Back to BASics: Sequences of Operation Cheat Sheet

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Introduction

This is a companion to last month's "Art and Science of Point Selection" column. The sequence of operation ("sequence") is the most important aspect of BAS design. BASs require extensive sequence programming by the installer to transform it from a pile of electronics into the brain of an HVAC operation. As with point selection, sequence writing: 1) Requires an "art and science" approach, and 2) Is an iterative process with the point selection. So this column won't provide much detail about these aspects (revisit last month's column, if necessary) but instead will focus on the key aspects unique to sequences..

Source: http://automatedbuildings.com/news/sep18/columns/18081-8094004ira.html

Objectives a Sequence needs to address

There are four objectives that a sequence needs to address:

- **Equipment Protection** – The sequence must include protection to minimize damage to equipment, such as freezing coils, short--cycling motors, duct damage due to over/under pressurization, etc. This objective is not optional and cannot be traded off for more-easily meeting the remaining objectives.
- **Reliable Operation** – Each building and building use will have a different definition of "reliable" (i.e., ranging from a high tolerance to periods of degraded interior conditions to the nearly 0% system downtime for a top-tier data center). The sequence needs to address the project's definition of reliability, which is also not an option.
- **Comfort** – Indoor temperatures, RH, and air quality need to be maintained at reasonable levels. These attributes have a range of acceptable values, which, along with owner's willingness to tolerate an even wider range, can be balanced with the next objective.
- **Energy Efficiency** – Increasing system efficiency can be a balancing act with comfort. Unfortunately, it is not always clear which sequence choices will improve efficiency and/or if they will be so complicated that it can affect reliability or even equipment protection.

The Process of Writing Sequences

1. Start with a schematic diagram and initial point list of the systems to be controlled.
2. The initial point list should take into account (this was also discussed in my last column):

Which factory-provided equipment safeties or controls will be used as-is vs. bypassed for control by the BAS. If used as-is the only points included should be for monitoring safeties and controls as well as providing supervisory control of the factory controls (e.g., on/off, setpoint reset, etc.); and

Which factory-provided controls are to be interfaced via points vs. digital communications (e.g., BACnet).

As with the point list, develop the sequences "top-down" – list all unique systems, then their components, and then the controlled devices (e.g., VFD's, damper/valve actuators, etc.).

For each component/device (or a logical group of components/d-evices) describe the normal mode of operation (e.g., unoccupied vs. occupied) and abnormal modes (e.g., failures, alarms). The latter needs to address the equipment safety requirements, while all modes need to meet the project reliability objective while achieving the project's comfort vs. energy efficiency balance.

- Review the point list to ensure it can fully address the sequence, then review the schematic diagram to ensure that the sequence and points match the mechanical design.
- Continue iterating this sequence vs. objectives vs. point list & schematic diagram comparison, and edit them further until they are all in agreement and meet the project's objectives.