Specification and special terms & conditions for Tender No **12/10-11 dated 30-06-2010** for voice, data cabling at GEC Sreekrishnapuram

Quantities mentioned are approximate, actual may vary.

Table 1

Sl No	Item	Specification	Quantity
1	Floor mountable rack, 19 inch 42U 1000mm Depth, Ventilated, with power strip, cable manager and all accessories	• 42U,19",600W,1000D • Cabinet should conform to DIN 41494 or EIA 310D standards. • Should be able to dismantle and reassemble at the site. • CRCA Should is “IS 513 Gr D” standard. • Fully adjustable 19” equipment mounting angles. • Nano Technology process with “Zirconium Coating” is desirable • Powder Coating min 80 Microns with scratch resistance properties is desirable • Product to be ROHS Complaint • Manufacturing should be as ISO Company. • Removable side panels with indents and slam latch • Top and bottom cover for cable entry • 19" mounting angles fixed front and rear accessible • Door, steel 600w, 42u hex prf ful doors, steel with hexagonal perforated (perforation percentage 70%) • KB tray, rotary, 19"/1000d+slides" tray for the keyboard • HRDWRE,FRNT PNL,SQR,PKT of 20nos packet hardware to fix the rack mount equipments • Castors med duty 4 nos per	1 No

		set each rack. set 2 with foot brake, 2 without brakes • Fan tray ,door mtg,2 posn fan on the door position • Fan 230v,90cfm fans for exhaust • AC main chnl 42u/ (14x5a) • Manufacturing as per ISO 14001 - 2004(Yes/No)	
2	Wall mounting rack, 19 inch 12U 500mm Depth, Ventilated, with power strip, cable manager and all accessories	• 12u wall mounting rack 500mm depth • Front glass door with lock & key • Fan 230v,90cfm • Power strip (6 x 5a) • Cable manger 1u 19” mtg • CKD type completely knock down condition(Yes/No)	8 Nos
3	Fiber Light Guide Interconnect Unit (LIU)	• 24 Port Fiber Patch Panel • Rack mount with 1 U height • Made of powder coated steel. • Have slots on front panel to accommodate SC duplex adapters • Loaded with 12 SC-SC duplex adapters (no pigtails) is preferred • Should have fiber management provision inside • Should have earthing lugs, splicing tray with sleeves, two set of moon cable routing and other accessories. • Panel cover should be slide out (front sliding) for easy maintenance • Dimensions : 19” X 11” X 1 U Approx.	1 Nos
4	Fiber Panel Rack Mount Type / wall mount type	• 06 Port Rack Mount/ wall mount • Aluminium housing with durable Epoxy / Powder Coated Steel Housing	8 Nos 3 Nos wall mountable type

		• powder coating • Suitable for 19” Rack Mountable cabinet/ wall mountable • Allow minimum two cable entries • Have slots on front panel to accommodate SC duplex adapters • Loaded with 3 SC-SC duplex adapters (no pigtails) is preferred • Flame retardant plastic, high impact resistance cable spool • Dimensions: 44 * 410 * 280 mm (H*W*D) (Approx.) • Material: Box - Powder Coated Aluminum alloy • Spool - FR Grade ABS • Cable grommets - FR Grade Nylon • Splice Tray - Aluminum + ABS • Splice Tray Dimensions : 140 x 125 x 10mm • Dimension-Sliding LIU: 44 x 410 x 330mm • (H*W*D)	
5	Coloured CAT6 UTP Jack Panel with Cable Manager	• 24 Port Rack Mount Patch Panel • 110 wiring block at rear end & RJ 45 jack on front panel • The modules should have high quality PCB • The IDC should have 45 degree contact • 19” rack mountable • It should have integrated in-built shutter with zero foot print. • It should have in-built Cable Manager • should conform or exceed the EIA/TIA 568 B.2-1 standards for CAT6	1 No

		• Metallic high strength & 1U height, should have routing rings, ties, labeling strips for identification • 750 mating cycles • 200 termination cycles • Jack contacts - Phosphorous bronze, plated with 1.27micro-meter thick gold	
6	Coloured CAT6 UTP Jack Panel with Cable Manager	• 48 Port Rack Mount Patch Panel • 110 wiring block at rear end & RJ 45 jack on front panel • The modules should have high quality PCB • The IDC should have 45 degree contact • 19” rack mountable • It should have integrated in-built shutter with zero foot print. • It should have in-built Cable Manager • should conform or exceed the EIA/TIA 568 B.2-1 standards for CAT6 • Metallic high strength & 1U or 2U height, should have routing rings, ties, labeling strips for identification • 750 mating cycles • 200 termination cycles • Jack contacts - Phosphorous bronze, plated with 1.27micro-meter thick gold	8 Nos
7	Coloured CAT6 UTP Patch Cord (factory crimped) - 1/0.5 mtr with marker ties	• Factory crimped Cat6 patch cord • Should conform or exceed the EIA/TIA 568 B standards for CAT 6 Factory molded boots on RJ 45 plugs at both ends • compliance with Cat 6 standards of ISO/IEC 11801, EIA/TIA 568, EN50173 and	Approx. 410

		UL, ETL,3P • Length – 1m/0.5m • Should have flexible Molded Boot • Phosphor Bronze, 50 micron gold plating over selected area and gold flash over remainder, over 100 micron nickel underplate • 24 AWG 7 / 32, stranded copper	
8	CAT6 UTP Patch Cord (factory crimped) - 3 mtrs	• Factory crimped Cat6 patch cord • Should conform or exceed the EIA/TIA 568 B standards for CAT 6 Factory molded boots on RJ 45 plugs at both ends • compliance with Cat 6 standards of ISO/IEC 11801, EIA/TIA 568, EN50173 and UL, ETL,3P • Length - 3mtrs • Should have flexible Molded Boot • Phosphor Bronze, 50 micron gold plating over selected area and gold flash over remainder, over 100 micron nickel underplate • 24 AWG 7 / 32, stranded copper	Approx. 250 Nos
9	Angular Face Plate with Cat-6 Keystone I/O – Single/Double Socket with wall/back box	• Shuttered flush mount wall plate to hold Keystone jack Cat 6 modules • Screw cap design for better looking fronts • Suitable for use with all RJ45 installations including CAT 5, CAT 5e and CAT 6. • Single wall plate, fits on to a single gang wall box and has space for one/two RJ45 sockets. • The Face Plate should have a	Approx.250 Nos

		icon symbol for Data/Voice. • It should have Angular Entry type. • Single Gang • Moulded PVC-U • Tough shatter resistant PVC • Designed for ease of use • Uncluttered internal design • Cat 6 Keystone Jack (Female RJ45 Jack) • Cat 6 Keystone Jack should bend limiting wire retainer. • Performance to met TIA/EIA-568-B.2-1 specifications • 750 mating cycles • 200 termination cycles • Jack contacts - Phosphorous bronze, plated with 1.27micro-meter thick gold	
10	Cat 6 500/600 MHz UTP Cable (preference will be given to 600MHz)	• 4 Pair Twisted Cable • Support for Fast and Gigabit Ethernet, IEEE 802.3/5/12, Voice, ISDN, ATM 155 & 622Mbps. • Physical Specification : • Conductor : 23 AWG Annealed bare solid copper • Insulation : High Density Polyethylene • Core Colour : Pair 1 : White - Blue, Pair 2 : White - Orange, Pair 3 : White - Green,Pair 4 : White - Brown • Sheath : Fire Retardant PVC Compound (FRPVC) • Should be Tested upto 500/ 600Mhz • 4 twisted pairs separated by internal X shaped, 4 channel, polymer spine / full separator. Half will not be accepted. • Approx. Cable OD : 6.2 mm	11, 000 mtrs approx. Actuals may vary

		• Operating Environment : Indoor • Flame Rating : 60 deg.C As per UL 1685 CM • Electrical Specification : (at 250 MHz) • Standards : TIA / EIA 568 B.2-1 • Impedance : 100Ohms +/- 4% • (NVP) Velocity of Propagation : 62.10% min. @ 250 MHz Approx • Delay Skew : 45 ns /100 mtrs. max. @ 20 deg. C, for 1 MHz~250 MHz Approx. • Propagation Delay : <=536 ns / 100 mtrs. max. @ 20 deg. C, @ 250 MHz • DC Resistance: <= 9.38 ohm / 100 mtrs. max. @ 20 deg. C • Mutual Capacitance: 5.60 nF / 100 mtrs. max. Approx	
11	Fiber Cable	• 6 Core • Single Mode Fiber to support 1310 nm & 1550 nm wavelengths, 9/125 micron graded index, anti rodent, fiber should be protected inside jelly filled loose tube armoring with acrylic coated good quality steel, should conform or exceed the EIA/TIA 455, EIA/TIA 568 , ISO 11801 & ICEA-640 standards for Fiber and cable performance specifications. • Attenuation : not more than 0.38 dB/km at 1310 nm and 0.25 dB/km at 1550 nm using ITU 652D fiber core • The Single Mode Fiber cores should be Low Water Peak. • Different tube colour coded for easy identification.	Approx. 1000 Mtrs

		• ECCS armour followed by a HDPE jacket, UL Compliant. Over the armour, water blocking powder applied for water tight cable. Optical characteristics Parameter / Unit / specification 1. Cladding Diameter / µm / 125.0 ± 1.0 2. Cladding Non-Circularity / % / ≤ 1.0% 3. Coated Fiber Diameter / µm / 235 to 255 4. Core/Cladding Concentricity Error / µm / ≤ 0.8 5. Mode Field Diameter / µm / 9.3 ± 0.5 @ 1310 nm 6. Coating/cladding concentricity error / µm / ≤ 12 7. Minimum Proof Strength Strain / GPa% / 0.70 (100 kpsi) 8. Fiber Curl / M / > 4 9. Zero-Dispersion Wavelength / Nm / 1300 to 1324 10. Zero-Dispersion Slope / ps/nm2-km / ≤ 0.092 11. Maximum Dispersion / ps/nm-km 1285-1330 / ≤ 3.5 1550 nm / ≤ 18 12. Polarization Mode / ps/√km / ≤ 0.2 Dispersion Coefficient / @ 1310 nm & 1550 nm 13. Fiber Macrobend / dB / ≤ 0.05@ 1310 nm (100 turns. 60 mm dia.) / ≤ 0.10@ 1550 nm 14. Fiber Macrobend / dB / ≤ 0.5 @ @ 1550 nm. (1 turn @ 32 mm diameter) 15. Coating Strip Force / N / 1.3 ≤ F ≤ 8.9 16. Dynamic Tensile Strength /	

		Kpsi / Unaged :>550 (3.8 GPa) Aged :>440 (3.0 GPa)	
12	Fiber Patch Cord SC-SC	• SC to SC • 9/125 micron SM fiber • Duplex • 3 meter in length	22 Nos Approx.
13	UPS Power cabling from NOC to 8 switches and inside NOC (Phase, Neutral & Earth)	Electrical wire spec • High quality online annealing (higher than the specified values as per IS 694) • Fire Retardant • 99.97% pure copper • High ageing property • High Oxygen index • ISO 9001 company • Low Resistance • 3 layer insulation • ISI Marked • 2.5 sq. mm. • Number & nominal dia.of wire No. /mm - 36/0.3 • Resistance (Max.) per km. @ 20°C in Ohms - 7.41 • Nominal thickness of insulation in mm - 0.8 Powder coated sheet metal boxes containing one ISI marked 15A socket & one switch	Apporx. 15 end points Apporx. 900 mtrs
14.1	Voice cabling Color coded each wire twisted with its mate wire to form a pair and each such pair twisted with respect to all other pairs in concentric layer milinex taped with 30% overlap and then sheathed with ripcord	• 0.5 mm diameter solid annealed, high conductivity bare copper conductor • Tinted preferred • Insulated with special grade high-density polyethylene with different colours. • Low Attenuation • Low Crosstalk • Fire Retardant Jacket with high oxygen and temperature index • Nylon rip cord • Conductor Resistance (max.)	2 Pair – Approx. 6000 mtr 50 Pair – Approx. 450 mtr

		ohms/km at 20^0C - 92.20 • Mutual Capacitance (max.) nf/km - 50 • Insulation Resistance in Air (min.) M-ohms/km - 10,000 • Capacitance Unbalance Pair to Pair (max.) pF/km - 250 • Conform to ITD specifications G/WIR-06/02, May 94	
14.2	RJ 11 Faceplate with Back box	• Product of reputed company with ISO 9000 certified & CE certification by CSA • CSA approved in accordance with IEC standards. • ISI Marked	130 Nos
14.3	Main distribution frame box with backmount frame	Product of Internationally renowned brand	200 pair – 2 Nos 50 pair – 6 Nos
14.4	Disconnection module 2/10	Product of Internationally renowned brand	50 Nos

Special Terms & Conditions

1. **A single System Integrator will only be preferred to carry out the supply of materials and installation.**
2. **Only a "single brand" will be preferred for all components in data cabling (copper/fiber) except racks and voice cabling & electrical cabling.**
3. Manufacturer Authorization Form should be provided for products quoted.
4. OEM Certified Technical Data Sheet should be enclosed for products quoted.
5. System Integrator must be ISO certified (ISO 9001) and in business for the last 5 years
6. System Integrator should have at least one registered office with sufficient engineers in Kerala State.
7. System Integrator must have completed similar projects at Govt/Public sector. Relevant documents of the same should be attached
8. Specify laying charges for UTP Cable, OFC, Electrical wires, Voice cables, Pipes/Capping Casing etc
9. Specify fixing charges for IOs, RJ45 Jack Panels, Racks, LIU, Main distribution frame box etc
10. Specify charges for SC Connectorisation, earthing etc
11. Specify if any other charges to be met
12. UTP data cables should be laid at minimum **ONE foot apart** from parallel electrical cables wherever applicable.
13. UTP cables should be laid in ISI marked capping casing
14. Electrical cables should be laid in ISI marked pipes
15. For inter-floor connections ISI marked water PVC pipes/HDPE should be used and floor damages should not be left as such and should be water proof cemented wherever applicable
16. Pipes/capping casing should be fire retardant low smoke(FRLS) - Legrand, Precision, National Pipes or similar
17. Cabling through the passages/stairways should make use of properly earthed cable managers/Trays
18. For voice cabling - Finolex, Delton or similar

19. For racks – APW President, NetRack, Rittel or similar
20. For rest of the data network components – AMP, Systimax, Panduit or similar
21. For electrical wiring – VGuard, Finolex or similar
22. For electrical accessories, RJ11 faceplate – ROMA, Anchor or similar
23. For main distribution frame box with backmount frame & disconnection module, AMP or similar
24. Brands of the components quoted should be clearly specified
25. 25 Years of warranty is required on parts and performance on installed networks for copper and fiber. (Item no. 5,6,9,10,11 & termination/ connectorisation of copper/fiber). If any faults reported, the same should be rectified within next two business days
26. UTP & its termination should pass the tests as per Annexure I in the presence of college authorized personnel. Test reports should be submitted in both soft copy and hard copy.
27. OF & its termination should pass the tests as per Annexure II in the presence of college authorized personnel. Test reports should be submitted in both soft copy and hard copy.
28. Detailed diagrams of the work carried out for voice, data & electrical should be submitted in soft copy and hard copy.
29. **Five years maintenance contract for Fiber and related components to rectify any faults within next two business days.**
30. Products may be quoted as per specifications mentioned in Table 1.

➔ For more details, please contact HOD, Computer Science & Engineering Department or HOD, Department of Information Technology.

➔ Kindly furnish the enclosed check list also.

Annexure I

Cat 6 Installation: field test requirements

A. General Requirements

1. Every cabling link in the installation shall be tested for:
    a. Wire Map
    b. Length
    c. Insertion Loss
    d. NEXT Loss
    e. PS NEXT Loss
    f. ACR-F Loss
    g. PS ACR-F Loss
    h. Return Loss
    i. Propagation Delay
    j. Delay Skew

    in accordance with the field test specifications defined in ANSI/TIA-568-C.2 "*Commercial Balanced Twisted-Pair Telecommunications Cabling and Components Standard*". This document will be referred to as the "Category 6 Standard."
2. The installed twisted-pair horizontal links shall be tested from the IDF in the telecommunications room to the telecommunication wall outlet in the work area for compliance with the "*Permanent Link*" performance specification as defined in the Category 6 Standard.
3. One hundred percent of the installed cabling links must pass the requirements of the Category 6 Standard mentioned in A.1 above and as further detailed in Section B. 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 in accordance with Section C below.
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).
5. The test equipment (tester) shall comply with the accuracy requirements for level III field testers as defined in ANSI/TIA-1152. 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 3 of ANSI/TIA-1152 (Table 3 in this TIA document also specifies the accuracy requirements for the Channel configuration).
6. The RJ45 test plug shall fall within the values specified in ANSI/TIA-568-C Annex C for NEXT, FEXT and Return Loss.
7. The tester shall be within the calibration period recommended by the vendor in order to achieve the vendor-specified measurement accuracy.

8. The tester interface adapters must be of high quality and the cable shall not show any twisting or kinking resulting from coiling and storing of the tester interface adapters. In order to deliver optimum accuracy, preference is given to a permanent link interface adapter for the tester that can be calibrated to extend the reference plane of the Return Loss measurement to the permanent link interface. The contractor shall provide proof that the interface has been calibrated within the period recommended by the vendor. To ensure that normal handling on the job does not cause measurable Return Loss change, the adapter cord cable shall not be of twisted-pair construction.
9. The Pass or Fail condition for the link-under-test is determined by the results of the required individual tests (detailed in Section 4.2.2 of ANSI/TIA-1152). 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*.
10. 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. To which extent '*' results shall determine approval or disapproval of the element under test shall be defined in the relevant detail specification, or agreed on as a part of a contractual specification.

Optional Requirements:

11. A representative of the end-user shall be invited to witness field testing. The representative shall be notified of the start date of the testing phase five business days before testing commences.
12. A representative of the end-user will select a random sample of 5% of the installed links. The representative (or his authorized delegate) shall test these randomly selected links and the results are to be stored in accordance with the prescriptions in Section I.C. The results obtained shall be compared to the data provided by the installation contractor. If more than 2% of the sample results differ in terms of the pass/fail determination, the installation contractor under supervision of the end-user representative shall repeat 100% testing and the cost shall be borne by the installation contractor.

B. Performance Test Parameters

The test parameters are defined in the Category 6 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**
   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 Category 6 Standard as shown in Table 1. . 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.

Table 1 -- Maximum frequency step size as defined in ANSI/TIA-1152

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

5. **PS NEXT 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). PS NEXT 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 Category 6 Standard as shown in Table 1. 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 PS NEXT. 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. **ACR-F Loss, pair-to-pair**
   Attenuation Crosstalk Ratio Far-end is calculated from the pair-to-pair FEXT Loss. It 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 ACR-F Loss that must be evaluated and reported in the test results. ACR-F 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. ACR-F 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. 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-F. 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. **PS ACR-F Loss**
   Power Sum Attenuation Crosstalk Ratio Far-end 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. 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 form 1 through 250 MHz in frequency increments that do not exceed the maximum step size defined in the Category 6 Standard as shown in Table 1. 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. **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.

10. **Delay Skew** [as defined in the Category 6 Standard; Section 6.2.19] 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.

C. Test Result Documentation

1. The test results/measurements 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.
2. 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.
3. A paper copy of the test results shall be provided that lists all the links that have been tested with the following summary information
    a. The identification of the link in accordance with the naming convention defined in the overall system documentation
    b. The overall Pass/Fail evaluation of the link-under-test including the NEXT Headroom (overall worst case) number
    c. The date and time the test results were saved in the memory of the tester.
4. General Information to be provided in the electronic data base with the test results information for each link:
    a. The identification of the customer site as specified by the end-user
    b. The identification of the link in accordance with the naming convention defined in the overall system documentation
    c. The overall Pass/Fail evaluation of the link-under-test
    d. The name of the test limit selected to execute the stored test results
    e. The cable type and the value of NVP used for length calculations
    f. The date and time the test results were saved in the memory of the tester
    g. The brand name, model and serial number of the tester
    h. The identification of the tester interface
    i. The revision of the tester software and the revision of the test limits database in the tester
    j. The test results information must contain information on each of the required test parameters that are listed in Section B and as further detailed below under paragraph C5.

5. The detailed test results data to be provided in the electronic database for must contain the following information:

   For each of the frequency-dependent test parameters, the value measured at every frequency during the test is stored. 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.

   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

   Insertion Loss (Attenuation): Minimum test results documentation as explained in Section B for the worst pair

   Return Loss: Minimum test results documentation as explained in Section B for the worst pair as measured from each end of the link

   NEXT, ACR-F: Minimum test results documentation as explained in Section B for the worst pair combination as measured from each end of the link

   PS NEXT and PS ACR-F: Minimum test results documentation as explained in Section B for the worst pair as measured from each end of the link

1: Nominal Velocity of Propagation (NVP) expresses the speed of the electrical signals along the cabling link in relation to the speed of light in vacuum ($3x10^8$ m/second). Insulation characteristics and twist rate of the wire pair influence NVP in minor ways. Typically, an 'average' value for NVP is published for all four wire-pairs in a data cable.

*2: 'Margin' designates the difference between the measured value and the corresponding test limit value. For passing links, 'worst case margin' identifies the **smallest** margin over the entire frequency range; the point at which the measured performance is "closest" to the test limit.*

Annexure II

TESTING, IDENTIFICATION AND ADMINISTRATION OF FIBER INFRASTRUCTURE

PART 1 - GENERAL

1.1 WORK INCLUDED

A. 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.

B. In order to conform to the overall project event schedule, the cabling contractor shall survey the work areas and coordinate cabling testing with other applicable trades.

C. 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.

1.2 SCOPE

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

B. This Section includes minimum requirements for:

1. Fiber optic test instruments
2. Fiber optic testing
3. Identification
    a) Labels and labeling
4. Administration
    a) Test results documentation
    b) As-built drawings

C. Testing shall be carried out in accordance with this document. This includes testing the attenuation and polarity of the installed cable plant with an optical loss test set (OLTS) and the installed condition of the cabling system and its components with an optical time domain reflectometer (OTDR). The condition of the fiber endfaces shall also be verified.

D. Testing shall be performed on each cabling link (connector to connector).

E. Testing shall be performed on each cabling channel (equipment to equipment) that is identified by the owner.

1. 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.

F. All tests shall be documented including OLTS dual wavelength attenuation measurements for multimode and singlemode links and channels and OTDR traces and event tables for multimode and singlemode links and channels.

1. Optionally documentation shall also include optical length measurements and pictures of the connector endface.

1.3 QUALITY ASSURANCE

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

1. ANSI Z136.2, ANS For Safe Use Of Optical Fiber Communication Systems Utilizing Laser Diode And LED Sources
2. ANSI/EIA/TIA-455-50B, Light Launch Conditions For Long-Length Graded-Index Optical Fiber Spectral Attenuation Measurements
3. ANSI/TIA/EIA-455-59A, Measurement of Fiber Point Discontinuities Using an OTDR.
4. ANSI/TIA/EIA-455-60A, Measurement of Fiber or Cable Length Using an OTDR.
5. ANSI/TIA/EIA-455-61A, Measurement of Fiber or Cable Attenuation Using an OTDR.
6. ANSI/TIA/EIA-526-7, Optical Power Loss Measurements of Installed Singlemode Fiber Cable Plant.
7. ANSI/TIA/EIA-526-14-A, Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant.
8. ANSI/TIA-568-C.0, Generic Telecommunications Cabling for Customer Premises.
9. ANSI/TIA-568-C.3, Optical Fiber Cabling Components Standard.
10. ANSI/TIA/EIA-606-A, Administration Standard for Commercial Telecommunications Infrastructure, including the requirements specified by the customer, unless the customer specifies their own labeling requirements.

B. 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:

1. Manufacturer of the fiber optic cable and/or the fiber optic connectors.

2. Manufacturer of the test equipment used for the field certification.

3. Training organizations (e.g., BICSI, A Telecommunications Association headquarters in Tampa, Florida; ACP [Association of Cabling Professionals™] Cabling Business Institute located in Dallas, Texas)

C. The Owner or the Owner's representative shall be invited to witness and/or review field-testing.

1. The Owner or the Owner's representative shall be notified of the start date of the testing phase five (5) business days before testing commences.

2. The Owner or the Owner's representative will select a random sample of 5% of the installed links. The Owner or the Owner's representative shall test these randomly selected links and the results are to be stored in accordance with Part 3 of this document. The results obtained shall be compared to the data provided by the installation contractor. If more than 2% of the sample results differ in terms of the pass/fail determination, the installation contractor under supervision of the representative shall repeat 100% testing at no cost to the Owner.

1.4 SUBMITTALS

A. Manufacturers catalog sheets and specifications for fiber optic field-test instruments including optical loss test sets (OLTS; power meter and source), optical time domain reflectometer (OTDR) and inspection scope.

B. A schedule (list) of all optical fibers to be tested.

C. Sample test reports.

1.5 ACCEPTANCE OF TEST RESULTS

A. Unless otherwise specified by the Owner or the Owners representative, each cabling link shall be in compliance with the following test limits:

1. Optical loss testing

a) Multimode and Singlemode links

1) The link attenuation shall be calculated by the following formulas as specified in ANSI/TIA-568-C.0.

(i) Link Attenuation (dB) = Cable_Attn (dB) + Connector_Attn (dB) + Splice_Attn (dB)

(ii) Cable_Attn (dB) = Attenuation_Coefficient (dB/km) * Length (Km)

(iii) Connector_Attn (dB) = number_of_connector_pairs * connector_loss (dB)

(iv) Maximum allowable connector_loss = 0.75 dB

(v) Splice_Attn (dB) = number_of_splices * splice_loss (dB)

(vi) Maximum allowable splice_loss = 0.3 dB

(vii) 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

2. OTDR testing
   a) Reflective events (connections) shall not exceed 0.75 dB.
   b) Non-reflective events (splices) shall not exceed 0.3 dB.
3. Magnified endface inspection
   a) Fiber connections shall be visually inspected for endface quality.
   b) Scratched, pitted or dirty connectors shall be diagnosed and corrected.

B. All installed cabling links and channels shall be field-tested and pass the test requirements and analysis as described in Part 3. 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 in accordance with Part 3.

C. Acceptance of the test results shall be given in writing after the project is fully completed and tested in accordance with Contract Documents and to the satisfaction of the Owner.

Note: High Bandwidth applications such as 1000BASE-SX, 10GBASE-S, and FC1200 impose stringent channel loss limits. Where practical, certification should consider loss length limits that meet maximum channel (transmitter to receiver) loss.

Performance specification for MM fiber at 850 nm

Fiber Type		Bandwidth	1000BASE-SX		10GBASE-SR		FibreChannel 1200-MX-SN-I	
	µm	(MHz• Km)	Length (m)	Loss (dB)	Length (m)	Loss (dB)	Length (m)	Loss (dB)

OM 1	62.5	200	275	2.38	33	2.5	33	2.4
OM 2	50	500	550	3.56	82	2.3	82	2.2
OM 3	50	2000	1000	3.56	300	2.6	300	2.6

PART 2 - PRODUCTS

2.1 OPTICAL FIBER CABLE TESTERS

A. The field-test instrument shall be within the calibration period recommended by the manufacturer.

B. Optical loss test set (OLTS)

1. Multimode optical fiber light source

a) Provide dual LED light sources with central wavelengths of 850 nm (± 30 nm) and 1300 nm (± 20 nm)

b) Output power of –20 dBm minimum.

c) The light source shall meet the launch requirements of ANSI/EIA/TIA-455-50B, Method A. This launch condition can be achieved either within the field test equipment or by use of an external mandrel wrap (as described in clause E.7 of ANSI/TIA-568-C.0) with a Category 1 light source.

2. Singlemode optical fiber light source

a) Provide dual laser light sources with central wavelengths of 1310 nm (± 20 nm) and 1550 nm (± 20 nm).

b) Output power of –10 dBm minimum.

3. Power Meter

a) Provide 850 nm, 1300/1310 nm, and 1550 nm wavelength test capability.

b) Power measurement uncertainty of ± 0.25 dB.

c) Store reference power measurement.

d) Save at least 100 results in internal memory.

e) PC interface (serial or USB).

4. Optional length measurement

a) It is preferable to use an OLTS that is capable of measuring the optical length of the fiber using time-of-flight techniques.

C. Optical Time Domain Reflectometer (OTDR)

1. Serial and USB ports to transfer data to a PC.

2. Multimode OTDR

a) Wavelengths of 850 nm (± 20 nm) and 1300 nm (± 20 nm).

b) Event deadzones of 3.7 m maximum at 850 nm and 1300 nm.

c) Attenuation deadzones of 10 m maximum at 850 nm and 13 m maximum at 1300 nm.

d) Distance range not less than 2000 m.

e) Dynamic range at least 10 dB at 850 nm and 1300 nm

3. Singlemode OTDR

a) Wavelengths of 1310 nm (± 20 nm) and 1550 nm (± 20 nm).

b) Event deadzones of 3.5 m maximum at 1310 nm and 1550 nm.

c) Attenuation deadzones of 10 m maximum at 1310 nm and 12 m maximum at 1550 nm.

d) Dynamic range at least 10 dB at 1310 nm and 1550 nm

D. Fiber Microscope

1. Magnification of 200X or 400X for endface inspection

2. Optional requirements

a) Video camera systems are preferred.

b) Camera probe tips that permit inspection through adapters are preferred.

c) It is preferable to use test equipment capable of saving and reporting the endface image.

E. Integrated OLTS, OTDR and fiber microscope

1. Test equipment that combines into one instrument an OLTS, an OTDR and a fiber microscope may be used.

2.2 IDENTIFICATION

A. Labels

1. Shall meet the legibility, defacement, exposure and adhesion requirements of UL 969.

2. Shall be preprinted using a mechanical means of printing (e.g., laser printer).

3. Where used for cable marking, provide vinyl substrate with a white printing area and a clear “tail” that self laminates the printed area when wrapped around the cable. If cable jacket is white, provide cable label with printing area that is any other color than white, preferably orange or yellow – so that the labels are easily distinguishable.

4. Where insert type labels are used provide clear plastic cover over label.

5. Provide plastic warning tape 6 inches wide continuously printed and bright colored 18” above all direct buried services, underground conduits and duct-banks.

2.3 ADMINISTRATION

A. Administration of the documentation shall include test results of each fiber link and channel.

B. The test result information for each link shall be recorded in the memory of the field-test instrument upon completion of the test.

C. The test result records saved within the field-test instrument shall be transferred into a Windows™-based database utility that allows for the maintenance, inspection and archiving of these test records.

PART 3 – EXECUTION

3.1 GENERAL

A. 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.

B. 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.

3.2 OPTICAL FIBER CABLE TESTING

A. Field-test instruments shall have the latest software and firmware installed.

B. 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.

C. Fiber endfaces shall be inspected at 200X or 400X magnification. 200X magnification is suitable for inspecting multimode and singlemode fibers. 400X magnification may be used for detailed examination of singlemode fibers. Scratched, pitted or dirty connectors shall be diagnosed and corrected.

1. It is preferable that the endface images be recorded in the memory of the test instrument for subsequent uploading to a PC and reporting.

D. Testing shall be performed on each cabling segment (connector to connector).

E. Testing shall be performed on each cabling channel (equipment to equipment) that is planned for use per the owner’s instructions.

F. 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.

G. Optical loss testing

1. Backbone link

a) 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.

b) Singlemode 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.

c) 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.

d) 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.

H. OTDR Testing

1. Fiber links shall be tested at the appropriate operating wavelengths for anomalies and to ensure uniformity of cable attenuation and connector insertion loss.

a) Multimode: 850 nm and 1300 nm

b) Singlemode: 1310 nm and 1550 nm

2. Each fiber link and channel shall be tested in both directions.

3. A launch cable shall be installed between the OTDR and the first link connection.

4. A receive cable shall be installed after the last link connection.

I. Magnified Endface Inspection

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

J. 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.

K. Polarity Testing

1. Paired duplex fibers in multi-fiber cables shall be tested to verify polarity in accordance with Clause E.5.3 of ANSI/TIA-568-C.0. The polarity of the paired duplex fibers shall be verified using an OLTS.

3.3 IDENTIFICATION

A. Labeling

1. Labeling shall conform to the requirements specified within ANSI/TIA/EIA-606-A or to the requirements specified by the Owner or the Owner's representative.

3.4 ADMINISTRATION

A. Test results documentation

1. Test results saved within the field-test instrument shall be transferred into a Windows™-based database utility that allows for the maintenance, inspection and archiving of the test records. These test records shall be uploaded to the PC unaltered, i.e., "as saved in the field-test instrument". The file format, CSV (comma separated value), does not provide adequate protection of these records and shall not be used.

2. The test results documentation shall be available for inspection by the Owner or the Owner's representative during the installation period and shall be passed to the Owner's representative within 5 working days of completion of tests on cabling served by a telecommunications room or of backbone cabling. The installer shall retain a copy to aid preparation of as-built information.

3. The database for the complete project, including twisted-pair copper cabling links, if applicable, shall be stored and delivered on CD-ROM prior to Owner acceptance of the building. This CD-ROM shall include the software tools required to view, inspect, and print any selection of the test reports.

4. Circuit IDs reported by the test instrument should match the specified label ID (see 3 of this Section).

5. The detailed test results documentation data is to be provided in an electronic database for each tested optical fiber and shall contain the following information

a) The identification of the customer site as specified by the end-user

b) The name of the test limit selected to execute the stored test results

c) The name of the personnel performing the test

d) The date and time the test results were saved in the memory of the tester

e) The manufacturer, model and serial number of the field-test instrument

f) The version of the test software and the version of the test limit database held within the test instrument

g) The fiber identification number

h) The length for each optical fiber

1) Optionally the index of refraction used for length calculation when using a length capable OLTS

i) Test results to include OLTS attenuation link and channel measurements at the appropriate wavelength(s) and the margin (difference between the measured attenuation and the test limit value).

j) Test results to include OTDR link and channel traces and event tables at the appropriate wavelength(s).

k) The length for each optical fiber as calculated by the OTDR.

l) The overall Pass/Fail evaluation of the link-under-test for OLTS and OTDR measurements

m) Optional

1) A picture or image of each fiber end-face

2) A pass/fail status of the end-face based upon visual inspection.

B. Record copy and as-built drawings

1. Provide record copy drawings periodically through out the project as requested by the Construction Manager or Owner, and at end of the project on CD-ROM. Record copy drawings at the end of the project shall be in CAD format and include notations reflecting the as built conditions of any additions to or variation from the drawings provided such as, but not limited to cable paths and termination point. CAD drawings are to incorporate test data imported from the test instruments.

2. The as-built drawings shall include, but are not limited to block diagrams, frame and cable labeling, cable termination points, equipment room layouts and frame installation details. The as-builts shall include all field changes made up to construction completion:

a) Field directed changes to pull schedule.

b) Field directed changes to cross connect and patching schedule.

c) Horizontal cable routing changes.

d) Backbone cable routing or location changes.

e) Associated detail drawings.