

## 250000 Building Automation General Requirements

### 1.1 General Guidelines

- A. This document is designed to assist the design team in the preparation of Building Automation System documents in the appropriate Construction Specifications Institute (CSI) format that will accompany a full set of design documents for new construction projects, major renovation projects, and minor renovation projects on the University of Florida Campus. This document is also intended as a standard by which all Building Automation Systems (BAS) shall be installed within the University of Florida system.

\*\*\*\* PROJECT NOTE, for the Consultant \*\*\*\*

When designing the Building Automation System as a 1st tier prime contract, it is imperative that the scope be clearly documented within the various divisions.

- A. It is the University's preference that the Building Automation System be designed as a first tier prime contract package. This includes a dedicated Division 25 specification package and a separate set of BAS discipline specific drawing set (For example IC-###).
- B. Within the UF Facilities Services (FS) Operations group, the Energy Services and Controls department is responsible for the maintenance and management of these systems.
- C. For all projects the Control System Company shall report directly to the Construction Management (CM) firm, General Contractor (GC) or lead Design Build (DB) firm. They shall not report to the Mechanical Contractor unless the contractor is acting as the GC.

### 1.2 Acceptable Control System Manufacturers:

\*\*\*\* PROJECT NOTE, for the Consultant \*\*\*\*

Consultant should edit list for each project. Coordinate acceptable manufacturer's list with the University of Florida Project Manager and Facilities Services. Some renovation projects may require sole-source selection, meaning the renovation project control system is intended to be an extension of the existing system. Deviation from this list of approved vendors or the decision to sole source a specific vendor shall be reviewed and approved, **in writing**, by Facilities Services.

- A. Johnson Controls, Inc (Metasys NAE only)  
B. Siemens Industry, Inc. (Desigo only)  
C. Automated Logic Corporation

\*\*\*\* PROJECT NOTE, for the Consultant \*\*\*\*

Some of the UF business units may require a sole source solution as it relates to building automation and control systems. The following business units should be consulted prior to any decisions regarding acceptable BAS vendors. In all cases the UF project manager shall approve a sole source solution when it is being considered for a project.

- University Athletic Association (UAA)
- Department of Housing and Residence Education (DHRE)
- Institute of Food and Agricultural Sciences (IFAS)
- J. Wayne Reitz Union (JWRU)

### 1.3 Basis of Design

- A. The basis of design for all projects shall be a complete microprocessor controlled BACnet compatible Building Automation System (BAS) tested and ready for operation and that meets the standards of ANSI/ASHRAE Standard 135.
- B. BACnet Addressing

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1. Each device address shall be unique. Addresses consist of a network number (up to 65,535) and a device media access control (MAC) address. Device MAC addresses can be the same, as long as they are in different networks. For MS-TP networks (up to 255 devices per network number), the Control Contractor shall obtain address assignments from UF FS.
  2. In the UF multi-vendor environment it is important to manage the assignment of these addresses to ensure that there are no duplicates on the same network. A site-specific plan for assigning MAC addresses has been developed and vendors shall be required to follow it. Guidance on how to do this for each of the relevant BACnet systems shall be provided by UF FS.
- C. The BAS shall utilize electronic sensing, microprocessor-based digital control, and electric actuation to perform the required control sequences and functions. In some cases it may be necessary to utilize existing pneumatic actuators, with the approval of FS. The BAS shall generally consist of control and/or monitoring of the systems as listed below.
1. Control and Monitoring
    - a) Supply Air Systems
    - b) Exhaust Air Systems
    - c) Zone Terminal Units
    - d) Fan Coil Units
    - e) Pumps and Pumping Packages
    - f) Variable Frequency Drives
    - g) Steam to Hot Water Heat Exchanger Systems
    - h) Process Water Heat Exchanger Systems
    - i) Energy Recovery Equipment
    - j) Chillers and Cooling Towers
    - k) Boilers
    - l) Laboratory and Pressurization Control Systems

\*\*\*\* PROJECT NOTE, for the Consultant \*\*\*\*

Consultant shall consider this list as a guideline. Coordinate list with University of Florida Project Manager and Facilities Services.

2. Monitoring Only
  - a) Generator System
  - b) Energy Meters
  - c) Central UPS Equipment
  - d) Vacuum System
  - e) Compressed Air System
  - f) Lighting System (occupancy sensor status)
  - g) Domestic Water Booster Pump System
  - h) Kitchen Equipment such as Hood Exhaust Fans and Make-up Air System
  - i) Others as required by specific project needs
3. All outputs, whether sequenced or not, shall have a separate and programmable hardwired outputs. For example, outside air, return, relief air, heating valves, cooling valves, etc., shall each be controlled by a separate output of the controller.

### **1.4 Reference Standards:**

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- A. ANSI/ASHRAE Standard 135 (latest version), BACnet
- B. UL 864/UJKL Smoke Control Listing as applicable
- C. NFPA 70 National Electrical Code
- D. Florida Building Code - Energy Conservation Code
- E. ASHRAE 90.1
- F. NFPA 72
- G. NFPA 92
- H. NFPA 96
- I. UF Telecommunication Standards

### **1.5 BAS Network Components:**

\*\*\*\* PROJECT NOTE, for the Consultant \*\*\*\*

Consultant should coordinate local operator terminal requirements with the UF Project Manager and FS. Not all projects will require local operator terminal or laptop.

- A. Local Operator Terminal – Fixed
- B. Service Laptop
- C. Building Level Controllers (BLC)
- D. Advanced Application Controllers (AAC)
- E. Application Specific Controllers (ASC)
- F. Connection to existing UF BAS Network via BAS virtual LAN.
- G. Third-party equipment integration as required.

\*\*\*\* PROJECT NOTE, for the Consultant \*\*\*\*

The consultant shall include points list defining all hardwired I/O points, set points, and other virtual points required by the control system to execute or monitor the specific system sequence

### **1.6 Quality Assurance:**

- A. Sensors and transducers shall closely match the expected sensing or control range.
- B. Provide weather protection (NEMA 4 or greater) cover or weatherproof control devices where required for controllers located outdoors. Provide weatherproof sealant on all penetrations. Penetrations on top of rooftop equipment are prohibited.
- C. All control devices located outdoors shall be rated for the anticipated ambient conditions.
- D. Include provisions for supplemental ventilation/cooling when control devices and controllers must be located within outdoor control panels that are not rated for the planned environment.

### **1.7 Calibration Guideline:**

- A. The system shall report all values with an end-to-end accuracy equal to or better than those listed below: The intent of this guideline is to establish criteria for the Control Contractor, Commissioning Agent, and/or Owner with regard to calibration and acceptance criteria.

\*\*\*\* PROJECT NOTE, for the Consultant \*\*\*\*

Acceptance criteria is dependent on instrument specified accuracy so this acceptance criteria will need to be adjusted in accordance with specified instrument accuracy. Consultant may want to relax or increase the accuracy requirements based on application.

| Measured Variable         | Criteria   |
|---------------------------|------------|
| Space Temperature         | +/- 1.0 °F |
| Ducted Air (Single Probe) | +/- 1.0 °F |

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|                                    |                               |
|------------------------------------|-------------------------------|
| Ducted Air (Averaging)             | +/- 1.0 °F                    |
| Outside Air                        | +/- 1.0 °F                    |
| Dew Point                          | +/- 3.6 °F                    |
| Water Temp                         | +/- 0.5 °F                    |
| Relative Humidity (duct and space) | +/- 2% RH                     |
| Water Flow                         | +/- 5% (GPM) of reading       |
| Air Flow (Terminal unit)           | +/- 5% (CFM) of reading       |
| Air Flow (Measuring Station)       | +/- 5% (CFM) of full scale    |
| Air Pressure (ducts)               | +/- 0.10 in WC                |
| Air Pressure (space)               | +/- 0.01 in WC                |
| Water Pressure                     | +/- 2% (psig/psid) of reading |
| Electrical (A, V, W, PF)           | +/- 5% of reading             |
| Carbon Monoxide (CO)               | +/- 5% of reading             |
| Carbon Dioxide (CO2)               | +/- 75 ppm                    |
| Volatile Organic Compounds (VOC)   | +/- 75 ppm                    |

### 1.8 Stability of Control Guideline:

\*\*\*\* PROJECT NOTE, for the Consultant \*\*\*\*

Acceptance criteria is dependent on the general systems being controlled so this acceptance criteria will need to be adjusted in accordance with specific project requirements. Consultant may want to relax or increase the accuracy requirements based on application.

- A. Control loops shall maintain measured variable at setpoint within the tolerances listed below and shall, upon any change to the feedback variable recover within 5 minutes of the initial event. The intent of this guideline is to establish criteria for the Control Contractor, A/E, and Commissioning Agent with regard to control loops and acceptance.

| <u>Controlled Variable</u> | <u>Control Accuracy</u> | <u>Typical Range of Medium</u> |
|----------------------------|-------------------------|--------------------------------|
| Air Pressure (ducts)       | +/- 0.2 in WC           | -6 to +6 in WC                 |
| Air Pressure (room)        | +/- 0.010 in WC         | -0.100 to +0.100 in WC         |
| Air flow                   | +/- 100 CFM             | 0 to Max CFM                   |
| Duct Temperature           | +/- 1.0 °F              | 40 °F to 120 °F                |
| Room Temperature           | +/- 1.5 °F              | 50 °F to 85 °F                 |
| Humidity                   | +/- 3% RH               | 10% to 90%                     |
| Fluid Pressure             | +/- 1.5 psi/psid        | 1 to 150 psi/psid              |
| Carbon Dioxide (CO2)       | +/- 100 ppm             | 400 to 2000 ppm                |

### 1.9 Commissioning:

- A. Control Contractor is to demonstrate all functions of the BAS to the Commissioning Agent (CxA), Owner and/or Engineer.
- B. Control Contractor is to provide trends, schedules, reports, etc to Commissioning Agent (CxA), Owner and/or Engineer as requested to document system performance. When a project includes commissioning, the contractor shall request format and setup parameters from the designated commissioning agent.

### 1.10 Submittal Requirements:

\*\*\*\* PROJECT NOTE, for the Consultant \*\*\*\*

Provide a consultant note to separate product data from shop drawings, preferably a separate submittal.

- A. Submittal packages should be organized, highlighting specific part numbers, options and accessories as

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applicable. Submittal packages shall include a Table of Contents with active links.

B. Submittal packages shall be approved in writing by Facilities Services.

C. Product Data Package to include

1. Product data (sensors, valves, dampers, devices, controllers, etc)
2. Control Dampers Schedule: Include a separate line for each damper and a column for each of the damper attributes, including: Damper tag, code number, fail position, damper type, blade type, bearing type, seal type, duct size, damper size, blade action (parallel or opposed) actuator type, actuator model number, actuator torque rating and quantity of actuators required to ensure total closure of damper(s). Provide leakage and flow characteristics data for all control dampers.
3. Control Valves Schedule: Include a separate line for each valve and a column for each of the valve attributes, including: valve tag, code number, fail position, pipe size, valve size, body configuration, close off pressure, capacity, selected valve CV, calculated target CV, design pressure drop, actual pressure drop, actuator type and model number.
4. Air Flow Measuring System: Provide schedule including a separate line for each flow measuring device and column for device type, model number, size, and location.

D. Shop Drawing Package to include

1. To include wiring diagrams, points list, sequence of operation, control power distribution and sourcing, etc. Drawings shall include installation wiring details for all proposed equipment including but not limited to controllers, sensors, actuators, relays, and all 3rd party equipment interfaces.
2. Include a points list schedule for each real hardware and virtual point in the BAS, including: Point name, point description, point type, system name and display units, device type, address, cable destination, module type, terminal ID, controller number, reference drawing, and cable number. Cable destination and terminal ID may also be identified in panel detail drawings.
3. Sequence of operation shall include all initial set-point values, time delay values, references to specific device tags. The sequences shall be detailed and include all vendor specific pre-engineered logic. In general, the vendor specific sequences shall satisfy the Engineer's design intent and provide the details specific to the vendor's application specific software.
4. Include identification of immersion wells, pressure taps, associated shut-off valves, flow switches, level switches, flow meters, air flow stations and other such items furnished by control vendor but installed by other trades.
5. Include initial setpoint or adjustable range of field instruments requiring field adjustment (low limit, high pressure, low pressure, etc...).
6. BAS network architecture riser diagrams including all Tier 1 (Ethernet) nodes, Tier 2 (MSTP) interconnections, communication protocol and 3rd party integration protocols. Include repeater locations, 120 VAC power points and source circuit number, central transformers and 24 VAC power wire routing. Include network number, device ID, addresses, device instance numbers, MAC addresses, and controller type for each proposed controller unit. In addition, show all optical

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isolators, repeaters, end-of-line resistors, junctions, ground locations etc... Tag all equipment with a unique identifier.

7. Provide color format samples of each typical system graphic display screen and associated menu penetrations to show hierarchy and functional interrelationships for systems specified. Sample graphic should show all proposed components, data point location/type and color schemes. Include sample floor plan and home page graphics.
8. Zone Terminal Unit Schedule: Provide a separate line for each terminal unit indicating terminal identification, occupied/unoccupied cfm setpoints, box area, thermostat /sensor location, heating/cooling setpoints and bias setting. The schedule shall include typical calibration factors to be filled in by TAB contractor during startup and verification. The final settings information shall be included in O&Ms and included in TAB report.
9. Required Electrical Wiring: Information including wire jacket colors for low voltage signal wiring, low voltage power wiring and communication cable. Indicate wire gauge for each type of cable. Electrical wiring diagrams shall include both ladder logic type diagram for motor starter, control, and safety circuits and detailed digital interface panel point termination diagrams with all wire numbers and terminal block numbers identified. Provide panel termination drawings on separate drawings. Ladder diagrams shall appear on system schematic. Clearly differentiate between portions of wiring which is existing, factory-installed and portions to be field-installed.
10. Integration Plan: Provide a coordination plan for all 3rd party systems to be integrated under this project and include the following information:
  - a) All vendor specific protocols (generally BACnet or MODBUS) requirements.
  - b) Vendor point list, cross referenced with designated BAS point name. Include the full list of vendor available integrated points (with point name and description) and the specific points to be mapped over to the BAS (with point name and description). Indicate points that are read-only points and points that are read-write.
  - c) Include a list of all communication hardware and software needed to implement full systems integration.
11. Training Plan: The Contractor shall submit a written training plan to the [Owner, A/E, and CxA] for review and approval prior to training. The plan shall include the following elements (See section 1.13 for additional requirements):
  - a) Equipment (included in training)
  - b) Intended audience
  - c) Location of training
  - d) Objectives
  - e) Subjects covered (description, duration of discussion, normal modes, failure modes, troubleshooting strategies, special methods, etc.)
  - f) Duration of training on each subject
  - g) Instructor name and qualifications for each subject
  - h) Methods (classroom lecture, video, site walk-through, actual operational demonstrations, written handouts, etc.)

### **1.11 Operating and Maintenance Manual Requirements:**

- A. The operation and maintenance manual shall be organized in the following manner, highlighting specific part numbers, options and accessories as applicable.

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1. Include descriptions of maintenance for all components supplied, including (but not limited to) sensors, actuators and controllers.
  2. Provide a separate calibration procedure report indicating all sensor types, recommended calibration procedures and recommended calibration frequency.
  3. Include inspection requirements, periodic preventive maintenance recommendations, fault diagnosis, instructions for repair or replacement of defective components Include parts lists, name, address, and phone number of equipment provider including all 3rd party material.
  4. Provide product operational and maintenance data in electronic PDF format and install on vendor specific server. PDF shall include a Table of Content page with hyperlinks to specific product sections. Provide means to access this data using intuitive operator interaction (quick links from main system graphics). All product sheets shall be marked to indicate specific part numbers, options and accessories used on project.
  5. Include name and 800 number of a 7 day a week 24 hour a day service line for needed service during the first year of operation
  6. Software Tab Section: The operating and maintenance manuals shall include a software tab. Provide separate CD including all requested information and include under this tab section. Include the following:
    - a) All building level and system level programs. Application specific system level programs shall include all configuration files showing final menu selections and applicable default settings.
    - b) Describe general operating procedures, starting with system overview and include printed graphic displays of all systems.
    - c) Include trend graphs of all relevant control loops with no less than 24 hours of data sampled at 10 minute intervals. Trend graphs shall include controlled variable, output signal and setpoint.
    - d) Software Backup: Include one archive copy of all accepted versions of source code and compiled code for all application programs and data files on compact disc media. All control software must be readily accessible by Owner using BLC system server. Software file naming for ASC controllers shall match ID reference on mechanical drawing – ID reference tags shall be unique. These backups shall be complete with all code and files sufficient to reinstall the complete project data base.
- B. As-Built Drawings:
1. Submit as-built shop drawings indicating all changes made during project. The drawing files shall be in pdf format and original control format software such as Visio or AutoCAD.
  2. Provide as-built shop drawings in electronic PDF format and install on vendor specific server. Provide means to access this data using intuitive operator interaction (quick links from main system graphics). All sequences shall include as programmed conditions and final setpoints. Each system web page shall allow for an automatic link to the relevant as-built control diagram and sequence of operation.
  3. Include updated BAS network architecture riser diagrams including all Tier 1 (Ethernet) nodes, Tier 2 (MSTP) interconnections, communication protocol and 3rd party integration protocols. Include repeater locations, 120 VAC power points and source circuit number, central transformers and 24 VAC power wire routing. Include network number, device ID, addresses, device instance

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
numbers, MAC addresses, and controller type for each proposed controller unit. In addition, show all optical isolators, repeaters, end-of-line resistors, junctions, ground locations etc... Tag all equipment with a unique identifier.

4. Mount (within major system control panels) laminated control flow drawing, sequence, point schedule and control panel wiring diagrams indicating all field points connected. [Not required for terminal unit controllers].
5. The control panel wiring diagrams shall utilize the same field device tag names used within the associated control diagram and software database.


C. Controller Performance Report:

1. Submit a controller performance report as summarized below. This report shall be a reflection of the current state of the controller after all programming, trending, alarming and commissioning efforts have been completed. Note: When documenting universal inputs/outputs the Contractor shall not report these under Analog/Digital input/output categories.

| Tag | Model # | Software Version | Analog Input Capacity | Analog Inputs Used | Analog Output Capacity | Analog Outputs Used |
|-----|---------|------------------|-----------------------|--------------------|------------------------|---------------------|
|     |         |                  |                       |                    |                        |                     |
|     |         |                  |                       |                    |                        |                     |

Continued 

| Digital Input Capacity | Digital Input Used | Digital Output Capacity | Digital Output Used | Memory Capacity | Memory Utilized | Processor % Utilization |
|------------------------|--------------------|-------------------------|---------------------|-----------------|-----------------|-------------------------|
|                        |                    |                         |                     |                 |                 |                         |
|                        |                    |                         |                     |                 |                 |                         |

Continued 

| Universal Input Capacity | Universal Input Used | Universal Output Capacity | Universal Output Used |
|--------------------------|----------------------|---------------------------|-----------------------|
|                          |                      |                           |                       |
|                          |                      |                           |                       |

D. Building Level Supervisory Controller Performance Report:

1. Submit a supervisory controller performance report as summarized below. This report shall be a reflection of the current state of the controller after all programming, trending, alarming and commissioning efforts have been completed.

| Tag | Model # | Software Version | Memory Capacity | Memory Utilized | Processor % Utilization |
|-----|---------|------------------|-----------------|-----------------|-------------------------|
|     |         |                  |                 |                 |                         |
|     |         |                  |                 |                 |                         |



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### **1.12 Warranty:**

- A. Warranty starts upon completion of commissioning or substantial completion, whichever comes later. The date of such certification shall be the start of the warranty period(s).
- B. At the end of final startup, testing, and commissioning phase, if equipment and systems are operating satisfactorily, the A/E and each of the University's agents shall certify that the controls system's operation has been tested and accepted in accordance with the terms of this specification.
- C. Submit warranty documentation upon substantial completion of project or phase (if applicable) and acceptance by Engineer and Owner.
- D. Repair or replace systems or parts found defective at no cost to Owner during the warranty period.
- E. Include parts, labor, and necessary travel during warranty.
- F. Provide vendor specific and 3rd party warranty and registration information as applicable.
- G. Provide services incidental to proper performance.
- H. First year of warranty includes parts and labor for entire system (including 3rd party equipment). Adjust, repair, or replace, at no additional cost to the owner, control system failures during the 1st year (includes software issues). Include an evaluation of control loops and required loop tuning as applicable.
- I. Provide a second year parts only warranty coverage for all equipment provided under this section. This second year warranty shall cover all defective hardware after final acceptance by the A/E and the Owner. Two year coverage shall include all 3rd party equipment.
- J. Provide as part of base bid a 5 year extended warranty for all actuators (valves and dampers).
- K. Warranty response time shall be as indicated. The designated UF FS representatives representing the operations and service departments shall be the authorized callers and will determine the required response level.
  - 1. Emergency service - must respond within two hours of being notified.
  - 2. General warranty service - must respond within 4 hours of being notified.
  - 3. Scheduled service – must respond within 48 hours of being notified.
- L. Include project-specific software, graphic software, database software, and firmware updates/patches which resolve known software deficiencies at no additional charge, during the 2 year warranty period.

### **1.13 Extended Warranty:**

\*\*\*\* PROJECT NOTE, for the Consultant \*\*\*\*

Verify with UF Project Manager and Facilities Services that the extended warranty services are required.

- A. Provide an add alternate with bid to include extended warranty services as an additive alternate price.
- B. Include 8 quarterly inspections during the 2 year warranty period. Each quarterly inspection shall include a final report documenting the tasks and findings described below. The quarterly inspections shall be

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coordinated through UF FS. The following tasks list shall define the scope of services for these inspections.

1. Verify calibration on at least 25% of all analog inputs and analog outputs during each quarterly visit.
2. Trend and document the performance of at least 25% of all control loops during each quarterly visit. Evaluate trends and correct known deficiencies. Include trend reports within report.
3. Verify startup and shutdown sequences for at least 25% of all major equipment. At least one major equipment sequence shall be tested in its entirety per quarterly visit.
4. Review entire system noting any specific anomalies or system performance issues. Repair known deficiencies and document those deficiencies that are not the responsibility of this Contractor.
5. Discuss performance issues with UF FS and document discussions.
6. Review alarm reports to determine any repetitive or unusually high number of incidents with each quarterly visit. Repair known deficiencies and document those deficiencies that are not the responsibility of this Contractor.
7. Review system and document operator overrides or points removed from service for all physical or software points.
8. Review and document communication failure/restarts of devices on the BAS Network.

### **1.14 Owner Instruction:**

\*\*\*\* PROJECT NOTE, for the Consultant \*\*\*\*

The consultant shall carefully review the training requirements and incorporate additional elements to address specific project elements or applications requiring additional training or detail (i.e. process control and/or any non HVAC controlled equipment). Coordinate training hours with UF-FS.

- A. During system startup and at such time as acceptable performance of the BAS system equipment and software has been established, the Contractor shall provide on-site operator instruction. This instruction shall be performed during normal working hours by a competent representative of the BAS vendor that is familiar with the system's software, hardware and accessories. The Contractor shall maintain a roster of all attendees at all training sessions.
- B. At a time mutually agreed upon during system training as stated above, the Contractor shall give [16/24/40 hours] divided into four sessions of instruction to the Owner's designated personnel on the operation of all equipment within the BAS and describe its intended use with respect to the programmed functions specified. The training session schedule shall be determined by FS and shall be completed within the first year warranty period. The training shall include but not be limited to the following:
  1. Review the following BAS deliverables with respect to general content and organization:
    - a) Operations and Maintenance manuals.
    - b) As-Built Control Drawing Package
    - c) Graphical User Interface
    - d) Reporting packages and content
    - e) As-Built Control Sequences
    - f) Maintenance service agreements, state of warranty date and similar continuing commitments.
    - g) Review location of all BAS equipment / panel locations

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2. Operations:
  - a) Startup procedures.
  - b) All equipment or system start-up procedures.
  - c) All equipment or system shut-down procedures.
  - d) Routine and normal operating sequence for all systems.
  - e) Special operating instructions and procedures not addressed above.
  - f) Seasonal and weekend operating instructions.
  - g) Software backup procedures and file locations
  
3. Emergencies:
  - a) Instructions on meaning of warnings, trouble indications, and error messages.
  - b) Instructions on stopping, manual overrides and BAS override procedures.
  - c) Safety device procedures and actions.
  - d) Operating procedures for system, subsystem, or equipment failure.
  - e) Shutdown instructions for each type of emergency.
  - f) Operating instructions for conditions outside of normal operating limits.
  - g) Special operating instructions and procedures.
  - h) Adjustments:
    - i) Proper adjustment procedures and points intended to be adjusted
    - ii) Economy and efficiency adjustments.
    - iii) Adjustments for efficient energy use.
  
4. Troubleshooting:
  - a) Diagnostic instructions procedures for each typical system installed.
  - b) Test and inspection procedures for each typical system installed.
  - c) Maintenance:
  - d) Inspection procedures.
  - e) Types of cleaning agents to be used and methods of cleaning.
  - f) Procedures for calibration.
  - g) Procedures for preventive maintenance.
  - h) Procedures for routine maintenance.
  - i) Instruction on use of special tools.
  
5. Repairs:
  - a) Diagnosis and repair instructions.
  - b) Disassembly; component removal, repair, and replacement; and reassembly instructions.
  - c) Instructions for identifying parts and components.
  - d) Review of spare parts needed for operation and maintenance.

### **1.15 Spare Parts:**

\*\*\*\* PROJECT NOTE, for the Consultant \*\*\*\*

Consultant should coordinate spare parts requirements with UF Project Manager and FS, which may include components such as sensors, relays, control valves, damper actuators, controllers, etc.