1 General

1.1 SHOP DRAWINGS AND PRODUCT DATA

.1 Submit shop drawings and product data in accordance with Section 26 05 01.

.2 Data shall include system components, operating instructions and wiring schematics.

1.2 RELATED WORK SPECIFIED ELSEWHERE

.1 Conduits, Conduit Fastenings and Conduit Fittings Section 26 05 34.

.2 Outlet Boxes and Fittings Section 26 05 32.

.3 Junction and Pull Boxes, Cabinets Section 26 05 31.

1.3 SYSTEM DESCRIPTION

.1 Complete communications horizontal cabling system consisting of outlet boxes, outlet jacks, cable, coverplates, conduits, pullboxes, and patch panels.

1.4 CERTIFICATION

.1 General Requirements

.1 Every cabling link in the installation shall be tested in accordance with the latest edition of Telecommunications Industry Association (TIA) standard ANSI/TIA/EIA-568. (CAT 6)

.2 The installed twisted-pair horizontal links shall be tested from the data jack at the patch panel to the data jack at the workstation against the “Permanent Link” performance limits specification as defined in the latest edition of ANSI/TIA/EIA-568. (CAT 6)

.3 100% of the installed cabling links must be tested and must pass the requirements of the standards noted above and as further detailed below. 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).

.5 The test equipment (tester) shall comply with or exceed the accuracy requirements for Level III field testers as defined in TIA-568. (CAT 6) 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 TIA/EIA-568. (CAT 6)

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

.7 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 and cord cable shall not be of twisted-pair construction. the Fluke DSP-LIA101S permanent link adapter available for the Fluke DSP-4000 Series CableAnalyzer™ is an example of a tester interface that fully complies with this requirement.

.8 The Pass or Fail condition for the link-under-test is determined by the results of the required individual tests (detailed in Section I.B). 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.

.10 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 hase 5 business days before testing commences.

.11 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.

.2 Performance Test Parameters

The test of each Category 6 link shall contain all of 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.

.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 permanent link or channel based on the propagation delay measurement and the average value for nominal velocity propagation (NVP). 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 ft) or the channel (100 meters – 328 ft) 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 0.5 MHz (500 kHz). It is preferred to measure attenuation 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: 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**

Pair-to-pair near-end crosstalk loss (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.

Minimum test result documentation: Identify the wire pair combination that exhibits the worst case NEXT margin ***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 shall include the frequency at which it occurs as well as the test limit value at this frequency.

.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 8 results). Like NEXT this test parameter must be evaluated from 1 through 250 MHz.

Minimum test result documentation: 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 shall 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 distribution 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.

Minimum test result documentation: 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 shall 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 8 wire-

pair combinations. Each wire-pair is evaluated from 1 through 250 MHz.
Minimum test result documentation: Identify the wire pair that exhibits the worst case margin and the wire pair that exhibits the worst value for PSELFEXT. These wire pairs must be identified for the tests performed from each end. Each reported case shall 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.
Minimum test result documentation: 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 shall include the frequency at which it occurs as well as the test limit value at this frequency.

.9 **ACR**

Attenuation to crosstalk ratio (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 result documentation: 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 shall include the frequency at which it occurs as well as the test limit value at this frequency.

.10 **PSACR**

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 8 combinations – one for each wire pair from both ends of the link.
Minimum test result documentation: 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 shall 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 result documentation: 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**

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 result documentation: 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.

.3 Test Result Documentation

.1 The test results information for each link shall be recorded in the memory of the field tester 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.

.3 The database for the completed job shall be stored and delivered on CD-ROM including the software tools required to view, inspect, and print any selection of test reports.

.4 A paper copy and an electronic copy (CD disk) 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

The CD disk shall be complete with a typewritten label indicating Data Test Results, Project Name, Date of Test.

.5 General Information to be provided in the electronic data base with the test results information for each link:

a) The identification of the project

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 standard 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 standards database in the tester

.6 The detailed test results data to be provided in the electronic database for each tested link must contain the following information:

a) For each of the frequency-dependent test parameters, the minimum test results documentation shall be stored for each wire-pair or wire-pair combination as observed from each end of the link.

Length: Identify the wire-pair with the shortest electrical length, the value of the length rounded to the nearest 0.5 m 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 for the wire pair with the worst insertion loss

Return Loss: Minimum test results documentation. Identify as detected from each end of the link, the wire pair that exhibits the worst case margin and the wire pair with the worst RL. Each reported case shall include the frequency at which it occurs as well as the test limit value at this frequency.

NEXT, ELFEXT, ACR: Minimum test results documentation. Identify as measured from each end of the link, the wire pair combination that exhibits the worst case margin and the wire pair combination that delivers the worst case value. Each reported case shall include the frequency at which it occurs as well as the test limit value at this frequency.

PSNEXT, PSELFEXT, and PSACR: Minimum test results documentation. Identify as detected from each end of the link, the wire pair that exhibits the worst case margin and the wire pair with the worst value. Each reported case shall include the frequency at which it occurs as well as the test limit value at this frequency.

Link length, propagation delay, and delay skew shall be reported for each wire pair as well as the test limit for each of these parameters.

1.5 SAMPLES

.1 A sample of the computer outlet jack and faceplate shall be submitted with the shop drawings.

2 Products

2.1 MATERIAL

.1 Conduits: EMT type 19 mm minimum.

.2 Fish Wires: Polypropylene type.

.3 Computer outlet box as detailed on drawings (multiple outlet detail).

2.2 DATA COMMUNICATIONS HORIZONTAL CABLING

.1 Data Outlet Jacks

.1 Eight conductor modular keystone jack (blue in colour) complete with dust cover.
.2 Standard ISDN T568A pin/pair configuration.
.3 Jacks must exceed the requirements of TIA/EIA 568 for Category 6.
.4 Contacts beryllium copper with a 50 micro-inch gold plating.
.5 Housing: blue thermoplastic.
.6 Jacks shall be mounted on a white nylon three-port rectangular faceplate, that matches the rectangular wiring devices (Hubbell #ISF3W, or Leviton #41643-W). The three-port rectangular faceplate color shall match wiring devices.
.7 CAT 6 jacks shall be Hubbell #HXJ6B, Leviton #61110-RL6 or approved equal.
.8 Coverplates shall be as specified in Section 26 27 26.

.2 Data Cable

.1 Data Outlet Cable

.1 Four pair, unshielded twisted pair cable.

.2 Conductors #23AWG solid copper, thermoplastic insulated, formed into four individually twisted pairs and enclosed in a blue thermoplastic jacket.

.3 Cable shall meet FT6 flammability requirements for use in plenums.

.4 Cable shall exceed requirements of TIA/EIA 568 for Category 6.

.5 General Cable #7131800.

.3 Wall Mounted Data Cable Termination Panel

.1 Bottom hinged wall mounted bracket (89 mm high x 483 mm wide x 203 mm deep). Patch panel shall be hinged and fold down for front access. Leviton #49251-W62, Hubbell #HPWWB2U8.

.2 Bracket shall be complete with 24 port Category 6 patch panel. Leviton #69585-U24, Hubbell #P6E24U.

.4 Data Patch Cords

.1 Provide and install one 10'-0" CAT 6 booted blue patch cord for each workstation data jack. Patch cords shall be tested and comply with Category 6 ANSI/T1A/E1A-568-B-2.1 requirements. Hubbell #PCX6B10, Leviton #62460-10B.

.2 Provide and install one 2'-0" CAT 6 booted blue patch cord for each patch panel data jack. Patch cords shall be tested, and comply with Category 6 ANSI/T1A/E1A-568-B-2.1 requirements. Hubbell #PCX6B02, Leviton #62460-02B.

.3 Patch cords must be factory made; hand made patch cords will not be accepted.

.4 Patch cords must be incorporated in the manufacturer's end-to-end system certification.

.5 Patch cords must be labelled at both ends. The labelling format will be 1-2m, 2-2m, 3-2m, 4-2m etc. where the first digit is the patch cord identifier while the second digit represents the length of the patch cord in meters.

.6 Patch cords must be fabricated and tested by the same manufacturer used for the horizontal cabling plant and will be compliant with TIA/EIA 568-B.2.

2.3 VOICE COMMUNICATIONS HORIZONTAL CABLING

.1 Telephone Cross Connect Terminations

.1 Connectors

.1 Fire-retardant plastic construction with double sided insulation displacement connections to terminate 22, 24 or 26 gauge plastic insulated solid copper conductors without stripping.

.2 Connection clips recessed to prevent accidental shorts or circuit contact.

.3 Contact resistance < 1 milliohm/contact.

.4 Insulation resistance > 100 megohms between clips.

.5 25 pair connectors, single pair terminations (one pair in - one pair out).

.6 Acceptable product: N.T. QCBIX1A

.2 Connector Mount
- .1 Stamped steel construction with fire retardant plastic fanning strips.
- .2 Capacity to mount up to ten 25 pair connectors and 5 designation strips.
- .3 Acceptable product: N.T. QMBIX10A.

.3 Designation Strips
- .1 Fire retardant plastic construction to snap onto mounts between connectors and top and bottom ridges for alignment.
- .2 Strips provided complete with I.D. labels.
- .3 Acceptable product: N.T. QSBIX20A.

.2 Telephone Outlet Jacks

- .1 Eight conductor modular keystone jack (white in colour) complete with dust cover.
- .2 Standard ISDN T568A pin/pair configuration.
- .3 Jacks must exceed the requirements of TIA/EIA 568 for Category 6.
- .4 Contacts beryllium copper with a 50 micro-inch gold plating.
- .5 Housing: White thermoplastic.
- .6 Outlet jacks shall be mounted on a white nylon three-port rectangular faceplate, that matches the rectangular wiring devices (Hubbell #ISF3W, or Leviton #4163-W). The three-port rectangular faceplate colour shall match wiring devices.
- .7 The CAT 6 jacks shall be Hubbell #HXJ6W, Leviton #61110-RW6 or approved equal.
- .8 Coverplates shall be as specified in Section 26 27 26.

.3 Cable

.1 Telephone Outlet Cable
- .1 Four pair, unshielded twisted pair cable.
- .2 Conductors #23AWG solid copper, thermoplastic insulated, formed into four individually twisted pairs and enclosed in a blue thermoplastic jacket.
- .3 Cable shall meet FT6 flammability requirements for use in plenums.
- .4 Cable shall exceed requirements of TIA/EIA 568 for Category 6.
- .5 General Cable #7131800.

.2 Panel Distribution Cables
- .1 Multi-pair 100 ohm UTP cable.
- .2 Conductors #24AWG solid copper, thermoplastic insulated, formed into binder groups of 25 pairs and enclosed in an overall thermoplastic jacket.
- .3 Cable shall meet requirements of CAN/CSA-T529-M91, Clause 10.3 for backbone wiring cable.

3 Execution

3.1 INSTALLATION

.1 When a data or voice outlet is located in a multi-gang outlet box with other devices, a 25 mm conduit (for both data and voice cabling) shall be installed to the cable tray. Identify conduit neatly with black felt marker "Voice/Data".

.2 When a separate data or voice outlet is specified (not in a multi-gang outlet box) one 102 x 102 mm square outlet box complete with a square cut single device raised cover shall be installed, with a 25 mm conduit to the cable tray. Identify conduit neatly with black felt marker “Voice/Data”.

.3 Install cable to manufacturer's recommendations regarding bending radius, pulling strain, etc. Maintain a maximum bend radius of eight (8) times the cable diameter.

.4 Communications horizontal cabling system shall be installed by trained personnel only.

.5 Install plastic bushing to protect conductors whenever conduit terminates.

.6 Identify both ends of each data and voice cable with permanent identification indicating the jack number. Data jack cables shall be terminated at patch panels dedicated to data, and voice jack cables shall be terminated at patch panels dedicated to voice.

.7 Identify each data jack with a clear self-adhesive label (black lettering) indicating the data cabinet number, the patch panel number, and the data jack number (i.e. C1-P2-D43 indicates cabinet #1, patch panel #2, data jack #43). Each data jack shall be identified with a consecutive number.

.8 Identify each voice jack with a clear self- adhesive label (black lettering) indicating the data cabinet number. the patch panel number and the voice jack number (i.e. C1-P3-V43 indicates cabinet #1, patch panel #2 and voice jack #43). Each telephone jack shall be identified with a consecutive number.

.9 Strip back a maximum of 12 mm of computer cable jacket. Maintain pair twists as close as possible to the point of mechanical termination.

.10 Apply cable restraints loosely and at random intervals. Velcro straps shall be used for all cable restraints.

.11 A pullbox is required after two 90° bends or equivalent deflections, and after every 30 metres of straight run.

.12 Conduit bending radius shall not exceed:
- 6 times internal diameter for conduit up to 50 mm diameter.
- 10 times internal diameter for conduit larger than 50 mm diameter.

.13 Terminate all four pair of voice conductors from each outlet to rear of connector (6 telephone outlets per connector). Identify designation strip on connector with telephone jack number corresponding with identification on telephone jack.

.15 Record the location and identification of all communication jacks on the electrical as-built drawings.

.16 Provide and install a mounted (glazed and framed) plan of the building showing the location and identification of all communications jacks. Locate adjacent to each patch panel.

.17 Data/voice cabling shall not exceed 90 meters in total length from workstation jack to the patch panel.

.18 Installation practices will conform to EIA/TIA standards.

.19 No splices are permitted in any data or fibre cable.

.20 In locations where the cabling is not in conduit, it will be installed in the same manner as conduit systems i.e., straight lines, parallel to walls etc. The cables shall be bundled together with Velcro straps every 610 mm.

END OF SECTION 27 15 00