Bureaucratic Affairs Building Description and History

The purpose of this document is to provide you with a description of the fictitious Bureaucratic Affairs Building, which is located on a college campus in the very beautiful town of Golden Girl, Missouri. It is one of the many facilities associated with Center of the State University (COStU), which is the major driver behind the economy in Golden Girl.

Figure 1 – The Bureaucratic Affairs Building

Despite being a college town, Golden Girl is a very quaint and quiet place, known for the exquisite beauty of the rolling hills that surround it and the peaceful quiet that settles in at sunset, especially during the summers when the fireflies rise up from the surrounding fields as the sun fades over the horizon and the stars begin to shine.

As a result, out of fear of becoming a sort of mecca for baby boomers, in 1954, the City Council passed a resolution limiting the size of the font used for the town's name on a map to 1 point. As a result, it is unlikely that you will find it if you go looking for it on a map of Missouri.

However, having spent many years of my life in Missouri and as a result, being somewhat familiar with the state, and despite only having discovered my Golden Girl after moving to Oregon, I can tell you that it is west of St. Louis, on the general route to Jefferson City. So, it would be reasonable to use the St. Louis or

Jefferson City, Missouri design conditions to develop our reset schedule. Towards that end, I have provided the St. Louis conditions in Figure 2 for your reference.

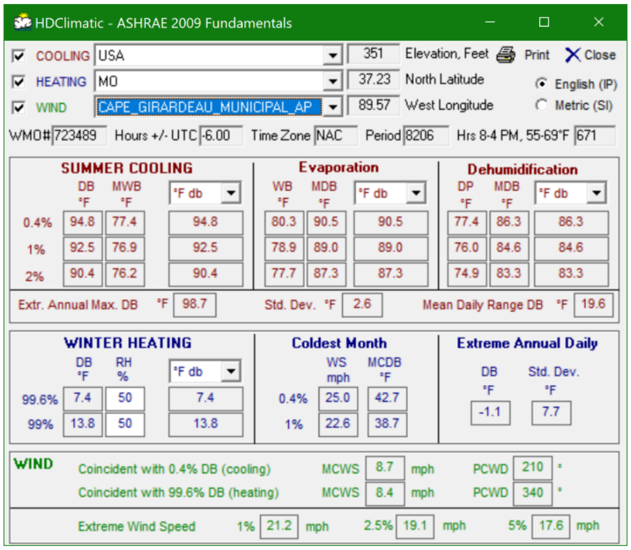

Figure 2 – St. Louis, MO Design Conditions

Original 1946 Facility Description

The facility is a 1940's vintage building that started life as the campus Administration Building. Originally, it was served by an economizer equipped constant volume air handling system with no mechanical cooling.

Heat was provided by a district steam system fed by the central boiler plant on campus. The steam served a shell and tube heat exchanger that supplied water to a finned tube radiation system (FTR) that picked up the perimeter heating load along with some heating coils that were provided for the core area on the second floor to offset the roof losses.

The hot water system was controlled by an outdoor air temperature reset schedule that reset the supply temperature from 210°F at 4°F outside (the winter design condition) to 120°F at 65°F (the balance point for the building). In addition the FTR covers were provided with adjustable dampers to allow local "fine tuning" of the heat delivered by the system for a given section of enclosure. And, each face on each floor of the building was provided with a line sized valve that was controlled by a thermostat intended to shut down the FTR for that zone if it was getting to warm due to solar gains or the desired temperature of the occupants.

1960 - Mechanical Cooling Addition

Mechanical cooling in the form of an air-cooled condensing unit serving a direct expansion (DX) coil was added in the late 1960's. The project was funded by donations from the student body after their beloved Dean died at his desk one on hot, humid summer evening of a heart attack, brought on by the strain of the peace demonstrations on campus, compounded by the heat and humidity in the unconditioned facility, which he refused to leave until the National Guard troops were removed from his campus.

1984-1985 Renovation and Conversion from the Administration Building to the Bureaucratic Affairs Building

The campus grew significantly over the years and by the mid 1980's, a new Administration Building was built, and the original Administration Building was converted to its current role of housing the Department of Bureaucratic Affairs. The renovation project was completed in 1985 and in addition to the architectural changes associated with its new role, the project addressed the need to replace aging equipment, perform asbestos abatement, reduce energy consumption, and improve comfort. Figure 3 illustrates the remodeled floor plans for the facility along with the FTR zones that were provided. Figure 4 adds the VAV zones to the floor plan.

As a part of this project:

1. The original operable casement windows were replaced with fixed pane double glazed windows with thermal breaks in the frames and lightly tinted glass. This improved comfort and reduced the losses and gains through the envelope, including infiltration. But it made the facility totally dependent on the mechanical cooling process during hot weather.
2. The air handling unit was replaced and converted to Variable Air Volume reheat (VAV reheat). The air handling replacement conversion consisted of:
    - Replacing the original air handling unit with a modular unit complete with economizer section, 30% ASHRAE dust spot efficiency prefilters, 65% ASHRAE dust spot efficiency final filters, a warm-up coil, a DX cooling coil, and a Double Width, Double Inlet Air Foil supply fan (DWDI AF).
    - Retaining the original low velocity supply duct system, including some modifications for zoning purposes and installing pneumatic VAV reheat terminals.
    - Retaining the low velocity return mains but eliminating the return branches in favor of a ceiling return plenum approach.
    - Retaining the original roof mounted relief hoods associated with the economizer cycle.

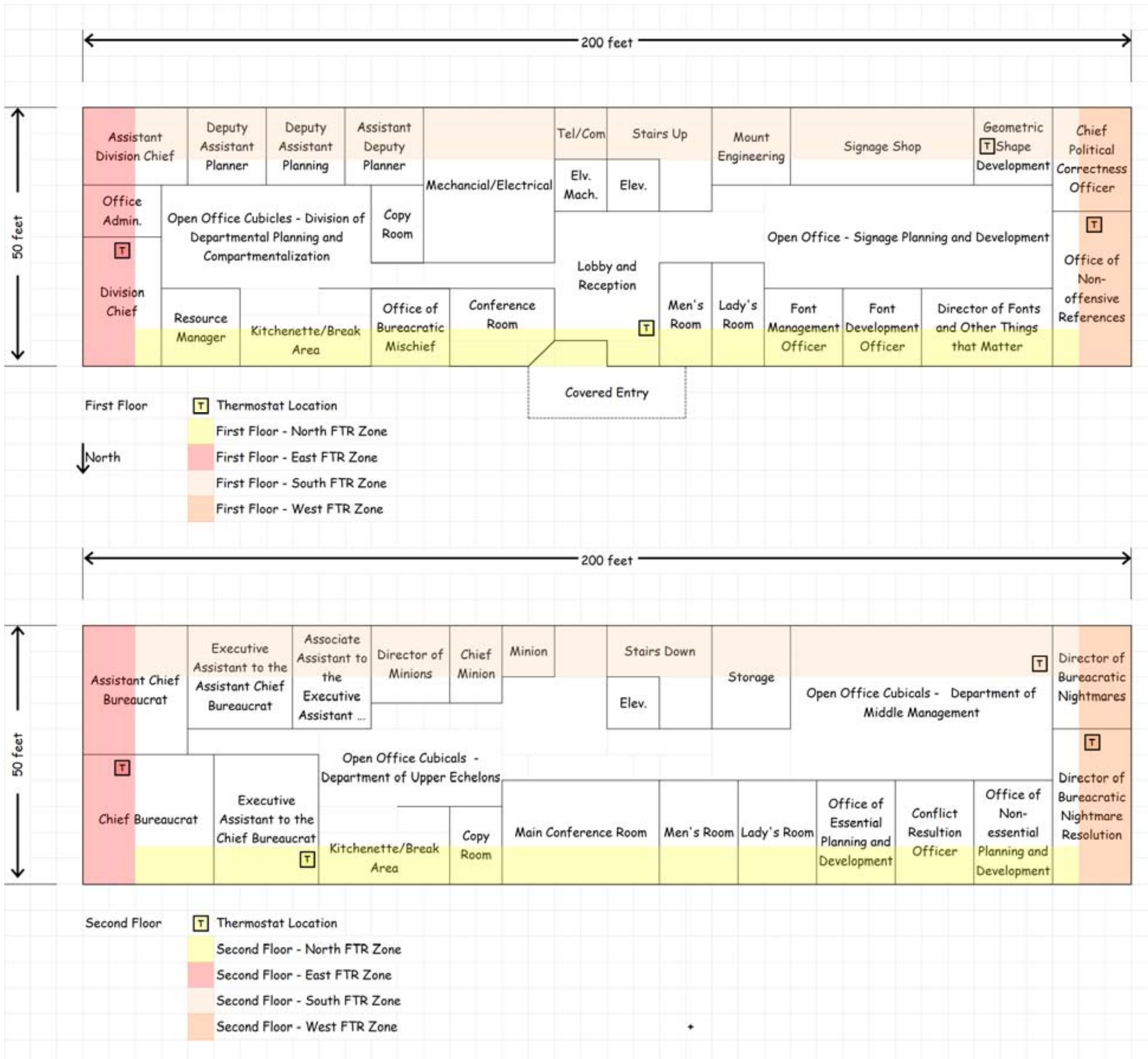

Figure 3 - Bureaucratic Affairs Building Floor Plans with FTR Zones

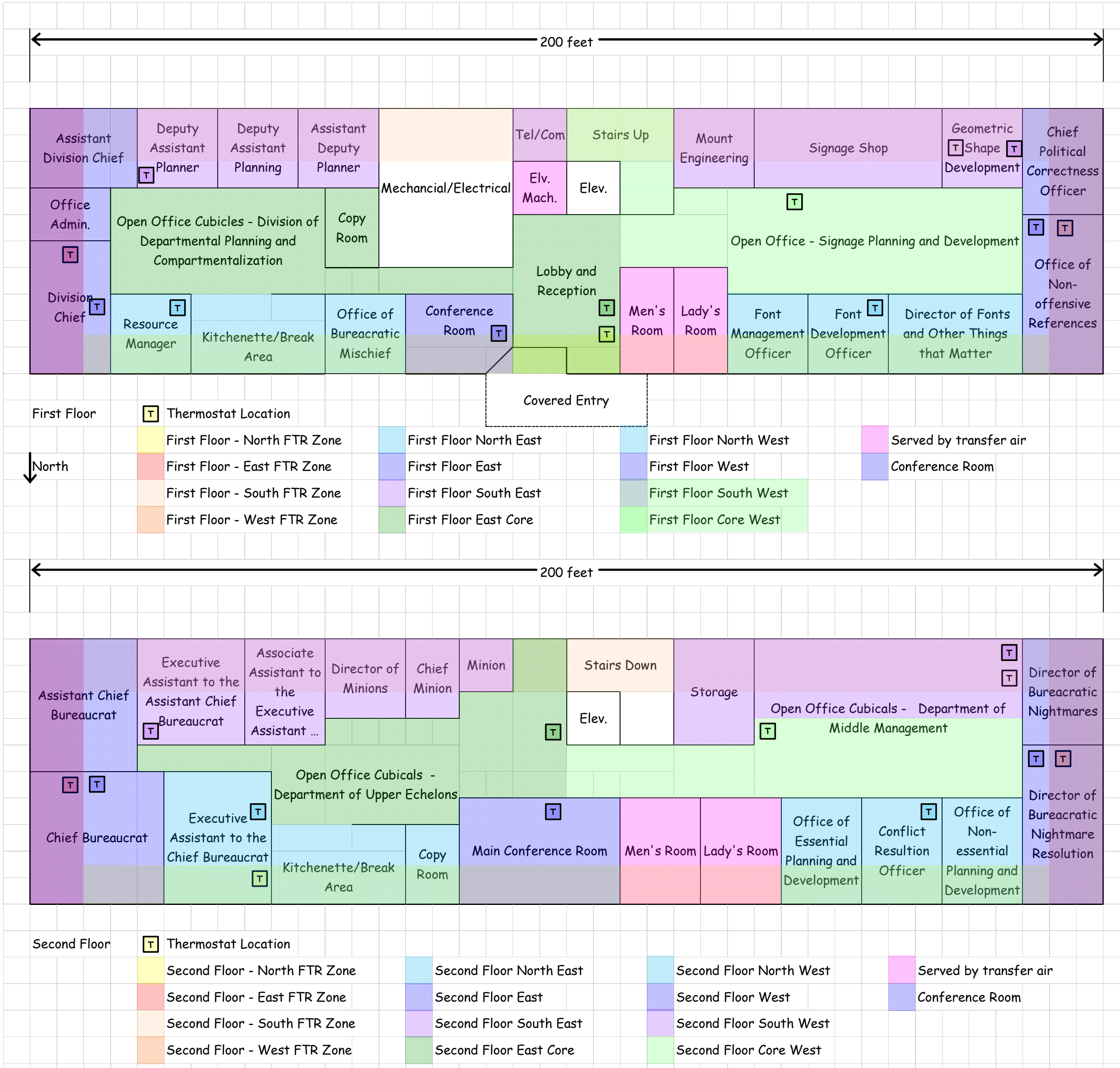

Figure 4 - Bureaucratic Affairs Building Floor Plans with FTR Zones and VAV Zones

3. The existing air handling unit economizer process was non-integrated to prevent short cycling the Dx compressors. During design development, an air-cooled chiller serving a chilled water system with a buffer tank was explored as an option, which would have allowed an integrate economizer cycle. This design concept was incorporated into the project but the system still experienced short cycling issues.

4. The hot water, steam, and condensate piping and associated equipment was reinsulated as a part of the asbestos abatement project. The hot water system

was tapped to serve the reheat coils and the existing finned tube radiation system was retained.

5. New hot water pumps were installed sized for the combined flow rate associated with the finned tube elements at full flow along with the warm-up coil at full flow.
6. The supply temperature for the hot water system was reduced from the original 210°F setting to 170°F due to the reduced perimeter load associated with the improved windows and the ability to calculate loads more accurately using computer-based techniques that took things like thermal lags into account.
7. The reheat coils were selected based on the new operating temperature and the reset schedule was eliminated to ensure that the reheat coils would always be supplied with water at the 170°F design temperature.
8. The FTR enclosures were replaced with enclosures identical to the original enclosures but painted to match the new décor and segmented to match the new partition arrangement on the perimeter.
9. Because DDC technology was still evolving and somewhat expensive for zone level control, pneumatic zone level control was retained for the finned tube radiation system and the new VAV reheat terminals.
10. The zone valves for the FTR were retained and the existing thermostats associated with them were replaced, allowing them to modulate the zone valves based on the temperature in each zone at the thermostat location.
11. The campus controls group installed a DDC controller in the main mechanical room that directly controlled the new air handling unit, the heating water pumps, the heat exchanger, and the chiller. The system also monitored zone temperatures at several points on the first and second floor. This project was accomplished totally in-house by a team that was very hands-on and quite competent but not given to formal documentation.

2008 Air Handling System and Cooling System Replacement and Control System Upgrade

By 2008, the 1985 vintage air handling unit was beginning to show its age and parts were no longer available for the air-cooled chiller. As a result, a renovation project was triggered that replaced the chiller with a current technology equivalent and replaced the air handling unit with an identical system using components from a modular, double-walled product line.

The project also upgraded the 1985 hybrid DDC/pneumatic control system with a full DDC system including DDC at the zone level. The zone level upgrade was accomplished by replacing the existing VAV terminals while retaining the existing reheat coils. The existing pneumatic reheat control valves were replaced with new valves with electronic actuators as were the FTR zone valves. Pneumatic actuation was retained for the central equipment due to the Owner's preference for that approach on their central systems.

As a result of policy developed by the Bureaucratic Affairs Department when it first was formed, the University was obligated to take bids for all projects with an anticipated budget of $30,000 or more, awarding the project to the lowest bidder for all projects other than computer and IT projects which were sole sourced to Dell for computer hardware, Microsoft for software, and Cisco for network infrastructure. As a result, the campus was served by control systems from several major vendors and one locally owned minor vendor.

The local vendor was preferred by the campus and was often sole-sourced for small control system upgrade projects because they had several employees that had originally worked for the campus control shop and thus, were very familiar with the campus and how the facilities group preferred to have things done.

The ex-University employees had been hired by the local vendor when the control shop was disbanded in 1990 after the Office of Essential Planning and Development concluded the practice was not cost effective and because they needed the space to house the new and growing IT department.

Unfortunately, there was no budget for a formal design process for the control system renovation. As a result, the contractors and vendors were furnished with the 1985 mechanical drawing set and told to bid a like for like replacement. As mentioned previously, documentation of the existing control system was nonexistent and there were no copies of the mechanical specification available and thus no narrative sequences or point lists to guide the control vendor bids.

During the pre-bid site visit, one of the control representatives, who had been involved with the 1985 control installation because he worked for the control shop at the time, discovered copies of the original pneumatic control drawings and some of his field sketches folded up in the DDC panel in the basement and asked that they be addended to the bid documents as a reference. Many of the other bidders felt this would be helpful, but project manager felt the documents were not relevant and might even expose the University legally somehow. Ultimately, the Office of Conflict Resolution sided with the project manager.

Bid were received with the vendor who employed the ex-university control tech coming in 20% above the other vendors, all of whom were with-in 5% of each other. This did not surprise the project manager because rumors circulated frequently that the ex-control shop technician tended to "gold plate" his projects with unnecessary features like terminal strips, calibration wells, and points that were not really needed to control the system.

In fact, on an air handling system control upgrade project the PM had managed, he had caught the ex-control shop tech including expensive averaging sensors in the mixed air plenum, after the preheat coil and after the cooling coil when all that was really needed to control the system was a single point sensor in the fan discharge.

Fortunately, he had been able to have the sensors eliminated and saved the cost. But keeping an eye out for problems like that was something he would rather not have to do. So, having one of the other vendors be the successful bidder assured him that he would not need to worry about those sorts of things.

Since it was a small, relatively simple facility, the successful bidder assigned it to some of their younger team members who, while being quite competent at working with the vendor's technology, were relatively new to Heating, Ventilating, and Air Conditioning (HVAC) and its related principles. As a result, they did their best in terms of developing the DDC control sequences but were constrained by their limited experience, the information given to them (the original 1985 mechanical drawings) and the budget that was set by this limited information during the bidding process.

Existing Building Commissioning Project

At the point in time when you are reading this (several years at least after the control system renovation), the building has been selected as a target for an EBCx project in an effort to save energy and also, ideally, address some of the comfort and operational issues that the occupants experience. During the initial site visit, the EBCx team developed the following list of potential targets based on walking the facility, reviewing some trends that were already running in the control system and discussions with the facility manager and the campus facility operations staff.

1. The valves on the discharge of the hot water and chilled water distribution pumps are throttled.
2. Insulation is missing from the heat exchanger steam control valve and the strainer ahead of it. Some of the condensate piping also has missing insulation.
3. Steam is emerging from the vent on the condensate pump receiver.
4. Steam is emerging from the vent line from the relief valve on the pressure reducing station.
5. The drain valve on the condensate pump receiver is open and condensate is going to the floor drain instead of back to the central plant.
6. The hot water system is enabled if it is below 65°F and runs to maintain a constant 170°F hot water supply temperature.
7. The air handling system runs round the clock to ensure that the server/telecom room is always adequately cooled.
8. The economizer is a non-integrated economizer.
9. The chiller cycles frequently, especially during mild weather when it needs to operate to supplement the outdoor air cooling provided by the economizer process.
10. The building is more comfortable during extreme weather than in moderate weather and the swing seasons.
    - The conference rooms and core areas, while comfortable when it is fairly hot outside tend to be cold during moderately warm weather. Once the climate pattern switches to the late fall and winter conditions, they tend to not be cold.

- The East end of the first floor tends to be cold during cold weather even though the rest of the building is fairly comfortable.
- The perimeter spaces, while comfortable during the peak heating season tend to overheat during the swing seasons and mild, cool spring and fall days.
- The settings of the zone thermostats are a constant source of disagreement between the person who's office the thermostat is located in and others who's offices are on the same zone.
- The building occupants were unaware of the dampers in the FTR covers until you discovered them when you became curious about what the little hex screw in the cover was for as you walked through the building.

The exercises we will be working will build from all of this information as we work on a virtual EBCx project to improve the facility.