**Workpaper: WPSCNRHC0039 Central Plant VFDs**

**2011 Discussion (with SCE Comments in Blue)**

* Provide more detailed description of the customer average, code baseline and measure performance characteristics. Using the chilled water VFD as an example: What is the performance of the customer average pumping system? Is it a variable flow system or constant flow system? If constant flow, does the measure include adding control valves at each coil to make the entire system variable flow? If it’s a variable flow system, how is the primary flow controlled (bypass, throttling, or something else).

The measure is appropriate for constant speed systems only. For chilled water pumping, all but vintage 07 is constant volume pumping in the baseline. The measure does add two-way valves to each coil to make the system variable flow. For the cooling towers, the 03 and 07 vintages had 2-speed fans; hence the savings is considerably reduced over the earlier vintages that had single-speed fans. The tables provided below were removed from an earlier draft and supply details on baseline and measure performance.

.

|  |  |  |  |
| --- | --- | --- | --- |
| **Measure** | | | |
| **Vintage(s)** | **Keyword** | **Baseline Design Value** | **Measure Design Value** |
| **CHW  Loop Pump EEM** | | | |
| 75,85,96,03 | CHW Loop Flow | Constant | Variable |
| 75,85,96,03 | Loop Pump Control | None | Variable Speed Drive |
| 07 | CHW Loop Flow | Variable | Variable |
| 07 | Loop Pump Control | VSD | Variable Speed Drive |
| **Chiller Plant Tower Fan EEM** | | | |
| 75,85,96 | Capacity Control | One-Speed Fan | Variable Speed Fan |
| 03,07 | Capacity Control | Two-Speed Fan | Variable Speed Fan |

|  |  |  |  |
| --- | --- | --- | --- |
| **Measure** | | | |
| **Vintage(s)** | **Keyword** | **Baseline Design Value** | **Measure Design Value** |
| **CHW  Loop Pump EEM** | | | |
| 85 | CHW Loop CAP-CTRL | One-Speed Pump | Variable-Speed Pump |
| 85 | CHW-VALVE-TYPE | Three-Way Valve | Two-Way Valve |
| **Chiller Plant Tower Fan EEM** | | | |
| 85 | CAPACITY-CTRL | One-Speed Fan | Variable Speed Fan |

* DEER values must be used for measures whose complete descriptions (customer average plus code baseline plus measure) match those in DEER. If the only purpose of the workpaper measure is to develop new normalizing units, then the measures should be rerun using the DEER 2005 MASTool and the appropriate results retrieved to establish new normalizing units.

We do not believe for either measure the complete description matches the DEER description. For example in the installation of a VFD on cooling tower fans, the baseline is constant volume for older vintages and speed for newer vintages. The DEER measure replaces single speed tower fans with 2 speed fans, and replaces 2 speed fans with variable speed fans. For the addition of a VFD to the chilled water loop pump, the DEER baseline includes 2 way valves where this paper includes 3 way valves in the baseline.

* For each measure, provide sample inputs for building types with different system types. These should include one set of simulations for each measure and building type and include sizing, customer average, code baseline and measure simulations.

For the tower fan VFD, the following changes were made:

**Baseline**

$ ---------------------------------------------------------

$ Heat Rejection

$ ---------------------------------------------------------

"Open Tower" = HEAT-REJECTION

TYPE = OPEN-TWR

NUMBER-OF-CELLS = 1

ELEC-INPUT-RATIO = 0.01055

CAPACITY-CTRL = ONE-SPEED-FAN

**Cooling Tower Fan VFD EEM**

$ ---------------------------------------------------------

$ Heat Rejection

$ ---------------------------------------------------------

"Open Tower" = HEAT-REJECTION

TYPE = OPEN-TWR

NUMBER-OF-CELLS = 1

ELEC-INPUT-RATIO = 0.01055

CAPACITY-CTRL = VARIABLE-SPEED-FAN

For the chilled water loop VFD, the following changes were made:

**Baseline**

$ ---------------------------------------------------------

$ Pumps

$ ---------------------------------------------------------

"CHW Loop Pump" = PUMP

NUMBER = 1

MOTOR-CLASS = HI-EFF

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

..

"HW Loop Pump" = PUMP

NUMBER = 1

MOTOR-CLASS = HI-EFF

..

"DHW System Loop Pump (1)" = PUMP

MOTOR-CLASS = HI-EFF

..

"Chlr1 (ElCentHerm) Pump" = PUMP

MOTOR-EFF = 1

..

"Chlr1 (ElCentHerm) CW Pmp" = PUMP

MOTOR-CLASS = HI-EFF

..

"Boiler1 (HWNatDrft) Pump" = PUMP

MOTOR-CLASS = HI-EFF

**Chilled water pump VFD EEM**

$ ---------------------------------------------------------

$ Pumps

$ ---------------------------------------------------------

"CHW Loop Pump" = PUMP

NUMBER = 1

MOTOR-CLASS = HI-EFF

CAP-CTRL = VAR-SPEED-PUMP

..

"HW Loop Pump" = PUMP

NUMBER = 1

MOTOR-CLASS = HI-EFF

..

"DHW System Loop Pump (1)" = PUMP

MOTOR-CLASS = HI-EFF

..

"Chlr1 (ElCentHerm) Pump" = PUMP

MOTOR-EFF = 1

CAP-CTRL = ONE-SPEED-PUMP

..

"Chlr1 (ElCentHerm) CW Pmp" = PUMP

MOTOR-CLASS = HI-EFF

..

"Boiler1 (HWNatDrft) Pump" = PUMP

MOTOR-CLASS = HI-EFF

..

$ \*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

$ \*\* \*\*

$ \*\* HVAC Systems / Zones \*\*

$ \*\* \*\*

$ \*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

"EL1 Sys1 (VAVS) (G)" = SYSTEM

TYPE = VAVS

HEAT-SOURCE = NONE

ZONE-HEAT-SOURCE = HOT-WATER

BASEBOARD-SOURCE = NONE

SIZING-RATIO = 1.3

COOL-SIZING-RATI = 0.930769

RETURN-AIR-PATH = PLENUM-ZONES

MAX-SUPPLY-T = 95

MIN-SUPPLY-T = 56

COOL-RESET-SCH = "S1 EL1 Sys1 (VAVS) (G) CRS"

COOL-CONTROL = RESET

ECONO-LIMIT-T = 70

MIN-AIR-SCH = "S1 Sys1 (VAVS) MinOA Sch"

OA-CONTROL = OA-TEMP

DUCT-AIR-LOSS = 0

DUCT-DT = 2

FAN-SCHEDULE = "S1 Sys1 (VAVS) Fan Sch"

FAN-CONTROL = FAN-EIR-FPLR

SUPPLY-STATIC = 3.5

SUPPLY-EFF = 0.63

RETURN-STATIC = 1.16667

RETURN-EFF = 0.63

NIGHT-CYCLE-CTRL = CYCLE-ON-ANY

FAN-EIR-FPLR = "ForCurve w Inlet Vanes FPLR"

RETURN-FAN-CONTR = FAN-EIR-FPLR

RETURN-EIR-FPLR = "ForCurve w Dischrg Dampers FPLR"

REHEAT-DELTA-T = 39

HW-LOOP = "EL1 HW 2-Lp Sys1 (G)"

CHW-LOOP = "EL1 CHW 2-Lp Sys1 (G)"

FURNACE-HIR = 1.24067

DUCT-AIR-LOSS-OA = 0

DUCT-ZONE = "EL1 Pl Zn (G.6)"

$ \*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

$ \*\* \*\*

$ \*\* HVAC Systems / Zones \*\*

$ \*\* \*\*

$ \*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

"EL1 Sys1 (VAVS) (G)" = SYSTEM

TYPE = VAVS

HEAT-SOURCE = NONE

ZONE-HEAT-SOURCE = HOT-WATER

BASEBOARD-SOURCE = NONE

SIZING-RATIO = 1.3

COOL-SIZING-RATI = 0.930769

RETURN-AIR-PATH = PLENUM-ZONES

MAX-SUPPLY-T = 95

MIN-SUPPLY-T = 56

COOL-RESET-SCH = "S1 EL1 Sys1 (VAVS) (G) CRS"

COOL-CONTROL = RESET

ECONO-LIMIT-T = 70

MIN-AIR-SCH = "S1 Sys1 (VAVS) MinOA Sch"

OA-CONTROL = OA-TEMP

DUCT-AIR-LOSS = 0

DUCT-DT = 2

FAN-SCHEDULE = "S1 Sys1 (VAVS) Fan Sch"

FAN-CONTROL = FAN-EIR-FPLR

SUPPLY-STATIC = 3.5

SUPPLY-EFF = 0.63

RETURN-STATIC = 1.16667

RETURN-EFF = 0.63

NIGHT-CYCLE-CTRL = CYCLE-ON-ANY

FAN-EIR-FPLR = "ForCurve w Inlet Vanes FPLR"

RETURN-FAN-CONTR = FAN-EIR-FPLR

RETURN-EIR-FPLR = "ForCurve w Dischrg Dampers FPLR"

REHEAT-DELTA-T = 39

HW-LOOP = "EL1 HW 2-Lp Sys1 (G)"

CHW-VALVE-TYPE = TWO-WAY

CHW-LOOP = "EL1 CHW 2-Lp Sys1 (G)"

FURNACE-HIR = 1.24067

DUCT-AIR-LOSS-OA = 0

DUCT-ZONE = "EL1 Pl Zn (G.6)"

* ED is concerned about the selection of the refrigerated warehouse as the representative prototype for the proposed Transportation-Communication-Utilities building type. The refrigerated warehouse prototype is purpose specific prototype developed for use in the refrigeration version of DOE-2.2. It is not clear how the proposed building type is even related to the DEER prototype. ED’s initial response is to reject his new building type and require measures for non-DEER building types to use the custom measure process.

The Transportation-Communication-Utilities building is a difficult building to represent with other building types. The refrigerated warehouse was chosen as the closest for this measure because of the 24 hour operation. That said there are many differences as well and using the custom process is reasonable.