

ASHRAE Standard 140-2023

Test Results Comparison for Section 9 - HVAC Equipment Performance Tests CE300 through CE545

Results for TRNSYS18.06.0002
(TRNSYS)
vs.
Informative Annex B16, Section B16.5.2 Example Results

Prepared By
Thermal Energy System Specialists, LLC
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Results Developed
19-Aug-2024

ASHRAE Standard 140-2023
Participating Organizations and Computer Programs for
Quasi-analytical Solutions and Example Simulation Results
Section 9 - HVAC Equipment Performance Tests CE300 through CE545

The quasi-analytical solutions and programs used to generate the example simulation results are described in Table B17-2. The first column of Table B17-2 ("Model"), indicates the proper program name and version number, or indicates a quasi-analytical solution.

The second column ("Authoring Organization") indicates the national research facility, university, or industry organization with expertise in building science that wrote the simulation software or did the quasi-analytical solutions.

The third column ("Implemented By") indicates the national research facility, university, or industry organization with expertise in building science that performed the simulations or did the quasi-analytical solutions.

The entries in the fourth column are the abbreviations for the simulations and quasi-analytical solutions generally used in the tables and charts which follow.

See Standard 140, Annex B17 for further details.

TABLE B17-2
Participating Organizations and Computer Programs

| Model | Authoring Organization | Implemented By | Abbreviation |
|--|---|---|-----------------------------|
| CODYRUN/LGIMAT | Université de la Reunion Island, France | Université de la Reunion Island, France | CODYRUN/UR |
| DOE-2.1E version 120 (ESTSC release) | LANL/LBNL/ESTSC/JJH, ^{a,b,c,d} United States | NREL/JNA, ^e United States | DOE-2.1E-E/NREL DOE21E-E |
| DOE-2.2 NT42j | LBNL/JJH, ^{b,d} United States | NREL/JNA, ^e United States | DOE-2.2/NREL |
| EnergyPlus 1.1.0.020 | LBNL/UIUC/CERL/OSU/GARD Analytics/FSEC/DOE-BT, ^{b,f,g,h,i,j} United States | GARD Analytics, United States | EnergyPlus/GARD |
| HOT3000/ESP-r | CETC/ESRU, ^{k,l} Canada/United Kingdom | CETC, ^k Canada | HOT3000/NRCan |
| TRNSYS 14.2-TUD with real controller model | University of Wisconsin, USA; Technische Universität Dresden, Germany | Technische Universität Dresden, Germany | TRNSYS/TUD |

^aLANL: Los Alamos National Laboratory, United States

^bLBNL: Lawrence Berkeley National Laboratory, United States

^cESTSC: Energy Science and Technology Software Center (at Oak Ridge National Laboratory), United States

^dJJH: James J. Hirsch & Associates, United States

^eNREL/JNA: National Renewable Energy Laboratory/J. Neymark & Associates, United States

^fUIUC: University of Illinois Urbana/Champaign, United States

^gCERL: U.S. Army Corps of Engineers, Construction Engineering Research Laboratories, United States

^hOSU: Oklahoma State University, United States

ⁱFSEC: University of Central Florida, Florida Solar Energy Center, United States

^jDOE-BT: U.S. Department of Energy, Office of Building Technologies, Energy Efficiency and Renewable Energy, United States

^kCETC: CANMET Energy Technology Centre, Natural Resources Canada, Canada

^lESRU: Energy Systems Research Unit, University of Strathclyde, Scotland, United Kingdom

**ASHRAE Standard 140-2023 Section 9 - HVAC Equipment Performance Tests CE300-CE545
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Note: The statistics in the tables below are based on the Standard 140 informative example results.
These statistics do not have any substantial importance and are not to be interpreted as acceptance criteria.

Table B16.5.2-1. Annual Space Cooling Electricity Consumption (Total, Compressor)

| Energy Consumption, Total (kWh,e) | | | | | | | Statistics, All Results | | | | TRNSYS TESS |
|-----------------------------------|---------------|-----------------|------------------|--------------------|---------------|------------------|-------------------------|-------|-------|---------------------|----------------|
| Case | TRNSYS TUD | DOE-2.2 NREL | DOE21E-E NREL | EnergyPlus GARD | CODYRUN UR | HOT3000 NRCan | Min | Max | Mean | (Max-Min) /Mean* | |
| CE300 | 35634 | 34750 | 34755 | 34746 | 34976 | 35070 | 34746 | 35634 | 34988 | 2.5% | 35120 |
| CE310 | 39973 | 39379 | 39384 | 39290 | 39520 | 39608 | 39290 | 39973 | 39526 | 1.7% | 39586 |
| CE320 | 40060 | 38745 | 38792 | 39079 | 39401 | 39457 | 38745 | 40060 | 39256 | 3.3% | 39666 |
| CE330 | 40963 | 39708 | 39438 | 40143 | 40535 | 40330 | 39438 | 40963 | 40186 | 3.8% | 40600 |
| CE340 | 40619 | 39358 | 39265 | 39783 | 40065 | 39947 | 39265 | 40619 | 39840 | 3.4% | 40286 |
| CE350 | 32237 | 30547 | 30548 | 31145 | 31587 | 31742 | 30547 | 32237 | 31301 | 5.4% | 31801 |
| CE360 | 55299 | 54064 | 54016 | 54705 | 54843 | 55068 | 54016 | 55299 | 54666 | 2.3% | 55141 |
| CE400 | 32045 | 30846 | 30876 | 31013 | | 31413 | 30846 | 32045 | 31239 | 3.8% | 31852 |
| CE410 | 32078 | 31668 | 31699 | | | 31503 | 31503 | 32078 | 31737 | 1.8% | 33597 |
| CE420 | 33387 | 32530 | 32910 | 32736 | | 33208 | 32530 | 33387 | 32954 | 2.6% | 33387 |
| CE430 | 32538 | 31932 | 31811 | 31772 | | 31818 | 31772 | 32538 | 31974 | 2.4% | 32608 |
| CE440 | 33691 | 33032 | 32973 | 33032 | | 33248 | 32973 | 33691 | 33195 | 2.2% | 33515 |
| CE500 | 22338 | 22817 | 22822 | 23035 | 22323 | 23138 | 22323 | 23138 | 22745 | 3.6% | 23251 |
| CE500 May-Sep | 17391 | 17872 | 17870 | 17996 | 17435 | 18051 | 17391 | 18051 | 17769 | 3.7% | 18164 |
| CE510 May-Sep | 34609 | 35971 | 35970 | 35732 | 34849 | 35845 | 34609 | 35971 | 35496 | 3.8% | 36013 |
| CE520 | 24987 | 25389 | 25390 | 25017 | 25131 | 25781 | 24987 | 25781 | 25282 | 3.1% | 26292 |
| CE522 | 23544 | 24293 | 24307 | 24078 | 23620 | 24360 | 23544 | 24360 | 24034 | 3.4% | 23567 |
| CE525 | 20321 | 20408 | 20421 | 20702 | 20242 | 21323 | 20242 | 21323 | 20569 | 5.3% | 21008 |
| CE530 | 17281 | 17540 | 17537 | 17742 | 17442 | 17875 | 17281 | 17875 | 17570 | 3.4% | 17181 |
| CE540 | 19430 | 19878 | 19874 | 19061 | 19537 | 20164 | 19061 | 20164 | 19657 | 5.6% | 19521 |
| CE545 | 15687 | 15802 | 15791 | 16636 | 15791 | 16339 | 15687 | 16636 | 16008 | 5.9% | 11571 |

| Energy Consumption, Compressor (kWh,e) | | | | | | | Statistics, All Results | | | | TRNSYS TESS |
|--|---------------|-----------------|------------------|--------------------|---------------|------------------|-------------------------|-------|-------|---------------------|----------------|
| Case | TRNSYS TUD | DOE-2.2 NREL | DOE21E-E NREL | EnergyPlus GARD | CODYRUN UR | HOT3000 NRCan | Min | Max | Mean | (Max-Min) /Mean* | |
| CE300 | 22354 | 21569 | 21573 | | 21770 | 21876 | 21569 | 22354 | 21828 | 3.6% | 21900 |
| CE310 | 26340 | 25813 | 25817 | | 25937 | 26053 | 25813 | 26340 | 25992 | 2.0% | 25994 |
| CE320 | 26433 | 25250 | 25294 | | 25846 | 25912 | 25250 | 26433 | 25747 | 4.6% | 26090 |
| CE330 | 27300 | 26172 | 25925 | | 26928 | 26775 | 25925 | 27300 | 26620 | 5.2% | 26988 |
| CE340 | 26963 | 25829 | 25745 | | 26473 | 26400 | 25745 | 26963 | 26282 | 4.6% | 26674 |
| CE350 | 19317 | 17802 | 17801 | | 18738 | 18891 | 17801 | 19317 | 18510 | 8.2% | 18931 |
| CE360 | 40106 | 38999 | 38955 | | 39697 | 39941 | 38955 | 40106 | 39540 | 2.9% | 39969 |
| CE400 | 19179 | 18106 | 18131 | | | 18629 | 18106 | 19179 | 18511 | 5.8% | 19007 |
| CE410 | 19204 | 18823 | 18850 | | | 18685 | 18685 | 19204 | 18891 | 2.8% | 20547 |
| CE420 | 20359 | 19596 | 19934 | | | 20214 | 19596 | 20359 | 20026 | 3.8% | 20361 |
| CE430 | 19599 | 19059 | 18951 | | | 18966 | 18951 | 19599 | 19144 | 3.4% | 19662 |
| CE440 | 20629 | 20042 | 19989 | | | 20249 | 19989 | 20629 | 20227 | 3.2% | 20474 |
| CE500 | 17854 | 18473 | 18478 | | 17858 | 18522 | 17854 | 18522 | 18237 | 3.7% | 18595 |
| CE500 May-Sep | 13942 | 14508 | 14506 | | 13989 | 14491 | 13942 | 14508 | 14287 | 4.0% | 14570 |
| CE510 May-Sep | 27748 | 28811 | 28810 | | 27902 | 28721 | 27748 | 28811 | 28398 | 3.7% | 28828 |
| CE520 | 19521 | 20121 | 20126 | | 19655 | 20185 | 19521 | 20185 | 19922 | 3.3% | 20562 |
| CE522 | 18620 | 19407 | 19418 | | 18690 | 19281 | 18620 | 19418 | 19083 | 4.2% | 18806 |
| CE525 | 16558 | 16880 | 16893 | | 16507 | 17443 | 16507 | 17443 | 16856 | 5.6% | 17137 |
| CE530 | 13657 | 14127 | 14124 | | 13856 | 14172 | 13657 | 14172 | 13987 | 3.7% | 13596 |
| CE540 | 15021 | 15680 | 15677 | | 15164 | 15664 | 15021 | 15680 | 15441 | 4.3% | 15110 |
| CE545 | 12622 | 12967 | 12957 | | 12751 | 13215 | 12622 | 13215 | 12902 | 4.6% | 9188 |

* ABS[(Max-Min) / (Mean of Example Simulation Results)]

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Note: The statistics in the tables below are based on the Standard 140 informative example results.
These statistics do not have any substantial importance and are not to be interpreted as acceptance criteria.

Table B16.5.2-2. Annual Space Cooling Electricity Consumption (Supply Fan, Condenser Fan)

| Energy Consumption, Supply Fan (kWh,e) | | | | | | | Statistics, All Results | | | | TRNSYS TESS |
|--|---------------|-----------------|------------------|--------------------|---------------|------------------|-------------------------|-------|-------|---------------------|----------------|
| Case | TRNSYS TUD | DOE-2.2 NREL | DOE21E-E NREL | EnergyPlus GARD | CODYRUN UR | HOT3000 NRCan | Min | Max | Mean | (Max-Min) /Mean* | |
| CE300 | 10880 | 10880 | 10880 | 10862 | 10880 | 10880 | 10862 | 10880 | 10877 | 0.2% | 10880 |
| CE310 | 10880 | 10880 | 10880 | 10862 | 10880 | 10880 | 10862 | 10880 | 10877 | 0.2% | 10880 |
| CE320 | 10880 | 10880 | 10880 | 10862 | 10880 | 10880 | 10862 | 10880 | 10877 | 0.2% | 10880 |
| CE330 | 10880 | 10880 | 10880 | 10862 | 10880 | 10880 | 10862 | 10880 | 10877 | 0.2% | 10880 |
| CE340 | 10880 | 10880 | 10880 | 10862 | 10880 | 10880 | 10862 | 10880 | 10877 | 0.2% | 10880 |
| CE350 | 10880 | 10880 | 10880 | 10862 | 10880 | 10880 | 10862 | 10880 | 10877 | 0.2% | 10880 |
| CE360 | 10880 | 10880 | 10880 | 10862 | 10880 | 10880 | 10862 | 10880 | 10877 | 0.2% | 10880 |
| CE400 | 10880 | 10880 | 10880 | 10862 | | 10880 | 10862 | 10880 | 10876 | 0.2% | 10880 |
| CE410 | 10880 | 10880 | 10880 | | | 10880 | 10880 | 10880 | 10880 | 0.0% | 10880 |
| CE420 | 10880 | 10880 | 10880 | 10862 | | 10880 | 10862 | 10880 | 10876 | 0.2% | 10880 |
| CE430 | 10880 | 10880 | 10880 | 10862 | | 10880 | 10862 | 10880 | 10876 | 0.2% | 10880 |
| CE440 | 10880 | 10880 | 10880 | 10862 | | 10880 | 10862 | 10880 | 10876 | 0.2% | 10880 |
| CE500 | 2564 | 2369 | 2369 | 2628 | 2553 | 2639 | 2369 | 2639 | 2520 | 10.7% | 2662 |
| CE500 May-Sep | 1972 | 1837 | 1837 | 2029 | 1970 | 2035 | 1837 | 2035 | 1947 | 10.2% | 2055 |
| CE510 May-Sep | 3923 | 4099 | 4099 | 4063 | 3972 | 4073 | 3923 | 4099 | 4038 | 4.4% | 4108 |
| CE520 | 3125 | 2874 | 2871 | 3019 | 3131 | 3200 | 2871 | 3200 | 3037 | 10.8% | 3277 |
| CE522 | 2816 | 2704 | 2707 | 2843 | 2819 | 2904 | 2704 | 2904 | 2799 | 7.1% | 2722 |
| CE525 | 2152 | 1886 | 1885 | 2180 | 2136 | 2221 | 1885 | 2221 | 2077 | 16.2% | 2213 |
| CE530 | 2072 | 1833 | 1833 | 2090 | 2051 | 2117 | 1833 | 2117 | 1999 | 14.2% | 2050 |
| CE540 | 2522 | 2258 | 2258 | 2309 | 2500 | 2573 | 2258 | 2573 | 2403 | 13.1% | 2522 |
| CE545 | 1753 | 1501 | 1501 | 1871 | 1739 | 1786 | 1501 | 1871 | 1692 | 21.9% | 1363 |

| Energy Consumption, Condenser Fan (kWh,e) | | | | | | | Statistics, All Results | | | | TRNSYS TESS |
|---|---------------|-----------------|------------------|--------------------|---------------|------------------|-------------------------|------|------|---------------------|----------------|
| Case | TRNSYS TUD | DOE-2.2 NREL | DOE21E-E NREL | EnergyPlus GARD | CODYRUN UR | HOT3000 NRCan | Min | Max | Mean | (Max-Min) /Mean* | |
| CE300 | 2400 | 2301 | 2302 | | 2326 | 2323 | 2301 | 2400 | 2331 | 4.3% | 2340 |
| CE310 | 2754 | 2686 | 2687 | | 2703 | 2691 | 2686 | 2754 | 2704 | 2.5% | 2712 |
| CE320 | 2747 | 2615 | 2618 | | 2675 | 2681 | 2615 | 2747 | 2667 | 4.9% | 2697 |
| CE330 | 2784 | 2656 | 2633 | | 2727 | 2693 | 2633 | 2784 | 2699 | 5.6% | 2732 |
| CE340 | 2776 | 2649 | 2640 | | 2713 | 2684 | 2640 | 2776 | 2692 | 5.1% | 2732 |
| CE350 | 2040 | 1865 | 1867 | | 1969 | 1970 | 1865 | 2040 | 1942 | 9.0% | 1990 |
| CE360 | 4313 | 4185 | 4181 | | 4266 | 4272 | 4181 | 4313 | 4243 | 3.1% | 4292 |
| CE400 | 1986 | 1860 | 1865 | | | 1902 | 1860 | 1986 | 1903 | 6.6% | 1965 |
| CE410 | 1994 | 1965 | 1969 | | | 1936 | 1936 | 1994 | 1966 | 3.0% | 2171 |
| CE420 | 2149 | 2054 | 2096 | | | 2115 | 2054 | 2149 | 2103 | 4.5% | 2147 |
| CE430 | 2059 | 1993 | 1980 | | | 1970 | 1970 | 2059 | 2001 | 4.5% | 2066 |
| CE440 | 2182 | 2110 | 2104 | | | 2120 | 2104 | 2182 | 2129 | 3.7% | 2162 |
| CE500 | 1920 | 1975 | 1975 | | 1912 | 1976 | 1912 | 1976 | 1952 | 3.3% | 1994 |
| CE500 May-Sep | 1477 | 1527 | 1527 | | 1476 | 1524 | 1476 | 1527 | 1506 | 3.4% | 1539 |
| CE510 May-Sep | 2938 | 3061 | 3061 | | 2974 | 3050 | 2938 | 3061 | 3017 | 4.1% | 3076 |
| CE520 | 2340 | 2394 | 2393 | | 2345 | 2396 | 2340 | 2396 | 2374 | 2.4% | 2454 |
| CE522 | 2108 | 2182 | 2182 | | 2111 | 2174 | 2108 | 2182 | 2151 | 3.4% | 2038 |
| CE525 | 1611 | 1642 | 1643 | | 1599 | 1663 | 1599 | 1663 | 1632 | 3.9% | 1657 |
| CE530 | 1552 | 1580 | 1580 | | 1536 | 1585 | 1536 | 1585 | 1567 | 3.1% | 1535 |
| CE540 | 1888 | 1940 | 1939 | | 1872 | 1926 | 1872 | 1940 | 1913 | 3.5% | 1889 |
| CE545 | 1312 | 1334 | 1333 | | 1302 | 1337 | 1302 | 1337 | 1324 | 2.7% | 1020 |

* ABS[(Max-Min) / (Mean of Example Simulation Results)]

Table B16.5.2-3. Weather Data Checks, CE300 Only

| Variable | TRNSYS | DOE-2.2 | DOE21E-E | EnergyPlus | CODYRUN | HOT3000 | Statistics, All Results | | | | TRNSYS TESS |
|--|---------|---------|----------|------------|---------|---------|-------------------------|---------|---------|---------------------|----------------|
| | TUD | NREL | NREL | GARD | UR | NRCan | Min | Max | Mean | (Max-Min) /Mean* | |
| Annual Mean Output | | | | | | | | | | | |
| ODB (°C) | 19.91 | 19.89 | 19.89 | 19.91 | 19.91 | 19.91 | 19.89 | 19.91 | 19.91 | 0.1% | 19.91 |
| OHR (kg/kg) | 0.01164 | 0.01160 | 0.01160 | 0.01159 | 0.01165 | 0.01160 | 0.01159 | 0.01165 | 0.01161 | 0.5% | 0.01161 |
| Annual Hourly Integrated Maxima | | | | | | | | | | | |
| ODB (°C) | 34.70 | 35.00 | 35.00 | 34.78 | 35.00 | 35.00 | 34.70 | 35.00 | 34.91 | 0.9% | 34.70 |
| OHR (kg/kg) | 0.02188 | 0.02250 | 0.02250 | 0.02184 | 0.02241 | 0.02230 | 0.02184 | 0.02250 | 0.02224 | 3.0% | 0.02173 |

* ABS[(Max-Min) / (Mean of Example Simulation Results)]

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 By Thermal Energy System Specialists, LLC (TESS), 19-Aug-2024.**

Note: The statistics in the tables below are based on the Standard 140 informative example results.
 These statistics do not have any substantial importance and are not to be interpreted as acceptance criteria.

Table B16.5.2-4. Annual Space Cooling Coil Loads (Total, Sensible)

| Total Sensible + Latent (kWh,thermal) | | | | | | | Statistics, All Results | | | | TRNSYS TESS |
|---------------------------------------|---------------|-----------------|------------------|--------------------|---------------|------------------|-------------------------|--------|--------|---------------------|----------------|
| Case | TRNSYS TUD | DOE-2.2 NREL | DOE21E-E NREL | EnergyPlus GARD | CODYRUN UR | HOT3000 NRCan | Min | Max | Mean | (Max-Min) /Mean* | |
| CE300 | 80427 | 77283 | 77292 | 77318 | 77745 | 78257 | 77283 | 80427 | 78054 | 4.0% | 78195 |
| CE310 | 99342 | 97395 | 97412 | 96448 | 97296 | 97261 | 96448 | 99342 | 97526 | 3.0% | 97553 |
| CE320 | 99792 | 96356 | 96493 | 96084 | 97141 | 96957 | 96084 | 99792 | 97137 | 3.8% | 98302 |
| CE330 | 105013 | 100730 | 100993 | 102211 | 103713 | 102008 | 100730 | 105013 | 102445 | 4.2% | 103989 |
| CE340 | 102728 | 99028 | 99223 | 99709 | 100676 | 99753 | 99028 | 102728 | 100186 | 3.7% | 101649 |
| CE350 | 69388 | 63736 | 63635 | 65790 | 66860 | 67389 | 63635 | 69388 | 66133 | 8.7% | 67545 |
| CE360 | 162974 | 159807 | 159854 | 161248 | 161200 | 162168 | 159807 | 162974 | 161209 | 2.0% | 162338 |
| CE400 | 68793 | 64918 | 65025 | 65414 | | 66898 | 64918 | 68793 | 66209 | 5.9% | 67976 |
| CE410 | 68673 | 66780 | 66844 | | | 66175 | 66175 | 68673 | 67118 | 3.7% | 72982 |
| CE420 | 72609 | 69611 | 70882 | 70349 | | 71803 | 69611 | 72609 | 71051 | 4.2% | 72170 |
| CE430 | 69756 | 67641 | 67219 | 67141 | | 67200 | 67141 | 69756 | 67792 | 3.9% | 69576 |
| CE440 | 73711 | 71380 | 71181 | 71417 | | 72029 | 71181 | 73711 | 71944 | 3.5% | 72679 |
| CE500 | 63357 | 65996 | 65992 | 65571 | 63105 | 65614 | 63105 | 65996 | 64939 | 4.5% | 65815 |
| CE500 May-Sep | 48443 | 50693 | 50690 | 50354 | 48440 | 50357 | 48440 | 50693 | 49830 | 4.5% | 50530 |
| CE510 May-Sep | 108974 | 114018 | 114015 | 112793 | 108979 | 112781 | 108974 | 114018 | 111927 | 4.5% | 113166 |
| CE520 | 63422 | 66571 | 66565 | 66088 | 63212 | 66146 | 63212 | 66571 | 65334 | 5.1% | 66531 |
| CE522 | 63389 | 66373 | 66372 | 65851 | 63157 | 65900 | 63157 | 66373 | 65174 | 4.9% | 65933 |
| CE525 | 63293 | 65399 | 65395 | 64973 | 63002 | 65155 | 63002 | 65399 | 64536 | 3.7% | 65271 |
| CE530 | 45046 | 46634 | 46631 | 46944 | 44875 | 47002 | 44875 | 47002 | 46189 | 4.6% | 46935 |
| CE540 | 45113 | 47130 | 47126 | 47297 | 44980 | 47462 | 44980 | 47462 | 46518 | 5.3% | 47514 |
| CE545 | 44981 | 46240 | 46236 | 46612 | 44775 | 46668 | 44775 | 46668 | 45919 | 4.1% | 46192 |

| Sensible Coil Load (kWh,thermal) | | | | | | | Statistics, All Results | | | | TRNSYS TESS |
|----------------------------------|---------------|-----------------|------------------|--------------------|---------------|------------------|-------------------------|--------|--------|---------------------|----------------|
| Case | TRNSYS TUD | DOE-2.2 NREL | DOE21E-E NREL | EnergyPlus GARD | CODYRUN UR | HOT3000 NRCan | Min | Max | Mean | (Max-Min) /Mean* | |
| CE300 | 56662 | 55797 | 55805 | 55252 | 55209 | 55191 | 55191 | 56662 | 55653 | 2.6% | 55309 |
| CE310 | 56256 | 56301 | 56313 | 55225 | 55185 | 55083 | 55083 | 56313 | 55727 | 2.2% | 55290 |
| CE320 | 62859 | 62697 | 62747 | 62043 | 62009 | 62734 | 62009 | 62859 | 62515 | 1.4% | 62066 |
| CE330 | 63083 | 63311 | 63328 | 63779 | 62649 | 61822 | 61822 | 63779 | 62995 | 3.1% | 62488 |
| CE340 | 63033 | 63053 | 63111 | 62886 | 62381 | 61406 | 61406 | 63111 | 62645 | 2.7% | 62386 |
| CE350 | 50371 | 47684 | 47677 | 48545 | 48589 | 48768 | 47677 | 50371 | 48606 | 5.5% | 49123 |
| CE360 | 134977 | 134920 | 134940 | 135287 | 134206 | 134697 | 134206 | 135287 | 134838 | 0.8% | 134720 |
| CE400 | 41952 | 41419 | 41437 | 40688 | | 41181 | 40688 | 41952 | 41335 | 3.1% | 42381 |
| CE410 | 45677 | 47659 | 47660 | | | 45585 | 45585 | 47660 | 46645 | 4.4% | 51109 |
| CE420 | 50390 | 49666 | 50612 | 49524 | | 49984 | 49524 | 50612 | 50035 | 2.2% | 50475 |
| CE430 | 47863 | 47731 | 47454 | 46739 | | 46143 | 46143 | 47863 | 47186 | 3.6% | 48310 |
| CE440 | 50876 | 50593 | 50492 | 50060 | | 49785 | 49785 | 50876 | 50361 | 2.2% | 50693 |
| CE500 | 45044 | 47650 | 47646 | 47491 | 44874 | 47530 | 44874 | 47650 | 46706 | 5.9% | 47492 |
| CE500 May-Sep | 34443 | 36596 | 36593 | 36476 | 34448 | 36480 | 34443 | 36596 | 35839 | 6.0% | 36471 |
| CE510 May-Sep | 77489 | 82306 | 82303 | 81566 | 77499 | 81563 | 77489 | 82306 | 80454 | 6.0% | 81546 |
| CE520 | 45110 | 48102 | 48096 | 47986 | 44977 | 48059 | 44977 | 48102 | 47055 | 6.6% | 48224 |
| CE522 | 45076 | 47962 | 47961 | 47758 | 44924 | 47795 | 44924 | 47962 | 46913 | 6.5% | 47597 |
| CE525 | 44979 | 47218 | 47213 | 46930 | 44775 | 47110 | 44775 | 47218 | 46371 | 5.3% | 46929 |
| CE530 | 45046 | 46574 | 46570 | 46944 | 44874 | 47002 | 44874 | 47002 | 46168 | 4.6% | 46927 |
| CE540 | 45112 | 47023 | 47019 | 47288 | 44977 | 47460 | 44977 | 47460 | 46480 | 5.3% | 47506 |
| CE545 | 44981 | 46214 | 46210 | 46612 | 44775 | 46668 | 44775 | 46668 | 45910 | 4.1% | 46138 |

* ABS[(Max-Min)/(Mean of Example Simulation Results)]

**ASHRAE Standard 140-2023 Test Results Comparison for Section 9 - HVAC Equipment Performance Tests CE300 through CE545
 TRNSYS18.06.0002 (TRNSYS) vs. Annex B16, Section B16.5.2 Example Results
 By Thermal Energy System Specialists, LLC (TESS), 19-Aug-2024.**

Note: The statistics in the tables below are based on the Standard 140 informative example results.
 These statistics do not have any substantial importance and are not to be interpreted as acceptance criteria.

Table B16.5.2-5. Annual Space Cooling Coil Loads (Latent)

| Latent Coil Load(kWh,thermal) | | | | | | | Statistics, All Results | | | | TRNSYS |
|-------------------------------|---------------|-----------------|------------------|--------------------|---------------|------------------|-------------------------|-------|-------|---------------------|--------|
| Case | TRNSYS TUD | DOE-2.2 NREL | DOE21E-E NREL | EnergyPlus GARD | CODYRUN UR | HOT3000 NRCan | Min | Max | Mean | (Max-Min) /Mean* | TESS |
| CE300 | 23765 | 21487 | 21487 | 22066 | 22535 | 23067 | 21487 | 23765 | 22401 | 10.2% | 22886 |
| CE310 | 43086 | 41094 | 41099 | 41222 | 42111 | 42178 | 41094 | 43086 | 41798 | 4.8% | 42263 |
| CE320 | 36932 | 33659 | 33746 | 34040 | 35133 | 34224 | 33659 | 36932 | 34622 | 9.5% | 36236 |
| CE330 | 41929 | 37419 | 37666 | 38433 | 41063 | 40186 | 37419 | 41929 | 39449 | 11.4% | 41501 |
| CE340 | 39695 | 35974 | 36113 | 36823 | 38296 | 38346 | 35974 | 39695 | 37541 | 9.9% | 39262 |
| CE350 | 19017 | 16052 | 15958 | 17245 | 18271 | 18621 | 15958 | 19017 | 17527 | 17.5% | 18422 |
| CE360 | 27997 | 24887 | 24914 | 25961 | 26994 | 27470 | 24887 | 27997 | 26371 | 11.8% | 27618 |
| CE400 | 26840 | 23498 | 23588 | 24726 | | 25717 | 23498 | 26840 | 24874 | 13.4% | 25595 |
| CE410 | 22996 | 19121 | 19184 | | | 20590 | 19121 | 22996 | 20473 | 18.9% | 21874 |
| CE420 | 22219 | 19945 | 20270 | 20826 | | 21855 | 19945 | 22219 | 21023 | 10.8% | 21695 |
| CE430 | 21893 | 19909 | 19765 | 20403 | | 21057 | 19765 | 21893 | 20605 | 10.3% | 21266 |
| CE440 | 22835 | 20788 | 20689 | 21357 | | 22244 | 20689 | 22835 | 21583 | 9.9% | 21986 |
| CE500 | 18313 | 18346 | 18346 | 18080 | 18231 | 18084 | 18080 | 18346 | 18233 | 1.5% | 18323 |
| CE500 May-Sep | 14000 | 14097 | 14097 | 13879 | 13991 | 13877 | 13877 | 14097 | 13990 | 1.6% | 14060 |
| CE510 May-Sep | 31485 | 31712 | 31712 | 31226 | 31480 | 31217 | 31217 | 31712 | 31472 | 1.6% | 31620 |
| CE520 | 18312 | 18470 | 18470 | 18101 | 18235 | 18087 | 18087 | 18470 | 18279 | 2.1% | 18308 |
| CE522 | 18313 | 18411 | 18410 | 18093 | 18233 | 18104 | 18093 | 18411 | 18261 | 1.7% | 18336 |
| CE525 | 18314 | 18182 | 18182 | 18044 | 18227 | 18045 | 18044 | 18314 | 18165 | 1.5% | 18342 |
| CE530 | 0 | 61 | 61 | 0 | 1 | 0 | 0 | 61 | 20 | 297.1% | 7 |
| CE540 | 1 | 107 | 107 | 9 | 3 | 2 | 1 | 107 | 38 | 278.2% | 8 |
| CE545 | 0 | 25 | 25 | 0 | 0 | 0 | 0 | 25 | 9 | 300.0% | 55 |

* ABS[(Max-Min) / (Mean of Example Simulation Results)]

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By Thermal Energy System Specialists, LLC (TESS), 19-Aug-2024.**

Note: The statistics in the tables below are based on the Standard 140 informative example results.
These statistics do not have any substantial importance and are not to be interpreted as acceptance criteria.

Table B16.5.2-6. Various Annual Means (COP2, IDB)

| COP2 | | | | | | | Statistics, All Results | | | | TRNSYS |
|---------------|---------------|-----------------|------------------|--------------------|---------------|------------------|-------------------------|-------|-------|---------------------|--------|
| Case | TRNSYS TUD | DOE-2.2 NREL | DOE21E-E NREL | EnergyPlus GARD | CODYRUN UR | HOT3000 NRCan | Min | Max | Mean | (Max-Min) /Mean* | TESS |
| CE300 | 3.249 | 3.238 | 3.237 | 3.237 | 3.226 | 3.230 | 3.226 | 3.249 | 3.236 | 0.7% | 3.294 |
| CE310 | 3.415 | 3.417 | 3.417 | 3.393 | 3.397 | 3.380 | 3.380 | 3.417 | 3.403 | 1.1% | 3.430 |
| CE320 | 3.420 | 3.458 | 3.457 | 3.405 | 3.406 | 3.390 | 3.390 | 3.458 | 3.423 | 2.0% | 3.389 |
| CE330 | 3.491 | 3.494 | 3.536 | 3.491 | 3.497 | 3.460 | 3.460 | 3.536 | 3.495 | 2.2% | 3.413 |
| CE340 | 3.454 | 3.477 | 3.496 | 3.448 | 3.450 | 3.420 | 3.420 | 3.496 | 3.457 | 2.2% | 3.396 |
| CE350 | 3.249 | 3.241 | 3.235 | 3.244 | 3.229 | 3.230 | 3.229 | 3.249 | 3.238 | 0.6% | 3.318 |
| CE360 | 3.669 | 3.701 | 3.706 | 3.678 | 3.667 | 3.660 | 3.660 | 3.706 | 3.680 | 1.2% | 3.577 |
| CE400 | 3.250 | 3.251 | 3.252 | 3.246 | | 3.260 | 3.246 | 3.260 | 3.252 | 0.4% | 3.262 |
| CE410 | 3.240 | 3.212 | 3.211 | | | 3.210 | 3.210 | 3.240 | 3.218 | 0.9% | 3.253 |
| CE420 | 3.226 | 3.215 | 3.218 | 3.216 | | 3.210 | 3.210 | 3.226 | 3.217 | 0.5% | 3.251 |
| CE430 | 3.221 | 3.213 | 3.211 | 3.211 | | 3.210 | 3.210 | 3.221 | 3.213 | 0.3% | 3.241 |
| CE440 | 3.231 | 3.222 | 3.222 | 3.221 | | 3.220 | 3.220 | 3.231 | 3.223 | 0.4% | 3.251 |
| CE500 | 3.204 | 3.227 | 3.227 | 3.213 | 3.192 | 3.200 | 3.192 | 3.227 | 3.211 | 1.1% | 3.221 |
| CE500 May-Sep | 3.142 | 3.161 | 3.162 | 3.154 | 3.132 | 3.140 | 3.132 | 3.162 | 3.148 | 0.9% | 3.157 |
| CE510 May-Sep | 3.551 | 3.577 | 3.577 | 3.562 | 3.530 | 3.550 | 3.530 | 3.577 | 3.558 | 1.3% | 3.568 |
| CE520 | 2.901 | 2.957 | 2.956 | 3.004 | 2.873 | 2.920 | 2.873 | 3.004 | 2.935 | 4.5% | 2.887 |
| CE522 | 3.058 | 3.074 | 3.073 | 3.101 | 3.036 | 3.070 | 3.036 | 3.101 | 3.069 | 2.1% | 3.184 |
| CE525 | 3.484 | 3.531 | 3.528 | 3.508 | 3.480 | 3.410 | 3.410 | 3.531 | 3.490 | 3.5% | 3.512 |
| CE530 | 2.962 | 2.969 | 2.969 | 2.999 | 2.916 | 2.980 | 2.916 | 2.999 | 2.966 | 2.8% | 3.137 |
| CE540 | 2.668 | 2.675 | 2.675 | 2.823 | 2.640 | 2.690 | 2.640 | 2.823 | 2.695 | 6.8% | 2.819 |
| CE545 | 3.228 | 3.233 | 3.236 | 3.157 | 3.186 | 3.200 | 3.157 | 3.236 | 3.207 | 2.5% | 4.752 |

| IDB (°C) | | | | | | | Statistics, All Results | | | | TRNSYS |
|---------------|---------------|-----------------|------------------|--------------------|---------------|------------------|-------------------------|-------|-------|---------------------|--------|
| Case | TRNSYS TUD | DOE-2.2 NREL | DOE21E-E NREL | EnergyPlus GARD | CODYRUN UR | HOT3000 NRCan | Min | Max | Mean | (Max-Min) /Mean* | TESS |
| CE300 | 23.62 | 24.06 | 24.06 | 24.09 | 24.08 | 23.99 | 23.62 | 24.09 | 23.98 | 1.9% | 23.46 |
| CE310 | 23.76 | 24.11 | 24.06 | 24.09 | 24.09 | 24.01 | 23.76 | 24.11 | 24.02 | 1.5% | 23.46 |
| CE320 | 23.90 | 24.39 | 24.39 | 24.25 | 24.33 | 24.53 | 23.90 | 24.53 | 24.30 | 2.6% | 24.33 |
| CE330 | 23.88 | 24.28 | 24.28 | 24.27 | 24.30 | 24.18 | 23.88 | 24.30 | 24.20 | 1.7% | 24.05 |
| CE340 | 23.88 | 24.28 | 24.28 | 24.30 | 24.31 | 24.21 | 23.88 | 24.31 | 24.21 | 1.8% | 23.82 |
| CE350 | 25.66 | 26.17 | 26.17 | 26.24 | 26.27 | 26.15 | 25.66 | 26.27 | 26.11 | 2.3% | 25.31 |
| CE360 | 25.36 | 25.61 | 25.56 | 25.32 | 25.48 | 25.37 | 25.32 | 25.61 | 25.45 | 1.1% | 24.70 |
| CE400 | 24.13 | 24.06 | 24.06 | 24.09 | | 23.99 | 23.99 | 24.13 | 24.06 | 0.6% | 22.40 |
| CE410 | 24.12 | 24.06 | 24.06 | | | 23.99 | 23.99 | 24.12 | 24.06 | 0.5% | 22.87 |
| CE420 | 23.93 | 24.06 | 24.06 | 24.09 | | 23.99 | 23.93 | 24.09 | 24.02 | 0.7% | 22.83 |
| CE430 | 23.99 | 24.06 | 24.06 | 24.09 | | 23.99 | 23.99 | 24.09 | 24.04 | 0.4% | 22.71 |
| CE440 | 23.91 | 24.06 | 24.06 | 24.09 | | 23.99 | 23.91 | 24.09 | 24.02 | 0.7% | 22.89 |
| CE500 | 20.23 | 20.67 | 20.56 | 20.38 | 21.10 | 22.86 | 20.23 | 22.86 | 20.97 | 12.5% | 20.88 |
| CE500 May-Sep | 24.57 | 25.00 | 25.00 | 24.98 | 25.00 | 25.00 | 24.57 | 25.00 | 24.93 | 1.7% | 25.00 |
| CE510 May-Sep | 25.82 | 25.11 | 25.11 | 24.96 | 25.00 | 25.00 | 24.96 | 25.82 | 25.17 | 3.4% | 25.00 |
| CE520 | 13.52 | 13.78 | 13.72 | 13.58 | 14.14 | 14.89 | 13.52 | 14.89 | 13.94 | 9.9% | 13.98 |
| CE522 | 16.95 | 17.28 | 17.22 | 17.00 | 17.73 | 18.70 | 16.95 | 18.70 | 17.48 | 10.0% | 17.50 |
| CE525 | 26.84 | 27.39 | 27.28 | 27.10 | 27.77 | 30.69 | 26.84 | 30.69 | 27.85 | 13.8% | 27.50 |
| CE530 | 20.03 | 20.61 | 20.56 | 20.59 | 21.10 | 22.86 | 20.03 | 22.86 | 20.96 | 13.5% | 20.88 |
| CE540 | 13.29 | 13.78 | 13.72 | 13.79 | 14.14 | 14.98 | 13.29 | 14.98 | 13.95 | 12.1% | 13.96 |
| CE545 | 26.61 | 27.33 | 27.28 | 27.31 | 27.72 | 30.69 | 26.61 | 30.69 | 27.82 | 14.7% | 27.50 |

* ABS[(Max-Min) / (Mean of Example Simulation Results)]

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By Thermal Energy System Specialists, LLC (TESS), 19-Aug-2024.**

Note: The statistics in the tables below are based on the Standard 140 informative example results.
These statistics do not have any substantial importance and are not to be interpreted as acceptance criteria.

Table B16.5.2-7. Various Annual Means (Humidity Ratio, Zone Relative Humidity)

| Humidity Ratio (kg/kg) | | | | | | | Statistics, All Results | | | | TRNSYS TESS |
|------------------------|---------------|-----------------|------------------|--------------------|---------------|------------------|-------------------------|--------|--------|---------------------|----------------|
| Case | TRNSYS TUD | DOE-2.2 NREL | DOE21E-E NREL | EnergyPlus GARD | CODYRUN UR | HOT3000 NRCan | Min | Max | Mean | (Max-Min) /Mean* | |
| CE300 | 0.0091 | 0.0092 | 0.0092 | 0.0093 | 0.0092 | 0.0092 | 0.0091 | 0.0093 | 0.0092 | 2.4% | 0.0095 |
| CE310 | 0.0111 | 0.0113 | 0.0113 | 0.0113 | 0.0112 | 0.0111 | 0.0111 | 0.0113 | 0.0112 | 2.0% | 0.0112 |
| CE320 | 0.0100 | 0.0101 | 0.0101 | 0.0101 | 0.0100 | 0.0099 | 0.0099 | 0.0101 | 0.0100 | 2.1% | 0.0100 |
| CE330 | 0.0097 | 0.0099 | 0.0099 | 0.0100 | 0.0098 | 0.0099 | 0.0097 | 0.0100 | 0.0099 | 2.3% | 0.0105 |
| CE340 | 0.0098 | 0.0099 | 0.0099 | 0.0100 | 0.0099 | 0.0099 | 0.0098 | 0.0100 | 0.0099 | 1.9% | 0.0103 |
| CE350 | 0.0097 | 0.0100 | 0.0100 | 0.0099 | 0.0098 | 0.0098 | 0.0097 | 0.0100 | 0.0099 | 3.0% | 0.0100 |
| CE360 | 0.0085 | 0.0087 | 0.0087 | 0.0088 | 0.0086 | 0.0086 | 0.0085 | 0.0088 | 0.0086 | 3.1% | 0.0089 |
| CE400 | 0.0098 | 0.0100 | 0.0100 | 0.0101 | | 0.0100 | 0.0098 | 0.0101 | 0.0100 | 2.9% | 0.0104 |
| CE410 | 0.0097 | 0.0095 | 0.0095 | | | 0.0095 | 0.0095 | 0.0097 | 0.0096 | 2.5% | 0.0096 |
| CE420 | 0.0093 | 0.0094 | 0.0094 | 0.0094 | | 0.0093 | 0.0093 | 0.0094 | 0.0094 | 2.0% | 0.0096 |
| CE430 | 0.0093 | 0.0094 | 0.0094 | 0.0095 | | 0.0094 | 0.0093 | 0.0095 | 0.0094 | 1.9% | 0.0097 |
| CE440 | 0.0092 | 0.0093 | 0.0093 | 0.0093 | | 0.0092 | 0.0092 | 0.0093 | 0.0093 | 1.9% | 0.0095 |
| CE500 | 0.0098 | | | 0.0094 | 0.0102 | 0.0107 | 0.0094 | 0.0107 | 0.0100 | 13.2% | 0.0102 |
| CE500 May-Sep | 0.0110 | 0.0114 | 0.0114 | 0.0113 | 0.0113 | 0.0109 | 0.0109 | 0.0114 | 0.0112 | 4.5% | 0.0109 |
| CE510 May-Sep | 0.0114 | 0.0114 | 0.0114 | 0.0113 | 0.0113 | 0.0109 | 0.0109 | 0.0114 | 0.0113 | 4.4% | 0.0109 |
| CE520 | 0.0067 | | | 0.0060 | 0.0070 | 0.0076 | 0.0060 | 0.0076 | 0.0068 | 23.1% | 0.0068 |
| CE522 | 0.0082 | | | 0.0076 | 0.0086 | 0.0090 | 0.0076 | 0.0090 | 0.0083 | 16.8% | 0.0109 |
| CE525 | 0.0137 | | | 0.0138 | 0.0140 | 0.0151 | 0.0137 | 0.0151 | 0.0141 | 9.8% | 0.0139 |
| CE530 | 0.0062 | | | 0.0067 | 0.0058 | 0.0067 | 0.0058 | 0.0067 | 0.0064 | 14.4% | 0.0021 |
| CE540 | 0.0045 | | | 0.0043 | 0.0039 | 0.0046 | 0.0039 | 0.0046 | 0.0043 | 17.9% | 0.0018 |
| CE545 | 0.0062 | | | 0.0067 | 0.0067 | 0.0072 | 0.0062 | 0.0072 | 0.0067 | 14.8% | 0.0018 |

| Relative Humidity (%) | | | | | | | Statistics, All Results | | | | TRNSYS TESS |
|-----------------------|---------------|-----------------|------------------|--------------------|---------------|------------------|-------------------------|-------|-------|---------------------|----------------|
| Case | TRNSYS TUD | DOE-2.2 NREL | DOE21E-E NREL | EnergyPlus GARD | CODYRUN UR | HOT3000 NRCan | Min | Max | Mean | (Max-Min) /Mean* | |
| CE300 | 48.61 | 48.26 | 48.28 | 48.59 | 47.83 | 47.93 | 47.83 | 48.61 | 48.25 | 1.6% | 50.80 |
| CE310 | 58.33 | 58.51 | 58.53 | 58.55 | 57.84 | 57.80 | 57.80 | 58.55 | 58.26 | 1.3% | 59.89 |
| CE320 | 52.01 | 51.21 | 51.25 | 51.84 | 51.10 | 49.94 | 49.94 | 52.01 | 51.22 | 4.0% | 51.00 |
| CE330 | 50.84 | 50.58 | 50.65 | 51.18 | 50.08 | 50.70 | 50.08 | 51.18 | 50.67 | 2.2% | 53.30 |
| CE340 | 51.09 | 50.69 | 50.73 | 51.15 | 50.30 | 50.78 | 50.30 | 51.15 | 50.79 | 1.7% | 53.07 |
| CE350 | 45.48 | 45.45 | 45.55 | 45.17 | 44.32 | 44.56 | 44.32 | 45.55 | 45.09 | 2.7% | 47.53 |
| CE360 | 41.03 | 41.49 | 41.49 | 42.37 | 40.87 | 41.21 | 40.87 | 42.37 | 41.41 | 3.6% | 44.24 |
| CE400 | 50.77 | 52.21 | 52.25 | 52.55 | | 52.01 | 50.77 | 52.55 | 51.96 | 3.4% | 59.73 |
| CE410 | 50.50 | 49.65 | 49.63 | | | 49.75 | 49.63 | 50.50 | 49.88 | 1.7% | 53.26 |
| CE420 | 48.78 | 49.14 | 48.97 | 49.40 | | 48.76 | 48.76 | 49.40 | 49.01 | 1.3% | 53.76 |
| CE430 | 48.82 | 49.17 | 49.30 | 49.60 | | 49.17 | 48.82 | 49.60 | 49.21 | 1.6% | 54.36 |
| CE440 | 48.33 | 48.46 | 48.57 | 48.83 | | 48.23 | 48.23 | 48.83 | 48.48 | 1.2% | 52.96 |
| CE500 | 66.53 | | | 59.20 | 65.94 | 63.73 | 59.20 | 66.53 | 63.85 | 11.5% | 68.91 |
| CE500 May-Sep | 57.05 | 57.47 | 57.47 | 57.32 | 57.07 | 55.13 | 55.13 | 57.47 | 56.92 | 4.1% | 55.04 |
| CE510 May-Sep | 54.70 | 57.36 | 57.36 | 57.44 | 57.06 | 55.24 | 54.70 | 57.44 | 56.53 | 4.8% | 55.14 |
| CE520 | 69.87 | | | 61.40 | 70.23 | 72.17 | 61.40 | 72.17 | 68.42 | 15.7% | 69.30 |
| CE522 | 68.68 | | | 60.75 | 68.23 | 68.11 | 60.75 | 68.68 | 66.44 | 11.9% | 86.97 |
| CE525 | 61.47 | | | 54.99 | 60.14 | 57.37 | 54.99 | 61.47 | 58.49 | 11.1% | 63.56 |
| CE530 | 46.73 | | | 48.97 | 41.45 | 39.60 | 39.60 | 48.97 | 44.19 | 21.2% | 20.88 |
| CE540 | 48.52 | | | 46.31 | 40.05 | 43.82 | 40.05 | 48.52 | 44.67 | 19.0% | 20.66 |
| CE545 | 36.62 | | | 38.63 | 36.87 | 29.20 | 29.20 | 38.63 | 35.33 | 26.7% | 19.00 |

* ABS[(Max-Min) / (Mean of Example Simulation Results)]

**ASHRAE Standard 140-2023 Test Results Comparison for Section 9 - HVAC Equipment Performance Tests CE300 through CE545
 TRNSYS18.06.0002 (TRNSYS) vs. Annex B16, Section B16.5.2 Example Results
 By Thermal Energy System Specialists, LLC (TESS), 19-Aug-2024.**

Note: The statistics in the tables below are based on the Standard 140 informative example results.
 These statistics do not have any substantial importance and are not to be interpreted as acceptance criteria.

Table B16.5.2-8. f(ODB) Sensitivity CE500 and CE530, April 30 and June 25 (Energy, Coil Loads)

| Case | TRNSYS TUD | DOE-2.2 NREL | DOE21E-E NREL | EnergyPlus GARD | CODYRUN UR | HOT3000 NRCan | Statistics, All Results | | | | TRNSYS TESS |
|--|---------------|-----------------|------------------|--------------------|---------------|------------------|-------------------------|-------|-------|---------------------|----------------|
| | | | | | | | Min | Max | Mean | (Max-Min) /Mean* | |
| Energy Consumption, Compr. + Both Fans (Wh,e) | | | | | | | | | | | |
| CE500Apr30 | 3893 | 3975 | 3975 | 4029 | 3901 | 4073 | 3893 | 4073 | 3974 | 4.5% | 4052 |
| CE500Jun25 | 5045 | 5204 | 5204 | 5229 | 5067 | 5230 | 5045 | 5230 | 5163 | 3.6% | 5275 |
| Del CE500 | 1152 | 1229 | 1229 | 1200 | 1165 | 1157 | 1152 | 1229 | 1189 | 6.5% | 1223 |
| CE530Apr30 | 3023 | 3062 | 3062 | 3101 | 3092 | 3144 | 3023 | 3144 | 3081 | 3.9% | 2990 |
| CE530Jun25 | 3894 | 3978 | 3978 | 4029 | 3935 | 4043 | 3894 | 4043 | 3976 | 3.7% | 3909 |
| Del CE530 | 871 | 916 | 916 | 927 | 843 | 899 | 843 | 927 | 896 | 9.4% | 919 |
| Energy Consumption, Compressor (Wh,e) | | | | | | | | | | | |
| CE500Apr30 | 3015 | 3120 | 3120 | | 3020 | 3159 | 3015 | 3159 | 3087 | 4.7% | 3135 |
| CE500Jun25 | 4084 | 4264 | 4263 | | 4106 | 4239 | 4084 | 4264 | 4191 | 4.3% | 4273 |
| Del CE500 | 1069 | 1144 | 1144 | | 1086 | 1080 | 1069 | 1144 | 1105 | 6.7% | 1138 |
| CE530Apr30 | 2311 | 2390 | 2390 | | 2378 | 2411 | 2311 | 2411 | 2376 | 4.2% | 2288 |
| CE530Jun25 | 3118 | 3243 | 3243 | | 3166 | 3248 | 3118 | 3248 | 3204 | 4.1% | 3134 |
| Del CE530 | 807 | 853 | 853 | | 787 | 837 | 787 | 853 | 827 | 8.0% | 846 |
| Energy Consumption, Condenser Fan (Wh,e) | | | | | | | | | | | |
| CE500Apr30 | 376 | 389 | 389 | | 377 | 391 | 376 | 391 | 385 | 3.9% | 393 |
| CE500Jun25 | 411 | 426 | 426 | | 411 | 424 | 411 | 426 | 420 | 3.6% | 429 |
| Del CE500 | 35 | 37 | 37 | | 34 | 33 | 33 | 37 | 35 | 12.0% | 37 |
| CE530Apr30 | 305 | 311 | 311 | | 305 | 314 | 305 | 314 | 309 | 3.1% | 300 |
| CE530Jun25 | 332 | 340 | 340 | | 329 | 340 | 329 | 340 | 336 | 3.2% | 332 |
| Del CE530 | 28 | 28 | 29 | | 24 | 26 | 24 | 29 | 27 | 17.0% | 31 |
| Energy Consumption, Supply Fan (Wh,e) | | | | | | | | | | | |
| CE500Apr30 | 502 | 467 | 466 | 519 | 504 | 522 | 466 | 522 | 497 | 11.2% | 524 |
| CE500Jun25 | 550 | 514 | 514 | 566 | 549 | 566 | 514 | 566 | 543 | 9.5% | 573 |
| Del CE500 | 47 | 48 | 48 | 47 | 45 | 44 | 44 | 48 | 47 | 8.5% | 49 |
| CE530Apr30 | 407 | 361 | 361 | 412 | 408 | 419 | 361 | 419 | 395 | 14.8% | 401 |
| CE530Jun25 | 444 | 396 | 396 | 450 | 440 | 454 | 396 | 454 | 430 | 13.6% | 443 |
| Del CE530 | 37 | 35 | 35 | 38 | 32 | 35 | 32 | 38 | 35 | 16.0% | 42 |
| Sensible + Latent Coil Load (Wh,th) | | | | | | | | | | | |
| CE500Apr30 | 13186 | 13733 | 13733 | 13655 | 13170 | 13673 | 13170 | 13733 | 13525 | 4.2% | 13705 |
| CE500Jun25 | 13188 | 13838 | 13837 | 13733 | 13198 | 13727 | 13188 | 13838 | 13587 | 4.8% | 13780 |
| Del CE500 | 2 | 105 | 104 | 78 | 29 | 54 | 2 | 105 | 62 | 165.3% | 75 |
| CE530Apr30 | 9353 | 9721 | 9721 | 9775 | 9365 | 9798 | 9353 | 9798 | 9622 | 4.6% | 9769 |
| CE530Jun25 | 9376 | 9761 | 9761 | 9835 | 9388 | 9834 | 9376 | 9835 | 9659 | 4.8% | 9832 |
| Del CE530 | 23 | 40 | 39 | 60 | 22 | 36 | 22 | 60 | 37 | 102.8% | 63 |
| Sensible Coil Load (Wh,th) | | | | | | | | | | | |
| CE500Apr30 | 9375 | 9925 | 9925 | 9884 | 9365 | 9902 | 9365 | 9925 | 9729 | 5.8% | 9882 |
| CE500Jun25 | 9378 | 9981 | 9981 | 9953 | 9388 | 9946 | 9378 | 9981 | 9771 | 6.2% | 9951 |
| Del CE500 | 3 | 56 | 56 | 69 | 22 | 44 | 3 | 69 | 42 | 158.2% | 70 |
| CE530Apr30 | 9353 | 9721 | 9721 | 9775 | 9365 | 9798 | 9353 | 9798 | 9622 | 4.6% | 9768 |
| CE530Jun25 | 9376 | 9761 | 9761 | 9835 | 9388 | 9834 | 9376 | 9835 | 9659 | 4.8% | 9832 |
| Del CE530 | 23 | 40 | 39 | 60 | 22 | 36 | 22 | 60 | 37 | 102.9% | 64 |
| Latent Coil Load (Wh,th) | | | | | | | | | | | |
| CE500Apr30 | 3811 | 3808 | 3808 | 3772 | 3804 | 3770 | 3770 | 3811 | 3795 | 1.1% | 3823 |
| CE500Jun25 | 3810 | 3856 | 3856 | 3781 | 3810 | 3780 | 3780 | 3856 | 3816 | 2.0% | 3828 |
| Del CE500 | -1 | 48 | 48 | 9 | 6 | 10 | -1 | 48 | 20 | 242.3% | 6 |
| CE530Apr30 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | ---- | 1 |
| CE530Jun25 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | ---- | 0 |
| Del CE530 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | ---- | -1 |

* ABS[(Max-Min) / (Mean of Example Simulation Results)]

**ASHRAE Standard 140-2023 Test Results Comparison for Section 9 - HVAC Equipment Performance Tests CE300 through CE545
 TRNSYS18.06.0002 (TRNSYS) vs. Annex B16, Section B16.5.2 Example Results
 By Thermal Energy System Specialists, LLC (TESS), 19-Aug-2024.**

Note: The statistics in the tables below are based on the Standard 140 informative example results.
 These statistics do not have any substantial importance and are not to be interpreted as acceptance criteria.

Table B16.5.2-9. f(ODB) Sensitivity CE500 and CE530, April 30 and June 25 (COP2, Zone Conditions)

| Case | TRNSYS TUD | DOE-2.2 NREL | DOE21E-E NREL | EnergyPlus GARD | CODYRUN UR | HOT3000 NRCan | Statistics, All Results | | | | TRNSYS TESS |
|-------------------------------|---------------|-----------------|------------------|--------------------|---------------|------------------|-------------------------|--------|---------|---------------------|----------------|
| | | | | | | | Min | Max | Mean | (Max-Min) /Mean* | |
| Humidity Ratio (kg/kg) | | | | | | | | | | | |
| CE500Apr30 | 0.0107 | 0.0110 | 0.0110 | 0.0110 | 0.0109 | 0.0160 | 0.0107 | 0.0160 | 0.0118 | 45.3% | 0.0105 |
| CE500Jun25 | 0.0112 | 0.0115 | 0.0115 | 0.0115 | 0.0115 | 0.0110 | 0.0110 | 0.0115 | 0.0114 | 4.4% | 0.0111 |
| Del CE500 | 0.0005 | 0.0005 | 0.0005 | 0.0005 | 0.0005 | -0.0050 | -0.0050 | 0.0005 | -0.0004 | 1334.8% | 0.0006 |
| CE530Apr30 | 0.0062 | 0.0071 | 0.0071 | 0.0068 | 0.0055 | 0.0067 | 0.0055 | 0.0071 | 0.0066 | 24.6% | 0.0004 |
| CE530Jun25 | 0.0062 | 0.0078 | 0.0078 | 0.0068 | 0.0055 | 0.0067 | 0.0055 | 0.0078 | 0.0068 | 34.2% | 0.0005 |
| Del CE530 | 0.0000 | 0.0007 | 0.0007 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0007 | 0.0002 | 304.5% | 0.0001 |
| COP2 | | | | | | | | | | | |
| CE500Apr30 | 3.845 | 3.914 | 3.914 | 3.850 | 3.837 | 3.850 | 3.837 | 3.914 | 3.868 | 2.0% | 3.844 |
| CE500Jun25 | 2.931 | 2.951 | 2.951 | 2.943 | 2.921 | 2.940 | 2.921 | 2.951 | 2.939 | 1.0% | 2.928 |
| Del CE500 | -0.914 | -0.963 | -0.963 | -0.907 | -0.916 | -0.910 | -0.963 | -0.907 | -0.929 | 6.1% | -0.916 |
| CE530Apr30 | 3.543 | 3.599 | 3.599 | 3.441 | 3.460 | 3.590 | 3.441 | 3.599 | 3.539 | 4.5% | 3.742 |
| CE530Jun25 | 2.720 | 2.724 | 2.724 | 2.780 | 2.690 | 2.740 | 2.690 | 2.780 | 2.730 | 3.3% | 2.845 |
| Del CE530 | -0.823 | -0.874 | -0.875 | -0.662 | -0.770 | -0.850 | -0.875 | -0.662 | -0.809 | 26.3% | -0.898 |
| ODB (°C) | | | | | | | | | | | |
| CE500Apr30 | 16.79 | 16.83 | 16.83 | 16.81 | 16.88 | 16.96 | 16.79 | 16.96 | 16.85 | 1.0% | 16.79 |
| CE500Jun25 | 29.52 | 29.50 | 29.50 | 29.52 | 29.52 | 29.50 | 29.50 | 29.52 | 29.51 | 0.1% | 29.52 |
| Del CE500 | 12.73 | 12.67 | 12.67 | 12.70 | 12.63 | 12.54 | 12.54 | 12.73 | 12.66 | 1.5% | 12.73 |
| CE530Apr30 | 16.79 | 16.83 | 16.83 | 16.81 | 16.88 | 16.96 | 16.79 | 16.96 | 16.85 | 1.0% | 16.79 |
| CE530Jun25 | 29.52 | 29.50 | 29.50 | 29.52 | 29.52 | 29.50 | 29.50 | 29.52 | 29.51 | 0.1% | 29.52 |
| Del CE530 | 12.73 | 12.67 | 12.67 | 12.70 | 12.63 | 12.54 | 12.54 | 12.73 | 12.66 | 1.5% | 12.73 |
| EDB (°C) | | | | | | | | | | | |
| CE500Apr30 | 24.64 | 24.94 | 24.94 | 24.98 | 25.00 | 25.00 | 24.64 | 25.00 | 24.92 | 1.4% | 25.00 |
| CE500Jun25 | 24.55 | 25.00 | 25.00 | 24.98 | 25.00 | 25.00 | 24.55 | 25.00 | 24.92 | 1.8% | 25.00 |
| Del CE500 | -0.09 | 0.06 | 0.06 | 0.00 | 0.00 | 0.00 | -0.09 | 0.06 | 0.00 | 4740.8% | 0.00 |
| CE530Apr30 | 24.37 | 24.94 | 24.67 | 25.00 | 25.00 | 25.00 | 24.37 | 25.00 | 24.83 | 2.6% | 25.00 |
| CE530Jun25 | 24.35 | 24.94 | 24.94 | 25.00 | 25.00 | 25.00 | 24.35 | 25.00 | 24.87 | 2.6% | 25.00 |
| Del CE530 | -0.01 | 0.00 | 0.28 | 0.00 | 0.00 | 0.00 | -0.01 | 0.28 | 0.04 | 651.2% | 0.00 |

* ABS[(Max-Min) / (Mean of Example Simulation Results)]

**IRAE Standard 140-2023 Test Results Comparison for Section 9 - HVAC Equipment Performance Tests CE300 through CE TRNSYS18.06.0002 (TRNSYS) vs. Annex B16, Section B16.5.2 Example Results
By Thermal Energy System Specialists, LLC (TESS), 19-Aug-2024.**

Note: The statistics in the tables below are based on the Standard 140 informative example results.
These statistics do not have any substantial importance and are not to be interpreted as acceptance criteria.

Table B16.5.2-16. June 28 Hourly Output - Case CE300

| TRNSYS-TUD Hour | Energy Consumption | | Evaporator Coil Load | | | Zone Hum. | COP2 | ODB (°C) | EDB (°C) | EWB (°C) | OHR (kg/kg) |
|--------------------|--------------------|------------------|----------------------|------------------|----------------|------------------|-------|-------------|-------------|-------------|----------------|
| | Compressor (Wh) | Cond Fan (Wh) | Total (Wh) | Sensible (Wh) | Latent (Wh) | Ratio (kg/kg) | | | | | |
| 1 | 2056 | 257 | 8132 | 6189 | 1942 | 0.0091 | 3.517 | 18.05 | 23.41 | 16.96 | 0.0113 |
| 2 | 2054 | 257 | 8116 | 6202 | 1914 | 0.0090 | 3.513 | 18.05 | 23.37 | 16.90 | 0.0113 |
| 3 | 2054 | 257 | 8128 | 6194 | 1934 | 0.0091 | 3.517 | 18.05 | 23.38 | 16.94 | 0.0113 |
| 4 | 1830 | 230 | 7224 | 5549 | 1676 | 0.0090 | 3.507 | 17.80 | 23.37 | 16.86 | 0.0111 |
| 5 | 2029 | 256 | 8105 | 6319 | 1786 | 0.0088 | 3.546 | 17.50 | 23.35 | 16.70 | 0.0106 |
| 6 | 1839 | 230 | 7131 | 5686 | 1445 | 0.0087 | 3.447 | 18.30 | 23.42 | 16.57 | 0.0106 |
| 7 | 2667 | 309 | 9711 | 7597 | 2115 | 0.0092 | 3.263 | 22.20 | 24.04 | 17.32 | 0.0121 |
| 8 | 3553 | 384 | 12121 | 9558 | 2563 | 0.0095 | 3.079 | 26.10 | 24.57 | 17.79 | 0.0122 |
| 9 | 4365 | 458 | 14556 | 11758 | 2798 | 0.0097 | 3.018 | 28.05 | 25.09 | 17.97 | 0.0115 |
| 10 | 4441 | 458 | 14639 | 11506 | 3133 | 0.0101 | 2.988 | 28.90 | 25.28 | 18.40 | 0.0124 |
| 11 | 5000 | 506 | 16374 | 12342 | 4032 | 0.0104 | 2.974 | 30.00 | 25.36 | 18.82 | 0.0138 |
| 12 | 5317 | 529 | 17248 | 12810 | 4438 | 0.0107 | 2.950 | 30.85 | 25.59 | 19.12 | 0.0140 |
| 13 | 6189 | 617 | 20498 | 16816 | 3682 | 0.0101 | 3.012 | 30.85 | 26.53 | 18.84 | 0.0123 |
| 14 | 6211 | 616 | 20234 | 17284 | 2951 | 0.0098 | 2.964 | 31.40 | 26.56 | 18.55 | 0.0115 |
| 15 | 7922 | 781 | 26687 | 22882 | 3805 | 0.0096 | 3.066 | 31.95 | 26.78 | 18.55 | 0.0121 |
| 16 | 7965 | 781 | 26723 | 22285 | 4438 | 0.0097 | 3.055 | 32.20 | 26.56 | 18.67 | 0.0133 |
| 17 | 5421 | 529 | 17231 | 13048 | 4183 | 0.0108 | 2.896 | 31.95 | 26.20 | 19.40 | 0.0145 |
| 18 | 5410 | 529 | 17506 | 12721 | 4785 | 0.0112 | 2.947 | 31.40 | 26.23 | 19.77 | 0.0152 |
| 19 | 5260 | 529 | 17662 | 12491 | 5171 | 0.0111 | 3.051 | 29.70 | 25.70 | 19.58 | 0.0151 |
| 20 | 4880 | 506 | 16990 | 11655 | 5335 | 0.0110 | 3.154 | 27.75 | 25.17 | 19.37 | 0.0157 |
| 21 | 3939 | 409 | 13540 | 8882 | 4658 | 0.0111 | 3.114 | 27.20 | 24.65 | 19.44 | 0.0169 |
| 22 | 3924 | 410 | 13565 | 8880 | 4684 | 0.0112 | 3.130 | 26.95 | 24.74 | 19.48 | 0.0169 |
| 23 | 4123 | 434 | 14531 | 9449 | 5082 | 0.0112 | 3.189 | 26.40 | 24.67 | 19.47 | 0.0169 |
| 24 | 3877 | 410 | 13692 | 8807 | 4885 | 0.0113 | 3.194 | 26.10 | 24.73 | 19.57 | 0.0171 |

| DOE-2.2 Hour | Energy Consumption | | Evaporator Coil Load | | | Zone Hum. | COP2 | ODB (°C) | EDB (°C) | EWB (°C) | OHR (kg/kg) |
|-----------------|--------------------|------------------|----------------------|------------------|----------------|------------------|-------|-------------|-------------|-------------|----------------|
| | Compressor (Wh) | Cond Fan (Wh) | Total (Wh) | Sensible (Wh) | Latent (Wh) | Ratio (kg/kg) | | | | | |
| 1 | 1897 | 237 | 7552 | 5889 | 1663 | 0.0094 | 3.539 | 17.78 | 23.83 | 17.34 | 0.0114 |
| 2 | 1941 | 240 | 7630 | 6070 | 1560 | 0.0093 | 3.499 | 18.33 | 23.94 | 17.29 | 0.0112 |
| 3 | 1897 | 237 | 7550 | 5881 | 1669 | 0.0094 | 3.538 | 17.78 | 23.83 | 17.34 | 0.0114 |
| 4 | 1891 | 237 | 7534 | 5878 | 1656 | 0.0094 | 3.540 | 17.78 | 23.83 | 17.34 | 0.0114 |
| 5 | 1697 | 215 | 6798 | 5675 | 1123 | 0.0089 | 3.555 | 17.22 | 23.78 | 16.85 | 0.0103 |
| 6 | 2126 | 259 | 8136 | 6439 | 1698 | 0.0092 | 3.411 | 19.44 | 24.11 | 17.30 | 0.0113 |
| 7 | 3198 | 352 | 11076 | 8342 | 2734 | 0.0100 | 3.120 | 25.00 | 24.94 | 18.39 | 0.0133 |
| 8 | 3135 | 332 | 10291 | 9070 | 1221 | 0.0094 | 2.968 | 27.22 | 25.28 | 17.78 | 0.0109 |
| 9 | 4528 | 469 | 14786 | 11873 | 2913 | 0.0099 | 2.959 | 28.89 | 25.56 | 18.36 | 0.0117 |
| 10 | 4651 | 479 | 15340 | 12039 | 3301 | 0.0103 | 2.990 | 28.89 | 25.56 | 18.68 | 0.0125 |
| 11 | 5434 | 537 | 17455 | 12812 | 4643 | 0.0109 | 2.923 | 31.11 | 25.89 | 19.48 | 0.0148 |
| 12 | 5019 | 498 | 16215 | 12612 | 3603 | 0.0108 | 2.939 | 30.56 | 25.83 | 19.23 | 0.0134 |
| 13 | 6040 | 597 | 19723 | 17139 | 2584 | 0.0101 | 2.972 | 31.11 | 25.94 | 18.56 | 0.0115 |
| 14 | 6420 | 633 | 20808 | 17638 | 3170 | 0.0100 | 2.950 | 31.67 | 26.06 | 18.60 | 0.0121 |
| 15 | 7671 | 751 | 25387 | 22196 | 3191 | 0.0098 | 3.014 | 32.22 | 26.11 | 18.46 | 0.0119 |
| 16 | 8190 | 800 | 27581 | 22528 | 5053 | 0.0100 | 3.068 | 32.22 | 26.17 | 18.84 | 0.0144 |
| 17 | 5715 | 561 | 18205 | 13599 | 4605 | 0.0107 | 2.901 | 31.67 | 26.06 | 19.35 | 0.0146 |
| 18 | 5536 | 544 | 17933 | 12830 | 5103 | 0.0112 | 2.950 | 31.11 | 25.94 | 19.75 | 0.0157 |
| 19 | 4711 | 481 | 16012 | 11876 | 4137 | 0.0110 | 3.084 | 28.33 | 25.50 | 19.32 | 0.0143 |
| 20 | 4859 | 504 | 17082 | 11532 | 5550 | 0.0114 | 3.185 | 27.22 | 25.33 | 19.76 | 0.0164 |
| 21 | 3913 | 405 | 13435 | 9302 | 4133 | 0.0113 | 3.111 | 27.22 | 25.33 | 19.76 | 0.0164 |
| 22 | 3825 | 399 | 13280 | 8974 | 4307 | 0.0114 | 3.144 | 26.67 | 25.22 | 19.80 | 0.0167 |
| 23 | 3750 | 395 | 13192 | 8787 | 4404 | 0.0115 | 3.183 | 26.11 | 25.11 | 19.84 | 0.0169 |
| 24 | 3880 | 407 | 13724 | 8799 | 4925 | 0.0117 | 3.201 | 26.11 | 25.11 | 20.14 | 0.0178 |

**IRAE Standard 140-2023 Test Results Comparison for Section 9 - HVAC Equipment Performance Tests CE300 through CE TRNSYS18.06.0002 (TRNSYS) vs. Annex B16, Section B16.5.2 Example Results
By Thermal Energy System Specialists, LLC (TESS), 19-Aug-2024.**

Note: The statistics in the tables below are based on the Standard 140 informative example results.
These statistics do not have any substantial importance and are not to be interpreted as acceptance criteria.

Table B16.5.2-16. June 28 Hourly Output - Case CE300 (continued)

| DOE-2.1E-E Hour | Energy Consumption | | Evaporator Coil Load | | | Zone Hum. | COP2 | ODB (°C) | EDB (°C) | EWB (°C) | OHR (kg/kg) |
|--------------------|--------------------|------------------|----------------------|------------------|----------------|------------------|-------|-------------|-------------|-------------|----------------|
| | Compressor (Wh) | Cond Fan (Wh) | Total (Wh) | Sensible (Wh) | Latent (Wh) | Ratio (kg/kg) | | | | | |
| 1 | 1894 | 237 | 7545 | 5887 | 1658 | 0.0094 | 3.541 | 17.78 | 23.83 | 17.34 | 0.0114 |
| 2 | 1941 | 241 | 7627 | 6067 | 1560 | 0.0093 | 3.495 | 18.33 | 23.94 | 17.29 | 0.0112 |
| 3 | 1894 | 237 | 7546 | 5878 | 1668 | 0.0094 | 3.541 | 17.78 | 23.83 | 17.37 | 0.0114 |
| 4 | 1890 | 236 | 7528 | 5873 | 1655 | 0.0094 | 3.541 | 17.78 | 23.83 | 17.37 | 0.0114 |
| 5 | 1694 | 215 | 6753 | 5672 | 1081 | 0.0090 | 3.537 | 17.22 | 23.78 | 16.94 | 0.0103 |
| 6 | 2133 | 259 | 8185 | 6439 | 1747 | 0.0092 | 3.422 | 19.44 | 24.11 | 17.30 | 0.0113 |
| 7 | 3223 | 353 | 11233 | 8348 | 2885 | 0.0098 | 3.141 | 25.00 | 24.94 | 18.23 | 0.0133 |
| 8 | 3145 | 335 | 10272 | 9069 | 1203 | 0.0094 | 2.952 | 27.22 | 25.28 | 17.78 | 0.0109 |
| 9 | 4526 | 467 | 14844 | 11875 | 2969 | 0.0099 | 2.973 | 28.89 | 25.56 | 18.28 | 0.0117 |
| 10 | 4655 | 478 | 15393 | 12041 | 3352 | 0.0102 | 2.999 | 28.89 | 25.56 | 18.60 | 0.0125 |
| 11 | 5456 | 536 | 17605 | 12818 | 4787 | 0.0107 | 2.938 | 31.11 | 25.89 | 19.33 | 0.0148 |
| 12 | 5015 | 498 | 16188 | 12611 | 3577 | 0.0108 | 2.936 | 30.56 | 25.83 | 19.23 | 0.0134 |
| 13 | 6036 | 600 | 19621 | 17135 | 2486 | 0.0102 | 2.957 | 31.11 | 25.94 | 18.64 | 0.0115 |
| 14 | 6429 | 635 | 20819 | 17639 | 3180 | 0.0100 | 2.947 | 31.67 | 26.06 | 18.60 | 0.0121 |
| 15 | 7683 | 754 | 25393 | 22197 | 3196 | 0.0098 | 3.010 | 32.22 | 26.11 | 18.46 | 0.0119 |
| 16 | 8222 | 803 | 27721 | 22533 | 5188 | 0.0098 | 3.072 | 32.22 | 26.17 | 18.76 | 0.0144 |
| 17 | 5696 | 556 | 18245 | 13600 | 4644 | 0.0107 | 2.918 | 31.67 | 26.06 | 19.35 | 0.0146 |
| 18 | 5531 | 541 | 17978 | 12832 | 5146 | 0.0112 | 2.961 | 31.11 | 25.94 | 19.68 | 0.0157 |
| 19 | 4689 | 479 | 15914 | 11871 | 4043 | 0.0111 | 3.079 | 28.33 | 25.50 | 19.40 | 0.0143 |
| 20 | 4855 | 503 | 17120 | 11534 | 5586 | 0.0113 | 3.195 | 27.22 | 25.33 | 19.76 | 0.0164 |
| 21 | 3918 | 406 | 13445 | 9303 | 4142 | 0.0113 | 3.109 | 27.22 | 25.33 | 19.76 | 0.0164 |
| 22 | 3823 | 399 | 13285 | 8974 | 4311 | 0.0114 | 3.147 | 26.67 | 25.22 | 19.80 | 0.0167 |
| 23 | 3748 | 394 | 13192 | 8787 | 4405 | 0.0115 | 3.185 | 26.11 | 25.11 | 19.84 | 0.0169 |
| 24 | 3880 | 407 | 13754 | 8800 | 4955 | 0.0117 | 3.208 | 26.11 | 25.11 | 20.06 | 0.0178 |

| EnergyPlus Hour | Energy Consumption | | Evaporator Coil Load | | | Zone Hum. | COP2 | ODB (°C) | EDB (°C) | EWB (°C) | OHR (kg/kg) |
|--------------------|----------------------|--------------------|----------------------|------------------|----------------|------------------|-------|-------------|-------------|-------------|----------------|
| | Compressor (Wh) * | Cond Fan (Wh) * | Total (Wh) | Sensible (Wh) | Latent (Wh) | Ratio (kg/kg) | | | | | |
| 1 | 2119 | | 7472 | 5811 | 1661 | 0.0094 | 3.527 | 17.99 | 23.95 | | 0.0112 |
| 2 | 2131 | | 7494 | 5853 | 1641 | 0.0094 | 3.516 | 18.11 | 23.96 | | 0.0113 |
| 3 | 2113 | | 7447 | 5809 | 1637 | 0.0094 | 3.525 | 17.99 | 23.95 | | 0.0112 |
| 4 | 2075 | | 7332 | 5744 | 1588 | 0.0093 | 3.534 | 17.80 | 23.92 | | 0.0111 |
| 5 | 1997 | | 7091 | 5614 | 1477 | 0.0092 | 3.550 | 17.43 | 23.86 | | 0.0105 |
| 6 | 2142 | | 7425 | 6015 | 1410 | 0.0090 | 3.467 | 18.58 | 24.03 | | 0.0106 |
| 7 | 2870 | | 9216 | 7532 | 1684 | 0.0093 | 3.212 | 22.90 | 24.68 | | 0.0123 |
| 8 | 3499 | | 10609 | 8757 | 1853 | 0.0096 | 3.033 | 26.38 | 25.21 | | 0.0118 |
| 9 | 4682 | | 14032 | 11767 | 2265 | 0.0098 | 2.997 | 28.26 | 25.49 | | 0.0116 |
| 10 | 4948 | | 14778 | 11996 | 2781 | 0.0102 | 2.987 | 28.90 | 25.59 | | 0.0124 |
| 11 | 5407 | | 15905 | 12488 | 3417 | 0.0106 | 2.942 | 30.28 | 25.79 | | 0.0140 |
| 12 | 5632 | | 16522 | 12671 | 3851 | 0.0109 | 2.933 | 30.79 | 25.87 | | 0.0138 |
| 13 | 7133 | | 21588 | 17401 | 4187 | 0.0104 | 3.027 | 30.91 | 25.88 | | 0.0120 |
| 14 | 6983 | | 20678 | 17592 | 3086 | 0.0100 | 2.961 | 31.48 | 25.97 | | 0.0115 |
| 15 | 8572 | | 26133 | 22481 | 3652 | 0.0098 | 3.049 | 32.01 | 26.05 | | 0.0121 |
| 16 | 8733 | | 26665 | 22557 | 4107 | 0.0099 | 3.053 | 32.20 | 26.08 | | 0.0135 |
| 17 | 5718 | | 16345 | 13061 | 3283 | 0.0106 | 2.858 | 31.89 | 26.04 | | 0.0145 |
| 18 | 5881 | | 17193 | 12870 | 4324 | 0.0112 | 2.924 | 31.33 | 25.95 | | 0.0153 |
| 19 | 5555 | | 16878 | 12170 | 4708 | 0.0113 | 3.038 | 29.35 | 25.65 | | 0.0149 |
| 20 | 5259 | | 16536 | 11556 | 4981 | 0.0113 | 3.144 | 27.61 | 25.39 | | 0.0159 |
| 21 | 4326 | | 13445 | 9063 | 4383 | 0.0116 | 3.108 | 27.20 | 25.33 | | 0.0168 |
| 22 | 4279 | | 13387 | 8953 | 4434 | 0.0116 | 3.129 | 26.89 | 25.29 | | 0.0168 |
| 23 | 4173 | | 13191 | 8753 | 4437 | 0.0116 | 3.161 | 26.33 | 25.20 | | 0.0168 |
| 24 | 4152 | | 13196 | 8674 | 4522 | 0.0117 | 3.178 | 26.10 | 25.17 | | 0.0171 |

* For EnergyPlus results, the reported compressor energy includes the condenser fan energy.

**IRAE Standard 140-2023 Test Results Comparison for Section 9 - HVAC Equipment Performance Tests CE300 through CE TRNSYS18.06.0002 (TRNSYS) vs. Annex B16, Section B16.5.2 Example Results
By Thermal Energy System Specialists, LLC (TESS), 19-Aug-2024.**

Note: The statistics in the tables below are based on the Standard 140 informative example results.
These statistics do not have any substantial importance and are not to be interpreted as acceptance criteria.

Table B16.5.2-16. June 28 Hourly Output - Case CE300 (continued)

| CODYRUN Hour | Energy Consumption | | Evaporator Coil Load | | | Zone Hum. | COP2 | ODB (°C) | EDB (°C) | EWB (°C) | OHR (kg/kg) |
|-----------------|--------------------|------------------|----------------------|------------------|----------------|------------------|-------|-------------|-------------|-------------|----------------|
| | Compressor (Wh) | Cond Fan (Wh) | Total (Wh) | Sensible (Wh) | Latent (Wh) | Ratio (kg/kg) | | | | | |
| 1 | 1886 | 237 | 7472 | 5788 | 1684 | 0.0093 | 3.520 | 17.80 | 23.92 | 17.16 | 0.0111 |
| 2 | 1964 | 244 | 7707 | 5961 | 1747 | 0.0093 | 3.490 | 18.30 | 24.00 | 17.24 | 0.0115 |
| 3 | 1881 | 236 | 7445 | 5788 | 1657 | 0.0092 | 3.517 | 17.80 | 23.92 | 17.12 | 0.0111 |
| 4 | 1878 | 236 | 7432 | 5788 | 1644 | 0.0092 | 3.516 | 17.80 | 23.92 | 17.10 | 0.0111 |
| 5 | 1756 | 224 | 7000 | 5580 | 1420 | 0.0090 | 3.535 | 17.20 | 23.83 | 16.79 | 0.0102 |
| 6 | 2075 | 253 | 7915 | 6341 | 1574 | 0.0090 | 3.400 | 19.40 | 24.16 | 17.03 | 0.0110 |
| 7 | 3035 | 334 | 10450 | 8277 | 2173 | 0.0095 | 3.102 | 25.00 | 25.00 | 17.91 | 0.0131 |
| 8 | 3303 | 352 | 10813 | 9038 | 1775 | 0.0093 | 2.958 | 27.20 | 25.33 | 17.65 | 0.0111 |
| 9 | 4483 | 463 | 14631 | 11971 | 2660 | 0.0097 | 2.958 | 28.90 | 25.59 | 18.12 | 0.0120 |
| 10 | 4594 | 472 | 15099 | 11971 | 3128 | 0.0100 | 2.980 | 28.90 | 25.59 | 18.44 | 0.0128 |
| 11 | 5238 | 516 | 16722 | 12731 | 3991 | 0.0106 | 2.906 | 31.10 | 25.91 | 19.14 | 0.0148 |
| 12 | 5066 | 504 | 16258 | 12559 | 3699 | 0.0106 | 2.919 | 30.60 | 25.84 | 18.94 | 0.0133 |
| 13 | 6442 | 642 | 21090 | 17422 | 3669 | 0.0100 | 2.977 | 31.10 | 25.91 | 18.33 | 0.0113 |
| 14 | 6523 | 645 | 21067 | 17629 | 3438 | 0.0098 | 2.939 | 31.70 | 26.00 | 18.27 | 0.0117 |
| 15 | 8000 | 785 | 26636 | 22491 | 4145 | 0.0096 | 3.032 | 32.20 | 26.08 | 18.24 | 0.0124 |
| 16 | 8169 | 799 | 27416 | 22491 | 4925 | 0.0097 | 3.057 | 32.20 | 26.08 | 18.56 | 0.0142 |
| 17 | 5306 | 519 | 16702 | 12939 | 3763 | 0.0104 | 2.867 | 31.70 | 26.00 | 19.06 | 0.0147 |
| 18 | 5381 | 528 | 17312 | 12729 | 4582 | 0.0109 | 2.930 | 31.10 | 25.91 | 19.46 | 0.0157 |
| 19 | 4791 | 492 | 16232 | 11761 | 4470 | 0.0109 | 3.072 | 28.30 | 25.50 | 19.20 | 0.0145 |
| 20 | 4809 | 498 | 16867 | 11381 | 5486 | 0.0113 | 3.178 | 27.20 | 25.33 | 19.65 | 0.0169 |
| 21 | 3939 | 408 | 13484 | 9036 | 4447 | 0.0113 | 3.102 | 27.20 | 25.33 | 19.71 | 0.0169 |
| 22 | 3852 | 402 | 13322 | 8864 | 4459 | 0.0114 | 3.132 | 26.70 | 25.25 | 19.70 | 0.0168 |
| 23 | 3752 | 395 | 13139 | 8656 | 4482 | 0.0114 | 3.168 | 26.10 | 25.16 | 19.69 | 0.0169 |
| 24 | 3794 | 399 | 13323 | 8656 | 4666 | 0.0115 | 3.177 | 26.10 | 25.16 | 19.81 | 0.0173 |

| HOT3000 Hour | Energy Consumption | | Evaporator Coil Load | | | Zone Hum. | COP2 | ODB (°C) | EDB (°C) | EWB (°C) | OHR (kg/kg) |
|-----------------|--------------------|------------------|----------------------|------------------|----------------|------------------|-------|-------------|-------------|-------------|----------------|
| | Compressor (Wh) | Cond Fan (Wh) | Total (Wh) | Sensible (Wh) | Latent (Wh) | Ratio (kg/kg) | | | | | |
| 1 | 1943 | 241 | 7668 | 5870 | 1798 | 0.0093 | 3.511 | 17.80 | 23.94 | 17.30 | 0.0111 |
| 2 | 1951 | 241 | 7674 | 5872 | 1803 | 0.0093 | 3.502 | 18.30 | 23.94 | 17.31 | 0.0114 |
| 3 | 1902 | 237 | 7528 | 5783 | 1745 | 0.0092 | 3.519 | 17.80 | 23.90 | 17.24 | 0.0111 |
| 4 | 1845 | 231 | 7317 | 5683 | 1634 | 0.0091 | 3.524 | 17.80 | 23.84 | 17.08 | 0.0111 |
| 5 | 1914 | 239 | 7514 | 5955 | 1559 | 0.0090 | 3.490 | 17.20 | 23.98 | 17.01 | 0.0102 |
| 6 | 2507 | 293 | 9223 | 7312 | 1911 | 0.0092 | 3.295 | 19.40 | 24.58 | 17.54 | 0.0110 |
| 7 | 3171 | 343 | 10770 | 8647 | 2123 | 0.0095 | 3.065 | 25.00 | 25.16 | 17.99 | 0.0131 |
| 8 | 3434 | 361 | 11186 | 9299 | 1888 | 0.0094 | 2.948 | 27.20 | 25.45 | 17.96 | 0.0110 |
| 9 | 4489 | 461 | 14744 | 11923 | 2821 | 0.0097 | 2.979 | 28.90 | 25.58 | 18.33 | 0.0120 |
| 10 | 4853 | 489 | 15882 | 12287 | 3595 | 0.0102 | 2.973 | 28.90 | 25.74 | 18.85 | 0.0127 |
| 11 | 5164 | 508 | 16615 | 12562 | 4053 | 0.0106 | 2.929 | 31.10 | 25.86 | 19.19 | 0.0148 |
| 12 | 5005 | 497 | 16030 | 12561 | 3468 | 0.0104 | 2.914 | 30.60 | 25.86 | 18.87 | 0.0132 |
| 13 | 6455 | 639 | 21180 | 17431 | 3749 | 0.0100 | 2.986 | 31.10 | 25.94 | 18.52 | 0.0113 |
| 14 | 6503 | 640 | 21055 | 17609 | 3447 | 0.0097 | 2.948 | 31.70 | 26.02 | 18.44 | 0.0117 |
| 15 | 8041 | 785 | 27070 | 22350 | 4719 | 0.0098 | 3.067 | 32.20 | 26.13 | 18.65 | 0.0123 |
| 16 | 8134 | 794 | 27623 | 22292 | 5331 | 0.0098 | 3.094 | 32.20 | 26.03 | 18.80 | 0.0142 |
| 17 | 5212 | 510 | 16551 | 12739 | 3812 | 0.0103 | 2.893 | 31.70 | 25.94 | 19.11 | 0.0147 |
| 18 | 5122 | 507 | 16830 | 12181 | 4649 | 0.0109 | 2.990 | 31.10 | 25.70 | 19.39 | 0.0156 |
| 19 | 4832 | 493 | 16635 | 11541 | 5095 | 0.0110 | 3.124 | 28.30 | 25.41 | 19.53 | 0.0145 |
| 20 | 4875 | 501 | 17131 | 11359 | 5772 | 0.0114 | 3.187 | 27.20 | 25.33 | 19.74 | 0.0168 |
| 21 | 3936 | 406 | 13525 | 8931 | 4593 | 0.0114 | 3.115 | 27.20 | 25.29 | 19.74 | 0.0168 |
| 22 | 3844 | 399 | 13356 | 8747 | 4609 | 0.0114 | 3.148 | 26.70 | 25.21 | 19.79 | 0.0168 |
| 23 | 3807 | 397 | 13343 | 8647 | 4697 | 0.0114 | 3.173 | 26.10 | 25.16 | 19.84 | 0.0168 |
| 24 | 3664 | 386 | 12973 | 8360 | 4613 | 0.0115 | 3.203 | 26.10 | 25.04 | 19.77 | 0.0173 |

**IRAE Standard 140-2023 Test Results Comparison for Section 9 - HVAC Equipment Performance Tests CE300 through CE TRNSYS18.06.0002 (TRNSYS) vs. Annex B16, Section B16.5.2 Example Results
By Thermal Energy System Specialists, LLC (TESS), 19-Aug-2024.**

Note: The statistics in the tables below are based on the Standard 140 informative example results.
These statistics do not have any substantial importance and are not to be interpreted as acceptance criteria.

Table B16.5.2-16. June 28 Hourly Output - Case CE300 (continued)

| TRNSYS Hour | Energy Consumption | | Evaporator Coil Load | | | Zone Hum. | COP2 | ODB (°C) | EDB (°C) | EWB (°C) | OHR (kg/kg) |
|----------------|--------------------|------------------|----------------------|------------------|----------------|------------------|-------|-------------|-------------|-------------|----------------|
| | Compressor (Wh) | Cond Fan (Wh) | Total (Wh) | Sensible (Wh) | Latent (Wh) | Ratio (kg/kg) | | | | | |
| 1 | 1969 | 245 | 7759 | 5926 | 1833 | 0.0094 | 3.504 | 18.05 | 23.96 | 17.18 | 0.0112 |
| 2 | 1954 | 243 | 7689 | 5894 | 1795 | 0.0094 | 3.500 | 18.05 | 23.95 | 17.13 | 0.0113 |
| 3 | 1967 | 245 | 7747 | 5925 | 1822 | 0.0094 | 3.503 | 18.05 | 23.96 | 17.16 | 0.0112 |
| 4 | 1918 | 240 | 7580 | 5826 | 1754 | 0.0094 | 3.513 | 17.80 | 23.92 | 17.09 | 0.0111 |
| 5 | 1853 | 233 | 7338 | 5726 | 1612 | 0.0092 | 3.518 | 17.50 | 23.87 | 16.91 | 0.0106 |
| 6 | 1937 | 241 | 7521 | 5995 | 1527 | 0.0090 | 3.454 | 18.30 | 23.99 | 16.79 | 0.0105 |
| 7 | 2589 | 298 | 9375 | 7314 | 2061 | 0.0095 | 3.247 | 22.20 | 24.58 | 17.47 | 0.0120 |
| 8 | 3261 | 351 | 10995 | 8631 | 2365 | 0.0099 | 3.044 | 26.10 | 25.17 | 17.95 | 0.0121 |
| 9 | 4359 | 455 | 14461 | 11631 | 2830 | 0.0098 | 3.004 | 28.05 | 25.46 | 17.98 | 0.0115 |
| 10 | 4619 | 474 | 15187 | 11916 | 3272 | 0.0103 | 2.982 | 28.90 | 25.59 | 18.41 | 0.0123 |
| 11 | 4978 | 500 | 16185 | 12284 | 3900 | 0.0109 | 2.955 | 30.00 | 25.75 | 18.91 | 0.0137 |
| 12 | 5226 | 516 | 16808 | 12570 | 4238 | 0.0112 | 2.927 | 30.85 | 25.88 | 19.25 | 0.0140 |
| 13 | 6470 | 646 | 21369 | 17260 | 4109 | 0.0102 | 3.003 | 30.85 | 25.88 | 18.40 | 0.0122 |
| 14 | 6404 | 637 | 20741 | 17431 | 3310 | 0.0096 | 2.946 | 31.40 | 25.96 | 17.99 | 0.0115 |
| 15 | 7878 | 778 | 26275 | 22315 | 3960 | 0.0095 | 3.035 | 31.95 | 26.05 | 17.95 | 0.0120 |
| 16 | 8046 | 790 | 26857 | 22407 | 4449 | 0.0099 | 3.040 | 32.20 | 26.09 | 18.27 | 0.0133 |
| 17 | 5360 | 522 | 16816 | 12936 | 3879 | 0.0112 | 2.859 | 31.95 | 26.05 | 19.25 | 0.0144 |
| 18 | 5433 | 531 | 17398 | 12750 | 4648 | 0.0117 | 2.917 | 31.40 | 25.97 | 19.64 | 0.0152 |
| 19 | 5180 | 518 | 17195 | 12180 | 5015 | 0.0116 | 3.018 | 29.70 | 25.71 | 19.50 | 0.0151 |
| 20 | 4840 | 498 | 16707 | 11531 | 5175 | 0.0116 | 3.129 | 27.75 | 25.42 | 19.38 | 0.0157 |
| 21 | 3967 | 410 | 13594 | 8996 | 4598 | 0.0120 | 3.106 | 27.20 | 25.33 | 19.67 | 0.0168 |
| 22 | 3928 | 408 | 13527 | 8926 | 4601 | 0.0120 | 3.120 | 26.95 | 25.30 | 19.66 | 0.0168 |
| 23 | 3829 | 401 | 13330 | 8744 | 4586 | 0.0120 | 3.151 | 26.40 | 25.22 | 19.64 | 0.0168 |
| 24 | 3790 | 398 | 13285 | 8627 | 4659 | 0.0121 | 3.172 | 26.10 | 25.17 | 19.67 | 0.0170 |

**ASHRAE Standard 140-2023 Test Results Comparison for Section 9 - HVAC Equipment Performance Tests CE300 through CE545
 TRNSYS18.06.0002 (TRNSYS) vs. Annex B16, Section B16.5.2 Example Results
 By Thermal Energy System Specialists, LLC (TESS), 19-Aug-2024.**

Note: The statistics in the tables below are based on the Standard 140 informative example results.
 These statistics do not have any substantial importance and are not to be interpreted as acceptance criteria.

Table B16.5.2-17. Delta Annual Space Cooling Electricity Consumptions (Total, Compressor)

| Total (kWh,e) | | | | | | | Statistics, All Results | | | | TRNSYS TESS |
|----------------------|-----------------------|-------------------------|--------------------------|----------------------------|-----------------------|--------------------------|--------------------------------|------------|--------------------------------------|-------|------------------------|
| Case | TRNSYS TUD | DOE-2.2 NREL | DOE21E-E NREL | EnergyPlus GARD | CODYRUN UR | HOT3000 NRCan | Min | Max | Mean (Max-Min) /Mean* | | |
| CE310-CE300 | 4340 | 4629 | 4629 | 4545 | 4543 | 4538 | 4340 | 4629 | 4537 | 6.4% | 4466 |
| CE320-CE300 | 4426 | 3995 | 4037 | 4333 | 4424 | 4387 | 3995 | 4426 | 4267 | 10.1% | 4546 |
| CE330-CE300 | 5330 | 4958 | 4683 | 5398 | 5559 | 5260 | 4683 | 5559 | 5198 | 16.8% | 5480 |
| CE330-CE320 | 904 | 963 | 646 | 1064 | 1134 | 873 | 646 | 1134 | 931 | 52.5% | 934 |
| CE340-CE300 | 4986 | 4608 | 4510 | 5037 | 5089 | 4877 | 4510 | 5089 | 4851 | 11.9% | 5166 |
| CE330-CE340 | 344 | 350 | 173 | 360 | 470 | 383 | 173 | 470 | 347 | 85.6% | 314 |
| CE350-CE300 | -3397 | -4203 | -4207 | -3601 | -3390 | -3328 | -4207 | -3328 | -3688 | 23.8% | -3319 |
| CE360-CE300 | 19665 | 19314 | 19261 | 19959 | 19867 | 19998 | 19261 | 19998 | 19677 | 3.7% | 20021 |
| CE400-CE300 | -3589 | -3904 | -3879 | -3733 | | -3657 | -3904 | -3589 | -3752 | 8.4% | -3268 |
| CE410-CE300 | -3555 | -3082 | -3056 | | | -3567 | -3567 | -3056 | -3315 | 15.4% | -1523 |
| CE420-CE300 | -2247 | -2220 | -1845 | -2010 | | -1862 | -2247 | -1845 | -2037 | 19.7% | -1733 |
| CE430-CE300 | -3096 | -2818 | -2944 | -2973 | | -3252 | -3252 | -2818 | -3017 | 14.4% | -2512 |
| CE440-CE300 | -1942 | -1718 | -1782 | -1714 | | -1822 | -1942 | -1714 | -1796 | 12.7% | -1604 |
| CE500-CE300 | -13296 | -11933 | -11933 | -11711 | -12653 | -11932 | -13296 | -11711 | -12243 | 12.9% | -11869 |
| CE510-CE500 | 17218 | 18099 | 18100 | 17736 | 17414 | 17794 | 17218 | 18100 | 17727 | 5.0% | 17849 |
| CE525-CE520 | -4666 | -4981 | -4969 | -4316 | -4889 | -4458 | -4981 | -4316 | -4713 | 14.1% | -5284 |
| CE530-CE500 | -5057 | -5277 | -5285 | -5293 | -4880 | -5263 | -5293 | -4880 | -5176 | 8.0% | -6070 |
| CE545-CE540 | -3743 | -4076 | -4083 | -2425 | -3745 | -3825 | -4083 | -2425 | -3650 | 45.4% | -7950 |

| Compressor (kWh,e) | | | | | | | Statistics, All Results | | | | TRNSYS TESS |
|---------------------------|-----------------------|-------------------------|--------------------------|----------------------------|-----------------------|--------------------------|--------------------------------|------------|--------------------------------------|-------|------------------------|
| Case | TRNSYS TUD | DOE-2.2 NREL | DOE21E-E NREL | EnergyPlus GARD | CODYRUN UR | HOT3000 NRCan | Min | Max | Mean (Max-Min) /Mean* | | |
| CE310-CE300 | 3986 | 4244 | 4244 | | 4167 | 4177 | 3986 | 4244 | 4164 | 6.2% | 4094 |
| CE320-CE300 | 4080 | 3681 | 3721 | | 4076 | 4036 | 3681 | 4080 | 3919 | 10.2% | 4190 |
| CE330-CE300 | 4946 | 4603 | 4352 | | 5158 | 4899 | 4352 | 5158 | 4792 | 16.8% | 5088 |
| CE330-CE320 | 867 | 922 | 631 | | 1082 | 863 | 631 | 1082 | 873 | 51.6% | 899 |
| CE340-CE300 | 4609 | 4260 | 4172 | | 4703 | 4524 | 4172 | 4703 | 4454 | 11.9% | 4774 |
| CE330-CE340 | 337 | 343 | 180 | | 455 | 375 | 180 | 455 | 338 | 81.4% | 314 |
| CE350-CE300 | -3037 | -3767 | -3772 | | -3032 | -2985 | -3772 | -2985 | -3319 | 23.7% | -2969 |
| CE360-CE300 | 17752 | 17430 | 17382 | | 17927 | 18065 | 17382 | 18065 | 17711 | 3.9% | 18069 |
| CE400-CE300 | -3175 | -3463 | -3442 | | | -3247 | -3463 | -3175 | -3332 | 8.7% | -2893 |
| CE410-CE300 | -3149 | -2746 | -2723 | | | -3191 | -3191 | -2723 | -2952 | 15.9% | -1353 |
| CE420-CE300 | -1995 | -1973 | -1639 | | | -1662 | -1995 | -1639 | -1817 | 19.6% | -1539 |
| CE430-CE300 | -2755 | -2510 | -2622 | | | -2910 | -2910 | -2510 | -2699 | 14.8% | -2238 |
| CE440-CE300 | -1724 | -1527 | -1584 | | | -1627 | -1724 | -1527 | -1616 | 12.2% | -1426 |
| CE500-CE300 | -4499 | -3096 | -3095 | | -3912 | -3354 | -4499 | -3095 | -3591 | 39.1% | -3305 |
| CE510-CE500 | 13806 | 14303 | 14304 | | 13913 | 14230 | 13806 | 14304 | 14111 | 3.5% | 14258 |
| CE525-CE520 | -2963 | -3241 | -3233 | | -3148 | -2742 | -3241 | -2742 | -3066 | 16.3% | -3424 |
| CE530-CE500 | -4197 | -4346 | -4354 | | -4002 | -4350 | -4354 | -4002 | -4250 | 8.3% | -4999 |
| CE545-CE540 | -2399 | -2713 | -2720 | | -2413 | -2449 | -2720 | -2399 | -2539 | 12.6% | -5922 |

* ABS[(Max-Min) / (Mean of Example Simulation Results)]

**ASHRAE Standard 140-2023 Test Results Comparison for Section 9 - HVAC Equipment Performance Tests CE300 through CE545
 TRNSYS18.06.0002 (TRNSYS) vs. Annex B16, Section B16.5.2 Example Results
 By Thermal Energy System Specialists, LLC (TESS), 19-Aug-2024.**

Note: The statistics in the tables below are based on the Standard 140 informative example results.
 These statistics do not have any substantial importance and are not to be interpreted as acceptance criteria.

Table B16.5.2-18. Delta Annual Space Cooling Electricity Consumptions (Fans)

| Supply Fan (kWh,e) | | | | | | | Statistics, All Results | | | | TRNSYS TESS |
|--------------------|---------------|-----------------|------------------|--------------------|---------------|------------------|-------------------------|-------|-------|---------------------|----------------|
| Case | TRNSYS TUD | DOE-2.2 NREL | DOE21E-E NREL | EnergyPlus GARD | CODYRUN UR | HOT3000 NRCan | Min | Max | Mean | (Max-Min) /Mean* | |
| CE310-CE300 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | ---- | 0 |
| CE320-CE300 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | ---- | 0 |
| CE330-CE300 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | ---- | 0 |
| CE330-CE320 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | ---- | 0 |
| CE340-CE300 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | ---- | 0 |
| CE330-CE340 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | ---- | 0 |
| CE350-CE300 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | ---- | 0 |
| CE360-CE300 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | ---- | 0 |
| CE400-CE300 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | ---- | 0 |
| CE410-CE300 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | ---- | 0 |
| CE420-CE300 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | ---- | 0 |
| CE430-CE300 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | ---- | 0 |
| CE440-CE300 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | ---- | 0 |
| CE500-CE300 | -8316 | -8511 | -8511 | -8234 | -8327 | -8241 | -8511 | -8234 | -8357 | 3.3% | -8218 |
| CE510-CE500 | 1951 | 2262 | 2262 | 2034 | 2002 | 2038 | 1951 | 2262 | 2092 | 14.9% | 2053 |
| CE525-CE520 | -973 | -988 | -986 | -839 | -996 | -979 | -996 | -839 | -960 | 16.3% | -1063 |
| CE530-CE500 | -491 | -536 | -536 | -538 | -502 | -522 | -538 | -491 | -521 | 9.0% | -613 |
| CE545-CE540 | -769 | -757 | -757 | -438 | -762 | -787 | -787 | -438 | -712 | 49.0% | -1160 |

| Condenser Fan (kWh,e) | | | | | | | Statistics, All Results | | | | TRNSYS TESS |
|-----------------------|---------------|-----------------|------------------|--------------------|---------------|------------------|-------------------------|------|------|---------------------|----------------|
| Case | TRNSYS TUD | DOE-2.2 NREL | DOE21E-E NREL | EnergyPlus GARD | CODYRUN UR | HOT3000 NRCan | Min | Max | Mean | (Max-Min) /Mean* | |
| CE310-CE300 | 354 | 385 | 385 | | 376 | 368 | 354 | 385 | 374 | 8.4% | 372 |
| CE320-CE300 | 346 | 314 | 316 | | 348 | 358 | 314 | 358 | 337 | 13.1% | 357 |
| CE330-CE300 | 383 | 355 | 331 | | 401 | 370 | 331 | 401 | 368 | 19.0% | 392 |
| CE330-CE320 | 37 | 41 | 15 | | 53 | 12 | 12 | 53 | 32 | 128.8% | 35 |
| CE340-CE300 | 376 | 348 | 338 | | 386 | 361 | 338 | 386 | 362 | 13.3% | 392 |
| CE330-CE340 | 7 | 7 | -7 | | 15 | 9 | -7 | 15 | 6 | 352.1% | 0 |
| CE350-CE300 | -360 | -436 | -435 | | -358 | -353 | -436 | -353 | -388 | 21.4% | -350 |
| CE360-CE300 | 1913 | 1884 | 1879 | | 1940 | 1949 | 1879 | 1949 | 1913 | 3.7% | 1952 |
| CE400-CE300 | -414 | -441 | -437 | | | -421 | -441 | -414 | -428 | 6.3% | -375 |
| CE410-CE300 | -406 | -336 | -333 | | | -387 | -406 | -333 | -366 | 20.1% | -169 |
| CE420-CE300 | -252 | -247 | -206 | | | -208 | -252 | -206 | -228 | 20.1% | -193 |
| CE430-CE300 | -341 | -308 | -322 | | | -353 | -353 | -308 | -331 | 13.6% | -274 |
| CE440-CE300 | -218 | -191 | -198 | | | -203 | -218 | -191 | -203 | 13.4% | -178 |
| CE500-CE300 | -481 | -326 | -327 | | -415 | -347 | -481 | -326 | -379 | 40.8% | -346 |
| CE510-CE500 | 1461 | 1534 | 1534 | | 1499 | 1526 | 1461 | 1534 | 1511 | 4.8% | 1537 |
| CE525-CE520 | -729 | -752 | -750 | | -746 | -733 | -752 | -729 | -742 | 3.1% | -796 |
| CE530-CE500 | -368 | -395 | -395 | | -376 | -391 | -395 | -368 | -385 | 7.0% | -459 |
| CE545-CE540 | -576 | -606 | -606 | | -571 | -589 | -606 | -571 | -589 | 6.0% | -868 |

* ABS[(Max-Min) / (Mean of Example Simulation Results)]

**ASHRAE Standard 140-2023 Test Results Comparison for Section 9 - HVAC Equipment Performance Tests CE300 through CE545
 TRNSYS18.06.0002 (TRNSYS) vs. Annex B16, Section B16.5.2 Example Results
 By Thermal Energy System Specialists, LLC (TESS), 19-Aug-2024.**

Note: The statistics in the tables below are based on the Standard 140 informative example results.
 These statistics do not have any substantial importance and are not to be interpreted as acceptance criteria.

Table B16.5.2-19. Delta Annual Cooling Coil Loads

| Sensible Coil Load (kWh,th) | | | | | | | Statistics, All Results | | | | TRNSYS TESS |
|-----------------------------|---------------|-----------------|------------------|--------------------|---------------|------------------|-------------------------|--------|-----------------------------|---------|----------------|
| Case | TRNSYS TUD | DOE-2.2 NREL | DOE21E-E NREL | EnergyPlus GARD | CODYRUN UR | HOT3000 NRCan | Min | Max | Mean (Max-Min) /Mean* | | |
| CE310-CE300 | -405 | 504 | 508 | -27 | -24 | -108 | -405 | 508 | 75 | 1224.5% | -20 |
| CE320-CE300 | 6197 | 6900 | 6942 | 6791 | 6799 | 7543 | 6197 | 7543 | 6862 | 19.6% | 6757 |
| CE330-CE300 | 6422 | 7514 | 7523 | 8527 | 7440 | 6631 | 6422 | 8527 | 7343 | 28.7% | 7179 |
| CE330-CE320 | 224 | 614 | 581 | 1735 | 641 | -912 | -912 | 1735 | 480 | 550.9% | 422 |
| CE340-CE300 | 6371 | 7257 | 7306 | 7634 | 7171 | 6215 | 6215 | 7634 | 6992 | 20.3% | 7077 |
| CE330-CE340 | 51 | 258 | 217 | 893 | 269 | 416 | 51 | 893 | 351 | 240.2% | 102 |
| CE350-CE300 | -6291 | -8112 | -8128 | -6707 | -6621 | -6423 | -8128 | -6291 | -7047 | 26.1% | -6186 |
| CE360-CE300 | 78315 | 79123 | 79135 | 80035 | 78996 | 79506 | 78315 | 80035 | 79185 | 2.2% | 79411 |
| CE400-CE300 | -14709 | -14378 | -14368 | -14564 | | -14010 | -14709 | -14010 | -14406 | 4.9% | -12928 |
| CE410-CE300 | -10985 | -8138 | -8145 | | | -9606 | -10985 | -8138 | -9219 | 30.9% | -4201 |
| CE420-CE300 | -6272 | -6131 | -5193 | -5728 | | -5207 | -6272 | -5193 | -5706 | 18.9% | -4834 |
| CE430-CE300 | -8798 | -8066 | -8351 | -8513 | | -9048 | -9048 | -8066 | -8555 | 11.5% | -6999 |
| CE440-CE300 | -5786 | -5204 | -5313 | -5192 | | -5406 | -5786 | -5192 | -5380 | 11.0% | -4616 |
| CE500-CE300 | -11618 | -8147 | -8159 | -7761 | -10335 | -7661 | -11618 | -7661 | -8947 | 44.2% | -7817 |
| CE510-CE500 | 43046 | 45710 | 45710 | 45091 | 43051 | 45083 | 43046 | 45710 | 44615 | 6.0% | 45076 |
| CE525-CE520 | -131 | -884 | -882 | -1057 | -202 | -949 | -1057 | -131 | -684 | 135.4% | -1295 |
| CE530-CE500 | 2 | -1076 | -1076 | -547 | 0 | -528 | -1076 | 2 | -538 | 200.6% | -565 |
| CE545-CE540 | -130 | -809 | -809 | -676 | -202 | -792 | -809 | -130 | -570 | 119.1% | -1368 |

| Latent Coil Load(kWh,th) | | | | | | | Statistics, All Results | | | | TRNSYS TESS |
|--------------------------|---------------|-----------------|------------------|--------------------|---------------|------------------|-------------------------|--------|-----------------------------|--------|----------------|
| Case | TRNSYS TUD | DOE-2.2 NREL | DOE21E-E NREL | EnergyPlus GARD | CODYRUN UR | HOT3000 NRCan | Min | Max | Mean (Max-Min) /Mean* | | |
| CE310-CE300 | 19321 | 19607 | 19612 | 19156 | 19576 | 19111 | 19111 | 19612 | 19397 | 2.6% | 19378 |
| CE320-CE300 | 13167 | 12173 | 12259 | 11974 | 12597 | 11157 | 11157 | 13167 | 12221 | 16.4% | 13351 |
| CE330-CE300 | 18164 | 15932 | 16179 | 16367 | 18528 | 17119 | 15932 | 18528 | 17048 | 15.2% | 18615 |
| CE330-CE320 | 4997 | 3760 | 3919 | 4393 | 5931 | 5962 | 3760 | 5962 | 4827 | 45.6% | 5265 |
| CE340-CE300 | 15930 | 14488 | 14625 | 14757 | 15760 | 15279 | 14488 | 15930 | 15140 | 9.5% | 16377 |
| CE330-CE340 | 2234 | 1445 | 1553 | 1610 | 2768 | 1840 | 1445 | 2768 | 1908 | 69.3% | 2239 |
| CE350-CE300 | -4748 | -5435 | -5529 | -4821 | -4264 | -4446 | -5529 | -4264 | -4874 | 26.0% | -4464 |
| CE360-CE300 | 4232 | 3401 | 3427 | 3895 | 4459 | 4403 | 3401 | 4459 | 3970 | 26.7% | 4732 |
| CE400-CE300 | 3075 | 2012 | 2101 | 2660 | | 2650 | 2012 | 3075 | 2500 | 42.5% | 2709 |
| CE410-CE300 | -769 | -2366 | -2303 | | | -2477 | -2477 | -769 | -1979 | 86.3% | -1012 |
| CE420-CE300 | -1546 | -1542 | -1217 | -1240 | | -1212 | -1546 | -1212 | -1351 | 24.7% | -1191 |
| CE430-CE300 | -1872 | -1577 | -1722 | -1663 | | -2010 | -2010 | -1577 | -1769 | 24.5% | -1619 |
| CE440-CE300 | -930 | -699 | -798 | -709 | | -823 | -930 | -699 | -792 | 29.1% | -900 |
| CE500-CE300 | -5452 | -3141 | -3141 | -3986 | -4304 | -4983 | -5452 | -3141 | -4168 | 55.5% | -4563 |
| CE510-CE500 | 17485 | 17615 | 17615 | 17348 | 17488 | 17340 | 17340 | 17615 | 17482 | 1.6% | 17560 |
| CE525-CE520 | 2 | -288 | -288 | -58 | -9 | -42 | -288 | 2 | -114 | 255.0% | 34 |
| CE530-CE500 | -18313 | -18285 | -18286 | -18080 | -18230 | -18084 | -18313 | -18080 | -18213 | 1.3% | -18315 |
| CE545-CE540 | -1 | -81 | -81 | -9 | -3 | -2 | -81 | -1 | -30 | 272.0% | 46 |

* ABS[(Max-Min) / (Mean of Example Simulation Results)]

**ASHRAE Standard 140-2023 Test Results Comparison for Section 9 - HVAC Equipment Performance Tests CE300 through CE545
 TRNSYS18.06.0002 (TRNSYS) vs. Annex B16, Section B16.5.2 Example Results
 By Thermal Energy System Specialists, LLC (TESS), 19-Aug-2024.**

Note: The statistics in the tables below are based on the Standard 140 informative example results.
 These statistics do not have any substantial importance and are not to be interpreted as acceptance criteria.

Table B16.5.2-20. Delta Various Annual Means (COP2, IDB)

| COP2 | | | | | | | | | Statistics, All Results | | | | |
|-------------|---------------|-----------------|------------------|--------------------|---------------|------------------|--------|--------|--------------------------------|---------------------|----------------|--|--|
| Case | TRNSYS TUD | DOE-2.2 NREL | DOE21E-E NREL | EnergyPlus GARD | CODYRUN UR | HOT3000 NRCan | Min | Max | Mean | (Max-Min) /Mean* | TRNSYS TESS | | |
| CE310-CE300 | 0.166 | 0.180 | 0.180 | 0.155 | 0.171 | 0.150 | 0.150 | 0.180 | 0.167 | 18.0% | 0.136 | | |
| CE320-CE300 | 0.171 | 0.220 | 0.220 | 0.168 | 0.180 | 0.160 | 0.160 | 0.220 | 0.186 | 32.3% | 0.095 | | |
| CE330-CE300 | 0.242 | 0.256 | 0.299 | 0.253 | 0.271 | 0.230 | 0.230 | 0.299 | 0.259 | 26.7% | 0.119 | | |
| CE330-CE320 | 0.071 | 0.036 | 0.079 | 0.086 | 0.091 | 0.070 | 0.036 | 0.091 | 0.072 | 76.3% | 0.024 | | |
| CE340-CE300 | 0.205 | 0.240 | 0.258 | 0.210 | 0.223 | 0.190 | 0.190 | 0.258 | 0.221 | 30.9% | 0.102 | | |
| CE330-CE340 | 0.036 | 0.017 | 0.041 | 0.043 | 0.048 | 0.040 | 0.017 | 0.048 | 0.037 | 82.5% | 0.016 | | |
| CE350-CE300 | 0.000 | 0.003 | -0.002 | 0.006 | 0.003 | 0.000 | -0.002 | 0.006 | 0.002 | 498.6% | 0.023 | | |
| CE360-CE300 | 0.420 | 0.463 | 0.468 | 0.441 | 0.440 | 0.430 | 0.420 | 0.468 | 0.444 | 10.9% | 0.283 | | |
| CE400-CE300 | 0.001 | 0.014 | 0.015 | 0.009 | | 0.030 | 0.001 | 0.030 | 0.014 | 210.3% | -0.032 | | |
| CE410-CE300 | -0.010 | -0.025 | -0.027 | | | -0.020 | -0.027 | -0.010 | -0.020 | 84.0% | -0.041 | | |
| CE420-CE300 | -0.023 | -0.022 | -0.020 | -0.021 | | -0.020 | -0.023 | -0.020 | -0.021 | 14.9% | -0.043 | | |
| CE430-CE300 | -0.028 | -0.025 | -0.026 | -0.026 | | -0.020 | -0.028 | -0.020 | -0.025 | 33.0% | -0.053 | | |
| CE440-CE300 | -0.018 | -0.015 | -0.015 | -0.016 | | -0.010 | -0.018 | -0.010 | -0.015 | 51.9% | -0.043 | | |
| CE500-CE300 | -0.045 | -0.010 | -0.011 | -0.024 | -0.034 | -0.030 | -0.045 | -0.010 | -0.026 | 135.4% | -0.073 | | |
| CE510-CE500 | 0.409 | 0.416 | 0.416 | 0.408 | 0.397 | 0.410 | 0.397 | 0.416 | 0.409 | 4.6% | 0.411 | | |
| CE525-CE520 | 0.582 | 0.574 | 0.572 | 0.504 | 0.606 | 0.490 | 0.490 | 0.606 | 0.555 | 21.0% | 0.625 | | |
| CE530-CE500 | -0.242 | -0.258 | -0.257 | -0.214 | -0.276 | -0.220 | -0.276 | -0.214 | -0.245 | 25.5% | -0.084 | | |
| CE545-CE540 | 0.560 | 0.559 | 0.560 | 0.334 | 0.546 | 0.510 | 0.334 | 0.560 | 0.511 | 44.3% | 1.934 | | |

| IDB (°C) | | | | | | | | | Statistics, All Results | | | | |
|-----------------|---------------|-----------------|------------------|--------------------|---------------|------------------|-------|-------|--------------------------------|---------------------|----------------|--|--|
| Case | TRNSYS TUD | DOE-2.2 NREL | DOE21E-E NREL | EnergyPlus GARD | CODYRUN UR | HOT3000 NRCan | Min | Max | Mean | (Max-Min) /Mean* | TRNSYS TESS | | |
| CE310-CE300 | 0.13 | 0.06 | 0.00 | 0.00 | 0.01 | 0.02 | 0.00 | 0.13 | 0.04 | 364.3% | 0.00 | | |
| CE320-CE300 | 0.28 | 0.33 | 0.33 | 0.16 | 0.25 | 0.54 | 0.16 | 0.54 | 0.32 | 119.3% | 0.87 | | |
| CE330-CE300 | 0.26 | 0.22 | 0.22 | 0.18 | 0.21 | 0.19 | 0.18 | 0.26 | 0.21 | 34.0% | 0.59 | | |
| CE330-CE320 | -0.02 | -0.11 | -0.11 | 0.02 | -0.03 | -0.35 | -0.35 | 0.02 | -0.10 | 365.4% | -0.28 | | |
| CE340-CE300 | 0.25 | 0.22 | 0.22 | 0.21 | 0.23 | 0.22 | 0.21 | 0.25 | 0.23 | 19.5% | 0.36 | | |
| CE330-CE340 | 0.00 | 0.00 | 0.00 | -0.02 | -0.01 | -0.03 | -0.03 | 0.00 | -0.01 | 319.0% | 0.23 | | |
| CE350-CE300 | 2.04 | 2.11 | 2.11 | 2.15 | 2.19 | 2.16 | 2.04 | 2.19 | 2.13 | 7.1% | 1.85 | | |
| CE360-CE300 | 1.74 | 1.56 | 1.50 | 1.23 | 1.40 | 1.38 | 1.23 | 1.74 | 1.47 | 34.6% | 1.24 | | |
| CE400-CE300 | 0.50 | 0.00 | 0.00 | 0.00 | | 0.00 | 0.00 | 0.50 | 0.10 | 498.8% | -1.06 | | |
| CE410-CE300 | 0.50 | 0.00 | 0.00 | | | 0.00 | 0.00 | 0.50 | 0.12 | 400.0% | -0.58 | | |
| CE420-CE300 | 0.30 | 0.00 | 0.00 | 0.00 | | 0.00 | 0.00 | 0.30 | 0.06 | 500.3% | -0.62 | | |
| CE430-CE300 | 0.37 | 0.00 | 0.00 | 0.00 | | 0.00 | 0.00 | 0.37 | 0.07 | 500.3% | -0.74 | | |
| CE440-CE300 | 0.29 | 0.00 | 0.00 | 0.00 | | 0.00 | 0.00 | 0.29 | 0.06 | 500.2% | -0.57 | | |
| CE500-CE300 | -3.39 | -3.39 | -3.50 | -3.71 | -2.98 | -1.13 | -3.71 | -1.13 | -3.02 | 85.5% | -2.58 | | |
| CE510-CE500 | 1.24 | 0.11 | 0.11 | -0.02 | 0.00 | 0.00 | -0.02 | 1.24 | 0.24 | 526.6% | 0.00 | | |
| CE525-CE520 | 13.33 | 13.61 | 13.56 | 13.53 | 13.63 | 15.80 | 13.33 | 15.80 | 13.91 | 17.8% | 13.52 | | |
| CE530-CE500 | -0.21 | -0.06 | 0.00 | 0.21 | 0.00 | 0.00 | -0.21 | 0.21 | -0.01 | 4302.5% | 0.00 | | |
| CE545-CE540 | 13.32 | 13.56 | 13.56 | 13.52 | 13.58 | 15.71 | 13.32 | 15.71 | 13.87 | 17.3% | 13.54 | | |

* ABS[(Max-Min) / (Mean of Example Simulation Results)]

**ASHRAE Standard 140-2023 Test Results Comparison for Section 9 - HVAC Equipment Performance Tests CE300 through CE545
 TRNSYS18.06.0002 (TRNSYS) vs. Annex B16, Section B16.5.2 Example Results
 By Thermal Energy System Specialists, LLC (TESS), 19-Aug-2024.**

Note: The statistics in the tables below are based on the Standard 140 informative example results.
 These statistics do not have any substantial importance and are not to be interpreted as acceptance criteria.

Table B16.5.2-21. Delta Various Annual Means (Zone Humidity, Relative Humidity)

| Humidity Ratio (kg/kg) | | | | | | | Statistics, All Results | | | | TRNSYS TESS |
|------------------------|---------------|-----------------|------------------|--------------------|---------------|------------------|-------------------------|---------|---------|---------------------|----------------|
| Case | TRNSYS TUD | DOE-2.2 NREL | DOE21E-E NREL | EnergyPlus GARD | CODYRUN UR | HOT3000 NRCan | Min | Max | Mean | (Max-Min) /Mean* | |
| CE310-CE300 | 0.0020 | 0.0021 | 0.0021 | 0.0020 | 0.0020 | 0.0019 | 0.0019 | 0.0021 | 0.0020 | 9.9% | 0.0018 |
| CE320-CE300 | 0.0009 | 0.0009 | 0.0009 | 0.0008 | 0.0009 | 0.0007 | 0.0007 | 0.0009 | 0.0009 | 25.7% | 0.0005 |
| CE330-CE300 | 0.0007 | 0.0007 | 0.0007 | 0.0007 | 0.0006 | 0.0007 | 0.0006 | 0.0007 | 0.0007 | 9.3% | 0.0011 |
| CE330-CE320 | -0.0002 | -0.0002 | -0.0002 | -0.0001 | -0.0002 | 0.0000 | -0.0002 | 0.0000 | -0.0002 | 143.9% | 0.0005 |
| CE340-CE300 | 0.0007 | 0.0007 | 0.0007 | 0.0007 | 0.0007 | 0.0007 | 0.0007 | 0.0007 | 0.0007 | 4.1% | 0.0008 |
| CE330-CE340 | -0.0001 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | -0.0001 | -0.0001 | 0.0000 | 0.0000 | 277.9% | 0.0003 |
| CE350-CE300 | 0.0006 | 0.0008 | 0.0008 | 0.0006 | 0.0006 | 0.0006 | 0.0006 | 0.0008 | 0.0007 | 34.2% | 0.0005 |
| CE360-CE300 | -0.0006 | -0.0005 | -0.0005 | -0.0005 | -0.0006 | -0.0006 | -0.0006 | -0.0005 | -0.0006 | 22.0% | -0.0006 |
| CE400-CE300 | 0.0007 | 0.0008 | 0.0008 | 0.0008 | | 0.0008 | 0.0007 | 0.0008 | 0.0008 | 8.7% | 0.0010 |
| CE410-CE300 | 0.0007 | 0.0003 | 0.0003 | | | 0.0003 | 0.0003 | 0.0007 | 0.0004 | 94.5% | 0.0001 |
| CE420-CE300 | 0.0002 | 0.0002 | 0.0002 | 0.0002 | | 0.0001 | 0.0001 | 0.0002 | 0.0002 | 58.3% | 0.0001 |
| CE430-CE300 | 0.0002 | 0.0002 | 0.0002 | 0.0002 | | 0.0002 | 0.0002 | 0.0002 | 0.0002 | 19.7% | 0.0002 |
| CE440-CE300 | 0.0001 | 0.0001 | 0.0001 | 0.0000 | | 0.0000 | 0.0000 | 0.0001 | 0.0001 | 148.5% | 0.0001 |
| CE500-CE300 | 0.0007 | | | 0.0001 | 0.0010 | 0.0015 | 0.0001 | 0.0015 | 0.0008 | 169.4% | 0.0007 |
| CE510-CE500 | 0.0004 | | | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0004 | 0.0001 | 394.2% | 0.0000 |
| CE525-CE520 | 0.0070 | | | 0.0078 | 0.0070 | 0.0075 | 0.0070 | 0.0078 | 0.0073 | 10.9% | 0.0071 |
| CE530-CE500 | -0.0035 | | | -0.0027 | -0.0044 | -0.0040 | -0.0044 | -0.0027 | -0.0037 | 48.0% | -0.0081 |
| CE545-CE540 | 0.0018 | | | 0.0024 | 0.0029 | 0.0026 | 0.0018 | 0.0029 | 0.0024 | 46.8% | 0.0001 |

| Relative Humidity (%) | | | | | | | Statistics, All Results | | | | TRNSYS TESS |
|-----------------------|---------------|-----------------|------------------|--------------------|---------------|------------------|-------------------------|--------|--------|---------------------|----------------|
| Case | TRNSYS TUD | DOE-2.2 NREL | DOE21E-E NREL | EnergyPlus GARD | CODYRUN UR | HOT3000 NRCan | Min | Max | Mean | (Max-Min) /Mean* | |
| CE310-CE300 | 9.72 | 10.25 | 10.25 | 9.96 | 10.01 | 9.87 | 9.72 | 10.25 | 10.01 | 5.3% | 9.09 |
| CE320-CE300 | 3.39 | 2.95 | 2.97 | 3.25 | 3.28 | 2.01 | 2.01 | 3.39 | 2.97 | 46.4% | 0.20 |
| CE330-CE300 | 2.23 | 2.32 | 2.37 | 2.59 | 2.26 | 2.77 | 2.23 | 2.77 | 2.42 | 22.3% | 2.50 |
| CE330-CE320 | -1.16 | -0.63 | -0.60 | -0.66 | -1.02 | 0.76 | -1.16 | 0.76 | -0.55 | 347.8% | 2.29 |
| CE340-CE300 | 2.47 | 2.43 | 2.45 | 2.56 | 2.47 | 2.85 | 2.43 | 2.85 | 2.54 | 16.5% | 2.27 |
| CE330-CE340 | -0.24 | -0.11 | -0.08 | 0.03 | -0.21 | -0.08 | -0.24 | 0.03 | -0.12 | 232.7% | 0.23 |
| CE350-CE300 | -3.13 | -2.81 | -2.73 | -3.42 | -3.51 | -3.37 | -3.51 | -2.73 | -3.16 | 24.7% | -3.27 |
| CE360-CE300 | -7.58 | -6.77 | -6.79 | -6.22 | -6.96 | -6.72 | -7.58 | -6.22 | -6.84 | 19.9% | -6.56 |
| CE400-CE300 | 2.16 | 3.95 | 3.97 | 3.96 | | 4.08 | 2.16 | 4.08 | 3.62 | 53.1% | 8.93 |
| CE410-CE300 | 1.88 | 1.39 | 1.35 | | | 1.82 | 1.35 | 1.88 | 1.61 | 33.0% | 2.46 |
| CE420-CE300 | 0.16 | 0.88 | 0.69 | 0.81 | | 0.83 | 0.16 | 0.88 | 0.67 | 106.1% | 2.96 |
| CE430-CE300 | 0.21 | 0.91 | 1.02 | 1.01 | | 1.24 | 0.21 | 1.24 | 0.88 | 117.8% | 3.56 |
| CE440-CE300 | -0.29 | 0.20 | 0.29 | 0.24 | | 0.30 | -0.29 | 0.30 | 0.15 | 394.1% | 2.16 |
| CE500-CE300 | 17.91 | | | 10.61 | 18.12 | 15.80 | 10.61 | 18.12 | 15.61 | 48.1% | 18.11 |
| CE510-CE500 | -2.35 | | | 0.11 | -0.01 | 0.11 | -2.35 | 0.11 | -0.53 | 461.4% | 0.10 |
| CE525-CE520 | -8.41 | | | -6.41 | -10.09 | -14.80 | -14.80 | -6.41 | -9.93 | 84.5% | -5.75 |
| CE530-CE500 | -19.80 | | | -10.22 | -24.49 | -24.13 | -24.49 | -10.22 | -19.66 | 72.6% | -48.03 |
| CE545-CE540 | -11.90 | | | -7.68 | -3.18 | -14.62 | -14.62 | -3.18 | -9.34 | 122.5% | -1.66 |

* ABS[(Max-Min) / (Mean of Example Simulation Results)]

**ASHRAE Standard 140-2023 Test Results Comparison for Section 9 - HVAC Equipment Performance Tests CE300 through CE545
 TRNSYS18.06.0002 (TRNSYS) vs. Annex B16, Section B16.5.2 Example Results
 By Thermal Energy System Specialists, LLC (TESS), 19-Aug-2024.**

Note: The statistics in the tables below are based on the Standard 140 informative example results.
 These statistics do not have any substantial importance and are not to be interpreted as acceptance criteria.

Table B16.5.2-22. Delta Hourly Integrated Maximum Total Consumptions

| Case | Total Consumption (Wh,e) | | | | | | Statistics, All Results | | | | TRNSYS TESS |
|-------------|--------------------------|-----------------|------------------|--------------------|---------------|------------------|-------------------------|-------|-------|---------------------|----------------|
| | TRNSYS TUD | DOE-2.2 NREL | DOE21E-E NREL | EnergyPlus GARD | CODYRUN UR | HOT3000 NRCan | Min | Max | Mean | (Max-Min) /Mean* | |
| CE310-CE300 | 968 | 1019 | 993 | 641 | 721 | 614 | 614 | 1019 | 826 | 49.0% | 1025 |
| CE320-CE300 | 1402 | 1352 | 1379 | 1055 | 1172 | 1327 | 1055 | 1402 | 1281 | 27.1% | 1683 |
| CE330-CE300 | 1721 | 1648 | 1805 | 1414 | 1535 | 1787 | 1414 | 1805 | 1652 | 23.7% | 2380 |
| CE330-CE320 | 319 | 296 | 426 | 360 | 363 | 460 | 296 | 460 | 371 | 44.3% | 697 |
| CE340-CE300 | 1555 | 1594 | 1588 | 1234 | 1345 | 1553 | 1234 | 1594 | 1478 | 24.3% | 1972 |
| CE330-CE340 | 166 | 54 | 217 | 180 | 190 | 234 | 54 | 234 | 173 | 103.8% | 407 |
| CE350-CE300 | 1 | 90 | 0 | 0 | 0 | -2 | -2 | 90 | 15 | 621.2% | 0 |
| CE360-CE300 | 1143 | 1172 | 1124 | 844 | 931 | 1214 | 844 | 1214 | 1071 | 34.5% | 1412 |
| CE400-CE300 | 2 | 0 | 75 | 0 | | -29 | -29 | 75 | 10 | 1087.2% | 276 |
| CE410-CE300 | 2 | 0 | 0 | | | 1 | 0 | 2 | 1 | 258.7% | -19 |
| CE420-CE300 | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | ---- | -19 |
| CE430-CE300 | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 500.0% | -19 |
| CE440-CE300 | 0 | 0 | 0 | 0 | | -87 | -87 | 0 | -17 | 500.0% | -19 |
| CE500-CE300 | -1460 | -1133 | -1177 | -1501 | -1755 | -1274 | -1755 | -1133 | -1383 | 45.0% | -961 |
| CE510-CE500 | 1038 | 1159 | 1162 | 1011 | 1009 | 1070 | 1009 | 1162 | 1075 | 14.2% | 1018 |
| CE525-CE520 | -1669 | -1451 | -1483 | -1531 | -1625 | -1099 | -1669 | -1099 | -1476 | 38.6% | -1308 |
| CE530-CE500 | -2138 | -2372 | -2370 | -2228 | -2185 | -2185 | -2372 | -2138 | -2246 | 10.4% | -2466 |
| CE545-CE540 | -1494 | -1593 | -1593 | -915 | -1495 | -1514 | -1593 | -915 | -1434 | 47.3% | -481 |

* ABS[(Max-Min) / (Mean of Example Simulation Results)]

**ASHRAE Standard 140-2023 Test Results Comparison for Section 9 - HVAC Equipment Performance Tests CE300 through CE545
 TRNSYS18.06.0002 (TRNSYS) vs. Annex B16, Section B16.5.2 Example Results
 By Thermal Energy System Specialists, LLC (TESS), 19-Aug-2024.**

Note: The statistics in the tables below are based on the Standard 140 informative example results.
 These statistics do not have any substantial importance and are not to be interpreted as acceptance criteria.

Table B16.5.2-23. Delta Hourly Integrated Maximum Coil Loads (Total, Sensible)

| Sensible + Latent Coil Load (Wh,th) | | | | | | | Statistics, All Results | | | | TRNSYS TESS |
|-------------------------------------|---------------|-----------------|------------------|--------------------|---------------|------------------|-------------------------|-------|-------|---------------------|----------------|
| Case | TRNSYS TUD | DOE-2.2 NREL | DOE21E-E NREL | EnergyPlus GARD | CODYRUN UR | HOT3000 NRCan | Min | Max | Mean | (Max-Min) /Mean* | |
| CE310-CE300 | 5154 | 5349 | 5578 | 4393 | 4759 | 4919 | 4393 | 5578 | 5025 | 23.6% | 5495 |
| CE320-CE300 | 8144 | 22412 | 22368 | 7032 | 7402 | 7848 | 7032 | 22412 | 12534 | 122.7% | 9003 |
| CE330-CE300 | 11318 | 12227 | 33117 | 10712 | 11476 | 10343 | 10343 | 33117 | 14865 | 153.2% | 12261 |
| CE330-CE320 | 3174 | -10185 | 10749 | 3680 | 4074 | 2495 | -10185 | 10749 | 2331 | 898.0% | 3258 |
| CE340-CE300 | 9478 | 19418 | 28094 | 8595 | 8864 | 9060 | 8595 | 28094 | 13918 | 140.1% | 10250 |
| CE330-CE340 | 1840 | -7191 | 5023 | 2117 | 2612 | 1283 | -7191 | 5023 | 947 | 1289.3% | 2012 |
| CE350-CE300 | -82 | 0 | -1 | 0 | 0 | 5 | -82 | 5 | -13 | 669.0% | 0 |
| CE360-CE300 | 6683 | 9212 | 9564 | 5726 | 5820 | 6379 | 5726 | 9564 | 7231 | 53.1% | 7391 |
| CE400-CE300 | 9005 | 9142 | 18383 | 7995 | | 8702 | 7995 | 18383 | 10645 | 97.6% | 10543 |
| CE410-CE300 | -82 | 0 | 0 | | | 1 | -82 | 1 | -20 | 409.8% | -40 |
| CE420-CE300 | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | ---- | -40 |
| CE430-CE300 | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 500.0% | -40 |
| CE440-CE300 | 0 | 0 | 0 | 0 | | -295 | -295 | 0 | -59 | 500.0% | -40 |
| CE500-CE300 | -4689 | -3694 | -3749 | -5087 | -5935 | -4517 | -5935 | -3694 | -4612 | 48.6% | -3590 |
| CE510-CE500 | 3108 | 3481 | 3482 | 3531 | 3381 | 3542 | 3108 | 3542 | 3421 | 12.7% | 3428 |
| CE525-CE520 | 410 | -412 | -412 | -76 | 8 | -881 | -881 | 410 | -227 | 568.4% | -320 |
| CE530-CE500 | -7651 | -8131 | -8131 | -8008 | -7791 | -7929 | -8131 | -7651 | -7940 | 6.0% | -8179 |
| CE545-CE540 | 500 | -291 | -292 | -187 | -30 | -302 | -302 | 500 | -100 | 800.3% | 3708 |

| Sensible Coil Load (Wh,th) | | | | | | | Statistics, All Results | | | | TRNSYS TESS |
|----------------------------|---------------|-----------------|------------------|--------------------|---------------|------------------|-------------------------|-------|-------|---------------------|----------------|
| Case | TRNSYS TUD | DOE-2.2 NREL | DOE21E-E NREL | EnergyPlus GARD | CODYRUN UR | HOT3000 NRCan | Min | Max | Mean | (Max-Min) /Mean* | |
| CE310-CE300 | -183 | -123 | -86 | -254 | -379 | -259 | -379 | -86 | -214 | 136.9% | -174 |
| CE320-CE300 | 8038 | 7916 | 7867 | 8441 | 7677 | 8059 | 7677 | 8441 | 8000 | 9.6% | 7846 |
| CE330-CE300 | 9949 | 10207 | 11285 | 11234 | 10540 | 10513 | 9949 | 11285 | 10621 | 12.6% | 9612 |
| CE330-CE320 | 1911 | 2291 | 3418 | 2793 | 2863 | 2454 | 1911 | 3418 | 2622 | 57.5% | 1766 |
| CE340-CE300 | 9552 | 8883 | 8881 | 9357 | 9483 | 9272 | 8881 | 9552 | 9238 | 7.3% | 9101 |
| CE330-CE340 | 397 | 1324 | 2404 | 1877 | 1057 | 1241 | 397 | 2404 | 1383 | 145.1% | 511 |
| CE350-CE300 | 0 | 0 | 0 | 0 | 0 | -32 | -32 | 0 | -5 | 603.8% | 0 |
| CE360-CE300 | 8783 | 8908 | 8860 | 9090 | 8524 | 9271 | 8524 | 9271 | 8906 | 8.4% | 8659 |
| CE400-CE300 | 0 | 0 | 0 | 0 | | -31 | -31 | 0 | -6 | 503.2% | -18 |
| CE410-CE300 | -12 | 0 | 0 | | | -15 | -15 | 0 | -7 | 224.7% | -18 |
| CE420-CE300 | 0 | 0 | 0 | 0 | | -15 | -15 | 0 | -3 | 500.0% | -18 |
| CE430-CE300 | 0 | 0 | 0 | 0 | | -15 | -15 | 0 | -3 | 500.0% | -18 |
| CE440-CE300 | 0 | 0 | 0 | 0 | | -33 | -33 | 0 | -7 | 500.0% | -18 |
| CE500-CE300 | -3728 | -3194 | -3197 | -3682 | -4681 | -3090 | -4681 | -3090 | -3595 | 44.3% | -3392 |
| CE510-CE500 | 2180 | 2504 | 2505 | 2441 | 2345 | 2451 | 2180 | 2505 | 2404 | 13.5% | 2447 |
| CE525-CE520 | 287 | -309 | -304 | -336 | -210 | -717 | -717 | 287 | -265 | 379.1% | -771 |
| CE530-CE500 | 285 | -433 | -433 | -211 | 0 | -192 | -433 | 285 | -164 | 437.9% | -201 |
| CE545-CE540 | 500 | -291 | -292 | -187 | -35 | -302 | -302 | 500 | -101 | 793.7% | -269 |

* ABS[(Max-Min) / (Mean of Example Simulation Results)]

**ASHRAE Standard 140-2023 Test Results Comparison for Section 9 - HVAC Equipment Performance Tests CE300 through CE545
 TRNSYS18.06.0002 (TRNSYS) vs. Annex B16, Section B16.5.2 Example Results
 By Thermal Energy System Specialists, LLC (TESS), 19-Aug-2024.**

Note: The statistics in the tables below are based on the Standard 140 informative example results.
 These statistics do not have any substantial importance and are not to be interpreted as acceptance criteria.

Table B16.5.2-24. Delta Hourly Integrated Maximum Coil Loads (Latent)

| Latent Coil Load (Wh,th) Case | TRNSYS | | | | | | Statistics, All Results | | | | TRNSYS TESS |
|----------------------------------|--------|-----------------|------------------|--------------------|---------------|------------------|-------------------------|-------|-------|---------------------|----------------|
| | TUD | DOE-2.2 NREL | DOE21E-E NREL | EnergyPlus GARD | CODYRUN UR | HOT3000 NRCan | Min | Max | Mean | (Max-Min) /Mean* | |
| CE310-CE300 | 6271 | 5835 | 5876 | 6040 | 5737 | 5685 | 5685 | 6271 | 5907 | 9.9% | 6035 |
| CE320-CE300 | 13512 | 22193 | 22109 | 11961 | 11322 | 11537 | 11322 | 22193 | 15439 | 70.4% | 13117 |
| CE330-CE300 | 18190 | 17637 | 31415 | 16899 | 17809 | 17096 | 16899 | 31415 | 19841 | 73.2% | 18244 |
| CE330-CE320 | 4678 | -4556 | 9306 | 4939 | 6487 | 5559 | -4556 | 9306 | 4402 | 314.9% | 5127 |
| CE340-CE300 | 15213 | 21147 | 26617 | 13676 | 13850 | 13402 | 13402 | 26617 | 17318 | 76.3% | 15082 |
| CE330-CE340 | 2977 | -3510 | 4798 | 3223 | 3959 | 3694 | -3510 | 4798 | 2523 | 329.2% | 3162 |
| CE350-CE300 | 116 | -1 | -1 | 1 | 380 | 1211 | -1 | 1211 | 284 | 426.5% | 0 |
| CE360-CE300 | -361 | 722 | 942 | -1715 | -1516 | -1458 | -1715 | 942 | -564 | 470.9% | -552 |
| CE400-CE300 | 17440 | 16274 | 23002 | 16082 | | 16253 | 16082 | 23002 | 17810 | 38.9% | 18244 |
| CE410-CE300 | 1503 | 0 | -3 | | | -15 | -15 | 1503 | 371 | 408.9% | -23 |
| CE420-CE300 | 115 | 0 | 0 | 0 | | 2 | 0 | 115 | 23 | 491.5% | -23 |
| CE430-CE300 | 0 | 1801 | 1707 | 839 | | 2 | 0 | 1801 | 870 | 207.1% | -23 |
| CE440-CE300 | 0 | 0 | -3 | 0 | | -253 | -253 | 0 | -51 | 494.1% | -23 |
| CE500-CE300 | -1670 | -1571 | -1661 | -2396 | -2570 | -2630 | -2630 | -1571 | -2083 | 50.8% | -1605 |
| CE510-CE500 | 927 | 990 | 990 | 1116 | 1045 | 1112 | 927 | 1116 | 1030 | 18.3% | 980 |
| CE525-CE520 | 123 | -122 | -122 | 249 | 212 | -144 | -144 | 249 | 33 | 1201.2% | -53 |
| CE530-CE500 | -7965 | -7733 | -7733 | -7838 | -7626 | -7726 | -7965 | -7626 | -7770 | 4.4% | -7023 |
| CE545-CE540 | -627 | 0 | 0 | -1655 | -841 | -1181 | -1655 | 0 | -717 | 230.7% | 2729 |

* ABS[(Max-Min) / (Mean of Example Simulation Results)]

**ASHRAE Standard 140-2023 Test Results Comparison for Section 9 - HVAC Equipment Performance Tests CE300 through CE545
 TRNSYS18.06.0002 (TRNSYS) vs. Annex B16, Section B16.5.2 Example Results
 By Thermal Energy System Specialists, LLC (TESS), 19-Aug-2024.**

Note: The statistics in the tables below are based on the Standard 140 informative example results.
 These statistics do not have any substantial importance and are not to be interpreted as acceptance criteria.

Table B16.5.2-25. Delta Hourly Integrated Maximum and Minimum COP2

| Maximum COP2 | | | | | | | | Statistics, All Results | | | | TRNSYS TESS |
|--------------|---------------|-----------------|------------------|--------------------|---------------|------------------|--------|-------------------------|--------|---------------------|--------|----------------|
| Case | TRNSYS TUD | DOE-2.2 NREL | DOE21E-E NREL | EnergyPlus GARD | CODYRUN UR | HOT3000 NRCAN | Min | Max | Mean | (Max-Min) /Mean* | | |
| CE310-CE300 | -0.025 | 0.272 | 0.271 | 0.248 | 0.257 | 0.240 | -0.025 | 0.272 | 0.210 | 141.1% | 0.259 | |
| CE320-CE300 | 0.000 | 1.274 | 1.110 | 0.014 | 0.073 | 0.500 | 0.000 | 1.274 | 0.495 | 257.3% | 0.060 | |
| CE330-CE300 | 0.000 | 0.240 | 1.738 | 0.146 | 0.251 | 0.170 | 0.000 | 1.738 | 0.424 | 409.6% | 0.166 | |
| CE330-CE320 | 0.000 | -1.034 | 0.628 | 0.132 | 0.179 | -0.330 | -1.034 | 0.628 | -0.071 | 2344.2% | 0.106 | |
| CE340-CE300 | 0.000 | 0.752 | 1.482 | 0.061 | 0.147 | 0.070 | 0.000 | 1.482 | 0.419 | 354.0% | 0.097 | |
| CE330-CE340 | 0.000 | -0.512 | 0.256 | 0.085 | 0.105 | 0.100 | -0.512 | 0.256 | 0.006 | 13685.7% | 0.069 | |
| CE350-CE300 | 0.000 | 0.020 | 0.006 | 0.630 | 0.061 | 0.000 | 0.000 | 0.630 | 0.120 | 526.8% | 0.019 | |
| CE360-CE300 | 0.233 | 0.559 | 0.570 | 0.530 | 0.561 | 0.560 | 0.233 | 0.570 | 0.502 | 67.2% | 0.490 | |
| CE400-CE300 | -0.091 | 0.219 | 0.919 | 0.146 | | 0.170 | -0.091 | 0.919 | 0.273 | 370.7% | 0.160 | |
| CE410-CE300 | -0.280 | 0.034 | -0.002 | | | -0.040 | -0.280 | 0.034 | -0.072 | 436.1% | -0.029 | |
| CE420-CE300 | -0.387 | -0.062 | -0.098 | -0.104 | | 0.060 | -0.387 | 0.060 | -0.118 | 378.3% | -0.182 | |
| CE430-CE300 | -0.387 | -0.064 | -0.098 | -0.133 | | 0.050 | -0.387 | 0.050 | -0.126 | 346.0% | -0.125 | |
| CE440-CE300 | -0.285 | -0.095 | -0.098 | -0.123 | | -0.070 | -0.285 | -0.070 | -0.134 | 160.0% | -0.142 | |
| CE500-CE300 | 0.107 | 3.498 | 1.444 | 0.273 | 0.314 | 0.260 | 0.107 | 3.498 | 0.983 | 345.1% | 0.280 | |
| CE510-CE500 | 0.417 | 0.000 | 0.000 | 0.487 | 0.505 | 0.390 | 0.000 | 0.505 | 0.300 | 168.4% | 0.492 | |
| CE525-CE520 | 0.904 | 1.429 | 1.379 | 0.766 | 0.836 | 0.560 | 0.560 | 1.429 | 0.979 | 88.8% | 0.829 | |
| CE530-CE500 | -0.269 | -3.386 | -1.451 | -0.273 | -0.345 | -0.260 | -3.386 | -0.260 | -0.997 | 313.5% | -0.121 | |
| CE545-CE540 | 0.794 | 0.819 | 0.973 | 0.470 | 0.490 | 0.480 | 0.470 | 0.973 | 0.671 | 74.9% | 2.841 | |

| Minimum COP2 | | | | | | | | Statistics, All Results | | | | TRNSYS TESS |
|--------------|---------------|-----------------|------------------|--------------------|---------------|------------------|--------|-------------------------|--------|---------------------|--------|----------------|
| Case | TRNSYS TUD | DOE-2.2 NREL | DOE21E-E NREL | EnergyPlus GARD | CODYRUN UR | HOT3000 NRCAN | Min | Max | Mean | (Max-Min) /Mean* | | |
| CE310-CE300 | 0.072 | 0.052 | 0.050 | 0.111 | 0.087 | 0.060 | 0.050 | 0.111 | 0.072 | 84.8% | 0.089 | |
| CE320-CE300 | 0.032 | 0.003 | 0.004 | 0.060 | 0.029 | 0.020 | 0.003 | 0.060 | 0.025 | 231.0% | 0.051 | |
| CE330-CE300 | 0.032 | 0.000 | 0.000 | 0.063 | 0.038 | 0.030 | 0.000 | 0.063 | 0.027 | 231.1% | 0.063 | |
| CE330-CE320 | 0.000 | -0.003 | -0.004 | 0.003 | 0.009 | 0.010 | -0.004 | 0.010 | 0.002 | 584.2% | 0.012 | |
| CE340-CE300 | 0.032 | 0.000 | 0.000 | 0.063 | 0.038 | 0.030 | 0.000 | 0.063 | 0.027 | 231.1% | 0.063 | |
| CE330-CE340 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | ---- | 0.000 | |
| CE350-CE300 | -0.003 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | -0.003 | 0.000 | 0.000 | 742.2% | 0.000 | |
| CE360-CE300 | 0.032 | 0.001 | 0.000 | 0.063 | 0.038 | 0.030 | 0.000 | 0.063 | 0.027 | 229.7% | 0.063 | |
| CE400-CE300 | -0.011 | -0.064 | -0.066 | 0.000 | | 0.000 | -0.066 | 0.000 | -0.028 | 233.8% | 0.000 | |
| CE410-CE300 | -0.007 | 0.000 | 0.000 | | | 0.000 | -0.007 | 0.000 | -0.002 | 400.0% | 0.000 | |
| CE420-CE300 | 0.000 | 0.000 | 0.000 | 0.000 | | 0.000 | 0.000 | 0.000 | 0.000 | ---- | 0.000 | |
| CE430-CE300 | -0.022 | -0.064 | -0.066 | 0.000 | | 0.000 | -0.066 | 0.000 | -0.030 | 217.2% | 0.000 | |
| CE440-CE300 | -0.011 | -0.064 | -0.066 | 0.000 | | 0.000 | -0.066 | 0.000 | -0.028 | 234.7% | 0.000 | |
| CE500-CE300 | -0.108 | -0.105 | -0.149 | -0.076 | -0.119 | -0.100 | -0.149 | -0.076 | -0.110 | 66.6% | -0.076 | |
| CE510-CE500 | 0.203 | 0.124 | 0.000 | 0.160 | 0.215 | 0.190 | 0.000 | 0.215 | 0.149 | 144.8% | 0.196 | |
| CE525-CE520 | 0.469 | 0.476 | 0.420 | 0.408 | 0.561 | 0.430 | 0.408 | 0.561 | 0.461 | 33.2% | 0.450 | |
| CE530-CE500 | -0.184 | -0.198 | -0.154 | -0.173 | -0.193 | -0.190 | -0.198 | -0.154 | -0.182 | 24.2% | -0.086 | |
| CE545-CE540 | 0.479 | 0.459 | 0.460 | 0.277 | 0.549 | 0.440 | 0.277 | 0.549 | 0.444 | 61.2% | 0.458 | |

* ABS[(Max-Min) / (Mean of Example Simulation Results)]

**ASHRAE Standard 140-2023 Test Results Comparison for Section 9 - HVAC Equipment Performance Tests CE300 through CE545
 TRNSYS18.06.0002 (TRNSYS) vs. Annex B16, Section B16.5.2 Example Results
 By Thermal Energy System Specialists, LLC (TESS), 19-Aug-2024.**

Note: The statistics in the tables below are based on the Standard 140 informative example results.
 These statistics do not have any substantial importance and are not to be interpreted as acceptance criteria.

Table B16.5.2-26. Delta Hourly Integrated Maximum and Minimum IDB

| Maximum IDB (°C) | | | | | | | | Statistics, All Results | | | | TRNSYS TESS |
|------------------|---------------|-----------------|------------------|--------------------|---------------|------------------|-------|-------------------------|-------|---------------------|-------|----------------|
| Case | TRNSYS TUD | DOE-2.2 NREL | DOE21E-E NREL | EnergyPlus GARD | CODYRUN UR | HOT3000 NRCan | Min | Max | Mean | (Max-Min) /Mean* | | |
| CE310-CE300 | 0.88 | 1.78 | 1.61 | 1.47 | 1.57 | 1.00 | 0.88 | 1.78 | 1.39 | 65.1% | 0.45 | |
| CE320-CE300 | 6.16 | 6.50 | 6.39 | 6.71 | 7.27 | 5.46 | 5.46 | 7.27 | 6.41 | 28.2% | 5.78 | |
| CE330-CE300 | 6.03 | 6.61 | 6.89 | 6.07 | 6.85 | 5.11 | 5.11 | 6.89 | 6.26 | 28.4% | 8.23 | |
| CE330-CE320 | -0.13 | 0.11 | 0.50 | -0.64 | -0.42 | -0.35 | -0.64 | 0.50 | -0.15 | 736.8% | 2.45 | |
| CE340-CE300 | 6.11 | 6.50 | 6.45 | 6.50 | 7.10 | 5.39 | 5.39 | 7.10 | 6.34 | 27.0% | 6.90 | |
| CE330-CE340 | -0.07 | 0.11 | 0.44 | -0.43 | -0.25 | -0.28 | -0.43 | 0.44 | -0.08 | 1078.3% | 1.33 | |
| CE350-CE300 | 8.38 | 9.83 | 9.83 | 10.00 | 9.95 | 8.81 | 8.38 | 10.00 | 9.47 | 17.1% | 7.52 | |
| CE360-CE300 | 7.56 | 7.67 | 7.45 | 7.51 | 7.95 | 6.94 | 6.94 | 7.95 | 7.51 | 13.4% | 6.92 | |
| CE400-CE300 | 0.91 | 2.45 | 3.72 | 1.91 | | -0.15 | -0.15 | 3.72 | 1.77 | 218.8% | 0.04 | |
| CE410-CE300 | 0.63 | 0.00 | 0.00 | | | 0.00 | 0.00 | 0.63 | 0.16 | 400.0% | 0.04 | |
| CE420-CE300 | 0.00 | 0.00 | 0.00 | 0.00 | | 0.04 | 0.00 | 0.04 | 0.01 | 500.0% | 0.04 | |
| CE430-CE300 | 1.00 | 0.00 | 0.00 | 0.00 | | 0.26 | 0.00 | 1.00 | 0.25 | 396.6% | 0.04 | |
| CE440-CE300 | 0.85 | 0.00 | 0.00 | 0.00 | | 0.07 | 0.00 | 0.85 | 0.18 | 461.5% | 1.39 | |
| CE500-CE300 | -0.39 | 0.00 | 0.00 | 0.00 | -0.03 | -1.19 | -1.19 | 0.00 | -0.27 | 441.5% | -1.47 | |
| CE510-CE500 | 0.29 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.29 | 0.05 | 600.0% | 0.00 | |
| CE525-CE520 | 19.96 | 18.95 | 19.12 | 20.00 | 19.02 | 16.38 | 16.38 | 20.00 | 18.90 | 19.1% | 17.76 | |
| CE530-CE500 | 0.31 | -0.05 | -0.05 | 0.00 | 0.00 | 0.00 | -0.05 | 0.31 | 0.04 | 1025.2% | 0.00 | |
| CE545-CE540 | 19.53 | 19.89 | 19.89 | 20.00 | 19.95 | 20.00 | 19.53 | 20.00 | 19.88 | 2.4% | 19.58 | |

| Minimum IDB (°C) | | | | | | | | Statistics, All Results | | | | TRNSYS TESS |
|------------------|---------------|-----------------|------------------|--------------------|---------------|------------------|-------|-------------------------|-------|---------------------|-------|----------------|
| Case | TRNSYS TUD | DOE-2.2 NREL | DOE21E-E NREL | EnergyPlus GARD | CODYRUN UR | HOT3000 NRCan | Min | Max | Mean | (Max-Min) /Mean* | | |
| CE310-CE300 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 600.0% | 0.00 | |
| CE320-CE300 | 0.00 | 1.94 | 1.95 | -0.96 | 0.00 | 0.00 | -0.96 | 1.95 | 0.49 | 597.5% | 2.30 | |
| CE330-CE300 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 600.0% | 0.00 | |
| CE330-CE320 | 0.00 | -1.94 | -1.95 | 0.96 | 0.00 | 0.00 | -1.95 | 0.96 | -0.49 | 596.8% | -2.30 | |
| CE340-CE300 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 600.0% | 0.00 | |
| CE330-CE340 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | ---- | 0.00 | |
| CE350-CE300 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | ---- | 0.00 | |
| CE360-CE300 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 600.0% | 0.00 | |
| CE400-CE300 | 0.00 | 0.00 | 0.00 | 0.00 | | 0.00 | 0.00 | 0.00 | 0.00 | 500.0% | 0.00 | |
| CE410-CE300 | 0.00 | 0.00 | 0.00 | | | 0.00 | 0.00 | 0.00 | 0.00 | ---- | 0.00 | |
| CE420-CE300 | 0.00 | 0.00 | 0.00 | 0.00 | | 0.00 | 0.00 | 0.00 | 0.00 | 500.0% | 0.00 | |
| CE430-CE300 | 0.00 | 0.00 | 0.00 | 0.00 | | 0.00 | 0.00 | 0.00 | 0.00 | 500.0% | 0.00 | |
| CE440-CE300 | 0.00 | 0.00 | 0.00 | 0.00 | | 0.01 | 0.00 | 0.01 | 0.00 | 500.0% | 0.00 | |
| CE500-CE300 | 0.50 | -0.72 | -0.89 | 0.22 | 0.54 | 17.05 | -0.89 | 17.05 | 2.78 | 644.6% | 1.92 | |
| CE510-CE500 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 600.0% | 0.00 | |
| CE525-CE520 | 0.14 | 0.06 | 0.05 | 0.18 | 0.03 | 19.44 | 0.03 | 19.44 | 3.32 | 585.3% | 0.02 | |
| CE530-CE500 | -0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | -0.01 | 0.00 | 0.00 | 533.6% | 0.00 | |
| CE545-CE540 | 0.22 | 0.06 | 0.05 | 0.18 | 0.03 | 18.06 | 0.03 | 18.06 | 3.10 | 581.6% | 0.02 | |

* ABS[(Max-Min) / (Mean of Example Simulation Results)]

**ASHRAE Standard 140-2023 Test Results Comparison for Section 9 - HVAC Equipment Performance Tests CE300 through CE545
 TRNSYS18.06.0002 (TRNSYS) vs. Annex B16, Section B16.5.2 Example Results
 By Thermal Energy System Specialists, LLC (TESS), 19-Aug-2024.**

Note: The statistics in the tables below are based on the Standard 140 informative example results.
 These statistics do not have any substantial importance and are not to be interpreted as acceptance criteria.

Table B16.5.2-27. Delta Hourly Integrated Maximum and Minimum Zone Humidity Ratio

| Maximum Humidity Ratio (kg/kg) | | | | | | | Statistics, All Results | | | | TRNSYS TESS |
|--------------------------------|---------------|-----------------|------------------|--------------------|---------------|------------------|-------------------------|---------|---------|---------------------|----------------|
| Case | TRNSYS TUD | DOE-2.2 NREL | DOE21E-E NREL | EnergyPlus GARD | CODYRUN UR | HOT3000 NRCan | Min | Max | Mean | (Max-Min) /Mean* | |
| CE310-CE300 | 0.0025 | 0.0050 | 0.0052 | 0.0020 | 0.0020 | 0.0023 | 0.0020 | 0.0052 | 0.0032 | 102.1% | 0.0023 |
| CE320-CE300 | 0.0047 | 0.0039 | 0.0039 | 0.0042 | 0.0041 | 0.0043 | 0.0039 | 0.0047 | 0.0042 | 19.9% | 0.0033 |
| CE330-CE300 | 0.0044 | 0.0040 | 0.0040 | 0.0043 | 0.0036 | 0.0043 | 0.0036 | 0.0044 | 0.0041 | 19.0% | 0.0070 |
| CE330-CE320 | -0.0004 | 0.0001 | 0.0001 | 0.0001 | -0.0005 | 0.0000 | -0.0005 | 0.0001 | -0.0001 | 696.5% | 0.0038 |
| CE340-CE300 | 0.0046 | 0.0039 | 0.0037 | 0.0042 | 0.0038 | 0.0043 | 0.0037 | 0.0046 | 0.0041 | 21.8% | 0.0047 |
| CE330-CE340 | -0.0002 | 0.0001 | 0.0003 | 0.0001 | -0.0002 | 0.0000 | -0.0002 | 0.0003 | 0.0000 | 3174.2% | 0.0023 |
| CE350-CE300 | 0.0035 | 0.0061 | 0.0062 | 0.0036 | 0.0030 | 0.0032 | 0.0030 | 0.0062 | 0.0043 | 74.6% | 0.0022 |
| CE360-CE300 | 0.0001 | 0.0000 | 0.0000 | 0.0002 | 0.0000 | 0.0000 | 0.0000 | 0.0002 | 0.0001 | 366.5% | -0.0007 |
| CE400-CE300 | 0.0037 | 0.0032 | 0.0033 | 0.0033 | | 0.0039 | 0.0032 | 0.0039 | 0.0035 | 20.2% | 0.0044 |
| CE410-CE300 | 0.0036 | 0.0031 | 0.0032 | | | 0.0039 | 0.0031 | 0.0039 | 0.0034 | 23.3% | 0.0001 |
| CE420-CE300 | 0.0010 | 0.0009 | 0.0004 | 0.0010 | | 0.0013 | 0.0004 | 0.0013 | 0.0009 | 98.3% | 0.0000 |
| CE430-CE300 | 0.0029 | 0.0018 | 0.0019 | 0.0025 | | 0.0024 | 0.0018 | 0.0029 | 0.0023 | 49.6% | 0.0014 |
| CE440-CE300 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 500.0% | 0.0000 |
| CE500-CE300 | -0.0016 | -0.0019 | -0.0019 | -0.0019 | -0.0017 | -0.0019 | -0.0019 | -0.0016 | -0.0018 | 20.6% | -0.0026 |
| CE510-CE500 | 0.0002 | 0.0000 | 0.0001 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0002 | 0.0000 | 352.6% | 0.0000 |
| CE525-CE520 | 0.0104 | 0.0103 | 0.0102 | 0.0115 | 0.0101 | 0.0067 | 0.0067 | 0.0115 | 0.0099 | 48.3% | 0.0089 |
| CE530-CE500 | -0.0047 | -0.0038 | -0.0037 | -0.0049 | -0.0062 | -0.0047 | -0.0062 | -0.0037 | -0.0047 | 53.9% | -0.0023 |
| CE545-CE540 | 0.0009 | 0.0072 | 0.0059 | 0.0000 | 0.0034 | 0.0013 | 0.0000 | 0.0072 | 0.0031 | 230.7% | 0.0018 |

| Minimum Humidity Ratio (kg/kg) | | | | | | | Statistics, All Results | | | | TRNSYS TESS |
|--------------------------------|---------------|-----------------|------------------|--------------------|---------------|------------------|-------------------------|---------|---------|---------------------|----------------|
| Case | TRNSYS TUD | DOE-2.2 NREL | DOE21E-E NREL | EnergyPlus GARD | CODYRUN UR | HOT3000 NRCan | Min | Max | Mean | (Max-Min) /Mean* | |
| CE310-CE300 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0001 | 0.0000 | 0.0000 | 0.0001 | 0.0000 | 646.4% | 0.0000 |
| CE320-CE300 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 600.0% | 0.0000 |
| CE330-CE300 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 600.0% | 0.0000 |
| CE330-CE320 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 600.0% | 0.0000 |
| CE340-CE300 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 600.0% | 0.0000 |
| CE330-CE340 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | ---- | 0.0000 |
| CE350-CE300 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | ---- | 0.0000 |
| CE360-CE300 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 600.0% | 0.0000 |
| CE400-CE300 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 500.0% | 0.0000 |
| CE410-CE300 | 0.0000 | 0.0000 | 0.0000 | | | 0.0000 | 0.0000 | 0.0000 | 0.0000 | ---- | 0.0000 |
| CE420-CE300 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 500.0% | 0.0000 |
| CE430-CE300 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 500.0% | 0.0000 |
| CE440-CE300 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 500.0% | 0.0000 |
| CE500-CE300 | 0.0050 | | | 0.0051 | 0.0049 | 0.0083 | 0.0049 | 0.0083 | 0.0058 | 58.2% | 0.0045 |
| CE510-CE500 | 0.0000 | | | 0.0000 | 0.0000 | 0.0002 | 0.0000 | 0.0002 | 0.0001 | 400.0% | 0.0000 |
| CE525-CE520 | 0.0007 | | | 0.0005 | 0.0004 | 0.0088 | 0.0004 | 0.0088 | 0.0026 | 322.8% | 0.0016 |
| CE530-CE500 | -0.0006 | | | -0.0003 | -0.0015 | -0.0037 | -0.0037 | -0.0003 | -0.0015 | 226.1% | -0.0061 |
| CE545-CE540 | 0.0021 | | | 0.0030 | 0.0034 | 0.0028 | 0.0021 | 0.0034 | 0.0028 | 47.3% | -0.0004 |

* ABS[(Max-Min) / (Mean of Example Simulation Results)]

**ASHRAE Standard 140-2023 Test Results Comparison for Section 9 - HVAC Equipment Performance Tests CE300 through CE545
 TRNSYS18.06.0002 (TRNSYS) vs. Annex B16, Section B16.5.2 Example Results
 By Thermal Energy System Specialists, LLC (TESS), 19-Aug-2024.**

Note: The statistics in the tables below are based on the Standard 140 informative example results.
 These statistics do not have any substantial importance and are not to be interpreted as acceptance criteria.

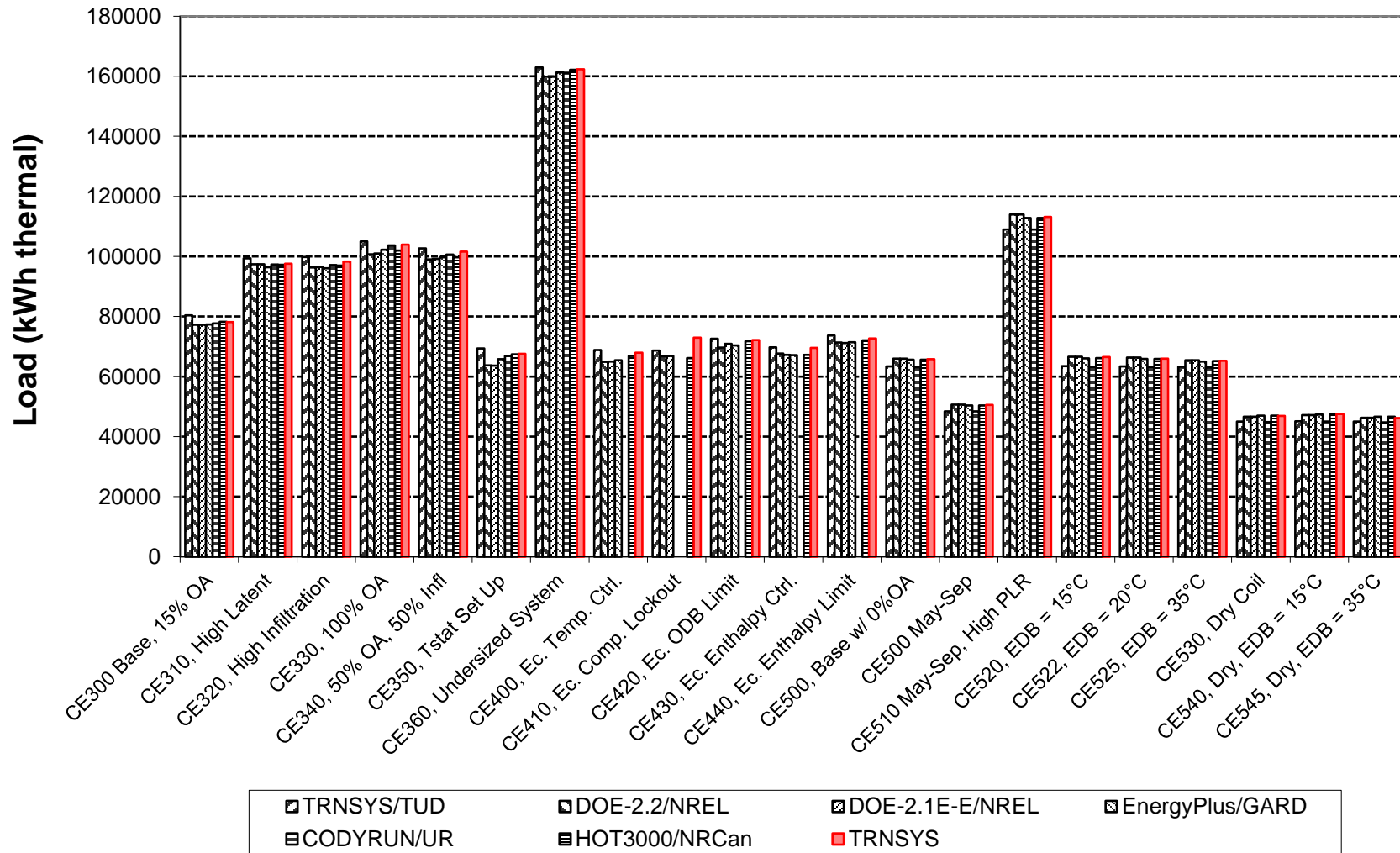
Table B16.5.2-28. Delta Hourly Integrated Maximum and Minimum Zone Relative Humidity

| Maximum Relative Humidity (%) | | | | | | | Statistics, All Results | | | | TRNSYS TESS |
|-------------------------------|---------------|-----------------|------------------|--------------------|---------------|------------------|-------------------------|-------|--------|---------------------|----------------|
| Case | TRNSYS TUD | DOE-2.2 NREL | DOE21E-E NREL | EnergyPlus GARD | CODYRUN UR | HOT3000 NRCan | Min | Max | Mean | (Max-Min) /Mean* | |
| CE310-CE300 | 8.91 | 30.83 | 31.85 | 10.28 | 9.00 | 10.75 | 8.91 | 31.85 | 16.94 | 135.4% | 9.17 |
| CE320-CE300 | 13.05 | 14.06 | 14.82 | 14.60 | 15.00 | 14.44 | 13.05 | 15.00 | 14.33 | 13.6% | 12.20 |
| CE330-CE300 | 7.87 | 9.11 | 9.09 | 8.51 | 8.00 | 11.26 | 7.87 | 11.26 | 8.97 | 37.8% | 28.16 |
| CE330-CE320 | -5.18 | -4.95 | -5.73 | -6.09 | -7.00 | -3.18 | -7 | -3 | -5.35 | 71.3% | 15.96 |
| CE340-CE300 | 11.14 | 12.02 | 12.41 | 12.43 | 12.00 | 12.81 | 11 | 13 | 12.13 | 13.8% | 17.00 |
| CE330-CE340 | -3.27 | -2.91 | -3.32 | -3.92 | -4.00 | -1.55 | -4 | -2 | -3.16 | 77.5% | 11.16 |
| CE350-CE300 | 0.00 | 11.77 | 12.27 | 0.00 | 2.00 | 5.21 | 0.00 | 12.27 | 5.21 | 235.6% | 0.00 |
| CE360-CE300 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 600.0% | 0.00 |
| CE400-CE300 | 14.96 | 16.22 | 16.72 | 16.27 | | 18.87 | 14.96 | 18.87 | 16.61 | 23.5% | 29.65 |
| CE410-CE300 | 14.44 | 15.44 | 15.94 | | | 18.74 | 14.44 | 18.74 | 16.14 | 26.7% | 16.81 |
| CE420-CE300 | 2.05 | 5.16 | 2.68 | 4.92 | | 6.41 | 2.05 | 6.41 | 4.24 | 102.7% | 16.65 |
| CE430-CE300 | 11.92 | 9.08 | 9.58 | 12.38 | | 11.50 | 9.08 | 12.38 | 10.89 | 30.3% | 26.23 |
| CE440-CE300 | -0.06 | 0.00 | 0.00 | 0.00 | | 0.07 | -0.06 | 0.07 | 0.00 | 13500.0% | 12.61 |
| CE500-CE300 | 31.21 | | | 31.63 | 32.00 | -7.36 | -7.36 | 32.00 | 21.87 | 180.0% | 29.65 |
| CE510-CE500 | 0.00 | | | 0.00 | 0.00 | -2.57 | -2.57 | 0.00 | -0.64 | 400.0% | 0.00 |
| CE525-CE520 | 9.77 | | | 6.19 | 5.00 | -20.65 | -20.65 | 9.77 | 0.08 | 39706.5% | 0.00 |
| CE530-CE500 | -8.96 | | | -3.84 | -21.00 | -24.07 | -24.07 | -3.84 | -14.47 | 139.8% | 0.00 |
| CE545-CE540 | 29.60 | | | 41.06 | 50.00 | -15.82 | -15.82 | 50.00 | 26.21 | 251.1% | 0.00 |

| Minimum Relative Humidity (%) | | | | | | | Statistics, All Results | | | | TRNSYS TESS |
|-------------------------------|---------------|-----------------|------------------|--------------------|---------------|------------------|-------------------------|--------|--------|---------------------|----------------|
| Case | TRNSYS TUD | DOE-2.2 NREL | DOE21E-E NREL | EnergyPlus GARD | CODYRUN UR | HOT3000 NRCan | Min | Max | Mean | (Max-Min) /Mean* | |
| CE310-CE300 | 0.06 | 0.00 | 0.00 | 1.10 | 1.00 | 0.99 | 0.00 | 1.10 | 0.52 | 209.6% | 0.02 |
| CE320-CE300 | 0.00 | 0.00 | 0.00 | 0.24 | 0.00 | -2.02 | -2.02 | 0.24 | -0.30 | 761.2% | -1.46 |
| CE330-CE300 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 600.0% | 0.00 |
| CE330-CE320 | 0.00 | 0.00 | 0.00 | -0.24 | 0.00 | 2.02 | -0.24 | 2.02 | 0.30 | 761.1% | 1.46 |
| CE340-CE300 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 600.0% | 0.00 |
| CE330-CE340 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | ---- | 0.00 |
| CE350-CE300 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | ---- | 0.00 |
| CE360-CE300 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 600.0% | 0.00 |
| CE400-CE300 | -0.12 | 0.00 | 0.00 | -0.48 | | -0.37 | -0.48 | 0.00 | -0.19 | 246.0% | 0.22 |
| CE410-CE300 | -0.12 | 0.00 | 0.00 | | | -0.36 | -0.36 | 0.00 | -0.12 | 298.7% | 0.22 |
| CE420-CE300 | -0.12 | 0.00 | 0.00 | -0.48 | | -0.35 | -0.48 | 0.00 | -0.19 | 251.4% | 0.22 |
| CE430-CE300 | -0.12 | 0.00 | 0.00 | -0.48 | | -0.36 | -0.48 | 0.00 | -0.19 | 248.3% | 0.22 |
| CE440-CE300 | -0.12 | 0.00 | 0.00 | -0.48 | | -0.40 | -0.48 | 0.00 | -0.20 | 238.1% | 0.22 |
| CE500-CE300 | 40.07 | | | 40.76 | 39.00 | 37.89 | 37.89 | 40.76 | 39.43 | 7.3% | 35.29 |
| CE510-CE500 | -1.32 | | | 0.12 | 0.00 | 0.32 | -1.32 | 0.32 | -0.22 | 747.8% | 0.00 |
| CE525-CE520 | -15.74 | | | -13.87 | -17.00 | -17.50 | -17.50 | -13.87 | -16.03 | 22.6% | -1.54 |
| CE530-CE500 | -23.81 | | | -21.14 | -26.00 | -19.15 | -26.00 | -19.15 | -22.53 | 30.4% | -48.26 |
| CE545-CE540 | -19.35 | | | -16.77 | -12.00 | -19.60 | -19.60 | -12.00 | -16.93 | 44.9% | -3.63 |

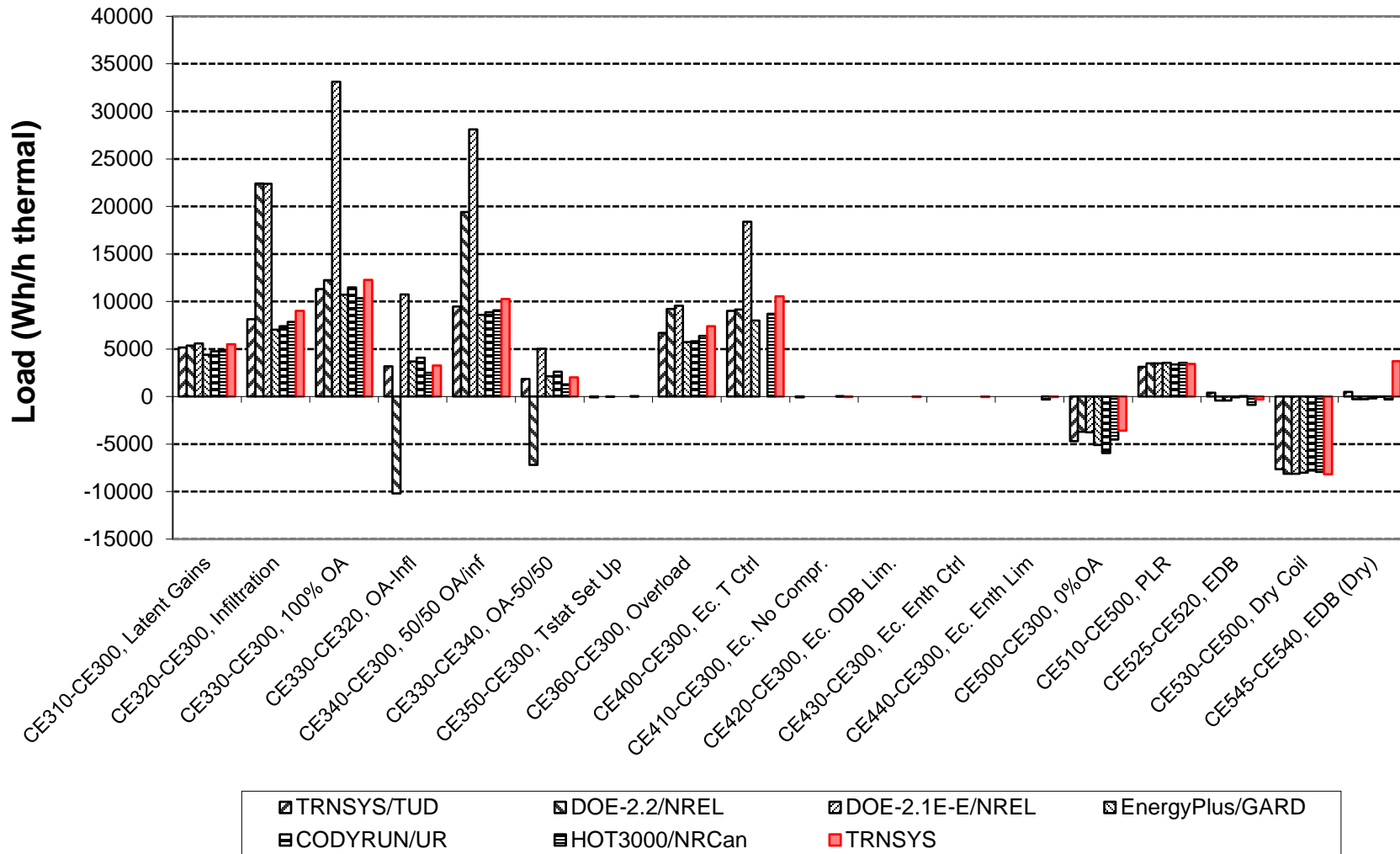
* ABS[(Max-Min) / (Mean of Example Simulation Results)]

Figure B16.5.2-11. HVAC BESTEST: CE300 - CE545
Annual Total Coil Load



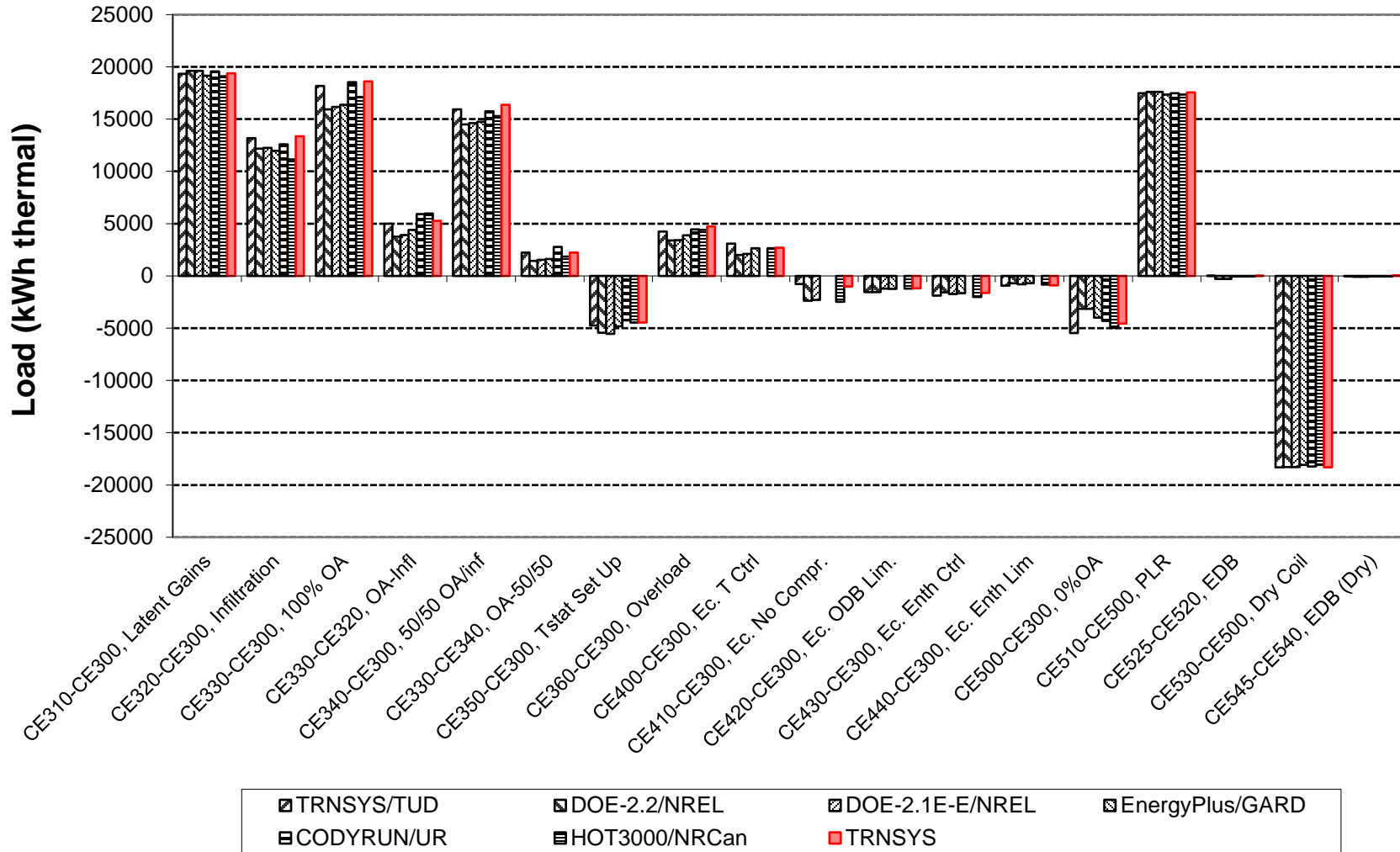
ASHRAE Standard 140-2023 Test Results Comparison for Section 9 - HVAC Equipment Performance Tests CE300 through CE545
 TRNSYS18.06.0002 (TRNSYS) vs. Annex B16, Section B16.5.2 Example Results

**Figure B16.5.2-13. HVAC BESTEST: CE300 - CE545
 Hourly Maximum Total Coil Load Sensitivities**



ASHRAE Standard 140-2023 Test Results Comparison for Section 9 - HVAC Equipment Performance Tests CE300 through CE545
 TRNSYS18.06.0002 (TRNSYS) vs. Annex B16, Section B16.5.2 Example Results

**Figure B16.5.2-18. HVAC BESTEST: CE300 - CE545
 Annual Latent Cooling Load Sensitivities**



ASHRAE Standard 140-2023 Test Results Comparison for Section 9 - HVAC Equipment Performance Tests CE300 through CE545
 TRNSYS18.06.0002 (TRNSYS) vs. Annex B16, Section B16.5.2 Example Results

**Figure B16.5.2-21. HVAC BESTEST: CE300 - CE545
 Annual Mean COP2**

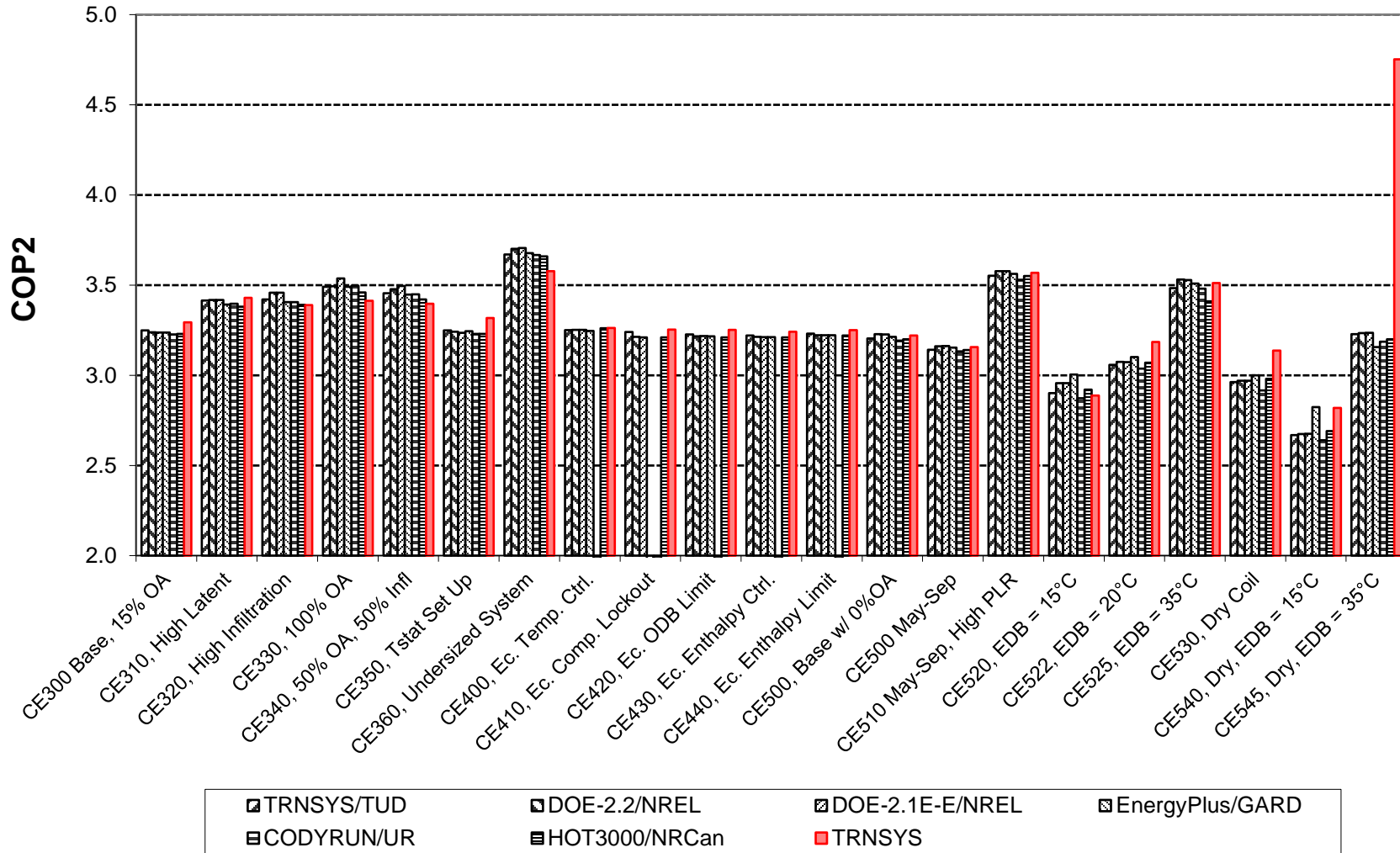
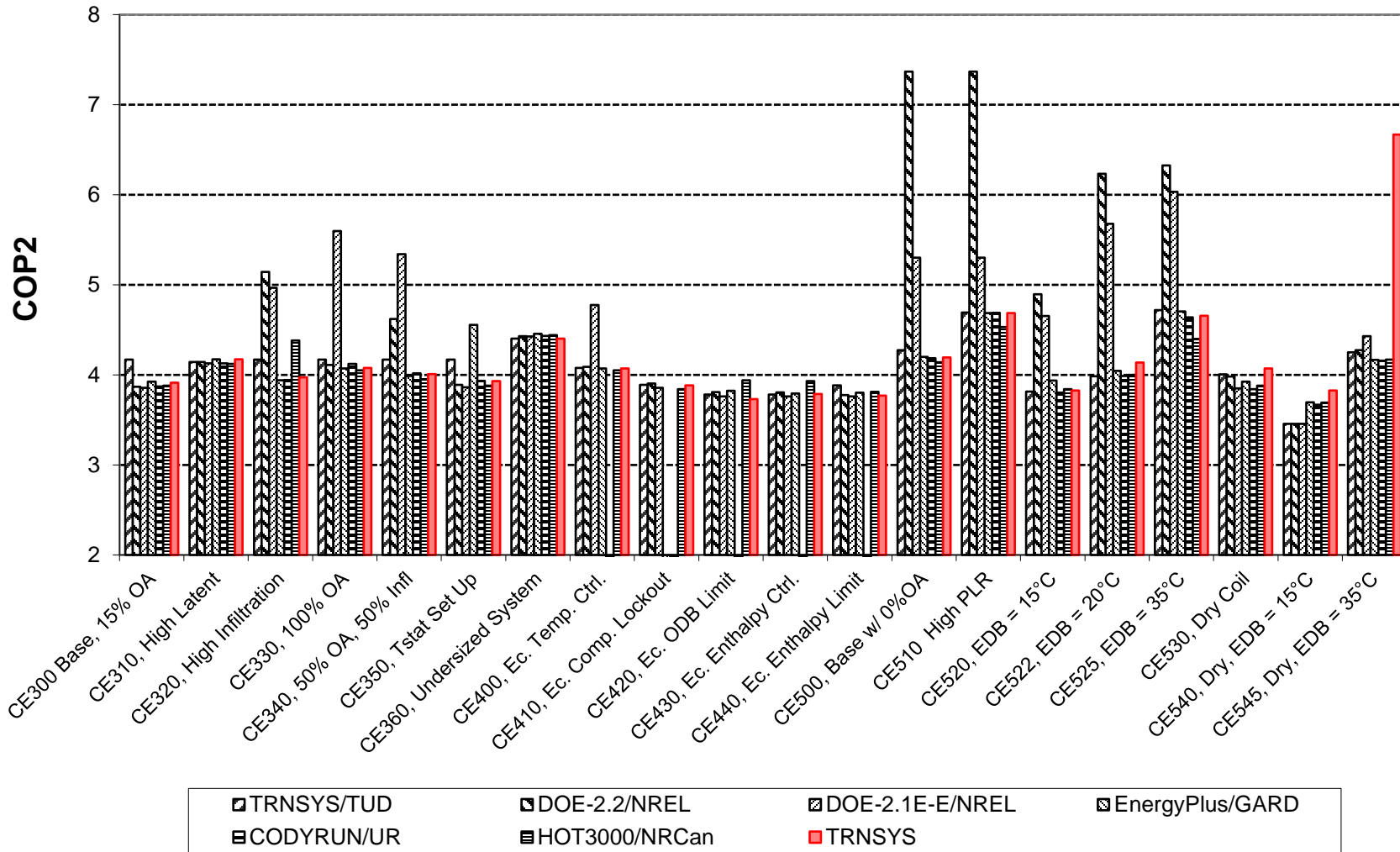
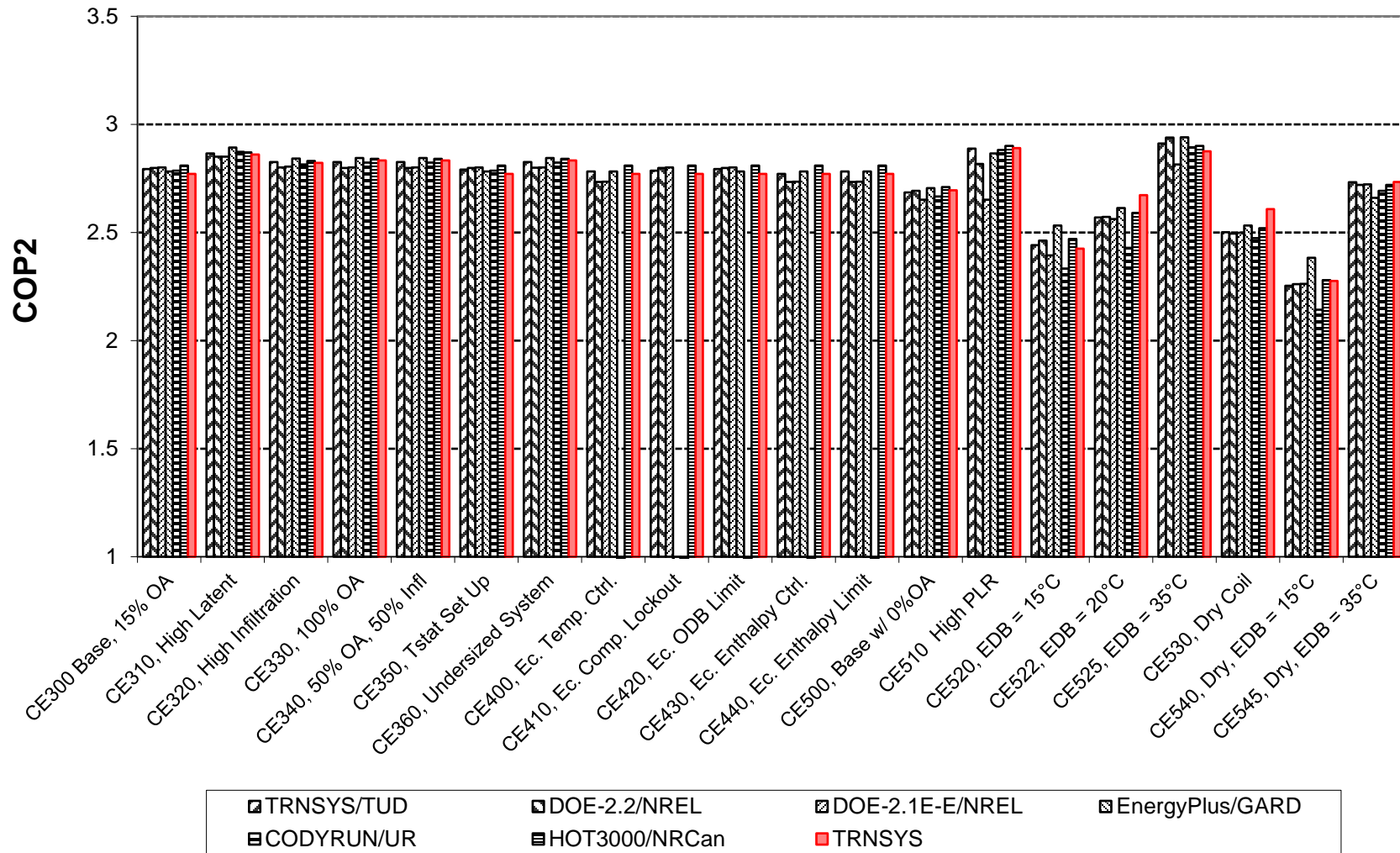


Figure B16.5.2-23. HVAC BESTEST: CE300 - CE545
Hourly Maximum COP2



**Figure B16.5.2-25. HVAC BESTEST: CE300 - CE545
 Hourly Minimum COP2**



**Figure B16.5.2-26. HVAC BESTEST: CE300 - CE545
 Hourly Minimum COP2 Sensitivities**

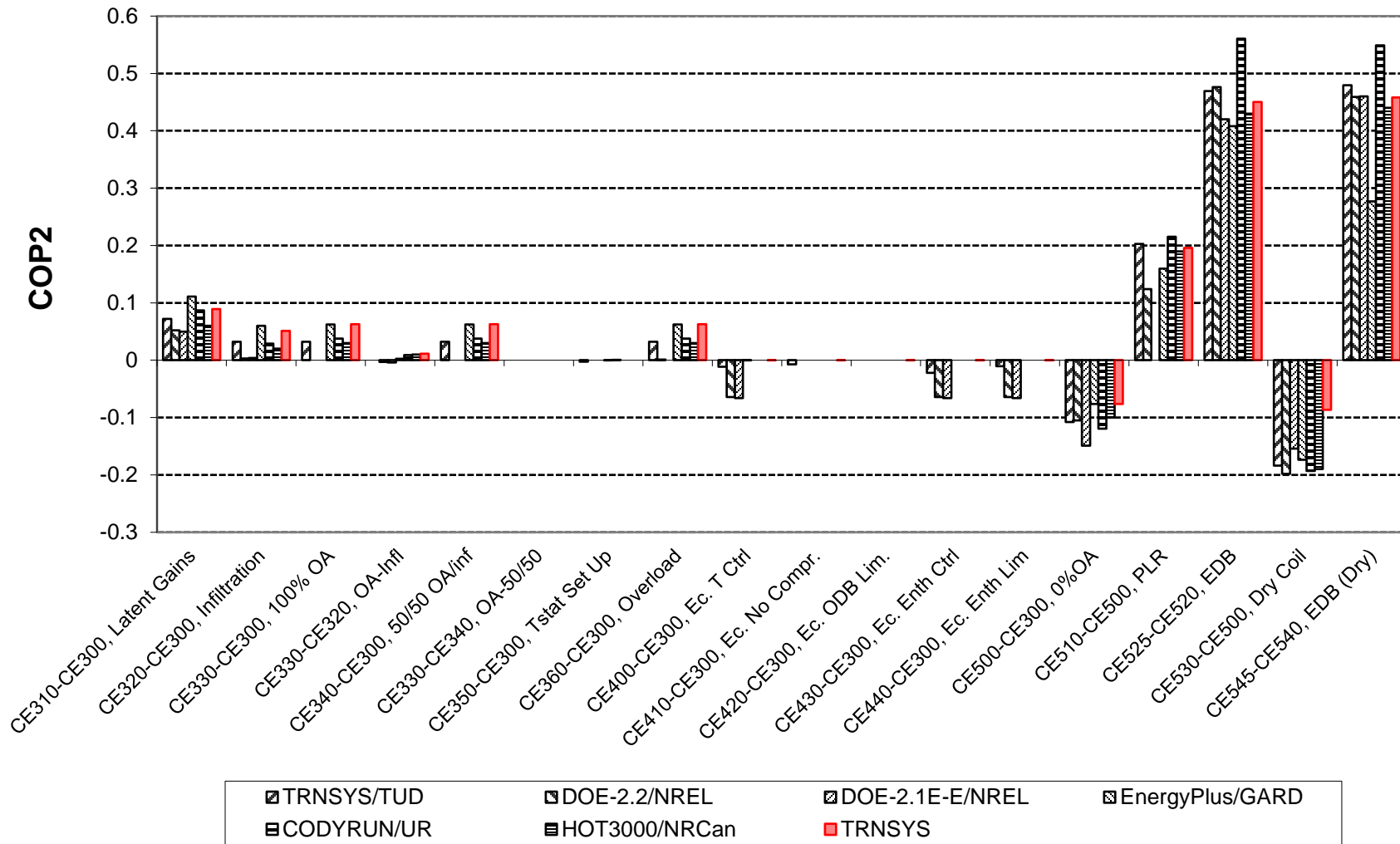


Figure B16.5.2-29. HVAC BESTEST: CE300 - CE545
Hourly Maximum Indoor Dry-Bulb Temperature

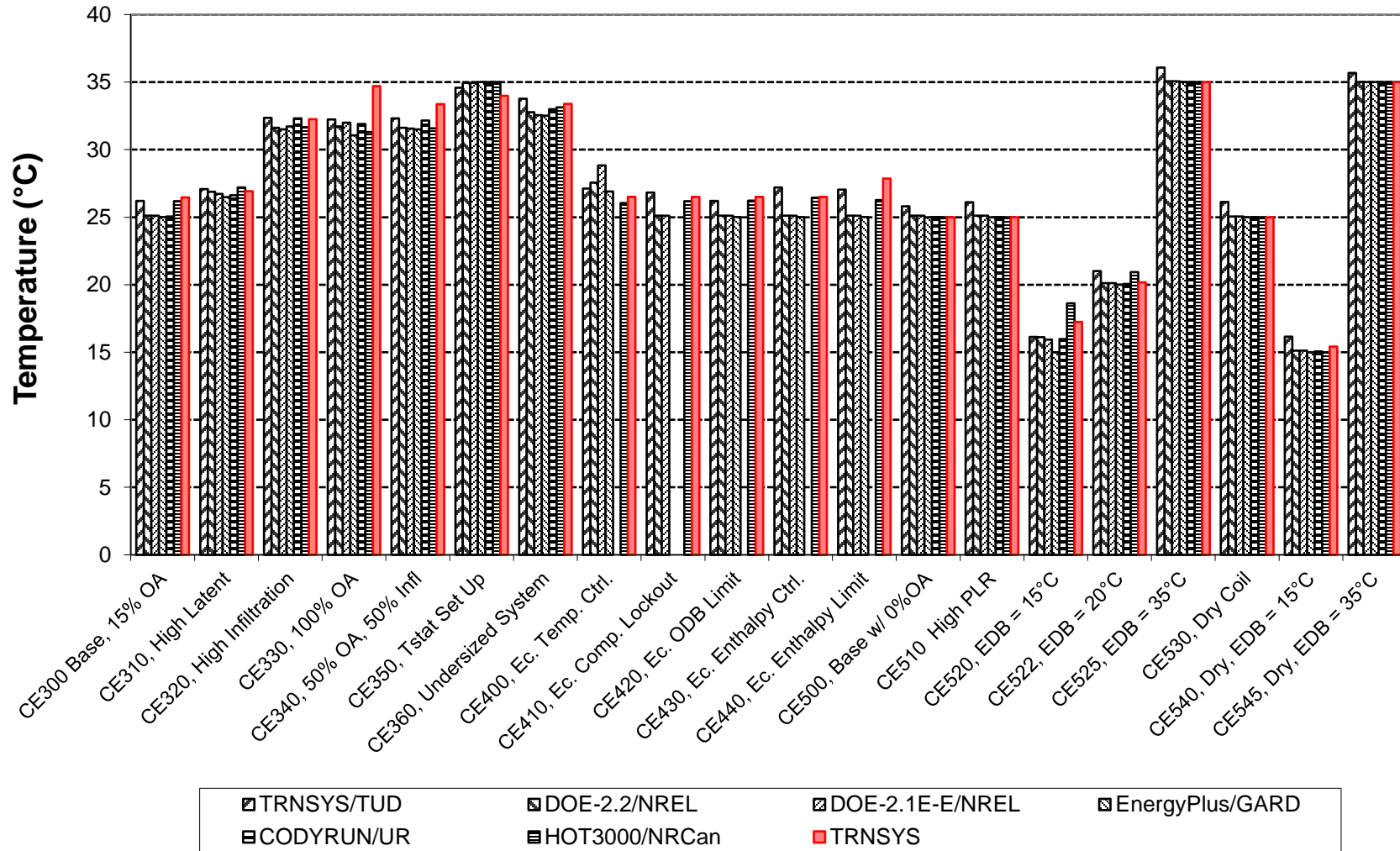


Figure B16.5.2-31. HVAC BESTEST: CE300 - CE545
Hourly Minimum Indoor Dry-Bulb Temperature

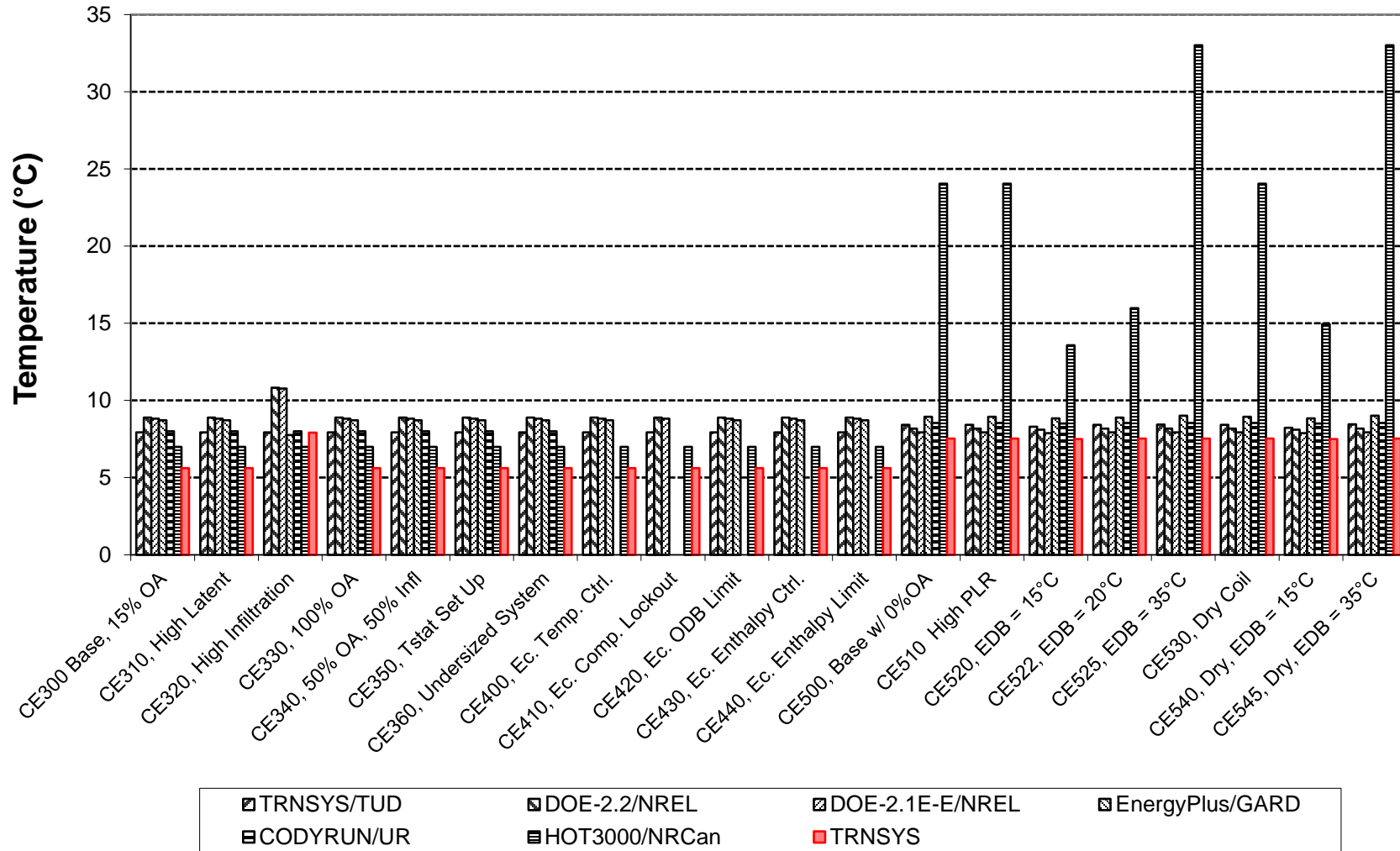
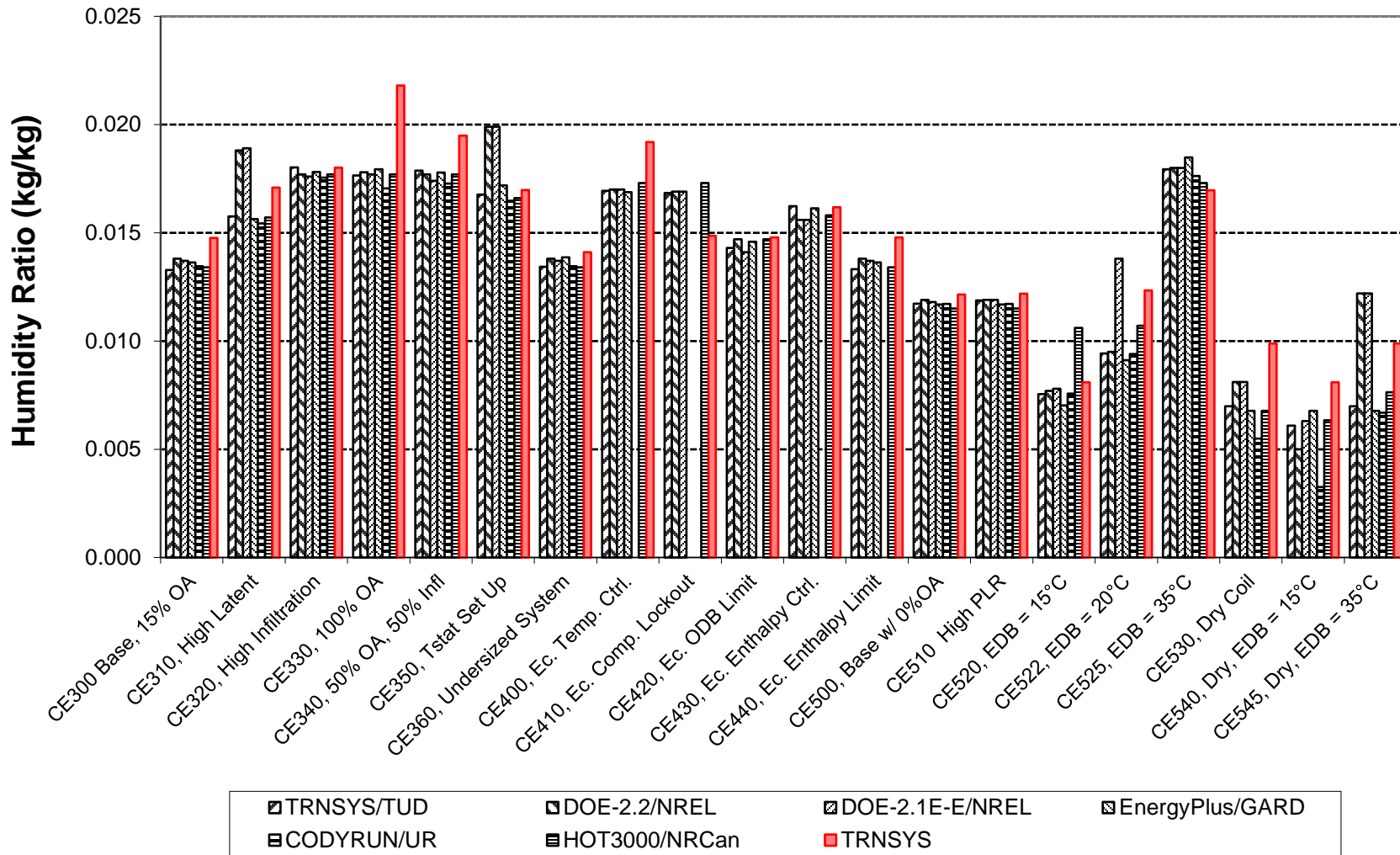


Figure B16.5.2-34. HVAC BESTEST: CE300 - CE545
Hourly Maximum Zone Humidity Ratio



**Figure B16.5.2-35. HVAC BESTEST: CE300 - CE545
 Hourly Maximum Humidity Ratio Sensitivities**

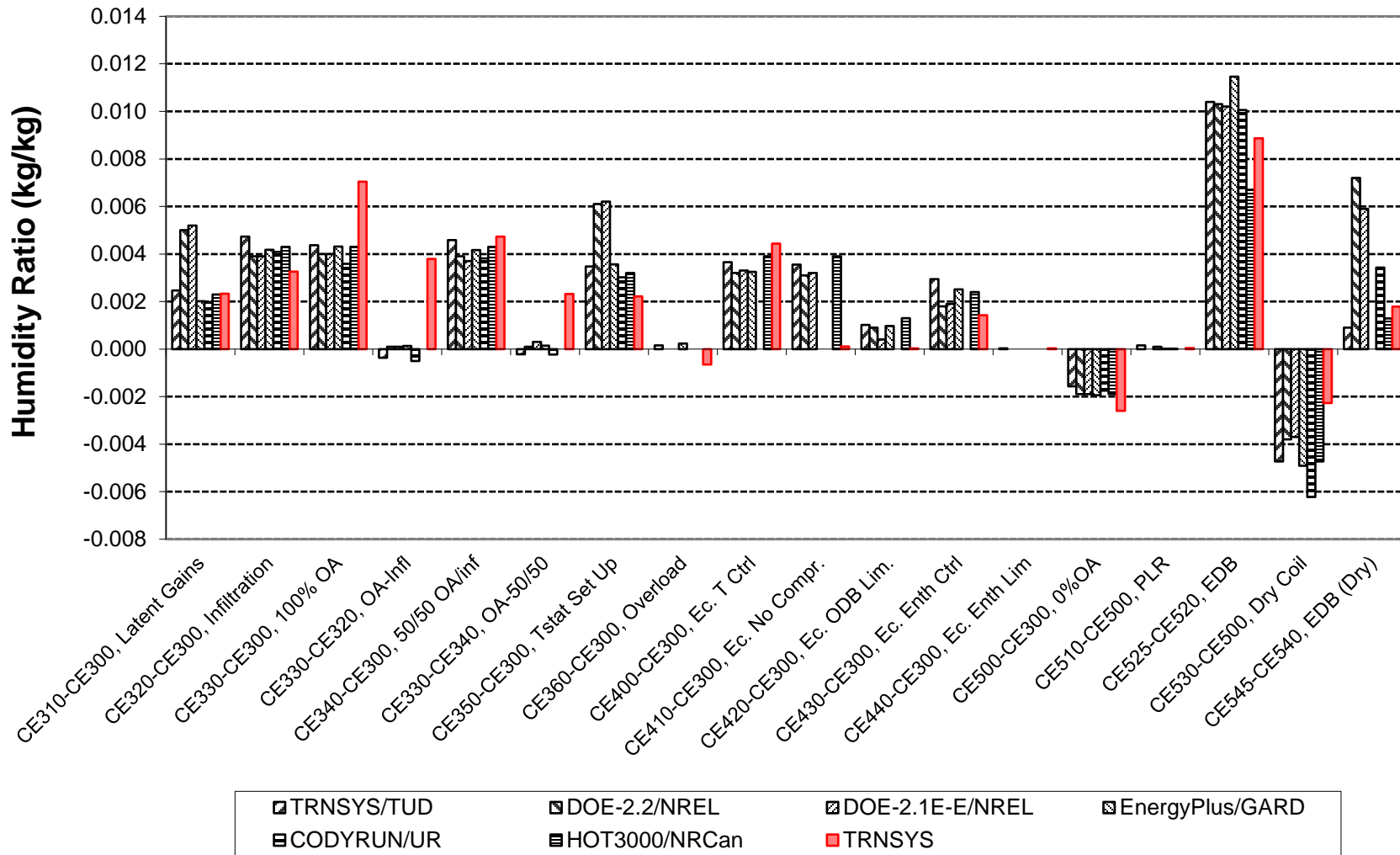


Figure B16.5.2-37. HVAC BESTEST: CE300 - CE545
Annual Mean Relative Humidity

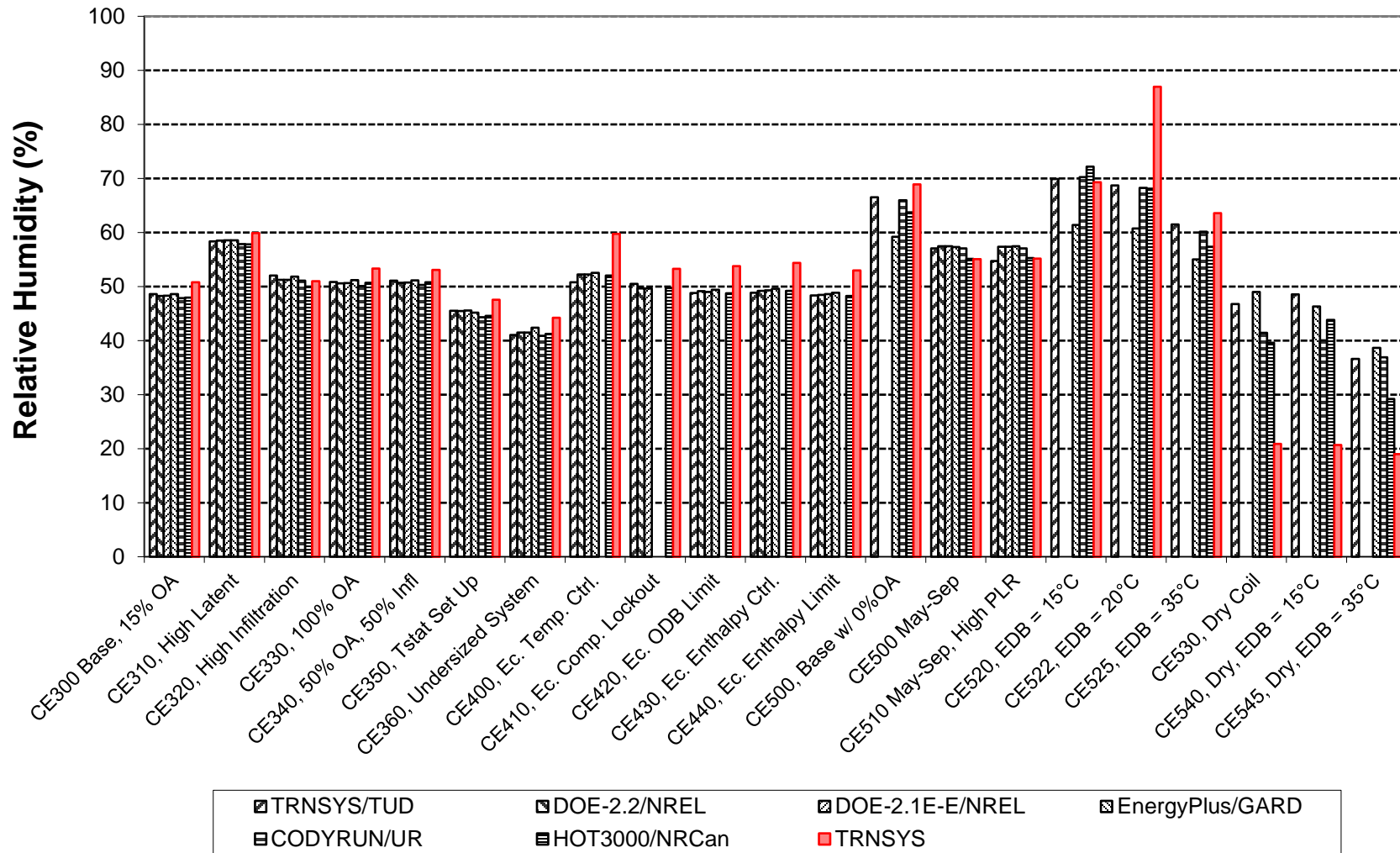
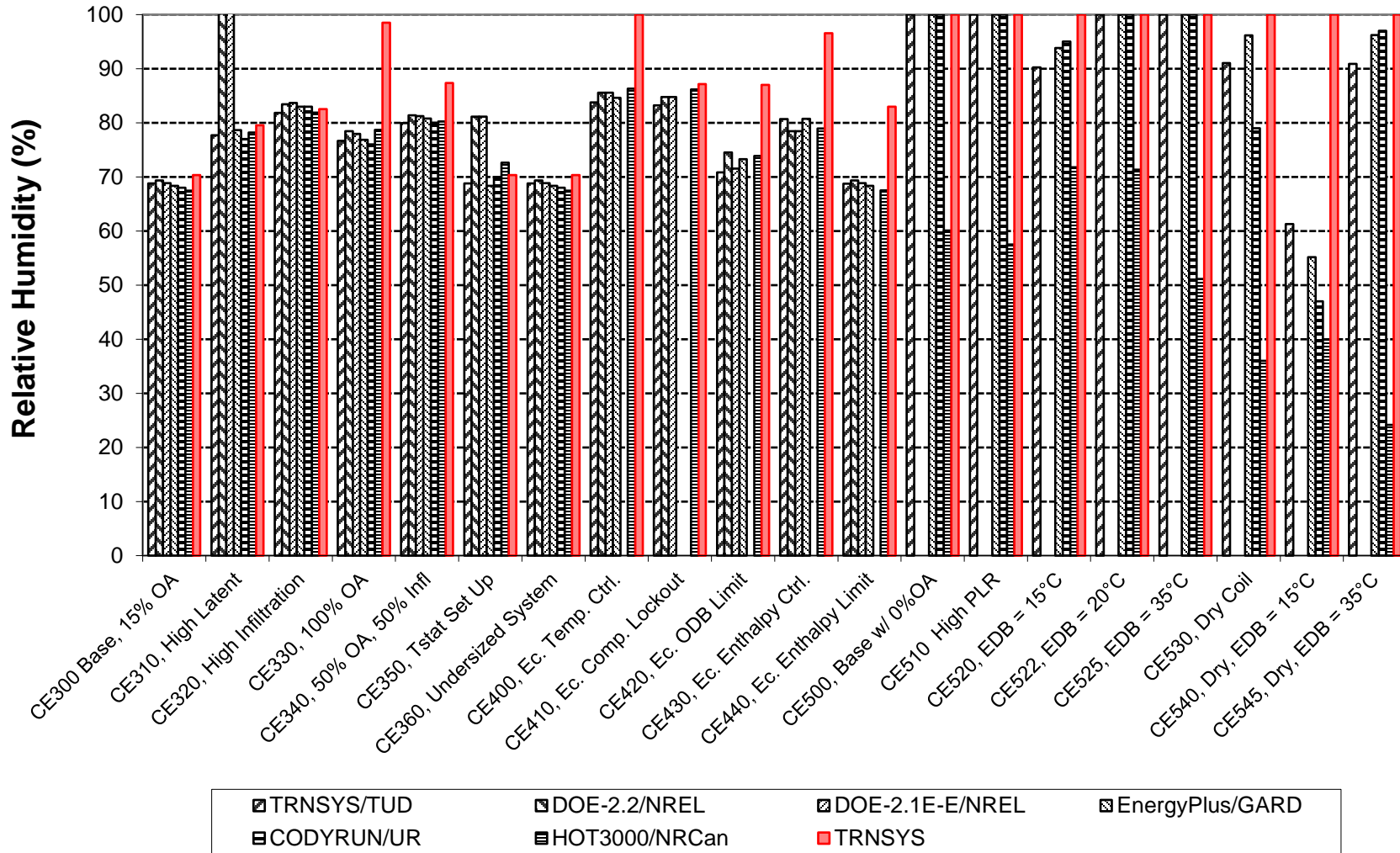


Figure B16.5.2-39. HVAC BESTEST: CE300 - CE545
Hourly Maximum Zone Relative Humidity



**Figure B16.5.2-40. HVAC BESTEST: CE300 - CE545
 Hourly Maximum Relative Humidity Sensitivities**

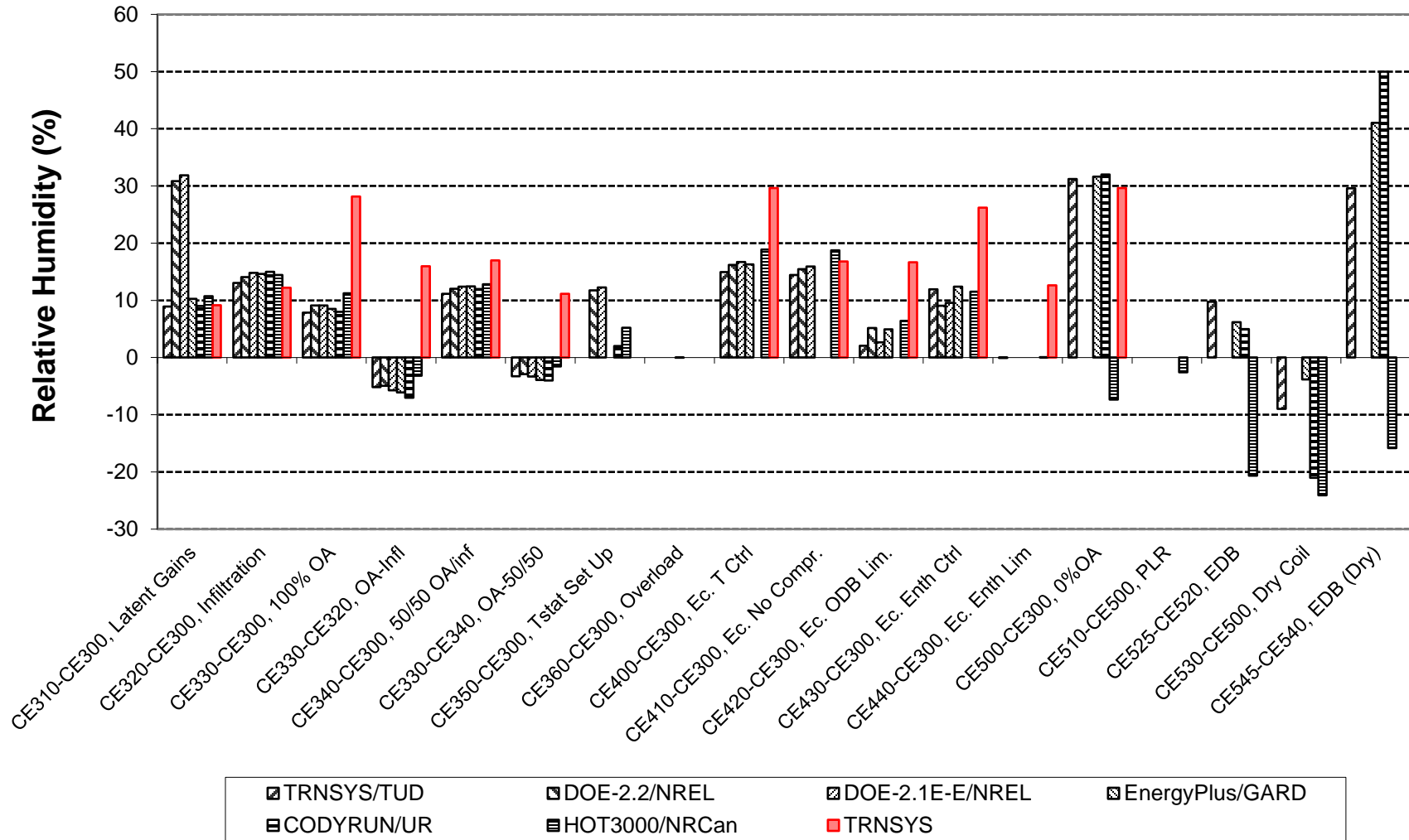
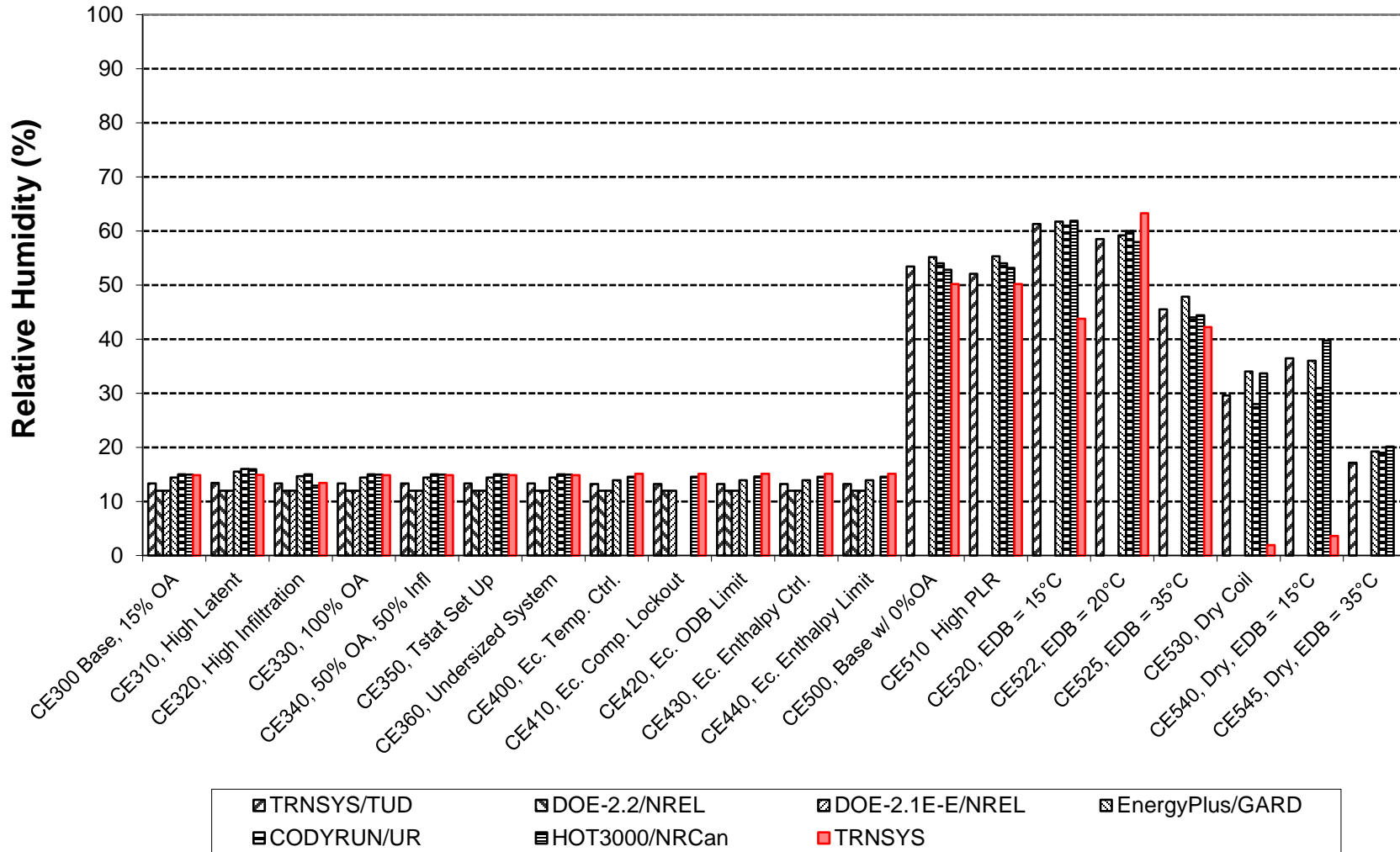


Figure B16.5.2-41. HVAC BESTEST: CE300 - CE545
Hourly Minimum Zone Relative Humidity



**Figure B16.5.2-42. HVAC BESTEST: f(ODB) for CE500, CE530
 Specific Day Electricity Consumptions**

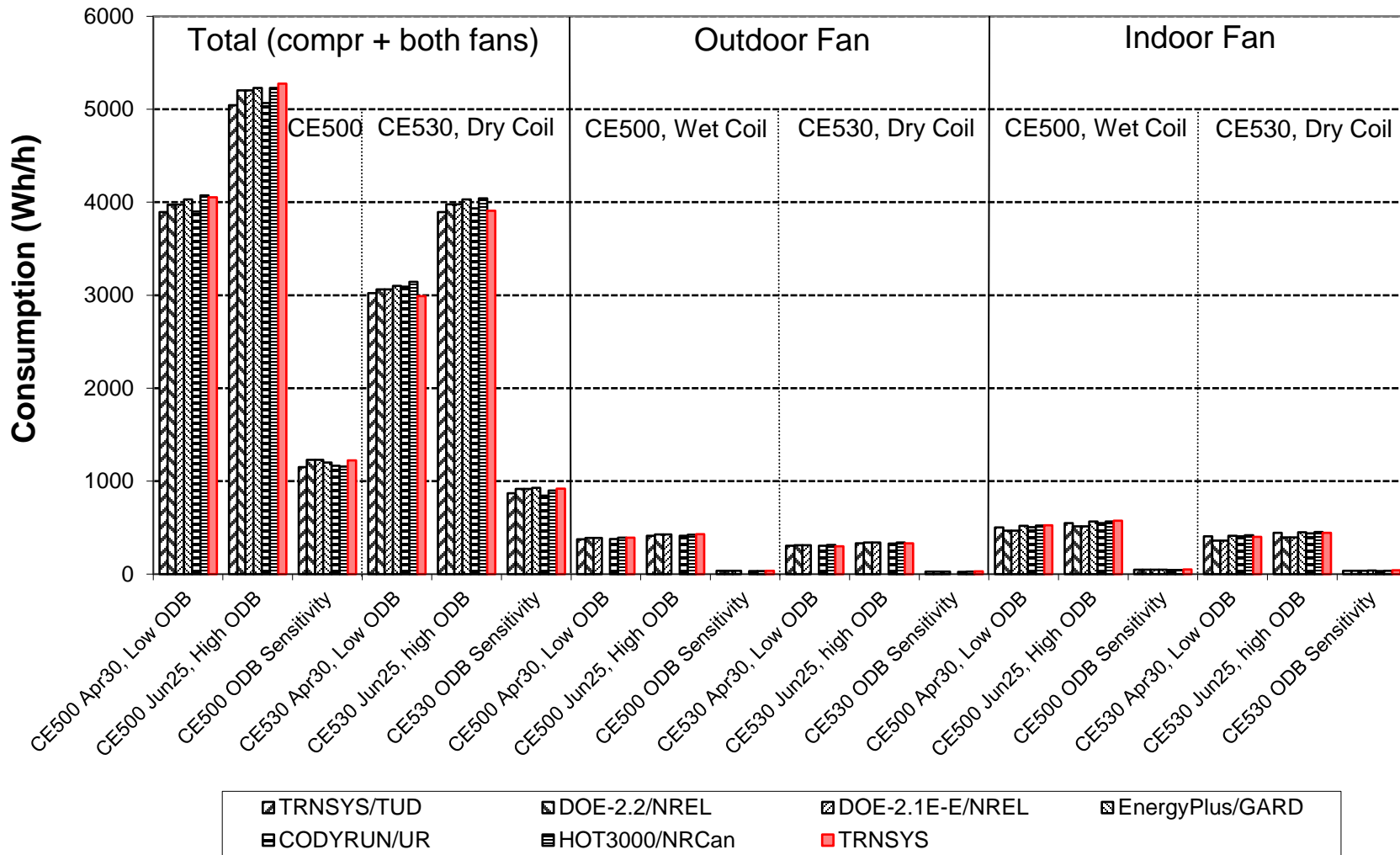
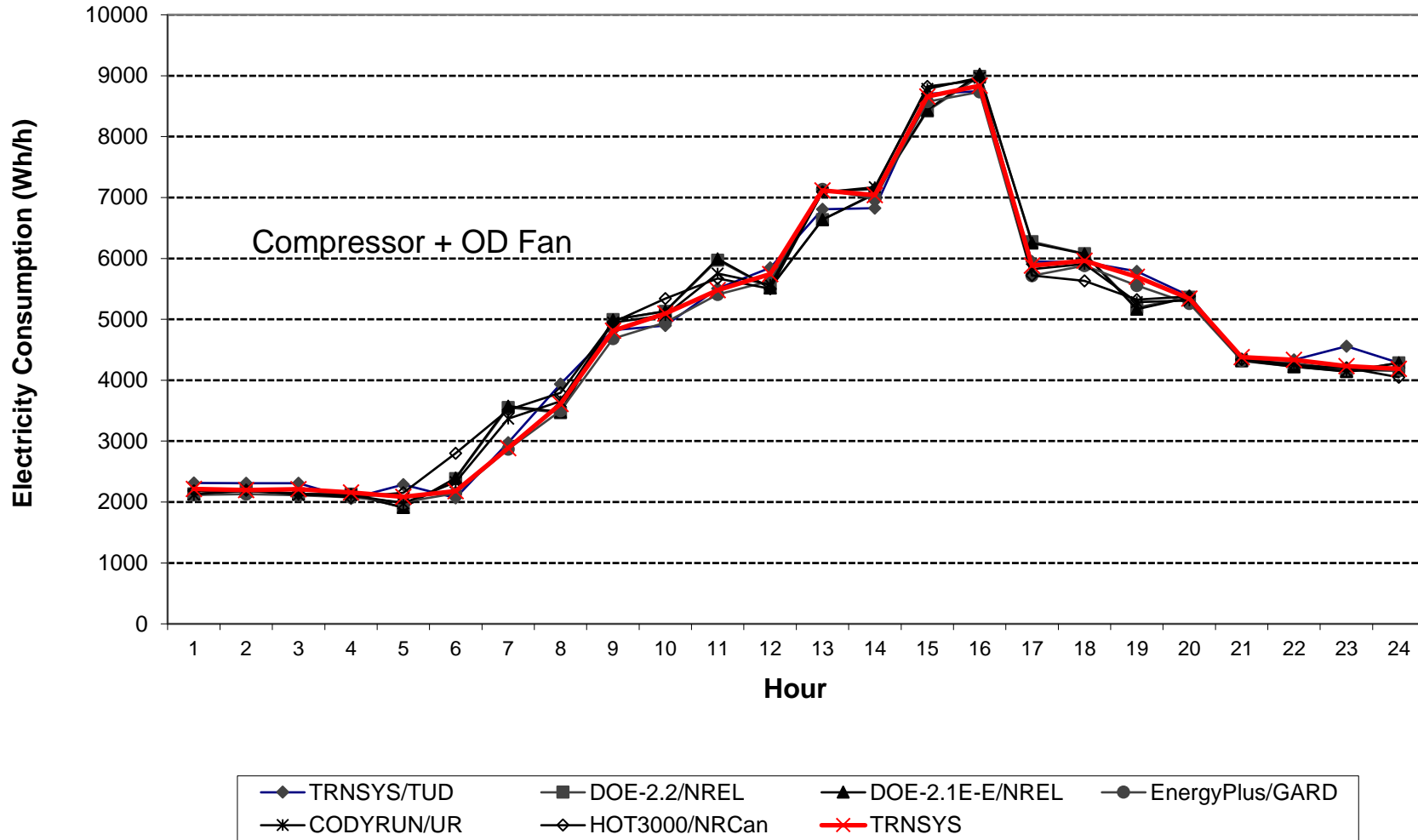
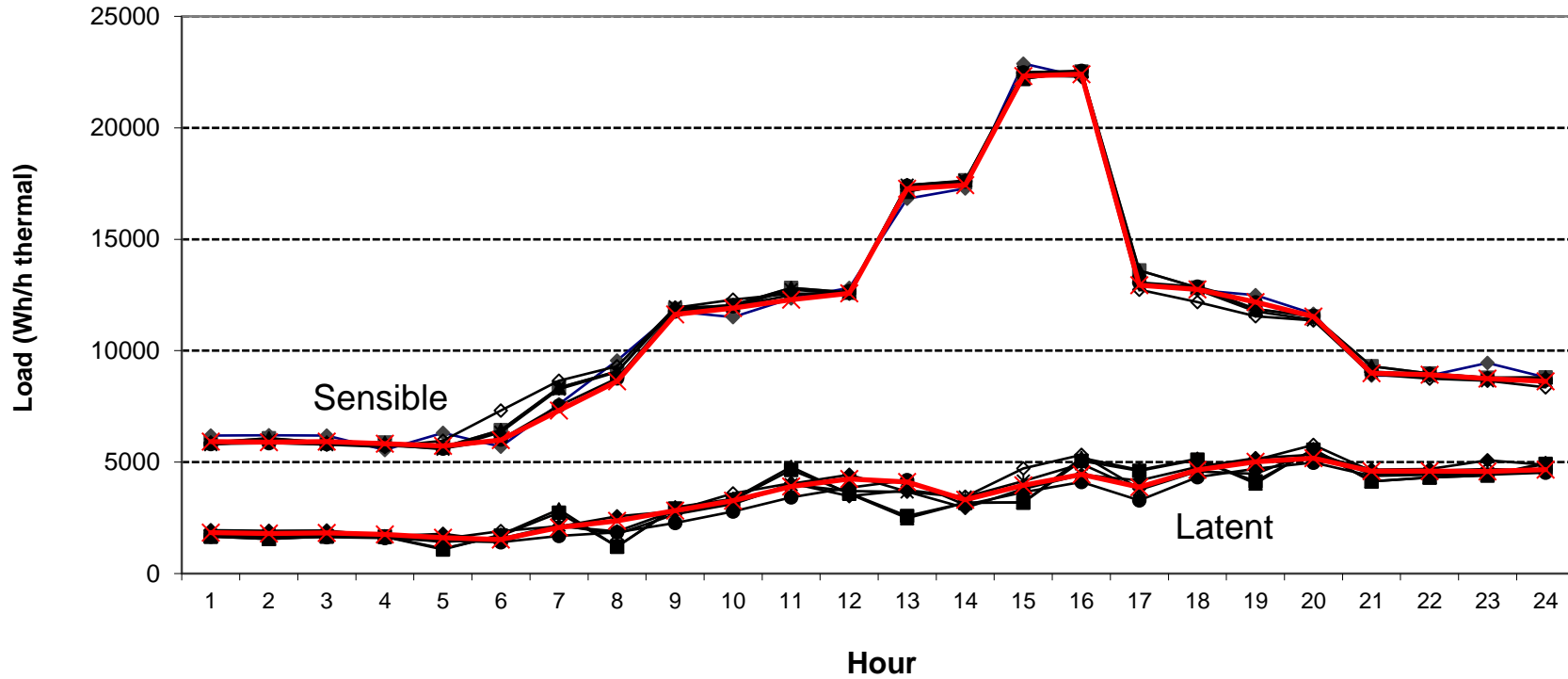


Figure B16.5.2-46. HVAC BESTEST: CE300
June 28 Hourly Electricity Consumption



**Figure B16.5.2-47. HVAC BESTEST: CE300
 June 28 Hourly Coil Loads**



| | | | |
|-----------------|-------------------|-------------------|-------------------|
| ◆ TRNSYS/TUD | ■ DOE-2.2/NREL | ▲ DOE-2.1E-E/NREL | ● EnergyPlus/GARD |
| * CODYRUN/UR | ◇ HOT3000/NRCAn | ✕ TRNSYS | ◆ TRNSYS/TUD |
| ■ DOE-2.2/NREL | ▲ DOE-2.1E-E/NREL | ● EnergyPlus/GARD | * CODYRUN/UR |
| ◇ HOT3000/NRCAn | ✕ TRNSYS | | |

ASHRAE Standard 140-2023 Test Results Comparison for Section 9 - HVAC Equipment Performance Tests CE300 through CE545
TRNSYS18.06.0002 (TRNSYS) vs. Annex B16, Section B16.5.2 Example Results

Figure B16.5.2-48. HVAC BESTEST: CE300
June 28 Hourly COP2

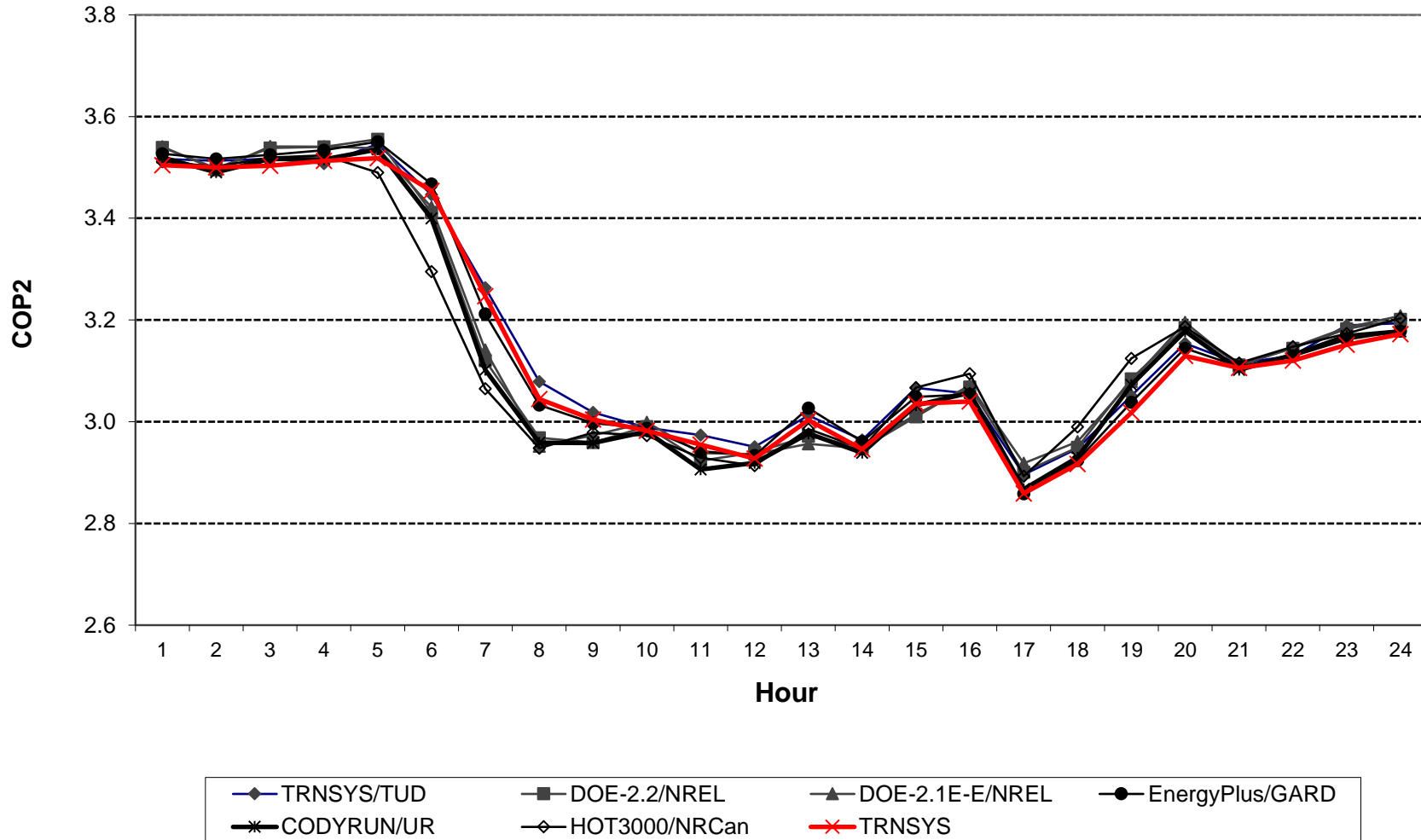
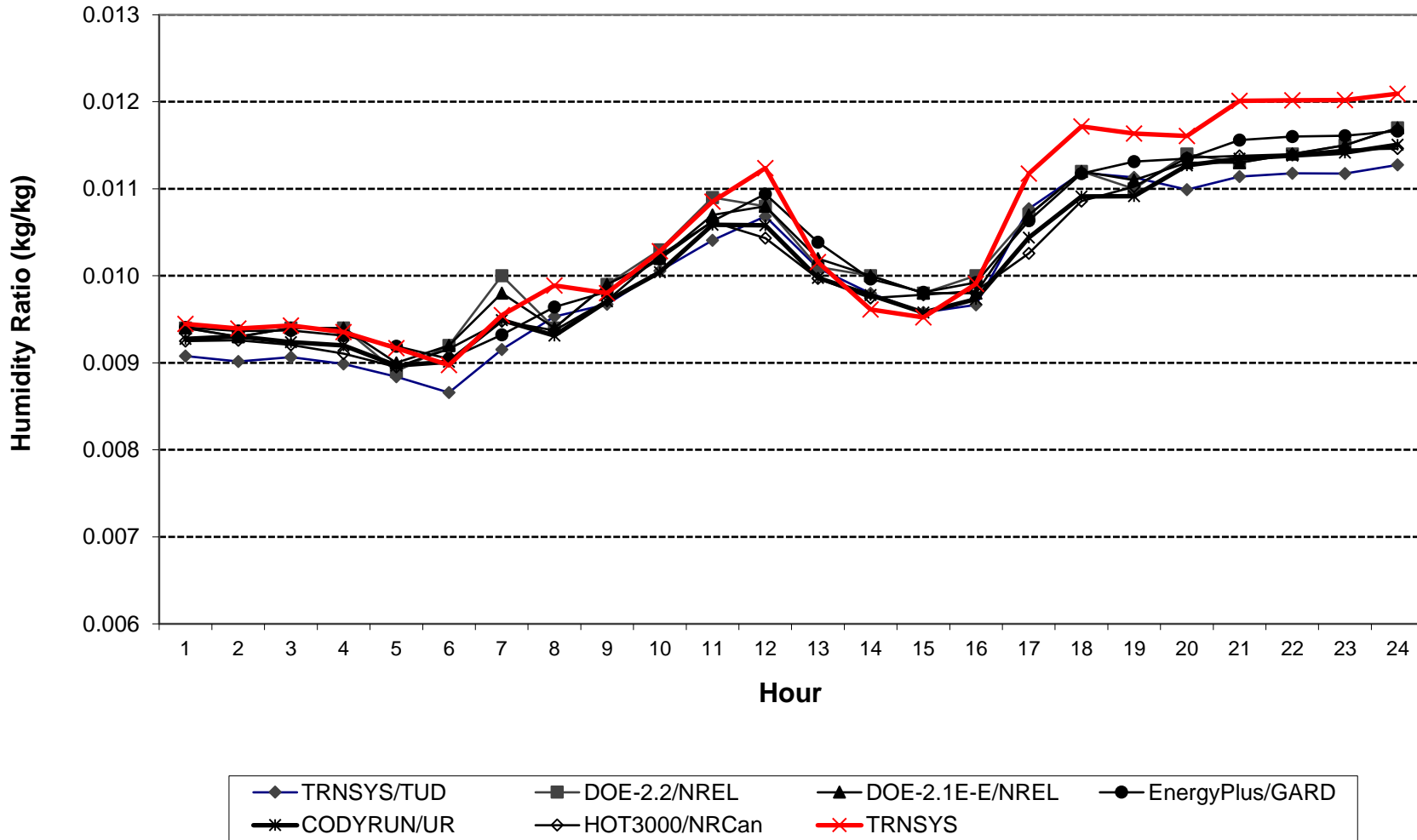
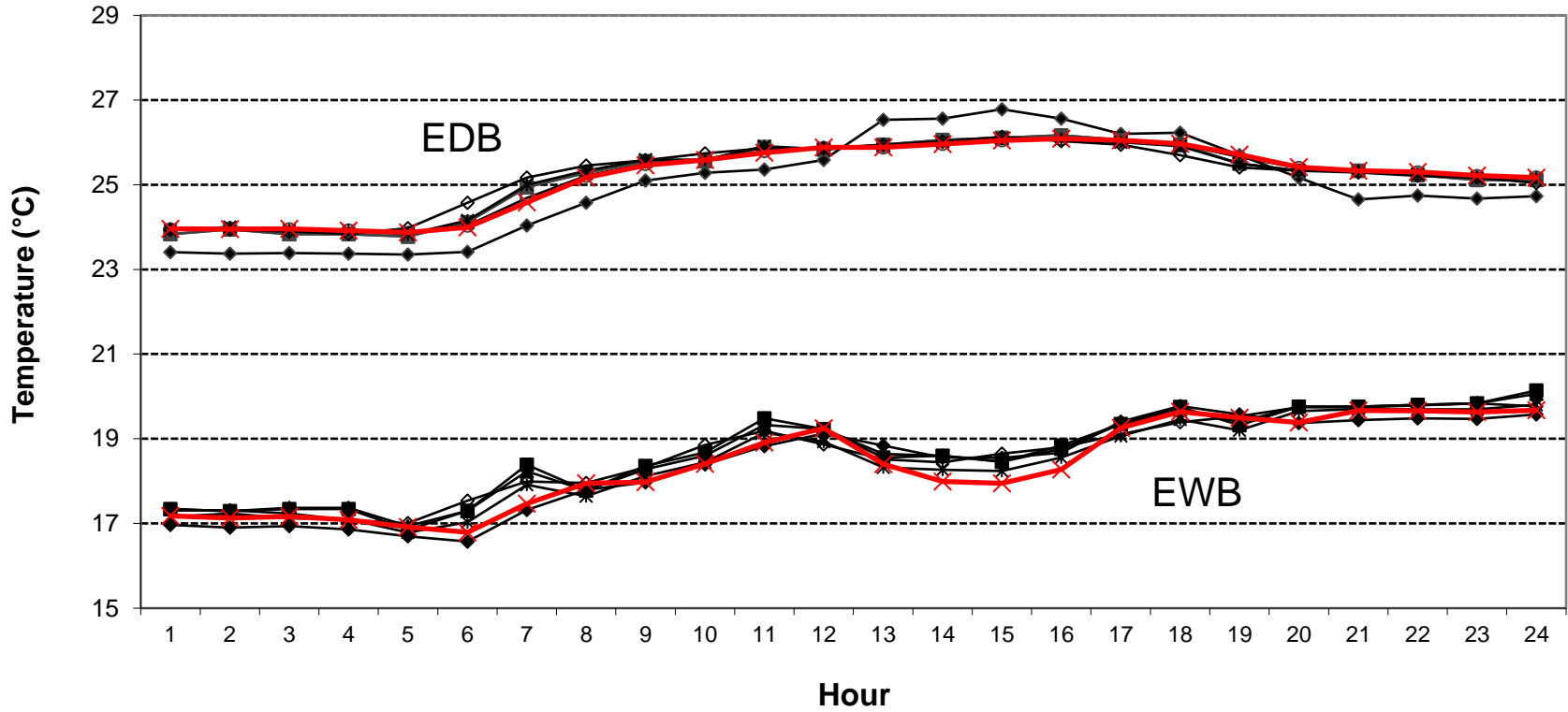


Figure B16.5.2-49. HVAC BESTEST: CE300
June 28 Hourly Zone Humidity Ratio



**Figure B16.5.2-50. HVAC BESTEST: CE300
 June 28 Hourly EDB & EWB**



| | | | | |
|-------------------|----------------|-------------------|-------------------|-------------------|
| ◆ TRNSYS/TUD | ■ DOE-2.2/NREL | ▲ DOE-2.1E-E/NREL | ○ EnergyPlus/GARD | * CODYRUN/UR |
| ◇ HOT3000/NRCan | ✖ TRNSYS | ◆ TRNSYS/TUD | ■ DOE-2.2/NREL | ▲ DOE-2.1E-E/NREL |
| ○ EnergyPlus/GARD | * CODYRUN/UR | ◇ HOT3000/NRCan | ✖ TRNSYS | |

