ADDENDUM NO. 1

TO THE DRAWINGS AND SPECIFICATIONS FOR THE Burgin Independent School Addition & Renovation Burgin, Kentucky RTA 1904 BG 19-262 October 1, 2019

To All Plan Holders of Record:

This Addendum modifies bid documents dated September 13, 2019 for the above project and shall become part of said documents in the preparation of proposals and execution of work of the subject project.

General:

- 1. The pre-bid meeting sign in sheet is attached to this addendum.
- 2. Refer to the attached Addendum #1-MEP dated 10/01/2019 for Plumbing, Mechanical, and Electrical items from CMTA Engineers.

Specifications:

1. **Refer to specification section 087100 Door Hardware**:

- a) 3.8 Door to Hardware Set Numbering Index:
 - i) Revise Door 102 listed under base bid to be listed under Alternate No. 2

2. Refer to specification section 093000 Tiling:

a) 2.04 Setting & Grouting Materials, C. Grouting Materials for complete information concerning the grout and the Grout Boost Advance Pro by H. B. Fuller Construction Products. Epoxy is not required.

3. Refer to specification section 096500 Resilient Tile Flooring:

a) 1.01, B Floor Slab Preparation; All areas to receive new resilient floor tile shall receive selfleveling material as required to product a smooth slab surface. If it is determined that the slab is smooth, tile installation may proceed without the leveler.

Note: all areas of new floor tile which exhibit high and low irregular surfaces shall be replaced.

4. Refer to specification section 101424 Signs:

a) 2.07 Frameless Display Wall Mounted Graphic Panels – Add note: Attachments shall be through CMU not gypsum as noted. Remove all references to gypsum attachments and contractor shall work with accepted manufacturer to provide standoffs and attachments that will work with CMU walls.

5. Refer to specification section 105000 Printed Display Materials:

- a) 1.02 Summary:
 - i) A.1.e: Add C/A2.1 to the list of locations for vinyl graphics.

6. Refer to specification section 105050 Metal Lockers:

a) 2.01 Manufacturers: Pending compliance with the specifications, Elite Storage Products, shall be considered an equal.

Drawings:

1. **Refer to sheet SD0.2 Site Demolition Plan**:

- a) Revise Tag #2 to: The owner to demo all portions of existing building above the ground. Contractor to demo portions under the existing ground.
- b) Revise Tag #8 to: The owner to demo all portions of existing canopy above the ground. Contractor to demo portions under the ground.

2. Refer to sheet SD2.2 Site Drainage Plan:

a) Refer to the attached sketch AD1.3: provide and install 4-inch PE line to connect new condensate drain to drainage structure DS-15.

3. **Refer to sheet S1.0 Basement Plan:**

a) Replace Basement Plan Alternate #1 with the attached sketch SK01.

4. Refer to sheet S4.2 Roof Framing Sections and Details:

a) Replace Detail 7 with the attached sketch SK02 and replace Detail 8 with the attached sketch SK03.

5. **Refer to sheet A1.1 Floor Plans**:

- a) On First Floor Plan A/A1.1, provide the following fire extinguishers (refer to specifications for further information)
 - i) Kitchen 175A: FE-3 near range hood
 - ii) Corridor A: FE-2 on west wall
 - iii) Mechanical 134: FE-1 on south wall

6. **Refer to sheet A1.2 Enlarged Floor Plans**:

- a) Enlarged Plan F/A1.2:
 - i) Replace detail F/A1.2 with the attached sketch AD1.1: Provide Mop and Broom Holder (MBH) in Mechanical 134 at the Mop Sink (MS)

7. Refer to sheet A2.1, Detail E:

a) Clarification; The floor pattern show is comprised of 12" x 12" tiles installed in a pattern of 1' x 6' and 1' x 1' areas using up to seven different colors.

8. **Refer to sheet A3.1 Roof Plan**:

- a) Refer to attached sketch AD1.4 for revisions to A/A3.1
- b) Add the following text to Roof Note #8: "Refer to MEP"

9. **Refer to sheet A3.2 Roof Details**:

- a) Replace detail E/A3.2 Aluminum Canopy Detail with the attached sketch AD1.2
- b) Canopy Wall Detail J/A3.2:
 - i) Revise Material Reference tag 107300.A to be 107300.B.

10. **Refer to sheet A4.1 Building Elevations**:

a) Revise the elevation of the base of the wall hung canopies to be at 109'-4"

11. **Refer to sheet A5.4 Wall Sections**:

- a) Refer to Wall Sections A/A5.4 and D/A5.4:
 - i) Revise the elevation of the base of the wall hung canopies to be at 109'-4"

12. Refer to sheet A6.1 Doors and Frame Schedule:

- a) At the Schedule of Door and Frames, revise the hardware set at the following doors:
 - i) Door B106B Hardware Set No. 14
 - ii) Door B106B.1 Hardware Set No. 15
- b) At the Schedule of Door and Frames Alternates #1 and #2, revise the hardware set at the following door:
 - i) Alternate #2, Door 102 Hardware Set No. 06B

13. Refer to sheet A8.1 Alternates #1 & #2:

- a) Refer to Plan A/A8.1 Alternate #1 Basement Demolition Plan:
 - i) Add the following demolition note to Kitchen B103, Storage B104, Cooler B104A, and Freezer B103A (demolition note to be located on schedule on D1.1):
 - a) M-1: Remove existing Kitchen equipment in its entirety.
 - ii) Add the following demolition note to Washroom B103B, Toilet B103C (demolition note to be located on schedule on D1.1):
 - a) M-3: Remove existing plumbing fixture and all other toilet accessory items (paper towel dispenser, etc.) Refer to MEP drawings for further information. Coordinate with Architectural drawings for new work.

END OF ADDENDUM



DATE: September 24, 2019

RE: Burgin Independent Schools Addition & Renovation, RTA#1904, BG#19-262

MEETING TYPE: Pre-Bid Meeting

IN ATTENDANCE:	REPRESENTING & PHONE NUMBER:	
Ron Murreli	RossTarrant Architects	859.254.4018
Mary Lynne Lange	RossTarrant Architects	859.254.4018
Faye Bahrami	RossTarrant Architects	859.254.4018
Milton Hammons	Abel Construction	854-447-3070
Ben Hobbs	CMTR	859-253-0892
Corey Carrico	CMTA	859-253-0892
Scott HAMMER	pedlag const.	502-936-4257
GARYTAT	THE WALKER CO	8594992414
Jeremy Roberts	BEX Construction	859-263-5052
Nick Clive	REX Contonuctor	~ 453-263-5052
DAVID HASTINGS	MARRILLIA	859-629-5001
Willie Turpins Jr	Turpin MASONRY	859-734-5992
TAUL BRATY	BRADY ELECTRIC	859-481-8061
Josés H Isaacs	OMNI Commercial	859-629-2021
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1904: BURGIN INDEPENDENT SCHOOL RENOVATION AND ADDITION ADDENDUM # 1 - MEP 10/01/2019

- Item #1 Refer to the specifications Section 250200 Controls Direct Digital
 - A. Delete Section 250200 Controls Direct Digital and replace with attached Section 250200 Controls Direct Digital in this addendum #1.
 - B. Refer to sheet M3.0. BAS headend shall be located in IDF 171; data drop and separate 120 volt circuit located in this location.
 - C. Controls contractor shall coordinate and provide all required hardware, wiring, software, etc. to tie in mechanical equipment to BAS system if alternates #1 and or #2 is accepted.
- Item #2 Refer to the specifications Section 262450 Electrical Distribution Transformers
 - A. Delete this specification section in its entirety.
- Item #3 <u>Refer to the specifications Section 270610 Voice Data Communications</u> A. This section shall be replaced in its entirety with the attached 270610 Voice Data Communication specification.
- Item #4 Refer to the specifications Section 270640 CATV Distribution System A. Delete this specification section in its entirety.
- Item #5 Refer to the specifications Section 275100 Paging/Intercom System
 - The following manufacturers, if implementing an IP based paging / intercom system, shall be acceptable: i. Carehawk, Telecor, ThreeSixty.
- Item #6 <u>Refer to the specifications Section 275313 GPS Wireless Clock System</u> A. Delete this specification section in its entirety.
- Item #7 <u>Refer to the specifications Section 281353 AV Intercom System</u> A. Delete this specification section in its entirety.
- Item #8 Refer to the specifications Section 282300 Digital Video Surveillance System
 - A. Delete this specification section in its entirety.
- Item #9 Refer to the drawing U1.0

Α.

- A. For clarification, the following utility poles shown with existing line type shall be demolished:
 - i. Pole tagged with note 17 and located plan south of "STEEL BLDG".
 - ii. Pole tagged with note 17 and located plan west of "STEEL BLDG STORAGE".
- Item #10 Refer to the drawing UE1.0
 - A. Provide fire alarm connection to tamper and flow switches in fire protection vault. Extend fire alarm cabling in 1" conduit to fire alarm control panel and integrate. Provide surge protection (Ditek or equal) for fire alarm circuit. Refer to ductbank detail on sheet UE2.0.
 - B. Provide GFI receptacle in fire protection vault and extend 2#10, #10 ground in 1" conduit to 20A/1P breaker in panel K2. Refer to ductbank detail on sheet UE2.0.
- Item #11 Refer to the drawings, sheet P1.0
 - A. Refer to plumbing fixture P-4. Delete "Provide with Elkay model LZWSRK retrofit bottle filler station kit, filtered non-refrigerated." P-4 shall not be provided with retrofit bottle filling station. P-4 shall be provided with one bottle filling station in lieu of two.
- Item #12 Refer to the drawings, sheet FP1.0
 - A. REFER TO FIRE PUMP FLOW DATA notes. This section title shall be edited to read as follows: "FLOW TEST DATA".
 - B. Refer to PHASING NOTES. Contractor shall refer to architectural phasing plan extensively during construction.
- Item #5 Refer to the drawings, sheet M1.0
 - A. Refer to PHASING NOTES. Contractor shall refer to architectural phasing plan extensively during construction.
- Item #6 Refer to the drawings, sheet M2.0
 - A. The existing, plan north, condensate line being demolished outside of GIRLS LOCKER ROOM 132 shall be demolished above ceiling and where exposed on exterior wall. Contractor shall patch wall per architectural requirements.
- Item #7 Refer to the drawings, sheet M3.0

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- A. Refer to plan south CAS-1 unit, located in CORRIDOR A CA, adjacent to COOLER 175F and BOYS LOCKER ROOM 136. Contractor shall route condensate from CAS-1 unit plan east into BOYS LOCKER ROOM 136 and tie line into the condensate line that routes plan north into MECHANICAL 134.
- B. Refer to EF-1 located in STAFF LOCKER ROOM 175C. Contractor shall provide manufacturer's wall toggle switch to control the exhaust fan.
- C. Refer to EF-2 located in ICE MACHINE 176. Contractor to provide manufacturer's wall toggle switch to control the exhaust fan.
- Item #8 Refer to the attached revision drawing, sheet M3.0R1.
- Item #9 Refer to the drawings, sheet M3.2
 - A. Coordinate location of pipe curb for CU-1 refrigerant piping such that it does not interfere with required equipment access for RTU-2.
 - B. Tagged note A38 shall read DEMOLISH EXISTING EXHAUST FAN IF ALT#1 IS ACCEPTED. EXISTING ROOF CURB TO REMAIN. CAP ROOF CURB WITH INSULATED SHEET METAL. CAP AIR AND WATER TIGHT. REFER TO SHEET M3.3.
- Item #10 Refer to the drawings, sheet M3.3
 - A. Transfer air ducts and associated transfer grilles shall be provided per Ducted Return/Exhaust/Relief Air Grille Detail.
 - B. Provide internal insulation for transfer grille plenum boxes and ductwork connecting transfer grilles per the below specification.

INTERNAL INSULATION (ACCOUSTICAL)

(1) Transfer air ductwork and transfer grille plenum boxes.

Duct liner shall be 1 ¹/₂" thick Armacell Coilflex duct liner or equalwith factory-applied edge coating or approved equivalent. The liner shall meet NFPA 90A and 90B, FHC 25/50 and Limited Combustibility and the airstream surface coating should contain an immobilized, EPA-registered, anti-microbial agent so it will not support microbial growth as tested in accordance with ASTM G21 and G22, UL 181. The duct liner shall conform to the requirements of ASTM C 1071, with an NRC not less than .60 as tested per ASTM C 423 using a Type "A" mounting, and a thermal conductivity no higher than .25 mean temperature. Minimum R-value of the 1 ¹/₂" thick insulation shall be 6.0. <u>All</u> exposed edges shall be sealed with edge treatment products in accordance with the manufacturer's recommendations. The duct size listed on the plans where internal insulation is used shall be the free area of the airstream.

- Item #11 Refer to the attached revision drawing, sheet M5.0R1.
- Item #12 Refer to the drawings, sheet M5.0.
 - A. Refer to HYDRONIC PIPING BRANCH DETAIL. Note indicating WHEN TRANSITIONING FROM HDPE TO STEEL PROVIDE THREADED, FUSED, BRASS FITTING shall be omitted.
- Item #13 Refer to the attached revision drawing, sheet M6.0R1.
- Item #14 Refer to the attached revision drawing, sheet M6.1R1.
- Item #15 Refer to the drawings, sheet M7.0.
 - A. Refer to ROOFTOP UNIT SCHEDULE. RTU-1 outside air damper shall be balanced to a minimum outside air flow of 1155 cfm. RTU-2 outside air damper shall balanced to minimum damper position.
 - B. Refer to EXHAUST FAN SCHEDULE. Remark 3 shall read PROVIDE MANUFACTURER'S TOGGLE SWITCH FOR CONTROLLING EXHAUST FAN, TYPICAL FOR EF-1 IN STAFF LOCKER ROOM 175C AND EF-2 IN ICE MACHINE 176.
 - C. Refer to WATER SOURCE HEAT PUMP SCHEDULE. Add remark 2. Provide console heat pumps with extended cabinet for housing condensate pump.
 - D. Refer to REGISTERS, GRILLES, AND DIFFUSERS. Delete Remark 4.
 - E. Refer to EXHAUST FAN SCHEDULE. Provide backdraft damper at the wall cap.
 - F. Refer to SPLIT SYSTEM INDOOR SCHEDULE AND SPLIT SYSTEM OUTDOOR SCHEDULE. Add remark 4. Provide manufacturer's recommended integral condensate pump. Power shall be provided via integral 208V contacts in wall mounted unit.

Item #16 Refer to attached revision drawing, sheet M7.0R1.

Item #13 All electrical drawings:

A. Refer to sheet G0.2 for phasing notes. Contractor shall refer to phasing plan extensively during construction.

- B. The following notes regarding wiremold shall apply to all sheets, lighting, power, systems, enlarged, etc.
 - i. WHERE LOCATED ON EXISTING CMU WALLS ROUTE CONDUCTORS AND CABLING IN METAL WIREMOLD. PAINT WIREMOLD TO MATCH FINAL WALL FINISH. WIREMOLD SHALL BE SINGLE CHANNEL LEGRAND V500/V700 SERIES (V500/V700 APPLIES TO LIGHT SWITCHES AND LIGHT FIXTURES ONLY).
 - ii. WHERE LOCATED ON EXISTING CMU WALLS ROUTE CONDUCTORS AND CABLING IN METAL WIREMOLD. LOCATE ALL LENGTHS OF VERTICAL WIREMOLD IN CORNER OF ROOM TO MINIMIZE APPEARANCE. PAINT WIREMOLD TO MATCH FINAL WALL FINISH. WIREMOLD SHALL BE MULTICHANNEL LEGRAND V2400D SERIES. COORDINATE BETWEEN POWER AND SYSTEMS PLANS FOR LINE AND LOW VOLTAGE DEVICES TO BE MOUNTED WITHIN SAME RUN OF WIREMOLD.
- Item #14 Refer to the drawing Sheet E1.0
 - A. For clarification, classroom projectors are provided and installed by the owner. AV cabling and terminations are provided by the contractor. Terminate AV cabling at owner provided projector mounting hardware. Coordinate with owner.
 - B. For clarification, security cameras are owner furnished, owner installed. Contractor shall provide conduit, cabling, and surge protection at camera locations shown on drawings.

Item #15 Refer to the drawing Sheet E2.0

A. Refer to tagged note ED7. Phasing of work shall occur during first week of Phase 1C per sheet G0.2. Downtime shall be limited to a maximum of one weekend. In lieu of a feeder tap, provide a 200A disconnect with double lugs and intercept panel P feeder and extend wiring to supply side of disconnect. Refeed panel P and panel G from load side of disconnect. Upon reinstallation of panel G feeder, remove panel G wiring from disconnect and reconnect to new feeder. Field verify location to install disconnect in mechanical room.

Item #16 Refer to the drawing Sheet E3.0

- A. Refer to Cafeteria 172. Revise the A3 fixture in each corner, four total, to be A3E with an integral 1400 lumen battery pack with self-diagnostics features. These four fixtures shall also be on a night-lighting zone. Provide separate lighting relay for these 4 fixtures. During occupied hours these fixtures shall be programmed to operate with the fixtures of the adjacent zone. During unoccupied hours these fixtures shall come on to 50% brightness and remain on until occupied hours are resumed.
- B. From the bottom left corner, revise the third fixture to the right, third fixture up to be A3E.
- C. From the top right corner, revise the third fixture to the left, third fixture down to be A3E.

Item #17 Refer to the drawing Sheet E4.0

- A. Refer to IDF 171. Provide dedicated 120V circuit for BMS located on plywood backboard in this room. Extend 3#12 in ¾" conduit to 20A/1P breaker in panel P1.
- B. Refer to ELECT 172A. Delete junction box indicated by tagged note 'E25'. SS-1 deleted as part of this addendum.
- C. Refer to LOCKER ROOM 175C. Provide rough-in for EF-1 exhaust fan toggle switch. Install switch and provide wiring between switch and fan. Refer to mechanical addenda items for additional information.
- D. Refer to ICE MACHINE 176. Provide rough-in for EF-2 exhaust fan toggle switch. Install switch and provide wiring between switch and fan. Refer to mechanical addenda items for additional information.
- E. Provide power to trap primer located in MECHANICAL 134. Extend 2#12, #12 ground in ³/₄" conduit to 20A/1P breaker in panel P. Provide 120V snap switch on trap primer.

Item #18 Refer to the drawing Sheet E4.1

- A. Delete circuits P1-13,15 and P1-17,19. Condensing units deleted as part of this addendum. Provide four 20A/1P breakers in panel P1 in place of deleted circuits.
- B. Rooftop receptacle circuit shall be K1-20.
- C. Provide circuit and NEMA 4X disconnect for kitchen hood exhaust fan EF-1. Extend 4#12, #12 ground in ¾" conduit from fan to panel K2. Provide 15A/3P breaker in panel. Refer to food service drawings for additional information and requirements. Refer to tagged note E13 for additional notes on operation. Provide Cooper B-Line Dura-Blok DB_DS rooftop support system for mounting of disconnect. Provide weather proof GFI receptacle and mount on rooftop support system. Connect receptacle to circuit K1-20. Provide Thybar TCC booted pipe curb for conduit penetration. Coordinate with kitchen equipment contractor.

- D. Provide Cooper B-Line Dura-Blok DB_DS rooftop support system and locate service receptacle serving RTU-2 and CU-1 on Unistrut framing of system. Locate CU-1 equipment disconnect on same system. Locate DB_DS support system over Thybar pipe curb serving CU-1 refrigerant piping and utilize booted pipe curb for roof penetration. Coordinate with mechanical contractor.
- E. Provide Cooper B-Line Dura-Blok DB_DS rooftop support system and locate service receptacle serving HP-1 on Unistrut framing of system. Locate HP-1 equipment disconnect on same system. Locate DB_DS support system over Thybar pipe curb serving HP-1 refrigerant piping and utilize booted pipe curb for roof penetration. Coordinate with mechanical contractor.
- F. Provide Cooper B-Line Dura-Blok DB_DS rooftop support system and locate service receptacle serving RTU-1 on Unistrut framing of system. Provide Thybar TCC series booted pipe curb for roof penetration near RTU-1 and locate DB_DS support system over pipe curb.
- G. Provide Cooper B-Line Dura-Blok DB_DS rooftop support system and locate service receptacle serving freezer/cooler condensers on Unistrut framing of system. Locate condenser disconnects on same system. Provide Thybar TCC series booted pipe curb for roof penetration near condensers and locate DB_DS support system over pipe curb. Coordinate with kitchen equipment contractor.
- H. Provide Cooper B-Line Dura-Blok DB_DS rooftop support system and locate service receptacle serving kitchen hood make-up air unit on Unistrut framing of system. Locate make-up air unit disconnect on same system. Provide Thybar TCC series booted pipe curb for roof penetration near make-up air unit and locate DB_DS support system over pipe curb. Coordinate with kitchen equipment contractor.
- I. Coordinate installation of Thybar TCC booted pipe curbs with roofing contractor to ensure proper flashing.

Item #19 Refer to the drawing Sheet E5.0

- A. Provide duct smoke detectors for RTU-1 and RTU-2. Connect to fire alarm control panel. Coordinate installation with mechanical contractor.
- B. Refer to IDF 171. Provide data drop to BMS located on plywood backboard in this room.
- C. Refer to view 2 FIRST FLOOR SYSTEMS PLAN AG BUILDING. Delete the following wall mount speaker strobe fire alarm devices:
 - i. One outside Restroom 5.
 - ii. One in Classroom 2.
 - iii. Two in Weight Room 1.
- D. Delete the wall mount visual notification device in room directly adjacent to Classroom 2.
- E. Refer to view 1 FIRST FLOOR SYSTEMS PLAN. Delete the following wall mount speaker strobe fire alarm devices:
 - i. Four in Cafeteria 172.
 - ii. Three in Kitchen 175A.
 - iii. Three in Corridor CA.
 - iv. One in Corridor CB.
- F. Provide one additional ceiling mount speaker strobe in plan southeast corner of Cafeteria 172 and align with nearby speaker strobes.
- G. Delete all "DP" door position switches at exterior doors.

Item #20 Refer to the drawing Sheet E6.0

A. Refer to the enlarged IDF Room. The following notes shall be applicable to the scope of the IDF room:

GENERAL AESTHETICS NOTE:

THE INSTALLATION OF ALL EQUIPMENT, DEVICES, ETC., SHALL BE AS INDICATED ON E6.0 AND SHALL BE SUITABLE FOR A FINISHED SPACE. INSTALLATION SHALL BE IN A NEAT AND WORKMANLIKE MANNER. FINAL DETERMINATION OF THE ACCEPTABILITY OF THE QUALITY OF WORK AND THE MEANS AND METHODS UTILIZED SHALL BE BY THE ENGINEER. ANY WORK NOT APPROVED BY THE ENGINEER SHALL BE REMOVED AND REINSTALLED SATISFACTORILY.

GENERAL NOTE:

ALL CAT6 AND CAT6A CABLES SEEN IN THIS DIAGRAM SHALL BE LANDED ON INDIVIDUAL PATCH PANELS ACCORDINGLY BASED ON USE. DATA CIRCUITS SHALL GO TO DATA PATCH PANELS, VOICE CIRCUITS SHALL GO TO VOICE PATCH PANELS, WAP CIRCUITS SHALL GO TO WAP PATCH PANELS, AND SECURITY DATA CIRCUITS SHALL GO TO SECURITY PATCH PANELS, ETC. CABLES SHALL NOT BE MIXED AND MATCHED ON PATCH PANELS IF THEY ARE SERVING DIFFERENT SYSTEMS. PROVIDE PATCH PANELS AND PATCH CABLES AS NEEDED TO INSTALL ALL COMMUNICATION CABLES ACCORDINGLY. PATCH PANELS SHALL BE LABELED ACCORDINGLY AS "S" FOR SECURITY CAMERA OUTLETS, "V" FOR VOICE OUTLETS, "W" FOR WAP'S, AND "D" FOR ALL DATA.

GENERAL COMMUNICATIONS RISER DIAGRAM NOTES:

- A. QUANTITY OF PATCH PANELS SHALL BE DETERMINED BY CONTRACTOR. CONTRACTOR SHALL PROVIDE SUFFICIENT QUANTITY OF PATCH PANELS FOR 100% OF ALL TERMINATIONS PLUS 25% SPARE CAPACITY. CONTRACTOR SHALL QUANTIFY ALL VOICE, DATA, HVAC, WIRELESS ACCESS POINTS, ACCESS CONTROL, INTERCOM, LIGHTING, AND VIDEO (TV) CONNECTIONS FOR THE FULL COUNT.
- B. ALL PENETRATIONS THROUGH FLOORS OR WALLS SHALL BE FIRE STOPPED PER ELECTRICAL DETAILS AND SPECIFICATIONS. INSTALL FIRE STOP IN ACCORDANCE WITH MANUFACTURERS RECOMMENDATIONS.
- C. ALL SPARE CONDUITS AND INNERDUCTS SHALL BE PROVIDED WITH PULL WIRE.
- D. TOTAL DISTANCE FROM HORIZONTAL PATCH PANEL OR CROSS CONNECT TO WORKSTATION OUTLET SHALL NOT EXCEED 275' PER TIA/EIA.
- E. CONTRACTOR SHALL PROVIDE SUFFICIENT PATCH PANEL QUANTITIES TO ALLOW FOR 4 PAIRS OF EACH STATION CABLE PER EACH PORT. QUANTITY OF PATCH PANELS SHOWN ON RACK LAYOUTS ARE DIAGRAMMATIC ONLY.
- F. CONTRACTOR SHALL PROVIDE VERTICAL CABLE MANAGEMENT BETWEEN EACH EQUIPMENT RACK AND ON EACH END OF A SERIES OF EQUIPMENT RACKS.
- G. CONTRACTOR SHALL PROVIDE HORIZONTAL CABLE MANAGEMENT BETWEEN PATCH PANELS.
- H. DEVICE BOXES FOR VOICE AND DATA OUTLETS SHALL BE DUAL GANG, WITH SINGLE GANG PLASTER RINGS.
 I. COMMUNICATIONS CONDUIT, CABLE TRAYS AND WIRE WAYS SHALL BE CLEARLY IDENTIFIED AT EVERY JUNCTION BOX VIA A PAINTED SECTION, OR BY USE OF CONDUIT STICKERS INDICATING EACH CONDUIT RUN; BLUE FOR TELEPHONE, GREEN FOR COMPUTER, YELLOW FOR TELEVISION, ORANGE FOR FIBER OPTIC. ALL EQUIPMENT RACKS AND CONNECTING BLOCKS SHALL BE PROPERLY IDENTIFIED. MARKER IS TO BE A FLAT PIECE OF ALUMINUM OR STAINLESS STEEL). NAMING SCHEME IS AS FOLLOWS:
 - Rm#-D# (Room Number-Data Drop Number)
 - Rm#-V# (Room Number-Voice Drop Number)
 - Rm#-C# (Room Number-Camera Drop Number)
- J. ALL 1" CONDUITS SERVING VOICE AND DATA OUTLETS ROUTED ABOVE CEILING, SHALL HAVE NO MORE THAN 180 DEGREES OF BENDS.
- K. ALL 1" HORIZONTAL CONDUITS AND 4" RISER CONDUITS TERMINATING IN MDF OR IDF ROOM SHALL BE BONDED TO THE GROUND BUS WITH #6 INSULATED GROUND.
- L. CONTRACTOR SHALL PROVIDE PULL STRING ALONG WITH CABLING IN ALL CONDUITS FOR FUTURE WIRE PULLS.
- M. FIBER CABLING SHALL BE ARMORED OM3.
- N. FIBER TERMINATIONS SHALL BE TYPE SC.
- 0. PROVIDE 2M MULTIMODE FIBER OPTIC PATCH CABLES FOR EACH STRAND OF FIBER.
- P. THE FIBER OPTIC PATCH PANEL SHALL BE MOUNTED IN THE TOP POSITION OF THE RACK. THE FIRST PATCH PANEL CAN BE 48 PORT.
- Q. EACH END OF ALL CABLES AND ALL PAIRS SHALL BE LABELED AT THEIR TERMINATION LOCATIONS. WITHIN EACH ROOM, ALL PATCH PANELS SHALL BE MARKED ALPHABETICALLY AND BEGIN CLOCKWISE AROUND THE ROOM, ALL JACKS WITHIN EACH LOCATION SHALL BE LABELED NUMERICALLY, E.G. THROUGH THE MAIN ENTRANCE TO THE LEFT, JACKS SHALL READ 102-A1, 102-A2, 102-B1, 102-B1, ETC. ALL MODULAR JACK ASSEMBLIES SHALL BE LABELED AND IDENTIFIED. ACTUAL ROOM NUMBERS SHALL BE UTILIZED.
- R. PROVIDE FACTORY SWEEPS 45'S AND 90'S FOR ALL CABLE TRAY TURNS. USE END OF TRAY TERMINATIONS WHERE WIRES DROP DOWN TO WALLS.
- S. CABLE COLORS SHALL BE PER SYSTEM COLOR LEGEND ON SHEET E1.0.
- T. PROVIDE RACK MOUNT SURGE PROTECTION FOR ALL EXTERIOR DATA DROPS. REFER TO SPECIFICATIONS FOR MORE INFORMATION.

Item #21 Refer to the drawing Sheet E6.1

- A. Refer to view 1 ALTERNATE #2 FIRST FLOOR ELECTRICAL DEMOLITION PLAN.
 - i. Revise note ED10 to read "DEMOLISH FIRE ALARM ANNUNCIATOR, PULLSTATION, AND NOTIFICATION DEVICE FOR INSTALLATION OF NEW DOOR. MAINTAIN INITIATION DEVICE CIRCUIT AND ANNUNCIATOR CIRCUIT FOR INSTALLATION OF NEW DEVICES IN SAME LOCATION. REWORK NOTIFICATION AS REQUIRED TO MAINTAIN DOWNSTREAM DEVICES. REFER TO ALTERNATE #2 SYSTEMS PLANS FOR NEW WORK IN THIS AREA."
- B. Refer to view 4 ALTERNATE #2 FIRST FLOOR SYSTEMS PLAN.
 - i. Delete the following wall mount speaker strobe fire alarm devices:
 - 1. One in FMD 102.
 - 2. One in First Aid 101.
 - 3. One in Vestibule L100.
 - ii. Relocate the two 2D data outlets in FMD 102 to the student workstations on the plan north wall.
 - iii. Locate the AV outlet at the teachers desk in FMD 102. Mount at same height as quadruplex receptacle and data outlet. Provide cabling types and faceplates as indicated on legend on sheet E1.0.
 - iv. Revise tagged note S34 to read "PROVIDE NEW PULL STATION IN WIREMOLD AND PAINT TO MATCH WALL FINISH. PROVIDE NEW FIRE ALARM ANNUNCIATOR COMPATIBLE WITH NEW FACP."
- C. Refer to view 8 ALTERNATE #1 BASEMENT SYSTEMS PLAN.
 - i. Delete the following wall mount speaker strobe fire alarm devices:
 - 1. One in each of the classrooms B101, B102, B103, and B104.

- 2. One in FRYSC B105.
- ii. The data outlets in classrooms B101 and B102 serving the student workstations shall each be 2D in lieu of 1D as shown on drawings.
- iii. The data outlet in FRYSC B105 serving the office desk shall be a 2D in lieu of 1D as shown on the drawings.
- iv. Locate the AV outlet at the teachers desk in Classrooms B101, B102, B103, B104. Mount at same height as quadruplex receptacle and data outlet. Provide cabling types and faceplates as indicated on legend on sheet E1.0.
- D. Demolish the three wall mount horn strobes in Corridor B100 and provide five ceiling mount speaker strobe fire alarm devices in the corridor. Space evenly to provide adequate coverage for intelligibility.
- E. Provide a pull station in FRYSC B105 at the exterior door.
- F. Delete all "DP" door position switches at exterior doors.
- G. Where circuits are tagged with E26, delete circuit to panel P3 and P4. Existing circuits are to be reworked per tagged note E26.

Item #22 Refer to the drawing Sheet E6.3

- A. Replace drawing with Sheet E6.3 included in this addendum.
- Item #23 Refer to the drawing Sheet E8.0
 - A. Refer to fixture type E1. Evenlite Telesis Telesis TEBL3 shall be considered an equal in lieu of Emergensee SEEOE.

Item #24 Refer to the drawing Sheet E8.1

- A. Refer to view 1 EXISTING ONE-LINE DIAGRAM. Work regarding Panel P and Panel G shall be schedule and phased accordingly. Refer to the notes in this addendum and the drawings for additional information.
- B. Refer to panel schedules P3 and P4. The following circuits shall be deleted and the existing HVAC circuits shall be reused per tagged note ED13. Provide 20A/1P breakers in their place:
 - i. P3-31,33
 - ii. P3-35,37
 - iii. P3-34,36
 - iv. P3-38,40
 - v. P4-20,22
 - vi. PR-24,26
 - vii. P4-21,23,
 - viii. P4-25, 26

Item #25 Refer to the drawing Sheet P1.0

A. Refer to plumbing general notes, all plumbing fixtures with mixing valves shall be equipped with check valves on the domestic water lines serving the fixture.

Item #26 Refer to the drawing Sheet P2.0

- A. Refer to mechanical room 134, shift new floor drain over closer to the center of the mechanical room and add vent piping for the new floor drain. The vent piping shall be exposed in the corner of the room behind the water heater.
- B. Remove the existing gas flue for the old gas water heater.
- C. The domestic water piping, valves and vent piping shall be exposed on the wall for the new mop basin in mechanical room 134.
- D. The invert elevation depth of -4'-6" is approximate. The contractor shall adjust invert elevation based on the existing invert elevation from the 4" sanitary from the existing locker room.

Item #27 Refer to the drawing Sheet P2.1

- A. Existing roof, ceilings and walls shall be cut and repaired to match existing for the installation of new roof drains.
- B. A PPP electronic trap primer shall be installed and connected to new floor drain in mechanical room 134.
- C. Omit P-1 tag for the water closet in locker room restrooms.

Item #28 Refer to the drawing Sheet P3.1

- A. Refer to basement demolition plan, cap existing vent piping and gas piping, and remove which is not being used.
- B. Repair exiting floor slab, wall and ceilings to match existing as required.
- C. Refer to level 1 alternate, provide shut-off valves and balancing valves on domestic water lines.

Item #29 Refer to the drawing Sheet P4.0

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- A. Contractor shall contact Atmos Energy before connecting to existing gas line/meter
- B. Expansion loops and joints shall be installed in all strait runs of gas piping on roof.
- C. Provide gas service lines to MAU and range hood on roof.
- D. The new gas line is not being installed on a flat roof at one elevation. Contractor shall provide fittings and piping to install gas piping on roof at different elevations. Field verify exact routing.
- E. Roof supports shall be added for all expansion loops and joints.
- F. Provide pipe portal system for a weathertight seal for the gas line roof penetration.
- G. Connect new gas line to existing building with stainless steel pipe straps and paint piping to match color of existing building.

Item #30 Refer to the drawing Sheet P5.0

- A. Refer to sheet P2.1 for roof leader and overflow leader locations.
- B. Remove domestic water line drops from exterior wall.
- C. Provide shut-off valves on domestic water lines serving kitchen equipment and plumbing fixtures.
- D. Increase size of grease waste line from disposer from 3" to 4" before existing the building.
- E. Move 4" vent to 4" VTR to corner of ice machine room.

END OF ADDENDA ITEMS

SECTION 250200 - CONTROLS – DIRECT DIGITAL

1. GENERAL

- A. The Contractor shall furnish all labor, materials, equipment and services required to provide a complete Web based temperature control system as specified and as shown on the plans.
- B. Prior to the installation of or payment for any work, the Contractor shall prepare submittals which shall be reviewed by the Architect and Engineer. These submittals shall include a complete control diagram and sequence of operation of the entire system, plus engineering data on all devices used.
- C. The Contractor shall be a licensed installer of HVAC temperature controls by a national temperature controls manufacturer. Acceptable manufacturers are Siemens, Johnson, Andover, TAC, Automated Logic, Alteron, and Reliable. The installer shall have 5 years experience and installed a minimum of 8 systems of similar size. Their offices shall be within 150 miles of the project site.
- D. The system herein specified shall be free from defects in workmanship and material under normal use and service if, within twelve (12) months from the date of acceptance by the Engineer, any of the equipment herein described is proved to be defective in workmanship or material, it will be adjusted, repaired, or replaced free of charge by the Contractor.
- E. All equipment, unless specified to the contrary, shall be fully proportioning and adjustable. The Control System shall consist of all room thermostats, air stream thermostats, valves, damper operators, relays, freeze protection equipment, dampers, panels, and other accessory equipment not provided with the equipment to fill the intent of the specifications and drawings.
- F. All units, controls, equipment, heat pumps, etc., and controls shall reset automatically when power is restored after an outage.
- G. All control wiring concealed in walls and exposed in mechanical rooms, closets, etc., shall be in conduit. In the existing building, surface mount wiremold is acceptable where conduit cannot be installed in the block wall. Architect shall select color of wiremold. Provide plenum rated wiring where cable is concealed above ceilings. Do not paint wiring. The Contractor is responsible for protecting wiring from paint. Any painted cabling shall be replaced.
- H. All dampers shall be capable of operating properly with the system pressures encountered. This shall include modulating and shut-off functions.
- I. The Contractor shall also refer to the mechanical maintenance, HVAC equipment, and all other sections of the specifications for additional control requirements.
- J. Provide smoke detectors and shut down control for all air handling units and combined air systems as required by the KBC and IMC Section 606.
- K. All DDC controllers or control modules shall have covers to protect the circuit boards. All wiring shall be anchored securely within 6" of the controller.
- L. Provide all control dampers, etc. not supplied with the equipment or required to accomplish the sequences specified.

- M. The Contractor shall provide all refrigeration control and interlock wiring as recommended by the equipment manufacturer.
- N. Wiring and required conduit in connection with the control system(s), including power wiring of any voltage, shall be installed by the Contractor. The Contractor may, at his option, engage the Electrical Contractor to accomplish this work. It is emphasized however, that the Contractor is finally responsible for all such work.
- O. Electric power for the control panels, modules, unit controller, damper motors, etc., shall be derived from the building electric system. Power shall not be derived from the HVAC equipment power source or equipment low voltage transformers (internal or integral).
- P. The electrical work required for the installation of the control system(s), shall be provided by the Contractor in accordance with all National and Local Electrical Codes. All wiring shall be concealed except in Mechanical Rooms. All electrical work specified under this division of the specifications shall also comply with Division 16 of these specifications.
- Q. All exterior electrical work, equipment, etc. shall be waterproofed.
- R. Controls system and all related components shall comply with ASHRAE Standard 135 (BACnet protocol).

2. OWNER'S TRAINING

- A. The Contractor shall provide full instructions to designated personnel in the operation, maintenance, and programming of the system. The training shall be specifically oriented to the system and interfacing equipment installed. Eight hours of Owner Training shall be provided at substantial completion, again after 6 months (four hours) and (four hours) again 1 year after substantial completion. The Owner Training shall include an overview of the entire HVAC system operation, temperature sensor setpoint manipulation, critical alarm training and graphics display overview. Subcontractors shall be present during Owner training sessions.
- B. The Contractor shall provide a Sign-in Sheet and Meeting Minutes of the training. The Contractor shall also video tape the initial training sessions. Complete Operations and Maintenance Manuals shall be reviewed by the Contractor during training.
- **3.** CONTROL SYSTEM CHECKOUT AND TESTING BY CONTROLS CONTRACTOR PRIOR TO DEMONSTRATION AND ACCEPTANCE
 - A. Startup Testing. Complete startup testing to verify operational control system before notifying Owner of system demonstration. Provide Owner with schedule for startup testing. Owner may have representative present during any of all startup testing.
 - (1) Calibrate and prepare for service each instrument, control, and accessory equipment furnished under Section 250200.
 - (2) Verify that control wiring is properly connected and free of shorts and ground faults.

- (3) Enable control systems and verify each input device's calibration. Calibrate each device according to manufacturer's recommendations.
- (4) Verify that binary output devices such as relays, solenoid valves, two-position actuators and control valves, and magnetic starters, operate properly and that normal positions are correct.
- (5) Verify that analog output devices such as I/Ps and actuators are functional, that start and span are correct, and that direction and normal positions are correct. Check control valves and automatic dampers to ensure proper action and closure. Make necessary adjustments to valve stem and damper blade travel.
- (6) Prepare a log documenting startup testing of each input and output device, with technician's initials certifying each device has been tested and calibrated. Submit log to Engineer for review.
- (7) Verify that system operates according to sequences of operation. Simulate and observe each operational mode by overriding and varying inputs and schedules. Tune PID loops and each control routine that requires tuning.
- (8) Alarms and Interlocks.
 - a. Check each alarm with an appropriate signal at a value that will trip the alarm.
 - b. Trip interlocks using field contacts to check logic and to ensure that actuators fail in the proper direction.
 - c. Test interlock actions by simulating alarm conditions to check initiating value of variable and interlock action.

4. CONTROL SYSTEM DEMONSTRATION AND ACCEPTANCE

- A. Demonstration. Prior to acceptance, perform the following performance tests to demonstrate system operation and compliance with specification after and in addition to tests specified in Control System Checkout and Testing. Provide Engineer with log documenting completion of startup tests. Submission of log is required before Demonstration and Acceptance may begin.
 - (1) Engineer will be present to observe and review system demonstration. Schedule with Engineer at least 14 days before system demonstration begins. Systems balancing shall be complete prior to demonstration, coordinate scheduling with TAB agency accordingly.
 - (2) Demonstrate actual field operation of each sequence of operation as specified in these specifications. Provide at least two persons for one day each (16 man hours) to demonstrate calibration and response of any input and output points requested by Engineer. Provide and operate test equipment required to prove proper system operation. Specified on site time does NOT include time necessary to correct deficiencies.
 - (3) Demonstrate complete operation of operator interface.
 - (4) Demonstrate all alarms, including external alarms to Owner selected pagers, phones, e-mail accounts, etc. Also demonstrate fire alarm system interface.
 - (5) Tests that fail to demonstrate proper system operation shall be repeated after Contractor makes necessary repairs or revisions to hardware or software to successfully complete each test.
 - (6) Provide all required tools to perform system demonstration and point calibration (drills, duct plugs, thermometers, hygrometers, hand-held carbon dioxide sensors, aerosol test smoke, 2-way radios, water probes, DP sensors for water and air, etc.)
- B. Acceptance.
 - (1) After tests described in this specification are performed to the satisfaction of both Engineer and Owner, Engineer will accept control system. Engineer may exempt tests from completion

requirements that cannot be performed due to circumstances beyond Contractor's control. Engineer will provide written statement of each exempted test. Exempted tests shall be performed as part of warranty.

(2) System shall not be accepted until completed demonstration forms and checklists are submitted and approved as required in these specifications. Warrantee will not start until acceptance by Owner and Engineer.

5. EQUIPMENT

A. CONTROL PANEL(S)

(1) Each system shall be provided with a local panel for mounting of all relays, switches, controllers, and thermometers associated with that system. Where one cabinet will not accommodate all the equipment necessary for one system, a second cabinet shall be mounted and bolted adjacent to it. Cabinets shall be provided with a 2/3's door. All devices shall be provided with lamacoid plastic nameplates for identification.

B. THERMOSTATS

- (1) Variable Refrigerant Flow Heat Pump and Split Systems
 - a. All thermostats shall have an LED display. Variable Refrigerant Flow units shall be provided with the thermostats by the manufacturer. This thermostat shall allow the user to reset the temperature up or down via BAS headend. The digital thermostat shall be set up to be a space sensor not adjustable by occupants.
 - b. The thermostat shall have an integral thermometer.
 - c. All thermostats provided for the project shall be similar in size and appearance.
 - d. Provide tamper-proof guards for all wall mounted thermostats selected by Owner.
 - e. All thermostats shall be mounted on a plastic base or other insulating material to prevent wall coupling effect.
 - f. Thermostats shall be mounted with the top at a maximum of 48" A.F.F. and shall be mounted to comply with A.D.A.
 - g. Thermostats shall provide temperature deadband of 5° F as required by IECC 2003.
 - (2) Water Source Heat Pumps
 - a. All thermostats shall have an LED display. Water Source Heat Pump units shall be provided thermostats by the control's contractor. This control shall allow the space occupants to reset the temperature up or down a predetermined amount. This amount or no amount at all, shall be settable thru the BAS. Thermostats that are required to average temperature to controls a single heat pump shall tie to a control's contractor provided

controller and shall communicate an average temperature (single value setpoint) through the BMS headend back to their respective Water Source Heat Pump.

- b. The thermostat shall have an unoccupied override button and an integral communications port.
- c. The thermostat shall have an integral thermometer.
- d. All thermostats provided for the project shall be similar in size and appearance.
- e. Provide tamper-proof guards for all wall mounted thermostats selected by Owner.
- f. All thermostats shall be mounted on a plastic base or other insulating material to prevent wall coupling effect.
- g. Thermostats shall be mounted with the top at a maximum of 48" A.F.F. and shall be mounted to comply with A.D.A.
- h. Thermostats shall provide temperature deadband of 5° F as required by IECC 2003.
- (3) Cafeteria and Kitchen RTU units
- a. Thermostat shall have an LED display. Water Source Heat Pump units shall be provided thermostat by the control's contractor. This control shall allow the space occupants to reset the temperature up or down a predetermined amount. This amount or no amount at all, shall be settable thru the BAS. Thermostat shall report to both 10-ton gym units and factory mounted controller shall allow the gym units to stage and operate via a single thermostat.
- b. The thermostat shall have an unoccupied override button and an integral communications port.
- c. The thermostat shall have an integral thermometer.
- d. All thermostats provided for the project shall be similar in size and appearance.
- e. Provide tamper-proof guards for all wall mounted thermostats in the gym and cafeteria.
- f. All thermostats shall be mounted on a plastic base or other insulating material to prevent wall coupling effect.
- g. Thermostats shall be mounted with the top at a maximum of 48" A.F.F. and shall be mounted to comply with A.D.A.
- h. Thermostats shall provide temperature deadband of 5° F as required by IECC 2003.
- C. DAMPERS

(1) Several louvers of practical widths shall be provided for larger dampers. Modulating dampers shall have opposed blades. Dampers shall have edge and end seals. Dampers shall be Ruskin CD-60 or better. Maximum leakage rate shall be 2 CFM per square foot at 1" W.G. pressure differential for dampers greater than 12" wide. Leak rate for dampers 12" and less shall be 3 CFM per square foot. NOTE: Do not mount outside air dampers so close to water coils, piping, etc., that freeze-up may occur due to a leaky damper.

D. RELAYS AND SWITCHES

(1) Relays and switches shall be of the positive and gradual acting type and shall be furnished and installed as required for the successful operation of the system. All switches shall have suitable indicating plates.

E. VALVES

(1) All valves shall be of the fully modulating or 2-position and silent type unless otherwise specified. They shall provide accurate control of the heating or cooling medium under all load conditions. All valves 2-inches or smaller shall have brass or bronze bodies with screwed ends. Valves 2-1/2 inches and larger shall have iron bodies, brass or bronze trimming with flange ends. Valves shall be normally open or normally closed as required. Valves shall be installed with the stem in the upright position or as recommended by the valve manufacturer.

6. DESCRIPTION

- A. General: The control system shall be as indicated on the drawings and described in the specifications.
- B. Direct Digital Control (DDC) technology shall be used to provide the functions necessary for control of mechanical systems on this project.
- C. The control system shall accommodate simultaneous multiple user operation. Access to the control system data should be limited only by operator password. Multiple users shall have access to all valid system data. An operator shall be able to log onto any workstation on the control system and have access to all appropriate data.
- D. The control system shall be designed such that each mechanical system will be able to operate under stand-alone control. As such, in the event of a network communication failure, or the loss of any other controller, the control system shall continue to independently operate under control.
- E. Communication between the control panels and all workstations shall be over a high-speed network. All nodes on this network shall be peers. The operator shall not have to know the panel identifier or location to view or control an object. Application Specific Controllers shall be constantly scanned by the network controllers to update point information and alarm information.
- F. The documentation is schematic in nature. The Contractor shall provide hardware and software necessary to implement the functions and sequences shown.

1. WEB BROWSER CLIENTS

- (1) The system shall be capable of supporting an unlimited number of clients using a standard Web browser such as Internet ExplorerTM, FirefoxTM, or SafariTM. Systems requiring additional software (to enable a standard Web browser) to be resident on the client machine, or manufacture-specific browsers shall not be acceptable.
- (2) The Web browser software shall run on any operating system and system configuration that is supported by the Web browser. Systems that require specific machine requirements in terms of processor speed, memory, etc., in order to allow the Web browser to function with the FMCS, shall not be acceptable.
- (3) The Web browser shall provide the same view of the system, in terms of graphics, schedules, calendars, logs, etc., and provide the same interface methodology as is provided by the Graphical User Interface. Systems that require different views or that require different means of interacting with objects such as schedules, or logs, shall not be permitted.
- (4) The Web browser client shall support at a minimum, the following functions:
 - a. User log-on identification and password shall be required. If an unauthorized user attempts access, a blank web page shall be displayed. Security using Java authentication and encryption techniques to prevent unauthorized access shall be implemented.
 - b. Graphical screens developed for the GUI shall be the same screens used for the Web browser client. Any animated graphical objects supported by the GUI shall be supported by the Web browser interface.
 - c. HTML programming shall not be required to display system graphics or data on a Web page. HTML editing of the Web page shall be allowed if the user desires a specific look or format.
 - d. Storage of the graphical screens shall be in the Network Area Controller (NAC), without requiring any graphics to be stored on the client machine. Systems that require graphics storage on each client are not acceptable.
 - e. Real-time values displayed on a Web page shall update automatically without requiring a manual "refresh" of the Web page.
 - f. Users shall have administrator-defined access privileges. Depending on the access privileges assigned, the user shall be able to perform the following:
 - 1) Modify common application objects, such as schedules, calendars, and set points in a graphical manner.
 - (a) Schedule times will be adjusted using a graphical slider, without requiring any keyboard entry from the operator.
 - (b) Holidays shall be set by using a graphical calendar, without requiring any keyboard entry from the operator.
 - 2) Commands to start and stop binary objects shall be done by selecting the appropriate

command from the pop-up menu. No entry of text shall be required.

- 3) View logs and charts.
- 4) View and acknowledge alarms.
- 5) Setup and execute SQL queries on log and archive information.
- (5) The system shall provide the capability to specify a user's (as determined by the log-on user identification) home page. Provide the ability to limit a specific user to just their defined home page. From the home page, links to other views, or pages in the system shall be possible, if allowed by the system administrator.
- (6) Graphic screens on the Web Browser client shall support hypertext links to other locations on the Internet or on Intranet sites, by specifying the Uniform Resource Locator (URL) for the desired link.

2. ONSITE RESPONSIBILITY

- A. Project Management Services: The building automation contractor shall have a project manager assigned to this project and shall attend all pre-construction and construction progress meetings. The project manager shall supervise the installation of the complete temperature control system and shall be available to the mechanical contractor to answer any questions related to the installation and operation of the 100% outside air units with energy recovery, ventilation fans, VRF systems, RTU units , water source heat pumps, etc, and temperature control system.
- B. Owner Training Services: The building automation contractor shall provide the specified owner-training services for the controls furnished under this specification section. This contractor shall assemble representatives from all of the equipment and control device vendors and perform the owner training with their assistance. The temperature control contractor representative shall be present during all owner training of the VRV units, 100% outside air units with energy recovery, RTU units, ventilation fans, water source heat pumps, etc., and temperature control system.

3. QUALITY ASSURANCE

- A. System Installer Qualifications
 - 1. The Installer shall have an established working relationship with the Control System Manufacturer of not less than six years.
 - 2. The Installer shall have successfully completed Control System Manufacturer's classes on the control system. The Installer shall present for review the certification of completed training, including the hours of instruction and course outlines upon request.
 - 3. The installer shall have an office within 150 miles of the project site and provide 24-hour response in the event of a customer call.
 - 4. The list of acceptable manufacturers applies to operator workstation software, controller software, the custom application programming language, Building Controllers, Custom

Application Controllers, and Application Specific Controllers. All other products specified herein (i.e., sensors, valves, dampers, and actuators) need not be manufactured by the above manufacturers.

- B. Codes and Standards: Meet requirements of all applicable standards and codes, except when more detailed or stringent requirements are indicated by the Contract Documents, including requirements of this Section.
- 1. Underwriters Laboratories: Products shall be UL-916-PAZX listed.
- 2. National Electrical Code -- NFPA 70.
- 3. Federal Communications Commission -- Part J.
- 4. ASHRAE/ANSI 135-1995 (BACnet)
- 5. EIA 901.2 (LonTalk)
 - C. All products used in this installation shall be new, currently under manufacture, and shall be applied in similar installations for a minimum of 5-years. This installation shall not be used as a test site for any new products unless explicitly approved by the Owner's representative in writing prior to bid date. Spare parts shall be available for at least 5 years after completion of this contract.

4. SYSTEM PERFORMANCE

- A. Performance Standards. The system shall conform to the following:
 - 1. Graphic Display. The system shall display a graphic with a minimum of 20 dynamic points. All current data shall be displayed within 20 seconds of the request.
 - 2. Graphic Refresh. The system shall update all dynamic points with current data within 30 seconds.
 - 3. Object Command. The maximum time between the command of a binary object by the operator and the reaction by the device shall be 10 seconds. Analog objects shall start to adjust within 10 seconds.
 - 4. Object Scan. All changes of state and change of analog values shall be transmitted over the high-speed network such that any data used or displayed at a controller or workstation will be current, within the prior 60 seconds.
 - 5. Alarm Response Time. The maximum time from when an object goes into alarm to when it is annunciated at the workstation shall not exceed 45 seconds.
 - 6. Program Execution Frequency. Custom and standard applications shall be capable of running as often as once every 5 seconds. The Contractor shall be responsible for selecting execution times consistent with the mechanical process under control.
 - 7. Performance. Programmable Controllers shall be able to execute DDC PID control loops at a selectable frequency from at least once every 5 seconds. The controller shall scan

and update the process value and output generated by this calculation at this same frequency.

- 8. Multiple Alarm Annunciation. All workstations on the network shall receive alarms within 5 seconds of each other.
- 9. Reporting Accuracy. Table 1 lists minimum acceptable reporting accuracies for all values reported by the specified system.

 Table I -- Reporting Accuracy

Measured Variable	Reported Accuracy	
Space temperature	±0.5°C [±1°F]	
Ducted air	$\pm 1.0^{\circ}C$ [$\pm 2^{\circ}F$]	
Outside air	$\pm 1.0^{\circ}C$ [$\pm 2^{\circ}F$]	
Water temperature	$\pm 0.5^{\circ} C [\pm 1^{\circ} F]$	
Delta-T	$\pm 0.15^{\circ}C[\pm 0.25^{\circ}F]$	
Relative humidity	±5% RH	
Water flow	$\pm 5\%$ of full scale	
Air flow (terminal)	$\pm 10\%$ of reading *Note 1	
Air flow (measuring stations)	$\pm 5\%$ of reading	
Air pressure (ducts)	±25 Pa [±0.1 "W.G.]	
Air pressure (space)	±3 Pa [±0.01 "W.G.]	
Water pressure	$\pm 2\%$ of full scale *Note 2	
Electrical Power	5% of reading *Note 3	
Carbon Monoxide (CO)	\pm 50 PPM	
Carbon Dioxide (CO_2)	\pm 50 PPM	

Note 1: (10%-100% of scale) (cannot read accurately below 10%) Note 2: for both absolute and differential pressure Note 3: * not including utility supplied meters

5. SUBMITTALS

Contractor shall provide shop drawings and manufacturers' standard specification data sheets on all hardware and software to be provided. No work may begin on any segment of this project until the Engineer and Owner have reviewed submittals for conformity with the plan and specifications. An electronic copy shall be provided for review. All shop drawings shall be provided to the Owner electronically as pdf file formats.

Quantities of items submitted shall be reviewed by the Engineer and Owner. Such review shall not relieve the contractor from furnishing quantities required for completion.

Provide the Engineer and Owner, any additional information or data that is deemed necessary to determine compliance with these specifications or which is deemed valuable in documenting the system to be installed.

Submit the following within 60 days of contract award:

1. A complete bill of materials of equipment to be used indicating quantity, manufacturer and model number.

- 2. A schedule of all control valves including the valve size, model number (including pattern and connections), flow, CV, pressure rating, and location.
- 3. A schedule of all control dampers. This shall include the damper size, pressure drop, manufacturer and model number.
- 4. Provide manufacturers cut sheets for major system components. When manufacturer's cut sheets apply to a product series rather than a specific product, the data specifically applicable to the project shall be highlighted or clearly indicated by other means. Each submitted piece of literature and drawings shall clearly reference the specification and/or drawing that the submittal is being submitted to cover. Include:
 - a) Building Controllers
 - b) Custom Application Controllers
 - c) Application Specific Controllers
 - d) Operator Interface Computer
 - e) Portable Operator Workstation
 - f) Auxiliary Control Devices
 - g) Proposed control system riser diagram showing system configuration, device locations, addresses, and cabling.
 - h) Detailed termination drawings showing all required field and factory terminations. Terminal numbers shall be clearly labeled.
 - i) Points list showing all system objects, and the proposed English language object names.
 - j) Sequence of operations for each system under control. This sequence shall be specific for the use of the Control System being provided for this project.
 - k) Provide a BACnet Product Implementation Conformance Statement (PICS) for each BACnet device type in the submittal.
 - 1) Color prints of proposed graphics with a list of points for display.

Project Record Documents: Upon completion of installation submit one copy of record (as-built) documents. The documents shall be submitted for approval prior to final completion and include:

- 1. Project Record Drawings These shall be as-built versions of the submittal shop drawings. One set of electronic media including CAD .DWG or .DXF drawing files shall also be provided.
- 2. Testing and Commissioning Reports and Checklists.
- 3. Operating and Maintenance (O & M) Manual These shall be as built versions of the submittal product data. In addition to that required for the submittals, the O & M manual shall include:
 - a) Names, address and 24-hour telephone numbers of Contractors installing equipment, and the control systems and service representative of each.
 - b) Operators Manual with procedures of operating the control systems including logging on/off, alarm handling, producing point reports, trending data, overriding computer control, and changing set points and other variables.
 - c) Programming Manual with a description of the programming language including syntax, statement descriptions including algorithms and calculations used, point database creation and modification, program creation and modification, and use of the editor.

- d) Engineering, Installation and Maintenance Manual(s) that explains how to design and install new points, panels, and other hardware; preventative maintenance and calibration procedures; how to debug hardware problems; and how to repair or replace hardware.
- e) A listing and documentation of all custom software created using the programming language including the point database. One set of magnetic media containing files of the software and database shall also be provided.
- f) One set of electronic media containing files of all color-graphic screens created for the project.
- g) A list of recommended spare parts with part numbers and supplier.
- h) Complete original issue documentation, installation, and maintenance information for all third party hardware provided including computer equipment and sensors.
- i) Complete original issue media for all software provided including operating systems, programming language, operator workstation software, and graphics software.
- j) Licenses, Guarantee, and Warrantee documents for all equipment and systems.
- k) Recommended preventive maintenance procedures for all system components including a schedule of tasks (inspection, cleaning, calibration, etc.) time between tasks, and task descriptions.

Training Manuals: The Contractor shall provide a course outline and training manuals for all training classes at least six weeks prior to the first class. The Owner reserves the right to modify any or all of the training course outline and training materials. Review and approval by Owner and Engineer and shall be completed at least 3 weeks prior to first class.

6. WARRANTY

- A. Warrant all work as follows:
 - 1. Labor & materials for control system specified shall be warranted free from defects for a period of twelve (12) months after final completion acceptance by the Owner. Control System failures during the warranty period shall be adjusted, repaired, or replaced at no charge or reduction in service to the Owner. The Contractor shall respond to the Owner's request for warranty service within 24 hours during customary business hours.
 - 2. At the end of the final start-up/testing, if equipment and systems are operating satisfactorily to the Owner and Engineer, the Owner shall sign certificates certifying that the control system's operation has been tested and accepted in accordance with the terms of this specification. The date of Owner's acceptance shall be the start of warranty.
 - 3. Operator workstation software, project specific software, graphics, database, and firmware updates shall be provided to the Owner at no charge during the warranty period. Written authorization by Owner must, however, be granted prior to the installation of such changes.
 - 4. The system provider shall provide a web-accessible Users Network to give the Owner access to question/answer forum, graphics library, user tips, upgrades, and training schedules.

7. OWNERSHIP OF PROPRIETARY MATERIAL

- A. All project developed hardware and software shall become the property of the Owner. These include but are not limited to:
 - 1. Project graphic images,
 - 2. Record drawings,
 - 3. Project database,
 - 4. Job-specific application programming code,
 - 5. All documentation.

8. OPERATOR INTERFACES

- A. Graphical User Interface
 - 1. Contractor shall supply all necessary software, and interfaces to provide for the uploading/downloading of controller databases and programs, monitoring of all network variable types, including display of all bound SNVTs, monitoring and overrides of all controller physical input/output points, and editing of controller resident time schedules.
 - 2. BAS headend shall be located in IDF 171
- B. Workstation information access shall use the BACnet Protocol. Communication shall use Annex J of ASHRAE Standard 135-95. Local connections of the workstation shall be on ISO 8802-3 (Ethernet). Remote communications shall use either the BACnet Point to Point Physical/Data Link Layer Protocol or IP over Point to point (PTP).

9. SYSTEM SOFTWARE

- 1. Operating System. Furnish a commercially available, concurrent multi-tasking operating system. The operating system shall also support the use of other common software applications that operate under DOS or Microsoft Windows. The operating system shall be Windows XP Professional.
- 2. System Graphics. The Operator Workstation software shall be graphically oriented. The system shall allow display of up to 10 graphic screens at once for comparison and monitoring of system status. Provide a method for the operator to easily move between graphic displays and change the size and location of graphic displays on the screen. The system graphics shall be able to be modified while on line. An operator with the proper password level shall be able to add, delete, or change dynamic points on a graphic. Dynamic points shall include analog and binary values, dynamic text, static text, and animation files. Graphics shall have the ability to show animation of equipment. Graphics shall be capable of launching other PC applications.
 - a) Custom Graphics. Custom graphic files shall be created with the use of commonly available graphics packages such as PC Paint. The graphics generation package shall create and modify graphics that are saved in industry standard formats such as PCX, BMP, GIF and JPEG. The graphics generation package shall also provide the capability of capturing or converting graphics from other programs such as Designer, or AutoCAD.
 - b) Graphics Library. Furnish a complete library of standard HVAC equipment such as chillers, boilers, air handlers, terminals, fan coils, and unit ventilators. This

library shall also include standard symbols for other equipment including fans, pumps, coils, valves, piping, dampers, and ductwork. The library shall be furnished in a file format compatible with the graphics generation package program.

c) Engineering Units. Allow for selection of the desired engineering units (i.e. Inch pound or SI) in the system. Unit selection shall be able to be customized by locality to select the desired units for each measurement. Engineering units on this project shall be: Standard Inch Pound.

10. SYSTEM APPLICATIONS:

Each workstation shall provide operator interface and off-line storage of system information. Provide the following applications at each workstation.

- 1. Automatic System Database Save and Restore. Each workstation shall store on the hard disk a copy of the current database of each building controller. This database shall be updated whenever a change is made in any panel in the system. The storage of this data shall be automatic and not require operator intervention. In the event of a database loss in a building management panel, the first workstation to detect the loss shall automatically restore the database for that panel.
- 2. Manual Database Save and Restore. A system operator with the proper password clearance shall be able to archive the database from any system panel and store on magnetic media. The operator shall also be able to clear a panel database and manually initiate a download of a specified database to any panel in the system.
- 3. System Configuration. The workstation software shall provide a graphical method of configuring the system. The user with proper security shall be able to add new devices, and assign modems to devices. This shall allow for future system changes or additions.
- 4. On-Line Help and Training. Provide a context sensitive, on line help system to assist the operator in operation and editing of the system. On-line help shall be available for all applications and shall provide the relevant data for that particular screen. Additional help information shall be available through the use of hypertext. Provide an interactive tutorial CD, which will act as on-line training/help for the systems operator.
- 5. Security. Each operator shall be required to log on to the system with a user name and password in order to view, edit, add, or delete data. System security shall be selectable for each operator. The system supervisor shall have the ability to set passwords and security levels for all other operators. Each operator password shall be able to restrict the operator's access for viewing and/or changing each system application, full screen editor, and object. Each operator shall automatically be logged off of the system if no keyboard or mouse activity is detected. This auto logoff time shall be set per operator password. All system security data shall be stored in an encrypted format.

- 6. System Diagnostics. The system shall automatically monitor the operation of all workstations, printers, modems, network connections, building management panels, and controllers. The failure of any device shall be annunciated to the operator.
- 7. Alarm Processing. Any object in the system shall be configurable to alarm in and out of normal state. The operator shall be able to configure the alarm limits, warning limits, states, and reactions for each object in the system.
 - a) Alarm Reactions. The operator shall be able to determine what actions, if any, are to be taken, by object (or point), during an alarm. Actions shall include logging, printing, starting programs, displaying messages, dialing out to remote stations, texting, forwarding to an e-mail address, providing audible annunciation or displaying specific system graphics. Each of these actions shall be configurable by workstation and time of day. An object in alarm that has not been acknowledged within an operator specified time period shall be re-routed to an alternate operator specified alarm receipt device.
 - b) Binary Alarms. Each binary object shall be set to alarm based on the operatorspecified state. Provide the capability to disable alarming when the associated equipment is turned off or is being serviced.
 - c) Analog Alarms. Each analog object shall have both high and low alarm limits and warning limits. Alarming must be able to be automatically and manually disabled.
- 8. Trend Logs. The operator shall be able to define a custom trend log for any data in the system. This definition shall include interval, start-time, and stop-time. Trend intervals of 1, 5, 15, 30, and 60 minutes as well as once a shift (8 hours), once a day, once a week, and once a month shall be selectable. All trends shall start based on the hour. Each trend shall accommodate up to 64 system objects. The system operator with proper password shall be able to determine how many samples are stored in each trend. Trend data shall be sampled and stored on the Building Controller panel and be archived. Trend data shall be able to be viewed and printed from the operator interface software. Trends must be viewable in a text-based format or graphically. They shall also be storable in a tab delimited ASCII format for use by other industry standard word processing and spreadsheet packages.
- 9. Dynamic Graphical Charting. The operator shall be able to select system values to be charted in real time. Up to three values at one time can be selected for each chart. The type of chart (bar, line, 3-D, etc.) shall be selectable.
- 10. Alarm and Event Log. The operator shall be able to view all logged system alarms and events from any location in the system. The operator shall be able to sort and filter alarms. Events shall be listed chronologically. An operator with the proper security level may acknowledge and clear alarms. All that have not been cleared by the operator shall be archived to the hard disk on the workstation.
- 11. Object and Property Status and Control. Provide a method for the operator with proper password protection to view, and edit if applicable, the status of any object and property in the system. These statuses shall be available by menu, on graphics, or through custom programs.

- 12. Clock Synchronization. The real time clocks in all building control panels and workstations shall be synchronized on command of an operator. The system shall also be able to automatically synchronize all system clocks; daily from any operator designated device in the system. The system shall automatically adjust for daylight savings and standard time if applicable.
- 13. Reports and Logs. Provide a reporting package that allows the operator to select, modify, or create reports. Each report shall be definable as to data content, format, interval, and date. Report data shall be archived on the hard disk for historical reporting. Provide the ability for the operator to obtain real time logs of designated lists of objects. Reports and logs shall be stored on the PC hard disk in a format that is readily accessible by other standard software applications including spreadsheets and word processing. Reports and logs shall be readily printed to the system printer. The operator shall be able to designate reports that shall be printed or stored to disk at selectable intervals.
 - a) Custom Reports: Provide the capability for the operator to easily define any system data into a daily, weekly, monthly, or annual report. These reports shall be time and date stamped and shall contain a report title and the name of the facility.
- C. Workstation Applications Editors. Each PC workstation shall support full screen editing of all system applications. Provide editors for each application at the PC workstation. The applications shall be downloaded and executed at the appropriate controller panels.
 - 1. Controller. Provide a full screen editor for each type controller and application, that shall allow the operator with proper password to view and change the configuration, name, control parameters, and system set-points.
 - 2. Air System Equipment Coordination. Provide a full screen editor that allows equipment to be grouped for proper operation as specified in the sequence of operations. This shall include the coordination of VAV boxes with their associated Air Handling Equipment.
 - 3. Custom Application Programming. Provide the tools to create, modify, and debug custom application programming. The operator shall be able to create, edit, and download custom programs at the same time that all other system applications are operating. The system shall be fully operable while custom routines are edited, compiled, and downloaded. The programming language shall have the following features:
 - a) The language shall be English language oriented and be based on the syntax of programming languages such as BASIC. It shall allow for free form or fill in the blank programming. Alternatively, the programming language can be graphically-based using function blocks as long as blocks are available that directly provide the functions listed below, and that custom or compound function blocks can be created.
 - b) A full screen character editor/programming environment shall be provided. The editor shall be cursor/mouse-driven and allow the user to insert, add, modify, and delete code from the custom programming. It shall also incorporate word processing features such as cut/paste and find/replace.

- c) The programming language shall allow independently executing program modules to be developed. Each module shall be able to independently enable and disable other modules.
- d) The editor/programming environment shall have a debugging/simulation capability that allows the user to step through the program and to observe any intermediate values and or results. The debugger shall also provide error messages for syntax and execution errors.
- e) The programming language shall support conditional statements (IF/THEN/ELSE/ELSE-IF) using compound Boolean (AND, OR, and NOT) and/or relations (EQUAL, LESS THAN, GREATER THAN, NOT EQUAL) comparisons.
- f) The programming language shall support floating point arithmetic using the following operators: +, -, /, x, square root, and xy. The following mathematical functions shall also be provided: natural log, log, absolute value, and minimum/maximum value from a list of values.
- g) The programming language shall have pre-defined variables that represent clock time, day of the week, and date. Variables that provide interval timing shall also be available. The language shall allow for computations using these values.
- h) The programming language shall have ability to pre-defined variables representing the status and results of the System Software, and shall be able to enable, disable, and change the values of BACnet objects in the system.

11. SYSTEM SOFTWARE

- A. Furnish the following applications software for building and energy management. All software applications shall reside and run in the system controllers. Editing of applications shall occur at the operator workstation.
- B. System Security
 - 1. User access shall be secured using individual security passwords and user names.
 - 2. Passwords shall restrict the user to only the objects, applications, and system functions as assigned by the system manager.
 - 3. User logon/logoff attempts shall be recorded.
 - 4. The system shall protect itself from unauthorized use by automatically logging off following the last keystroke. The delay time shall be user definable.
- C. Scheduling. Provide the capability to schedule each object or group of objects in the system. Each of these schedules shall include the capability for start, stop, optimal start, optimal stop, and night economizer actions. Each schedule may consist of up to [10] events. When a group of objects are scheduled together, provide the capability to define advances and delays for each member. Each schedule shall consist of the following:
 - 1. Weekly Schedule. Provide separate schedules for each day of the week.

- 2. Exception Schedules. Provide the ability for the operator to designate any day of the year as an exception schedule. This exception schedule shall override the standard schedule for that day. Exception schedules may be defined up to a year in advance. Once an exception schedule is executed it will be discarded and replaced by the standard schedule for that day of the week.
- 3. Holiday Schedules. Provide the capability for the operator to define up to [99] special or holiday schedules. These schedules may be placed on the scheduling calendar and will be repeated each year. The operator shall be able to define the length of each holiday period.
- 4. Optimal Start/Stop. The scheduling application outlined above shall support an optimal start/stop algorithm. This shall calculate the thermal characteristics of a zone and start the equipment prior to occupancy to achieve the desired space temperature at the specified occupancy time. The algorithm shall calculate separate sets of heating and cooling rates for zones that have been unoccupied for less then and greater than 24 hours. Provide the ability to modify the start/stop algorithm based on outdoor air temperature. Provide an early start limit in minutes to prevent the system from starting before an operator determined time limit.
- D. Remote Communications. The system shall have the ability to email or text alarm message. The system shall use a priority array to determine which alarms to send out and to whom.

12. BUILDING CONTROLLERS

- A. General. Provide Building Controllers to provide the performance specified in section 1 of this division. Each of these panels shall meet the following requirements.
 - 1. The Building Automation System shall be composed of one or more independent, standalone, microprocessor based Building Controllers to manage the global strategies described in System software section.
 - 2. The Building Controller shall have sufficient memory to support its operating system, database, and programming requirements.
 - 3. The controller shall provide a communications port for connection of the Portable Operators Terminal.
 - 4. The operating system of the Controller shall manage the input and output communications signals to allow distributed controllers to share real and virtual point information and allow central monitoring and alarms.
 - 5. Controllers that perform scheduling shall have a real time clock.
 - 6. Data shall be shared between networked Building Controllers.
 - 7. The Building Controller shall continually check the status of its processor and memory circuits. If an abnormal operation is detected, the controller shall:
 - a) Assume a predetermined failure mode.
- b) Generate an alarm notification.
- 8. BACnet. The Building Controller shall use the Read (Initiate) and Write (Execute) Services as defined in these BIBBS:

DS-RP-A,B	
DS-RPM-A,B	
DS-WP-A,B	
DS-WPM-B	

- B. Communications. Each Building Controller shall reside on the Enterprise wide network, which is same high-speed network as the workstations. The Enterprise wide network will be provided by the owner and supports the Internet Protocol (IP). Local connections of the Building Controller shall be on ISO 8802-3 (Ethernet). Communications shall use Annex J of ASHRAE Standard 135-95. Each Building Controller shall also perform routing to a network of Custom Application and Application Specific Controllers. Each Building Controller shall perform communications to a network of Custom Application and Application Specific Controllers. Bach Building Controller shall perform communications to a network of Custom Application and Application Specific Controllers using LonTalk FTT-10 and LonMark profiles or BACnet.
- C. Environment. Controller hardware shall be suitable for the anticipated ambient conditions. Controller used in conditioned ambient shall be mounted in an enclosure, and shall be rated for operation at 0 C to 50 C [32 F to 120 F].
- D. Serviceability. Provide diagnostic LEDs for power, communications, and processor. All wiring connections shall be made to field removable, modular terminal strips or to a termination card connected by a ribbon cable.
- E. Memory. The Building Controller shall maintain all BIOS and programming information in the event of a power loss for at least 72 hours.
- F. Immunity to power and noise. Controller shall be able to operate at 90% to 110% of nominal voltage rating and shall perform an orderly shut-down below 80% nominal voltage
- 13. CUSTOM APPLICATION CONTROLLERS
 - A. General. Provide Custom Application Controllers to provide the performance specified in section 1 of this division. Each of these panels shall meet the following requirements.
 - 1. The Building Automation System shall be composed of one or more independent, standalone, microprocessor based Building Controllers to manage the local strategies described in System software section.
 - 2. The Controller shall have sufficient memory to support its operating system, database, and programming requirements.
 - 3. Controllers that perform scheduling shall have a real time clock.

- 4. The operating system of the Controller shall manage the input and output communications signals to allow distributed controllers to share real and virtual point information and allow central monitoring and alarms.
- 5. The Controller shall continually check the status of its processor and memory circuits. If an abnormal operation is detected, the controller shall:
 - a) Assume a predetermined failure mode.
 - b) Generate an alarm notification.
- 6. Custom application controllers shall communicate using LonTalk. Controllers shall use FTT-10 transceivers. All communications shall be with the use of LonMark-approved SNVTs.
- B. Environment. Controller hardware shall be suitable for the anticipated ambient conditions.
 - 1. Controller used in conditioned ambient shall be mounted in NEMA 1 type enclosures, and shall be rated for operation at 0 C to 50 C [32 F to 120 F].
 - 2. Controllers used outdoors and/or in wet ambient shall be mounted within NEMA 4 type waterproof enclosures, and shall be rated for operation at -40 C to 70 C [-40 F to 158 F].
- C. A local operator interface shall be provided at building locations where specified in the sequence of operations or point list. The operator interface shall be provided for interrogating and editing data. A system security password shall be available to prevent unauthorized use of the keypad and display.
- D. Serviceability. Provide diagnostic LEDs for power, communications, and processor. All low voltage wiring connections shall be made such that the controller electronics can be removed and/or replaced without disconnection of field termination wiring.
- E. Memory. The Controller shall maintain all BIOS and programming information in the event of a power loss for at least 72 hours.
- F. Immunity to power and noise. Controller shall be able to operate at 90% to 110% of nominal voltage rating and shall perform an orderly shutdown below 80% nominal voltage.

14. APPLICATION SPECIFIC CONTROLLERS

- A. General. Application specific controllers (ASC) are microprocessor-based DDC controllers, which through hardware or firmware design are dedicated to control a specific piece of equipment. They are not fully user programmable, but are customized for operation within the confines of the equipment they are designed to serve.
 - 1. Each ASC shall be capable of stand-alone operation and shall continue to provide control functions without being connected to the network.
 - 2. Each ASC will contain sufficient I/O capacity to control the target system.
- B. Environment. The hardware shall be suitable for the anticipated ambient conditions.

- 1. Controllers used outdoors and/or in wet ambient shall be mounted within NEMA 4 type waterproof enclosures, and shall be rated for operation at -40 C to 65 C [-40 F to 150 F].
- 2. Controller used in conditioned ambient shall be mounted in NEMA 1 type rated enclosures. Controllers located where not to be disturbed by building activity (such as above ceiling grid), may be provided with plenum-rated enclosures and non-enclosed wiring connections for plenum cabling. All controllers shall be rated for operation at 0 C to 50 C [32 F to 120 F].
- C. Serviceability. Provide diagnostic LEDs for power and communications. All wiring connections shall be clearly labeled and made to be field removable.
- D. Memory. The Application Specific Controller shall maintain all BIOS and programming information in the event of a power loss for at least 90 days.
- E. Immunity to Power and noise. Controller shall be able to operate at 90% to 110% of nominal voltage rating and shall perform an orderly shutdown below 80%.
- F. Transformer. Power supply for the ASC must be rated at minimum of 125% of ASC power consumption, and shall be fused or current limiting type.
- G. Application Specific Controllers shall communicate using LonTalk. Controllers shall use FTT-10 transceivers. All communications shall follow LonMark profiles. ASCs which do not have a profile that applies must comply with LonMark standards, utilize SNVTs for all listed points, and be provided with a XIF file for self-documentation.

15. COMMUNICATIONS

- A. This project shall comprise a network utilizing BACnet for communications between Building Controllers and PC Workstations. LonTalk or BACnet subnetworks shall be used for communications between Building Controllers, Custom Application Controllers and Application Specific Controllers.
- B. Each BACnet device shall operate on the BACnet physical/data link protocols specified for that device as defined earlier in this section.
- C. The owner will provide all communication media, connectors, repeaters, hubs, and routers necessary for the inter-network. A 10BaseT jack will be provided adjacent to each Building Control Panel and PC Workstation for connection to this network.
- D. All Building Controllers shall have a communications port for connections with the operator interfaces. This may be either an RS-232 port for Point to Point connection or a network interface node for connection to the Ethernet. Building controllers shall also have a LonTalk communications port which supports FTT-10.
- E. Communications services over the internetwork shall result in operator interface and value passing that is transparent to the internetwork architecture as follows:
 - 1. Connection of an operator interface device to any one controller on the internetwork will allow the operator to interface with all other controllers as if that interface were directly connected to the other controllers. Data, status information, reports, system software,

custom programs, etc., for all controllers shall be available for viewing and editing from any one controller on the internetwork.

- 2. All database values (i.e., points, software variable, custom program variables) of any one controller shall be readable by any other controller on the internetwork. This value passing shall be automatically performed by a controller when a reference to a point name not located in that controller is entered into the controller's database. An operator/installer shall not be required to set up any communications services to perform internetwork value passing.
- F. The time clocks in all controllers shall be automatically synchronized daily.

16. INPUT/OUTPUT INTERFACE

- A. Hard-wired inputs and outputs may tie into the system through Building, Custom, or Application Specific Controllers.
- B. All input points and output points shall be protected such that shorting of the point to itself, another point, or ground will cause no damage to the controller. All input and output points shall be protected from voltage up to 24V of any duration, such that contact with this voltage will cause no damage to the controller.
- C. Binary inputs shall allow the monitoring of on/off signals from remote devices. The binary inputs shall provide a wetting current of at least 12 ma to be compatible with commonly available control devices.
- D. Pulse accumulation input points. This type of point shall conform to all the requirements of Binary Input points, and also accept up to 2 pulses per second for pulse accumulation, and shall be protected against effects of contact bounce and noise.
- E. Analog inputs shall allow the monitoring of low voltage (0-10 Vdc), current (4-20 ma), or resistance signals (thermistor, RTD). Analog inputs shall be compatible with, and field configurable to commonly available sensing devices.
- F. Binary outputs shall provide for on/off operation, or a pulsed low voltage signal for pulse width modulation control. Binary outputs on custom and building controllers shall have 3-position (on/off/auto) override switches and status lights. Outputs shall be selectable for either normally open or normally closed operation.
- G. Analog outputs shall provide a modulating signal for the control of end devices. Outputs shall provide either a 0-10 Vdc or a 4-20 ma signal as required to provide proper control of the output device. Analog outputs on building or custom programmable controllers shall have status lights, a 2-position (auto/manual) switch, and manually adjustable potentiometer for manual override.

17. AUXILIARY CONTROL DEVICES

- A. Motorized dampers, unless otherwise specified elsewhere, shall be as follows:
 - 1. Damper frames shall be 16 gauge galvanized sheet metal or 1/8" extruded aluminum with reinforced corner bracing.

- 2. Damper blades shall not exceed 8" in width or 48" in length. Blades are to be suitable for medium velocity performance (2,000 fpm). Blades shall be not less than 16 gauge.
- 3. Damper shaft bearings shall be as recommended by manufacturer for application.
- 4. All blade edges and top and bottom of the frame shall be provided with compressible seals. Side seals shall be compressible stainless steel. The blade seals shall provide for a maximum leakage rate of 10 CFM per square foot at 2.5" w.c. differential pressure.
- 5. All leakage testing and pressure ratings will be based on AMCA Publication 500.
- 6. Individual damper sections shall not be larger than 48" x 60". Provide a minimum of one damper actuator per section.
- B. Control dampers shall be parallel or opposed blade types as scheduled on drawings.
- C. Electronic damper/valve actuators.
 - 1. The actuator shall have electronic overload or digital rotation sensing circuitry to prevent damage to the actuator throughout the rotation of the actuator.
 - 2. Where shown, for power-failure/safety applications, an internal mechanical, spring return mechanism shall be built into the actuator housing.
 - 3. All rotary spring return actuators shall be capable of both clockwise or counter clockwise spring return operation. Linear actuators shall spring return to the retracted position.
 - 4. Proportional actuators shall accept a 0-10 VDC or 0-20 ma control signal and provide a 2-10 VDC or 4-20 ma operating range.
 - 5. All 24 VAC/DC actuators shall operate on Class 2 wiring and shall not require more than 10 VA for AC or more than 8 W for DC applications. Actuators operating on 120 VAC or 230 VAC shall not required more than 11 VA.
 - 6. All non-spring return actuators shall have an external manual gear release to allow manual positioning of the damper when the actuator is not powered. Spring return actuators with more than 60 in-lb. torque capacity shall have a manual crank for this purpose.
 - 7. All modulating actuators shall have an external, built-in switch to allow the reversing of direction of rotation
 - 8. Actuators shall be provided with a conduit fitting and a minimum 1m electrical cable and shall be pre-wired to eliminate the necessity of opening the actuator housing to make electrical connections.
 - 9. Actuators shall be Underwriters Laboratories Standard 873 listed.
 - 10. Actuators shall be designed for a minimum of 60,000 full stroke cycles at the actuator's rated torque.

D. Control Valves

- 1. Control valves shall be two-way or three-way type for two-position or modulating service as scheduled or shown.
- 2. Close-off (differential) Pressure Rating: Valve actuator and trim shall be furnished to provide the following minimum close-off pressure ratings:
 - a) Water Valves:
 - i. Two-way: 150% of total system (pump) head.
 - ii. Three-way: 300% of pressure differential between ports A and B at design flow or 100% of total system (pump) head.
 - b) Steam Valves: 150% of operating (inlet) pressure.
- 3. Water Valves:
 - a) Body and trim style and materials shall be per manufacturer's recommendations for design conditions and service shown, with equal percentage ports for modulating service.
 - b) Sizing Criteria:
 - i. Two-position service: Line size.
 - ii. Two-way modulating service: Pressure drop shall be equal to twice the pressure drop through heat exchanger (load), 50% of the pressure difference between supply and return mains, or [5] psi, whichever is greater.
 - iii. Three-way Modulating Service: Pressure drop equal to twice the pressure drop through the coil exchanger (load), [5] psi maximum.
 - iv. Valves 1/2" through 2" shall be bronze body or cast brass ANSI Class 250, spring loaded, Teflon packing, quick opening for two-position service. Two-way valves to have replaceable composition disc, or stainless steel ball.
 - v. 2-1/2" valves and larger shall be cast iron ANSI Class 125 with guided plug and Teflon packing.
 - c) Water valves shall fail normally open or closed as scheduled on plans or as follows:
 - i. Heating coils in air handlers normally open.
 - ii. Chilled water control valves normally closed.
 - iii. Other applications as scheduled or as required by sequence of operation.
 - d) Zone valves shall be sized to meet the control application and they shall maintain their last position in the event of a power failure.

E. TEMPERATURE SENSORS

- 1. Temperature sensors shall be Resistance Temperature Device (RTD) or Thermistor.
- 2. Duct sensors shall be rigid or averaging as shown. Averaging sensors shall be a minimum of 1.5m [5 feet] in length.
- 3. Immersion sensors shall be provided with a separable stainless steel well. Pressure rating of well is to be consistent with the system pressure in which it is to be installed.

- 4. Provide matched temperature sensors for differential temperature measurement. Differential accuracy shall be within 0.1 C [0.2 F].
- F. HUMIDITY SENSORS
 - 1. Duct and room sensors shall have a sensing range of 20% to 80% with accuracy of \pm 5% R.H.
 - 2. Duct sensors shall be provided with a sampling chamber.
 - 3. Outdoor air humidity sensors shall have a sensing range of 20% to 95% R.H. It shall be suitable for ambient conditions of -40 C to 75 C [-40 F to 170 F].
 - 4. Humidity sensor's drift shall not exceed 1% of full scale per year.

G. CARBON DIOXIDE (CO2) SENSORS

- 1. Carbon Dioxide sensors shall measure CO2 in PPM in a range of 0-2000 ppm. Accuracy shall be +/- 2% of reading with stability within 3% over 5 years.
- 2. Devices shall be recalibrated six months and 12 months, 24 months, and 36 months after Substantial Completion by the Contractor. A Cal-Gas kit shall be used by contractor to calibrate each CO2 sensor in project scope. A calibration report will be provided to the owner.
- 3. Device shall have a field replaceable non-dispersive infrared sensing element (NDIR) to negate the need to replace the entire device upon sensor failure.
- 4. Provide in locations as shown on plans.
- 5. Provide 1 outdoor CO2 sensor which is designed to be installed and withstand outdoor elements to provide differential for CO2 demand control ventilation. This sensor shall be recalibrated in accordance to the above and will be provided with a 2-year warranty.

H. STATIC PRESSURE SENSORS

- 1. Sensor shall have linear output signal. Zero and span shall be field-adjustable.
- 2. Sensor sensing elements shall withstand continuous operating conditions plus or minus 50% greater than calibrated span without damage.
- 3. Water pressure sensor shall have stainless steel diaphragm construction, proof pressure of 150 psi minimum. Sensor shall be complete with 4-20 ma output, required mounting brackets, and block and bleed valves. Mount in location accessible for service.
- 4. Water differential pressure sensor shall have stainless steel diaphragm construction, proof pressure of 150 psi minimum. Over-range limit (DP) and maximum static pressure shall be 3,000 psi. Transmitter shall be complete with 4-20 ma output, required mounting brackets, and five-valve manifold. Mount in a location accessible for service.

I. LOW LIMIT THERMOSTATS

- 1. Safety low limit thermostats shall be vapor pressure type with an element 6m [20 ft] minimum length. Element shall respond to the lowest temperature sensed by any one foot section.
- 2. Low limit shall be manual reset only.

J. FLOW SWITCHES

- 1. Flow-proving switches shall be either paddle or differential pressure type, as shown.
- 2. Paddle type switches (water service only) shall be UL listed, SPDT snap-acting with pilot duty rating (125 VA minimum). Adjustable sensitivity with NEMA 1 Type enclosure unless otherwise specified:
- 3. Differential pressure type switches (air or water service) shall be UL listed, SPDT snapacting, pilot duty rated (125 VA minimum), NEMA 1 Type enclosure, with scale range and differential suitable for intended application, or as specified.
- 4. Current sensing relays may be used for flow sensing or terminal devices.

K. RELAYS

- 1. Control relays shall be UL listed plug-in type with dust cover. Contact rating, configuration, and coil voltage suitable for application.
- 2. Time delay relays shall be UL listed solid-state plug-in type with adjustable time delay. Delay shall be adjustable plus or minus 200% (minimum) from set-point shown on plans. Contact rating, configuration, and coil voltage suitable for application. Provide NEMA 1 Type enclosure when not installed in local control panel.

L. TRANSFORMERS and POWER SUPPLIES

- 1. Control transformers shall be UL listed, Class 2 current-limiting type, or shall be furnished with over-current protection in both primary and secondary circuits for Class 2 service.
- Unit output shall match the required output current and voltage requirements. Current output shall allow for a 50% safety factor. Output ripple shall be 3.0 mV maximum Peak-to-Peak. Regulation shall be 0.10% line and load combined, with 50 microsecond response time for 50% load changes. Unit shall have built-in over-voltage protection.
- 3. Unit shall operate between 0 C and 50 C.
- 4. Unit shall be UL recognized.

M. CURRENT SWITCHES

1. Current-operated switches shall be self-powered, solid state with adjustable trip current. The switches shall be selected to match the current of the application and output requirements of the DDC system.

N. LOCAL CONTROL PANELS

- 1. All indoor control cabinets shall be fully enclosed NEMA 1 Type construction with [hinged door], key-lock latch, and removable sub-panels. A single key shall be common to all field panels and sub-panels.
- 2. Interconnections between internal and face-mounted devices pre-wired with color-coded stranded conductors neatly installed in plastic troughs and/or tie-wrapped. Terminals for field connections shall be UL listed for 600-volt service, individually identified per control/interlock drawings, with adequate clearance for field wiring. Control termination's for field connection shall be individually identified per control drawings.
- 3. Provide on/off power switch with over-current protection and main air gauge for control power sources to each local panel.

18. EXAMINATION

- A. The project plans shall be thoroughly examined for control device and equipment locations, and any discrepancies, conflicts, or omissions shall be reported to the Architect/Engineer for resolution before rough-in work is started.
- B. The contractor shall inspect the site to verify that equipment is installable as shown, and any discrepancies, conflicts, or omissions shall be reported to the Architect/Engineer for resolution before rough-in work is started.

19. GENERAL WORKMANSHIP

- A. Install equipment, piping, wiring/conduit parallel to building lines (i.e. horizontal, vertical, and parallel to walls) wherever possible.
- B. Provide sufficient slack and flexible connections to allow for vibration of piping and equipment.
- C. Install all equipment in readily accessible location as defined by chapter 1 article 100 part A of the NEC. Control panels shall be attached to structural walls unless mounted in equipment enclosure specifically designed for that purpose. Panels shall be mounted to allow for unobstructed access for service.
- D. Verify integrity of all wiring to ensure continuity and freedom from shorts and grounds.
- E. All equipment, installation, and wiring shall comply with acceptable industry specifications and standards for performance, reliability, and compatibility and be executed in strict adherence to local codes and standard practices.

20. WIRING

A. All control and interlock wiring shall comply with the national and local electrical codes and Division 16 of these specifications. Where the requirements of this section differ with those in Division 16, the requirements of this section shall take precedence. Also refer to section 4 of this Specification section.

- B. Boxes and panels containing high voltage may not be used for low voltage wiring except for the purpose of interfacing the two (e.g. relays and transformers).
- C. All wire-to-device connections shall be made at a terminal blocks or terminal strip. All wire-to wire connections shall be at a terminal block, or with a crimped connector. All wiring within enclosures shall be neatly bundled and anchored to permit access and prevent restriction to devices and terminals.
- D. Maximum allowable voltage for control wiring shall be 120V. If only higher voltages are available, the Control System Contractor shall provide step down transformers.
- E. All wiring shall be installed as continuous lengths, where possible. Any required splices shall be made only within an approved junction box or other approved protective device.
- F. Install plenum wiring in sleeves where it passes through walls and floors. Maintain fire rating at all penetrations in accordance with other sections of this specification and local codes.
- G. Size of conduit and size and type of wire shall be the design responsibility of the Control System Contractor, in keeping with the manufacturer's recommendation and NEC.
- H. Control and status relays are to be located in designated enclosures only. These relays may also be located within packaged equipment control panel enclosures. These relays shall not be located within Class 1 starter enclosures.
- I. Follow manufacturer's installation recommendations for all communication and network cabling. Network or communication cabling shall be run separately from other wiring.
- J. Adhere to Division 16 requirements for installation of raceway.
- K. This Contractor shall terminate all control and/or interlock wiring and shall maintain updated (as-built) wiring diagrams with terminations identified at the job site.
- L. Flexible metal conduits and liquidtight, flexible metal conduits shall not exceed 3' in length and shall be supported at each end. Flexible metal conduit less than 1/2" electrical trade size shall not be used. In areas exposed to moisture, including chiller and boiler rooms, liquidtight, flexible metal conduits shall be used.
- M. New thermostats, sensors, etc. installed on existing wall shall be installed with concealed wiring.

21. FIBER OPTIC CABLE SYSTEM

- A. All cabling shall be installed in a neat and workmanlike manner. Minimum cable and unjacketed fibber bend radii as specified by cable manufacturer shall be maintained.
- B. Maximum pulling tensions as specified by the cable manufacturer shall not be exceeded during installation. Post installation residual cable tension shall be within cable manufacture's specifications.
- C. Fiber optic cabinets, hardware, and cable entering the cabinet shall be installed in accordance with manufacturers' instructions. Minimum cable and unjacketed fiber bend radii as specified by cable manufacturer shall be maintained.

22. INSTALLATION OF SENSORS

- A. Install sensors in accordance with the manufacturer's recommendations.
- B. Mount sensors rigidly and adequate for the environment within which the sensor operates.
- C. Room temperature sensors shall be installed on concealed junction boxes properly supported by the wall framing.
- D. All wires attached to sensors shall be air sealed in their conduits or in the wall to stop air transmitted from other areas affecting sensor readings.
- E. Install duct static pressure tap with tube end facing directly down-stream of air flow.
- F. Sensors used in mixing plenums, and hot and cold decks shall be of the averaging type. Averaging sensors shall be installed in a serpentine manner horizontally across duct. Each bend shall be supported with a capillary clip.
- G. All pipe mounted temperature sensors shall be installed in wells. Install all liquid temperature sensors with heat conducting fluid in thermal wells.
- H. Wiring for space sensors shall be concealed in building walls. EMT conduit is acceptable within mechanical and service rooms.
- I. Install outdoor air temperature sensors on north wall complete with sun shield at designated location.
- 23. FLOW SWITCH INSTALLATION
 - A. Install using a thread-o-let in steel pipe. In copper pipe use C x C x F Tee, no pipe extensions or substitutions allowed.
 - B. Mount a minimum of 5 pipe diameters upstream and 5 pipe diameters downstream or 2 feet whichever is greater, from fittings and other obstructions.
 - C. Install in accordance with manufacturers' instructions.
 - D. Assure correct flow direction and alignment.
 - E. Mount in horizontal piping flow switch on top of the pipe.

24. ACTUATORS

- A. Mount and link control damper actuators per manufacturer's instructions.
- B. To compress seals when spring return actuators are used on normally closed dampers, power actuator to approximately 5° open position, manually close the damper, and then tighten the linkage.

- C. Check operation of damper/actuator combination to confirm that actuator modulates damper smoothly throughout stroke to both open and closed positions.
- D. Valves Actuators shall be mounted on valves with adapters approved by the actuator manufacturer. Actuators and adapters shall be mounted following manufacturer's recommendations.
- 25. WARNING LABELS
 - A. Affix plastic labels on each starter and equipment automatically controlled through the Control System. Label shall indicate the following:

C A U T I O N This equipment is operating under automatic control and may start at any time without warning.

26. IDENTIFICATION OF HARDWARE AND WIRING

- A. All wiring and cabling, including that within factory-fabricated panels, shall be labeled at each end within 2" of termination with a cable identifier and other descriptive information.
- B. Permanently label or code each point of field terminal strips to show the instrument or item served.
- C. Identify control panels with minimum 1-cm letters on laminated plastic nameplates.
- D. Identify all other control components with permanent labels. Identifiers shall match record documents. All plug-in components shall be labeled such that removal of the component does not remove the label.

27. CONTROLLERS

- A. Provide a separate Controller for each major piece of HVAC equipment. Points used for control loop reset such as outside air or space temperature are exempt from this requirement.
- B. Building level Controllers shall be BACnet/IP. Local controllers for equipment may be BACnet/mstp or LON.
- C. Building Controllers and Custom Application Controllers shall be selected to provide a minimum of [15%] spare I/O point capacity for each point type found at each location. If input points are not universal, [15%] of each type is required. If outputs are not universal, [15%] of each type is required for each type of point used.
- D. Future use of spare capacity shall require providing the field device, field wiring, points database definition, and custom software. No additional Controller boards or point modules shall be required to implement use of these spare points.

28. PROGRAMMING

- A. Provide sufficient internal memory for the specified control sequences and trend logging. There shall be a minimum of 25% of available memory free for future use.
- B. Point Naming: System point names shall be modular in design, allowing easy operator interface without the use of a written point index.
- C. Software Programming
 - Provide programming for the system as per specifications and adhere to the strategy algorithms provided. All other system programming necessary for the operation of the system but not specified in this document shall also be provided by the Control System Contractor. Imbed into the control program sufficient comment statements to clearly describe each section of the program. The comment statements shall reflect the language used in the sequence of operations.
- D. Operators' Interface
 - 1. Standard Graphics. Provide graphics for each major piece of equipment and floor plan in the building. These standard graphics shall show all points dynamically as specified in the points list.
 - 2. The controls contractor shall provide all the labor necessary to install, initialize, start-up, and trouble-shoot all operator interface software and their functions as described in this section. This includes any operating system software, the operator interface database, and any third party software installation and integration required for successful operation of the operator interface.
 - 3. As part of this execution phase, the controls contractor will perform a complete test of the operator interface. Test duration shall be a minimum of 8 hours on-site. Tests shall be made in the presence of the Owner or Owner's representative.
- E. Demonstration: A complete demonstration and readout of the capabilities of the monitoring and control system shall be performed. The contractor shall dedicate a minimum of 16 hours on-site with the Owner and his representatives for a complete functional demonstration of all the system requirements. This demonstration constitutes a joint acceptance inspection, and permits acceptance of the delivered system for on-line operation.

29. CLEANING

- A. This contractor shall clean up all debris resulting from his or her activities daily. The contractor shall remove all cartons, containers, crates, etc. under his control as soon as their contents have been removed. Waste shall be collected and placed in a location designated by the Construction Manager or General Contractor.
- B. At the completion of work in any area, the Contractor shall clean all of his/her work, equipment, etc., making it free from dust, dirt and debris, etc.
- C. At the completion of work, all equipment furnished under this Section shall be checked for paint damage, and any factory finished paint that has been damaged shall be repaired to match the adjacent areas. Any metal cabinet or enclosure that has been deformed shall be replaced with new material and repainted to match the adjacent areas.

30. PROTECTION

- A. The Contractor shall protect all work and material from damage by his/her work or workers, and shall be liable for all damage thus caused.
- B. The Contractor shall be responsible for his/her work and equipment until finally inspected, tested, and accepted. The Contractor shall protect his/her work against theft or damage, and shall carefully store material and equipment received on site that is not immediately installed. The Contractor shall close all open ends of work with temporary covers or plugs during storage and construction to prevent entry of foreign objects.

31. FIELD QUALITY CONTROL

- A. All work, materials and equipment shall comply with the rules and regulations of applicable local, state, and federal codes and ordinances as identified in Part 1 of this Section.
- B. Contractor shall continually monitor the field installation for code compliance and quality of workmanship. All visible piping and or wiring runs shall be installed parallel to building lines and properly supported.
- C. Contractor shall arrange for field inspections by local and/or state authorities having jurisdiction over the work.
- 7. SEQUENCE OF CONTROL
 - A. Refer to control drawings.

END OF SECTION 250200

SECTION 270610 – VOICE/DATA SYSTEM

PART 1 - GENERAL SPECIFICATIONS

1.1 RELATED DOCUMENTS

- A. The Contractor is directed to examine each and every section of these specifications, all drawings relating to the Contract Documents, any and all Addenda, etc., for work described elsewhere that may relate to the provision of the work described herein. Materials and performance requirements are specified elsewhere herein that relate to these systems.
- B. The use of proprietary or copyrighted names or reference to patented trade items within this specification or elsewhere in the Contract Documents is meant to establish a standard of quality and performance. In no way does such use establish a restrictive competitive bidding situation, or exclude materials or equipment that is truly equivalent to the standard of quality. All materials and equipment proposed for installation must meet or exceed all specified requirements and be approved. Known equals are listed, but will require cut sheets with performance parameters to be submitted for final approval at least 10 days prior to bid.

1.2 SUMMARY

A. Section Includes:

- (a) Work Area Outlets
- (b) 110 Copper Termination Block & Patch Panels
- (c) Racks, Cabinets and Cable Management
- (d) Horizontal Distribution Cable
- (e) Backbone & DAS Cabling Cable
- (f) Fiber Optic Termination Hardware
- (g) Patch Cords and Fiber Jumpers
- (h) Pathways & Penetrations
- (i) Audio Visual Infrastructure
- (j) Power (UPS and PDU)
- (k) Grounding and Bonding
- (1) Copper Cable Protection Units
- (m) Firestopping
- (n) Cable System Identification System

1.3 SCOPE OF WORK

- A. The intent of this specification section is to cover the materials and installation of a structured cabling system and termination equipment as outlined herein and as detailed on the drawings. Work shall consist of
 - 1. Work area outlets including faceplates, jacks (voice, data, CATV, A/V), and labels. Boxes and conduit are being provided by Div 26 contractor.
 - 2. Voice and data copper station cabling from work area outlets to telecommunications rooms including termination testing and labeling.
 - 3. Voice and data work area equipment cords.
 - 4. Voice and data horizontal cross-connect jumpers and patch cables including labeling.
- B. System Description -- Voice and Data station cabling (copper) system shall consist of:

- 1. Workstation outlet jacks.
- 2. Voice and data station cabling as specified herein from each workstation outlet to the termination equipment located in the Main Distribution Frame (MDF) or the Intermediate Distribution Frame (IDF).
- 3. Station Cable Termination Equipment in each MDF and IDF.
- 4. Final connections of the station cabling at the workstation outlet jack and the termination equipment in each MDF and IDF.
- 5. Cross connects / patch cable to connect work area outlets to backbone / network electronics.
- 6. Testing and labeling.

1.4 REGULATORY REFERENCES:

- A. All work and materials shall conform in every detail to the rules and requirements of the National Fire Protection Association, the local Electrical Code and present manufacturing standards.
- B. All materials shall be UL or ETL Listed and shall be marked as such. If UL/ETL 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/ETL has an applicable system listing and label, the entire system shall be so labeled.
- C. All modular jacks, patch cords, consolidation point, and patch cords performance shall be verified (not just tested) by a third party to be category 6 (or 6A) component and channel compliant.
- D. The cabling system described in this is derived from the recommendations made in recognized telecommunications industry standards. The following documents are incorporated by reference:
 - 1. ANSI/TIA-568.0-D, Generic Communications Cabling for Customer Premises, September 2015
 - ANSI/TIA-568.1-D, Commercial Building Communications Infrastructure Standard September 2015
 - 3. ANSI/TIA-568.2-D, Balanced Twisted-Pair Telecommunications Cabling and Components Standard, September 2018
 - 4. ANSI/TIA-568.3-D, Optical Fiber Cabling Components Standard, September 2016
 - 5. ANSI/TIA-569-D, Telecommunications Pathways and Spaces, November 2015
 - 6. ANSI/TIA–606-C, Administration Standard for Communications Infrastructure, June 2017
 - 7. ANSI/TIA–607-C, Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises, November 2015
 - 8. ANSI/ TIA–758-B, Customer-Owned Outside Plant Telecommunications Infrastrucfure Standard, March 2014.
 - 9. ANSI/TIA-1179-A, Healthcare Facilities Telecommunications Infrastructure Standard, August 2017
 - 10. BICSI TDMM, Building Industries Consulting Services International, Communications Distribution Methods Manual (TDMM) 13th Edition.
 - 11. National Fire Protection Agency (NFPA 70)
 - 12. FCC 47 CFR 68
 - 13. NEMA 250
 - 14. NEC 2017
 - 15. ADA, Americans with Disabilities Act
- E. If this document and any of the documents listed above are in conflict, then the more stringent requirement shall apply. All documents listed are believed to be the most current releases of the documents. The Contractor has the responsibility to determine and adhere to the most recent release when developing the proposal for installation.
- F. This document does not replace any code, either partially or wholly. The contractor must be aware of local codes that may impact this project.

1.5 APPROVED VENDORS

- A. The Installation Vendors (Contractors) must at a minimum possess the following qualifications:
 - 1. Be in business a minimum of five (5) years
 - 2. Shall demonstrate satisfaction of sound financial condition and shall be adequately bonded and insured per owner's requirements.
 - 3. Possess those licenses/permits required to perform communications installations in the specified jurisdiction
 - 4. Personnel knowledgeable in local, state, province and national codes and regulations. All work shall comply with the latest revision of the codes and regulations. When conflict exists between local and national codes or regulations, the most stringent codes or regulations shall be followed.
 - 5. Must possess and provide proof of current owners insurance certificates
 - 6. Installers with RCDD on staff are preferred, at least one BICSI certified technician required.
 - 7. Must have prior experience with this type of installation or work activity. The customer may, with full cooperation of the contractor, visit client installations to observe equipment operations and consult with references. Specified visits and discussion shall be arranged through the contractors; however, the contractor's personnel shall not be present during discussions with references. The contractor must provide a minimum of three (3) references of similar jobs, one within the past 6 months and one at least 3 years ago where the same solution was installed.
 - 8. Documentation of ALL certifications to be provided in bid package
 - 9. Outside Plant Projects will be done by pre approved vendor according to demographic and size of project

1.6 WORK INCLUDED

- A. The work included under this specification consists of furnishing all labor, equipment, materials, and supplies and performing all operations necessary to complete the installation of this structured cabling system in compliance with the specifications and drawings. The Telecommunications contractor will provide and install all of the required material to form a complete system whether specifically addressed in the technical specifications or not.
- B. The work shall include, but not be limited to the following:
 - 1. Furnish and install a complete telecommunications wiring infrastructure.
 - 2. Furnish, install, and terminate all UTP and Optical Fiber cable
 - 3. Furnish and install all wall plates, jacks, patch panels, and patch cords.
 - 4. Furnish and install all required cabinets and/or racks as required and as indicated.
 - 5. Furnish any other material required to form a complete system.
 - 6. Furnish and install j-hooks where needed for the horizontal distribution
 - 7. Furnish and install all materials to build out the MDFs/IDFs as depicted on drawings
 - 8. Telecommunications contractor is responsible for the basket tray in MDFs/IDFs. The basket tray for the horizontal distribution may be done by or in coordination with the electrical contractor
 - 9. Perform link testing (100% of horizontal and/or backbone links/channels) and certification of all components.
 - 10. Furnish test results of all cabling to the owner electronically, listed by each closet, then by workstation ID.
 - 11. Adhere and comply with all requirements of Manufacturer Certification.

12. Provide owner training and documentation. (Testing documentation and As-built drawings)

1.7 SUBMITTALS

- A. Under the provisions of this request for proposal, prior to the start of work the telecommunications contractor shall:
 - 1. Submit copies of the certification of the company and names of staff that will be performing the installation and termination of the installation to provide proof of compliance of this spec.
 - 2. Submit proof from manufacturer of contractor's good standing in manufacturer's program.
 - 3. No substitutions/alternatives from the manufacturers listed in this document will be permitted. No substituted materials shall be installed except by written approval.
 - 4. Product Data: For each type of product indicated.
 - a. Submittals shall include manufacturer's data sheets (cut sheets) and be accompanied by a detailed bill of material, including part numbers and quantities.
 - 5. Shop Drawings:
 - a. System Labeling Schedules: Electronic copy of labeling schedules, in software and format selected by Owner.
 - b. Wiring diagrams to show typical wiring schematics including the following:
 - 1) Cross-connects.
 - 2) Patch panels.
 - 3) Patch cords.
 - c. Cross-connects and patch panels. Detail mounting assemblies, and show elevations and physical relationship between the installed components.
 - d. Cable tray layout, showing cable tray route to scale, with relationship between the tray and adjacent structural, electrical, and mechanical elements. Include the following:
 - 1) Vertical and horizontal offsets and transitions.
 - 2) Clearances for access above and to side of cable trays.
 - 3) Vertical elevation of cable trays above the floor or bottom of ceiling structure.
 - 4) Load calculations to show dead and live loads as not exceeding manufacturer's rating for tray and its support elements.
 - 6. Qualification Data: For Installer, qualified layout technician, installation supervisor, and field inspector.
 - 7. Source quality-control reports.
 - 8. Field quality-control reports.
 - 9. Maintenance Data: For connectors to include in maintenance manuals.
- B. Work shall not proceed without the Owner's approval of the submitted items.

1.8 QUALITY ASSURANCE

A. The work included under this specification consists of furnishing all labor, equipment, materials, and supplies and performing all operations necessary to complete the installation of this structured cabling system in compliance with the specifications and drawings. The contractor will provide and install all of the required material to form a complete system whether specifically addressed in the technical specifications or not. All installers must be employees of the contractor.

1.9 DELIVERY, STORAGE AND HANDLING

A. Cable shall be stored according to manufacturer's recommendations as a minimum. In addition, cable must be stored in a location protected from theft, 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 40 degrees F., the cable shall be moved to a heated (50 degrees F. minimum) location. If necessary, cable shall be stored off site at the contractor's expense.

B. If the telecommunications contractor wishes to have a trailer on site for storage of materials, arrangements shall be made with the Owner.

1.10 DRAWINGS

- A. It shall be understood that the electrical details and drawings provided with the specification package are diagrammatic. They are included to show the intent of the specifications and to aid the telecommunications contractor in bidding the job. The telecommunications contractor shall make allowance in the bid proposal to cover whatever work is required to comply with the intent of the plans and specifications.
- B. The contractor shall verify all dimensions at the site and be responsible for their accuracy.
- C. Prior to submitting the bid, the telecommunications contractor shall call the attention of the Engineer to any materials or apparatus the telecommunications contractor believes to be inadequate and to any necessary items of work

1.11 COORDINATION

- A. Coordinate layout and installation of communications equipment with Owner's telecommunications and LAN equipment and service suppliers.
 - 1. Meet jointly with telecommunications and LAN equipment suppliers, Engineer, and Owner to exchange information and agree on details of equipment arrangements and installation interfaces.
 - 2. Record agreements reached in meetings and distribute them to other participants.
 - 3. Adjust arrangements and locations of racks, sleeves, cross-connects, and patch panels in equipment rooms to accommodate and optimize arrangement and space requirements of utility demarcation, telephone and LAN equipment.
- B. Coordinate location of power raceways and receptacles with locations of communications equipment requiring electrical power to operate.

PART 2 - PRODUCTS

2.1 EQUIVALENT PRODUCTS

- A. Due to the nature and type of communications all products and solutions in this document have a standard of quality listed. Substitutions are listed, but products MUST demonstrate performance equivalency.
- 2.2 WORK AREA OUTLETS
 - A. Work area cables shall each be terminated at their designated work area location in the connector types described in the subsections below. Included are modular telecommunication jacks. These connector assemblies shall snap into a faceplate.
 - B. The Telecommunications Outlet Assembly shall accommodate:
 - 1. A minimum of two (2) modular jacks unless specified. Additional copper cables as necessary.
 - 2. A blank filler will be installed when extra ports are not used.
 - 3. The same orientation and positioning of jacks and connectors shall be utilized throughout the installation.
 - 4. The modular jack shall incorporate printed label strip on the dust cap module for identifying the outlet. Printed labels shall be permanent and compliant with ANSI/TIA–606-C standard specifications. Hand printed labels shall not be accepted.
 - C. Faceplates: Standard of quality is Legrand Part # OR-403HDJ14 (4 port) or OR-403HDJ12 (2 port) The faceplates shall:
 - 1. Be of the style as appropriate to fit the modular jack used
 - 2. Have mounting screws located under recessed designation windows.
 - 3. Comply with ANSI/TIA 606-C work area labeling standard.

- 4. Workstation Outlets: Connector assemblies mounted in faceplate. Provide number of ports as shown on the Drawings.
- 5. Retain one of first two subparagraphs below, or retain both as required to match Division 26 Section "Wiring Devices."
- 6. Plastic Faceplate: High-impact plastic.
- 7. For use with snap-in jacks accommodating any combination of UTP, F/UTP, optical fiber, and coaxial work area cords.
- 8. Acceptable substitutions are Systimax and Panduit
- D. Voice / Data Jacks: Standard of quality is Legrand Cat 6 for voice/data; Cat 6A for wireless access points
 - 1. Cat 6 Jacks: 100-ohm, unshielded balanced, twisted-pair connector; four-pair, eight-position modular. Comply with ANSI/TIA-568.2-D up to 250 MHz.
 - 2. All pair combinations must be considered, with the worst-case measurement being the basis for compliance. Modular jack performance shall be third-party verified by a nationally recognized independent testing laboratory.
 - 3. The modular jack shall be backwards compatible to Category 3, 5, and 5e.
 - 4. The modular jack shall be center tuned to category 6 test specifications.

Part Number	Description
OR-HDJ6-36	Legrand Category 6 T568A/B High Density (HD) Jack Blue (Data)
OR-HDJ6	Legrand Category 6 T568A/B High Density (HD) Jack Fog White (Voice)
OR-HDJ6 - xx	xx - Refer to systems plans for breakdown of systems by color.

5. Cat 6A jacks (qty 2) to be used for each Wireless Access Points

(to accommodate for speeds in excess of 1 Gigabit transmission).

- 6. Jacks: 100-ohm, unshielded balanced, twisted-pair connector; four-pair, eight-position modular. Comply with ANSI/TIA-568.2-D up to 500 MHz.
- 7. The modular jack shall be backwards compatible to Category 3, 5e and 6.
- 8. The Wireless Access Point jacks shall be terminated in a 2-port surface mount box.
- 9. The modular jack shall be center tuned to category 6A test specifications.

Part Number	Description
OR-HDJ6A-43	Legrand Category 6A T568A/B High Density (HD) Jack Orange (Wireless Access Points)

10. Acceptable substitutions are Systimax and Panduit

2.3 110 COPPER TERMINATION BLOCK

- A. The voice cross connect shall be a passive connection between the horizontal termination blocks and the backbone termination blocks. The wall mount frames shall be field terminated kits including all blocks, connecting blocks, and designation strips.
- B. Management rings shall be mounted between vertical columns of blocks to provide management of cross-connect wire.

- C. Backbone and horizontal blocks shall use 4-pair connecting blocks. Blocks shall be oriented so that backbone terminations are located on the left and horizontal frames are located on the right of the termination field when facing the frame assembly.
- D. Standard of quality: Legrand
- E. 110 Block Kits shall:
 - 1. include both the wiring block in a 50, 100 and 300 pair footprint and the connecting block C6110C5
 - 2. be manufactured using fire retardant molded plastic.
 - 3. support termination of 22-24 AWG solid conductor
 - 4. wiring block shall contain back openings for the feed through of cable
 - 5. have color-coded tips on the wiring block and color coding on the connector blocks for installation identification.
 - 6. shall use standard termination practice requiring a single conductor 110 impact tool
 - 7. have termination hardware that maintains the paired construction of the cable to facilitate minimum untwisting of the wires.
 - 8. be backwards compatible to category 3, 5 and 5e
- F. 110 Cross-Connect System Backboard Channels Shall
 - 1. be available in 300 and 900 pair sizes.
 - 2. allow the mounting of 110 100-pair blocks without legs.
 - 3. include bottom trough and grounding bar.
 - 4. be wall mountable.
 - 5. be of cold roll steel construction.
- G. 110 Wall Mount Vertical Trough Shall
 - 1. be available in single channel or dual channel configurations.
 - 2. in dual channel configuration shall be used to provide separation for different wiring media.
 - 3. be available in 300 pair and 900 pair sizes.
 - 4. be wall mountable.
 - 5. be used with wall mountable backboard channels. Acceptable configurations include a 300 pair and a 900 pair.
 - 6. be of cold roll steel construction.

Note: Project may require horizontal analog and backbone cables to be terminated on patch panels in IDF/MDF's. Contact Telecom Representative for details.

2.4 MODULAR PATCH PANELS

- A. The Modular Patch Panels shall
 - 1. meet category 6 or 6A component compliance and be verified by a third-party nationally recognized independent testing laboratory
 - 2. be backward compatible to category 3, 5 and 5e
 - 3. be center tuned to category 6 or 6A test specifications
 - 4. Standard of Quality is Legrand

Part Number	Description
OR-PSAHJU48	48 Port unloaded 2RU Angled Panel (for HD Jacks)

5. Acceptable Substitutions are Systimax or Panduit

2.5 RACKS, CABINETS, AND CABLE MANAGEMENT

The equipment rack shall provide vertical cable management and support for the patch cords at the front and back of the rack. Waterfall cable management shall be provided at the top of the rack to maintain proper bend radius and cable support. Wire management shall also be mounted above each patch panel and/or piece of equipment on the rack. The rack shall include mounting brackets for cable tray ladder rack to mount to the top of the rack.

- A. Free-Standing Rack shall:
 - 1. provide the necessary strain relief, bend radius and cable routing for proper installation of high performance cross connect products, meeting all specifications of ANSI/TIA 568-D.
 - 2. provide pre-drilled base for floor attachment of rack.
 - 3. be available in standard color of black or white.
 - 4. Provide channels with 10" depth for routing of horizontal cable
 - 5. Standard of quality for 2 and 4 post racks shall be Legrand.

Part Number	Description
OR-MM20710-B	Black 2 Post Rack, 7' high with 10" channel depth
OR-MM20742ADJ12-B	Adjustable 4 Post MM Rack, 7' high with tapped mounting holes
OR- MM20742ADJ38-B	Adjustable 4 Post MM Rack, 7' high with square mounting holes

- 6. Acceptable substitutions are Tripp Lite and Middle Atlantic
- B. The vertical and horizontal cable management shall be utilized and installed with the 2 and 4 post racks.
 - 1. They shall include snap on covers/doors that can swing either direction.
 - 2. Standard of quality for cable management shall be Legrand MM20 for vertical and SHMC series for horizontal.

Part Number	Description
OR-MM20VMD706-B	Single Sided 6" Vertical Cable Management with door, 6" W x 10.25" D x 7' H (for end of row or single racks)
OR- MM20VMD710-B	Single Sided Vertical Cable Management with door,10.5" W x 15"D x 7' H (for between racks)
OR-SHMC2RU	2U Horizontal cable manager to be used between patch panels and/or switch gear
OR-SHMC4RU	4U Horizontal cable manager to be used to pass patch cords from one side of the rack to the other

- 3. Acceptable substitutions are Tripp Lite and Middle Atlantic
- C. Wall Mounted Cabinet shall:
 - 1. provide the necessary strain relief, bend radius and cable routing for proper installation of high performance cross connect products, meeting all specifications of ANSI/TIA 568-D.
 - 2. have wall mount braces with locator posts for easy wall mounting.
 - 3. have side access points that allow for access to manage/install distribution cables in the vertical channels.
 - 4. be lockable.
 - 5. contain integrated vertical cable management
 - 6. The standard of quality for wall mount cabinet shall be Legrand:

Part Number	Description
SWM12RUPL-26-26	26"W x 25"H x 28"D, plexi-glass door 12 RU; 200 lbs*
SWM26RUPL-26-26	26"W x 28"D x 49.5"H, plexi-glass door 26 RU; 300 lbs*

*weight capacity

- 7. Acceptable substitutions are Tripp Lite and Middle Atlantic
- D. Free-Standing Cabinet shall have full flat mesh front door with locking swing handles
 1. Standard of quality is Legrand

Part Number	Description
OR-QC422442	Legrand Server Cabinet, free-standing, 42U, 24" W, 42"D, with
	side panels (cabinet accessories to be specified)
OR-QC422942	Legrand Network Cabinet, free-standing, 42 RU, 29.5" W, 42" D with side panels (cabinet accessories to be specified).

2. Acceptable substitutions are Middle Atlantic and Tripp Lite

2.6 HORIZONTAL DISTRIBUTION CABLE

- A. All horizontal data station cable and voice cable shall terminate on modular patch panels (copper), or patch/splice cabinets (fiber) in their respective MDF or IDF as specified on the drawings.
- B. Category 6 cable will be utilized for standard voice and data drops, and Category 6A cable will be utilized for wireless access points.
- C. Copper or fiber cable that offers EPDs (Environmental Product Declaration) and / or HPDs (Health Product Declaration) to apply toward LEED certification are PREFERRED.
 - 1. Products covered by EPDs and HPDs contribute towards one (1) point each in the Material and Resources credit (MRc) category for projects pursuing those credits
 - 2. Products that have both EPDs and HPDs will effectively contribute towards two (2) separate credits in the MR category
- D. 100 OHM Category 6 UTP with fire-resistant thermoplastic jacket **with separator or divider** between pairs.
 - 1. Physical Characteristics:

a.Plenum

- 1) Insulation FEP
- 2) Jacket: FR, low smoke PVC
- 3) Nominal Velocity of Propagation: 73
- b. Non Plenum
 - 1) Insulation: Polyolefin
 - 2) Jacket: FR PVC
 - 3) Nominal Velocity of Propagation: 70

c.Solid annealed copper conductors

- d. 23 AWG copper conductors
- e.Low-dielectric thermoplastic insulation

f. Pair-separator for improved performance

- g. Characteristic Impedance: 100 ± 15 Ohms
- h. Comply with UL 444
- i. Comply with NFPA 262
- j. Comply with ICEA S-90-661 for mechanical properties.

- k. Comply with ANSI/TIA-568.2-D for Category 6 UTP cables.
- 1. Verified for Category 6 performance by an NRTL
- m. RoHS compliant materials
- 2. Performance Characteristics:
 - a.Guaranteed electrical performance up to 400 MHz
 - b. Guaranteed 3 dB margin over ANSI/TIA-568.2-D requirements for NEXT and PSNEXT
 - c.Guaranteed 4 dB margin over ANSI/TIA-568.2-D calculated requirements for ACR and PSACRd. Printed with unique alpha-numeric code for each package of product
 - e.Printed in both feet and meters with the units of length decrementing to indicate the amount of cable remaining in the box.
 - f. Tip colors shall be a lighter version of the ring color.
 - g. **4 pair UTP for Wireless Access Points for speeds in excess of 1 Gigabit transmission (see section F for 6A specification)**: Cat 6A with isolation wrap (no ground required) or actual shield (needs grounding).
- 3. Design Make:

a.Standard of quality for Cat 6 is Superior Essex Datagain Cat 6 enhanced UTP.

Plenum Part Number	Description
66-240-2B	Data / Blue / CMP
66-240-4B	Voice / White CMP

Non-Plenum Part Number	Description
66-240-2A	Data / Blue / CMR
66-240-4A	Voice / White CMR

E. 100 OHM Category 6A UTP with fire-resistant thermoplastic jacket with separator or divider between pairs and isolation wrap.

- 1. Physical Characteristics:
 - a.Plenum
 - 1) Insulation FEP
 - 2) Jacket: FR, low smoke PVC
 - 3) Nominal Velocity of Propagation: 73
 - b. Non Plenum
 - 1) Insulation: Polyolefin
 - 2) Jacket: FR PVC
 - 3) Nominal Velocity of Propagation: 70
 - c.Solid annealed copper conductors
 - d. 23 AWG copper conductors
 - e.Low-dielectric thermoplastic insulation

f. Pair-separator for improved performance

- g. Characteristic Impedance: 100 ± 15 Ohms
- h. Comply with UL 444
- i. Comply with NFPA 262
- j. Comply with ICEA S-90-661 for mechanical properties.
- k. Comply with ANSI/TIA-568-C.2 for Category 6A UTP cables.
- 1. Verified for Category 6A performance by an NRTL
- m. RoHS compliant materials
- 2. Performance Characteristics:
 - a.Guaranteed electrical performance up to 400 MHz
 - b. Guaranteed 3 dB margin over ANSI/TIA-568.2-D requirements for NEXT and PSNEXT
 - c.Guaranteed 4 dB margin over ANSI/TIA-568.2-D calculated requirements for ACR and PSACR
 - d. Printed with unique alpha-numeric code for each package of product

e.Printed in both feet and meters with the units of length decrementing to indicate the amount of cable remaining in the box.

f. Tip colors shall be a lighter version of the ring color.

- g. 4 pair UTP for Wireless Access Points for speeds in excess of 1 Gigabit transmission: Cat 6A with isolation wrap (no ground required) or actual shield (needs grounding).
- 3. Design Make:

a.Standard of quality for Cat 6A Superior Essex 10GainXP Plenum (CMP) UTP w/ isolation wrap

Plenum Cat 6A Part #	Description
6H-272-2B	Wireless / Blue / CMP

Non-Plenum Cat 6A Part #	Description
6H-272-2A	Wireless / Blue / CMR

b. Acceptable Substitutions are Panduit or Systimax

2.7 BACKBONE CABLE

A. Intrabuilding multipair unsheilded twisted pair

- 1. General purpose 25 pair plenum Cat 5e (Superior Essex cmp part #51-478-48)
- 2. For higher pair counts when Cat 3 is acceptable; 100 pair category 3 plenum unshielded twisted pair (Superior Essex Category 3 cmp part number 18-799-36) may be used.

B. Fiber Optic Cables

- 1. Fiber cable that offers EPDs (Environmental Product Declaration) and / or HPDs (Health Product Declaration) to apply toward LEED certification are PREFERRED.
- 2. Products covered by EPDs and HPDs contribute towards one (1) point each in the Material and Resources credit (MRc) category for projects pursuing those credits
- 3. Products that have both EPDs and HPDs will effectively contribute towards two (2) separate credits in the MR category
- 4. **Multimode:** Armored Optical Fiber Plenum (OFCP) Tight Buffered With 10 Gigabit OM3 Laser Optimized 50/125 Optical Fibers
 - a. Each Multimode Fiber shall be:
 - 1) Graded-index optical fiber wave-guide with nominal 50/125µm-core/cladding diameter.
 - 2) The fiber shall comply with the latest revision of ANSI/TIA-492AAAC.
 - 3) Attenuation shall be measured in accordance with ANSI/TIA-455-78.
 - 4) Information transmission capacity shall be measured in accordance with ANSI/TIA-455-204 or -455-220.
 - 5) The measurements shall be performed at $23^{\circ}C \pm 5^{\circ}C$.
 - 6) Maximum attenuation dB/km @ 850/1300 nm: 3.5/1.5
 - 7) Bandwidth: 1500 MHz-km @ 850nm for overfilled launch,
 - 8) Bandwidth 500 MHz-km @ 1300nm.
 - 9) Optical Fiber shall be laser optimized and guaranteed for 40/100 Gigabit Ethernet distances of 100 meters
 - 10) Optical Fiber shall be laser optimized and guaranteed for 10 Gigabit Ethernet distances of 300m/300m for 850nm and 1300nm respectively

- 11) Optical Fiber shall be laser optimized and guarantee Gigabit Ethernet distances of 1000m/600m for 850nm and 1300nm respectively
- b. Physical Characteristics:
 - 1) Shall be suitable for use in indoor applications.
 - 2) Shall be suitable for use in risers, plenums and horizontal applications.
 - 3) Shall be available with a fiber strand count range from 6 to 144.
 - 4) Shall meet NFPA 626
 - 5) Shall comply with Telcordia GR-409.
 - 6) Shall comply with the requirements of ICEA S-83-596.
 - 7) Buffered fibers shall be color coded in accordance with TIA-598 with an overall aqua jacket.
 - 8) Shall have a central strength member
 - 9) Suitable for operation between -20° C to $+75^{\circ}$ C
 - 10) Shall meet UL 1569, UL 1651
 - 11) Shall be RoHS compliant
 - 12) Shall have spiral wrapped aluminum armor and outer jacket
- c. Design Make:
 - 1) Standard of quality for Premise Distribution optical fiber cable with OM3 laser optimized 50/125 micron multi mode fiber is Superior Essex, part numbers below:

Part Number	Description
L4012N401	12 strand armored laser optimized 50 micron multi mode
L4024NK1Q	24 strand armored laser optimized 50 micron multi mode
L4048N401	48 strand armored laser optimized 50 micron multi mode

2) Acceptable Substitutions are Systimax and Corning

5. Single Mode: Armored Optical Fiber Plenum (OFCP) Tight Buffered With Enhanced (Low Water Peak) Single-mode Optical Fibers

a.Each Single-mode Fiber shall be:

- 1) Class IVa dispersion unshifted single mode optical fibers with Low Water Peak complying with ANSI/ TIA-492CAAB-2000.
- 2) The zero dispersion wavelength shall be between 1300 nm and 1320 nm. The ANSI/TIA-455-168 maximum value of the dispersion slope shall be no greater than 0.090 ps/km-nm². Dispersion measurements shall be made in accordance with ANSI/TIA-455-169 or ANSI/TIA-455-175-B.
- 3) The nominal mode field diameter shall be 9.1 μ m with a tolerance of \pm 0.4 μ m at 1310 nm when measured in accordance with ANSI/TIA-455-191-B.
- 4) Transmission Characteristics:
- 5) Maximum cabled attenuation dB/km @ 1310/1550 nm: 0.7/0.7
- 6) The cabled cutoff wavelength shall be ≤1260 nm when measured in accordance with ANSI/TIA-455-80-C
- 7) Distance vs. bandwidth using a Laser transmitter operating at a 1310 nm wavelength
- b. Physical Characteristics:
 - 1) Shall be suitable for use in indoor applications.
 - 2) Shall be suitable for use in risers, plenums and horizontal applications.
 - 3) Shall be available with a fiber strand count range from 6 to 144.
 - 4) Shall comply with Telcordia GR-409.
 - 5) Shall comply with the requirements of ICEA S-83-596.

- 6) Buffered fibers shall be color coded in accordance with TIA-598 with an overall yellow jacket.
- 7) Shall have a central strength member
- 8) Suitable for operation between -20° C to $+75^{\circ}$ C
- 9) Shall meet UL 1569, UL 1651
- 10) Shall have spiral wrapped aluminum armor and outer jacket

c.Design Make:

1) Standard of quality for Armored Plenum Single Mode Low Water Peak is Superior Essex

Superior Essex Part Numbers

Part Number	Description
L4012K401	12 strand, Single-Mode armored plenum optical fiber
L4024KK1Q	24 strand, Single-Mode armored plenum optical fiber
2)	Acceptable Substitutions are TE Connectivity, Systimax and Corning

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C. DAS (Distributed Antenna System)

- 1. Regardless of which DAS active equipment is to be installed, (Andrews, Mobile Access, Tyco Electronics, etc) standard of quality for copper 6A or helix copper DAS cabling & connectors as well as fiber shall be Superior Essex & Legrand.
- 2. DAS Integrator will be required to work with **certified cabling** contractor for pulling of and termination of all DAS copper and fiber cabling infrastructure.

a.RF Feeder Infrastructure

- 1) Cable
 - a) LHF Series Low Loss High Flexible Foam Dielectric
 - b) HFSC Series Super Flexible Foam Dielectric
 - c) FTTA Fiber to the Antenna
- 2) Jumpers
 - d) Available in ³/₈ inch and ¹/₂ inch diameters, jumper cables are used in areas that require extremely small bending radius, such as between main feeders and antennas or between main feeders and RF equipment
- Connectors
 DIN Series for LHF and HFSC
 f)N Series for LHF and HFSC
- b. In Building Infrastructure
 - 1) Cable Available in Plenum or Riser
 - g) DAS Hybrid Fiber + Copper
 - h) LHF Riser Low Loss High Flexible Foam Dielectric
 - i)LHF Plenum Low Loss High Flexible Air Dielectric
 - j) HFSC Riser Super Flexible Foam Dielectric
 - k) HFSC Plenum Super Flexible Air Dielectric
 - 2) Jumpers Available in Plenum or Riser
 - a) Available in ½ inch diameters, jumper cables are used in areas that require an extremely small bending radius between main feeders and antennas or between main feeders and RF equipment.
 - 3) Connectors
 - a) DIN Series for LHF and HFSC

b) N Series for LHF and HFSC

2.8 FIBER OPTIC TERMINATION HARDWARE

A. FIBER OPTIC ENCLOSURES

- 1. Fiber optic termination hardware is rack mountable, lockable, and holds various coupler panels based on density requirements.
- 2. Fusion Splicing (splice cassettes, pigtails, or splice on connectors) shall be the preferred termination style for any new installations, unless otherwise stated.
- 3. Internal lighting for ease of use
- 4. Pivot arms for fiber slack management
- 5. Standard of quality is Legrand
- 6. Acceptable Substitutions are Systimax and Corning
- 7. Fiber Enclosures

Part Number	Description
OR-INFC01U-M4	1U combo splice/patch enclosure, holds 4 adapter panels,
OR-INFC02U-M4	2U combo splice/patch enclosure, holds 8 adapter panels,
OR-INFC04U-M4	4U combo splice/patch enclosure, holds 16 adapter panels,

B. Splice cassettes (used instead of standard fiber optic adaptor panels)

Part Number	Description
OR-M4LCD12-50ES2A1	Fusion Splice Cassette 50um Multimode 12 fiber LC
OR-M4LCD12-09S1A1	Fusion Splice Cassette Singlemode 12 fiber LC

Fan Out Kits (if needed to build up 250um fiber before termination)

Part Number	Description
OR-61500858	Breakout Kit 12 fiber

C. FIBER OPTIC ADAPTER PANELS (used w/ pigtail or splice on connector terminations)

Legrand Adapter panels will be of 6 duplex LC connectors (12 fibers) for both multimode and single mode connections.

Part Number	Description
OR-HDFP-LCD12LC	6-LC Duplex multimode, aqua adapters, ceramic sleeve 12 fiber
OR-HDFP-LCD12AC	6-LC Duplex Single mode, blue adapters, ceramic sleeve 12 Fiber
OR-HDFP-BLANK	Blank Filler modules

D. FIBER OPTIC PIGTAILS / CONNECTORS

- 1. For fiber **splicing**, utilize Legrand 12 strand LC fiber pigtails or fusion splice on connectors. Legrand part numbers:
- 2. When **mechanical** terminations are acceptable for MAC work, Utilize Legrand LC single mode (OR-205KNT9SA-09) and multimode (OR-205KNT9GA-50T) Infinium Connectors for standard terminations.

Part Number	Description
OR-P1TC4ZRSZZZ001M	12 strand Single mode LC fusion splice pigtail
OR-P1TF4ZRGZZZ001M	12 strand Multimode LC fusion splice pigtail
OR-205KNF9SA-09	Single mode fusion splice on connector,

OR-205KNF9FA-50T	Multi Mode fusion splice on connector
OR-205KNT9SA-09	LC Single mode Infinium mechanical connectors
OR-205KNT9GA-50T	LC Multimode Infinium mechanical connectors
0 1 11	

3. Acceptable Substitutions are Systimax and Corning

2.9 PATCH CORDS & FIBER JUMPERS

- A. The contractor shall provide factory terminated and tested UTP and optical fiber patch cords and equipment cords for the complete cabling system. The UTP patch cables shall meet the requirements of ANSI/TIA 568-D for patch cord testing.
- B. Copper (UTP) patch cords shall:
 - 1. Standard of quality is Legrand **Cat 6**; OR-MC6-zz-xx (zz=length; xx = color) and **Cat6A** for WAPs; OR-MC6A-zz-xx
 - 2. Standard lengths include, 3 ft, 5 ft, 7 ft, 9 ft, 10 ft, 15 ft.
 - 3. use 8 position connector with impedance matched contacts and designed using dual reactance.
 - 4. be constructed of 100 ohm, 4 pair, 24 AWG, stranded conductor, unshielded twisted pair copper per the requirements of the ANSI/TIA 568.2-D.
 - 5. meet TIA category 6 component specifications in ANSI/TIA 568.2-D
 - 6. 100% factory tested to meet category 6 performance and
 - 7. ETL or any other nationally recognized 3rd party verification
 - 8. be capable of universal T568A or T568B wiring schemes.
 - 9. Modular connector shall maintain the paired construction of the cable to facilitate minimum untwisting of the wires.
 - 10. have "snagless" protection for the locking tab to prevent snagging and to protect locking tab in tight locations and provide bend relief
 - 11. be backwards compatible to Category 3, 5 and 5e
 - 12. be manufactured by an ISO 9001 registered company.
 - 13. Provide one 10 foot Cat6 patch cord for every switch port.
 - 14. Provide one 7 foot Cat6 patch cord for every workstation phone and computer.
 - 15. Provide one 3 foot Cat6A patch cord for every wireless access point
 - 16. The contractor shall include the labor cost in the quote to install all patch cords in the wiring closets as well as the workstation and wireless access points.
 - 17. **Cat 6A copper patch cords for Wireless Access Points** for speeds in excess of 1 Gigabit transmission: Cat 6A Standard of Quality is Legrand. OR-MC6A-zz-xx
 - 18. Acceptable substitutions are Quiktron, Systimax and Panduit
- C. Fiber jumper cords shall:
 - 1. Standard of quality for Multimode duplex 5 meter 50 um 10 gig aqua for multimode applications is Legrand LC to LC (OR-P1DF2LRGZGZ005M).
 - 2. Provide four (4) duplex LC-LC 5 meter jumpers per switch in each TR.
 - 3. Standard of quality for Single Mode duplex 5 meter for single mode applications is Legrand LC to LC (OR-P1DC2IRSZSZ005M).
 - 4. Provide two (2) duplex LC-LC 5 meter jumpers per rack in each TR.
 - 5. Acceptable substitutions are Quiktron, Systimax and Corning

2.10 PATHWAYS & PENETRATIONS

A. Conduit

- 1. All conduit work shall meet the requirements of the National Electrical Code.
- All voice, data and video wiring inside rooms shall be protected by metallic conduit or other means such as Legrand/Wiremold or troughs in the floor. Aluminum is not acceptable in caustic environments. EMT conduit shall be used for all interior wiring. All conduits are to be concealed.
- 3. No more than an equivalent of two 90-degree bends are allowed in a run between junction boxes or pull boxes.
- 4. Entrance to junction boxes or distribution panels shall be adjacent to the corners.
- 5. In major renovation and new construction projects where the MDF/IDF are not in alignment, the contract shall include provisions for installation of four riser conduits (4 inches minimum diameter) from the MDF to each IDF. A pull string and appropriate junction pull box shall also be provided in each conduit run to facilitate future installation of cable(s). Maxcell fabric innerduct should be used to create multiple pathways in each 4" conduit.
- 6. All conduits in slab shall be a minimum of 1 inch. All exceptions shall be determined during the design stage of the project and shall be subject to the approval of the engineer.
- 7. All sleeves must protrude 4 inches AFF and below and be capped at both ends. Coordinate with customer for the number of conduits entering the facility. All sleeves <u>must</u> be bonded to the telecommunications bonding system.
- 8. No horizontal conduit run shall be more than 100 feet between pull boxes.
- 9. Pull boxes must be installed every 180 degrees or 100 feet of the conduit run. All conduit stubs <u>must</u> be bonded to the telecommunications grounding system.
- B. Conduit/Raceway Capacity
 - Conduit shall be sized using industry standard guidelines for telecommunications distribution methods. Guidelines can be found in the Building Industry Consulting Service International (BICSI) Telecommunications Distribution Methods Manual and/or cabling manufacturers' guidelines. Utilize Maxcell fabric innerduct to maximize conduit fills

Part Number / Series	Description
MXC4003 series	Standard 4" 3 Cell fabric innerduct
MXP4003 series	Plenum 4" 3 Cell fabric innerduct
MXR4003 series	Riser 4" 3 Cell fabric innerduct
MXD4003 series	Detectable 4" 3 Cell fabric innerduct
MXC3456 series	Standard 3" 3 Cell fabric innerduct
MXP3456 series	Plenum 3" 3 Cell fabric innerduct
MXR3456 series	Riser 3" 3 Cell fabric innerduct
MXD3456 series	Detectable 3" 3 Cell fabric innerduct

- C. Cable Trays
 - 1. Standard of quality for basket tray is **Cablofil.**
 - 2. All cable trays shall be designed to accommodate all types of cabling. Note that installation shall be in non-return air plenum space only. All telecommunications pathways (Caddy J-hooks, basket tray or Legrand/Wiremold raceways) shall be used for communications medium (voice, data and fiber optic cabling) only.
 - 3. The minimum dimensions for a cable tray shall be 12 inches wide and 4 inches deep. The tray must consist of continuous, rigid, welded steel or stainless steel wire mesh cable management system. The cable tray systems are defined to include, but are not limited to, straight sections, supports and accessories. Wire mesh cable tray will have continuous Safe-T-Edge T-welded top side

wire to protect cable insulation and installers. Basket tray shall be spliced using EDRNs on the sides as well as an SWK washer/nut in the bottom of the tray.

- 4. Contract documents shall show cross section of the communication wire way or cable tray. The drawing must show reference to other utilities in the building. All sections of the cable tray must be bonded together with approved bonding methods and devices. For installation of other types of "approved" low voltage cables in the cable tray, a separate tray or at minimum a divider in the basket tray to prevent interference from unshielded cables is required.
- 5. Supports for cable trays larger than 12 inches in width are to be installed according to the manufacturer specifications. A single support is not acceptable. All supports are to be fastened to the building structure above. If the cable tray will be of a wall mount type, it must be installed properly to provide proper permanent support at trays maximum capacity.
- 6. Radius Drop outs shall be used whenever multiple cables are exiting the tray.
- 7. STI's EZ Path's (44, 33 or 22 series) shall be used in conjunction with the tray whenever cabling is going through a fire rated wall.
- 8. Cable trays must maintain a minimum of 6-inch clearance from obstructions above the tray and a minimum of 8 feet AFF. Trays are to provide access via the most direct path to all communications outlets on the floor.
- 9. Install sweeping factory 90's for all turns. Use end-of tray terminations where wire drops down to walls to prevent abrasions and cuts from metal tray edges. Use a trapeze supported cable tray mounting method suspended by manufacturer recommended size all-thread. Fasten all-thread to ceiling anchors, allowing no bends in all-thread. Support the cable tray in this manner at every section-to-section junction and at 5 feet to 6 feet intervals (mid span) between joints. Whenever possible, the tray should be no closer than 6 inches from the structural ceiling, ducts or pipes, considering all other possible obstructions. A minimum of 5 inches distance from lighting, especially fluorescent lighting, is desired.
- 10. Coordinate layout and installation of cable tray with other trades. Revise locations and elevations from those indicated as required to suit field conditions and as approved by the Architect. Basket tray installation in the TRs shall be installed as depicted on the drawings by the Telecommunications Contractor. The basket tray that is to be installed for the horizontal and backbone distribution will be provided and installed by the electrical contractor.
- 11. Storage and Handling: Avoid breakage, denting and scoring finishes. Damaged products will not be installed. Store cable trays and accessories in original cartons and in clean dry space; protect from weather and construction traffic. Wet materials will be unpacked and dried before storage.
- 12. Refer to the drawings for the size and location of the tray to be installed.
- 13. Ground cable trays at end of continuous run. Ground continuous cable tray runs every 60 feet. Cable trays that are not UL Classified will be grounded per NEC requirements and manufacturer recommendations.
- 14. Ground cable trays against fault current, noise, lightning, and electromagnetic interference by mounting grounding wire to each 10' cable tray section with grounding clamp.
- D. Open Top Cable Supports (J-hooks)
 - 1. Standard of quality is Erico/Caddy HP series of j-hook
 - 2. All open top cable supports (J-hooks) must be suspended from or attached to the structural ceiling or walls with hardware or other installation aids from Caddy specifically designed to support their

weight. When used, Caddy J hooks shall be located on 48 to 60 inch centers to adequately support and distribute the cables weight. These types of supports may typically hold up to fifty 0.25-inch diameter cables.

- 3. No other cables shall be run in the same j-hooks along with the voice and data cables. A separate painted (white, red, blue, green) Caddy j-hook system must be provided to facilitate the installation of other low voltage cabling.
- 4. For larger quantities of cables that convene at the Telecommunications Closet, provide Cablofil cable trays or other special ERICO/CADDY supports that are specifically designed to support the required cable weight and volume.
- 5. No plastic j-hooks will be allowed.
- 6. Substituted material must demonstrate product equivalency.
- E. Floor Mounted Assemblies (Floor Boxes and Poke Throughs)
 - All Floor Mounted Assemblies including floor boxes, poke through, floor outlets, floor mounted whips, tombstones, etc. shall be sized using industry standard guidelines for telecommunications distribution methods; specifically relating to cable fill ratios and limitations. Guidelines can be found in the Building Industry Consulting Service International (BICSI) Telecommunications Distribution Methods Manual and/or through individual cabling manufacturers' installation guidelines.
 - 2. Standard of quality for all Poke-throughs and floor boxes is the Evolution series from Legrand/Wiremold.
 - 3. Floor boxes Shall:

a.be used in concrete, raised floor and wood floor applications and are fully adjustable both pre and post concrete pour.

b. have removable dividers and a tunnel feature that allows all compartments to be connected. c.have removable modules through the top or back of the floor box.

- d. The floor box hinge must is able to open to a full 180° and lie flat on the floor surface providing easy access to interior modules. Cable egress doors lock in position when open and will automatically close around wires to protect cabling and avoid tripping hazards.
- e.accept single, double or triple wall plates as well as accommodate power, communications and A/V devices.

f. be designed to maintain up to a 2 hour fire rating.

- 4. Poke throughs Shall
 - a.provide the interface between power, communication and audio/ visual (A/V) cabling in an above grade concrete floor and the workstation or activation location where power communication and/or A/V device outlets are required.
 - b. provide recessed device outlets that will not obstruct the floor area. The poke-thru device shall be compatible with the complete line of workstation connectivity outlets and modular inserts.

c. permit all wiring to be completed at floor level.

- 1) The 6AT, and 6ATCFF units shall mount in a 6" [152mm] cored hole, actual 6 1/16" [154mm] core hole.
- 2) The 8AT units shall mount in an 8" [203mm] cored hole, actual 8 1/16" [205mm] core hole. Use is defined by the UL Fire Resistance Directory as a minimum spacing of "2 ft. [610mm] on center and not more than one device per each 65 sq. ft. [6m2] of floor area in each span."
- F. Wall Boxes (A/V, Power, Data behind flat screens)
 - 1. Standard of quality for all wall boxes is the Evolution series from Legrand/Wiremold.

2. Wall Boxes Shall:

a.be used for TVs, Monitors, & Digital Signage for use in new construction and renovation construction projects.

- b. be compatible with complete line of workstation connectivity outlets and modular inserts, and most audio/video manufacturers' products.
- c.provide the interface between power, communication and audio/video (A/V) cabling new construction and renovation location where power and communication and/or A/V device outlets are required.
- d. provide recessed device outlets that will not obstruct the wall area.

e.permit all wiring to be completed at box level

- G. Conference/Collaboration/Training Room Solutions (Table Boxes; Cable Retractors, Under-table cable management)
 - 1. Standard of quality is Wiremold/Legrand Integreat series

2. Table Boxes / Table penetrations:

- a.Cover: Brushed, anodized aluminum cover in a black or aluminum finish with beveled edges and "soft-touch" handle.
 - Cover contains a "pocket" door which fully recesses into the box when open, giving access to connections without obstructing work surface. A finishing plate hides hardware on activation surface and permits labeling of the AVIP plates.
 - 2) Cover flange allows for 1/4-inch [6.4mm] of forgiveness in the cut out opening.
- b. Activation Surface: Adjustable downward in 1/2-inch [12.7mm] increments, from one (1) inch to four (4) inches [25mm to 102mm] to allow cover to close even when large style connectors are used.

c.Provide table boxes with a 12 foot SJT cord for easy connection to electrical infrastructure.

- d. Supply tables boxes with a cable grommet kit that can accommodate up to eight (8) pull out connections. Boxes shall also be capable of accepting up to five (5) Wiremold AVIP connectors.
- e.Provide table boxes with two (2) 15 amp receptacles in top compartment and one (1) 15 amp receptacle on underside of box.

3. **Cable Retractors**: InteGreat[™] Series cable retractors; mounts directly to InteGreat[™] Series A/V Table Box or underside of conference room table using a horizontal mounting bracket.

- a.Cable Retractors with Category 6 Cable: Catalog No. TBCRCAT6; loaded with 12 feet [3.66m] of Cat6 cable that extends out five (5) feet [1.52m] from retractor. Supply retractor with a female input from building infrastructure and a male connector on the output side.
- b. Cable Retractors with VGA Cable: Catalog No. TBCRVGA; loaded with 12 feet [3.66m] of VGA cable that extends out five (5) feet [1.52m] from retractor. Supply retractor with a female input from building infrastructure and a male connector on the output side.
- c.Cable Retractors with HDMI Cable: Catalog No. TBCRHDMI; loaded with 12 feet [3.66m] of HDMI cable that extends out five (5) feet [1.52m] from retractor. Supply retractor with a female input from building infrastructure and a male connector on the output side. Provide input side with mounting tab that allows installer to cable tie HDMI to retractor to minimize chances of loose connections.
- d. Cable Retractors with 3.5MM Audio Cable: Catalog No. TBCR3.5MM; loaded with 12 feet [3.66m] of audio cable that extends out five (5) feet [1.52m] from retractor. Supply retractor with a female input from building infrastructure and a male connector on the output side.
- e.Cable Retractor Horizontal Mounting Brackets: Catalog No. TBCRHMK; permits retractor to mount horizontally under conference room table, enabling cable access through a table grommet. Multiple retractors can be mounted to each other by attaching the mounting brackets to each other.
- 4. **Under Table Cable Management Kit**: InteGreat[™] Series under table cable management kit provides clean cable management for power, communication and A/V cables on horizontal underside of table.

- a.Under Table Cable Management Kit: Catalog No. UTCM5; includes five (5) feet [1.524mm] length of divided base, five (5) feet [1.524mm] length of mounting hinge rail and four (4) latching clips; black, nonmetallic construction.
- b. Transition Channels: InteGreat[™] Series transition channels continue cable management and protection from underside of the table to the floor, where cables can gain access to building infrastructure. Channel fits directly into under table cable management kit on underside of table and mates with poke-thru device or over floor raceway for smooth transition to building infrastructure.
- c.Transition Channels: Catalog No. MRTC; consists of aluminum center spline with steel mounting plate and four (4) screws, black aluminum side channels, black nonmetallic bottom boot and two (2) black nonmetallic transition covers.

Part Number / Series	Description
EFB Series	Evolution Floor Box
6AT Series	Evolution Poke Throughs 6"
8AT Series	Evolution Poke Throughs 8"
EFSB2 Series	Evolution 2 Gang Wall Box
EFSB4 Series	Evolution 4 Gang Wall Box
TB Series	Integreat A/V Table Box
TBCRCAT6	InteGreat Cable Retractor Cat 6
TBCRVGA	InteGreat Cable Retractor VGA
TBCRHDMI	InteGreat Cable Retractor HDMI
UTCM5	InteGreat Under Table Cable Mgmt.
MRTC	InteGreat Transition Channel

5. Substituted materials for floor boxes, poke throughs, wall boxes and conference room applications must be able to demonstrate product equivalency.

2.11 AUDIO/VISUAL INFRASTRUCTURE

For applications involving patient rooms, classrooms, conference rooms, collaborative work spaces, etc., that require HDMI, USB, Display Port, VGA, and other digital and/or analog A/V connections, the cabling infrastructure shall utilize Quiktron as the standard of quality. Substituted materials for all A/V applications must be able to demonstrate product equivalency.

- A. HDMI-to-HDMI, HDMI-to-DVI, DVI-to-HDMI and DVI-to-DVI
 - 1. Direct (native signal) connections (point-to-point) shall be HDMI High Speed Rated and designed and tested to handle video resolutions of 1920 x 1080p or greater, including advanced display technologies such as 4K, UltraHD, 3D, and Deep Color
 - 2. Direct (native signal) connections (point-to-point) shall not exceed 20 meters in total combined length and may be CMP, CMR, CM, CL3 or CL2 rated as appropriate to the installation and applicable code
 - 1. Connections less than 20 meters in total combined length shall be a certified copper cable or connectivity solution, except when:
 - a.Direct (native signal) connections (point-to-point) that require a form factor different than that typically available in a quality copper assembly may leverage the selection of "media conversion" and other solutions offered for such situations, and will include as acceptable alternatives RapidRunTM, RapidRun OpticalTM HDMI-over-Coax, HDBaseT, HDMI-over-UTP.

- Connections greater than 20 meters in total combined length shall be certified connectivity solutions, as best serves the form factor needed, from the selection defined below: a.RapidRun OpticalTM
 - b. HDMI-over-UTP, HDMI w/ serial RS232-over-UTP, HDMI w/ VGA-over-UTP, HDMI w/ VGA and Stereo Audio-over-UTP, HDMI w/ VGA, Audio, and Composite Video-over-UTP or HDMI-over-Coax
- 3. In installations where it is determined that insufficient bus power (Vbus) exists for reliable performance, the Quiktron HDMI Power Inserter may be used
- B. Universal Serial Bus (USB)
 - 1. USB connections (point-to-point) less than 5 meters total length shall be Quiktron USB 2.0 rated for all applications
 - a.Systems specifically requiring USB 3.0 or faster speed transfer ability (SuperSpeed or SuperSpeed Plus) may include Quiktron USB 3.0 cables, which may not exceed 3 meters total combined length
 - USB connections (point-to-point) more than 5 meters in total length shall be Quiktron connectivity solutions, as best serves the form factor needed for installation, from the selection defined below:

 a.USB connections greater than 5 meters but less than 12 meters in length shall be Quiktron USB Active Extender Cable solutions, or
 - b. USB connections greater than 5 meters but less than 100 meters in length shall be Quiktron USB 1.1 over Cat 5 SuperBooster or Quiktron USB 2.0 over Cat 5 SuperBooster solutions as required by the system design
 - 3. USB external hubs shall be Quiktron USB 3.0 SuperSpeed rated with dedicated power supply (powered hubs)
 - a.No more than four (4) tiers of USB connectivity shall be allowed without inclusion of a powered hub to restore full USB bus (V_{bus}) power for proper operation of downstream devices and links
- C. DisplayPort
 - 1. DisplayPort cables shall be Quiktron DisplayPort rated 1.1 performance or greater, and
 - 2. DisplayPort point-to-point direct connections shall not be more than 10 meters in total combined length
 - 3. DisplayPort point-to-point direct connections greater than 10 meters in total combined length shall be transported via DisplayPort-to-HDMI conversion (dongle) and shall then use an HDMI connection solution approved for connections of HDMI signals beyond 20 meters as detailed above (see HDMI), or
 - 4. DisplayPort point-to-point direct connections greater than 10 meters in length shall be transported via RapidRun Optical
- D. D-sub 15, mini sub D15, mini D15, DB-15, HDB-15, HD-15 or HD15, hereafter collectively called VGA
 - 1. VGA direct (native signal) connections (point-to-point) shall be designed and tested to support video resolutions of up to QXGA (2048x1536) and pass Extended Display Identification Data (EDID) signals
 - 2. VGA direct (native signal) connections (point-to-point) shall not exceed 50 meters in total combined length without appropriate signal conditioning and may be CMP, CMR, CM, CL3 or CL2 rated as appropriate to the installation and applicable code
 - VGA direct (native signal) connections (point-to-point) shall be certified connectivity solutions, as best serves the form factor needed, from the selection defined below: a.RapidRunTM
 - b. RapidRun Optical ™

c.Select or Select w/audio

d. Premium Shielded or Premium Shielded w/audio

2.12 POWER – UPS AND PDU OPTIONS

- A. UPS (Uninterrupted Power Supply)
 - 1. Standard of quality for Communications Rack Online UPS is Tripp Lite. Substituted material must be able to demonstrate product equality
 - 2. Provide true online battery back-up, power conditioning UPS, rack mounted in each TR to serve network electronics as indicated on the drawings. UPS shall have the following features: a.5000/3000/2200/1500 VA capacity as indicated
 - b. Output operating range—280V (5000VA)/120V (<3000VA) nominal
 - c.Communications—Unit shall provide an Ethernet based SNMP management interface, through the LAN to provide remote diagnostics and alarm conditions.
 - d. Expandability—Unit shall provide for the connection if external battery packs in modules to extend the total unit run-time.
 - e.Complete battery independence- Battery independent restart ensures automatic UPS power-up without user interaction after lengthy power outages, even when batteries are completely drained\discharged.
 - f. Cord Length 10'.
 - g. Transfer Time- zero transfer time to battery.
 - h. Battery Type- maintenance free sealed lead acid with electrolyte: leakproof.
 - i. LED Status- On battery/Replace Battery/and overload indicators.
 - j. Audible Alarms.
 - k. Filtering -full time multi- pole noise filtering
 - 1. All UPS units shall be rack mountable with proper mounting hardware and support.
 - m. UPS External battery Packs for 2200 or 3000 VA Tripp Lite for systems that specify extended run time such as the phone system.
 - 3. UPS Sizes
 - a.1500 VA UPS (Tripp Lite part number SU1500RTXLCD2U) Used in podiums, credenzas, conference rooms or classrooms
 - 1) Output Power Capacity- 1350W/ 1500VA.
 - 2) Nominal Output Voltage- 120V.
 - 3) Output Connections (6) NEMA 5-15R
 - 4) Nominal Input Voltage- 120V.
 - 5) Input connections- NEMA 5-15P.
 - b. 2200 VA UPS (Tripp Lite part number SU2200RTXLCD2U). Used in podiums, credenzas, conference rooms, classrooms and IDFs
 - 1) Output Power Capacity 1800 wattts/2200VA.
 - 2) Nominal Output Voltage- 120V.
 - 3) Output Connections- (6) NEMA 5-15\20R and (1) NEMA L5-20R.
 - 4) Nominal Input Voltage- 120V.
 - 5) Input connections NEMA 5-20P.
 - 6) Rack Mounted 2U rack space.
 - 7) Backup time- 12 minutes at half load (925 watts) 4 minutes at full load (1800 watts.)
 - 8) Surge energy Rating 570 joules.

c.3000 VA UPS (Tripp Lite part number SU3000RTXLCD3U) Used in IDFs and MDFs

- 1) Output Power Capacity- 2700 wattts/3000VA.
- 2) Nominal Output Voltage- 120V.
- 3) Output Connections- (4) NEMA 5-15R and (4) NEMA 5-15\20R and (1) NEMA L5-30.
- 4) Nominal Input Voltage- 120V.
- 5) Input connections- NEMA L30P.
- 6) Rack Mounted 2U rack space.
- 7) Backup time- 11 minutes at half load (1350 watts) 4 minutes at full load (2700 watts.)
- 8) LED Status- On battery/Replace Battery/and overload indicators.
- 9) Surge energy Rating 570 joules.
- d. 5000 VA UPS (Tripp Lite part number SU5000RT4U) Used in MDFs
 - 1) Output Power Capacity--3800 Watts/5000 VA
 - 2) Max Configurable Power--3800 Watts/ 5000 VA
 - 3) Nominal Output Voltage--120V, 208V
 - 4) Power factor equals 75% or greater
 - 5) Output Voltage Distortion--Less than 2%
 - 6) Output Frequency--(sync to mains) 50/60 Hz +/- 3 Hz user adjustable +/- 0.1
 - 7) Other Output Voltages--240
 - 8) Crest Factor--3 : 1
 - 9) Topology--Double Conversion Online
 - 10) Waveform Type--Sine wave
 - 11) Output Connections--(8) NEMA 5-15\20R, (2) NEMA L6-30R, (2) NEMA L6-20R
 - 12) Bypass--Internal Bypass (Automatic and Manual)
 - 13) Nominal Input Voltage--208V
 - 14) Input Frequency--50/60 Hz +/- 5 Hz (auto sensing)
 - 15) Input Connections--NEMA L14-30P
 - 16) Input voltage range for main operation--100 140VAC (L1-N:L2-N)
 - 17) Input voltage adjustable range for mains operation--85 136V
 - 18) Other Input Voltages--240
 - 19) Interface Port(s)--RJ-45 10/100 Base-T
 - 20) Control panel LED status display with load and battery bar-graphs and On Line : On Battery : Replace Battery : Overload and Bypass Indicators
 - 21) Alarm when on battery : distinctive low battery alarm : overload continuous tone alarm
 - 22) Emergency Power Off (EPO)
 - 23) Surge energy rating 365 Joules
 - 24) Filtering Full time multi-pole noise filtering : 0.3% IEEE surge let-through : zero clamping response time : meets UL 1449
- B. PDU Standard of quality is Tripp Lite part number PDUMV20NET SWITCHED/IP FEATURE SET REQUIRED. Substituted material must be able to demonstrate product equivalency.
 - 1. Raceway and all components shall be UL listed. The base and cover shall be ivory in color, and shall be attached to the cable ladder of the rack system or wall field as per the drawings.
 - 2. Electrical outlet strip shall have (13) NEMA 5-15\20 outlets.
 - 3. Provide all attachment hardware required to securely attach the outlet strip to the back of the vertical cable ladder or wallfield. Refer to the detailed drawings for required locations.
 - 4. All power strips shall be equipped with surge protection.
 - 5. All power strips shall be come with adjustable mounting brackets for 2 or 4 post installation.
 - 6. Strips shall be 20A-120V with NEMA 5.20P on a 15 foot line cord.
 - 7. Install and test all outlets prior to project completion.
 - 8. Provide outlet strip with attached cord and 3-prong plug.
 - 9. All power strips will plug into UPS units unless otherwise specified.

2.13 COPPER CABLE PROTECTION UNITS

- A. All copper circuits shall be provided with protection between each building with an entrance cable protector panel. All building-to-building circuits shall be routed through this protector. The protector shall be connected with a #6 AWG copper bonding conductor between the protector ground lug and the TC ground point.
- B. Standard of quality of protection units is Circa.
- C. The two most frequently used lightning protectors are listed below.
- D. Circa Protector -- "Circa", part number 1900A1-100, and Circa 3B3S-300 "Red" modules -100 for 100 pair.
- E. Use Circa ,part number 1880ENA1/NSC-6 for single drops of 6-pair or less. Use Circa, part number 3B1E gas protector modules.

Part Number / Series	Description
1890BC1-25	25 Pair Protector
1890BC1-50	50 Pair Protector
1900A1-100K	100 Pair Protector
3B1E	Solid State Protector Module for 189B1
2626QC/QC	Protection Block (66 connection must add gas modules 3B1E (black) or 3B3E (red))
4B1E	Gas state Protector 5 Pin Black with Heat Coil
4B3S-75	Protector Module 5 Pin Red Solid state with Heat Coil
3B3S-300	Protector module 5 Pin Red Solid state w/o Heat coil
4B1S-300	Protector Module 5 Pin Black Solid state with Heat Coil
1880ENA1/NSC-6	6 Pair Protector

2.14 FIRESTOP

- A. Standard of quality is EZ Path Fire rated cable pathway devices shall be used in fire-rated construction for ALL low-voltage, video, data and voice cabling, optical fiber raceways and certain high-voltage cabling where frequent cable moves, adds and changes may occur. Pathways required for high voltage cabling will be detailed on the prints. Such devices shall:
 - 1. Meet the hourly fire-rating of fire rated wall and or floor penetrated.
 - 2. Be tested for the surrounding construction and cable types involved.
 - 3. Have UL Systems permitting cable loads from; "Zero to 100% Visual Fill." This requirement eliminates need for fill-ratio calculations to be made by cable technicians to ensure cable load is within maximum allowed by UL System.
 - 4. Not have inner fabric liner that tightens around and compresses cables tightly together encouraging potential cable damage or interference.
 - 5. Be "Zero-Maintenance", zero-maintenance is defined as; No action required by cabling technician to open and/or close pathway for cable moves, adds or changes, such as, but not limited to:

- a. Opening or closing of doors.
- b. Spinning rings to open or close fabric liner.
- c. Removal and or replacement of any material such as, but not limited to, firestop caulk, putty, pillows, bags, foam muffins, foam, foam plugs, foam blocks, or foam closures of any sort.
- d. Furnish letter from manufacturer certifying compliance with this definition of "Zero-Maintenance".
- 6. Pathways shall be engineered such that two or more devices may be ganged together for larger cable capacities.
- 7. Pathways shall be engineered to be re-enterable so they can be retrofitted and removed from around existing cables without cutting and re-splicing them.
- 8. Affix adhesive wall label immediately adjacent to devices to communicate to future cable technicians, authorities having jurisdiction and others the manufacturer of the device and the corresponding UL System number installed.
- 9. Cable pathway shall replace conduit sleeves in walls and floors, and;
- 10. When installed individually in floors, devices shall pass through core-drilled opening utilizing tested floor plates.
- 11. When installed individually in floors, devices shall pass through core-drilled opening utilizing tested floor plates.
- 12. When multiple units are ganged in floors, devices shall be anchored by means of a tested grid.
- 13. When installed individually in walls, devices shall pass through core drilled opening utilizing tested wall plates or integrated flanges.
- 14. When multiple units are ganged in walls, devices shall be anchored by means of a tested grid.
- 15. Cable tray shall terminate at each barrier (wall) and resume on the other side such that cables pass independently through devices. Cable tray shall be properly supported on each side of the barrier (wall). Cable tray shall NOT pass through the barrier (wall).
- 16. Substituted material must demonstrate product equivalency.
- B. As an alternate to using a fire-rated or non-rated cable pathway device for single low voltage cables (up to 0.27 in. (7 mm) O.D) penetrating one or two-hour, gypsum board/stud wall assemblies or non-rated assemblies, either as a through-penetration or as a membrane-penetration, a fire-rated EZ Path individual cable grommet may be substituted. The product shall consist of a molded, two-piece, plenum-rated grommet having a foam fire and smoke sealing membrane that conforms to the outside diameter of the individual cable. The grommet product shall be capable of locking into place to secure the cable penetration within the wall assembly. The grommet shall be UL Classified and tested to the requirements of ASTM E814 (UL1479) and CAN/ULC S115.

Part Number / Series	Description
EZD22	2" EZ Path Firestop Device
EZD33FWS	3" EZ Path Firestop Device
EZDP133CWK	3" EZ Path Firestop Device Kit (for 4" conduit)
EZDP33FWS	3" EZ Path Firestop Device Kit (square mount)
EZP433W	3" Ganging Accessory (Qty 4) for 3" EZ Paths
EZD44S	6" EZ Path Firestop Device
EZDP44S	6" EZ Path Firestop Device Kit (square or round mount)

17. Acceptable Products from STI:

EZP544W	Ganging Accessory (Qty1-5) for 6" EZ Paths	
EZGxxxxx	Grid for riser applications	
RFG2	Individual Cable EZ firestop grommet (10 pack)	

2.15 GROUNDING AND BONDING

- A. The facility shall be equipped with a Telecommunications Bonding Backbone (TBB). This backbone shall be used to ground all telecommunications cable shields, equipment, racks, cabinets, raceways, and other associated hardware that has the potential to act as a current carrying conductor. The TBB shall be installed independent of the building's electrical and building ground and shall be designed in accordance with the recommendations contained in the ANSI/TIA-607 Telecommunications Bonding and Grounding Standard.
- B. The main entrance facility/equipment room in each building shall be equipped with a PBB (Primary Bonding Busbar) formerly known as the telecommunications main grounding bus bar (TMGB). Each telecommunications room shall be provided with a SBB (Secondary Bonding Busbar formerly known as the telecommunications ground bus bar (TGB). The PBB shall be connected to the building electrical entrance grounding facility. The intent of this system is to provide a grounding system that is equal in potential to the building electrical ground system. Therefore, ground loop current potential is minimized between telecommunications equipment and the electrical system to which it is attached.
- C. All racks, metallic backboards, cable sheaths, metallic strength members, splice cases, cable trays, etc. entering or residing in the TR or ER shall be grounded to the respective SBB or PBB using a minimum #6 AWG stranded copper bonding conductor and compression connectors.
- D. All wires used for telecommunications grounding purposes shall be identified with a green insulation. Non-insulated wires shall be identified at each termination point with a wrap of green tape. All cables and bus bars shall be identified and labeled in accordance with the System Documentation Section of this specification.
- E. Standard of quality for all grounding and bonding products shall be Legrand.
- F. Acceptable substitutions are Erico and Panduit

PART 3 - EXECUTION

- 3.1 WORK AREA OUTLETS
 - A. Cables shall be coiled in the in-wall or surface-mount boxes if adequate space is present to house the cable coil without exceeding the manufacturer's bend radius. In hollow wall installations where Caddy box-eliminators are used, excess wire can be stored in the wall. No more than 12" of UTP and 36" of fiber slack shall be stored in an in-wall box, modular furniture raceway, or insulated walls. Excess slack shall be loosely coiled and stored in the ceiling above each drop location when there is not enough space present in the outlet box to store slack cable.
 - B. Cables shall be dressed and terminated in accordance with the recommendations made in the ANSI/TIA 568.1-D document, manufacturer's recommendations and best industry practices.
 - C. Pair untwist at the termination shall not exceed 12 mm (one-half inch).
 - D. Bend radius of the twisted-pair horizontal cable shall not be less than 4 times the outside diameter of the cable.
 - E. The cable jacket shall be maintained to within 25mm (one inch) of the termination point.

- F. Data jacks, unless otherwise noted in drawings, shall be located in the bottom position(s) of each faceplate. Data jacks in horizontally oriented faceplates shall occupy the right-most position(s).
- G. Voice jacks shall occupy the top position(s) on the faceplate. Voice jacks in horizontally oriented faceplates shall occupy the left-most position(s).

3.2 HORIZONTAL DISTRIBUTION CABLE INSTALLATION

- A. Cable shall be installed in accordance with manufacturer's recommendations and best industry practices.
- B. A pull cord (nylon; 1/8" minimum) shall be co-installed with all cable installed in any conduit.
- C. Cable raceways shall not be filled greater than the ANSI/TIA 569-D maximum fill for the particular raceway type or 40%.
- D. Cables shall be installed in continuous lengths from origin to destination (no splices) except for transition points, or consolidation points.
- E. Where transition points, or consolidation points are allowed, they shall be located in accessible locations and housed in an enclosure intended and suitable for the purpose.
- F. The cable's minimum bend radius and maximum pulling tension shall not be exceeded.
- G. If a J-hook or trapeze system is used to support cable bundles all horizontal cables shall be supported at a maximum of 48 to 60 inch (1.2 to 1.5 meter) intervals. At no point shall cable(s) rest on acoustic ceiling grids or panels.
- H. Horizontal distribution cables shall be bundled in groups of no more than 50 cables. Cable bundle quantities in excess of 50 cables may cause deformation of the bottom cables within the bundle and degrade cable performance.
- I. Cable shall be installed above fire-sprinkler systems and shall not be attached to the system or any ancillary equipment or hardware. The cable system and support hardware shall be installed so that it does not obscure any valves, fire alarm conduit, boxes, or other control devices.
- J. Cables shall not be attached to ceiling grid or lighting fixture wires. Where support for horizontal cable is required, the contractor shall install appropriate carriers to support the cabling.
- K. Any cable damaged or exceeding recommended installation parameters during installation shall be replaced by the contractor prior to final acceptance at no cost to the Owner.
- L. Cables shall be identified by a self-adhesive label in accordance with the System Documentation Section of this specification and ANSI/TIA 606-C. The cable label shall be applied to the cable behind the faceplate on a section of cable that can be accessed by removing the cover plate.
- M. Unshielded twisted pair cable shall be installed so that there are no bends smaller than four times the cable outside diameter at any point in the run and at the termination field.
- N. Pulling tension on 4-pair UTP cables shall not exceed 25-lbf for a four-pair UTP cable.

3.3 HORIZONTAL CROSS CONNECT INSTALLATION

- A. Cables shall be dressed and terminated in accordance with the recommendations made in the ANSI/TIA 568-D standard, manufacturer's recommendations and best industry practices.
- B. Pair untwist at the termination shall not exceed 13 mm (0.5 inch).
- C. Bend radius of the cable in the termination area shall not exceed 4 times the outside diameter of the cable.
- D. Cables shall be neatly bundled and dressed to their respective panels or blocks. Each panel or block shall be fed by an individual bundle separated and dressed back to the point of cable entrance into the rack or frame.
- E. The cable jacket shall be maintained as close as possible to the termination point.
- F. Each cable shall be clearly labeled on the cable jacket behind the patch panel at a location that can be viewed without removing the bundle support ties. Cables labeled within the bundle, where the label is obscured from view shall not be acceptable.

3.4 OPTICAL FIBER TERMINATION HARDWARE

- A. Fiber slack shall be neatly coiled within the fiber splice tray or enclosure. No slack loops shall be allowed external to the fiber panel.
- B. Each cable shall be individually attached to the respective splice enclosure by mechanical means. The cables strength member shall be securely attached the cable strain relief bracket in the enclosure.
- C. Each fiber bundle shall be stripped upon entering the splice tray and the individual fibers routed in the splice tray.
- D. Each cable shall be clearly labeled at the entrance to the splice enclosure. Cables labeled within the bundle shall not be acceptable.
- E. A maximum of 12 strands of fiber shall be spliced in each tray
- F. All spare strands shall be installed into spare splice trays.

3.5 BACKBONE CABLE INSTALLATION

- A. Backbone cables shall be installed separately from horizontal distribution cables
- B. A pull cord (nylon; 1/8" minimum) shall be co-installed with all cable installed in any conduit.
- C. Where cables are housed in conduits, the backbone and horizontal cables shall be installed in separate conduits
- D. Where backbone cables are installed in an air return plenum, riser rated cable shall be installed in metallic conduit.
- E. Where backbone cables and distribution cables are installed in a cable tray or wireway, backbone cables shall be installed first and bundled separately from the horizontal distribution cables.
- F. All backbone cables shall be securely fastened to the sidewall of the TR on each floor.
- G. Backbone cables spanning more than three floors shall be securely attached at the top of the cable run with a wire mesh grip and on alternating floors or as required by local codes.
- H. Vertical runs of cable shall be supported to messenger strand, cable ladder, or other method to provide proper support for the weight of the cable.
- I. Large bundles of cables and/or heavy cables shall be attached using metal clamps and/or metal banding to support the cables.

3.6 COPPER TERMINATION HARDWARE

- A. Cables shall be dressed and terminated in accordance with the recommendations made in the ANSI/TIA-568-D standard, manufacturer's recommendations and best industry practice.
- B. Pair untwist at the termination shall not exceed 12 mm (one-half inch).
- C. Bend radius of the cable in the termination area shall not exceed 4 times the outside diameter of the cable.
- D. Cables shall be neatly bundled and dressed to their respective panels or blocks. Each panel or block shall be fed by an individual bundle separated and dressed back to the point of cable entrance into the rack or frame.
- E. The cable jacket shall be maintained to within 25 mm (one inch) of the termination point.
- F. Each cable shall be clearly labeled on the cable jacket behind the patch panel at a location that can be viewed without removing the bundle support ties. Cables labeled within the bundle, where the label is obscured from view shall not be acceptable.

3.7 RACKS

- A. Racks shall be securely attached to the concrete floor using a minimum 3/8" hardware or as required by local codes.
- B. Racks shall be placed with a minimum of 36 inch clearance from the walls on all sides of the rack. When mounted in a row, maintain a minimum of 36 inches from the wall behind and in front of the row of racks and from the wall at each end of the row.

- C. All racks shall be grounded to the telecommunications ground bus bar in accordance with Section 2.11 of this document.
- D. Rack mount screws not used for installing patch panels and other hardware shall be bagged and left with the rack upon completion of the installation.
- E. Wall mounted termination block fields shall be mounted on 4' x 8' x .75" void free plywood. The plywood shall be mounted vertically 12" above the finished floor. The plywood shall be painted with two coats of white fire retardant paint.
- F. Wall mounted termination block fields shall be installed with the lowest edge of the mounting frame 18" from the finished floor.

3.8 FIRESTOP SYSTEM

A. All firestop systems shall be installed in accordance with the manufacturer recommendations and shall be completely installed and available for inspection by the local inspection authorities prior to cable system acceptance.

3.9 GROUNDING SYSTEM

- A. The TBB shall be designed and/or approved by a qualified PE, licensed in the state that the work is to be performed. The TBB shall adhere to the recommendations of the ANSI/TIA 607-C standard, and shall be installed in accordance with best industry practice.
- B. Installation and termination of the main bonding conductor to the building service entrance ground shall be performed by a licensed electrical contractor.

3.10 IDENTIFICATION AND LABELING

- A. The contractor shall develop and submit for approval a labeling system for the cable installation. The Owner will negotiate an appropriate labeling scheme with the successful contractor. At a minimum, the labeling system shall clearly identify all components of the system: racks, cables, panels and outlets. The labeling system shall designate the cables origin and destination and a unique identifier for the cable within the system. Racks and patch panels shall be labeled to identify the location within the cable system infrastructure. All labeling information shall be recorded on the as-built drawings and all test documents shall reflect the appropriate labeling scheme. Labeling shall follow the guidelines of ANSI/TIA-606-C.
 - B. Comply with requirements in Division 09 Section "Interior Painting" for painting backboards. For fire-resistant plywood, do not paint over manufacturer's label.
 - C. Cable Schedule: Post in prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish an electronic copy of final comprehensive schedules for Project.
 - D. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications closets, backbone pathways and cables, entrance pathways and cables, terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors. Follow convention of ANSI/TIA-606-C. Furnish electronic record of all drawings, in software and format selected by Owner.

- E. Cable and Wire Identification:
 - 1. Label each cable within 4 inches of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
 - 2. Label each terminal strip and screw terminal in each cabinet, rack, or panel.
 - a. Individually number wiring conductors connected to terminal strips, and identify each cable or wiring group being extended from a panel or cabinet to a building-mounted device shall be identified with name and number of particular device as shown.
 - b. Label each unit and field within distribution racks and frames.
 - 3. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use a different color for jacks and plugs of each service.
 - 4. Both ends of all backbone cable shall be labeled. Labels will be self laminating and machine generated. The label shall contain the following information:
 - a. The Origination (TR it is feeding from).
 - b. The Destination (TR it is feeding).
 - c. Number of pairs or fibers
 - 5. Both ends of all horizontal cables shall be labeled. Labels shall be self-laminating and machine generated. The cable, workstation faceplate, panel ports and block positions shall be labeled with the room number, location in room, outlet type & # (data D1, D2, etc). In rooms with multiple outlets, label clockwise as you enter the room: 1, 2, 3 e.g. a data port at the first drop location to the left of Room 216 door would be (216-1 D1). When terminating workstation cables in the TR, organize and label the cables in numeric room number order at the patch panel.
 - 6. CNS will approve all labeling schematics prior to installation. "As-Built" drawing with all outlets identified shall be provided.
- F. Labels shall be self-laminating or computer-printed type with printing area and font color that contrasts with cable jacket color. Handwritten labels will not be acceptable.
 - 1. Cables use flexible vinyl or polyester that flex as cables are bent.
 - 2. All labeling methodology, identification logic, and materials will be approved by customer prior to installation.
 - 3. If existing labeling scheme is in place, all labeling will defer to currant scheme as to stay consistent with facility.

3.11 TESTING AND ACCEPTANCE

- A. General
 - All cables and termination hardware shall be 100% tested for defects in installation and to verify cabling system performance under installed conditions according to the requirements of ANSI/TIA 568D; marginal passes (*PASS) are not acceptable. All pairs of each installed cable shall be verified prior to system acceptance. Any defect in the cabling system installation including but not limited to cable, connectors, feed through couplers, patch panels, and connector blocks shall be

repaired or replaced in order to ensure 100% useable conductors in all cables installed.

2. All cables shall be tested in accordance with this document, the ANSI/TIA standards, the Legrand Certification Program Information Manual and best industry practice. If any of these are in conflict, the Contractor shall bring any discrepancies to the attention of the project team for clarification and resolution.

B. Copper Channel Testing

- 1. All twisted-pair copper cable links shall be tested for continuity, pair reversals, shorts, opens and performance as indicated below. Additional testing is required to verify Category performance.
- 2. Horizontal cabling shall be tested using a Level III test unit for category 6 performance compliance.
- 3. The basic tests required are:
 - a. Wire Map
 - b. Length
 - c. Attenuation
 - d. NEXT (Near end crosstalk)
 - e. Return Loss
 - f. ELFEXT Loss
 - g. Propagation Delay
 - h. Delay skew
 - i. PSNEXT (Power sum near-end crosstalk loss)
 - j. PSELFEXT (Power sum equal level far-end crosstalk loss)
- 4. Continuity Each pair of each installed cable shall be tested using a test unit that shows opens, shorts, polarity and pair-reversals, crossed pairs and split pairs. Shielded/screened cables shall be tested with a device that verifies shield continuity in addition to the above stated tests. The test shall be recorded as pass/fail as indicated by the test unit in accordance with the manufacturers' recommended procedures, and referenced to the appropriate cable identification number and circuit or pair number. Any faults in the wiring shall be corrected and the cable re-tested prior to final acceptance.
- 5. Length Each installed cable link shall be tested for installed length using a TDR type device. The cables shall be tested from patch panel to patch panel, block to block, patch panel to outlet or block to outlet as appropriate. The cable length shall conform to the maximum distances set forth in the ANSI/TIA 568-D Standard. Cable lengths shall be recorded, referencing the cable identification number and circuit or pair number. For multi-pair cables, the shortest pair length shall be recorded as the length for the cable.
- 6. Category 6 Performance

Shall meet the channel requirements outlined below for a 100-meter, 4-connector channel.

Channel Margin Guarantees

Parameter	Margin vs. TIA-568-C.2
Insertion Loss	3%
NEXT	5 dB
PSNEXT	5 dB
Return Loss	3 dB
ACRF	5 dB
PSACRF	5 dB

ACR	5 dB
PSACR	5 dB

- C. Fiber Testing
 - 1. Testing procedures shall be in accordance with the following:
 - a. ANSI/TIA 568-D
 - b. ANSI/TIA 568.1-D
 - c. ANSI/TIA 526-7-A, Method A.1
 - d. ANSI/TIA 526-14-C, Method B
 - e. TSB-140 Tier 1 fiber testing is required. Tier 2 Fiber Testing is recommended
 - f. ANSI-TIA-1152-A determines the copper field test instrument values.
 - 2. Preparation
 - a. Properly clean all connectors, adapters, and jumpers prior to testing.
 - b. Insure that the testing jumpers are of the same fiber core diameter and connector type as the fibers to be tested.
 - c. The power meter shall be properly calibrated prior to testing. Contractor to provide written confirmation of the calibration, with the power meter serial number, to the Owner, if requested. If this documentation is not available upon request, the Contractor shall re-test all optical fiber cables after documented calibration of the power meter is accomplished.
 - 3. Test Equipment
 - a. Optical power meter and source (Certification tester Fluke or Agilent preferred). Suitable OTDR with launch cable for Tier 2 testing. OTDR Launch Cable length recommendation is 75 meters for MMF and 300 meters for SMF systems.
 - 4. Testing
 - a. All Multimode fibers shall be tested to the requirements of ANSI/ TIA-568-D, TIA-525-14A (Method A.1) and TSB-140. Optical fibers shall be tested at both 850 nm and 1300 nm wavelengths for end-to-end insertion loss .and Bi –Directional (MTR to TR-1, TR-1 to MTR)
 - b. All Single-mode fibers shall be tested to the requirements of ANSI/TIA-568-D, TIA-526-7 (or Method A.1) and TSB-140. Optical fibers shall be tested at both 1310 nm and 1550 nm wavelengths for end-to-end insertion loss and Bi-Directional (MTR to TR-1, TR-1 to MTR)
 - c. Insure that the power meter and light source are set to the same wavelength prior to testing each fiber.
 - d. Connect an appropriate test jumper to the light source and power meter.
 - e. Power on both the power source and light meter, allowing them to stabilize.
 - f. Record the reference power reading in dB. If the jumper is removed from the light source for any reason, the reference power reading must be re-established.
 - g. Insert a second appropriate jumper, using an appropriate adapter, between the first jumper and the power meter. Record the power reading in dB.
 - h. Reference TSB-140 for additional recommendations and testing guidelines.
 - i. Provide written documentation of all test results to owner. Provide electronic copy of test results, in original tester format, to manufacturer when registering project for warranty on-line.

3.12 SYSTEM DOCUMENTATION

- A. Upon completion of the installation, the telecommunications contractor shall provide three (3) full documentation sets to the Engineer for approval. Documentation shall include the items detailed in the sub-sections below.
- B. Documentation shall be submitted within ten (10) working days of the 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 the completion of each testing phase. At the

request of the Engineer, the telecommunications contractor shall provide copies of the original test results.

C. The Engineer may request that a 10% random field re-test be conducted on the 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 the telecommunications contractor, additional testing can be requested to the extent determined necessary by the Engineer, including a 100% re-test. This re-test shall be at no additional cost to the Owner.

3.13 TEST RESULTS

- A. Test documentation shall be provided on disk within three weeks after the completion of the project. The disk shall be clearly marked on the outside front cover with the words "Project Test Documentation", the project name, and the date of completion (month and year). The results shall include a record of test frequencies, cable type, conductor pair and cable (or outlet) I.D., measurement direction, reference setup, and crew member name(s). The test equipment name, manufacturer, model number, serial number, software version and last calibration date will also be provided at the end of the document. Unless the manufacturer specifies a more frequent calibration cycle, an annual calibration cycle is anticipated on all test equipment used for this installation. The test document shall detail the test method used and the specific settings of the equipment during the test as well as the software version being used in the field test equipment.
- B. The field test equipment shall meet the requirements of ANSI/TIA 568-C including applicable TSB's and amendments. The appropriate Level III tester shall be used to verify Category 6 cabling systems.
- C. Printouts generated for each cable by the wire (or fiber) test instrument shall be submitted as part of the documentation package. The telecommunications contractor must furnish this information in electronic form (format to be determined by the end user).
- D. Test documentation shall also be provided to the manufacturer within three weeks after the completion of the project. Test results shall be uploaded when registering the project for warranty using the manufacturer's on-line system. Test results shall be in the tester's original format from an approved tester listed on manufacturer's website. All test results must show a PASS; marginal passes (*PASS) are not accepted.
- E. When repairs and re-tests are performed, the problem found and corrective action taken shall be noted, and both the failed and passed test data shall be documented.

3.14 AS-BUILT DRAWINGS

- A. The 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. The Owner will provide floor plans in paper and electronic (DWG, AutoCAD rel. 14) formats on which as-built construction information can be added. These documents will be modified accordingly by the telecommunications contractor to denote as-built information as defined above and returned to the Owner.
- B. The Contractors shall annotate the base drawings and return a hard copy (same plot size as originals) and electronic (AutoCAD rel. 14) form.

PART 4 - WARRANTY AND SERVICES

4.1 WARRANTY

- A. A warranty shall be provided for all internal infrastructure wiring as it pertains to voice and data networking for both copper and fiber systems. All installations must be performed according to the manufacturer's System Warranty and Performance Application.
- B. The warranty will combine an extended product and applications assurance warranty for a minimum of 25 years.
- C. An Extended Product Warranty shall be provided which warrants functionality of all components used in the system from the date of registration. The Extended Product Warranty shall warrant the installed horizontal and/or backbone copper, and both the horizontal and the backbone optical fiber portions of the cabling system.
- D. The Application Assurance Warranty shall cover the failure of the wiring system to support the applications that are designed for the link/channel specifications of ANSI/TIA-568.1-D. These applications include, but are not limited to, 10BASE-T, 100BASE-T, 1000BASE-T, and 155 Mb/s ATM.
- E. The contractor shall provide a warranty on the physical installation.

4.2 CONTINUING MAINTENANCE

A. The contractor shall furnish an hourly rate with the proposal submittal, which shall be valid for a period of one year from the date of acceptance. This rate will be used when cabling support is required to affect moves, adds, and changes to the system (MACs). MACs shall be performed by a certified Contractor and shall be added to the warranty when registered with manufacturer.

4.3 FINAL ACCEPTANCE & SYSTEM CERTIFICATION

A. Completion of the installation, in-progress and final inspections, receipt of the test and as-built documentation, and successful performance of the cabling system for a two week period will constitute acceptance of the system. Upon successful completion of the installation and subsequent inspection, the end user shall be provided with a certificate, from the manufacturer, registering the installation.





S6 S7 S9 S10 S11 S12 S15 S15 S18 S19 S20
S10 S11 S12 S15 S15 S18 S19 S20
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PROV MDF F WIRE
S25 S29 S30 S31 S32 S33 S46 S49 S49





TAGGED NOTES

H1 H3

H32

OF EDUCATION

(##)

A29 REFER TO VRV PIPING SCHEMATIC ON SHEET M5.0. REFRIGERANT SUPPLY AND RETURN PIPING UP. CONDENSATE TO EXIT BUILDING AT LOCATION INDICATED 24" BELOW THE FFE ELEVATION. ROUTE CONDENSATE DOWN TO BELOW UNDERSLAB TRANSITION CONDENSATE PIPING TO 4" PRIOR TO ROUTING. PROVIDE CONDENSATE CLEANOUT PRIOR TO ROUTING CONDENSATE TO UNDERSLAB.

	FIRST FL PLAN VR	OOR MECH V SYSTEM	IANI REV	CAL ISION
	Project number	1904		
	Date	9/30/19	M	3.0R1
BOARD	Drawn by	WGW		
	Checked by	BDH	Scale	1/8" = 1'-0"
			401410	040 0 0 7 0 7 0 8
			10/1/2	019 8:27:37 AN







TAGGED NOTES



H2REFRIGERANT SUPPLY AND RETURN PIPING DOWN.H5PROVIDE THYBAR TC SERIES INSULATED PIPE CURB
FOR REFRIGERANT PIPING PENTRATIONS.

	ROOF M SYSTEM	ECHANICAL REVISION	PLA	N VRV	
	Project number	1904			
	Date	9/30/19	M	3.2R1	
OARD	Drawn by	WGW			
<i>c</i> , <i>z</i>	Checked by	BDH	Scale	1/8" = 1'-0"	
			10/1/0	010 9.93.01 AK	
			10/1/20	019 0.23.01 AN	/1





)	BV	AI	AO	AV	ALARM TYPE	GRAPHIC
					BOOLEAN CHANGE OF STATUS	YES
	x					YES
		Х			OUT OF RANGE	YES
		х				YES
		Х				YES
		Х				YES
		Х				YES
						YES
					BOOLEAN CHANGE OF STATUS	YES
					BOOLEAN COMMAND FAIL	YES
						YES
						YES
				Х		YES
				Х		YES
				Х		YES
				Х		YES
				Х		YES
				Х		YES
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				Х		YES
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				Х		YES
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				Х		
				Х		YES

EXHAUST $\rangle \rightarrow \rightarrow$ 40 TO BUILDING AIR TERMINALS \COA $\{ \in \mathcal{S} \in \mathcal{S} \}$ NOT TO SCALE

OUTSIDE AIR SYSTEM (DOAS-1) SCHEMATIC

SCR

	DOAS-1 POIN	TSI	IS	т					
				•					
DISPLAY NAME	POINT NAME	BI	BO	BV	AI	AO	AV	ALARM TYPE	С
			00		7.1	7.0	X		YES
OA INTAKE HUMIDITY SENSOR 1	OA HUM S 1				x				YES
EA DISCHARGE HUMIDITY SENSOR 2	FA HUM S 2				X				YES
	OA INT DAMP C				~	X		BOOLEAN COMMAND FAIL	YES
OA INTAKE DAMPER STATUS	OA INT DAMP ST	X							YES
OA INTAKE DAMPER OVERIDE	OA INT DAMP OVRD						X		YES
EA RELIEF DAMPER	EA INT DAMP C					X		BOOLEAN COMMAND FAIL	YES
EA RELIEF DAMPER STATUS	EA INT DAMP ST	X							YES
EA RELIEF DAMPER OVERIDE	EA INT DAMP OVRD						X		YES
OUTSIDE AIR TEMPERATURE SENSOR 1	OA TEMP S 1				Х				YES
OUTSIDE AIR TEMPERATURE SENSOR 2	OA TEMP S 2				Х				YES
OUTSIDE AIR DX TEMPERATURE SENSOR 3	OA TEMP S 3				Х				YES
OUTSIDE AIR SCR HEAT TEMPERATURE SENSOR 4	OA TEMP S 4				X				YES
OUTSIDE AIR HOT GAS REHEAT TEMPERATURE SENSOR 5	OA TEMP S 5				Х				YES
OA PREFILTER STATUS	OA FLTR DP S				Х			OUT OF RANGE	YES
OA INTAKE HUMIDITY SENSOR 1	OA RH S				Х				YES
LOW LIMIT FREEZE STAT	LL-FRZ STAT	X						OUT OF RANGE	YES
SCHEDULE	occ s			X					YES
OA FAN START/STOP	OAFAN RUN C		X					BOOLEAN COMMAND FAIL	YES
OA FAN START/STOP OVERRIDE	OAFAN RUN OVRD			X				BOOLEAN COMMAND FAIL	YES
OA FAN STATUS	OAFAN RUN ST	X						BOOLEAN COMMAND FAIL	YES
OA FAN ECM MOTOR FAULT	OAFAN VFDFLT S	X						BOOLEAN CHANGE OF STATUS	YES
OA FAN ECM SPEED	OAFAN_VFD_SPD_C					Х			YES
OA FAN ECM SPEED OVERRIDE	OAFAN_VFD_SPD_OVRD						X		YES
OCCUPIED COOLING SETPOINT	OCC_CLG_SETP						Х		YES
OCCUPIED HEATING SETPOINT	OCC_HTG_SETP						Х		YES
EXHAUST AIR TEMPERATURE SENSOR 6	EA_TEMP_S_6				Х				YES
EXHAUST AIR TEMPERATURE SENSOR 7	EA_TEMP_S_6				Х				YES
EA PREFILTER STATUS	EA_FLTR_DP_S				Х			OUT OF RANGE	YES
ENERGY RECOVERY WHEEL DIFF. PRESS. SENSOR	ERW_DP_S				Х			OUT OF RANGE	YES
ENERGY RECOVERY WHEEL START/STOP	ERW_RUN_C		Х					BOOLEAN COMMAND FAIL	YES
ENERGY RECOVERY WHEEL START/STOP OVERIDE	ERW_RUN_OVRD			X				BOOLEAN COMMAND FAIL	YES
ENERGY RECOVERY WHEEL STATUS	ERW_RUN_ST	X						BOOLEAN COMMAND FAIL	YES
ENERGY RECOVERY WHEEL FREEZE CONTROL	ERW_FRZ_C			X					YES
EA FAN START/STOP	EAFAN_RUN_C					Х		BOOLEAN COMMAND FAIL	YES
EA FAN START/STOP OVERRIDE	EAFAN_RUN_OVRD						Х	BOOLEAN COMMAND FAIL	YES
EA FAN STATUS	EAFAN_RUN_ST	X						BOOLEAN COMMAND FAIL	YES
EA FAN ECM MOTOR FAULT	EAFAN_VFDFLT_S	Х						BOOLEAN CHANGE OF STATUS	YES
EA FANS ECM SPEED	EAFAN_VFD_SPD_C					Х			YES
EA FANS ECM SPEED OVERRIDE	EAFAN_VFD_SPD_OVRD						X		YES

MECHANICAL CONTROL LEGEND

AFF	ABOVE FINISHED FLOOR	Ts	TEMPERATURE SENSOR
BAS	BUILDING AUTOMATION SYSTEM		HUMIDITY SENSOR
co ₂	CARBON DIOXIDE		
TCC	TEMPERATURE CONTROL CONTRACTOR	(L)	LOW LIMIT TEMPERATURE SEI
DP			PRESSURE SENSOR
EA		ſ	
RA		(DP)	DUCT STATIC PRESSURE
SA			DIFFERENTIAL PRESSURE SW
HPS/R	HEAT PUMP WATER SUPPLY/RETURN		
NC	NORMALLY CLOSED	(DPS)	DIFFERENTIAL PRESSURE SEM
OA OCC	OUTSIDE AIR PATH OCCUPANCY	С	START/STOP COMMAND
PRESS	PRESSURE	Μ	MOTORIZED DAMPER
DI		F	FLOW METER
DO			
		CS	CURRENT SENSOR
VED		SD	DUCT SMOKE DETECTOR
RH	RELATIVE HUMIDITY		
MAU	MAKE-UP AIR UNIT	005	
O/H O/C	OCCUPIED HEATING SETPOINT OCCUPIED COOLING SETPOINT	DSP-HL	DUCT STATIC PRESSURE - HIG
U/H	UNOCCUPIED HEATING SETPOINT	DSP-LL	DUCT STATIC PRESSURE - LO
U/C (K)	EMERGENCY HVAC/VENTILATION	ZN-DP	ZONE DEW POINT
Ta	AVERAGING TEMPERATURE SENSOR	ZN-CO2	ZONE CARBON DIOXIDE SENS
		ZN-OCC	ZONE OCCUPANCY SENSOR
		ZN-T	ZONE TEMPERATURE SENSOR
		CO2	AVERAGING TEMPERATURE S
		ଡ଼	CENTRIFUGAL FAN
		AFS	AIR FLOW MONITORING STATI
		VFD	VARIABLE FREQUENCY DRIVE

OUTSIDE AIR SYSTEMS:

- THERE IS ONE OUTSIDE AIR UNIT THAT SERVES ALTERNATE #1 BASEMENT SPACES.
- THE SYSTEM SHALL OPERATE UNDER THE CONTROL OF A LOCAL, STAND-ALONE MICROPROCESSOR BASED DDC CONTROLLER AND SHALL BE TIED INTO THE BMS AND FACTORY INSTALLED PER SPECIFICATIONS. 3. THE SYSTEM SHALL BE PLACED INTO THE OCCUPIED/UNOCCUPIED MODE BASED UPON THE USER ADJUSTABLE SCHEDULE AT THE NETWORK



- SHALL BE PLACED INTO THE UNOCCUPIED MODE UNTIL COMMUNICATION IS RESTORED. 5. THE SYSTEM WILL BE PLACED INTO A MODE OF OPERATION BASED UPON THE FOLLOWING ADJUSTABLE TERMPERATURE SCHEDULE: MODE OF OPERATION COOLING MODE
 - OUTSIDE AIR TEMPERATURE 78 DEG F OR GREATER (ADJ.) BETWEEN 50 DEG F AND 78 DEG F (ADJ.) ECONOMIZER MODE
 - 50 DEG F OR LESS (ADJ.) HEATING MODE
- 6. IN THE UNOCCUPIED MODE OR FREEZESTAT (LOW LIMIT SET AT 36 DEGREES F) MODE: THE SUPPLY FAN AND EXHAUST SHAL BE OFF.
 - THE ENERGY RECOVERY WHEEL SHALL BE OFF, THE OUTSIDE AIR DAMPER AND EXHAUST AIR DAMPER SHALL BE FULLY CLOSED.
- 7. WHEN PLACED INTO THE OCCUPIED MODE, THE FOLLOWING SHALL OCCUR IN SEQUENTIAL ORDER
 - THE ENERGY RECOVERY WHEEL SHALL START AND OPERATION SHALL BE PROVED VIA CURRENT SWITCH, THE OUTSIDE AIR DAMPER AND EXHAUST AIR DAMPER SHALL FULLY OPEN AND BE PROVED VIA END SWITCH,
 - THE SUPPLY FAN/VFD AND EXHAUST FAN/VFD SHALL START AND OPERATION SHALL BE PROVED VIA CURRENT SWITCH
 - THE SYSTEM SHALL NOT START IF ANY ONE COMPONENT DOES NOT PROVE OPERATION

8. IN THE OCCUPIED MODE THE DX COIL, SCR ELECTRIC HEAT, AND HOT GAS REHEAT COIL SHALL MODULATE TO MAINTAIN DISCHARGE AIR TEMPERATURE (ADJ.) BASED UPON THE FOLLOWING SCHEDULE:

72 DEG F (ADJ.)

VARIES 68 DEG F (ADJ.)

- DISCHARGE AIR TEMPERATURE MODE OF OPERATION COOLING MODE
 - ECONOMIZER MODE HEATING MODE
- 9. IN ECONOMIZER THE ENERGY RECOVERY WHEEL SHALL BE OFF. THE COOLING/HEATING SHALL BE OFF. THE FANS SHALL REMAIN ON.

10. DEHUMIDIFICATION MODE: WHEN THE DUCT-MOUNTED EXHAUST AIR RELATIVE HUMIDITY SENSOR READS 65% OR GREATER, ENERGY RECOVERY WHEEL SHALL BE ON AND THE UNIT SHALL BE PLACED INTO COOLING MODE UNTIL EXHAUST AIR RELATIVE HUMIDITY IS BELOW 60%. 11. THE ECM MOTOR SUPPLY FAN SHALL BE CONTROLLED AND BALANCED TO A CONSTANT VOLUME VIA BMS CONTROL SIGNAL TO THE FACTORY MOUNTED LOCAL CONTROLLER. REFER TO SCHEDULE FOR SUPPLY AIR CFM.

12. THE ECM MOTOR EXHAUST FAN SHALL BE CONTROLLED AND BALANCED TO A CONSTANT VOLUME VIA BMS CONTROL SIGNAL TO THE FACTORY MOUNTED LOCAL CONTROLLER. REFER TO SCHEDULE FOR EXHAUST AIR CFM.

13. THE DX COOLING COIL SHALL MODULATE TO MAINTAIN A 55 DEGREE (ADJ.) DISCHARGE TEMPERATURE IN COOLING MODE.

14. THE SCR ELECTRIC HEATING COIL SHALL BE CONTROLLED AND MODULATE TO MAINTAIN A 68 DEGREE (ADJ.) DISCHARGE TEMPERATURE IN HEATING MODE. 15. THE DX HOT GAS REHEAT COIL SHALL BE CONTROLLED AND MODULATE TO MAINTAIN A 72 DEGREE (ADJ.) DISCHARGE TEMPERATURE IN COOLING MODE. 16. VFD DEFROST CONTROL-WHEN THE OUTSIDE AIR TEMPERATURE IS BELOW 5 DEGREES F (ADJ.). THE ENERGY WHEEL SHALL SLOW TO 25% OF DESIGN SPEED FOR A PERIOD OF 3 MINUTES, IT SHALL DO THIS EVERY 60 MINUTES.

17. A MANUAL RESET LOW LIMIT TEMPERATURE SENSOR INSTALLED DOWNSTREAM OF THE SCR HEATING COIL SHALL STOP THE OPERATION OF THE SYSTEM IF THE DISCHARGE TERMPATURE FALLS BELOW 55 DEG F (ADJ.) IN HEATING MODE.

(Ts) ⁷	M
→	EA
CS ECM	
$\overline{\mathbf{v}}$	OA 🕴 🤇
ENERGY — RECOVER Y WHEEL	M



9/30/19

#	DATE	DESCRIPTION
1	Date 1	Revision 1
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_		

	RF-SS-1 CAS-1 CAS-2 SS-1a THERMOSTAT
CU-1 HP-1	
VRV AND SPL SCHEMATIC NOT TO SCALE	IT SYSTEM CONT

1. VRV AND SPLIT SYSTEM SS-1 AND CAS-1

1.1. These units shall be provided with factory controls and space sensors. The DDC system shall monitor space temperature and provide an out of range alarm. Provide all necessary wiring conduit, etc. as required to interlock the space sensor with indoor unit and condensing unit. Rooms shall have a space temperature setpoint via wall mounted space sensor and the split system shall control to maintain space at 72°F (adj.).

1.2. The DDC system shall have the ability to start and stop the split system, adjust temperature setpoints, and read in space temperature. All VRV/Mini-split systems shall be provided with a BACnet over MSTP communication and all points shall be available to the DDC system.

VI	RV/SPLIT SYSTEM H	HEAT	PUN	MP C	ONT	ROLS	S POI
POINT DESCRIPTION	POINT NAME	BI	BO	BV	AI	AO	AV
ROOM TEMPERATURE ACTUAL	VRW_ROOM_T				Х		
TEMPERATURE SETTING	VRW_TS					Х	
HEATING_COOL MODE	VRW_H_C						Х
OCCUPIED SCHEDULE	OCC_S						Х
UNOCCUPIED SCHEDULE	UNOCC_S						Х

RTU-1	AND R	TU-2 POI	NTS LIS	Т		
POINT NAME	BI	BO	AI	AO	SETPOINT	ALARM
DX COMPRESSOR 1 ENABLE/DISABLE		Х				
DX COMPRESSOR 2 ENABLE/DISABLE		Х				
ECONOMIZER MIXED AIR TEMP SETPOINT					Х	
ECONOMIZER MIXED AIR TEMP SETPOINT OVERRIDE					Х	
SUPPLY AIR TEMP SETPOINT					Х	
EMERGENCY SHUTDOWN	Х					Х
MIXED AIR DAMPERS				Х		
MIXED AIR DAMPERS OVERRIDE				Х		
MIXED AIR TEMP			Х			
OCC COOLING SETPOINT					Х	
OUTSIDE AIR DAMPER STATUS	Х					Х
OUTSIDE AIR DAMPERS				Х		
OUTSIDE AIR DAMPERS OVERRIDE					Х	
OUTSIDE AIR TEMP			Х			
PREFILTER STATUS	Х					Х
PREHEATING MIXED AIR TEMP SETPOINT					Х	
PREHEATING MIXED AIR TEMP SETPOINT OVERRIDE					Х	
RETURN AIR HUMIDITY			Х			
RETURN AIR SMOKE DETECTOR	Х					Х
RETURN AIR TEMP			Х			
SCHEDULE					Х	
SUPPLY AIR TEMP			Х			Х
SUPPLY AIR TEMP SETPOINT					Х	
SUPPLY FAN START/STOP		X				
SUPPLY FAN START/STOP OVERRIDE					Х	
SUPPLY FAN STATUS	Х					Х
UNOCC COOLING SETPOINT					Х	
UNOCC HEATING SETPOINT					Х	
SUPPLY AIR TOTAL CFM			X			
RETURN AIR TOTAL CFM			X			
SUPPLY FAN AIR CFM			X			
RETURN FAN AIR CFM			X			
RETURN AIR HUMIDITY SENSOR			Х			
RELIEF AIR DAMPER STATUS	X					Х
RELIEF AIR DAMPERS				Х		
RELIEF AIR DAMPERS OVERIDE					Х	
MIXED AIR DAMPER STATUS	Х					Х
SPACE TEMPERATURE			Х			Х
CO2 SENSOR			Х			Х
GAS HEAT VALVE				X		



- 1. All electric heaters shall be set to 65 degrees F. 2. All electric heaters shall be scheduled on and off via an electric heater
- Schedule shall be intially setup so heaters are always occupie 3. Provide all electric heaters with 24 volt space sensors/thermostat. Controls contractor will be required to provide any transformers required to control electric heater by space sensor.

	E	ELECT	RIC HI	EATEF	RS CO	NTRO	LS PC) [
DISPLAY NAME	POINT NAME	BI	BO	BV	AI	AO	AV	
START/STOP	EH_C		Х					E
START/STOP OVERRIDE	EH_C_OVRD			Х				E
STATUS	EH_S	Х						E
SCHEDULE	OCC_S			Х				
SPACE TEMPERATURE	EH_T				Х			
SPACE TEMPERATURE SETPOINT	EH_T_SPT					Х		

NTROLS

DINTS





RTU#: LOCATION: AREA SERVED: OCCUPIED/UNOCCUPIED



1. Rooftop Units

1.1. <u>Occupancy</u> Schedule:

1.1.1. 7am to 4pm Monday Thru Friday. Contractor to verify schedule with owner.

1.1.2. The unit shall be placed into occupied/unoccupied, morning warm-up or morning cool-down mode from the BAS control system. The RTU's shall be provide with factory mounted controllers that shall be capable of integrating into the BAS.

1.2. Outside Air/Return Air/Relief Air Damper Control: In occupied mode, the outside air damper shall maintain minimum outside air ventilation rate unless in economizer mode. The return air damper shall modulate inversely to the outside air damper. The relief air damper shall modulate to a minimum position during normal mode and shall fully open when in economizer mode with the exhaust fan active. In the unoccupied mode, the outside and relief air damper shall be closed.

1.3. Supply and Exhaust Fan Control

1.3.1. Supply fan will be started and stopped from the local BAS Panel per the ATC schedule. When the start command is issued the supply air fan shall be engaged. If the fan status does not match the commanded value an alarm will be generated. When the supply fan status indicates the fan has started, the control sequence will be enabled.

1.3.1.1 RTU-1 shall be provided with an ECM exhaust fan motor that shall be balanced and controlled via a control signal sent from the BAS. Refer to schedule for exhaust fan CFM. The supply fan shall be controlled by a VFD and operate the supply fan to achieve a single zone variable air volume operation. The supply fan and compressors will modulate to maintain space thermostat setpoint.

1.3.1.1 RTU-2 shall be provided with an ECM exhaust fan motor that shall be balanced and controlled via a control signal sent from the BAS. Refer to schedule for exhaust fan CFM. The supply fan is an ECM motor and shall be controlled via a control signal sent from the BAS. by a control signal from the BAS system that shall operate the supply fan to achieve a single zone variable air volume operation. The supply fan and compressors will modulate to maintain space thermostat setpoint.

1.3.2. The exhaust fan shall be enabled when the unit enters economizer mode and shall be disabled when in normal mode. 1.3.3 Supply Fan and Exhaust Fan: Each fan shall have a current switch monitoring motor status and provide an alarm at the BAS for fan failures.

1.4. <u>Supply Air Temperature Controls - Cooling/Heating</u>

1.4.1 Building Automation System Interface: The Building Automation System (BAS) shall send the unit's controller Occupied/Unoccupied and Heat/Cool modes. The BAS shall also send the discharge air temperature setpoint. If a BAS is not present, or communication is lost with the BAS the controller shall operate using default modes and setpoints.

1.4.2 Occupied: During occupied periods, the supply fan shall run upom a call for cooling or heating. The DX cooling shall stage compressors to maintain the discharge air temperature set point 55 Deg. F (adj.). If economizing is enabled the outside air damper shall also modulate to maintain the discharge air temperature set point 55 Deg F (adj.). If the discharge air temperature sensor fails the DX compressors shall disable and an alarm shall be annunciated at the BAS. An auto changeover deadband shall be set up to automatically change unit from cooling to heating. In the heating mode, if the space temperature falls below 70 deg F (adj.) setpoint, then the gas heating valve shall modulate to maintain space temperature setpoint. The unit shall not simultaneously heat and cool.

1.4.3 Economizer: The discharge air temperature sensor shall measure the dry bulb temperature of the air leaving the cooling coil while economizing. When economizing is enabled and the unit is operating in the cooling mode, the economizer damper shall be modulated between its minimum position and 100% to maintain the discharge air temperature setpoint 55 Deg. F. The economizer damper shall modulate toward minimum position in the event the mixed air temperature falls below the low temperature limit setting 50 Deg. F (adj.)

The factory mounted controller may also be used to control economizer mode utilizing built in comparative enthalpy control.

1.5. <u>Smoke Shutdown</u>:

1.5.1. Smoke detectors shall be located in the return air streams. If smoke is detected, the supply and return fans shall de-activate and an audio/visual alarm shall activate. Upon correction of the problem, the system shall be reset and unit shall return to normal operation. The smoke detectors shall provide a supervisory signal to the Fire Alarm System. This shall be reset automatically when smoke is no longer present.

1.6. <u>Unoccupied Mode</u>:

1.6.1. In the unoccupied mode, the air handling unit shall be "off". The outside air damper and exhaust air damper shall be closed and the return air damper shall be open. If the building space temperature is above 80 deg. F (adj.) the unit shall be placed into occupied mode until the space temperatures are 76 deg. F (adj.). If the building temperature is below 60 deg F (adj.) thr unit shall be placed into occupied mode until space temperature is 64 degrees F (adj.)

1.6.2. Morning Warm-Up (Building temperature is allowed to drop to 63°F): Under morning warm-up the unit shall be activated at a time provided by the BAS control system. Morning warm-up shall occur via indirect gas burner. Unit shall be 100% recirculating.

1.6.3. Morning Cool Down (The Building temperature is allowed to raise to 80°F adj.): Under morning cool-down the unit shall be activated at a time provided by the BAS control system. During this cool down the outside air damper and relief air damper shall remain closed. The unit shall circulate air through the building and the supply air temperature shall be controlled to 55 F (adj.) until the temperature drops to 75°F (adj.) When the space temperature has been lowered to 75°F (adj.) the unit shall go into normal operation. This shall occur 2 hours (adj.) before the occupied schedule. The unit shall do this via the DX cooling coil and staging of associated compressors.

space temperature to the space temperature offset setpoint.

1.6.6. All systems shall be disabled in the unoccupied mode. If the system is required to be enabled in the unoccupied mode due to space conditions, then all relevant PID loops shall be enabled as well to maintain appropriate control. 1.7. Filter Status

1.7.1 A filter pressure differential sensor shall be provided across the filter bank and shall monitor filter static pressure. Provide an alarm if pressure drop exceeds 0.6" W.G. (adj.). 1.8.1 RTU-1 shall be provided with a space CO2 sensor that shall modulate the outside air damper from 700 CFM to 1155 CFM where 700 PPM is 700 CFM and 1100 PPM is 1155 CFM.



ROOFTOP UNITS

1.6.4. Optimal Start: The BAS shall monitor the scheduled occupied time, occupied space setpoints and space temperature to calculate the optimal start time in order for the building to reach occupied setpoint by the occupied time.

1.6.5. Optimal Stop: The BAS shall monitor the scheduled unoccupied time, occupied setpoints and space temperature to calculate when the optimal stop occurs. When the optimal stop mode is active the unit controller shall maintain the



VARIABLE REFRIGERANT FLOW INDOOR UNIT SCHEDULE

A MARKMANUFACTURERMODELROOMTOTAL COOLING CAPACITY (MBH)SENSIBLE COOLING CAPACITY (MBH)TOTAL HEATING (MAIF (MCAS-1DAIKINFXZQ18TAVJUCORRIDOR A-CA10.9176.94213.99(MCAS-1DAIKINFXZQ18TAVJUCORRIDOR A-CA10.9176.94213.99(MCAS-2DAIKINFXZQ18TAVJUVESTIBULE-17016.03510.95720.814(MSS-1aDAIKINFXAQ24PVJUIDF 17121.49714.39827.5(M	~ _										
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SS-1a DAIKIN FXAQ24PVJU IDF 171 21.497 14.398 27.5	2	CAS-2	DAIKIN	FXZQ18TAVJU	VESTIBULE-170	16.035	10.957	20.814	511	33-43	22.6X
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VARIABLE REFRIGERANT FLOW OUTDOOR UNIT SC

			MINIMUM ACTUAL		NOI	MINAL SIZE ((IN)	
			INSTALLED	MINIMUM NOMINAL				ĺ
MARK	MANUFACTURER	MODEL #	COOLING	HEATING (MBH)	LENGTH	WIDTH	HEIGHT	WEIGHT (LBS)
HP-1	DAIKIN	RXTQ72XATJU	29.7	38.2	49	67	30	727

REMARKS:

1. PROVIDE NEC COMPLIANT DISCONNECT MEANS.

ACCEPTABLE MANUFACTURER'S ARE TRANE, MITSUBISHI, SAMSUNG, AND LG.
PROVIDE MANUFACTURER'S RECOMMENDED INTEGRAL CONDENSATE PUMP. POWER SHALL BE PROVIDED VIA INTEGRAL 208V CONTA

4. PROIVDE MANUFACTURER'S SHROUD FOR EXPOSED REFRIGERANT AND CONDENSATE PIPING SERVING WALL MOUNTED UNIT. PAINT REQUIREMENTS.



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NAL SIZ XHXD)	٤	/OLTAGE	PHASE	MCA	MOP	WEIGHT (LBS)
10.2X22	2.6	208 V	1	0.4 A	15 A	36.4
10.2X22	2.6	208 V	1	0.4 A	15 A	36.4
10.2X22	2.6	208 V	1	0.6 A	15 A	36.4
11.4X9.	.3	208 V	1	0.6 A	15 A	30.9
HE	DU	LE				
		ELECTRI	CAL	1		
VOLTA	GE (V)	PHASE	MCA	MOCF	P RE	EMARKS
208	V	1	38 A	45		ALL
ACTS IN SHROL	I WALI JD IN /	- MOUNT ACCORD	ED UNIT. ANCE WIT	TH ARCI	HITECT	URAL
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