Ballroom AHU-2 Preliminary Findings List

	Finding or Opportunity	Obvious Indicator	Associated Scenes	Savings		Non-resource Benefit					Potential low cost/no cost	Next Step	Precautions/Considerations
				Energy Savings	Other Resource Savings	Cleaner	Safer	Comfort	Productivity	Performance			
1.	The leaving air temperature sensor is after the fan, not after the coil. Since it is likely this sensor is controlling the heat transfer elements, the impact of fan heat may be causing unnecessary reheat, dehumidification, cooling.	Sensor after the fan, but the typical design metric would be leaving air temperature (LAT). The coil schedule specifies coil LAT.	2-5	X		X	X			X	X	Measure fan heat and capture flow profile and leaving air temperature profile to estimate savings potential.	If the designer did not include fan heat in their calculation then the current location solves that issue; offsetting the set point as a solution will become complex if the system becomes VAV.
2.	Control valve is heavily throttled even though there seems to be a significant load; distribution pumps may be making more head than needed	Valve position indicator and cooling coil water side pressure drop and air side temperature drop.	43	X						X	X	Estimate or test for the pump head requirement between the plant and the most hydraulically remote location and develop a reset schedule for the CHW distribution pumps.	Other loads on the piping system may be the hydraulically most remote zones so this should be considered as the optimization plan is developed.
3.	The mixed air temperature sensor is a single point sensor.	Observing the sensor and observing the mixing box configuration.	8-Feb	X						X	X	Test plenum stratification with different damper positions and evaluate the options for upgrading the sensor to one or more averaging type sensors.	The stratification pattern will be dynamic and vary with system flow rate, damper position and return and outdoor air temperatures. If the coil cross-section is big enough, a second freezestat may be required to adequately cover the coil face.
4.	The drain pan is flooding because the trap is not piped correctly.	Drain trap piping configuration and flooding in the fan compartment.	42, 45-46			X	X				X	Modify the drain pan piping to include a vent and maintain a water seal with the maximum anticipated pressure difference inside to outside. See https://tinyurl.com/DrainPanPiping for details.	
5.	This is a constant volume system with a VFD.	Observing the VFD and then observing the system configuration.	14, 19-23	X						X		Consider options for leveraging the VFD or consider moving the VFD to a place where it can provide benefit and saving the VFD losses that are occurring in this system	If a conversion to VAV is considered, review diffuser performance characteristics at minimum flow to make sure that they will still properly distribute air. Diffusers loose their ability to throw air as the neck velocity drops.
6.	It may be possible to optimize the way filters are operated; at a minimum they need to be provided with differential pressure indicators to comply with most codes.	Multiple filter banks with relatively high efficiency filters.	30, 39	X	X						X	Explore life cycle cost based filter operation. See http://tinyurl.com/NCBC2015FilterPaper for additional information.	If differential pressure indicators are installed, consider using an analog indicator instead of a switch to support future life cycle cost based optimization and VAV operation where peak filter DP may not occur when a manual reading is logged.
7.	Blade seals are missing on the dampers.	Observing the degraded blade seals.	8, 31-32	X						X	X	Repair the blade seals; if the savings potential is significant, consider upgrading the dampers to improve economizer performance; coordinate with findings 12, 13, 15, and 18.	The benefits of good blade seals will vary with climate and range from preventing infiltration during off hours, minimizing the potential for coils to freeze during off hours, and maximizing the benefits of the economizer process.
8.	The area served by the system has highly variable occupancy and minimizing OA to match requirements may be desirable.	Observing the area served and discussions with the operators.	19, 21-22, 44	X						X	X	Log CO_2 data for each half of the ballroom along with flow profile data to provide the information necessary to evaluate demand controlled ventilation.	If CO_2 sensors are recommended, the Owner needs to be willing to maintain them, otherwise the benefit will not persist
9.	The area served by the system has highly variable occupancy and zone level scheduling may be desirable	Observing the area served and discussions with the operators.	19, 21-22, 44	X						X		Investigate using the fire/smoke dampers at the return shaft for zone level scheduling with the code authority; collect event schedule data, flow and temperature profile data for assessment.	Some jurisdictions may not allow fire/smoke dampers to be used for any function other than life safety, in which case dampers will need to be added
10.	One of the filters is installed backwards.	Observing the reverse installed filter .	30, 39			X	X					Install a new filter oriented in the right direction at the next filter change.	
11.	The area served by the system has highly; variable occupancy and it may be possible to reset the leaving air temperature.	Observing the area served and discussions with the operators.	19, 21-22, 44	X						X		Collect zone temperature and humidity data to allow reset options to be assessed.	Reset schedules can save energy in one area and cost energy in another; e.g. raising the system LAT could cause the AHU to move more air. In humid environments, the upper limit needs to take dewpoint and condensation into account.
12.	The economizer damper arrangement does not promote good mixing.	Observing the mixed air plenum and the physical configuration of the dampers.	8, 31-32	X						X		Coordinate solving this with the solution to findings 7, 13, 15, and 18.	The importance of good mixing will vary with the climate and is more critical for climates where subfreezing air must be mixed with out freezing a coil or causing nuisance freezestat trips.
13.	The freezestat element is not strung out.	Observing the freezestat element after removing a filter to get filter specs.	9-Feb		X		X			X	X	Coordinate solving this with the solution to findings 7, 12, 15, and 18.	If the coil cross-section is big enough, a second freezestat may be required to adequately cover the coil face. A general rule of thumb is 2 feet of element for every 4 feet of face area.
14.	The preheat coil is active and probably should not be.	Observing a temperature rise while the CHW coil is active and while on minimum outdoor air (MOA).	6	X						X	X	Test for valve leakage; obtain control code to check for programming issues.	Verify that the issue is not a sensor relative calibration or accuracy issue vs. an actual temperature rise across the coil before spending a lot of time and effort trying to track down the issue.
15.	The economizer dampers may be stuck on MOA; need to check current conditions on a psych chart to be sure.	Observing the dampers and comparing to current conditions.	8-13, 31-32,	X						X	X	Compare current outdoor air enthalpy with target enthalpy for the area served, log economizer data and assess. test economizer operation. Coordinate with findings 7, 12, 13, and 18.	If an upgrade to an enthalpy based economizer limit strategy is considered, the Owner needs to be willing to invest in high accuracy humidity sensors and also to commit to calibrating them several times a year if the benefit is to persist.
16.	The fan discharge arrangement imposes significant system effect.	Observing the existing condition relative to what should be going on.	23, 37	X						X		Resolve to check for poor fan inlet and outlet conditions during design and submittal review, and during construction observation on future projects prevent system effect problems from happening.	System effect problems can be expensive to fix. Once in place, it can be more cost effective to focus on mitigating the impact of system effect; i.e. making sure a VAV system is really varying volume, using zone level scheduling, fine tuning minimum flows, etc.
17.	The relief dampers are open and probably should not be give the state of the economizer.	Observing the existing condition relative to what should be going on.	8, 31-32, 47	X		X	X	X		X		Coordinate with addressing finding 17; log building pressure relative to atmosphere.	In a large facility like this, building pressure can be impacted by a lot of things including the operation of other systems, large open doors at entries and loading docks, and stack effect, all of which must be considered when resolving this issue.
18.	The economizer dampers may be oversized and as a result, could cause the flow shift above design as they stroke and will not deliver a linear relationship between damper stroke and air flow.	Field assessment based on estimated design flow and estimated damper face velocity rules of thumb.	8, 31-32, 39	X						X	X	Coordinate solving this with the solution to findings 7, 12, 13, and 15. Determine how minimum out door air percentage is set and test for actual MOA flow under different operating conditions	A control strategy that sets the minimum outdoor air percentage based on a percent of damper stroke (i.e. command 15% open to get 15% outdoor air) assumes a linear relationship between damper stroke and flow which will not exist with oversized dampers.
19.	The impact of clean vs. dirty filters could cause the system to move more air than necessary after a filter change.	Observation of filter MERV ratings and familiarity with the fan curves, characteristics and performance.	30, 39	X	X					X	X	Coordinate solving this with the resolution of findings 6, 8, and 9.	When considering alternative filtration technologies and strategies, verify that there are no quality control measures in place in a production or lab facility that specifically reference a specific filtration approach that needs to be complied with.
20.	The outdoor air temperature sensor is in a duct inside the building and could give erroneous readings.	Observation of the sensor location and past experience.	9	X						X		Relocate the sensor. Consult the World Meteorological Association *Guide to Meteorological Instruments and Methods of Observation* for OAT sensor installation guidance.	Accurately measuring outdoor air temperature can be very challenging. Bad data can impact operations on many fronts in situations where outdoor temperatures trigger events and optimize set points.

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21.	The VFD is in "Hand".	Observation of the VFD control panel.	14, 15	X	X					X	X	Restore the AHU schedule. Coordinate with event planning to optimize the schedule for each day. Consider adding an optimized start/stop routine and fine tuning night set-back/set-up.	Night set-back/set-up achieves energy savings by trading the energy it takes to maintain internal conditions and storing heat or cool in the mass of the facility with the energy it will take to replace the thermal energy that is lost if the spaces are allowed to drift.