SECTION 17045
TELECOMMUNICATIONS TESTING AND DOCUMENTATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Facilities Management Design and Construction Guide, apply to this Section.

B. When included as a part of this specification, the following contain related requirements:

1. Division 16 Section “General Electrical Requirements”.
2. Division 16 Section “Basic Electrical Materials and Methods”.
3. Division 17 Section “General Telecommunications Infrastructure Requirements”.
4. Division 17 Section “Equipment Rooms, Telecommunications Rooms, and Service Entrances”.
5. Division 17 Section “Backbone Cabling”.
6. Division 17 Section “Horizontal Cabling”.
7. Division 17 Section “Customer-Owner Outside Plant”.
8. Division 17 Section “Telecommunications Labeling”.

1.2 SUMMARY

A. This Section includes testing and documentation for wiring systems to be used as signal pathways for voice and high-speed data transmission.

1.3 DEFINITIONS

A. Telecommunications Cables: Term includes horizontal copper, copper riser, optical and coaxial cabling.

1.4 SUBMITTALS

A. Field quality-control test reports.

B. Construction record drawings.

1.5 QUALITY ASSURANCE


PART 2 - PRODUCTS

2.1 APPROVED TEST EQUIPMENT MANUFACTURERS

A. Horizontal Copper Test Equipment:
   1. Agilent Technologies.
   2. Fluke.
   3. Ideal Industries.

B. Fiber Optic Test Equipment:
   1. Agilent Technologies.
   2. Alcoa Fujikura.
   3. Corning Cable Systems.
   4. Fluke.
   5. Ideal Industries.

C. Coaxial Cable Testers:
   1. Leader.
   2. Fluke.
   3. Ideal.

PART 3 - EXECUTION

3.1 GENERAL TESTING REQUIREMENTS

A. Install and terminate cables prior to testing.

B. Rerterminate and retest cables which fail.

C. Replace cables which fail the second test.

D. Utilize cable testing equipment capable of generating a report for each cable tested. Provide a hard copy report per TIA/EIA-568-B.

E. Provide certification reports printed on 8-1/2 inch x 11 inch sheets. Provide one or more three-ring binders as required to contain reports. Provide a separate tab for each group of cables served from a common communication room. Provide an additional tab for backbone cables. Present cable testing results in a matrix format.
F. Perform Operational Test: After installation of cables and connectors, demonstrate product capability and compliance with requirements. Test each signal path for end-to-end performance from each end of all pairs installed. Remove temporary connections when tests have been satisfactorily completed.

G. Inspect for physical damage and test each conductor signal path for continuity and shorts. Test for faulty connectors, splices, and terminations.

3.2 COPPER HORIZONTAL CABLE TESTING

A. Test horizontal cables from the punch-down blocks, patch panels, or other termination equipment, to the jacks unless otherwise noted.

B. Test horizontal cables from punch-down block to punch-down block.

C. Field Test Requirements for a Category 6 Balanced Twisted-Pair Cabling System:

1. General Requirements:
   a. Test every cabling link in the installation in accordance with the Telecommunications Industry Association (TIA) Standard ANSI/TIA/EIA-568B, 100-Ohm Twisted-Pair Transmission Performance and Field Test Requirements.
   b. The installed twisted-pair horizontal links shall be tested from the IDF in the telecommunications room to the telecommunications wall outlet in the work area against the “Permanent Link” performance limits specification as defined in ANSI/TIA/EIA-568-B.
   c. Test 100 percent of the installed cabling links. All cable links must pass the requirements of the standards mentioned above and as further detailed below. Any failing link shall be diagnosed and corrected. Follow corrective action with a new test to prove the corrected link meets the performance requirements. Provide the final and passing result of the tests for all links in the test results documentation as specified below.
   d. Tests must be performed by trained technicians who have successfully attended an appropriate training program and have obtained a certificate as proof thereof. Appropriate training programs include, but are not limited to, installation certification programs provided by BICSI or the ACP (Association of Cabling Professionals).
   e. The test equipment (tester) must comply with or exceed the accuracy requirements for the 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.
   f. The tester must be within the calibration period recommended by the manufacturer in order to achieve the manufacturer-specified measurement accuracy.
   g. The tester interface adapters must be of high quality and the cable must not show any twisting or kinking resulting from coiling and storing of the tester interface adapters. Provide proof that the interface has been calibrated within the period recommended by the manufacturer.
   h. Determine the Pass or Fail condition for the link-under-test by the results of the required individual tests as detailed below. 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*.
   i. Determine a Pass or Fail result for each parameter by comparing the measured values with the specified test limits for that parameter. Mark
with an asterisk (*) the test result of a parameter when the result is closer to the test limit than the accuracy of the field tester. Provide documentation as an aid to interpret results marked with asterisks.

2. Performance Test Parameters:
   a. Test all horizontal copper station cables for Category 6 according to the parameters set for in the TIA/EIA-568-B Standard. The test of each Category 6 link must contain the following parameters as detailed below. In order to pass the link 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 Category 6 standard.
   b. Perform the following tests as defined in TIA/EIA-568-B: Wire map, length, insertion loss (attenuation), NEXT loss, pair-to-pair PSNEXT loss, ELFEXT loss, pair-to-pair PSELFEXT loss, return loss, ACR, PSACR, propagation delay and delay skew.

3. Test Result Documentation:
   a. Record the test results information for each link in the memory of the field tester upon completion of the test.
   b. Transfer the test results records saved by the tester into a Windows™-based database utility that allows for the maintenance, inspection and archiving of these test records. Guarantee 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.
   c. Store and deliver the database for the completed job on CD-ROM including the software tools required to review, inspect, and print any selection of test reports.
   d. Provide a paper copy of the test results that lists all the links that have been tested with the following summary information:
      1) The identification of the link in accordance with the naming convention defined in the overall system documentation.
      2) The overall Pass/Fail evaluation of the link-under-test including the NEXT Headroom (overall worst case) number.
      3) The date and time the rest results were saved in the memory of the tester.
   e. Provide the following general information in the electronic database with the test results information for each link:
      1) The identification of the project site as specified by the end-user.
      2) The identification of the link in accordance with the naming convention defined in the overall system documentation.
      3) The overall Pass/Fail evaluation of the link-under-test.
      4) The name of the standard selected to execute the stored test results.
      5) The cable type and the value of NVP used for length calculations.
      6) The date and time the rest results were saved in the memory of the tester.
      7) The brand name, model, and serial number of the tester.
      8) The identification of the tester interface.
9) The revision of the tester software and the revision of the test standards database in the tester.

10) The test results information must contain information on each of the required test parameters that are listed above and as further detailed below.

f. The detailed test results data to be provided in the electronic database for each tested link must contain the results obtained for each parameter in accordance with the description above. 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 shall also provide and print the summary numeric information for each test parameter as defined and prescribed by the TIA/EIA-568-B Standard document.

3.3 CATEGORY 5E RISER CABLE TESTING

A. Test for continuity and wire map.

3.4 OPTICAL FIBER TESTING

A. General Requirements:

1. Test every fiber optic cabling link in the installation in accordance with the field test specifications defined by the Telecommunications Industry Association (TIA standard ANSI/TIA/EIA-568-B or by the appropriate network application standard(s)) whichever is more demanding. See paragraph “Performance Test Parameters” in this Section.

2. ANSI/TIA/EIA-568-B defines the passive cabling network to include cable, connectors, and splices (if present) between two optical fiber patch panels (connecting hardware). A typical horizontal link segment is from the telecommunications outlet/connector to the horizontal cross-connect. This TIA document describes three typical backbone link segments: (1) main cross-connect to intermediate cross-connect, (2) main cross-connect to horizontal cross-connect, or (3) intermediate cross-connect to horizontal cross-connect. The test must include the representative connector performance at the connecting hardware associated with the mating of patch cords. The test does not, however, include the performance of the connector at the interface with the test equipment.

3. Test 100 percent of the installed cabling links. The cable must pass the requirements of the standards mentioned above and as further detailed below. Any failing link must be diagnosed and corrected. Follow the corrective action with a new test to prove that the corrected link meets the performance requirements. Provide the final and passing result of the tests for all links in the test results documentation in accordance with this Section.

4. Trained technicians who have successfully attended an appropriate training program and have obtained a certificate as proof thereof shall execute the tests. These certificates shall have been issued by any of the following organizations or an equivalent organization:

   a. The manufacturer of the fiber optic cable and/or the fiber optic connectors.

   b. The manufacturer of the test equipment used for the field certification.

   c. Training organizations authorized by BICSI (Building Industry Consulting Services International with headquarters in Tampa, Florida) or by the ACP (Association of Cabling Professionals Cabling Business Institute located in Dallas, Texas).
5. Field test instruments for singlemode fiber cabling must meet the requirements of ANSI/EIA/TIA-526-7.

6. Calibrate the tester within the calibration period recommended by the vendor in order to achieve the vendor-specified measurement accuracy.

7. The fiber optic launch cables and adapters must be of high quality. The launch cables must not show excessive wear resulting from repetitive coiling and storing of the tester interface adapters.

8. The Pass or Fail condition for the link-under-test is determined by the results of the required individual tests.

9. A Pass or Fail result for each parameter is determined by comparing the measured values with the specified test limits for that parameter.

B. Performance Test Parameters:

1. ANSI/TIA/EIA Standard 568-B prescribes that the single performance parameter for field testing of fiber optic links is link attenuation (alternative and equivalent term: insertion loss), when installing components compliant with this standard.

2. Calculate the link attenuation by the following formulas specified in ANSI/TIA/EIA Standard 568-B:
   a. Link Attenuation = Cable Attn + Connector Attn + Splice Attn.
   b. Cable Attn (dB) = Attenuation Coefficient (dB/km) * Length (km).
   c. The values for the Attenuation Coefficient are listed below:

<table>
<thead>
<tr>
<th>Type of Optical Fiber</th>
<th>Wavelength (nm)</th>
<th>Attenuation Coefficient (dB/km)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single-mode (Inside Plant)</td>
<td>1310</td>
<td>1.5</td>
</tr>
<tr>
<td></td>
<td>1550</td>
<td>1.0</td>
</tr>
<tr>
<td>Single-mode (Outside Plant)</td>
<td>1310</td>
<td>0.5</td>
</tr>
<tr>
<td></td>
<td>1550</td>
<td>0.5</td>
</tr>
</tbody>
</table>
   
   d. Connector Attn (dB) = number of connector pairs * connector loss (dB).
   1) Maximum allowable connector loss = 0.75 dB.
   e. Splice Attn (dB) = number of splices (S) * splice loss (dB).
   1) Maximum allowable splice loss = 0.3 dB.
   f. 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.
   g. Test equipment that measures the link length and automatically calculates the link loss based on the above formulas is preferred.

3. The above link test limits attenuation are based on the use of the One Reference Jumper Method specified by ANSI/TIA/EIA-526-14A, Method B, and ANSI/TIA/EIA-526-7, Method A.1. Follow the procedures established by these standards or application notes to accurately conduct performance testing.

4. Test the singlemode backbone links at 1310 nm and 1550 nm in accordance with ANSI/TIA/EIA-526-7, Method A.1. Certify all singlemode links with test tools using laser light sources at 1310 nm and 1550 nm.
C. Test Result Documentation:

1. Record the test result information for each link in the memory of the field tester upon completion of the test.
2. Transfer the test result records saved by the tester into a Windows-based database utility that allows for the maintenance, inspection, and archiving of these test records. Guarantee these results are transferred to the PC unaltered; i.e., “as saved in the tester” at the end of each test.
   a. The popular “csv” format (comma separated value format) does not provide adequate protection and will not be acceptable.
3. Store and deliver the database for the completed job, including twisted-pair copper cabling links if applicable, on CD-ROM. Include the software tools required to view, inspect, and print any selection of test reports.
4. Provide a paper copy of the test results 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 attenuation worst case margin (margin is defined as the difference between the measured value and the test limit value).
   c. The date and time the test results were saved in the memory of the tester.
5. General information to be provided in the electronic database containing the test result information for each link:
   a. The identification of the customer site as specified by the end-user.
   b. The overall Pass/Fail evaluation of the link-under-test.
   c. The name of the standard selected to execute the stored test results.
   d. The cable type and the value of the “index of refraction” used for length calculations.
   e. The date and time the rest results were saved in the memory of the tester.
   f. The brand name, model and serial number of the tester.
   g. The revision of the tester software and the revision of the test standards database in the tester.
6. The detailed test results data to be provided in the electronic database for each tested optical fiber must contain the following information:
   a. The identification of the link/fiber in accordance with the naming convention defined in the overall system documentation.
   b. The insertion loss (attenuation) measured at each wavelength, the test limit calculated for the corresponding wavelength, and the margin (difference between the measured attenuation and the test limit value).
   c. Report the link length for each optical fiber for which the test limit was calculated based on the formulas.

END OF SECTION 17045