BID PACKAGE #2-REBID & BID PACKAGE #3: ADDENDUM NUMBER 5

MILWAUKEE COUNTY CENTRAL FLEET MAINTENANCE BUILDING MODIFICATION: OFFICE ADDITION AND RENOVATION: BID PACKAGE #2-REBID& BID PACKAGE #3
Site #365, Bldg. #5600
10320 W. Watertown Plank Rd.
Wauwatosa, Wisconsin 53226

Project Number: O230-13636

Date of Addendum: June 2, 2014

This Addendum to the Contract Documents is issued to modify, explain or correct the original documents, dated May 2, 2014, and is hereby made part of the Contract Documents.

MODIFICATIONS & CLARIFICATIONS TO SPECIFICATIONS

1. Project Manual Volume 2: Bid Package #2-Rebid:

   a. Specification Section 07 27 26 Fluid-Applied Membrane Air and Vapor Retarder, page 072726-1, part 1.4, A, 1 & 2, **CLARIFICATION: REVISE** specification as follows,

      "1. Installer shall be licensed by ABAA according to ABAA's Quality Assurance Program and shall employ ABAA-certified installers and supervisors on project.

      2. A installer/firm with a minimum of 5 years' experience in applying air, water & vapor barrier materials similar in material, design and extent to those indicated for this project, whose work resulted in applications with a record of successful in-service performance."

2. Project Manual Volume 4: Bid Package #3:

   a. Specification Section 27 00 00 Communication Cable and Equipment: **ADD** this specifications section to the project to describe the horizontal telecommunications CAT6 station cabling requirements (Specification attached).

MODIFICATIONS & CLARIFICATIONS TO DRAWINGS

1. Drawings: Bid Package #2-Rebid:

   a. Drawing Sheet A402 dated 5/2/14: Detail 13 note "2"X2" X 1/4" GALVANIZED STEEL ANGLE AROUND ENTIRE PERIMETER OF WIRE MESH, TYPICAL" **REVISE** as follows,

      "2"X2" X 1/4" GALVANIZED STEEL ANGLE AROUND ENTIRE PERIMETER OF WIRE MESH, TYPICAL. ATTACH WIRE MESH TO STEEL ANGLE BY BOLTING (12" O.C.) A CONTINUOUS 1" x 1/4" STEEL BAR TO THE STEEL ANGLE AROUND ENTIRE PERIMETER"

2. <u>Drawings: Bid Package #3</u>:

   a. Drawing Sheet E201 dated 5/16/14: **REVISE** general note #4 to read as follows,

      "ELECTRICAL CONTRACTOR SHALL BE RESPONSIBLE FOR PROVIDING RACEWAYS, SUPPORTS, AND BOXES TO NEAREST ACCESSIBLE CEILING. PROVIDE CAT6 CABLING TO DATA AND PHONE OUTLETS. ALL OTHER SYSTEMS SHALL BE RACEWAY ONLY. ACTUAL CABLING FOR THESE SYSTEMS SHALL BE COORDINATED WITH MILWAUKEE COUNTY IMSD."

   b. Drawing Sheet E202 dated 5/16/14: **REVISE** general note #6 to read as follows,

      "ELECTRICAL CONTRACTOR SHALL BE RESPONSIBLE FOR PROVIDING RACEWAYS, SUPPORTS, AND BOXES TO NEAREST ACCESSIBLE CEILING. PROVIDE CAT6 CABLING TO DATA AND PHONE OUTLETS. ALL OTHER SYSTEMS SHALL BE RACEWAY ONLY. ACTUAL CABLING FOR THESE SYSTEMS SHALL BE COORDINATED WITH MILWAUKEE COUNTY IMSD."

   c. Drawing Sheet E203 dated 5/16/14: **REVISE** general note #3 to read as follows,

      "ELECTRICAL CONTRACTOR SHALL BE RESPONSIBLE FOR PROVIDING RACEWAYS, SUPPORTS, AND BOXES TO NEAREST ACCESSIBLE CEILING. PROVIDE CAT6 CABLING TO DATA AND PHONE OUTLETS. ALL OTHER SYSTEMS SHALL BE RACEWAY ONLY. ACTUAL CABLING FOR THESE SYSTEMS SHALL BE COORDINATED WITH MILWAUKEE COUNTY IMSD."

End of Addendum No. 5

SECTION 27 00 00
COMMUNICATIONS CABLE AND EQUIPMENT

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. Products and execution requirements relating to furnishing and installation of Telecommunications Cabling at the Fleet Maintenance Building.
2. Horizontal (Station) cabling comprised of Copper.

B. Related Sections:
1. Applicable provisions of Division 01 shall govern all work under this Section.
2. Section 26 00 00 – Basic Electrical Requirements.
3. Section 26 05 26 – Grounding and Bonding.
4. Section 26 05 29 – Electrical Hangers and Supports.
5. Section 26 05 33 – Raceway and Boxes.
6. Section 26 05 36 – Cable Trays.
7. Section 26 05 53 – Electrical Identification.
8. Section 26 08 00 – Commissioning of Electrical Systems.
9. Section 26 27 26 – Wiring Devices.
10. Section 27 05 33 – Raceway and Boxes for Communication Systems.

1.2 REGULATORY REFERENCE

A. All work and materials shall conform in every detail to the rules and requirements of the National Fire Protection Association, the Wisconsin Electrical Code and present manufacturing standards.

B. All materials shall be listed by UL and shall bear the UL label. If UL has no published standards for a particular item, then other national independent testing standards shall apply and such items shall bear those labels. Where UL has an applicable system listing and label, the entire system shall be so labeled.

1.3 REFERENCES

A. ICEA publication S-80-576-2002.

B. Institute of Electrical and Electronics Engineers (IEEE):
1. IEEE 48 - Standard Test Procedures and Requirements for Alternating-Current Cable Terminations 2.5 kV Through 765 kV.
2. IEEE 142 - Recommended Practice for Grounding of Industrial and Commercial Power Systems.
3. IEEE C2 - National Electrical Safety Code.

C. National Electrical Manufacturers Association (NEMA):
1. NEMA WC 3 - Rubber Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.
2. NEMA WC 5 - Thermoplastic-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.
3. NEMA WC 74, 5-46 kV Shielded Power Cable for Use in the Transmission and Distribution of Electric Energy.

D. International Electrical Testing Association (NETA):
1. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

E. National Fire Protection Association (NFPA):
   1. NFPA 70 - National Electrical Code (NEC).

F. State of Wisconsin, Department of Industry, Labor, and Human Relations (DILHR):
   1. Chapter 16 – Wisconsin Electrical Code.

G. TIA/EIA Standards:
   1. 526-14A (OFSPT-14A)
   2. 526-7 (OFSPT-7)
   3. 568B.1 (Category 5e)
   4. 568B.2 (Category 6)
   5. 568B.3
   6. 569A
   7. 606A
   8. 607 (with exception).

H. Underwriters' Laboratories, Inc. (UL).

1.4 DESIGN INTENT

A. The Horizontal (Station) Cabling System is based on the installation of 4-Pair Unshielded Twisted Pair (UTP) DATA Category 6 and 4-Pair UTP VOICE Category 6 Copper Cables. The cables shall be installed from the Standard Information Outlet (SIO) in the work area to the Telecommunications Room (TR) or Equipment Room (ER) serving that area and terminated as specified in this document.

B. Station cables shall be installed in conduit, in cable tray and in modular furniture.

C. Backbone Copper and Fiber Optic Cables (linking Equipment Rooms and/or Telecommunications Rooms) shall be installed in conduit in building riser pathways, in cable tray and/or free-air in as identified on the Drawings. Backbone Intra-building Fiber Optic Cabling shall be installed via Conduit and/or Cable Tray.

D. All cables and related termination, support and grounding hardware, bonding, shall be furnished, installed, wired, tested, labeled, and documented by the Contractor, as detailed in the following sections.

E. The Contractor shall provide all labor and materials necessary to construct the system as described herein. This includes - but is not limited to - furnishing and installing cable, cable supports, innerduct, racking and termination components, termination, testing, labeling and documentation.

1.5 SEALING AND FIRESTOPPING

A. Sealing and firestopping shall be provided of sleeves/openings between conduits, cable trays, wireways, troughs, cablebus, busduct, etc. and structural or partition opening shall be responsibility of contractor whose work penetrates opening. Contractor responsible shall hire individuals skilled in such work to do sealing and firestopping. These individuals hired shall normally and routinely be employed in sealing and fireproofing occupation.

1.6 WORK SEQUENCE

A. During the construction period, coordinate telecommunications schedule and operations with the Owner's Representative and Owner.

1.7 SUBMITTALS

A. Division 01 - Submittal Procedures: Procedures for submittals.

B. Product Data: Submit catalog data for each termination device, cable, and outlet device.

C. Under provisions of Division 01, prior to the state of work, Contractor shall submit:
   1. Six (6) sets of Manufacturer's Data covering all products proposed indicating construction, materials, ratings and all other parameters identified in Part 2 (Products) below.
   2. Manufacturer's installation instructions.
   3. One (1) two-foot section of each cable type to be utilized for final approval by Engineer. This two-foot section shall have manufacturer's cable markings visible. Upon request, samples from every reel sent to the site shall be provided.

D. Submittals should be grouped to include complete documentation of related systems, products and accessories in a single submittal. Where applicable, dimensions should be marked in units to match those specified.

E. Submittals shall be original catalog sheets, photocopies, or electronic format (ADOBE Portable Document format ".pdf") thereof. Facsimile (fax) sheets shall not be accepted.

F. Two sets of submittals. Engineer shall review the Submittals and annotate them indicating approvals and shall return to contractor.

G. Work shall not proceed without Engineer's approval of the submitted items.

H. If materials are furnished as specified no further qualifications is necessary, except for items requiring shop drawings. However, if Contractor wishes to substitute another manufacturer and/or catalog number, the following information in triplicate shall be submitted to Engineer.
   1. A complete description of the material which the contractor proposes to substitute (shop drawings, illustrations, catalog data, performance characteristics, etc.) and the reason for the substitution identifying any benefit to the Owner.

I. Contractor shall receive approval from Engineer on all substitutions of material. No substituted materials shall be installed except by written approval from Engineer.

J. Labeling submittals:
   1. Include schedule for nameplates and stenciling.

K. Prior to installation, the Contractor shall provide samples of all label types planned for the project. These samples shall include examples of the lettering to be used. Samples shall be mounted on 8 1/2" x 11" sheets annotated, explaining their purposed use.

1.8 PROJECT RECORD DOCUMENTS

A. Submit and record documents under provisions of Division 01.

B. Accurately record exact sizes, locations and quantities of cables.

1.9 QUALITY ASSURANCE

A. Manufacturer shall be a company specializing in communication cable and/or accessories with a minimum of five years documented experience in producing cable

and/or accessories similar to those specified below.

B. Contractor shall have been in this line of business for a minimum of five (5) years and completed four (4) jobs of magnitude specified in the following sections.

C. Installing contractor shall have at a minimum one (1) Certified Installer trained to the latest industry standards to ensure most reliable installation available. Certified Installer shall have been trained by a company(s) that offer a minimum fifteen (15) year system warranty.

1.10 DELIVERY, STORAGE AND HANDLING

A. Cable shall be stored according to manufacturer's recommendations as minimum. In addition, cable must be stored in a location protected from vandalism and weather. If cable is stored outside, it must be covered with opaque plastic or canvas with provision for ventilation to prevent condensation and for protection from weather. If air temperature at cable storage location will be below 4 degrees C., the cable shall be moved to a heated (10 degrees C. minimum) location.

B. If contractor wishes to have a trailer on site for storage of materials, arrangements shall be made with Owner. If necessary, cable shall be stored off site at contractor's expense.

1.11 DRAWINGS

A. It shall be understood that electrical and telecommunication details and drawings provided with the specification package are diagrammatic. They are included to show the intent of specifications and to aid Contractor in bidding the job. Contractor shall make allowance in bid proposal to cover whatever work is required to comply with intent of drawings and specifications.

B. Contractor shall verify all dimensions at the site and be responsible for their accuracy.

C. Prior to submitting the bid, Contractor shall call attention of Engineer to any materials or apparatus Contractor believes to be inadequate and to any necessary items of work omitted, within ten (10) days prior to Bid Due Date.

PART 2 PRODUCTS

2.1 LABELING MATERIALS

A. Labels: All labels shall be permanent, and machine generated. NO HANDWRITTEN OR NON-PERMANENT LABELS ARE ALLOWED. Exception: back side of device plates and junction boxes may use handwritten, legible labeling on box covers, unless specifically prohibited by other specification sections.

B. Cable label size shall be appropriate for the conductor or cable size(s), outlet faceplate layout and patch panel design. All labels shall be self-laminating, white/transparent vinyl and be wrapped around the cable or sheath. Labels for power conductors (600V and lower) shall be cloth-type. Flag type labels are not allowed. The labels shall be of adequate size to accommodate the circumference of the cable being labeled and properly self-laminate over the full extent of the printed area of the label.

C. Nameplates: Engraved three-layer laminated plastic, black letters on a white background. Emergency system (level 1 and level 2) shall use white letters on red background.

D. Tape (phase identification only): Scotch #35 tape in appropriate colors for system voltage and phase.

E. Adhesive type labels not permitted except for phase and wire identification. Machine generated adhesive labels shall be permitted for device plates, 4-11/16" and smaller junction boxes, Fire alarm and control devices.

2.2 HORIZONTAL MEDIA (STATION CABLES)

A. Horizontal (Station) Cable System is based on the installation of Un-shielded Twisted Pair (UTP) DATA Category 6 and VOICE (Telephone) Category 6 copper cables to install from work area to the wiring hub locations(s). Refer to Floor plan Drawings(s) which identify location of wiring hubs and Standard Information Outlets (SIO) locations.

B. Voice and Data Station Cables shall be constructed of individually twisted pairs with 24-AWG insulated solid copper conductors.

C. All Cables and Termination hardware shall be technically compliant with and installed in accordance with the referenced TIA/EIA documents.

D. All cables shall be suitable for installation in the environment defined and shall meet a CMP rating (or approved substitutes as defined by the 2002 NEC).

E. Cables shall be Underwriters Laboratory (UL) listed, comply with Article 800 (Communications Circuits) of the National Electrical Code and shall meet the specifications of NEMA (low loss), UL 444, and ICEA.

F. Pairs of all 4-pair cables shall be unshielded and shall be identified by a banded color code in which conductor insulation is marked with a dominant color and banded with a contrasting color. By pair number, the pair colors or dominant band are:
   1. Pair 1: Tip - White/Blue; Ring - Blue (or Blue/White).
   2. Pair 2: Tip - White/Orange; Ring - Orange (or Orange/White).
   3. Pair 3: Tip - White/Green; Ring - Green (or Green/White).
   4. Pair 4: Tip - White/Brown; Ring - Brown (or Brown/White).

G. Horizontal Data and Voice Station Cable (Copper):
   1. All horizontal Data Station Cables shall terminate on modular Patch Panels in their respective Telecommunications Rooms (TR) or Equipment Room (ER) as specified on Drawings.
   2. All horizontal Voice Station Cables shall terminate on modular Category 6 Patch Panels or Category 6 110 blocks in their respective Telecommunications Rooms (TR) or Equipment Room (ER) as specified on Drawings.
   3. All cables, termination components and support hardware shall be furnished, tested, installed and wired by Contractor.
   4. Transmission characteristics of Data and Voice Station Cables shall meet full Category 6 performance criteria as defined by referenced TIA/EIA documents. Refer to the Execution Section which details the required performance criteria of the completed Link of which Cable is a part.

H. IMPORTANT: Cable and Termination Components (Jack, Patch Panel, Wiring Blocks) are specified to function as a System. The compatibility of the Cable to be installed with the proposed termination components shall be recognized and documented by the Termination Component Manufacturer.

I. The jacket color for Data cables shall be by agency.

J. The jacket color for Voice cables shall be by agency.

K. Cable shall be packaged in a way that minimizes tangling and kinking of the cable during installation. Examples are open reels or packages that incorporate a rotating reel.

PART 3 EXECUTION

3.1 GENERAL

A. Optical Fiber and Copper Pair counts of cables to be supplied are detailed on the Project Drawings. Contractor shall furnish and install all cables, connectors and equipment as shown on drawings and as specified above. It shall be noted that all cables shall be installed in continuous lengths from endpoint to endpoint. No splices shall be allowed unless noted otherwise.

B. Refer to Project Drawings which indicate cable routes to follow and termination location(s) within each building. Duct allocation shall be coordinated as part of construction.

C. It is contractor's responsibility to survey the site and include all necessary costs to perform installation as specified. This includes any modifications required to route and conceal horizontal distribution wiring.

D. Beginning installation means contractor accepts existing conditions.

E. Contractor shall furnish all required installation tools to facilitate cable pulling without damage to cable jacket. Such equipment is to include, but not limited to, sheaves, winches, cable reels, cable reel jacks, duct entrance tunnels, pulling tension gauge and similar devices. All equipment shall be of substantial construction to allow steady progress once pulling has begun. Makeshift devices, which may move or wear in a manner to pose a hazard to cable, shall not be used.

F. All cable shall be pulled by hand unless installation conditions require mechanical assistance. Where mechanical assistance is used, care shall be taken to insure that maximum tensile load for cable as defined by manufacturer is not exceeded. This may be in the form of continuous monitoring of pulling tension, use of a "break-away" or other approved method.

G. Contractor will be responsible for identifying and reporting to Site Coordinator(s) any existing damage to walls, flooring, tiles and furnishings in work area prior to start of work. All damage to interior spaces caused by installation of cable, raceway or other hardware must be repaired by Contractor. Repairs must match preexisting color and finish of walls, floors and ceilings. Any contractor-damaged ceiling tiles are to be replaced by contractor to match color, size, style and texture.

H. Where unacceptable conditions are found, Contractor shall bring this to the attention of construction supervisor immediately. A written resolution will follow to determine appropriate action to be taken.

I. Qualified personnel utilizing state-of-the-art equipment and techniques shall complete all installation work. During pulling operation an adequate number of workers shall be present to allow cable observation at all points of duct entry and exit as well as feed cable and operate pulling machinery.

J. Cable pulling shall be done in accordance with cable manufacturer's recommendations and ANSI/IEEE C2 standards. Manufacturer's recommendations

shall be a part of cable submittal. Recommended pulling tensions and pulling bending radius shall not be exceeded. Any cable bent or kinked to radius less than recommended dimension shall not be installed. If any installed cable is kinked to a radius less than recommended dimension it shall be replaced by contractor with no additional cost to the project.

K. All wiring shall be run "free-air", in conduit, in a secured metal raceway or in modular furniture as designated on the floorplan(s). All cable shall be free of tension at both ends.

L. Avoid abrasion and other damage to cables during installation.

M. Pulling Lubricant may be used to ease pulling tensions. Lubricant shall be of a type that is non-injurious to the cable jacket and other materials used. Lubricant shall not harden or become adhesive with age.

N. Cable system will be tested and documented upon completion of installation as defined in Section below.

O. A pull cord (nylon; 1/8" minimum) shall be co-installed with all cable installed in any conduit.

P. Should it be found by Engineer, that materials or any portion thereof, furnished and installed under this contract, fail to comply with specifications and drawings, with respect or regard to quality, amount of value of materials, appliances or labor used in the work, it shall be rejected and replaced by Contractor and all work distributed by changes necessitated in consequence of said defects or imperfections shall be made good at Contractor's expense.

3.2 COMMUNICATIONS SYSTEM IDENTIFICATION AND LABELING

A. Per Milwaukee County IMSD

3.3 SYSTEM TOPOLOGY AND CABLE SIZE REQUIREMENTS

A. Station Cabling:
   1. Information Outlets cables with copper media (Voice & Data UTP and "TV" coax) shall be located as detailed on the Project Drawings.
   2. The Bidder in determining materials quantities and routing should utilize these documents.
   3. Station Cabling on each Floor shall be routed to Telecommunications Room (TR) on that floor or to designated TR if on another floor.
   4. Station cables shall be run to Information Outlet from Telecommunications Room serving each area in conduit, free-air above drop ceiling, in cable tray and/or in modular furniture.
   5. The maximum station cable drop length for Data and Voice UTP (Category 5e or Category 6) shall not exceed 295-feet (90-meters) in order to meet data communications performance specifications. This length is measured from termination panel in the wiring closet to outlet and must include any slack required for installation and termination. Contractor is responsible for installing station cabling in a fashion as to avoid unnecessarily long runs. Any area that cannot be reached within above constraints should be identified and reported to Engineer prior to installation. Changes to plan shall be approved by Engineer.
   6. All cables shall be installed splice-free unless otherwise specified.
   7. During pulling operation an adequate number of workers shall be present to allow cable observation at all points of duct entry and exit as well as feed cable and operate pulling machinery.

8. Avoid abrasion and other damage to cables during installation.
9. All cable shall be free of tension at both ends. In cases where cable must bear some stress, Kellom grips may be used to spread strain over a longer length of cable.
10. Where installed free-air, installation shall consider the following:
    a. Cable shall run at right angles and be kept clear of other trades work.
    b. Cables shall be supported according to code utilizing "J-" or "Cable Tray" anchored to ceiling concrete, piping supports or structural steel beams. Rings shall be designed to maintain cables bend to larger than the minimum bend radius (typically 4 x cable diameter).
    c. Supports shall be spaced at a maximum 4-foot interval unless limited by building construction. If cable "sag" at mid-span exceeds 6-inches, another support shall be used.
    d. Cable shall never be laid directly on the ceiling grid or attached in any manner to the ceiling grid wires.
    e. Cables shall not be attached to existing cabling, plumbing or steam piping, ductwork, ceiling supports or electrical or communications conduit.
11. Manufacturer's minimum bend radius specifications shall be observed in all instances.
12. Care should be taken in use of cable ties to secure and anchor station cabling. Ties should not be over tightened as to compress the cable jacket. No sharp burrs should remain where excess length of cable tie has been cut.
13. Cable sheaths shall be protected from damage from sharp edges. Where a cable passes over a sharp edge, a bushing or grommet shall be used to protect cable.
14. A coil of 4 feet in each cable shall be placed in ceiling at last support (e.g. J-Hook, Bridal Ring, etc.) before cables enter a fishable wall, conduit, surface raceway or box. At any location where cables are installed into movable partition walls or modular furniture via a service pole, approximately 15-feet of slack shall be left in each station cable under 250-feet in length to allow for change in the office layout without re-cabling. These "service loops" shall be secured at last cable support before cable leaves ceiling and shall be coiled from 100% to 200% of cable recommended minimum bend radius.
15. At all Telecommunication Rooms (TR), approximately 10-feet of slack shall be left in each station cable under 250-feet in length to allow for changes in the telecommunication room layout without re-cabling. These "service loops" shall be secured to ladder rack, with "J" hooks, or "D" rings above equipment, racks, and patch panels and shall be coiled from 100% to 200% of the cable recommended minimum bend radius.
16. To reduce or eliminate EMI, following minimum separation distances from ≤480V Power lines shall be adhered to:

    a. Twelve (12) inches from power lines of <5-kVa.
    b. Eighteen (18) inches from high voltage lighting (including fluorescent).
    c. Thirty-nine (39) inches from power lines of 5-kVa or greater.
    d. Thirty-nine (39) inches from transformers and motors.

17. All openings shall be sleeved and firestopped per prevailing code requirements upon completion of cable installation.
18. IMPORTANT: Within the room in which Data Cabling is to be terminated, Hook and Loop(e.g. "Velcro") ties only shall be used from room entry to point of termination. This is to facilitate addition of future cables.

B. Station Cabling on Modular Furniture:
    1. Where furniture panels are installed to include contact with a wall, cabling shall be fed to furniture panels via existing conduit.

2. Where modular furniture is installed without wall contact, contractor shall install a "poke-thru" and route station cabling via floor below (but terminate at the TR on floor on which the jack appears). Selection of "poke-thru" shall consider fill ratios, bend limits on Category 5e/6 UTP and eventual feed into furniture partition.
3. Cabling shall be protected in transition from "Poke-thru" or Wall Fittings to modular furniture via a length of flexible plastic conduit or other approved protective means. Conduit fittings shall be compatible with "Poke-thru" and Wall Fittings proposed. There shall be no exposed cable in transition to modular furniture. Fill Ratio (Cable Area vs. Conduit Area) in each feed shall not exceed 40 percent.
4. For purposes of bidding, it is to be assumed that cable pathway shall be limited to bottom panel of modular furniture only. Communications cables would be run through these channels to jack location.
5. For purposes of bidding, it is to be assumed that it will be responsibility of Contractor to punch and re-install bottom molding panels on modular furniture as required to accommodate Communications cabling and SIOs. Panels shall be marked prior to installation by owner to identify desired location of SIOs. Any discrepancy between Project Drawing identifying Outlet locations and markings should be brought to attention of Site Coordinator(s).
6. SIO shall be secured to panel via mounting tabs, pop-rivets, screws or other approved method. Use of adhesive tape is not acceptable. Method of securing SIO to panel shall not result in sharp protrusions (e.g. sheet metal screw tip) into channel behind panel.

C. Information Outlet:
1. Information Outlets shall be flush mounted on wall-mounted boxes, in floor-mounted boxes, on Surface Raceway and on modular furniture.
2. Any outlets to be added where these conditions are not met shall be positioned at a height matching that of existing services or as directed otherwise by Site Coordinator and Engineer. Nominal height (from finished floor to center line of Outlet) in new installation shall be as follows:

Standard Voice & Data Outlet	18-inches
Wall-Mounted Telephone Outlet (Standard Voice only)	54-inches.
Wall-mounted Telephone Outlets for Wheelchair Persons:	
Approach head on	per ADA regulations
Approach parallel	per ADA regulations

3.4 TESTING AND ACCEPTANCE

A. Contractor is responsible to perform acceptance tests as indicated below for each sub-system (e.g. backbone, station, etc.) as it is completed

B. All tests shall be documented.

C. Contractor is responsible for supplying all equipment and personnel necessary to conduct the acceptance tests. Prior to testing, the Contractor shall provide a summary of proposed test plan for each cable type including equipment to use used, set-up, test frequencies or wavelengths, results format, etc. Method of testing shall be approved by Engineer.

D. Contractor shall visually inspect all cabling and termination points to insure that they are complete and conform to the wiring pattern defined herein. Contractor shall

provide Engineer with a written certification that this inspection has been made

E. Contractor shall conduct acceptance testing according to a schedule coordinated with the Engineer. Representatives of the Owner may be in attendance to witness the test procedures. Contractor shall provide a minimum of one (1) week advance notice to Engineer as to allow for such participation. The notification shall include a written description of the proposed conduct of the tests including copies of blank test result sheets to be used.

F. IMPORTANT: Failure to provide the above information shall be grounds for the Owner/Engineer to reject any and all Documentation of Results on related testing and to require a repeat of the affected test.

G. Tests related to connected equipment of others shall only be done with the permission and presence of Contractor involved. Contractor shall ascertain that testing only as required to prove the wiring connections are correct.

H. Contractor shall provide test results and describe the conduct of the tests including the date of the tests, the equipment used and the procedures followed. At the request of Engineer, contractor shall provide copies of the original test results.

I. All cabling shall be 100% fault free unless noted otherwise. If any cable is found to be outside the specification defined herein, that cable and the associated termination(s) shall be replaced at the expense of contractor. Applicable tests shall then be repeated.

J. Should it be found by Engineer that the materials or any portion thereof furnished and installed under this contract fail to comply with the specifications and drawings, with the respect or regard to the quality, amount of value of materials, appliances or labor used in the work, it shall be rejected and replaced by Contractor and all work distributed by changes necessitated in consequence of said defects or imperfections shall be made good at Contractor's expense.

K. Voice Station Cabling (Category 5e and Category 6):
   1. Testing shall be done from voice jack at SIO to voice 110 blocks/patch panel at TR where the cables are terminated. When SIO is located on/in wall behind modular furniture, a patch cord may be inserted into SIO to allow furniture to be returned to its normal location. Cat 5e and Cat 6 cable testing, in this case, will be done with patch cord. Cabling must pass all Cat 5e or Cat 6 TIA requirements. If cable test fails only due to length of patch cord, the DSF will accept cable as passing.
   2. Horizontal "Station" cables shall be free of shorts within pairs, and be verified for continuity, pair validity and polarity, and Wire Map (Conductor Position on Modular Jack). Any defective, split or mis-positioned pairs must be identified and corrected.
   3. Testing of Cabling Systems rated at TIA Category 6 shall be performed to confirm proper functioning and performance.
   4. Where cross-connection of cabling sub-systems (e.g. Station & Backbone) by Contractor is specified, each subsystem shall be tested separately as defined above followed by a Voice Channel Test after cross-connection is complete.

L. Data Station Cabling (Category 5e and Category 6):
   1. Testing shall be from the Jack at SIO to Data Patch Panel at TR on which cables are terminated. When SIO is located on/in wall behind modular furniture, a patch cord may be inserted into SIO to allow furniture to be returned to its normal location. Cat 5e and Cat 6 cable testing, in this case, will be done with patch cord. Cabling must pass all Cat 5e or Cat 6 TIA requirements. If cable test fails

only due to length of patch cord, Owner's Representative will accept cable as passing.

2. Horizontal "Station" cables shall be free of shorts within the pairs, and be verified for continuity, pair validity and polarity, and Wire Map (Conductor Position on Modular Jack). Any defective, split or mis-positioned pairs must be identified and corrected.
3. Testing of Cabling Systems rated at TIA Category 6 shall be performed to confirm proper functioning and performance.

M. Category 5e and Category 6 Performance Testing:

1. "In addition to the above, Performance Testing shall be performed on all cables. Testing of Transmission Performance of station cables (Category 5e and Category 6) shall include following:

   a. Length
   b. Attenuation
   c. Pair to Pair NEXT Loss (new limits)
   d. PSNEXT Loss
   e. Pair to Pair ELFEXT Loss (Equal Level Far End Cross-talk)
   f. PSEFEXT Loss
   g. Propagation Delay
   h. Delay Skew
   i. Return Loss

2. Cables shall be tested to maximum frequency defined by standards covering that performance category. Transmission Performance Testing shall be performed using a test instrument designed for testing to specified frequencies. Test records shall verify "PASS" on each cable and display the specified parameters - comparing test values with standards based "templates" integral to the unit.
3. Category 5e testing shall be per ANSI/TIA/EIA 568B.1Permanent Link test configurations and ANSI/TIA/EIA 568B.1 Category 5e.
4. Category 6 testing shall be per ANSI/TIA/EIA 568B.2 Permanent Link test configurations and ANSI/TIA/EIA 568B.2 Category 6.
5. Maximum length of station cable shall not exceed 90 meters which allows 10 meters for equipment and patch cables. Worst case performance at 20°C, based on a Horizontal Cable length of 90 meters and Equipment Cord length of 4 meters, shall be as follows:

Category 6 Test Parameters:

			Category 6 Cable Permanent Link Test			
Frequency Mhz	TIA/EIA 568B.2-1 Insertion Loss Attenuation Max. dB	TIA/EIA 568B.2-1 NEXT Worst Pair to Pair dB	TIA/EIA 568B.2-1 PSNEXT Worst Case Loss dB	TIA/EIA 568B.2-1 ELFEXT Worst Pair to Pair Loss DB	TIA/EIA 568B.2-1 PSELFEXT Loss dB	TIA/EIA 568B.2-1 Return Loss dB
1.00	1.9	65.0	62.0	64.2	61.2	19.1
4.00	3.5	64.1	61.8	52.1	49.1	21.0
8.00	5.0	59.4	57.0	46.1	43.1	21.0
10.00	5.5	57.8	55.5	44.2	41.2	21.0
16.00	7.0	54.6	52.2	40.1	37.1	20.0
20.00	7.9	53.1	50.7	38.2	35.2	19.5
25.00	8.9	51.5	49.1	36.2	33.2	19.0
31.25	10.0	50.0	47.5	34.3	31.3	18.5
62.50	14.4	45.1	42.7	28.3	25.3	16.0
100.00	18.6	41.8	39.3	24.2	21.2	14.0
200.00	27.4	36.9	34.3	18.2	15.2	11.0

250.00	31.1	35.3	32.7	16.2	13.2	10.0

N. Propagation Delay:
   1. Maximum propagation delay determined in accordance with ANSI/TIA/EIA – 568B.2 for a Permanent Link configuration shall be less than 498-ns measured at 10MHz. (Note: In determining permanent link propagation delay, propagation delay contribution of connecting hardware is assumed to not exceed 2.5 ns from 1 MHz to 100MHz).

O. Delay Skew:
   1. For all frequencies from 1 MHz to 250 MHz, Category 6 cable propagation delay skew shall not exceed 44ns/100m at 20 degrees C, 40 degrees C, and 60 degrees C. In addition, propagation delay skew between all pairs shall not vary more than +/- 10ns from measured value at 20 degrees C when measured at 40 degrees C and 60 degrees C. Compliance shall be determined using a minimum 100m of cable.
   2. In order to establish testing baselines, cable samples of known length and of cable type and lot installed shall be tested. Cable may be terminated with an 8-position Category 6 Modular plug (8-pin) to facilitate testing. Net Propagation Velocity (NPV) and nominal attenuation values shall be calculated based on this test and be utilized during testing of the installed cable plant. This requirement can be waived if NPV data is available from cable manufacturer for exact cable type under test.
   3. In the event results of the tests are not satisfactory, Contractor shall make adjustments, replacement and changes as are necessary, and shall then repeat test or tests which disclosed faulty or defective material, equipment or installation method, and shall make additional tests as Engineer deems necessary at no additional expense to the project or user agency.

3.5 DOCUMENTATION

A. Upon completion of installation, contractor shall provide three (3) full Documentation Sets to Engineer for approval. Documentation shall include items detailed in sub-sections below.

B. Documentation of Test Results shall be submitted in hard copy or in electronic form (preferred). Electronic documents may be submitted on CD-ROM (preferred) or 3½" diskettes for review and distribution. Where documentation provided in electronic form requires unique software (other than an MS-Word compatible Word Processor or MS-Excel spreadsheet) for viewing test results, Contractor shall provide along with above documentation, one (1) licensed copy of such software. The software shall run on a MICROSOFT *Windows*-based personal computer supplied by Owner.

C. Documentation shall be submitted within ten (10) working days of completion of each testing phase (e.g. subsystem, cable type, area, floor, etc.). This is inclusive of all test result and *draft* as-built drawings. Draft drawings may include annotations done by hand. Machine generated (final) copies of all drawings shall be submitted within 30 working days of completion of each testing phase.

D. Engineer may request that a 10 percent random field re-test be conducted on cable system at no additional cost to verify documented findings. Tests shall be a repeat of those defined above. If findings contradict the documentation submitted by Contractor, additional testing can be requested to the extent determined necessary by Engineer, including a 100 percent re-test. This re-test shall be at no additional cost to Owner.

E. Test Data – Copper Media:
   1. Test results shall include a record of test frequencies, cable type, conductor pair and cable (or Outlet) I.D., measurement direction, test equipment type, model and serial number, date, reference setup, and crew member name(s).
   2. Printouts generated for each cable by wire test instrument (e.g. *PentaScanner*) shall be submitted as part of documentation package. Alternately contractor may furnish this information in electronic form on CD-ROM (preferred) or (3.5" diskette).

3.6 SLEEVES

A. Pipe sleeves for conduits 6" in diameter and smaller, in new poured concrete construction, shall be schedule 40 steel pipe, plastic removable sleeve or sheet metal sleeve, all cast in place.

B. In wet area floor penetrations, top of sleeve to be 2 inches above adjacent floor. In existing wet area floor penetrations, core drill sleeve openings large enough to insert schedule 40 sleeve and grout area around sleeve. If a pipe clamp resting on sleeve supports pipe penetrating sleeve, weld a collar or struts to the sleeve that will transfer weight to existing floor structure. Wet areas for this paragraph are rooms or spaces containing air handling unit coils, converters, pumps, chillers, boilers, and similar waterside equipment.

C. Pipe penetrations in existing concrete floors that are not in wet areas may omit use of schedule 40 sleeve and use core drilled opening as sleeve.

3.7 SEALING AND FIRESTOPPING

A. Fire and/or Smoke Penetrations:
   1. Install approved product in accordance with manufacturer's instructions where a pipe (i.e. cable tray, bus, cable bus, conduit, wireway, trough, etc.) penetrates a fire rated surface.
   2. Where firestop mortar is used to infill large fire-rated floor openings that could be required to support weight, provide permanent structural forming. Firestop mortar alone is not adequate to support any substantial weight.

B. Non-Rated Surfaces:
   1. When opening is through a non-fire rated wall, floor, ceiling or roof, opening must be sealed using an approved type of material.
   2. Install escutcheons or floor/ceiling plates where conduit, penetrates non-fire rated surfaces in occupied spaces. Occupied spaces for this paragraph include only those rooms with finished ceilings and the penetration occurs below ceiling.
   3. In exterior wall openings below grade, assemble rubber links of mechanical seal to the proper size for conduit and tighten in place, in accordance with the manufacturer's instructions. Install so that bolts used to tighten seal are accessible from interior of building or vault.
   4. At interior partitions, conduit penetrations are required to be sealed for all clean rooms, laboratories, and most hospital spaces, computer rooms, dormitory rooms, tele/data/com rooms and similar spaces where the room pressure or odor transmission must be controlled. Apply sealant to both sides of penetration in such a manner that annular space between conduit sleeve and the conduit is completely filled.

3.8 AS-BUILT CONSTRUCTION DRAWINGS

A. Drawings included with specifications set shall be modified by contractor to denote as-built information.

B. Drawings are to include cable routes and outlet locations. Outlet locations shall be identified by their sequential number as defined elsewhere in this document. Numbering, icons and drawing conventions used shall be consistent throughout all documentation provided.

C. Owner through the Consultant will provide floor plans in paper and electronic (".dwg", *AutoCAD* rel. 2006) formats on which as-built construction information can be added. These documents will be modified accordingly by contractor to denote as-built information as defined above and returned to Consultant for acceptance. This information shall be supplied to Consultant/Engineer no later than four (4) weeks prior to scheduled occupancy of affected floors.

D. Contractors shall annotate the base drawings and return to Architect/Engineer in hard copy (same plot size as originals) and electronic (*AutoCAD* rel. 2006) form.

E. Each drawing submitted by Contractor as part of Project Documentation shall be identified as an "As-built" drawing and include the following (1) Contractor name and/or logo (2) Date of the drawing.

F. All fonts, color, layer, Model Space/Paper Space conventions established in base drawings shall be retained by Contractor in preparation of the As-built drawings.

G. Prior to generation of drawings, Contractor shall provide a sample file and test plot to Engineer for review and approval.

H. All documentation, including hard copy and electronic forms shall become the property of Owner.

3.9 WARRANTY

A. This Contractor shall guarantee all materials, equipment, etc., two (2) years from date of substantial completion of this work. In the case of data cabling, contractor shall furnish complete Category 6 system warranty consisting of no less than fifteen (15) years. This guarantee shall include all labor, material and travel time.

3.10 AS-BUILT COMMUNICATION CABLE COSTS

A. Contractor determine the "installed" price for the telecommunication cabling: 1) the average installed cost of a Cat 6 voice and a Cat 6 data cable from the TR to the outlet jack, 2) the average installed cost for a coaxial run from the F connector to the AV source equipment, 3) the average installed cost for a single mode fiber cable (state the number of fibers/cable and average length of cable), and 4) the average installed cost for a multimode fiber cable (state the number of fibers/cable and average length of cable).

B. Costs are to include material, labor, installation, testing, documentation, manuals, training, warranty; and the telecommunications proportion of the Schedule of Values consisting of general conditions, bond, mobilization, record drawings, punch list, cleanup, and demobilization.

3.11 EXISTING WORK

A. Remove exposed abandoned telephone cables and pathways, including abandoned cables and pathways above accessible ceiling finishes. Cut flush with walls and floors, and patch surfaces.

B. Disconnect and remove abandoned telephone equipment.

C. Maintain access to existing telephone equipment, cabling, and terminations and other installations remaining active and requiring access. Modify installation or provide access panel.

D. Extend existing telephone installations using materials and methods compatible with existing installations, or as specified.

E. Clean and repair existing telephone equipment to remain or to be reinstalled.

3.12 INSTALLATION

A. Install pathways in accordance with EIA/TIA 569.

B. Install wire and cable in accordance with EIA/TIA 570.

C. Finish paint termination backboards with durable white enamel prior to installation of telephone equipment.

D. Install termination backboards plumb, and attach securely to building wall at each corner. Install cabinet trim plumb.

E. Install pull wire or polyethylene pulling string in each empty telephone conduit over 10 feet in length or containing bend.

END OF SECTION