The Regional Municipality of Durham
Works Department
Facilities Design, Construction and Asset Management and Facilities Maintenance and Operations

Building Automation System Design Standards and Guidelines for Facilities Projects

Building Automation System Guidelines for Facilities Projects

Table of Contents

1 General

1.1 Introduction

.1 Building Automation Systems play a major part in the daily maintenance and operation of the Region of Durham facilities. As a consultant or contractor, retained by the Region of Durham, it is important you use the following guideline when designing and installing equipment related to the Building Automation systems for each building.

1.2 Codes and Standards

.1 The following codes and standards intended to apply as applicable as not all will apply to all installations. Current and applicable codes are inserted as required.

.1 American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE) - 90.1 Energy Standards and 62.1 Ventilation Standards

.2 ASHRAE 135-2004: BACNET - A Data Communication Protocol for Building Automation and Control Networks. American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. 2004 including Addendums A through D

1.3 Baseline Protocols or All Projects

.1 The purpose of having a baseline protocol is to create a level playing field for all future HVAC, Fire and Electrical upgrades.

.2 This protocol will be open source, meaning that products, programming tools, training and support provide a level of access that is in conformance with current ASHRAE, industry standards and that multiple vendors can provide connection of new equipment to the BAS system.

.3 This standard applies to all BAS projects – new buildings, renovations, retrofits, BAS upgrades, new BAS which shall conform entirely to these BAS design standards. Any deviation from these standards, or the intent, can only be written approvals from the Region of Durham.

.4 The BAS contractor shall provide the design, products, installation, programming, supervision, commissioning, and training to ensure and warrant a complete and fully operational BAS that meets or exceeds these Standards.

.5 Systems i.e., chillers, boilers, cooling towers, VFD's and energy recovery units that are equipped with manufacturer factory controls shall use controllers that follow these standards.

.6 All facilities must be provided with two (2) Outdoor Air Temperature sensors and two (2) Outdoor Air Humidity Sensors. The connection to the BAS must ensure that if one sensor fails, the other sensor acts as backup.

.7 New HVAC system installations must include fire alarm disconnect relays directly connected to the fire alarm panels. BAS connections are for status only.

.8 Critical applications (server rooms, etc.) which have a lead lag application for HVAC equipment, must have separate controllers.

.9 All buildings with fire alarm panels must ensure fire alarm and trouble points are available for connection to the BAS.

- .1 All fire alarm points must be identified on the BAS.

.10 VFD modulation on fans and pumps must be represented as follows:

- .1 0% = minimum operating speed
- .2 100% = maximum speed (60hz)

.11 All valve and damper position must be represented by % open and as follows:

- .1 0% = Valve / Damper is closed
- .2 100% = Valve / Damper is open

.12 Units of measurement

- .1 All pressure measurement shall be represented in metric Pascals.
- .2 All airflow measurement must be represented in metric L/S.
- .3 All thermostats and temperature sensors must be represented in metric units (ºC).
- .4 Relative humidity should be represented in %RH.

.13 Stand-Alone Systems

.1 Any new stand-alone equipment, which is not connected to a BAS server must:

.1 Have a MSTP connection (daisy-chain) between multiple controllers.

.2 Have a supervisory controller and the ability to access all systems locally with graphics and short-term trending.

.3 Have a BACNet IP card if equipment has the option for BACNet communications.

.4 Be ready for future connection to suitable Region BAS Server.

.14 BAS Graphics

.1 When building graphics contractors must follow naming conventions, colours, symbols, tag name nomenclature, units and layouts identified on the graphics provided in the screenshots in Appendix B.

.2 Graphics must reside in all supervisory controllers and its associated BAS server.

.15 BAS Programming

.1 Tag names must follow the examples outlined in Appendix D and be identified on the graphics for all components.

.2 BAS Alarms must be provided on all projects. Alarms must follow alarm tag naming conventions outlined in Appendix D.

.16 Trends

.1 When trends are requested, trend sampling shall be taken at 10-minute intervals.

.2 Short term trending must reside in the supervisory controller and set to archive at its associated BAS server for long term trending.

.17 Labelling

.1 Equipment, devices, thermostats, and text in the BAS graphics must be labelled to match systems in the engineering drawings.

.2 Locations of controllers in ceiling spaces must be identified using a label maker with the system names on T-Bar ceilings.

.18 BAS Drawings

.1 A copy of the working drawings from the controls contractor used for MSTP network installation to be submitted by the contractor for records.

.2 An editable, electronic copy of the as-built controls shop drawing to be submitted once the project has been completed.

.19 Energy Meters

.1 Building energy meters for electricity, gas and water must have a BACNet IP connection to the BAS.

.2 Energy consumption shall be calculated within the metering system not through BAS programming (i.e. pulse counts).

All new field controllers, supervisory controllers and equipment must be BACNet open protocol conforming to ASHRAE 135 (Latest Edition).

1.4 Optimum Energy Efficient Design and Implementation

.1 The Region of Durham is committed to efficient, cost effective and sustainable designs for all its facilities. The BAS design shall present the best use of technologies and sequences of operation for consideration by the Consultant Design Team before the final version is submitted for tender or implementation.

.2 The BAS shall be capable of implementing the latest in energy conserving sequences of operation such as those described in ASHRAE 90.1 or other industry recognized sequences.

.3 The BAS design shall be capable of preparing and presenting performance metrics that illustrate energy use at the BAS and EMRS and/or sharing the data with energy reporting tools as used by the Region of Durham.

.4 Demand level control shall be the basis of design for HVAC+L control and integrated into the BAS. In particular, the BAS will use actual occupancy loads (people counts) for the control of HVAC+L equipment to minimize over ventilation / lighting while still meeting the minimums of ASHRAE 62.1 and 90.1.

2 Steps to Preparing Building Automation System (BAS) Specifications for Region of Durham (ROD) Projects, for Consultants

.1 Contact the Region of Durham Facilities DCAM Specifications and Support Services division to receive the most up to date BAS specification.

.2 Contact the Region of Durham Facilities Operations and Maintenance department to discuss the controls strategy for the project.

.1 Request Visio template graphics from Facilities Maintenance and operations to begin construction of new or modified BAS graphics.

.3 Ensure all new equipment specified is compatible with the ROD projects and meets this standard.

3 Existing Building Automation (BAS) Systems

.1 The Region of Durham currently operates four building automation systems (BAS) for its regional facilities:

- Metasys ADX Main Server (version 12.0.50.724) by Johnson Controls for admin buildings, paramedic services, depots, water supply and water pollution control plants.
- Metasys ADX LTC Server (version 12.0.50.724) for the long-term care facilities.
- Metasys ADS Server (version 6.5.0.5500) for buildings within the Duffin Creek Water Pollution Control Plant.
- Tridium Niagara N4 Server (New in 2023)

The two Metasys ADX and Tridium Niagara N4 are hosted on virtual servers, located, and maintained by IT personnel at the Durham Regional Headquarters, 605 Rossland Road, East. Whitby.

The Metasys ADS server is located and maintained by SCADA personnel at the Duffin Creek Water Pollution Control Plant in the Administration Building, 905 McKay Rd, Pickering.

.2 The following is a list of facilities with BAS currently connected to the Region of Durham's Metasys ADX Main Server.

- Pickering Paramedic Services
- Ajax Water Supply Plant
- Ajax Depot
- Durham Regional Headquarters (Whitby)
- 101 Consumers Rd – Traffic & Health (Whitby)
- Whitby Water Supply Plant
- Whitby Paramedic Services
- Oshawa Depot
- Oshawa North Paramedic Services
- Oshawa South Paramedic Services
- Oshawa Water Supply Plant
- Courtice Water Pollution Control Plant
- Courtice Paramedic Services
- Bowmanville Water Pollution Control Plant
- Lake Simcoe Water Pollution Control Plant
- Sunderland Paramedic Services
- Orono Depot

.3 The following is a list of long-term care facilities with BAS that are connected to the Region of Durham's Metasys ADX LTC Server.

- Hillsdale Estates
- Hillsdale Terraces
- Fairview Lodge
- Lakeview Manor

.4 The following is a list of buildings with BAS that are connected to the Duffin Creek Water Pollution Control Plant Metasys ADS Server.

- Liquids Building
- Disinfection & Effluent Building
- Blower Building
- Headworks Building
- Boiler Building
- Waste Gas Burner Building
- Digester 1 & 2 Buildings
- Dewatering Building
- Polymer Building

- Incineration Building
- Ash Building
- Disinfection Facility Building
- Stage 1 & 2 Headworks Building
- West Pumping Electrical Building
- East Influent Pumping Station
- North Dewatering Building
- South Dewatering Building
- Administration Building

.5 There are no facilities that are currently connected to the new Tridium Niagara N4 Server. Facilities that are considered for future connection to the server with supplied JACE supervisory controllers include:

- Corbett Creek Water Pollution Control Plant - Administration Building
- Harmony Creek Water Pollution Control Plant
- Durham Transit East – 715 Farewell St.
- Edna Thompson Child Care

4 Design Considerations

.1 Equipment Selection.

.1 The following must be considered when selecting equipment (where possible) for new or replacement projects throughout the ROD facilities.

.1 New and replacement Air Handling (AHU) and Make Up Air (MUA) units must have a BACNet MSTP controller or factory installed BACNet IP communication card.

.2 New and replacement boilers must have factory installed BACNet IP communication card.

.3 New and replacement Chillers must have factory installed BACNet IP communication card.

.4 New and replacement CO and NO_2 systems must be provided with a BACNet IP communication card.

.5 New and replacement humidifiers and dehumidifiers must have factory installed BACNet IP communication card.

.6 New and replacement lighting systems must be provided with a BACNet IP communication card.

.7 New and replacement metering systems (electricity, gas or water) must be provided with a BACNet IP communication card.

.8 New controls to regional facilities with existing BAS must provide controllers of the same manufacturer for compatibility and seamless addition.

.2 Field Controllers

.1 BACNet MSTP or BACNet IP are the only acceptable communications protocol for field (and factory) controllers.

.2 In existing facilities, where installed existing field controller brands are compatible, contractors must, where possible, match existing controller manufacturers.

.1 If a different manufacturer than the existing manufacturer is selected, a BACNet IP controller or new supervisory controller must be provided and connected to the IT switch directly.

.3 Supervisory Controllers

.1 Only Series Network Engines (SNE) by Johnson Controls or a Java Application Control Engines (JACE) available with most building automation manufacturers compatible with the Tridium Niagara N4 platform are acceptable for the Regional BAS.

.1 Each new or existing building with controls must be on its own dedicated supervisory controller.

.2 All programming and graphics must reside within the controller for local access, control and monitoring.

.3 Default factory passwords shall remain left unchanged in the controller.

.2 Supervisory controllers must not exceed more than 80% capacity.

.3 When capacity is reached on an existing controller, the ROD requires that a new controller is provided for new additions.

.4 Supervisory controllers that have been replaced must be turned over to the ROD.

.5 Provide a new 250Va uninterruptible power supply (UPS) for all new and replacement SNEs and JACEs.

.6 Refer to Appendix C for schematic diagrams on installation of UPS and Transformers to SNEs and JACEs.

.4 Network Devices

.1 I.T. Switches

.1 Switches should have sufficient capacity to accept new BACNet IP connections on new and replacement projects. Consultants or Contractors must contact the Region of Durham's CS-IT Department to confirm capacity.

.2 If new controls require a significant amount of network connections (5 or more), the project must provide a quality grade switch approved by the Region of Durham's CS-IT Department.

.3 CS-IT non-approved, unsecured network switches will not be permitted to connect to the Regional network.

.5 Air Handling Units

.1 Package Controllers

.1 Air Handling Units / Make Up Air Units generally should be supplied but not limited to the following applicable points through a dedicated field controller or factory BACNet IP:

- System Enable / Occupied Command
- Fan Command – Supply, Return (Exhaust)
- Fan Status – Supply, Return (Exhaust)
- Fan VFD Speed – Supply, Return (Exhaust)
- Fan Alarms – Supply, Return (or Exhaust)
- Supply Air Temp / Humidity / Static Pressure
- Return Air Temp / Humidity / CO2
- Space Temp / Humidity
- Mixed Air Temp
- Heating Command / Modulation
- Cooling Command / Modulation
- Damper Command / Modulation / Position
- Humidifier Command / Modulation
- Adjustable Setpoints – Temp, Humidity, Dehumidification, Static Pressure, Free Cooling, Min Outdoor Air, Return CO2
- Working / Calculated Setpoints – Space Temp, Supply Air Temp, Return Air Humidity
- Modes – Winter / Summer, Free Cooling, Dehumidification
- Alarms / Fault / Fault Code

.6 Boilers

.1 Package Controllers

.1 Boiler heating systems generally should be supplied with but not limited to the following points through a factory BACNet IP:

- System Enable Command
- Boiler Lead/Lag Status (multiple boilers)
- Boiler Command (Stages) / Modulation
- Boiler Status
- Boiler Alarm / Flame Failure
- Boiler Pump Command
- Boiler Pump Status
- Boiler Pump Alarm

- Hot Water Supply Temp
- Hot Water Return Temp
- Outdoor Air Temp
- Alarms / Fault / Fault Codes
- Adjustable Setpoints – Outdoor Air Enable, Supply Reset Schedule
- Working / Calculated Setpoints – Hot Water Supply Temp

.7 Chillers

.1 Package Controllers

.1 Chiller systems generally should be supplied with but not limited to the following points through a factory BACNet IP:

- System Enable Command
- Chiller Command / Modulation
- Chiller Unit Status
- Chiller Lead / Lag Status (multiple chillers)
- Chiller Alarm
- Condenser & Evaporator Pump Command
- Condenser & Evaporator Pump Status
- Condenser & Evaporator Pump Alarm
- Chilled Water Supply Temp
- Chilled Water Return Temp
- Condenser Water Supply Temp
- Condenser Water Return Temp
- Outdoor Air Temp
- Alarms / Fault / Fault Code / Refrigerant Alarm
- Adjustable Setpoints – Outdoor Air Enable, Chilled Water Setpoint
- Working Setpoints – Chilled Water Supply Setpoint

.8 Diesel Generator System

.1 Diesel Generator Package Controllers

.1 Diesel generator systems generally should be supplied with but not limited to the following points through a factory BACNet IP:

- Generator Status – Standby, Ready, Running
- Generator Alarm
- Generator Trouble
- Battery Alarm
- Engine Run Hours
- Engine RPM
- Battery Voltage
- Active Power kW
- Power Factor
- Line to Neutral Voltage (A,B,C)
- Line to Line Voltage (A-B, B-C, C-A)
- Line Current (A,B,C)
- Oil Pressure
- Coolant Temp
- Engine Temp
- Emergency Stop
- Combustion Damper Status (Open/Close)

.2 If the fuel tank is integrated with the generator, include the following:

- Fuel Tank Level (% full) or (L)
- High Tank Alarm
- Low Tank Alarm
- Fuel Leak Alarm

.2 Fuel System Package Controllers

.1 Separate fuel systems for diesel generators generally should be supplied with but not limited to the following points through a dedicated field controller or factory BACNet IP:

- Fuel Panel Power Status
- Main Tank Fuel Level (% Full) or (L)
- Main High-High Tank Alarm
- Main High Tank Alarm
- Main Low Tank Alarm
- Main Low-Low Tank Alarm

- Day Tank Fuel Level (% Full) or (L)
- Day Tank Alarm
- Fuel Pump Status
- Fuel Pump Alarm
- Fuel Pressure Alarm
- Fuel Leak Alarm

.3 Diesel Generator Room Ventilation Package Controllers

.1 Diesel generator room ventilation generally should be supplied with but not limited to the following points through a dedicated field controller:

- Room Temp
- Diesel Generator Run Status
- Damper Command / Modulation – Supply, Return, Exhaust
- Combustion Damper Status (Open/Close)
- Exhaust Fan Command
- Exhaust Fan Status
- Exhaust Fan Alarm
- Unit Heater Command
- Setpoints – Room Temp
- Alarms – High / Low Room Temp Alarm

.9 Variable Air Volume (VAV) / Fan Power Box (FPB)

.1 Package Controllers

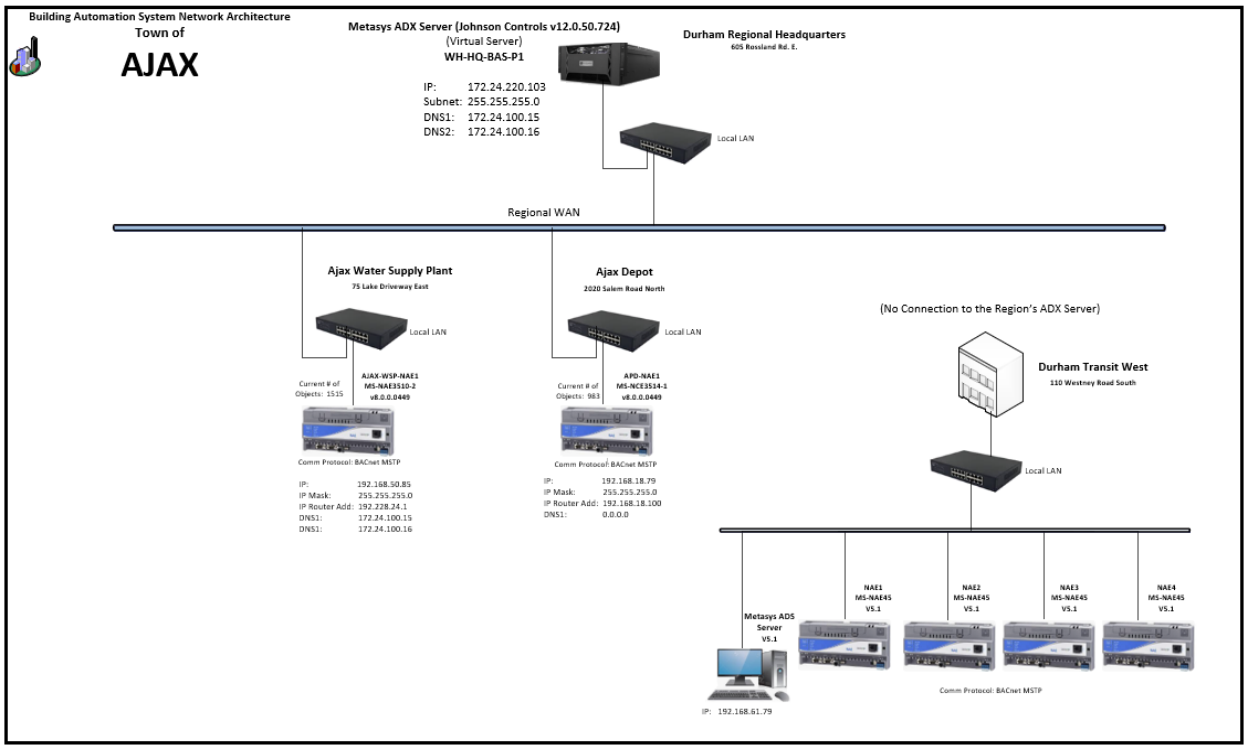
.1 VAV or FPB systems generally should be supplied with but not limited to the following points through a dedicated field controller:

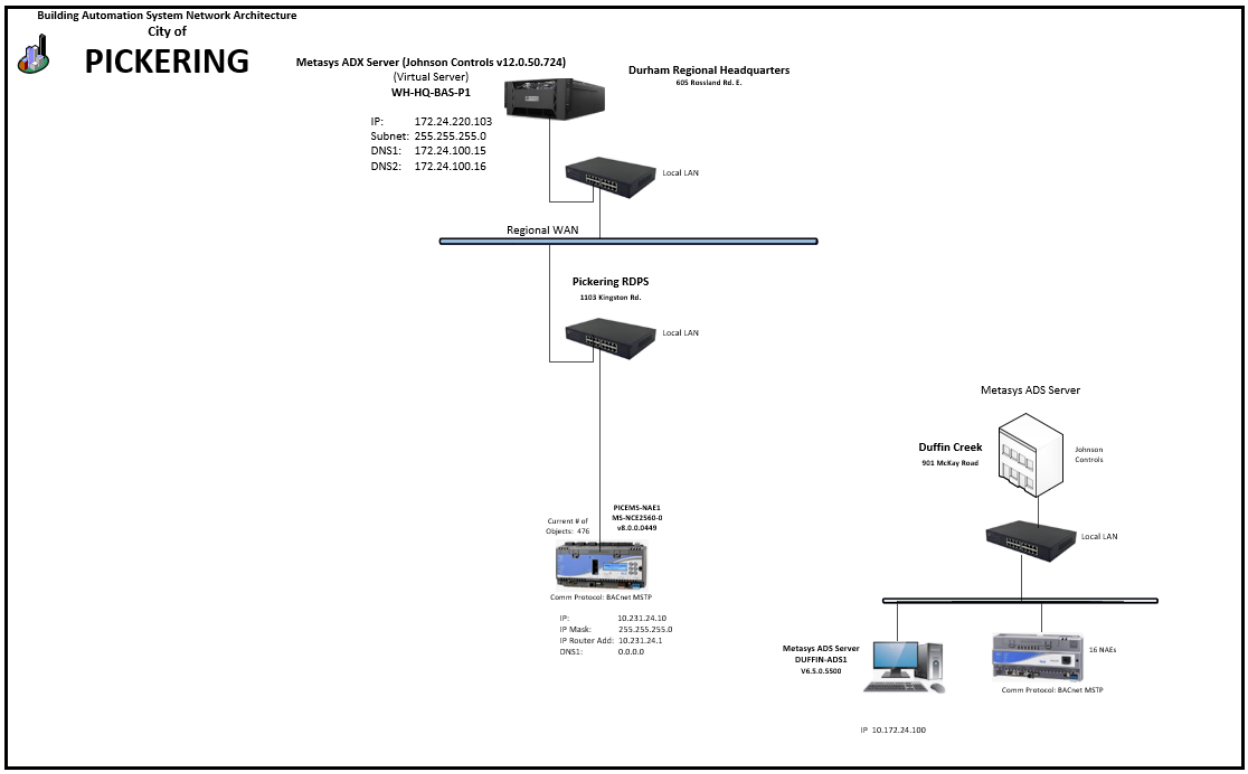
- Occupied / Unoccupied Command
- Space Temp
- Warm/Cool Temp Adjust
- Supply Air Temp
- Occupied Space Setpoint
- Unoccupied Space Setpoint
- Actual Space Cooling Setpoint
- Actual Space Heating Setpoint
- Supply Air Flow
- Supply Air Flow Setpoint

- Cooling Max Air Flow
- Cooling Min Air Flow
- Heating Min Air Flow
- Damper Command / Position
- Fan Command

5 Appendices

Appendix A – Regional BAS Network Architecture





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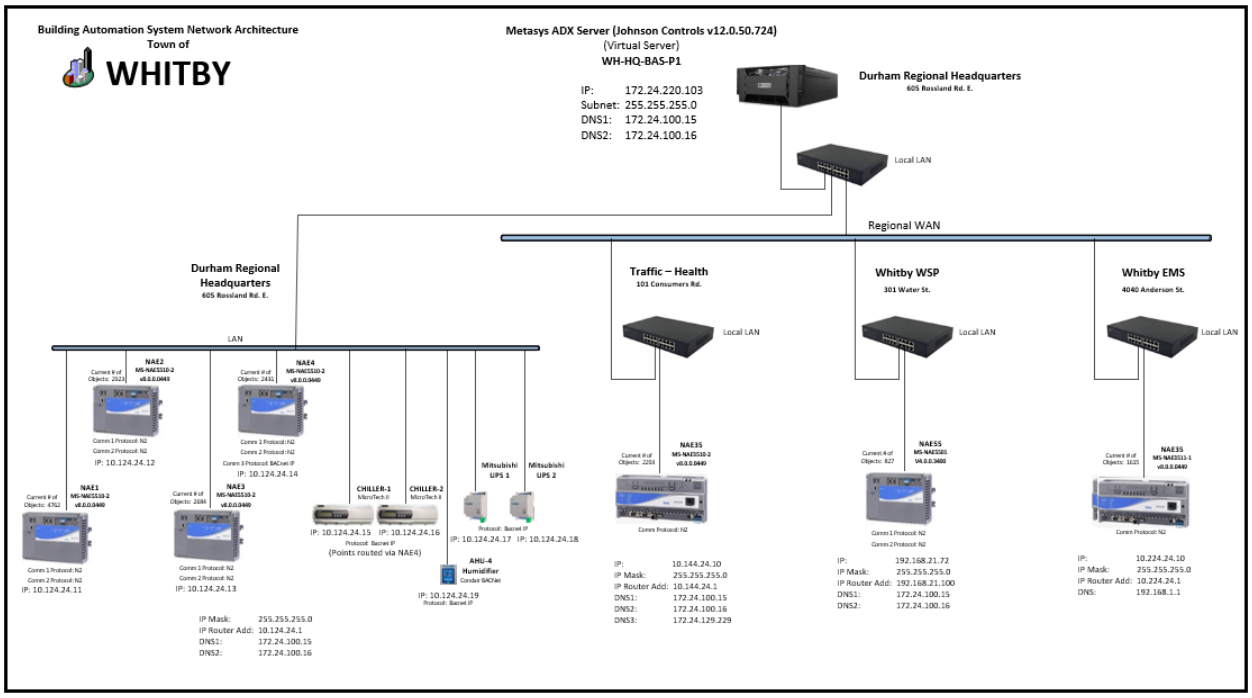

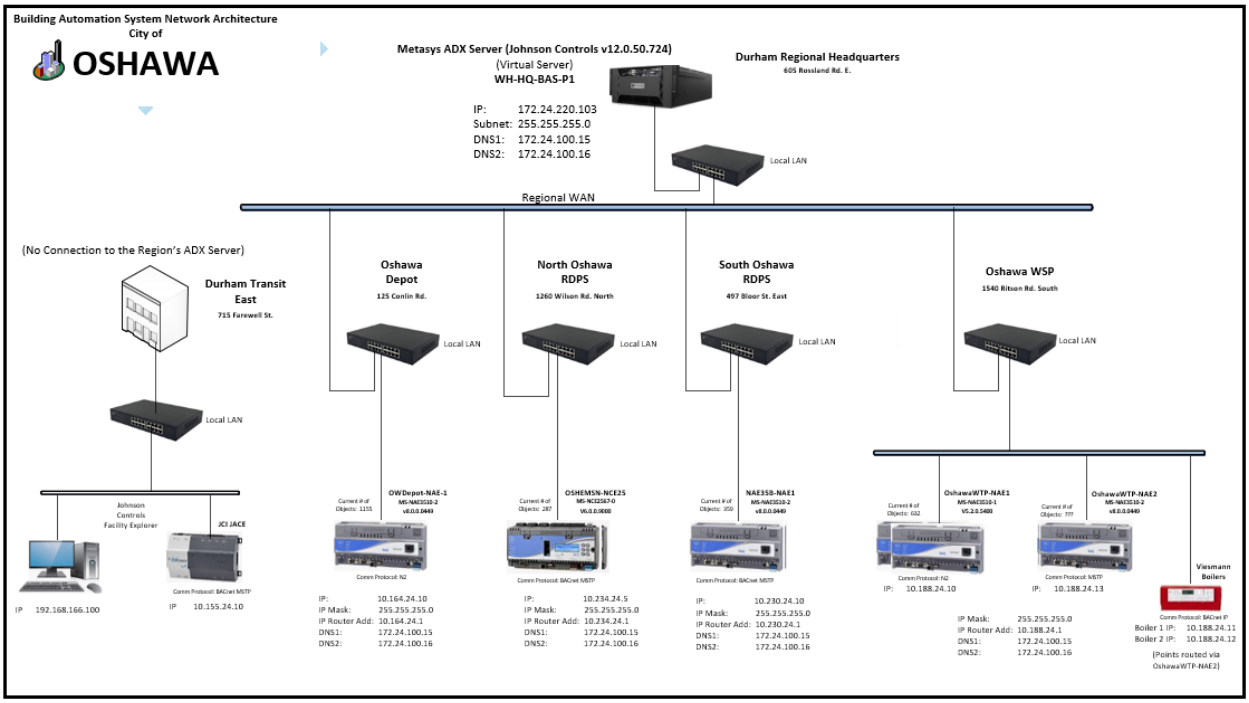

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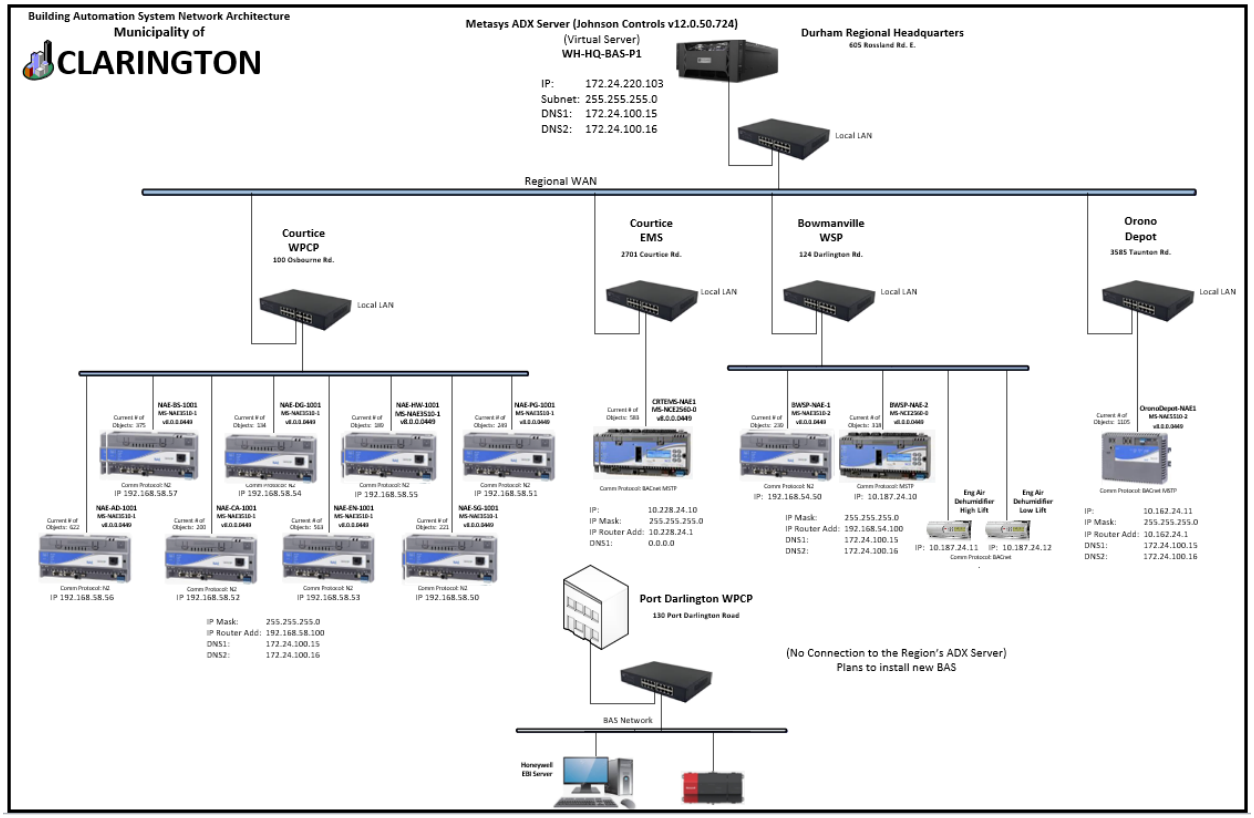

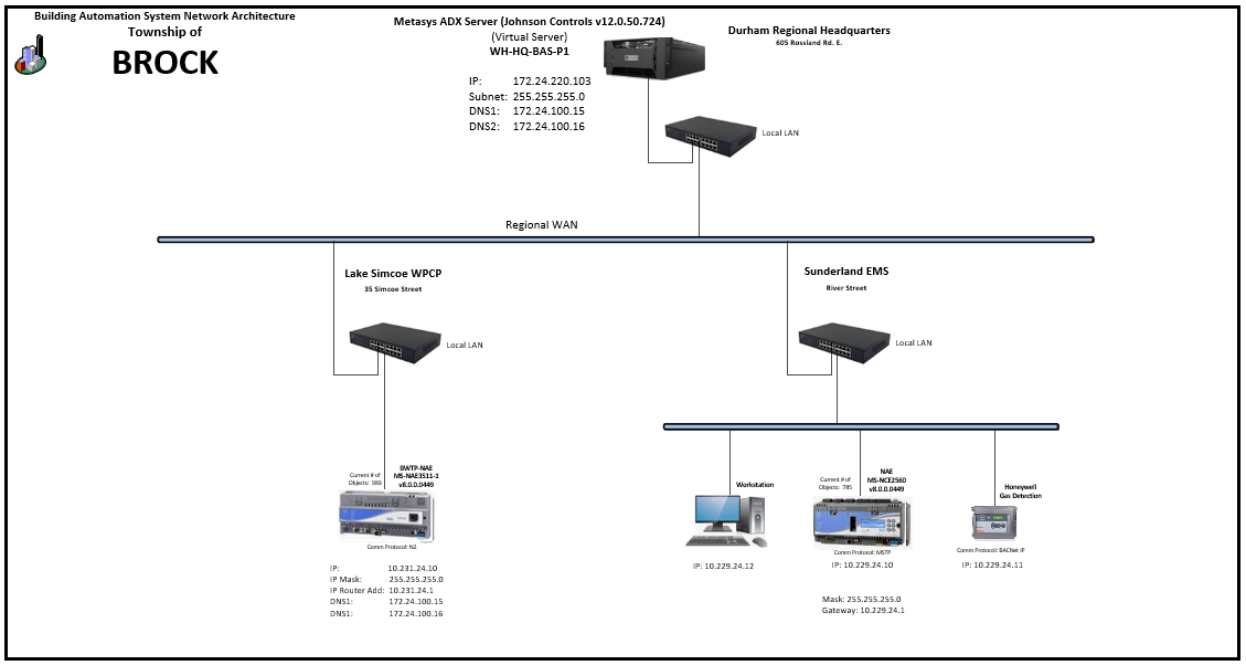

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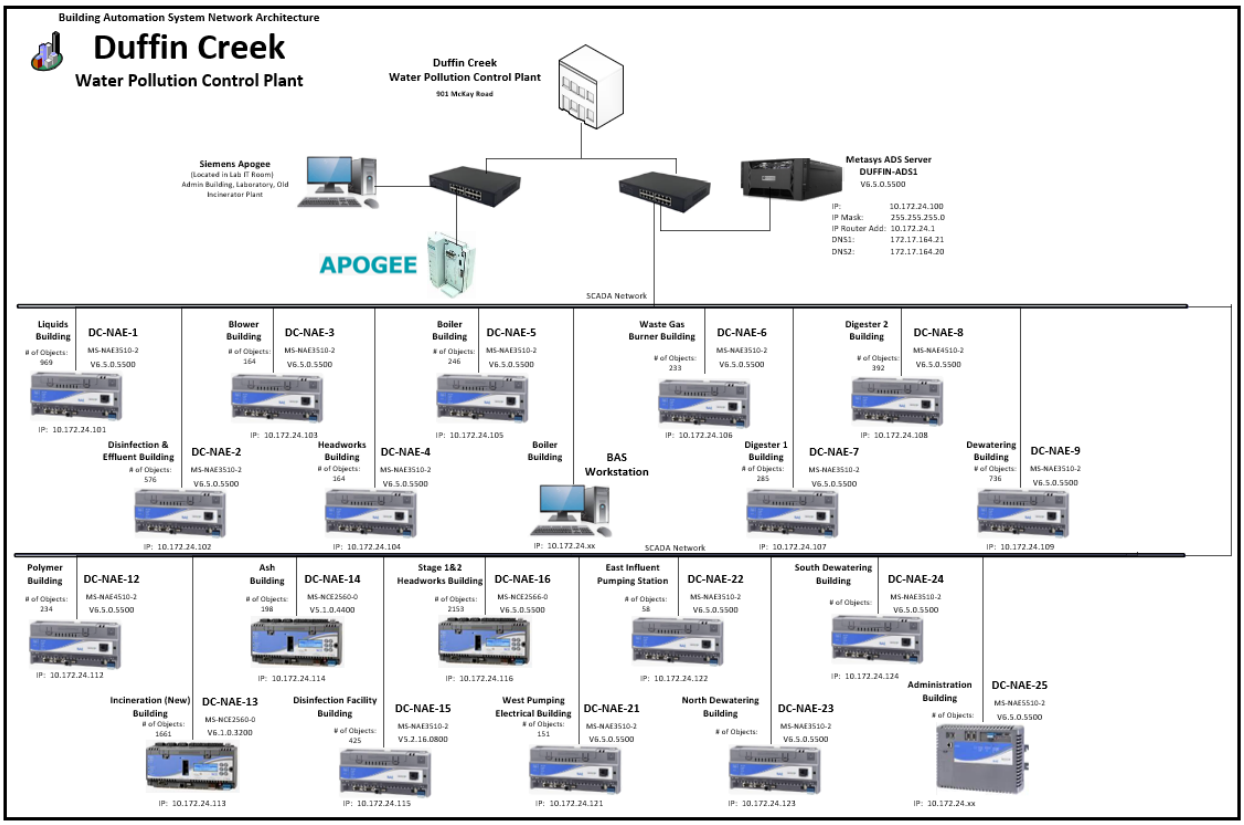
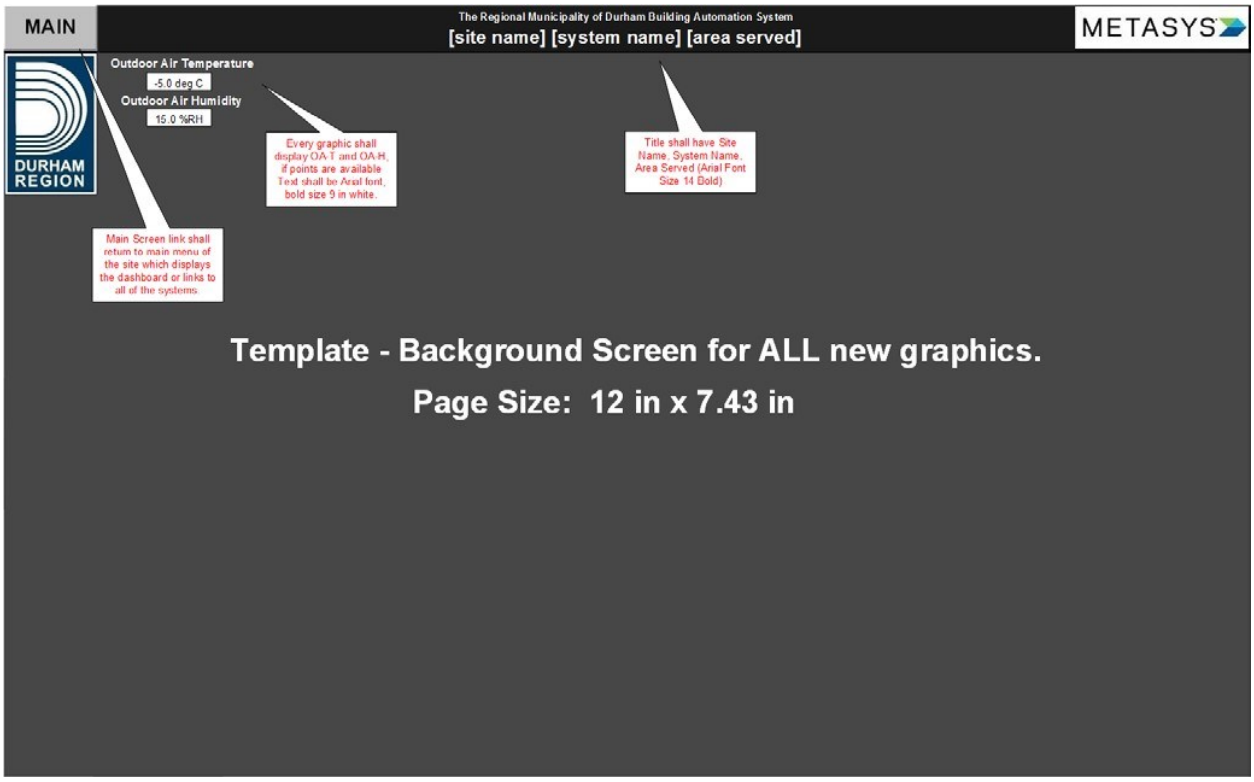
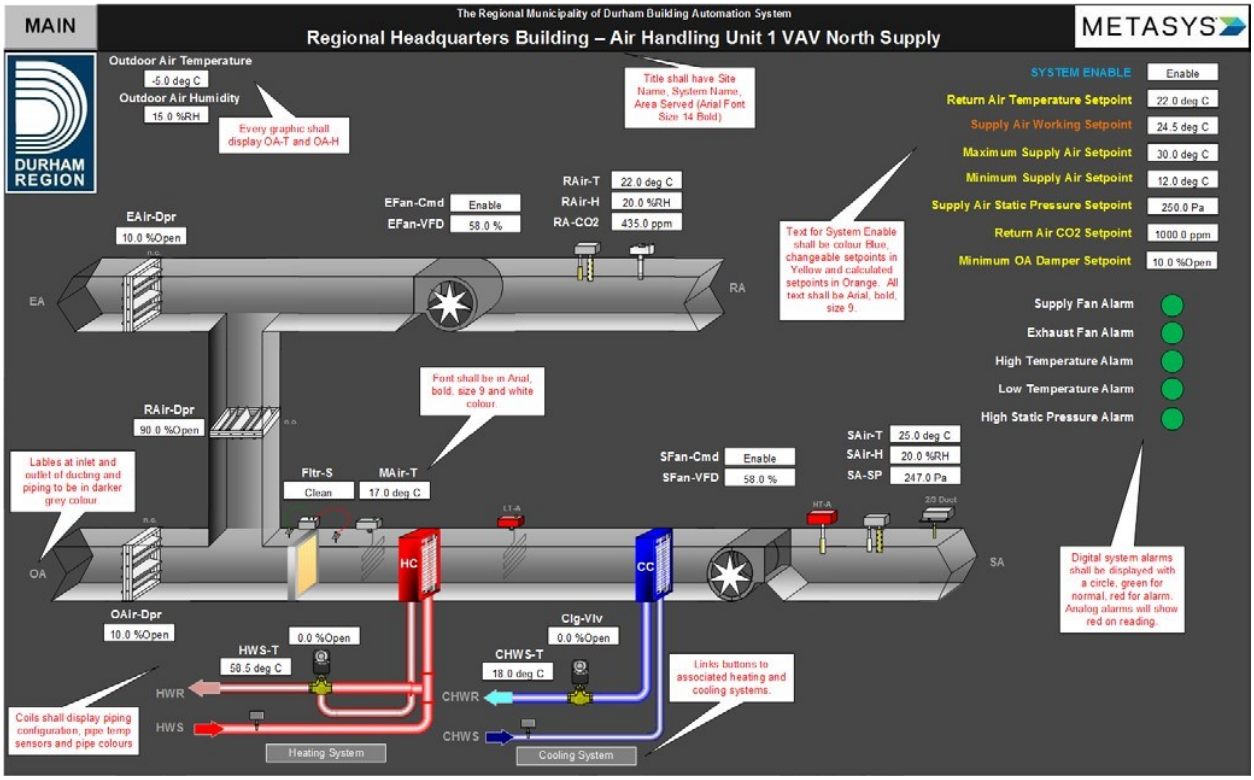


Appendix B – Graphical User Interface Standards

Screen Shots of Standard Johnson Controls, NAE/SNE Graphics





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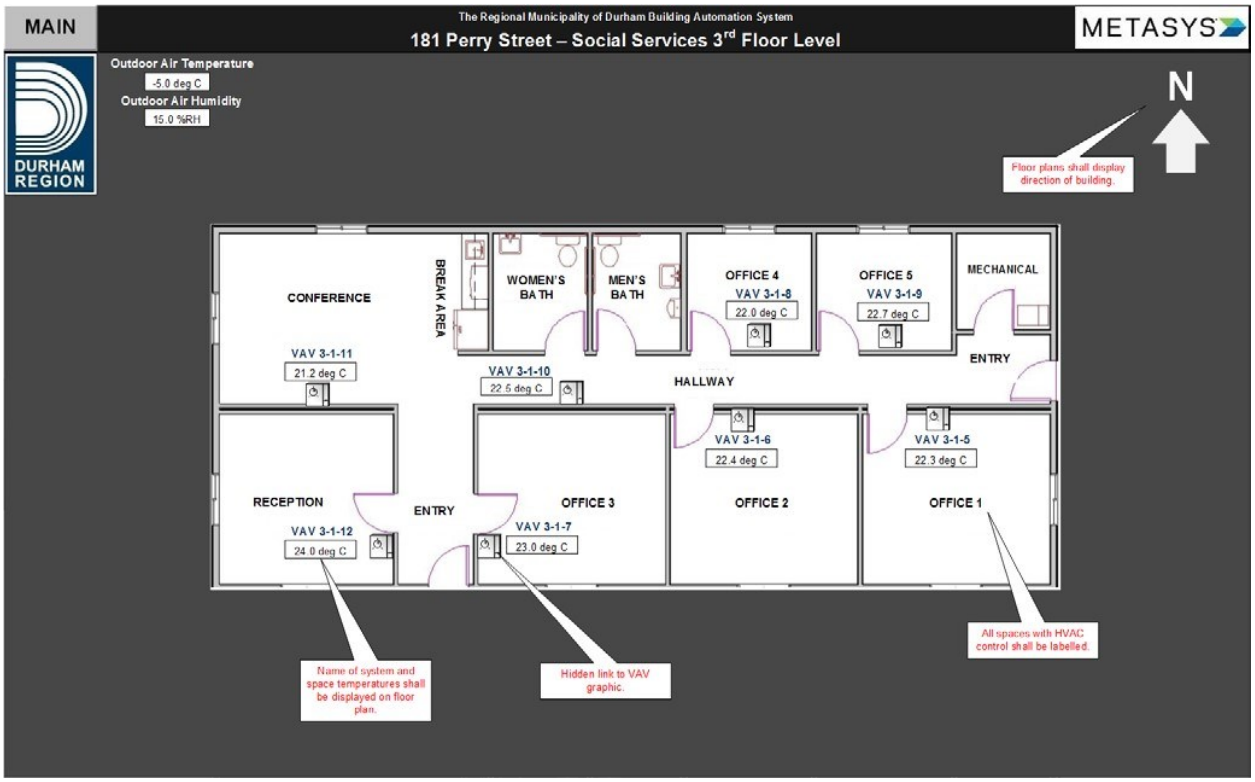
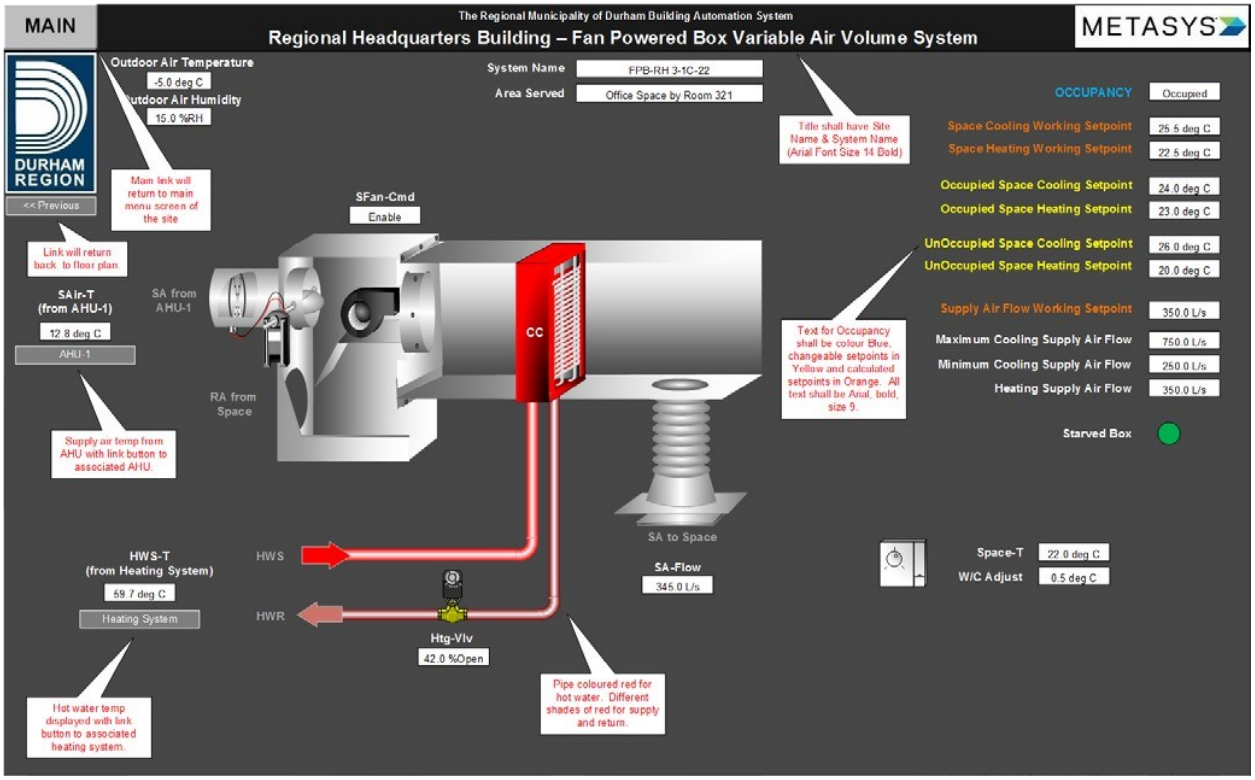
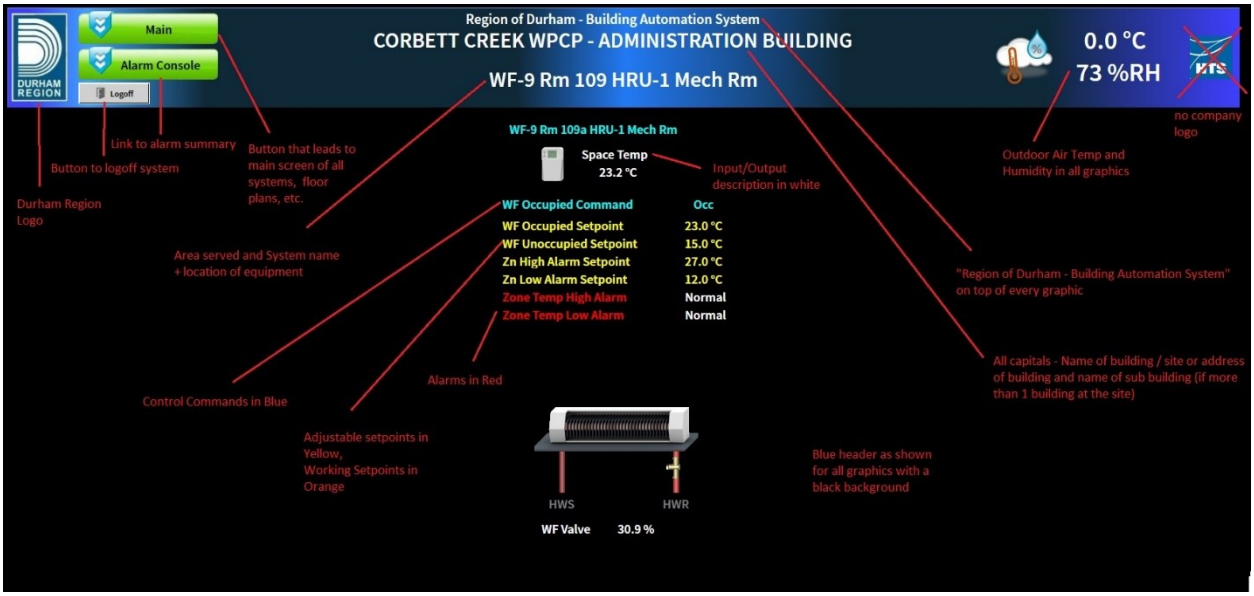
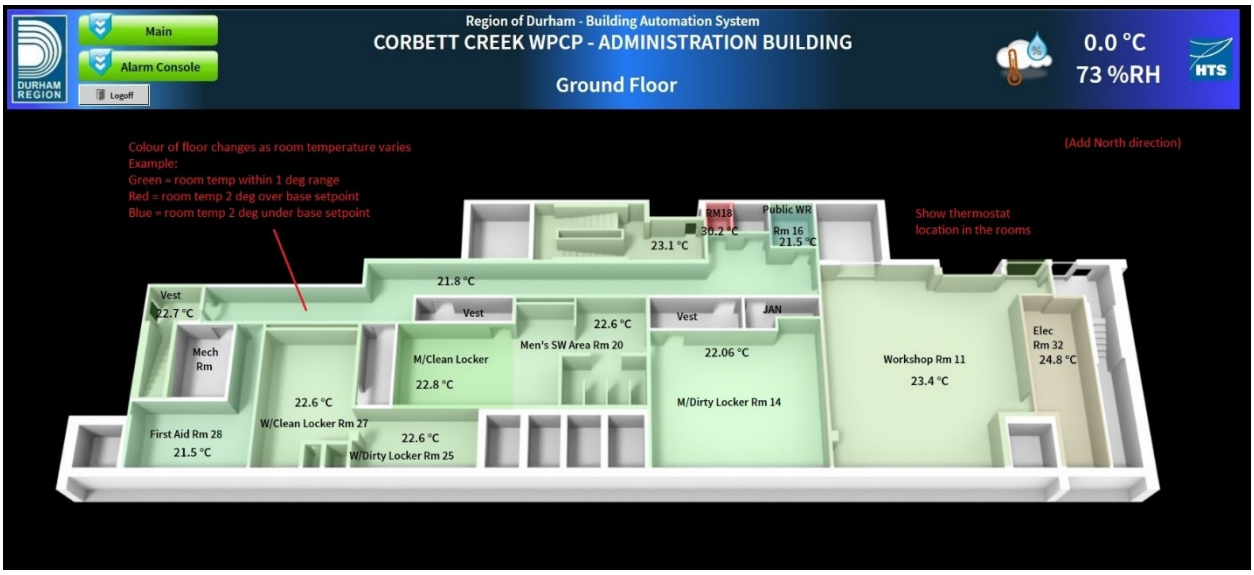




Appendix B – Graphical User Interface Standards

Screen Shots of Standard Tridium Niagara N4, JACE Graphics





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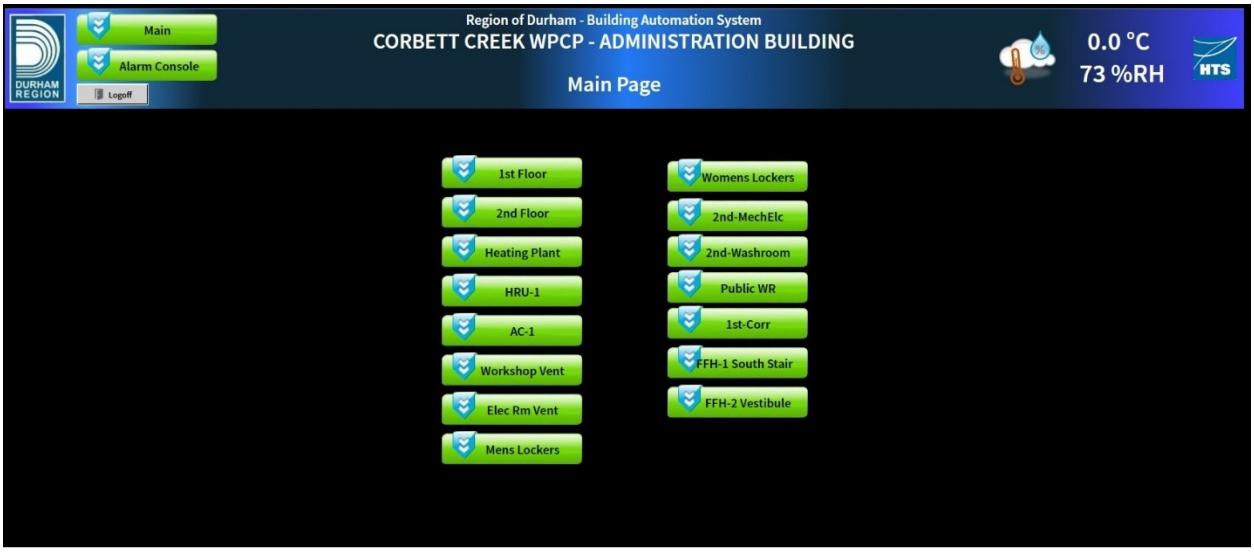

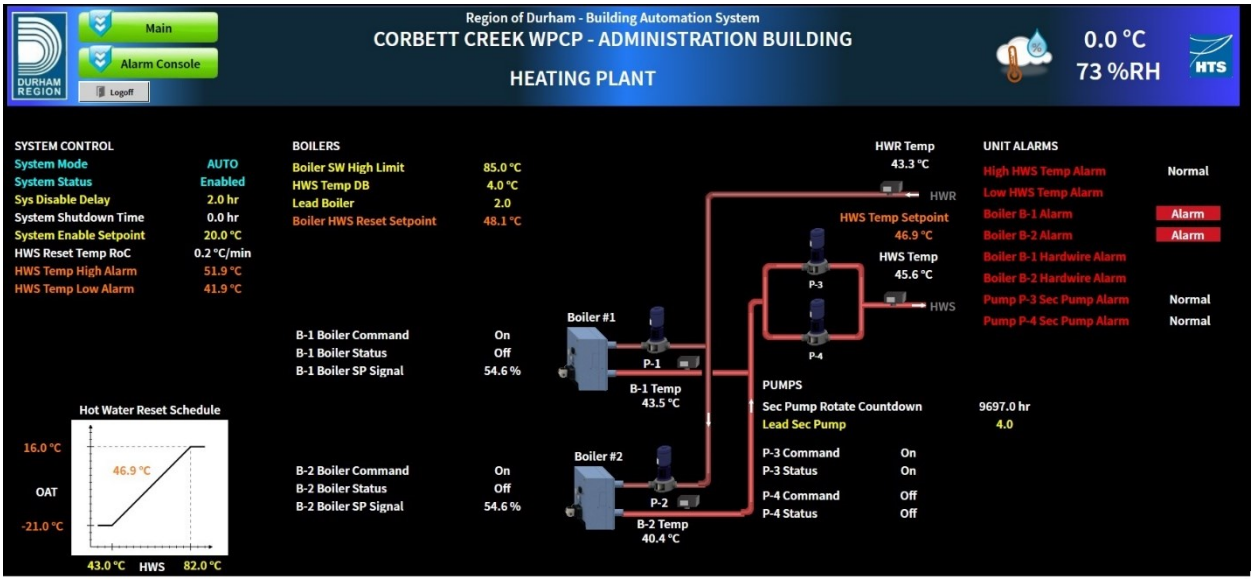

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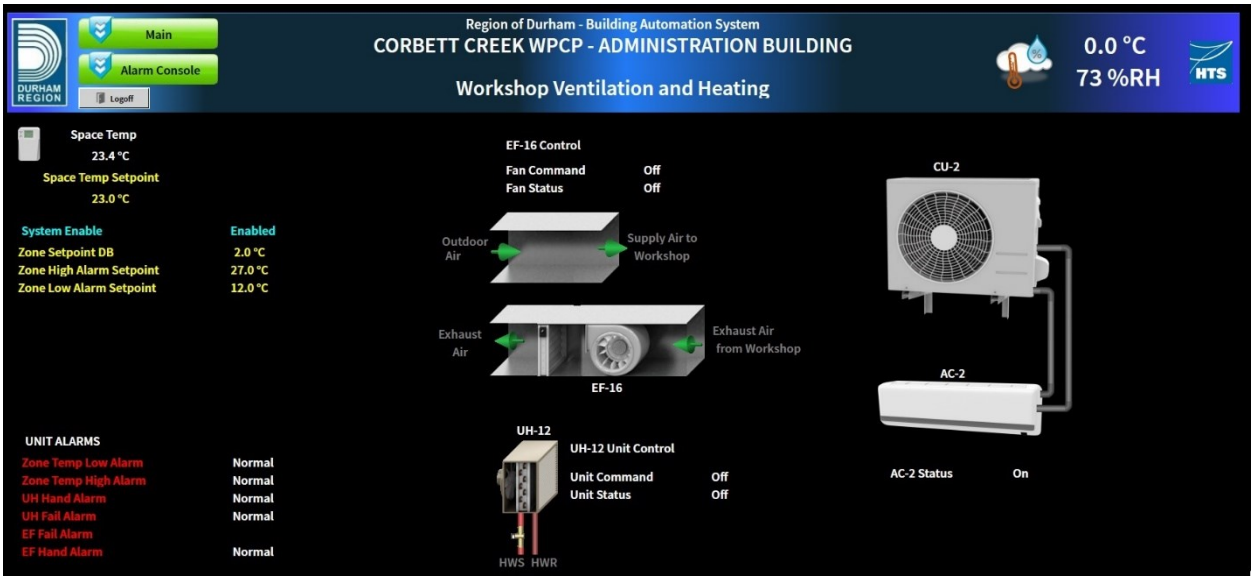
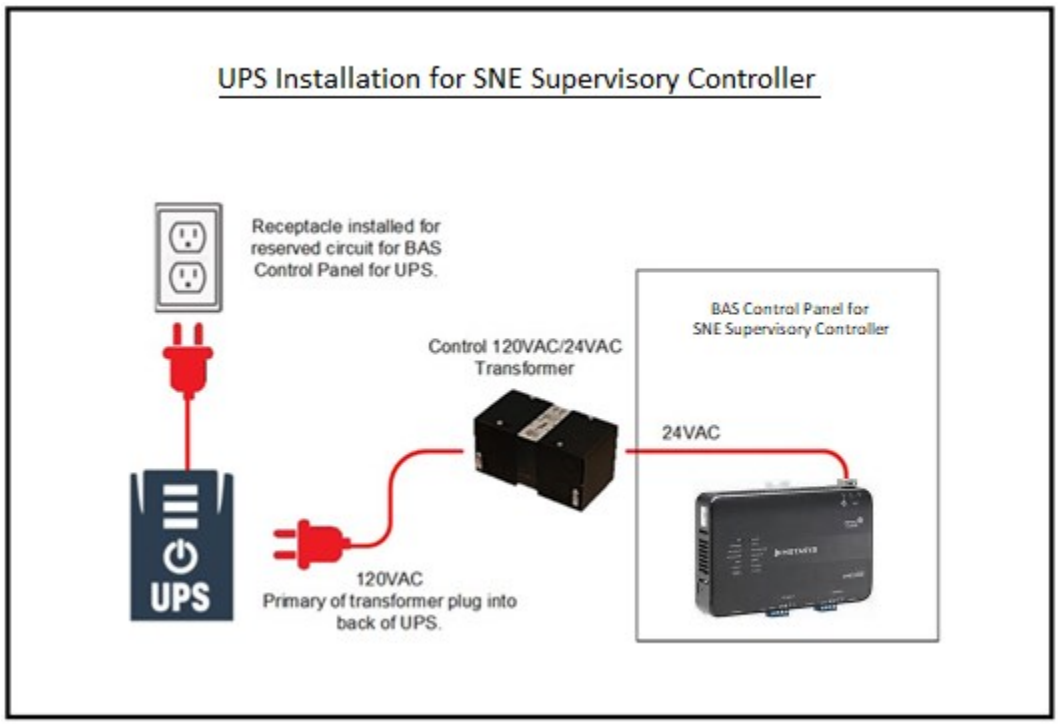
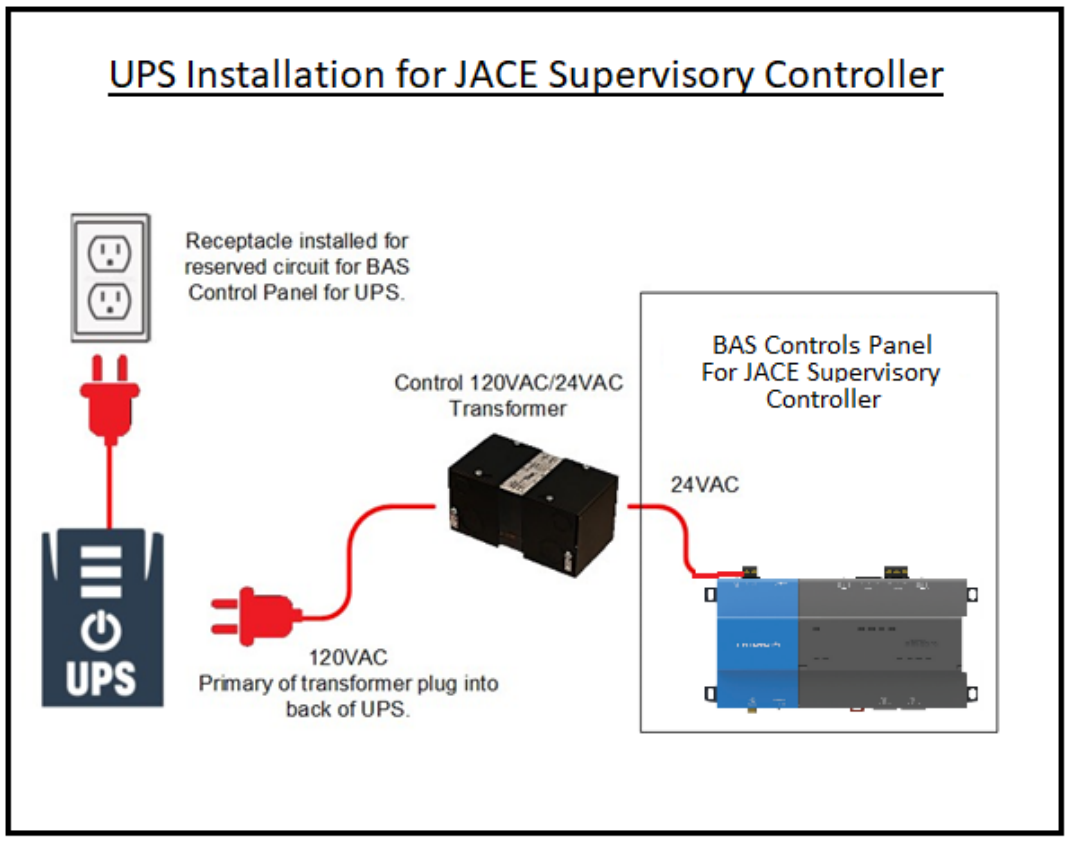


Appendix C – UPS Installation for Supervisory Controllers





Appendix D – BAS Alarm Tag Naming and Configuration

1 BAS Alarm Tag Naming and Configuration

1.1 Alarm Description

.1 To effectively identify an alarm from the Region's Metasys ADX BAS, the following format is recommended:

[Region/Site Name – System – Area Served (or Equipment Location) – Alarm Item]

This is configured under the Name & Description Fields in the Alarm Tab.*

Examples:

- Ajax Depot - MUA1-South Vehicle Storage Bay–Supply Fan Alarm
  or
- Ajax Depot - MUA1-South Vehicle Bay-High CO Level Alarm
  or
- RHQ – CS-IT AC Unit 1 – Server Room – High Discharge Temp

**Description field only has a limit of 64 characters.*

1.2 Alarm Message Text

.1 The Alarm Message Text field should convey specific instruction on what actions to take, who to contact (if applicable), etc. Most problems can be easily dealt with in a timely manner if a user or an operator sees instructions for an alarm on what to look for or what needs to be done or who to contact in case of equipment failure or critical readings of alarm levels, etc.

Examples:

- Confirm supply fan operation. Check power at main & remote disconnect, fuses, high/low safety limits, belt, fire alarm contacts and controls (fan relay & current sensor).
  or
- Turn off any vehicles or gas-powered equipment running in the service bay and check ventilation system operation. Temporarily open garage door.
  or
- On the display of the AC Unit, take note of the alarm. Reset unit by pressing the 'Clear Alarm' button. Wait for alarm to clear and ensure good operation. Contact Facilities if alarm will not clear.