ENERGY-SAVING STRATEGIES: SYSTEM SETBACKS

Goal: To use appropriate, risk-managed mechanical system set point setbacks in temperature or relative humidity to achieve energy savings with minimal impact on the preservation environment.

Advantages	Disadvantages
Often simple mechanical control	Potential to forget to restore equipment to normal operation
Potential to temporarily improve environmental conditions for collections, particularly in modern buildings	Decreases in temperature may increase human comfort complaints
Fluctuations in temperature or RH should be short in duration and have little effect on collection materials	
Cumulative energy savings over time	

Description of Potential

Many institutions that would like to implement HVAC system shutdowns find that they are not capable of doing so for various reasons. Though these facilities cannot take advantage of shutdowns they can often explore implementing nightly setbacks in temperature and RH. These nightly setbacks do not produce the same energy savings that shutdowns can, but they still allow the facilities to reduce use of the HVAC system and potentially take advantage of seasonal conditions that may temporarily help produce a better environment and save some energy when the facility is unoccupied.

Setbacks are defined as methodical nightly, weekend, or seasonal adjustments to HVAC settings. This strategy deals specifically with setbacks in temperature and relative humidity set points. It is NOT recommended that institutions experiment with setbacks in summer dehumidification/dew point control. The intention of setbacks is to use less heating or cooling during unoccupied hours when human comfort is not a concern, similar to adjusting a home thermostat when the house is unoccupied or the occupants are asleep. The use of setbacks does not involve using more outside air or economizing more to get a different condition. The setbacks in temperature and relative humidity set points are programmed into the mechanical system and typically tied to the occupied hours of the facility. During the unoccupied hours the system initiates the lower set points. The system should hold these set points for the period of time that the facility is unoccupied and return to the normal set points just before staff arrive.

The use of setbacks does not involve simply turning the temperature in a space down as low as possible. As the temperature of a space is lowered, if the dew point remains constant, the relative humidity will rise. If the temperature in a space is lowered too much there could be significant issues associated with the higher humidity, such as condensation on walls or windows, or mechanical damage to vulnerable, exposed collections in the space. Before setbacks are programmed the average dew point control for the AHU zone must be known. Inputting a dew point into Dew Point Calculator (www.dpcalc.org) allows for the determination of how low the space temperature can drop and still maintain safe RH levels.

Most setback experiments will focus on temperature, especially if a facility is already using different seasonal set points and maintaining seasonal upper and lower limits in RH. The experimental goal is to allow the condition of the space to alter slightly while still providing the same quantity of airflow. In cold environments/seasons, one example might be dropping the temperature set point from 68°F to 64°F during unoccupied hours, reducing the amount of heating performed while slightly improving the preservation environment for the unoccupied period.

RH setbacks are typically only feasible if the AHU zone is currently maintaining a mid-range (40-50%) constant RH control in dry environments/seasons. In these situations, an institution may experiment with a short-term RH setback down to 30-35% as a means of saving energy at the humidifier while maintaining safe conditions for most materials. However, if the collection is tolerant of 30-35% RH conditions, most facilities will be better off experimenting with and implementing a full seasonal set point change to those RH levels, rather than only using an unoccupied setback setting.

Summer setback testing must be carefully considered before experimentation. AHUs that are dehumidifying via subcool and reheat WILL NOT see an energy benefit from rises in space temperature during unoccupied hours. Due to the nature of the subcool/reheat process, raising temperature set points during unoccupied hours will actually result in increased energy use at the reheat coil, while slightly reducing the preservation quality of the zone. Summer temperature setbacks with other system designs – desiccant dehumidifiers and sensible cooling controls – have greater potential for success with minimal collection risk.

Experimentation with temperature setbacks should always take the potential impact in relative humidity levels into consideration. A separate two week testing period is recommended for each season to verify if the setbacks will work in that facility with the collection. Pre-testing is described later in this document.

Requirements

- Automated control of mechanical system is preferable
- Ability to program system operation
- Knowledge of temperature and RH limits based on vulnerable collection materials
- Knowledge of hours of operation and/or work schedule for the AHU zone
- Data logging within the mechanical system (if you want to quantify energy savings)
- Data logging in the collection space (to monitor the storage environment for any potential risk)

Critical Data Points

- Preservation

- Space data from each space affected by the system during the setbacks
- Identification and monitoring of potential microclimate areas that may fluctuate differently than the rest of the space (especially near doors, windows, or anywhere that outside air may infiltrate)

- Energy
  - Data from each location in the system where a component can mechanically work on the air:
    - Return air
    - Mixed air
    - Pre-heated air
    - Cooled air
    - Heated/supply air
    - Fan amps
    - Downstream reheats
    - Others (as needed)

Pre-Testing

- Use Dew Point Calculator (www.dpcalc.org) to evaluate the temperature and relative humidity conditions you intend to use
  - Analyze dew point graphs for the selected space over time in eClimateNotebook® (www.eClimateNotebook.com) to determine the expected dew point. Use this dew point with the selected temperature to find the potential relative humidity for the space.
- Verify the hours of operation and staff work schedule for the facility
- Notify all staff of after-hours temperature adjustments

System Notes

- Be sure to set start and end dates if the use of seasonal setbacks is necessary
  - One helpful method may be to look at your outdoor data in eClimateNotebook® (www.eClimateNotebook.com) and identify the seasonal transition points
- Verify the type of system that serves your space
  - If the AHU operates as a subcool/reheat arrangement, be careful of the misconception that turning the temperature up in the summertime in a space means you are using less energy. With sub-cool and reheat systems, turning the heat up in the summer will use more energy.

Selection Criteria/Variables That Impact Potential

- Outdoor Climate
    - Take advantage of cooler outside temperatures by employing passive methods to let the space temperature drop naturally
- Building Envelope
    - Infiltration of outside air near doors, windows, open plenum returns, stairwells, etc. may produce microclimates causing the temperature in some areas to drop lower than desired and could impact the relative humidity levels
- Occupancy
    - Staff who work after hours may have comfort complaints due to the different temperatures in a space
    - Communicate the experimental process clearly to all staff in the AHU zone to be tested
        - Complaints to facility managers may result in unforeseen adjustments
        - Test results may be skewed if facility mangers or staff members alter space temperatures due to comfort complaints
- Space Load
    - Ensure that staff are not using independent space heaters that can be left on and may provide false readings or add extra heat to the space
- Power
    - Verify that in the event of a power outage, system operation is restored and the system is working properly

Setback Experimentation (Test) and Implementation

PREPARATION

- Complete documentation, data gathering, and analysis steps for the system/spaces in being evaluated
- Use the selection criteria above to review whether the system/space is a good candidate for setback testing
- Confirm that appropriate data gathering capabilities are deployed, determine who will pull and check data, and how often. The frequency of data pulls and analysis is up to the institution and is based on staff scheduling and the level of risk management desired for a particular collection space. Common approaches include:
    - A daily walk-through of the space to be sure that set points are being held

        - Weekly data pulls from loggers to analyze data
- Determine test parameters
    - Occupied space setbacks
        - Avoid testing setbacks during occupied hours.
        - Occupied spaces are limited in the amount of temperature setback possibilities due to use. Set points should be selected that consider human comfort as well as collection risks.
    - Unoccupied space seasonal set point changes
        - Unoccupied spaces benefit from the ability to lower the temperature significantly compared to occupied spaces. When evaluating unoccupied spaces, the most significant factor may be the relative humidity level.
        - Be sure that the temperature you are using produces a safe relative humidity.
    - Length of setback test
        - Set a start and end date for the test period.
        - The set points for a setback can be introduced at any time of the year. However, separate setback set points may be needed for the winter and the summer seasons
        - Typically an initial test should be allowed to run for two weeks. Environments can respond differently based on outdoor weather conditions and two weeks is a reasonable compromise between gathering a representative sample set for a season and limiting any long-term risk.
- Communicate the setback changes to collections and facilities staff responsible for managing the areas involved.
    - Discuss the potential impact on human comfort in the space
        - If the setbacks will occur in occupied spaces be sure all staff are aware of the changes and that they can plan accordingly
        - Be sure staff do not use alternative methods of heating during the testing period
        - Set up a communication structure during the test period for any environmental complaints or work-orders associated with comfort or temperature complaints
    - Finalize start and end date for the test period and make sure that they fit with departmental needs

ON THE TEST START DATE

- Facilities staff should physically confirm that the system has switched over to the setback set points
- Facilities staff should notify team members on the day that the testing starts
- Collections staff should notify other staff members on the day that the testing starts

DURING THE TEST PERIOD

- Facilities staff should be sure to forward any comfort complaint calls to the facilities team representative
- Collections staff should conduct daily walk-throughs of test space and check space dataloggers for deviation from set point range.
- Follow schedule for data retrieval from space and mechanical systems
- Facilities staff should conduct regular checks of BMS for alterations in system operation
- First data retrieval as per test schedule
    - Look for evidence of setbacks in data from both the space and mechanical system dataloggers
        - If setbacks do not appear to be employed, work with facilities staff and/or controls technicians to find and resolve the problem
    - Evaluate results of test setbacks
- If the results of the initial test are acceptable, continue the setback test protocol until the end date

AT THE END OF THE TEST PERIOD

- Conduct a final walk-through of systems and spaces
- Retrieve and upload data from space and mechanical system dataloggers
- Conduct final analysis of the test data as a team
- Meet with collections and facilities staff that manage the area to discuss any observations on their part during the test period and communicate the results of the final data analysis to them
- Results of analysis will determine the next step:
    - If test results were favorable
        - Continue using the conditions through the season
        - Consider testing with cooler conditions
    - If test results were not favorable
        - Consider altering the test in some manner (raising/lowering the desired temperature) to achieve more acceptable results
- If testing of all strategies for that AHU is complete, remove mechanical system dataloggers and reset them to be used in experimentation for other systems
- Compile, quantify, and report test results to appropriate administrative staff

Once a team has determined a setback, procedure should be adopted on a schedule to follow, and the set points to use, the process enters the implementation/maintenance phase. At this point, the team should be satisfied that

they have tested the potential variants of temperature and relative humidity set points allowable, and have chosen the best operation for the needs of both preservation and energy savings.

Implementation/Maintenance

- If the team has determined that using setbacks is desirable be sure to agree on solid start and end dates for the use of seasonal setbacks before implementation
- If possible, add setbacks to the schedule for the AHU, both in programming and in any written documentation
- Be sure to add setback changes to the facility calendar and the collections calendar as a reminder to verify the implementation of winter setback set points and return to summer setbacks set points

Evaluating Test Results

SPACE DATA

- **Temperature** – Look for day/night curves that match the setback schedule. Changes should match the designed setback set points and schedule.
- **Relative Humidity** – Unless a serious moisture incursion significantly raises the dew point, the relative humidity typically does one of two things during the setback – the RH either moves slightly, inversed to temperature changes, or it remains steady as a result of the collection releasing or taking on moisture due to the ambient temperature change.
    - Research conducted by IPI has shown that the moisture equilibration rates (for full equilibration at the core of an object) for many hygroscopic materials found in libraries and archives are relatively slow, and may take weeks for materials to fully equilibrate to a one-time RH change in the ambient environment. Material surfaces will equilibrate faster and significant RH changes (again, typically due to dew point fluctuation) may cause mechanical change to sensitive media.
- **Dew Point** – Any fluctuations in dew point as a result of the setback typically indicate a moisture incursion in the space that is independent of any moisture brought in through the outside air intakes (assuming that the outside air intake successfully closes during the setback). If more than a 1-2°F variation in dew point is observed as part of the testing, team members should inspect the space and building envelope for sources of moisture or outside moisture intrusion.

MECHANICAL SYSTEM DATA

- **Supply Air** – Use the datalogger in the supply air to provide the clearest "air" illustration for confirmation of the setbacks. During normal operation, the system provides conditioned air to spaces downstream, while during setbacks, the condition of supply air should alter either warmer or cooler depending on the experimental set point.

REMINDERS FOR MAXIMIZING EFFECTIVENESS

Be sure to fully inform staff:

- Not to adjust the temperature due to comfort issues in occupied spaces
- To dress for lower temperatures in unoccupied spaces

System Setback Sheet for Zone/AHU#

[Organization Name]

Collection Staff:
Facilities Staff:

Logger Placement: Mech System Collection Space

Mechanical System Logger Locations:

Is System Capable of Daily Setbacks
YES NO

Outside Air/Preheated Air Cooled Air Downstream Reheat
Heated Air Supply Air Return Air Other_____
Mixed Air

2 Week Test

Date	Normal Temp/RH	Setback Temp/Rh	Duration	Recovery Time	Other Changes Made to the System	Notes

Daily Walk-through Log: Check if System and Space are Following Setback Schedule

Mon	Tues	Wed	Thurs	Fri	Sat/Sun

Daily Log: Verify That the Space and System Return to Normal Operation

Mon	Tues	Wed	Thurs	Fri	Sat/Sun

Daily Check of the BMS System:

Mon	Tues	Wed	Thurs	Fri	Sat/Sun

Weekly Data Pull

Post Tests:

Did Setbacks Occur as Planned: Yes No

Did Space Temperature Return to Normal: Yes No

NOTES: