per cut sheet unless otherwise approved by TMCC Project Manager.

A.3.3.3 LIGHTING

Lighting shall be a minimum of 50 foot candles (500 lux) measured 3 ft. above floor. This lighting must be achieved using long lasting fluorescent lamps. The lighting must be controlled by a power/energy saving switch located immediately inside the access door of each room.

A.3.3.4 SECURITY

All telecommunication areas must be kept secure behind a locked door. Keys and access should only be given to Information Technology Operations staff.

A.3.3.5 ELECTRICAL CIRCUITS

See section [A.5.2](#).

A.3.3.6 TELECOMMUNICATION STANDARDS

TIA/EIA-569-A specifies the standards for demark space. Unless otherwise noted these standards must be followed.

A.4 TESTING AND DOCUMENTATION REQUIREMENTS

A.4.1 OVERVIEW

Contractor must supply to the TMCC Project Manager a completed set of cable test records. The records shall indicate run numbers, room numbers, patch panel numbers, port numbers, cable length, pair 1 test, pair 2 test, pair 3 test, pair 4 test, ground test and the name of technician performing the tests and the date and time of the test. Testing shall be per IEEE Standards and TIA/EIA TSB-67 and shall include, but not be limited to, these tests:

1. Resistance
2. Impedance
3. Relative power loss test for fiber optic cable (where present)
4. Near-end cross talk
5. Length verification using time-domain reflectometer testing
6. Proper pinning/termination
7. Tension testing during installation for fiber optic cable (where present)

Unsatisfactory test results will require the electrical contractor to correct the system, at no cost to TMCC, before acceptance of the work will be given.

The following items will be tested for operational performance:

1. Unshielded twisted pair cable for voice and data
2. Fiber-optic cable (if present)
3. Passive network components
4. Miscellaneous supporting equipment

End to end continuity, performance and diagnostic test should be the final test performed in all cases.

A.4.2 CATEGORY 6 UTP TESTING

A.4.2.1 GENERAL REQUIREMENTS

1. Every cabling link in the installation shall be tested in accordance with the field test specifications defined in ANSI/TIA/EIA-568-B.2-1
2. The installed twisted-pair horizontal links shall be tested from the telecommunications room to the telecommunication wall outlet in the work area against the *"Permanent Link"* performance limits specification as defined in ANSI/TIA/EIA-568-B.2-1.
3. One hundred percent of installed cabling links must be tested and must pass the requirements of the standards mentioned above. Any failing link must be diagnosed and corrected. The corrective action shall be followed with a new test to prove that the corrected link meets the performance requirements. The final and passing result of the tests for all links shall be provided in the test results documentation.
4. Trained technicians who have successfully attended an appropriate training program and have obtained a certificate as proof thereof shall execute the tests. Appropriate training programs include but are not limited to installation certification programs provided by BiCSi or the ACP (Association of Cabling Professionals). Technician's certification must be made available upon request.
5. The test equipment (tester) shall comply with the accuracy requirements for level III field testers as defined in the TIA Cat 6 Document. The tester including the appropriate interface adapter must meet the specified accuracy requirements. The accuracy requirements for the permanent link test configuration (baseline accuracy *plus* adapter contribution) are specified in Table B.2 of Annex B of the TIA Cat 6 Standard. (Table B.3 in this TIA document specifies the accuracy requirements for the Channel configuration.)
6. The test plug shall fall within the values specified in E.3.2.2 Modular test plug NEXT loss requirements of the TIA Cat 6 Standard.
7. The tester shall be within the calibration period recommended by the manufacture in order to achieve the manufactures specified measurement accuracy.
8. The Pass or Fail condition for the link-under-test is determined by the results of the required individual tests. Any Fail or Fail* result yields a Fail for the link-under-test. In order to achieve an overall Pass condition, the results for each individual test parameter must Pass or Pass*.
9. A Pass or Fail result for each parameter is determined by comparing the measured values with the specified test limits for that parameter. The test result of a parameter shall be marked with an asterisk (*) when the

result is closer to the test limit than the accuracy of the field tester. The field tester manufacturer must provide documentation as an aid to interpret results marked with asterisks.

A.4.2.2 TESTING PARAMETERS

The test parameters for Cat 6 are defined in TIA Cat 6 standard, which refers to the ANSI/TIA/EIA-568-B.2 standard. The test of each link shall contain all of the following parameters as detailed below. In order to pass the test all measurements (at each frequency in the range from 1 MHz through 250 MHz) must meet or exceed the limit value determined in the above-mentioned standard.

1. **Wire Map:** Wire Map shall report Pass if the wiring of each wire-pair from end to end is determined to be correct. The Wire Map results shall include the continuity of the shield connection if present.
2. **Length:** The field tester shall be capable of measuring length of all pairs of a basic link or channel based on the propagation delay measurement and the average value for NVP (1). The physical length of the link shall be calculated using the pair with the shortest electrical delay. This length figure shall be reported and shall be used for making the Pass/Fail decision. The Pass/Fail criteria are based on the maximum length allowed for the Permanent Link configuration (90 meters – 295 feet) plus 10% to allow for the variation and uncertainty of NVP.
3. **Insertion Loss (Attenuation):** Insertion Loss is a measure of signal loss in the permanent link or channel. The term “Attenuation” has been used to designate “Insertion Loss.” Insertion Loss shall be tested from 1 MHz through 250 MHz in maximum step size of 1 MHz. It is preferred to measure insertion loss at the same frequency intervals as NEXT Loss in order to provide a more accurate calculation of the Attenuation-to-Crosstalk ratio (ACR) parameter. Minimum test results documentation (summary results): Identify the worst wire pair (1 of 4 possible).

The test results for the worst wire pair must show the highest attenuation value measured (worst case), the frequency at which this worst case value occurs, and the test limit value at this frequency.

4. **NEXT Loss:** Pair-to-pair near-end crosstalk loss (abbreviated as NEXT Loss) shall be tested for each wire pair combination from each end of the link (a total of 12 pair combinations). This parameter is to be measured from 1 through 250 MHz. NEXT Loss measures the crosstalk disturbance on a wire pair at the end from which the disturbance signal is transmitted (near-end) on the disturbing pair. The maximum step size for NEXT Loss measurements shall not exceed the maximum step size defined in the standard as shown in Table 1, column 2. Minimum test results documentation (summary results): Identify the wire pair combination that exhibits the worst case NEXT margin (2) and the wire pair combination that exhibits the worst value of NEXT (worst case). NEXT is to be measured from each end of the link-under-test. These wire pair combinations must be identified for the tests performed from each end. Each reported case should include the frequency at which it occurs as well as the test limit value at this frequency.

Frequency Range (MHz)	Maximum Step size (MHz)
1 – 31.25	0.15
31.26 – 100	0.25
100 – 250	0.50
250 – 350	1.00

Table 1

5. **PSNEXT Loss:** Power Sum NEXT Loss shall be evaluated and reported for each wire pair from both ends of the link under-test (a total of eight results). PSNEXT Loss captures the combined near-end crosstalk effect (statistical) on a wire pair when all other pairs actively transmit signals. Like NEXT this test parameter must be evaluated from 1 through 250 MHz and the step size may not exceed the maximum step size defined in the standard as shown in Table 1, column 2.

Minimum test results documentation (summary results): Identify the wire pair that exhibits the worst-case margin and the wire pair that exhibits the worst value for PSNEXT. These wire pairs must be identified for the tests performed from each end. Each reported case should include the frequency at which it occurs as well as the test limit value at this frequency.

6. **ELFEXT Loss, pair-to-pair:** Pair-to-pair FEXT Loss shall be measured for each wire-pair combination from both ends of the link under-test. FEXT Loss measures the crosstalk disturbance on a wire pair at the opposite end (far-end) from which the transmitter emits the disturbing signal on the disturbing pair. FEXT is measured to compute ELFEXT Loss that must be evaluated and reported in the test results. ELFEXT measures the relative strength of the far-end crosstalk disturbance relative to the attenuated signal that arrives at the end of the link. This test yields 24 wire pair combinations. ELFEXT is to be measured from 1 through 250 MHz and the maximum step size for FEXT Loss measurements shall not exceed the maximum step size defined in the standard as in Table 1, column 2.

Minimum test results documentation (summary results): Identify the wire pair combination that exhibits the worst-case margin and the wire pair combination that exhibits the worst value for ELFEXT. These wire pairs must be identified for the tests performed from each end. Each reported case should include the frequency at which it occurs as well as the test limit value at this frequency.

7. **PSELFEXT Loss:** Power Sum ELFEXT is a calculated parameter that combines the effect of the FEXT disturbance from three wire pairs on the fourth one. This test yields eight wire-pair combinations. Each wire-pair is evaluated from 1 through 250 MHz in frequency increments that do not exceed the maximum step size defined in the standard as shown in Table 1, column 2. Minimum test results documentation (summary results): Identify the wire pair that exhibits the worst pair combinations must be identified for the tests performed from each end. Each reported case should include the frequency at which it occurs as well as the test limit value at this frequency.

8. **Return Loss:** Return Loss (RL) measures the total energy reflected on each wire pair. Return Loss is to be measured from both ends of the link-under-test for each wire pair. This parameter is also to be measured from 1 through 250 MHz in frequency increments that do not exceed the maximum step size defined in the standard as shown in Table 1, column 2.

Minimum test results documentation (summary results): Identify the wire pair that exhibits the worst-case margin and the wire pair that exhibits the worst value for Return Loss. These wire pairs must be identified for the tests performed from each end. Each reported case should include the frequency at which it occurs as well as the test limit value at this frequency.

9. **ACR (Attenuation to crosstalk ratio)** [This parameter is not demanded by the standard but may be required in order to obtain the premise wiring manufacturer's warranty]: ACR provides an indication of bandwidth for the two wire-pair network applications. ACR is a computed parameter that is analogous to ELFEXT and expresses the signal to noise ratio for a two wire-pair system. This calculation yields 12 combinations – six from each end of the link. Minimum test results documentation (summary results): Identify the wire pair combination that exhibits the worst-case margin and the wire pair combination that exhibits the worst value for ACR. These wire pair combinations must be identified for the tests performed from each end. Each reported case should include the frequency at which it occurs as well as the test limit value at this frequency.

10. **PSACR** [This parameter is not required by the standard but may be required in order to obtain the premise wiring vendor's warranty]: The Power Sum version of ACR is based on PSNEXT and takes into account the combined NEXT disturbance of all adjacent wire pairs on each individual pair. This calculation yields eight combinations –one for each wire pair from both ends of the link. Minimum test results documentation (summary results): Identify the wire pair that exhibits the worst-case margin and the wire pair that exhibits the worst value for PSACR. These wire pairs must be identified for the tests performed from each end. Each reported case should include the frequency at which it occurs as well as the test limit value at this frequency.
11. **Propagation Delay**: Propagation delay is the time required for the signal to travel from one of the link to the other. This measurement is to be performed for each of the four wire pairs. Minimum test results documentation (summary results): Identify the wire pair with the worst-case propagation delay. The report shall include the propagation delay value measured as well as the test limit value.
12. **Delay Skew** [as defined in TIA/EIA-568-B.1; Section 11.2.4.11]: This parameter shows the difference in propagation delay between the four wire pairs. The pair with the shortest propagation delay is the reference pair with a delay skew value of zero. Minimum test results documentation (summary results): Identify the wire pair with the worst-case propagation delay (the longest propagation delay). The report shall include the delay skew value measured as well as the test limit value.

A.4.3 FIBER TESTING

A.4.3.1 GENERAL

Contractor is to provide all labor, materials, tools, field-test instruments and equipment required for the complete testing, identification and administration of the work called for in the Contract Documents.

In addition to the tests detailed in this document, the contractor shall notify the Owner or the Owner's representative of any additional tests that are deemed necessary to guarantee a fully functional system. The contractor shall carry out and record any additional measurement results at no additional charge.

All installed cabling links and channels shall be field-tested and pass the test requirements and analysis. Any link or channel that fails these requirements shall be diagnosed and corrected. Any corrective action that must take place shall be documented and followed with a new test to prove that the corrected link or channel meets performance requirements. The final and passing result of the tests for all links and channels shall be provided in the test results documentation.

A.4.3.2 SCOPE

This section includes the minimum requirements for the test certification, identification and administration of backbone and horizontal optical fiber cabling.

Testing shall be performed on each cabling link (connector to connector). Testing shall not include any active devices or passive devices within the link or channel other than cable, connectors and splices, i.e. link attenuation does not include such devices as optical bypass switches, couplers, repeaters or optical amplifiers. All tests shall be documented including OLTS dual wavelength attenuation measurements for multimode and single mode links and channels and OTDR traces and event tables for multimode and single mode links and channels. Documentation shall also include optical length measurements.

A.4.3.3 QUALITY ASSURANCE

All testing procedures and field-test instruments shall comply with applicable requirements of:

- ANSI Z136.2, ANS For Safe Use Of Optical Fiber Communication Systems Utilizing Laser Diode And LED Sources
- ANSI/EIA/TIA-455-50B, Light Launch Conditions For Long-Length Graded-Index Optical Fiber Spectral Attenuation Measurements

- ANSI/TIA/EIA-455-59A, Measurement of Fiber Point Discontinuities Using an OTDR.
- ANSI/TIA/EIA-455-60A, Measurement of Fiber or Cable Length Using an OTDR.
- ANSI/TIA/EIA-455-61A, Measurement of Fiber or Cable Attenuation Using an OTDR.
- ANSI/TIA/EIA-526-7, Optical Power Loss Measurements of Installed Single mode Fiber Cable Plant.
- ANSI/TIA/EIA-526-14-A, Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant.
- ANSI/TIA/EIA-568-B.1, Commercial Building Telecommunications Cabling Standard, Part 1, General Requirements.
- ANSI/TIA/EIA-568-B.3, Optical Fiber Cabling Components Standard.
- TIA/EIA TSB-140, Additional Guidelines for Field-Testing Length, Loss and Polarity of Optical Fiber Cabling Systems.

A.4.3.4 TESTING CERTIFICATIONS

Trained technicians who have successfully attended an appropriate training program, which includes testing with an OLTS and an OTDR and have obtained a certificate as proof thereof shall execute the tests. These certificates may have been issued by any of the following organizations or an equivalent organization:

- Manufacturer of the fiber optic cable and/or the fiber optic connectors.
- Manufacturer of the test equipment used for the field certification.
- Training organizations (e.g., BICSI)

Technician's certification must be made available upon request.

A.4.3.5 TESTING SPECIFICATIONS

Optical loss testing

- The link attenuation shall be calculated by the following formulas as specified in ANSI/TIA/EIA-568-B.1:
- $\text{Link_Atttn (dB)} = \text{Cable_Attn (dB)} + \text{Connector_Attn (dB)} + \text{Splice_Attn (dB)}$
- $\text{Cable_Attn (dB)} = \text{Attenuation_Coefficient (dB/km)} * \text{Length (Km)}$
- $\text{Connector_Attn (dB)} = \text{number_of_connector_pairs} * \text{connector loss (dB)}$
- Maximum allowable connector loss = 0.75 dB
- $\text{Splice_Attn (dB)} = \text{number_of_splices} * \text{splice_loss (dB)}$
- Maximum allowable splice_loss = 0.3 dB

The values for the Attenuation_Coefficient (dB/km) are listed in the table below:

Type of Optical Fiber	Wavelength (nm)	Attenuation coefficient (dB/km)	Wavelength (nm)	Attenuation coefficient (dB/km)
Multimode 62.5/125 μm	850	3.5	1300	1.5
Multimode 50/125 μm	850	3.5	1300	1.5
Single-mode (Inside plant)	1310	1.0	1550	1.0
Single-mode (Outside plant)	1310	0.5	1550	0.5

OTDR testing

- Reflective events (connections) shall not exceed 0.75 dB.
- Non-reflective events (splices) shall not exceed 0.3 dB.

Magnified end face inspection

- Fiber connections shall be visually inspected for end face quality.
- Scratched, pitted or dirty connectors shall be diagnosed and corrected.

A.4.3.6 TESTING PROCEDURE

All tests performed on optical fiber cabling that use a laser or LED in a test set shall be carried out with safety precautions in accordance with ANSI Z136.2.

All outlets, cables, patch panels and associated components shall be fully assembled and labeled prior to field-testing. Any testing performed on incomplete systems shall be redone on completion of the work.

Optical fiber cable testing

1. Field-test instruments shall have the latest software and firmware installed.
2. Link and channel test results from the OLTS and OTDR shall be recorded in the test instrument upon completion of each test for subsequent uploading to a PC in which the administrative documentation (reports) may be generated.
3. Fiber end faces shall be inspected at 250X or 400 X magnifications. 250X magnification is suitable for inspecting multimode and single mode fibers. 400X magnification may be used for detailed examination of single mode fibers. Scratched, pitted or dirty connectors shall be diagnosed and corrected.
4. Testing shall be performed on each cabling segment (connector to connector).
5. Testing shall be performed on each cabling channel (equipment to equipment) that is planned for use per the owner's instructions.
6. Testing of the cabling shall be performed using high-quality test cords of the same fiber type as the cabling under test. The test cords for OLTS testing shall be between 1 m and 5 m in length. The test cords for OTDR testing shall be approximately 100 m for the launch cable and at least 25 m for the receive cable.

Optical loss testing

1. Multimode backbone links shall be tested at 850 nm and 1300 nm in accordance with ANSI/EIA/TIA-526-14A, Method B, One Reference Jumper or the equivalent method.
2. Single mode backbone links shall be tested at 1310 nm and 1550 nm in accordance with ANSI/TIA/EIA-526-7, Method A.1, One Reference Jumper or the equivalent method.
3. Link attenuation does not include any active devices or passive devices other than cable, connectors and splices, i.e. link attenuation does not include such devices as optical bypass switches, couplers, repeaters or optical amplifiers.
4. Use the One Reference Jumper Method specified by ANSI/TIA/EIA-526-14A, Method B and ANSI/TIA/EIA-526-7, Method A.1 or the equivalent method. The user shall follow the procedures established by these standards or application notes to accurately conduct performance testing.

OTDR testing

1. A launch cable shall be installed between the OTDR and the first link connection.
2. A receive cable shall be installed after the last link connection.

Magnified endface inspection

Fibers shall be inspected at 250X or 400 X magnifications. 250X magnification is suitable for inspecting multimode and single mode fibers. 400X magnification may be used for detailed examination of single mode fibers.

Length measurement

1. The length of each fiber shall be recorded.
2. It is preferable that the optical length be measured using an OLTS or OTDR.

Polarity testing

Paired duplex fibers in multi-fiber cables shall be tested to verify polarity in accordance with sub clause 10.3 of ANSI/TIA/EIA-568-B.1. The polarity of the paired duplex fibers shall be verified using an OLTS.

A.4.4 DELIVERY FORMAT FOR TESTING RESULTS

1. The test results information for each link shall be recorded in the memory of the field test equipment upon completion of the test.
2. The test results records saved by the tester shall be transferred into a Windows™-based database utility that allows for the maintenance, inspection and archiving of these test records. A guarantee must be made that the measurement results are transferred to the PC unaltered, i.e., "as saved in the tester" at the end of each test and that these results cannot be modified at a later time. Superior protection in this regard is offered by testers that transfer the numeric measurement data from the tester to the PC in a non-printable format.
3. The database for the completed job shall be stored and delivered on CD-ROM or DVD including the software tools required to view, inspect and print any selection of test reports.
4. A paper copy of the test results shall be provided that lists all the links that have been tested with the following summary information:
 - The identification of the link in accordance with the naming convention defined in the overall system documentation
 - The overall Pass/Fail evaluation of the link-under-test including the NEXT Headroom (overall worst case) number
 - The date and time the test results were saved in the memory of the tester.
 - Name of technician performing tests.
5. General Information to be provided in the electronic data base with the test results information for each link:
 - The identification of the customer site as specified by the end-user
 - The identification of the link in accordance with the naming convention defined in the overall system documentation
 - The overall Pass/Fail evaluation of the link-under-test
 - The name of the standard selected to execute the stored test results
 - The cable type and the value of NVP used for length calculations
 - The date and time the test results were saved in the memory of the tester
 - The brand name, model and serial number of the tester
 - The identification of the tester interface
 - The revision of the tester software and the revision of the test standards database in the tester
 - The test results information must contain information on each of the required test parameters that are listed in Section I.B and as further detailed below under paragraph I.C6.

6. The detailed test results data to be provided in the electronic database:
 - For each of the frequency-dependent test parameters:
 - The value measured at every frequency during the test is stored. In this case, the PC-resident database program must be able to process the stored results to display and print a color graph of the measured parameters.
 - The PC-resident software must also provide a summary numeric format in which some critical information is provided numerically as defined by the summary results (minimum numeric test results documentation) as outlined above for each of the test parameters.
 - Data for each tested link must contain the following information:
 - Length: Identify the wire-pair with the shortest electrical length, the value of the length rounded to the nearest 0.1 m (1) and the test limit value.
 - Propagation delay: Identify the pair with the shortest propagation delay, the value measured in nanoseconds (ns) and the test limit value.
 - Delay Skew: Identify the pair with the largest value for delay skew, the value calculated in nanoseconds (ns) and the test limit value.
 - Attenuation: Minimum test results documentation as explained in Section I.B for the worst pair.
 - Return Loss: Minimum test results documentation as explained in Section I.B for the worst pair as measured from each end of the link.
 - NEXT, ELFEXT, ACR: Minimum test results documentation as explained in Section I.B for the worst pair combination as measured from each end of the link.
 - PSNEXT, PSELFEXT and PSACR: Minimum test results documentation as explained in Section I.B for the worst pair as measured from each end of the link.

A.4.5 AS-BUILT DRAWINGS AND CONFIGURATION FILES

The contractor shall record all changes and deviations from the contract drawings, with special emphasis on the exact location of all underground facilities by offset distances to surface improvements such as building corners, curbs, etc. Entries and notations shall be neat, legible and permanent. These prints shall be delivered to the TMCC Project Manager upon completion of this project. Approval of final payment will be contingent upon compliance with these provisions. In the event of time and materials work, the contractor shall provide drawings depicting the location of newly installed drops.

A.4.6 PRODUCT USER AND MAINTENANCE MANUALS

At completion of the contract, TMCC shall be provided with two (2) bound copies of operations and maintenance instructions for any equipment provided under the contract.

A.4.7 LABELING OF CABLE, DROPS, AND PATCH PANELS

A.4.7.1 OVERVIEW

Every component of the telecommunications wiring system must be labeled. All cables must be labeled to show the source and destination at each end. See [A.4.7.3](#) and [A.4.7.5](#).

All labels must be easily viewed. All cables, components and device identifiers must be unique. All labels must be permanent and machine printed.

All cables shall be labeled with a wrap around self-laminating machine produced label. All cables shall be labeled at the faceplate and in the Telecommunication Room. Labels shall be located not less than 4 inches from the jack at the faceplate and not more than 10 inches from the jack at the faceplate. Labels in the Telecommunication Room shall be located so that they can be easily read. Placement of the label should not exceed more than 6 inches from the jack.

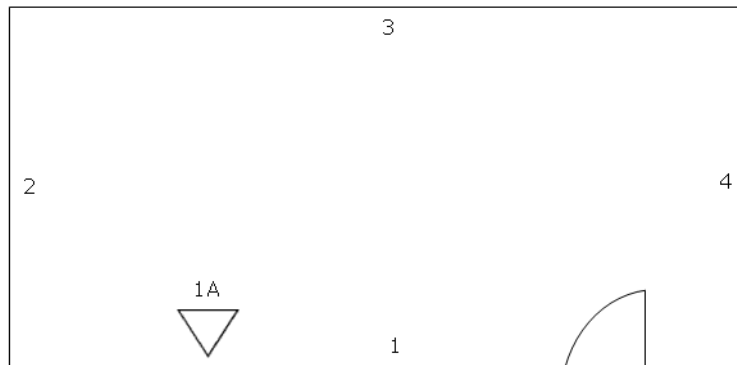
All faceplates shall be individually labeled along with labels for each cable located behind the faceplate in accordance with the TMCC labeling scheme. All patch panels shall be individually labeled and each port on the patch panel labeled in accordance with the TMCC labeling scheme.

A.4.7.2 BUILDING DESIGNATIONS

1. IGT Applied Technical Center = E
2. High Technology Center at Redfield = T
3. Nell J. Redfield Foundation Performing Arts Center = K
4. Elizabeth Sturm Library = L
5. Meadowood Center = M
6. Facilities Services = P
7. Red Mountain Building = R
8. Sierra Building = S
9. Vista Building = V

A.4.7.3 DATA FACEPLATE

All faceplates are labeled in sequential order in a clockwise manner from the main entrance of the room containing the cable drops starting with the number one ("1"). If new faceplates are installed between existing drops (i.e., between faceplate 1 and two 2), then a letter beginning with the letter "A" shall be used to designate the new faceplate (i.e., 1A).



The data faceplate in the room shall be labeled with the name of the Telecommunication Room from which the drop originated, the rack position number (if applicable), the number of the patch panel from which the drop is terminated within the Telecommunication Room, and the number of the port on the patch panel on which the drop is terminated. For example, if the Telecommunication Room is designated as Red Mountain 205, the rack position is number 1, the patch panel is number 2 and the port on the patch panel is number 3, then the faceplate in the room shall be labeled R205-1-2-3 (Telecommunication Room, rack position, patch panel and port).

A.4.7.4 VOICE FACEPLATE

The voice faceplate in the room shall be labeled with the name of the room in which the faceplate resides, the jack number on the faceplate, the Telecommunication Room from which the drop originated and the block number and pair number on the punch down block on which the voice drop is terminated. For example, if the room in which the faceplate resides is Red Mountain 205X, the jack number on the faceplate is 2, the Telecommunication Room from which the drop originated is Red Mountain 205J the block number is 3 and pair number is 5 on the punch down block on which the voice drop is terminated, then the faceplate in the room shall be labeled R205X-2-205J-3-5 (room, jack, Telecommunication Room, block and pair).

A.4.7.5 DATA PATCH PANELS

The patch panel shall be clearly identified in sequential order, top to bottom, starting with the number one. The patch panel at the top left shall be labeled as patch panel number one. Patch panels beneath patch panel number one shall be labeled two, three, etc. If multiple distribution racks are present in the Telecommunication Room, the patch panels adjacent to the leftmost rack (when facing the racks), rack #1, shall continue the sequential labeling beginning with the patch panel at the top and will start with number one.

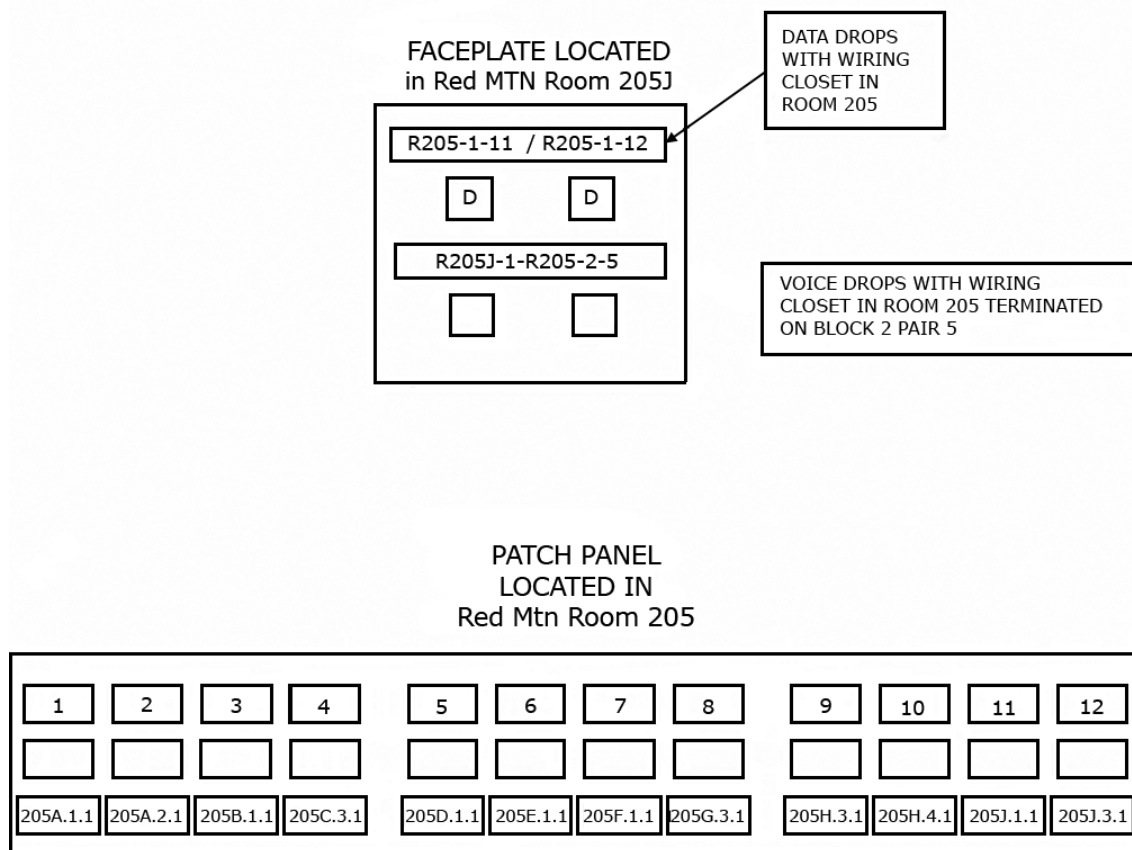
The patch panel ports shall be labeled with the name of the room from which the drop was terminated, the sequential number of the faceplate in the room in which the drop is terminated, and the number of the port on the faceplate on which the drop is terminated. For example, if the room is designated as Sierra 201, the sequential number of the face plate is number 2 and the port number is 3, then the faceplate in the room shall be labeled S201-2-3.

A.4.7.6 VOICE PUNCH DOWN BLOCKS

The punch down blocks shall be labeled with the room number in which the telephone jack resides and the jack number (i.e., R205J-1).

A.4.7.7 LABELING SCHEME EXAMPLE

TMCC Labeling Scheme



A.5 ENVIRONMENT AND POWER CONSIDERATIONS

A.5.1 HVAC

All telecommunication closets must maintain certain environmental conditions. Equip all telecommunications rooms to provide an appropriate atmosphere for active network equipment on a year round basis. HVAC equipment must operate 24/7/365 days of the year. Emergency power must be provided to the HVAC systems.

Temp. Range: 18 to 24 C (64 to 75 F) Humidity: 30 to 55% RH.

A.5.2 ELECTRICAL CIRCUITS

A minimum of two dedicated 20A, 110V AC duplex outlets, each on separate circuits shall be provided for equipment power. Install, in all Telecommunication Rooms and Entrance Facilities. Receptacles should be evenly placed around the telecommunications room, eighteen inches (18") AFF (above finished floor), in accordance with NEC specifications and/or local fire codes.

A.5.3 ELECTRICAL GROUNDING AND BONDING

Solid copper grounding busbars with insulated standoffs must be installed in all entrance facilities, equipment rooms and telecommunications rooms. All frames, cabinets and telecommunications equipment shall be grounded to the telecommunications grounding busbar (TGB) system.

A 1/4-inch X 4-inch X 20-inch or larger insulated copper telecommunications grounding busbar is to be bonded to building steel, or to an approved telecommunications main grounding busbar (TMGB) system, with #2 AWG copper wire in 3/4-inch PVC conduit in accordance with ANSI/TIA/EIA-607 (CSA T527) and J-STD-607-A.

The conduit system and neutral conductors of the wiring system shall be grounded in accordance with NEC. The grounding system shall be installed in a workmanlike manner and shall be inconspicuous. Continuity of the ground shall be maintained throughout the building. Continuity of equipment and raceway ground shall be insured by the use of double lock nuts and insulated grounding bushings bonded to enclosures in accordance with NEC Article 250-79 and Table 250-95 at service equipment at all panel boards, safety switches, pull boxes, etc. Convenience outlets shall be grounded by means of a bonding wire attached to the outlet box in a manner approved by NEC Article 250-114. All equipment or device grounds at panel boards, service or distribution equipment shall be connected to ground bars in such equipment with set screw connectors. All equipment and device feeders (receptacles, motor connections, etc.) shall include a green ground wire, sized as per NEC, to be run in conduit with

A.5.4 UPS & DIESEL GENERATORS

If emergency power is available, circuits should be connected, otherwise an approved Uninterruptible Power Supply that is capable of handling all of equipment load plus 50% for expansion is required.

SECTION B: CODE COMPLIANCE, INSPECTION AND CERTIFICATES

B.1 OVERVIEW

Where applicable, all contractor-provided equipment shall be UL listed, FCC approved and registered, meet State and Federal fire codes, electrical codes and REA standards. All equipment furnished by the contractor shall be manufactured, assembled, installed and tested in accordance with the following current industry standards, and shall be considered minimum requirements:

1. The American National Standards Institute (ANSI)
2. The Institute of Electrical and Electronic Engineers (IEEE)
3. The National Electrical Manufacturer's Association (NEMA)
4. Insulated Power Cable Engineers Associates (IPCEA)
5. Occupational Safety Health Act (OSHA)
6. National Fire Protection Associations (NFPA)

7. The National Electrical Code (NEC)
8. The Telecommunications Industry Association (TIA)
9. The Electronics Industry Association (EIA)
10. International Organization for Standardization (ISO)
11. International Electrotechnical Commission (IEC)
12. National Fire Protection Association (NFPA)
13. Building Industry Consulting Service International (BICSI)
14. Underwriters' Laboratories (UL) (where applicable)

All work shall be accomplished in strict conformity with all laws and ordinances applying to the operation under this contract, including the latest regulations of all municipal and other public authorities having jurisdiction and state electrical codes. Installation shall also meet the standard requirements of NEC, OSHA and NFPA. The contractor will be held to complete all work necessary and to provide all equipment required to comply with the foregoing without extra compensation.

The contractor and subcontractors, upon award of the contract, shall be required to conform to Labor Laws of the State of Nevada and various acts amendatory and supplementary thereto and to other laws, ordinances and legal requirements applicable thereto.

Unless otherwise stated within this document the following industry standards, codes and all of their addendums must be followed closely.

B.2 INDUSTRY STANDARDS AND CODES:

1. ANSI/TIA/EIA-568-A: The commercial building standard for telecommunications wiring.
2. ANSI/TIA/EIA-568-B: This standard specifies the component and transmission requirements for media
3. ANSI/TIA/EIA-569-A: Commercial Building Standard for Telecommunications Pathways and Spaces.
4. ANSI/TIA/EIA-606-A: Administration Standard for Commercial Telecommunications Infrastructure.
5. ANSI/TIA/EIA-607-A: Commercial Building Grounding and Bonding Requirements for Telecommunications.
6. EIA/TIA TSB-36: Technical Systems Bulletin Additional Cable Specifications for Unshielded Twisted Pair Cables.
7. EIA/TIA TSB-40A: Telecommunications Systems Bulletin Additional Transmission Specifications for Unshielded Twisted-Pair Connecting Hardware.
8. ANSI/TIA/EIA-942: Telecommunications Infrastructure Standard for Data Centers.
9. ISO/IEC 11801: Generic cabling for customer premises.

B.3 PERMITS, LICENSES AND INSPECTION FEES

Permits, Licenses and Inspections Fees: The contractor must be licensed to perform work, and they shall prepare and submit to all authorities having jurisdiction, for their approval, all applications and working drawings required by them and

obtain all necessary permits and certificates of compliance or approvals issued by such authorities and deliver these to Truckee Meadows Community College (TMCC) paying all necessary fees in such instance. Any work the contractor performs under this contract will fully comply with the Federal Occupational Safety and Health Act of 1970 and any rules and regulations pursuant to the Act. Any fines incurred as a result of contractor's neglecting the requirements of this paragraph shall be paid by the contractor.

SECTION C: SPECIAL CONDITIONS

C.1 COMPLETION & PAYMENT REQUIREMENTS

C.1.1 RECEIPT AND WAIVER OF MECHANICS LIEN RIGHTS

The contractor and any subcontractor shall provide TMCC a Receipt and Waiver of Mechanics Lien Rights prior to receipt of payment from TMCC for all material, equipment, labor and components billed.

C.1.2 TAXES

As a state agency, the Nevada System of Higher Education (NSHE) and TMCC are exempt from Nevada sales taxes. The contractor and their subcontractors shall pay Unemployment and Social Security taxes or other taxes imposed by local, state and federal governments, and certify that such taxes have been paid before final payment.

C.1.3 TIME FOR COMPLETION

Substantial Completion: The total work to be done by the contractor when committed to this combined construction contract shall be commenced at the time stipulated in the work order to the contractor, and shall be substantially complete within forty-five (45) consecutive calendar days thereafter.

Final Completion: The total work to be done by the contractor when committed to this combined construction contract shall be fully completed within fifteen (15) consecutive calendar days after the date of substantial completion.

The date of final completion shall be the date that the work is complete and all contract requirements have been fulfilled by the contractor.

C.1.4 LIQUIDATED DAMAGES

As actual damages for any delay in completion are impossible to determine, the contractors and their sureties shall be liable for and shall pay to TMCC the sum of one hundred (\$100.00) as fixed, agreed and liquidated damages for each calendar day of delay, beyond the date of substantial and final completion as defined in paragraph 2.1 above, until such time the contract work is determined to be substantially and finally complete.

C.1.5 INSPECTION CERTIFICATES

The contractor shall furnish TMCC with a Certificate of Inspection and Approval from the local building inspector, as required.

Electrical inspection will be performed throughout the course of construction by a certified electrical inspector. Upon project completion and when wiring equipment and fixtures have been installed, inspected and found to be in compliance with the latest NEC, the inspector shall issue a Certificate of Compliance and Inspection to TMCC. There will be no charge to TMCC for electrical inspection

C.1.6 OPERATING INSTRUCTIONS AND MAINTENANCE MANUALS

At completion of the contract, TMCC shall be provided with two (2) bound copies of operations and maintenance instructions for any equipment provided under the contract.

C.1.7 CONTRACTOR'S RESPONSIBILITY FOR DEVIATIONS

The mention of an acceptable supplier does not necessarily imply that their particular "standard" product is totally adaptable to details shown. Therefore the cost of deviations, extensions or adjustments required for the low bidder's product must be included in the contractor's bid.

The specifications covering this work are closed. Where a specific manufacturer's item is specified, it is intended as a standard to be met and only items which are listed, in the specifications or on the drawings, as acceptable manufacturers will be accepted. Contractors wishing to use alternate manufacturers must submit documentation to the TMCC Project Manager ten (10) days prior to the bid date. Documentation is to include original color catalog brochures and data which indicate that the submitted materials meet or exceed the specifications contained herein. Alternate manufacturers accepted by the TMCC Project Manager will be listed in an Addendum prior to bid or they will not be accepted. Acceptance of an alternate manufacturer does not relieve the contractor of the requirements of section C.1.7, Contractor's Responsibility for Deviations.

C.1.8 PAYMENTS AND COMPLETION

If the manner of completion of the work and its progress are and remain satisfactory to the TMCC Project Manager and is absent of other good and sufficient reasons, upon presentation by the Contractor of Consent of Surety for each application, TMCC will pay the contractor no less than ninety percent of the amount due the contractor for work completed and in place on account of progress payments. Pay requests shall be submitted to the TMCC Project Manager and only one pay request per month will be accepted. No pay request will be accepted until the work is at least ten percent complete. Pay requests shall be broken down to indicate, at a minimum, separate labor and material costs and percent completed for various portion of work. Portions of work shall be defined by specifications section, with separate line items for mechanical and fiber optic work. Contractor will not be paid for materials kept offsite. Payments by the TMCC Controller's Office will normally occur within a 60 day time period.

C.1.9 TMCC OCCUPANCY

TMCC will occupy the site and the building during the entire period of construction unless otherwise specified by TMCC. The contractor shall cooperate fully with TMCC during construction to minimize conflicts and to facilitate TMCC's usage.

C.1.10 WARRANTIES AND GUARANTIES

The System shall have a minimum 1-year labor and 5-year product warranty.

C.1.11 COMPLETION CHECKLIST

Upon completion by the contractor of the project, the following general checklist will be used for inspection of the completed work. This checklist does not release the contractor from their obligation to follow the specifications in this document:

1. All drops are clearly labeled at the faceplate and on cable ends.
2. All drops are clearly labeled at the Telecommunication Rooms patch panels and cable ends.
3. As-built documentation clearly shows cable routes and location of drops.
4. As-built documentation clearly shows labeling scheme.
5. Equipment racks are securely anchored in concrete and grounded (see [A.5.3](#)).
6. All cables are neatly bundled and tied together with Velcro ties.
7. Appropriate service loops are set in cables

8. Electronic media test results have been delivered
9. All drops passed compliance tests per specifications
10. All work areas are returned to neat and tidy condition

A signature with date of acceptance shall be secured from the TMCC Project Manager or designee. The contractor's job site supervisor shall also acknowledge by signature the agreement or non concurrence of the TMCC Project Manager of the contractor's quality of work.

C.2 MATERIALS

The contractor shall include furnishing of all labor, materials, equipment and other related items required to complete the work called for and indicated on the Contract Drawings and specified for a complete system. All materials shall be new and the best of their respective kinds unless otherwise specified and shall be listed by UL and shall be so labeled. All equipment shall conform to the latest approved standards of the IEEE, NEMA, ANSI, TIA/EIA and OSHA.

C.2.1 ORDERING MATERIALS

Immediately following the award of contract for this work, contractor shall determine source of supply for all materials and length of time required for their delivery, including materials of subcontractors and order shall be placed for such materials promptly.

If, for any reason, any item specified will not be available when needed and contractor can show that he has made a reasonably persistent effort to obtain item in question, the TMCC Project Manager is to be notified in writing within ten (10) days after contract is signed, otherwise, the contractor will not be excused for delays in securing material specified and will be held accountable if completion of building is thereby delayed.

C.2.2 STORAGE OF MATERIALS

Each contractor providing materials and equipment shall be responsible for the proper and adequate storage of his materials and equipment and for the removal of same upon completion of this work. Storage of materials at the site shall be confined to areas within contract limits where designated by the TMCC Project Manager.

The contractor may store materials on site in a trailer provided by contractor. Location of trailer will be at the rear of a designated parking area. Trailer location must be approved by the TMCC Project Manager prior to trailer being brought on site. If power, telephone, or other utilities are required at trailer, it shall be the contractor's responsibility to arrange for and provide all utility connections and contractor will assume all costs.

C.2.3 TMCC FURNISHED MATERIALS

TMCC may provide to the contractor various materials for the contractor's use on this project. The contractor shall provide any and all additional materials required to complete the installation of this project and shall include all costs in the bid. At submission of bid, the contractor shall provide TMCC, in writing, the quantity of TMCC provided materials to be used in this project. TMCC will furnish the quantity specified by the contractor up to the amount indicated. The contractor will be expected to transport materials from TMCC's storage to the jobsite.

C.2.4 HAZARDOUS MATERIALS

Prior to creating any floor penetrations, the contractors shall comply with all applicable hazardous materials reporting and abatement procedures at least fourteen calendar days prior to such work. It shall be the contractor's responsibility to provide adequately trained and appropriately certified personnel to perform said hazardous materials abatement.

C.3 FACILITY AND SITE ACCESS

C.3.1 USE OF THE PREMISES CONTRACT LIMIT

The contractor shall confine his operations, including delivery and unloading of materials and equipment, to the areas within the designated contract limits. Also, each individual contractor shall confine his operations within the contract limits to those areas directly relating to his work. The contract limits shall be defined as only those areas within the building and surrounding area that actual work is being required.

The contractor shall consult with the TMCC Project Manager or his representative and agree on a general "Plan of Operations." The plan of operations shall show concisely the manner in which the contractor proposed to carry out the work, shall indicate the areas where work will be first carried on, the course the Contractor intends to pursue, the sequence of operations, the traffic pattern for delivery of material and equipment, etc. Once this plan of operation in writing is agreed upon, the contractor shall not deviate from the plan unless approval is secured from the TMCC Project Manager in writing.

Within seven calendar days of the notice to proceed, the contractor shall forward to the TMCC Project Manager a proposed project schedule, in bar chart format, with milestone dates, indicating completion of phases of work. The project schedule shall be updated, revised and resubmitted with each pay request submitted.

C.3.2 DAMAGED FACILITIES

The contractor shall repair and/or replace, at no expense to TMCC, any sections of existing roads, drives, streets, sidewalks, curbs, utilities, buildings, building interiors, ceiling tiles, ceiling grids, and other structures damaged by reason of work performed under this contract or incidental thereto, whether by his own forces or by his subcontractors or by his material suppliers. All damaged items shall be repaired or replaced to exactly match the existing condition prior to damage.

C.3.3 ACCESS TO SITE

Access to the site shall only be as permitted by arrangement with the TMCC Project Manager. Contractor shall arrange all access to the buildings with the TMCC contact and with the TMCC Campus Police Department where necessary.

C.3.4 ACCESS TO BUILDINGS

The contractor will be required to coordinate the accessibility and use of the buildings with the TMCC Project Manager. The contractor will be allowed access to the building(s) on Mondays through Fridays when classes are in session. Contractor shall arrange the work schedules to begin work at 8 a.m. Access to the building on weekends and weekdays when school doesn't meet shall be coordinated with the TMCC Project Manager.

C.3.5 PARKING FACILITIES

TMCC will provide limited parking facilities for the contractor or his employees; however, the contractor must make arrangements for use of parking space with the TMCC Project Manager and see that all employees and subcontractors park only in the assigned areas. Note: Areas of designated parking available to the contractor and his subcontractors will be assigned at the pre-construction meeting.

C.3.6 SITE CLEAN UP

At the completion of the work required and just prior to acceptance by TMCC, the contractor shall thoroughly clean all exposed equipment fittings, fixtures and accessories.

At the completion of work each day, the contractor shall clean all areas of work of debris, trash, dust, etc. All ceiling tiles shall be installed and materials placed in the designated storage areas. During work, all computers, bookshelves, desks,

television, etc. shall be covered with drop clothes to protect from dust and debris. Drop clothes shall be removed at the end of each day of work. All areas shall be restored to a normal condition, as found, at the end of each day of work.

C.4 PROJECT COORDINATION

C.4.1 PROGRESS MEETING

With the express purpose of expediting construction and providing the opportunity for cooperation of affected parties, meetings may be called which shall be attended by (a) the TMCC Project Manager or designated representative, (b) the Contractor, and (c) all Subcontractors. A location on or near the site will be designated where such meetings will be held. The frequency of meeting shall be at the discretion of the TMCC Project Manager or designated representative.

C.4.2 CONTRACTOR COORDINATION

The contractor and all subcontractors shall cooperate and coordinate their work to expedite the progress of the project. All subcontractors shall review and refer to the drawings and specifications of other trades involved with their particular work before proceeding. Any work installed which conflicts with another trade and had not been brought to the attention of the TMCC Project Manager prior to installation shall be removed at no additional expense to TMCC.

It shall not be the responsibility of the TMCC Project Manager nor of TMCC to coordinate the work of the Subcontractors. It shall not be the responsibility of the TMCC Project Manager nor of TMCC to solve conflicts between the installation of new work and existing conditions.

C.4.3 CONTACTS

All correspondence, questions, submittals, etc. shall be made to the TMCC Project Manager. The TMCC contact for the project will be **Randy Miller**, at telephone number **775-674-7078**. The address for the TMCC Project Manager is 7000 Dandini Blvd., RDMT 205, Reno, NV 89512-3999.

The Contractor shall provide an emergency number to the TMCC Project Manager in case of emergencies during non-working hours.

C.4.4 JOBSITE OFFICE

While the contractor will not be required to maintain a physical office at the job site, the Contractor's Job Site Superintendent shall keep a set of as-built drawings, one copy of all shop drawings, and a set of specifications available for reference at the job site at all times. The Job Site Superintendent is not required to maintain a telephone at the site, but there shall be means of contacting the Superintendent at any time by pager, cellular phone, or some other approved method. All costs shall be borne by Contractor.

SECTION D: SUPPLEMENTATION

D.1 PRODUCT SUPPLEMENTATION

Products, equipment and materials may be substituted only with the direct approval of TMC ITO for the following reasons: higher quality, technological improvements, improved industry standards or cost savings.