

ADDENDUM

PROJECT NAME: **Robarts 5th floor**

COMPANY: **Superkul**

ATTENTION: **Kate Myers**

PROJECT NO.: **08086-009**

DATE: **2024-11-13**

ADDENDUM NO.: **M-01**

ISSUED BY: **Scott Gould**

The following amendments are hereby made as part of the Contract Documents. The following revisions and/or additions shall be made to contract documents and the cost shall be included in the Tender Price.

1.0 SPECIFICATION

1.1 Section 20 08 00.00 – Commissioning (included herein)

1.1.1 New Section Added.

1.2 Section 23 09 00.02 – Building Automation System (BAS) (included herein)

1.2.1 New line added – 1.2 Related Sections 20 08 00.00 Commissioning.

END OF MECHANICAL ADDENDUM

20 08 00.00 Commissioning

4. General

4.1. WORK INCLUDED

4.1.1. Conform to Section 20 05 00.00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

4.1.2. Conform to Section 20 05 02.00 - AS-BUILT DRAWINGS.

4.1.3. Conform to Section 20 05 03.00 - SHOP DRAWINGS.

4.1.4. Conform to Section 23 05 93.23 - TESTING AND BALANCING AIR SYSTEMS.

4.1.5. Conform to Section 23 09 00.00 - BUILDING AUTOMATION SYSTEM (BAS).

4.1.6. The commissioning process for the Mechanical Systems shall include:

- .1 Verification that the installation meets the requirements of the Contract Documents.
- .2 Verification that the system's performance meets the design intent.
- .3 Provision of building operator training.
- .4 Provision of as-built documentation, operating and maintenance manuals, and systems operating manuals.

4.1.7. Provide labour, equipment and material to conduct the Contractor commissioning process as outlined in this Section.

4.1.8. The Owner will hire a Commissioning Agent who will provide services identified in the Commissioning Agent articles within this Section.

4.2. SUBMITTALS

4.2.1. Submittals requested in this Section shall be submitted in accordance with Section 20 05 03.00 – SHOP DRAWINGS.

5. Products

5.1. MATERIALS

5.1.1. The Contractor and manufacturers shall provide all instrumentation and equipment necessary to conduct the tests as specified in the Mechanical Sections. The Contractor shall advise the Engineer's Representatives or Commissioning Agent of instrumentation to be used and the dates the instruments were calibrated.

6. Execution

6.1. INSTALLATION

6.1.1. This Section describes the commissioning process to be performed by the Contractor. The process shall provide a high level of quality control during the construction.

6.1.2. The commissioning process shall consist of:

- .1 Shop Drawings/as-built drawings
- .2 Installation review and equipment verification

- .3 Testing of air systems
- .4 Testing of equipment and systems
- .5 Building Automation System Commissioning
- .6 Commissioning Agent performance testing
- .7 Operating and maintenance manuals
- .8 Training
- .9 Systems acceptance

6.2. INSTALLATION REVIEW AND EQUIPMENT VERIFICATION

- 6.2.1. The Contractor shall complete the equipment verification forms for each piece of equipment. The completed forms shall be forwarded to the Engineer's Representative for review and be included in the operating and maintenance manuals.

6.3. TEST FORMS AND VERIFICATION FORMS

- 6.3.1. The Commissioning Agent will prepare a test form manual, which will contain a form for every test identified in the Specification. A copy of this manual will be given to the Contractor, the General Contractor and the Engineer's Representative.
- 6.3.2. The Contractor shall prepare test forms for every test identified in this Specification. The Contractor shall complete each form as tests are completed and forward a copy to the Engineer's Representative for review on a monthly basis.
- 6.3.3. The forms shall be signed by either the Authorities Having Jurisdiction, the Engineer's Representative or the Commissioning Agent where applicable.
- 6.3.4. Test forms and verification forms have been included with this Section. Obtain approval from the Engineer's Representative if the Contractor wishes to use different forms.

6.4. PLUMBING AND DRAINAGE SYSTEM TESTING

- 6.4.1. The plumbing and drainage system shall be tested in accordance with Section 23 05 93.13 - TESTING AND BALANCING PIPING SYSTEMS.
- 6.4.2. The Contractor shall notify the Building Inspector when systems are available for testing. The Contractor shall document all tests performed and shall arrange for the Building Inspector to sign the forms for tests completed.

6.5. TESTING OF AIR SYSTEMS

- 6.5.1. Conform to Section 23 05 93.23 - TESTING AND BALANCING AIR SYSTEMS.

6.6. TESTING OF EQUIPMENT AND SYSTEMS

- 6.6.1. Should equipment or systems fail a test, the test shall be repeated after repairs or adjustments have been made. The additional tests shall be witnessed by the Engineer's Representative or the Commissioning Agent.
- 6.6.2. Tests which have not been witnessed shall not be accepted and shall be repeated.

6.7. COMMISSIONING MEETINGS AND SCHEDULING

- 6.7.1. The Contractor shall include the schedule for all tests and equipment start-up tests in the construction schedule.

6.8. OPERATOR TRAINING

6.8.1. Training will begin when the operating and maintenance manuals have been delivered to the Owner and reviewed by the Engineer's Representative.

6.8.2. Each training session will be structured to cover:

- .1 Operating procedures
- .2 Trouble-shooting procedures

6.8.3. The training sessions will be scheduled and co-ordinated by the Commissioning. The Commissioning Agent Training shall be provided for the following systems:

System	Minimum Training Times
Air handling units	2 hours
BAS Controls System	Conform to 23 09 00.00

6.8.4. Refer to Section 23 09 00.00 - BUILDING AUTOMATION SYSTEMS (BAS).

6.8.5. The training requirement for the mechanical system shall include a walk-through of the building by the Contractor. During the walk through the Contractor shall:

- .1 Identify equipment
- .2 Identify access doors
- .3 Review general maintenance of equipment

6.8.6. When each training session has been completed with the Owner's representative, the Commissioning Agent will sign the associated form to verify completion.

6.9. COMMISSIONING AGENT

6.9.1. A Commissioning Agent will be hired by the Owner.

6.9.2. The Commissioning Agent responsibilities shall include:

- .1 Preparing the commissioning plan
- .2 Co-ordinating with the Contractor to schedule tests
- .3 Preparing a test form manual
- .4 Witnessing selected tests
- .5 Receiving all test forms
- .6 Conducting performance test
- .7 Co-ordinating the Contractor's training

6.9.3. The Contractor shall co-ordinate and co-operate with the Commissioning Agent.

6.10. PERFORMANCE TESTING

6.10.1. The Commissioning Agent will conduct performance tests on each mechanical system to verify that the design intent performance has been met. The performance tests will cover all seasonal modes. The Commissioning Agent will visit the building in six months to retest the systems.

6.10.2. The Contractor shall conduct performance tests on all mechanical systems and document the results on the performance forms. Request form from the Engineer's Representative.

- 6.10.3. The Contractor shall provide assistance to the Commissioning Agent and have personnel available during the performance testing procedures during construction and the warranty period.
- 6.10.4. Performance testing will begin when all mechanical systems have been completed, tested by the Contractor, reviewed by the Engineer's Representative and Substantial Completion has been achieved.
- 6.11. COMMISSIONING PROCESS ALLOCATION
- 6.11.1. The commissioning process shall be allocated a value equal to 8% of the contract. This value shall be itemized in the Statement of Prices which forms the basis for progress payment for the various portions of Work. The Contractors may draw from this allocation as the commissioning process is completed.
- .1 The Contractors shall submit all test and verification forms. The Engineer's Representative will use these forms to calculate a percentage complete.
- .2 The Contractor may claim up to 5% of the contract, as per Schedule of Breakdown, on a monthly basis, from this allocation leading up to performance testing. The remaining 3% shall not be paid out until the performance testing, O&M manuals and training have been completed satisfactorily.
- 6.11.2. The commissioning process allocation shall be broken down as follows:
- | | |
|--|-------|
| Shop Drawings | 0.50% |
| Installation review and equipment verification | 0.50% |
| Testing of air systems | 0.50% |
| Testing of equipment and systems (system start-up) | 0.50% |
| BAS commissioning | 1.00% |
| Commissioning Agent Performance Testing | 2.00% |
| Training | 0.50% |
| As-built drawings | 0.50% |

END OF SECTION

23 09 00.02 Building Automation System (BAS)

1. General

1.1. WORK INCLUDED

- 1.1.1. Provide all labour, materials, Products, equipment and services to supply, install, test and commission new additions and integrate into existing Building Automation System (BAS) with Direct Digital Control (DDC) for building mechanical and electrical systems as indicated on Drawings and described herein.
- 1.1.2. Conform to Section 20 05 00.00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.
- 1.1.3. Conform to Section 23 09 23.00 - SEQUENCE OF OPERATION FOR BAS.
- 1.1.4. Conform to University of Toronto – Building Automation System – Design Standards and Guidelines. Including building standard temperature sensors, cabling colours, system hierarchy, maximum cable distances, point nomenclature, As-built requirements etc.
- 1.1.5. Conform to University of Toronto F&S Standards and submit all forms required, refer to U ofT website for more information.
- 1.1.6. Conform to University of Toronto F&S Standards and submit all forms required, refer to U ofT website for more information

1.2. RELATED SECTIONS

Section 20 08 00.00 - COMMISSIONING

1.3. PROJECT SCOPE PHASE 1

- 1.3.1. Input/output wiring, if it is installed per this Specification, can be reused.
- 1.3.2. Install new controls for all floor by-pass boxes and connect to the BAS. Acceptable control contractor is Johnson's Controls

1.4. SYSTEM OUTLINE

1.4.1. General

- .1 The documentation contained in this section and other Contract Documents pertaining to Building Automation System (BAS) is schematic in nature. The Contractor shall provide all required hardware and software necessary to implement the functions shown or implied in the Contract Documents.
- .2 Control system to consist of microprocessor based DDC controllers.
- .3 DDC controllers shall be based on open type protocols, BACnet as defined by ANSI/ASHRAE standard 135-2012 for potential future connection to Building Automation System (BAS).
- .4 Control system to consist of high-speed, peer-to-peer network of microprocessor based DDC controllers and integrate with existing BAS.
- .5 Each system, building floor plan and control device shall be displayed through point-and-click graphics.
- .6 BAS to operate on building LAN communication infrastructure.

1.4.2. Functional Principals

- .1 Controls to control mechanical and electrical equipment as specified in CONTROL SEQUENCES
 - .2 System architecture to be modular permitting expansion of application software, system peripherals and field hardware.
 - .3 Each controller to operate independently by performing its own specified control, alarm management, operator I/O and historical data collection receiving information from input field devices and controlling output field devices to perform the control sequences.
 - .4 DDC controller may control more than one system provided that points associated with those systems are connected to that same controller.
 - .5 DDC controllers to be configured so that main inputs and outputs from any control loop are located in that same controller.
 - .6 Global points used for control loop reset such as outdoor air temperature are exempt from this requirement.
 - .7 DDC controllers to be capable of operating with local closed loop programming, independent from the server if communication is interrupted.
 - .8 Where PID control loops are called for in the sequences, they are to be implemented within the controller.
 - .9 BAS server shall perform global control programs and data consolidation and storage, communicating and obtaining data from all controllers and transmitting instructions to all controllers.
 - .10 The supplied system must incorporate the ability to access all data including graphics, reports and alarm detection using standard Web Browsers without requiring proprietary operator interface and configuration programs. An Open Data Base Connectivity (ODBC) or Structured Query Language (SQL) compliant server database is required for all system database parameter storage. This data shall reside on a Supplier-installed server for all database access. Systems requiring proprietary database and user interface programs shall not be acceptable
 - .11 Support for the exchange of Comma-Separated Value (CSV) files must be provided.
- 1.4.3. Mechanical Contractor to carry the cost of Controls Contractor.
- 1.5. BASE BUILDING BAS PROVIDER
- 1.5.1. Approved Suppliers And Manufacturers
JCI (Johnson's Controls international)
- 1.6. OPEN PROTOCOL STANDARD
- 1.6.1. Intention of this Specification is to provide an integrated, open protocol BAS, BACnet as defined by ANSI/ASHRAE Standard 135.
- 1.6.2. BACnet devices on the lower tier network to support all BACnet functional groups, standard application services and standard object types necessary, but not limited to provide reading and writing functionality of all analog and binary inputs and outputs and change-of-value initiation and reporting between BACnet devices on the network.
- 1.6.3. All BACnet devices to be BTL tested. Provide Protocol Implementation Conformance Statement (PICS) for all BACnet devices.

1.7. BAS PERFORMANCE

- 1.7.1. Graphic Display: Display the selected graphic representation at Operator Interfaces with current point object data at a minimum rate of twenty points in ten seconds.
- 1.7.2. Graphic Refresh: Update the selected graphic representation at Operator Interfaces with current point object data at a minimum rate of twenty points in ten seconds.
- 1.7.3. Data Scan: Update point object data at controllers and Operator Interfaces with current point object data at a minimum rate of once every ten seconds.
- 1.7.4. Binary Object Command: Controlled device will react within five seconds of an operator initiated command on a binary point object.
- 1.7.5. Analog Object Command: Controlled device will start to react within five seconds of an operator initiated command on an analog point object.
- 1.7.6. Alarmed Object Display: Alarm will annunciate visually and audibly at Operator Interfaces within five seconds on local area networks and within forty-five seconds on wide-area networks from the time the object entered the alarmed state.
- 1.7.7. Program Execution Rate: Provide ability to execute programs at a minimum rate of once every five seconds. Provide execution rates suitable for processes controlled.
- 1.7.8. PID Execution Rate: Provide adjustable execution rates for proportional-integral-derivative (PID) loops; update the controlled variable and command the controlled device at this same rate. Provide execution rates suitable for processes controlled.
- 1.7.9. Display and Report Accuracy: Provide minimum accuracy for point object data displayed at Operator Interfaces, reported to printers, reported to data files to Table 1: Display and Report Accuracy.

Table 1: Display and Report Accuracy.	
Point Object	Accuracy
Room Air Temperature	+/-0.2 deg. C (+/-0.36 deg. F) from actual
Air Flow, Terminal Unit	+/-5.0 % of actual
Electrical (current, voltage, power)	+/-1.2 % of actual (see Note 2)
Note 1: For both absolute and differential pressure.	
Note 2: Does not include utility grade meters.	

- 1.7.10. Control Tolerance: Maintain controlled variable to control tolerance from set point to Table 2: Control Tolerance.

Table 2: Control Tolerance.		
Controlled Variable	Range	Control Tolerance from Set Point
Room Temperature		+/-0.6 deg. C (+/-1.1 deg. F)
Air Flow		+/-1.0 % of scale length

1.8. SUBMITTALS

- 1.8.1. Product Data and Shop Drawings:
 - .1 Within 30 days of award of contract, before start of construction, submit completely engineered and coordinated shop drawing package.

- .2 Before start of construction, submit completely engineered and coordinated shop drawing package including graphics samples
 - .3 Submittals in printed format and as amended below.
 - .4 Provide drawing files through Email to Client and S+A Representative.
 - .5 System Flow Diagrams: Indicate: control devices, control device designation, control device range, control device fail-safe position, point object type, point object name, point object address. Indicate flow directions for gases and liquids relevant to the controlled process. Indicate hardwired interlocks between control devices and equipment. Indicate the location of field control devices.
 - .6 Products Schedule: Indicate: Product designation, Product name, Product manufacturer, Product model number, Product data sheet reference number, quantities. Provide quantities required under the Work.
 - .7 Room Schedule: Indicate: controller object name, controller address, controller model number, application designation, room designation, VAV air volume set points, and sensor model numbers.
 - .8 Cabinet Layouts: Interior: Indicate: orientation of contents including controllers, transformers, cable trays, terminal strips, relays, control devices, labels. Exterior: Indicate: orientation of gauges, displays, switches, labels.
 - .9 Wire Details: Indicate: connections between control devices, controllers and equipment; connections to sources of power and grounds; control device designations, control device terminal designations, control device location; equipment terminal designations; cabinet terminal strip designations; wire designations. For control devices shown on multiple Drawings, indicate the control device with the same designation on all Drawings. Differentiate between manufacturer installed wire and field installed wire.
 - .10 Sequence of Operation: Provide a complete description of operation to Section 23 09 23.00 - SEQUENCE OF OPERATION FOR BAS. Provide description of operation for interlocks that directly connect to the Work. Indicate references to the system flow diagram by control device designation or point object name.
 - .11 Points Schedule: Indicate: input points, output points and virtual points for each controller. Indicate: point object address, point object name, point object description, point object alarm limits. List points in ascending order based on point object address.
 - .12 Submit floor plan drawing indicating the coverage of Thermostats sensors where applicable or a spreadsheet to convey the same information..
- 1.8.2. Work Schedule:
- .1 Provide a schedule of the Work within four weeks of contract award. Indicate: intended sequence of tasks, start dates, task durations, and delivery dates for material and equipment requiring long lead times, restraints on Work by other trades or situations.
 - .2 Provide monthly updated Work Schedule indicating percentage complete and revisions to expected delivery dates.
- 1.8.3. Project as-built documents:
- .1 As-built Product data and Shop Drawings:
 - .1 Provide drawing files through Electronic File Transfer.
 - .2 Points Schedule: For points schedule generated under Part 1: Submittals, Product Data and Shop Drawings, indicate operating conditions for point object data; list point objects by system designation and alphabetically by point object name.

- .3 Time-of-Day (TOD) Schedules: Indicate: objects assigned to the TOD Schedule, Occupied Mode times.
 - .2 As-built floor plans:
 - .1 Maintain on the Project site as-built conditions on one full-size set of Contract Drawings, referred to as marked-up drawings; indicate on these drawings as-built locations for: control devices, cabinets, network devices with network address, communication networks by type and address, connection points to communication networks for Operator Interfaces, power networks, conduit paths, junction boxes, Operator Interfaces.
- 1.9. WARRANTY
 - 1.9.1. Warrant the Work free from defects for a period of 12 months and in accordance with the General Conditions and as amended below.
 - 1.9.2. Provide a single warranty start date even when the Owner has received beneficial use prior to acceptance of the Work. For Work split into multiple contracts or for a multi-phase contract, provide a separate warranty start date and period for each contract or phase.
 - 1.9.3. Adjust, repair or replace defects and failures in the Work at no additional cost during the warranty period and without reduction in service to the Owner. Provide warranty service during normal business hours and within 24 hours of the Owner's request for service.
 - 1.9.4. Provide warranty service by factory trained service representatives of the Supplier.
 - 1.9.5. Replace Operator Interface software, Controller Resident Software, controller firmware and database files with revisions that correct deficiencies or defects during the warranty period at no charge to the Owner. Notify the Owner of changes and schedule the installation. Update Operation and Maintenance Manuals with firmware release notes.
 - 1.9.6. Warrant Products that are reconditioned under the Work to the same requirements as new Products.
- 2. Products
 - 2.1. MATERIALS
 - 2.1.1. Existing Products: To Part 3: Execution, Existing Products.
 - 2.1.2. New Products: Non-beta versions currently under manufacture and have been applied in similar installations for a minimum period of one year.
 - 2.1.3. Revisions: Latest available revision for Operator Software, Controller Resident Software and controller firmware at start of Warranty.
 - 2.1.4. Revisions: Latest available revision for Controller Resident Software and controller firmware at start of Warranty.
 - 2.1.5. Replacement Parts: Readily available and not scheduled for discontinuation at time of Total Project Completion.
 - 2.2. CONTROL DEVICES
 - 2.2.1. Temperature Sensors:
 - .1 General Requirements:

- .1 Temperature sensors shall be of the resistance type, two-wire 1000 ohm nickel RTD, two-wire 1000 ohm platinum RTD or two-wire 10,000 ohm thermistor.
 - .2 Space Temperature Sensors:
 - .1 Stainless Steel plate sensors or white-plate sensors For installation throughout the facility where local control is not required (such as corridors or lobby) unless otherwise noted.
 - .3 Averaging Temperature Sensors:
 - .1 Minimum 1.5 m (5 ft) of capillary per 1 sq m (10 sq ft) of duct cross-section.
 - .2 Provide multiple sensors where single averaging element is unable to be positioned to provide complete duct or plenum traverse.
- 2.3. WIRE AND CONDUIT
 - 2.3.1. Conduit: Electrical metallic tubing EMT with compression type fittings in dry locations; cold rolled steel zinc coated or zinc coated rigid steel with threaded fittings in wet locations or where exposed to weather.
 - 2.3.2. Outlet boxes: Dry locations: sheradized or galvanized drawn steel 100 mm (4 in.) square or octagon with suitable raised cover; Exposed to Weather: threaded hub cast aluminum boxes with gasket plate.
 - 2.3.3. Junction boxes: Sized according to number, size and position of entering raceway; type: suitable for the environment.
 - 2.3.4. Wire:
 - .1 Network:
 - .2 Analog Input, Output: Stranded 18 gauge copper twisted shielded.
 - .3 Binary Input, Output: 18 gauge, minimum insulation rating of 600 volts.
 - .4 Class 2: FT-6 without conduit in ceiling plenums; FT-4 in conduit for all other cases.
 - .5 Plenum rated wiring to be used.
- 3. Execution
 - 3.1. GENERAL WORKPERSONSHIP
 - 3.1.1. Install Products to manufacturer's installation instructions.
 - 3.1.2. Install parallel to building walls and floors unless indicated or specified or required by manufacturer's installation instructions.
 - 3.2. COORDINATION
 - 3.2.1. Submittals: To Part 1: General, Submittals.
 - 3.2.2. Integrate and coordinate Work under this section to controls and control devices provided or installed by others.
 - 3.2.3. Resolve compatibility issues between control Product provided under this section and those provided under other sections or divisions of this Specification.
 - 3.3. EXISTING PRODUCTS
 - 3.3.1. This scope only applies to the Products that have become redundant as a result of this scope

- 3.3.2. Performance: During construction check and verify reused existing Products are operational. For existing Product that is not operational submit a proposal to replace existing Product for approval by the Consultant. Generally, Products which will potentially become redundant as a result of this scope of Work will only be reused if it meets the standards of this Specification.
- 3.3.3. Existing Sensors and Transmitters: Reuse.
- 3.4. WIRING AND CONDUIT
- 3.4.1. Wire shall be neatly tie wrapped to conduit mounted to the building structure but must be installed at right angles or parallel to the building. Loose wiring shall only be allowed over a distance of 1500 mm (5 ft.) but must not pass over lighting fixtures.
- 3.4.2. Should it become necessary to splice field wiring it shall be soldered. If soldering is not possible, approved B type crimp connectors are an acceptable alternative. Wire nuts and Marr connections are not acceptable. Provide a 500 mm (20 in.) loop length at all splices.
- 3.4.3. Conceal conduit within finished shafts, ceilings, and walls as required. Install exposed conduit parallel with or at right angles to the building walls.
- 3.4.4. Plug or cap unused conduit openings and stubs with compatible fittings.
- 3.4.5. Route all conduit to clear beams, plates, footings and structural members except through column footings and grade beams.
- 3.4.6. Provide watertight seals at penetrations through outside foundation walls.
- 3.4.7. Support conduit 25 mm (1 in.) and smaller to the building with one-hole non-perforated malleable iron or steel pipe straps. Suspend conduits larger than 1 in. on pipe racks with splitting hangers and rods.
- 3.4.8. Maintain caps on conduit openings throughout construction.
- 3.4.9. Where conduit is attached to vibrating or rotating equipment, install and anchor flexible metal conduit with a minimum length of 450 mm (18 in.) and a maximum length of 900 mm (36 in.) in such a manner that vibration and equipment noise will not be transmitted to the rigid conduit.
- 3.4.10. Where exposed to weather or in damp or wet locations, provide waterproof flexible conduit.
- 3.4.11. Fill conduit to maximum of 60% of its capacity. Provide a pull rope within the conduit when the installation is complete. Bend conduit to a radius of greater than 3 times the conduit diameter to a maximum of three 1/4 bends permitted between pull boxes.
- 3.4.12. Wire within cabinets shall be installed in a plastic tray with a cover. Terminate wires to field-removable, modular terminal strips.
- 3.4.13. All field sensors shall be provided with a flexible conduit connection minimum length of 450mm (18 in.) and an enclosure for the electrical connections.
- 3.5. POWER WIRING
- 3.5.1. Where power for equipment is fed from MCC, 120 VAC power for Section 23 09 00.00 - BUILDING AUTOMATION SYSTEM (BAS) shall also be fed from the MCC from the 120 VAC section. Wiring and conduit from the MCC to control devices being electrically powered to be provided by section 23 09 00.00 - BUILDING AUTOMATION SYSTEM (BAS).
- 3.6. COMMUNICATION WIRING
- 3.6.1. Install communication wiring per controls manufacturer recommendations as to type of wire used and segment lengths.
- 3.6.2. Install communication wiring in conduit and raceways separated from other wiring.

- 3.6.3. Verify entire network's integrity following cable installation using appropriate tests for each cable.
- 3.6.4. Each run of communication wiring to be continuous length without splices.
- 3.1.10. Provide data cables in conduit back to the closest data/telecom closet/room to allow all BAS head end equipment to connect to the network and all BAS controllers in the building as applicable to the project.
- 3.1.11. Ensure data cables are coordinated with requirements of BAS equipment based on submitted Shop Drawings.
- 3.7. IDENTIFICATION
 - 3.7.1. All wires shall be tagged at both ends. The tagging shall identify the device it is connected to. Use of the point object name is acceptable.
 - 3.7.2. All wires passing through a junction box shall be tagged with the device identity or its termination point.
 - 3.7.3. The junction boxes shall be tagged "BAS" with a sequential number suffix.
 - 3.7.4. Label wires, control devices, controllers.
- 3.8. TESTING AND COMMISSIONING
 - 3.8.1. Upon completion of the installation, the Control System Contractor shall load all system software and start-up the system. The Control System Contractor shall perform all necessary calibration, testing and de-bugging and perform all required operational checks to insure that the system is functioning in full accordance with these Specifications.
 - 3.8.2. Device tests shall identify and confirm successful completion of the following:
 - .1 Device installation.
 - .2 Device identification.
 - .3 Device calibration.
 - .4 Device operation.
 - .5 Wiring to device, connection details and wire type.
 - .6 Validation of the device signal at the controller.
 - 3.8.3. Controller tests shall identify and confirm successful completion of the following:
 - .1 Controller installation.
 - .2 Power source and grounding.
 - .3 Make, model and serial number, software revisions.
 - 3.8.4. Software tests shall identify and confirm successful completion of the following:
 - .1 Custom application programs.
 - .2 Alarm reporting.
 - .3 Trending and reports.
 - .4 Energy management programs.
 - 3.8.5. Loop tuning tests shall identify and confirm successful completion of the following:
 - .1 Loop input signal.
 - .2 Loop output signal.
 - .3 Set point adjustment.

- .4 Device response.
 - .5 Control response.
- 3.8.6. Network communication tests shall identify and confirm successful completion of the following:
 - .1 Primary network communication function.
 - .2 Secondary network communication function.
 - .3 Alarm reporting function.
 - .4 Operator communication.
- 3.8.7. Dynamic graphics tests shall identify and confirm successful completion of the following
 - .1 All graphics.
 - .2 All point objects per graphic.
 - .3 All set-points per graphic.
- 3.9. DEMONSTRATION
- 3.9.1. When all tests have been completed and the documentation completed, request a meeting with the Consultant and Owner. Provide at this meeting a demonstration that all systems on the controls are operating.
- 3.9.2. At the discretion of the Consultant and Owner, demonstrate up to 10% of the tests described in Part 3: Execution, Testing and Commissioning and witnessed by the Consultant and Owner. Should any test fail then the BAS Contractor shall retest the failed components or functionality.
- 3.10. INSTRUCTION AND TRAINING
- 3.10.1. Provide one day of instruction during the BAS installation. This instruction shall include: identification of devices, power sources, conduit and wire installation, the operation of controlled devices and how they interface with the mechanical systems.
- 3.10.2. Provide one day of instruction that shall cover the operation and maintenance of the control systems.

END OF SECTION