

Implementation Table

Category	DR Strategy	Definition	A	B	C	D
Zone control	Global temperature adjustment	Increase zone temperature setpoints for an entire facility	X	X	X	X
	Passive thermal mass storage	Decrease zone temperature setpoints prior to DR operation to store cooling energy in the building mass, and increase zone setpoints to unload fan and cooling system during DR.	X	X	X	X
Air distribution	Duct static pressure decrease	Decrease duct static pressure setpoints to reduce fan power.		X		X
	Fan variable frequency drive limit	Limit or decrease fan variable frequency drive speeds or inlet guide vane positions to reduce fan power.		X		X
	Supply air temperature increase	Increase SAT setpoints to reduce cooling load.	X	X	X	X
	Fan quantity reduction	Shut off some of multiple fans or package units to reduce fan and cooling loads.	X	X	X	X
	Cooling valve limit	Limit or reduce cooling valve positions to reduce cooling loads.	X	X		
Central plant	Chilled water temperature increase	Increase chilled water temperature to improve chiller efficiency and reduce cooling load.	X	X		
	Chiller demand limit	Limit or reduce chiller demand or capacity.	X	X		
	Chiller quantity Reduction	Shut off some of multiple chiller units.	X	X	*	*
Rebound avoidance	Slow recovery	Slowly restore HVAC control parameters modified by DR strategies.	**	**	**	**
	Sequential equipment recovery	Restore HVAC control to equipment sequentially within a certain time interval.	**	**	**	**
	Extended DR control Period	Extend DR control period until after the occupancy period.	**	**	**	**

* The strategy can be applied to package systems by reducing shutting off some of the compressors.

** Applicability of rebound avoidance strategies is determined by the DR strategies selected.

Global Temperature Adjustment

Definition	Increase zone temperature setpoints for an entire facility.
HVAC type	All
Target loads	Air distribution, cooling
Category	Demand shed
System applicability	1. DDC zone control 2a. Global temperature adjustment (GTA) capability at zone level, or 2b. Capability to program GTA at each VAV box.
Sequence of operation	Option 1: Absolute setpoint adjustment Globally adjust (increase) all zone cooling setpoints to a common value (e.g. 76°F), T_c °F Globally adjust (decrease) or leave unchanged all zone heating setpoints to a common value (e.g. 68°F), T_h °F (T_c : DR mode cooling setpoint, T_h : DR mode heating setpoint)
	Option 2: Relative setpoint adjustment Globally adjust (increase) all zone cooling setpoints by a common differential temperature from their prior setpoint (e.g. 2°F), T_c °F Globally adjust (decrease) or leave unchanged all zone heating setpoints by a common differential temperature from their prior setpoint (e.g. 2°F), T_h °F (T_c : DR mode cooling setpoint, T_h : DR mode heating setpoint)
EE potential	Some occupants may be more comfortable during DR events. This would indicate making permanent changes to the setpoints.
Rebound	Rebound avoidance strategy required.
Cautions	Adjust zone temperature setpoints in multiple steps if a long shed duration is required.
Applied sites	15 office buildings, 6 retail stores, 2 laboratory facilities, 2 schools, 1 manufacturing facility, 1 museum, 1 archive storage, 1 detention facility

Supply Air Temperature Increase

Definition	Increase supply air temperature (SAT) setpoints to reduce cooling load.
HVAC type	A (CAV-Central), C (CAV-Package) (B (VAV-Central), D (VAV-Package with additional measures)
Target loads	Cooling. May increase air distribution load slightly.
Category	Demand shed
System requirement	1. Applicable to all zone control systems including pneumatic and DDC without GTA feature. 2. DDC for air handling unit
Sequence of operation	Increase supply air temperature (SAT) by X °F. For VAV, lock fan VFD or IGv at the position prior to DR operation.
EE potential	If the building has a large reheat load, this strategy will save reheat energy.
Rebound	Rebound avoidance strategy required.
Caution	For a VAV system, cooling demand shed will not be achieved until some VAV boxes begin to starve. It is hard to predict the SAT increase that will result in demand savings. A series of tests is recommended prior to actual implementation.
Applied sites	4 office buildings, 2 laboratory facilities

Chilled Water Temperature Increase

Definition	Increase chilled water temperature to reduce cooling load.
HVAC type	A (CAV-Central), B (VAV-Central)
Target load	Chiller demand
Category	Demand shed
System applicability	DDC for central plant
Sequence of operation	Increase chilled water supply temperature by X °F. VAV system: Lock fan VFD or IGV in position prior to curtailment.
EE potential	Raising chilled water temperature increases chiller efficiency. Until the AHU loses control of the SAT setpoints, total HVAC power can be reduced without a reduction in service.
Rebound	Rebound avoidance strategy required.
Caution	For cooling load savings, lock the fan VFD or IGV in position to prevent the fans from speeding up. If the chilled water temperature setpoints are already optimized properly, a chilled water temperature increase strategy may cause inefficient operation.
Applied sites	3 office buildings

Cooling Valve Limit

Definition	Limit or reduce cooling valve positions to reduce cooling load.
HVAC type	A (CAV-Central), B (VAV-Central with additional measures)
Target loads	Chiller demand. Chilled water pump demand if variable speed drive (VFD) pump.
Category	Demand shed
System requirement	1. DDC for air distribution 2. Chilled water temperature setpoint is not optimized by feedback from zones or fans.
Sequence of operation	Option 1: Cooling valve limit Limit cooling valve position to X% open.
	Option 2: Cooling valve position reduction Limit cooling valve position to ΔX % lower than A%. (A%: cooling valve percentage open prior to a curtailment)
	VAV system: Limit supply fan VFD or IGV at the position prior to a curtailment.
EE potential	None
Rebound	Rebound avoidance strategy required.
Caution	Cooling valve limit must not be set lower than the threshold to shut off chiller operation. For cooling load savings, lock the supply fan VFD or IGV in position to prevent the fans from speeding up.
Applied sites	2 office buildings, 1 library

Duct Static Pressure Decrease

Definition	Decrease duct static pressure (DSP) setpoints to reduce fan power.
HVAC type	B (VAV-Central), D (VAV-Package)
Target loads	Air distribution, cooling (occasionally)
Category	Demand shed
System applicability	1. All zone control systems including pneumatic and DDC 2. DDC for air handling unit
Sequence of operation	Lower DSP setpoints by X%.
EE potential	Tuning DSP setpoints can save fan power consistently without a reduction in service.
Rebound	Rebound avoidance strategy required.
Cautions	Less airflow for some zones that may cause ventilation rates to drop below specified design levels.
Applied sites	5 office buildings, 1 library

Chiller Demand Limits

Definition	Limit or reduce chiller demand or capacity.
HVAC type	A (CAV-Central), B (VAV-Central)
Target loads	Cooling
Category	Demand shed
System applicability	1. DDC for central plant 2. Chiller demand limit or capacity limit is available. 3. For VAV system, DDC for air distribution
Sequence of operation	Option 1: Chiller demand limit Limit chiller demand at X%
	Option 2: Chiller demand reduction Limit chiller demand at ΔX % lower than the demand provided by the cooling valve position of the pre-DR mode
	Prevent offline chillers from starting up to make up the reduced cooling load. VFD pumps: Limit chilled water pump speed to that prior to curtailment. VAV systems: Limit fan VFD% speed to that prior to curtailment.
EE potential	None
Rebound	Rebound avoidance strategy required.
Caution	Severe reduction of cooling may occur if large percent of demand limit is applied. Impact on zone temperatures is hard to predict. . For demand savings, lock the pump speed at the state prior to DR. In VAV systems, lock the fan VFD or IGV in position to prevent the fans from speeding up.
Applied sites	1 distribution center

Definition	Shut off some of multiple chiller units.
HVAC type	A (CAV-Central), B (VAV-Central)
Target loads	Cooling
Category	Demand shed
System requirement	Central plant with multiple chillers
Sequence of operation	Shut off some operating chillers. Prevent offline chillers from starting up to make up the reduced cooling load. VFD pumps: Limit chilled water pump speed to that prior to curtailment. VAV systems: Limit fan VFD% speed to that prior to curtailment.
EE potential	None
Rebound	Rebound avoidance strategy required.
Caution	Remaining chillers may run at lower efficiency if they begin to run at full-load, which may result in a net demand increase. Impact on zone temperatures is hard to predict. For demand savings, lock the pump speed at the state prior to DR. In VAV systems, lock the fan VFD or IGV in position to prevent the fans from speeding up.
Applied sites	None

Fan VFD Limit

Definition	Limit or decrease fan variable frequency drive (VFD) speed or change position of IGV) to reduce fan power.
HVAC type	B (VAV-Central), D (VAV-Package)
Target loads	Air distribution, cooling (occasionally)
Category	Demand shed
System applicability	<ol style="list-style-type: none"> 1. Applicable to all zone control systems including pneumatic and DDC without GTA feature. 2. DDC for air handling unit 3. Supply fans have VFD or IGV.
Sequence of operation	Option 1: VFD limit (absolute) Limit supply fan VFD to X% of normal condition, or limit IGV opening to provide the same result.
	Option 2: VFD reduction (relative) Limit supply fan VFD at $\Delta X\%$ lower than A% (pre-DR mode), or limit IGV opening to provide the same result.
EE potential	If DSP setpoints are set too high, the VFD limit will decrease DSP and save fan power without reduction in service.
Rebound	Rebound avoidance strategy required.
Caution	Less airflow for some zones that may cause ventilation rates to drop below specified design levels.
Applied sites	2 office buildings, 1 library

Fan Quantity Reduction

Definition	Shut off some of multiple fans or direct expansion units to reduce fan and cooling load.
HVAC type	A (CAV-Central), C (CAV-Package)
Target loads	Air distribution, cooling
Category	Demand shed
System requirement	1. Open floor space with multiple air handling or package units, or 2. Multi-fan single-duct system where GTA feature is not available.
Sequence of operation	Shutdown part of multiple supply fans or package units. Multiple CAV fans: Prevent any offline fans from starting up to make up the shut-off load. VFD fans: Limit VFD% of remaining supply fans at the position prior to curtailment.
EE potential	None
Rebound	Rebound avoidance strategy required.
Caution	Significant reduction of airflow is expected if the building has only few fans in the system. Make sure that the remaining fans can supply the required airflow to all zones. Low airflow can cause the pollutant level to rise in the conditioned space.
Applied sites	4 office buildings, 1 retail store

Turn Off Lights in Specific Zones

Definition	Switching off luminaires in an entire zone.
Lamp type	Any (except high-intensity discharge (HID) lamps if full light output is needed when lights are turned back on).
System applicability	Availability of daylighting in affected zones. Separate zoning of luminaires in common spaces such as a lobby, corridor, or cafeteria.
Sequence of operation	Switch off lighting in an entire zone.
Target loads	Lighting. May decrease cooling load and/or increase heating load.
Category	Demand shed
EE potential	None
Rebound	Rebound avoidance strategy required for all lamps, especially HID lamps.
Cautions	Visible, may disrupt work. Do not use in high-security areas.
Applied sites	3 office buildings

Definition	Luminaire Switching: Switching off a percentage of luminaires. Lamp Switching: Switching off various fractions (e.g. one-half, one-third, two-thirds) of lamps within a luminaire.
Lamp type	Fluorescent or incandescent
System applicability	Wiring and circuiting of fixtures that allow for separate luminaire or lamp switching
Sequence of operation	Switch off a portion of the luminaires or lamps in luminaires.
Target load	Lighting. May decrease cooling load and/or increase heating load.
Category	Demand shed
EE potential	None.
Rebound	No capability for slow recovery.
Caution	Visible, may disrupt work.
Applied sites	2 retail stores

Dimmable Ballasts

Definition	Dimming lamps using dimmable ballasts.
Lamp type	Fluorescent, HID
System applicability	Dimmable ballasts
Sequence of operation	1. Absolute reduction: Dim to a preset level, or 2. Relative reduction: Dim a certain percent of the current light level.
Target load	Lighting. May decrease cooling load and/or increase heating load.
Category	Demand shed
EE potential	Fully utilize daylighting where applicable.
Rebound	May want to come gradually back to full light level to avoid disturbing the visual environment.
Caution	Design according to ballast dimming capability (some ballasts do not dim below a certain light level).
Applied sites	3 office buildings

Stepped or Bi-Level Lighting Controls

Definition	Dimming a fixture in discrete steps using lamp switching
Lamp type	Fluorescent, incandescent
System applicability	Fixture wiring that allows for two or three lighting levels.
Sequence of operation	Switch off a portion of the lamps in luminaires.
Target load	Lighting. May decrease cooling load and/or increase heating load.
Category	Demand shed
EE potential	Only when replacing existing fixtures that do not have dimming ballasts
Rebound	No capability for slow recovery. Stepping up the lighting level to recover the original level may be even more disruptive to occupants than switching immediately back to the original level.
Caution	Visible, may disrupt work.
Applied sites	None.

Addressing Miscellaneous Equipment

- Fountain pumps
- Anti-sweat heaters
- Electric vehicle chargers
- Industrial process loads
- Cold storage
- Elevator cycling
- Irrigation water pumps

Demand Limit Strategy

- Many advanced EMCS have the capability to minimize the whole building peak demand from exceeding a pre-specified peak demand limit. **Demand limit strategy** is a supervisory control algorithm that manages a combination of single or multiple DR control strategies.
 - When the whole building demand exceeds a warning level, the EMCS deploys strategy #1. If the whole building demand still exceeds the warning level, strategy #2 is deployed, and so on. Thus, whenever the demand hits the warning level, the whole building demand is suppressed by a combination of sequential strategies.
 - Strategies that have a lower impact on occupants' comfort should come first, and strategies that have more impact should come later.
- If the EMCS has a function to develop dynamic demand limit set-points based on the baseline, the demand limit target can be set as shown below, so that the desired demand savings can always be achieved.

$$[Demand\ limit\ target] = [Baseline] - [Desired\ demand\ savings]$$

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