Technical report:

Validation of IDA Indoor Climate and Energy 4.0 with respect to CEN Standards EN 15255-2007 and EN 15265-2007

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Equa Simulation AB
Råsundavägen 100
169 57 Solna
Sweden

Equa Simulation Finland Oy
Keskiyöntie 3
02210 Espoo
Finland

Contents

1 Introduction and overview

This report treats the tests of IDA - Indoor Climate and Energy 4.0 build 4 (IDA-ICE) with respect to CEN standards EN 15255 and EN 15265 titled:

Thermal performance of buildings - Sensible room cooling load calculation - General criteria and validation procedures. (EN 15255)

Thermal performance of buildings - Calculation of energy needs for space heating and cooling using dynamic methods – General criteria and validation procedures. (EN 15265)

The main reason for performing the tests is to ascertain that the computational models of IDA ICE 4.0 give acceptable results compared to those given in the reference results in CEN Standards EN 15255 and EN 15265

The validation process is described in standards EN 15255-2007 and EN 15265-2007.

It is important to recognize that the reference model that is used in standards EN 15255-2007 and EN 15265-2007 is significantly simplified with respect to state-of-the-art thermal building models. Some key physical phenomena such as non-linear film coefficients, dynamic solar patch tracing and full Stephan-Boltzmann radiation between surfaces have a significant impact on results and are not considered by the reference model. Only programs with the same level of simplification will get a "perfect match" with the reference model.

The default IDA ICE model had to be downgraded in several respects to better match the reference model. This was exclusively done by choice of parameters and only to a sufficient degree to get passing results. The ambition has not been to match the reference model as closely as possible. For details, see the Modeler Report Section.

1.1 Validation accuracy requirements for EN 15255

In standard EN 15255 the maximum operative temperature and both maximum and average cooling powers are calculated and compared to given reference results.

To complete the validation 15 test cases has to be passed within the accuracy given below. The calculation results for maximum operative temperature ($\theta_{op,max}$,°C), maximum cooling power (P_{max}, W) and average cooling power (P_{av}, W) are compared to sum of reference values ($\theta_{op,max,ref}$, $P_{max,ref}$ and $P_{av,ref}$) with following equations:

$ABS(\theta_{op,max} – \theta_{op,max,ref}) \leq 0.5$, for maximum operative temperature

$ABS(P_{max} – P_{max,ref}) / P_{max,ref} \leq 0.05$, for maximum cooling power

$ABS(P_{av} – P_{av,ref}) / P_{av,ref} \leq 0.05$, for average cooling power

1.2 Validation accuracy requirements for EN 15265

In EN 15265 the objective is to calculate annual heating and cooling energies for the given test cases and to achieve desired accuracy compared to reference results given in kWh.

The calculation results for heating (Q_H, kWh) and for cooling (Q_C, kWh) are compared to the sum of the reference values ($Q_{H,ref}$ and $Q_{C,ref}$) with following equations:

$rQ_h = ABS(Q_H – Q_{H,ref}) / Q_{tot,ref}$, for heating

$rQ_c = ABS(Q_C – Q_{C,ref}) / Q_{tot,ref}$, for cooling

The required accuracy levels for all tests are the following:

Level A: $r_{Qh} \leq 0.05$ and $r_{Qc} \leq 0.05$

Level B: $r_{Qh} \leq 0.10$ and $r_{Qc} \leq 0.10$

Level C: $r_{Qh} \leq 0.15$ and $r_{Qc} \leq 0.15$

Eight validation cases have to be passed within at least accuracy level C. Four additional validation tests are described, but they are not mandatory.

2 Test results

The validation process, input data and validation tests are described in CEN standards EN 15255-2007 and EN 15265-2007. The validation was performed strictly with the given standard guidelines and instructions. For comments on the application of IDA, see the Modeler Report below.

2.1 Performed tests based on EN 15255 standard

The following tests were performed as described in the CEN standard:

- Test 1 – reference case
- Test 2 – reference case + modification of the thermal inertia
- Test 3 – reference case + modification of the internal gains
- Test 4 – reference case + modification of the type of glazing system
- Test 5 – reference case + modification of the system control
- Test 6 – reference case + intermittent operation of the system
- Test 7 – test 6 + modification of the thermal inertia
- Test 8 – test 6 + modification of the internal gains
- Test 9 – test 6 + modification of the shading of the glazing system
- Test 10 – test 6 + modification of the ventilation
- Test 11 – test 6 + modification of the maximum cooling power
- Test 12– test 6 + modification of system control
- Test 13 – test 6 + modification of the functioning of the shading system
- Test 14 – cooled floor at fixed temperature
- Test 15– cooled ceiling with the control of the internal air temperature

2.2 Performed tests based on EN 15265 standard

The following tests were performed as described in the CEN standard:

- Test 1 – reference case
- Test 2 – as test 1 + change inertia
- Test 3 – as test 1 + no internal gains
- Test 4 – as test 1 + no solar protection
- Test 5 – as test 1 + intermittent heating and cooling during weekdays from 08:00 to 18:00
- Test 6 – as test 2 + intermittent heating and cooling as for test 5
- Test 7 – as test 3 + intermittent heating and cooling as for test 5
- Test 8 – as test 4 + intermittent heating and cooling as for test 5
- Test 9 – as test 5 + external roof
- Test 10 – as test 6 + external roof
- Test 11 – as test 7 + external roof
- Test 12– as test 8 + external roof

2.3 Results EN 15255

The results are presented in the tables and diagrams below.

Table 1. Reference values and IDA ICE 4 values for maximum operative temperature and maximum and average cooling power [W] test cases 1-15 (EN 15255).

Case	Ref max. op. temp.	Ref max. cool. pow.	Ref av. cool. pow.	ICE 4.0 max. op. temp.	ICE 4.0 max. cool. pow.	ICE 4.0 av. cool. pow.
Test 1	28.7	1683.0	585	28.6	1610	600
Test 2	28.1	1431	584	28.2	1417	611
Test 3	27.6	1191.0	358.0	27.6	1139	374
Test 4	32.6	3619	1259	32.5	3480	1320
Test 5	26	1906	609	26.1	1898	618
Test 6	28.8	1742	554	28.8	1697	576
Test 7	28.6	1623	552	28.5	1574	571
Test 8	27.8	1238	340	27.7	1185	354
Test 9	33.3	3837	1125	32.9	3664	1160
Test 10	28.6	1608	396	28.5	1587	410
Test 11	31.5	1400.0	523.0	31.0	1400	548
Test 12	26	1909	574	26.1	1912	587
Test 13	28.7	1796	646	29.2	1798	678
Test 14	30.5	1967	700	27.4	1886	729
Test 15	25.9	2218	723	25.7	2220	690

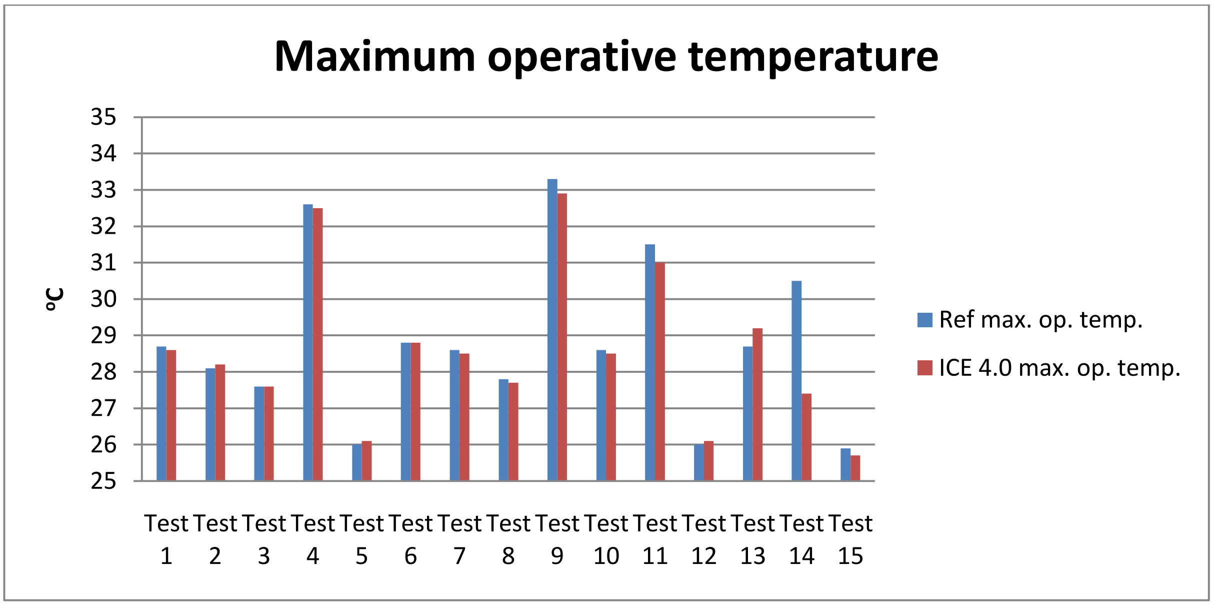

Figure 1. Reference values and IDA ICE 4 values for EN 15255 maximum operative temperature test cases 1-15 (°C).

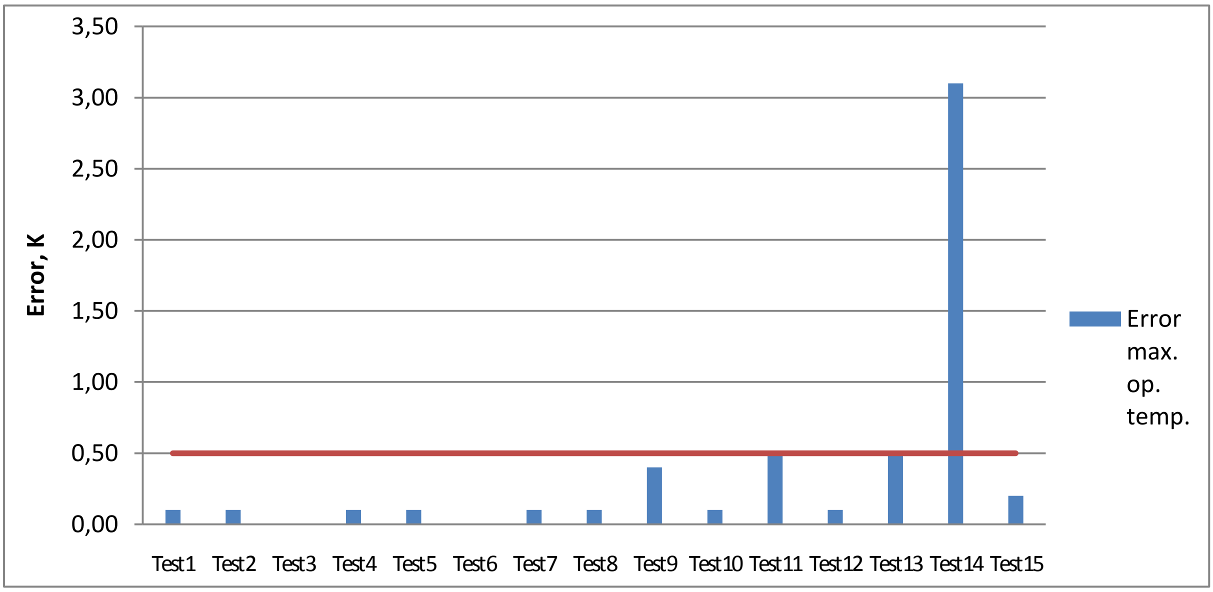

Figure 2. Error diagram for IDA ICE 4 maximum operative temperature test cases 1-15 (EN 15255). The value of test 14 operative reference temperature given in standard EN 15255-2007 was unrealistic high and thereby considered mistakenly given in standard.

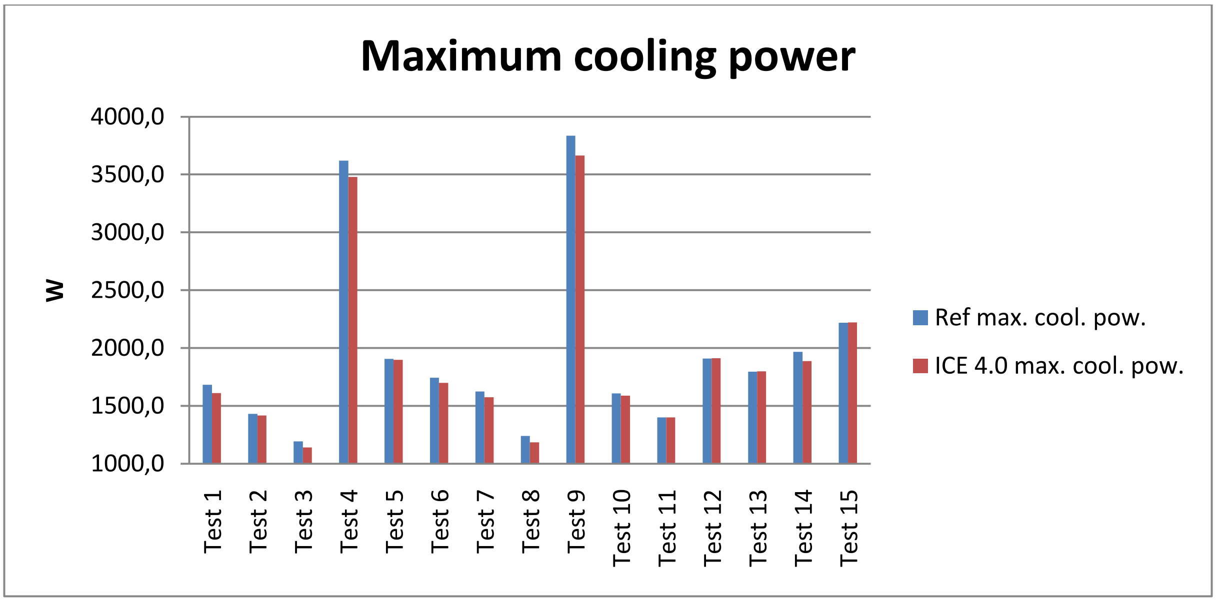

Figure 3. Reference values and IDA ICE 4 values for EN 15255 maximum cooling power test cases 1-15 (W).

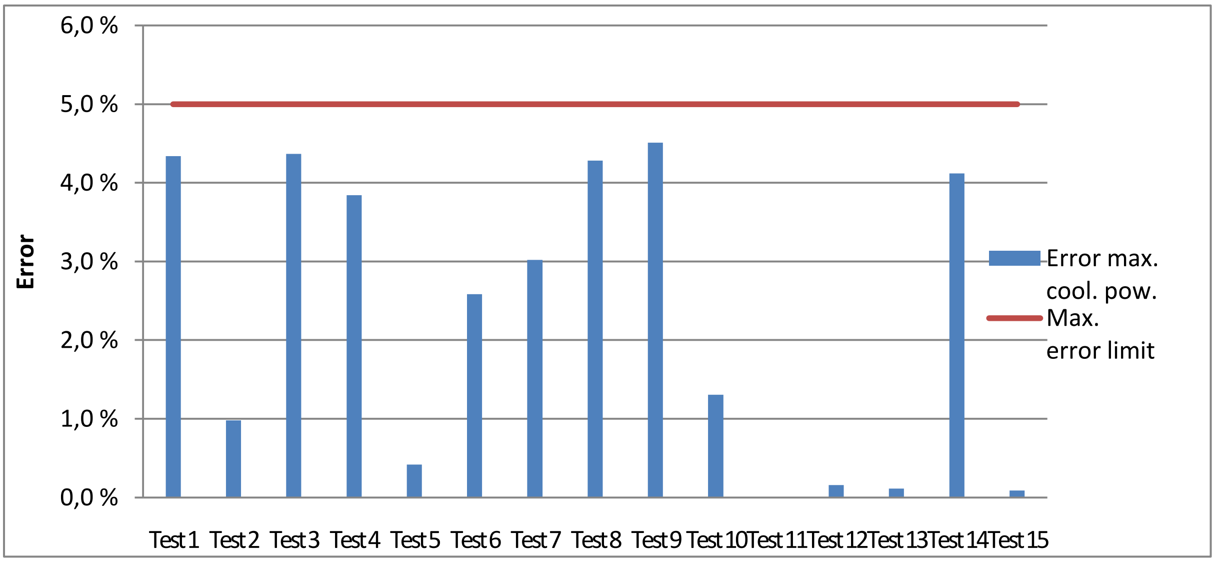

Figure 4. Error diagram for IDA ICE 4 maximum cooling power test cases 1-15 (EN 15255).

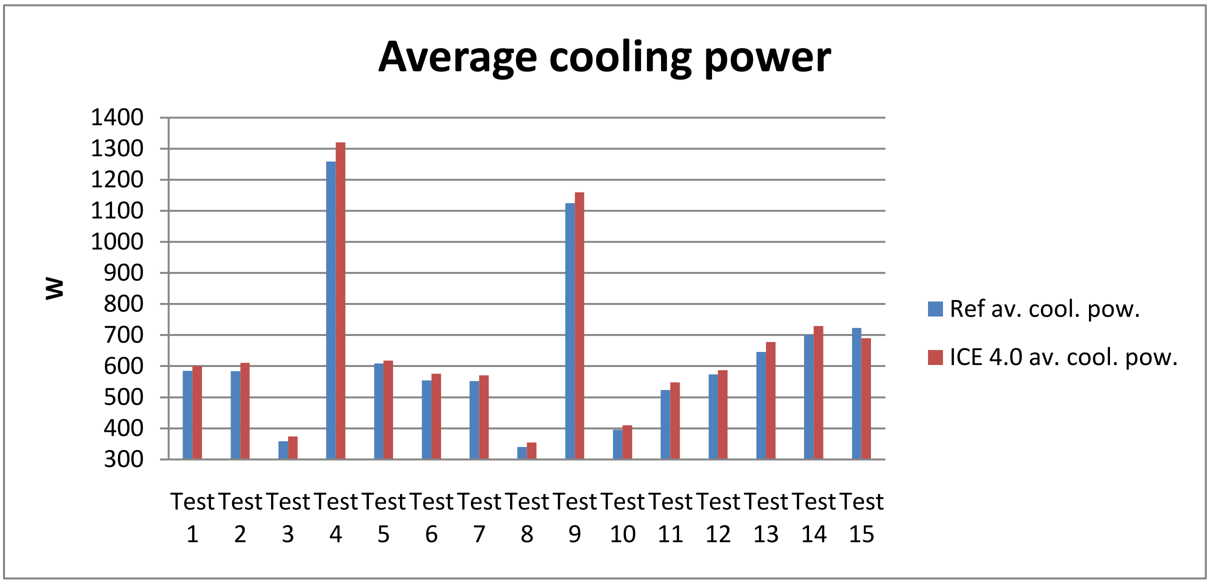

Figure 5. Reference values and IDA ICE 4 values for EN 15255 average cooling power test cases 1-15 (W).

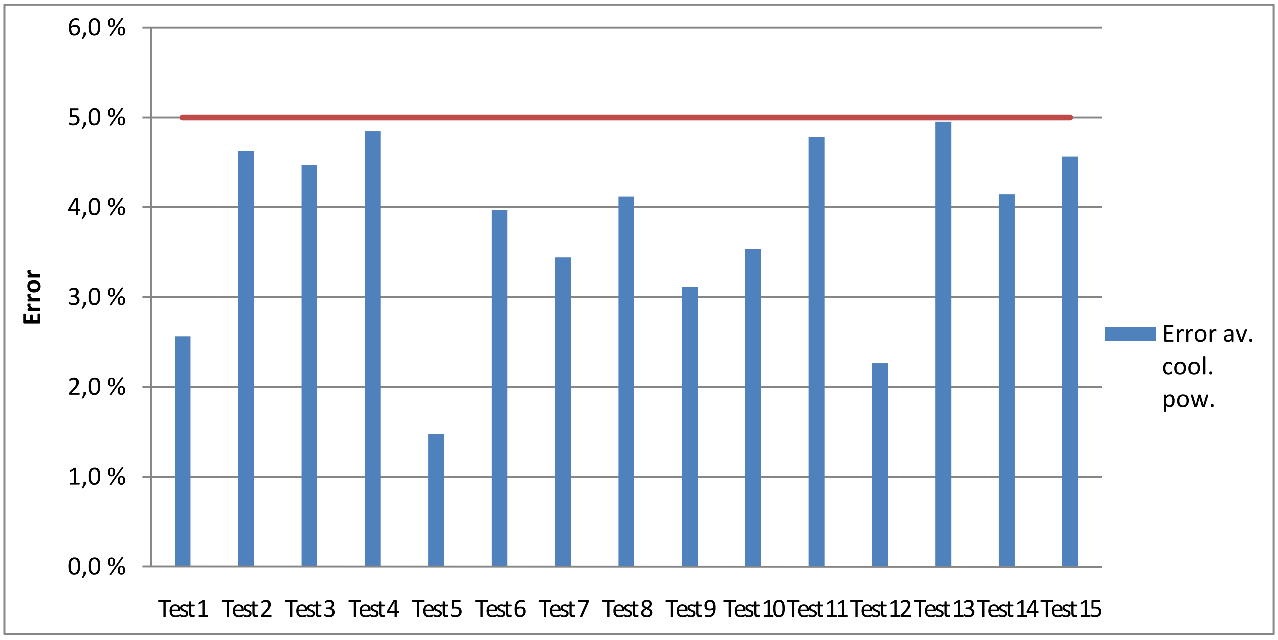

Figure 6. Error diagram for IDA ICE 4 average cooling power test cases 1-15 (EN 15255).

2.4 Results EN 15265

The results for EN 15265 are presented in the tables and diagrams on the following pages.

Table 2. Reference values and IDA ICE 4 values for heating and cooling test [kWh] cases 1-12 (EN 15265).

Test	Ref cool	Ref heat	Ref tot	ICE 4.0 Cool	ICE 4.0 Heat	ICE 4.0 Tot
Test 1	233.8	748.0	981.8	201	737.3	938.3
Test 2	200.5	722.7	923.2	179.7	719	898.7
Test 3	43.0	1368.5	1411.6	13.7	1359	1372.7
Test 4	1530.9	567.4	2098.3	1288.4	565.8	1854.2
Test 5	201.7	463.1	664.8	237.9	507.5	745.4
Test 6	185.1	509.8	694.9	229.5	555.9	785.4
Test 7	19.5	1067.4	1086.9	68.6	1109.1	1177.7
Test 8	1133.2	313.2	1446.4	1052.7	359.2	1411.9
Test 9	158.3	747.1	905.4	234.5	760.1	994.6
Test 10	192.4	574.2	766.6	248.1	598.5	846.6
Test 11	14.1	1395.1	1409.3	80.9	1287	1367.9
Test 12	928.3	533.5	1461.8	954.1	566.7	1520.8

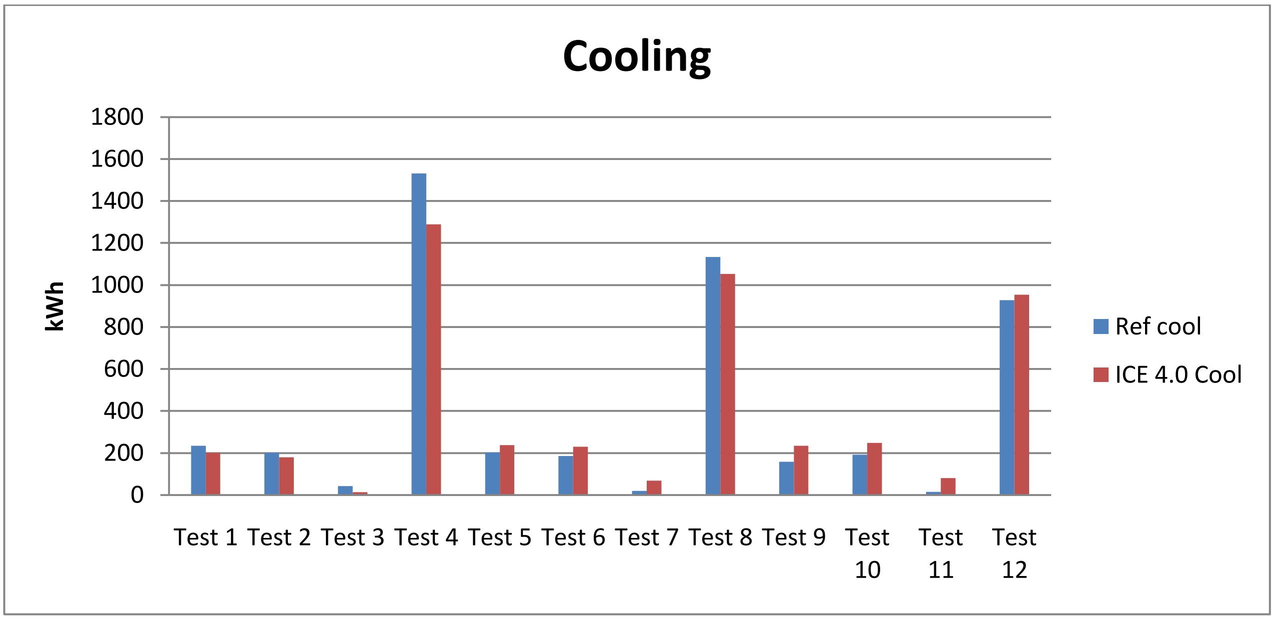

Figure 7. Reference values and IDA ICE 4 values for EN 15265 cooling test cases 1-12 (kWh).

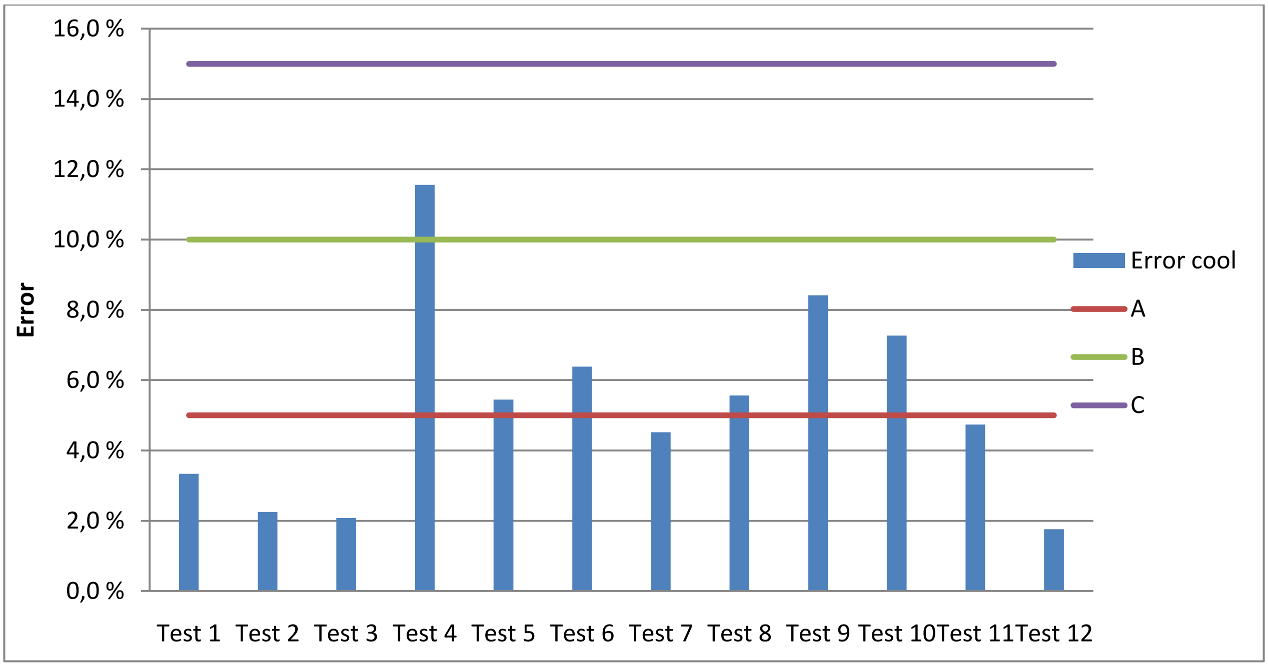

Figure 8. Levels of accuracy for IDA ICE 4 cooling test cases 1-12 (EN 15265).

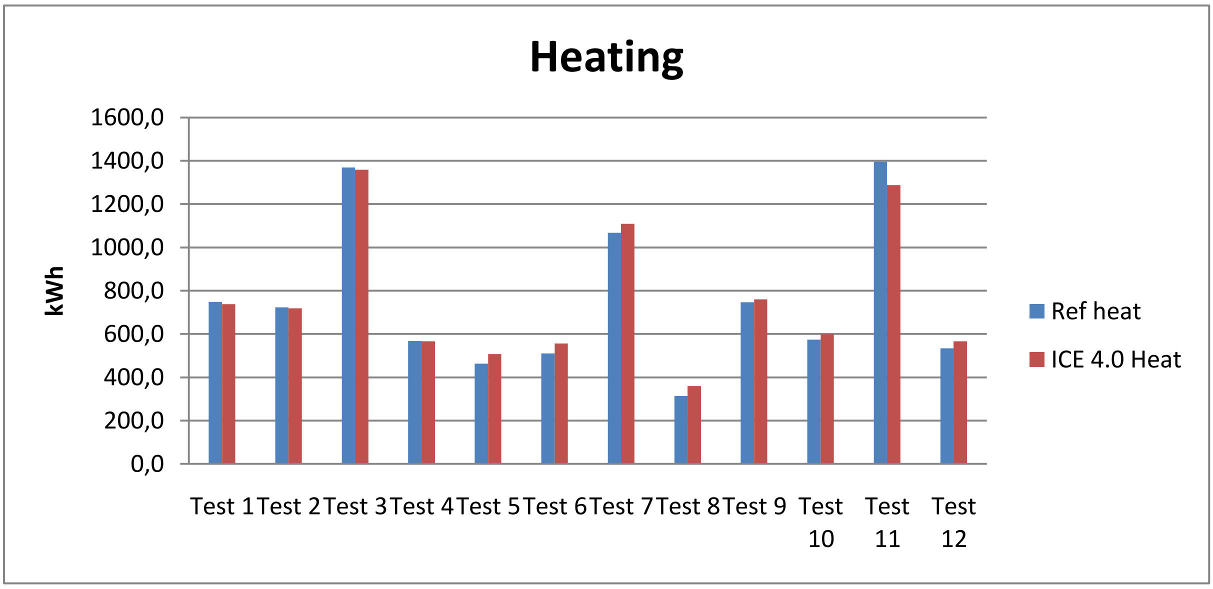

Figure 9. Reference values and IDA ICE 4 values for EN 15265 heating test cases 1-12 (kWh).

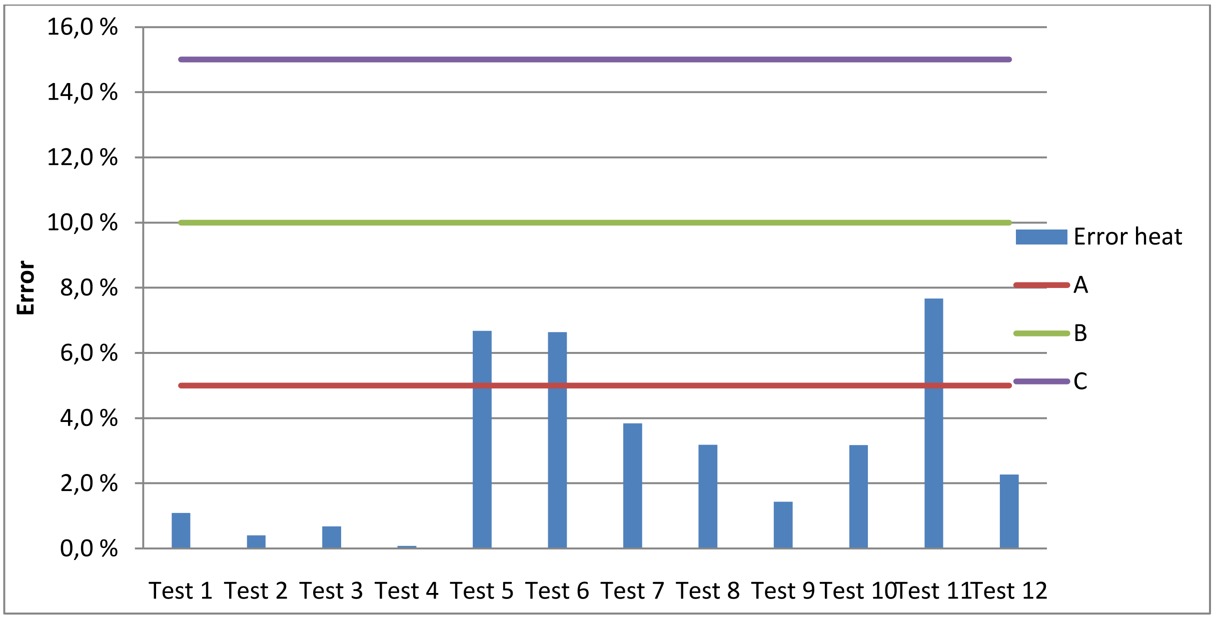

Figure 10. Levels of accuracy for IDA ICE 4 heating test cases 1-12 (EN 15265).

3 Modeler Report

3.1 Non-default models and settings used

The IDA ICE 4 objects Ideal Heater and Ideal Cooler with pure convective power directly to air capacity node were used to implement heating and cooling of the zone.

The detailed (Climate) zone model was used for all cases.

Solar distribution has been calculated in each time step by the (default) beam tracing algorithm, i.e. the location of the solar patch from a window is computed as a function of time. The fixed values given in the standard have not been used. This is a major cause of differences between computed and reference results. Although possible without programming, it is impractical to turn off this feature in IDA ICE.

3.2 Non-default models and settings used for validation EN 15265

Window solar transmission and absorption factors have been calculated by the IDA ICE detailed window model from given pane-by-pane information.

3.3 General modeling difficulties

The default IDA ICE model repertoire had to be downgraded in several respects to better match the reference model that is prescribed by the standard. This was exclusively done by choice of parameters and only to a sufficient degree to get passing results. The ambition has not been to match the reference model as closely as possible.

Fixed internal convective heat transfer coefficients have been used according to the given values in the standards.

3.4 Modeling difficulties with CEN standard EN 15255

To be able the use the total radiation given in the standard (Instantaneous total solar radiation on the exposure of the wall W/m2) the IDA ICE native radiation processing was bypassed and the radiation was given directly from a source file.

To reach the given proportion of the total radiation entering through the window, the total radiation was assumed to consist only of direct radiation. Due to the same reason it was necessary to use constant values of solar time, azimuth angle and elevation angle. Furthermore, it was also necessary to totally prevent diffuse short wave radiation from escaping the room.

The given solar to air factor 0.1 was modeled by letting 10 % of the entering radiation heat the furniture.

The solar absorptance of external wall was set to the given value 0.6.

The convective heat transfer coefficient on external surfaces was set to given constant value 8 W/m^2K.

In order to effectively bypass the above mentioned beam tracing algorithm (section 3.1) some inner wall absorptances were changed from default values.

3.5 Modeling difficulties with CEN standard EN 15265

The isotropic ASHRAE sky model for diffuse solar radiation has been used instead of the (default) more detailed anisotropic Perez model.

To turn off short wave radiation from surfaces back out of the window towards ambient, all absorption factors of internal surface have been set to 1.

The sky temperature was set equal to the ambient temperature.

Wind speed and direction have been fixed to values that result in the prescribed fixed external film coefficient.

Ground reflectance is not explicitly defined. IDA ICE default (0.2) has been assumed.

4 Conclusions

4.1 EN 15255 test cases

In all EN 15255-2007 test cases, IDA ICE 4.0 performs within given error boundaries given as 0,5 Kelvin for maximum operative temperature and 5 % for maximum and average cooling power. The only exception to this was the operative temperature of Test 14. The value of test 14 operative reference temperature given in standard EN 15255-2007 was unrealistic high and thereby considered mistakenly given in standard.

Table 3. Deviation and classification of test cases 1-12 (EN 15255).

	Maximum operative temperature		Maximum cooling power		Average cooling power	
Case	Deviation, K	Classific.	Deviation	Classific.	Deviation	Classific.
Test 1	0.10	pass	4.3 %	pass	2.6 %	pass
Test 2	0.10	pass	1.0 %	pass	4.6 %	pass
Test 3	0.00	pass	4.4 %	pass	4.5 %	pass
Test 4	0.10	pass	3.8 %	pass	4.8 %	pass
Test 5	0.10	pass	0.4 %	pass	1.5 %	pass
Test 6	0.00	pass	2.6 %	pass	4.0 %	pass
Test 7	0.10	pass	3.0 %	pass	3.4 %	pass
Test 8	0.10	pass	4.3 %	pass	4.1 %	pass
Test 9	0.40	pass	4.5 %	pass	3.1 %	pass
Test 10	0.10	pass	1.3 %	pass	3.5 %	pass
Test 11	0.50	pass	0.0 %	pass	4.8 %	pass
Test 12	0.10	pass	0.2 %	pass	2.3 %	pass
Test 13	0.50	pass	0.1 %	pass	5.0 %	pass
Test 14	3.10	error	4.1 %	pass	4.1 %	pass
Test 15	0.20	pass	0.1 %	pass	4.6 %	pass

4.2 EN 15265 test cases

In all EN 15265-2007 cases, IDA ICE 4.0 performs within accuracy level C.

For the cooling cases, six out of 12 tests passed within accuracy level A; five within B and a single within level C.

For the heating cases, nine out of 12 passed within accuracy level A and three within level B.

Table 4. Deviation and classification of test cases 1-12 (EN 15265).

Case	Cooling		Heating	
	Deviation	Classification	Deviation	Classification
Test 1	3.3 %	A	1.1 %	A
Test 2	2.3 %	A	0.4 %	A
Test 3	2.1 %	A	0.7 %	A
Test 4	11.6 %	C	0.1 %	A
Test 5	5.4 %	B	6.7 %	B
Test 6	6.4 %	B	6.6 %	B
Test 7	4.5 %	A	3.8 %	A
Test 8	5.6 %	B	3.2 %	A
Test 9	8.4 %	B	1.4 %	A
Test 10	7.3 %	B	3.2 %	A
Test 11	4.7 %	A	7.7 %	B
Test 12	1.8 %	A	2.3 %	A

Appendix 1. Monthly values for EN 15265 validation

Heating and cooling energy needs on monthly basis for EN 15265 test cases 1-12 (kWh).

Test 1:

Month	Zone heating	Zone cooling	AHU heating	AHU cooling	Heat re-covery	Cold re-covery	Humidi-fication
1	171.2	0.0	0.0	0.0	0.0	0.0	0.0
2	118.1	0.0	0.0	0.0	0.0	0.0	0.0
3	70.4	0.3	0.0	0.0	0.0	0.0	0.0
4	48.1	0.0	0.0	0.0	0.0	0.0	0.0
5	5.4	8.9	0.0	0.0	0.0	0.0	0.0
6	0.0	43.2	0.0	0.0	0.0	0.0	0.0
7	0.0	87.2	0.0	0.0	0.0	0.0	0.0
8	0.0	50.0	0.0	0.0	0.0	0.0	0.0
9	0.3	11.5	0.0	0.0	0.0	0.0	0.0
10	41.1	0.0	0.0	0.0	0.0	0.0	0.0
11	126.3	0.0	0.0	0.0	0.0	0.0	0.0
12	156.4	0.0	0.0	0.0	0.0	0.0	0.0
Total	737.3	201.0	0.0	0.0	0.0	0.0	0.0

Test 2:

Month	Zone heating	Zone cooling	AHU heating	AHU cooling	Heat re-covery	Cold re-covery	Humidi-fication
1	172.1	0.0	0.0	0.0	0.0	0.0	0.0
2	117.0	0.0	0.0	0.0	0.0	0.0	0.0
3	64.6	0.0	0.0	0.0	0.0	0.0	0.0
4	43.7	0.0	0.0	0.0	0.0	0.0	0.0
5	2.4	5.1	0.0	0.0	0.0	0.0	0.0
6	0.0	37.3	0.0	0.0	0.0	0.0	0.0
7	0.0	85.1	0.0	0.0	0.0	0.0	0.0
8	0.0	43.3	0.0	0.0	0.0	0.0	0.0
9	0.0	9.0	0.0	0.0	0.0	0.0	0.0
10	37.5	0.0	0.0	0.0	0.0	0.0	0.0
11	125.7	0.0	0.0	0.0	0.0	0.0	0.0
12	156.1	0.0	0.0	0.0	0.0	0.0	0.0
Total	719.0	179.7	0.0	0.0	0.0	0.0	0.0

Test 3:

Month	Zone heating	Zone cooling	AHU heating	AHU cooling	Heat re-covery	Cold re-covery	Humidi-fication
1	263.0	0.0	0.0	0.0	0.0	0.0	0.0
2	196.3	0.0	0.0	0.0	0.0	0.0	0.0
3	144.2	0.0	0.0	0.0	0.0	0.0	0.0
4	118.8	0.0	0.0	0.0	0.0	0.0	0.0
5	34.9	0.0	0.0	0.0	0.0	0.0	0.0
6	3.1	0.2	0.0	0.0	0.0	0.0	0.0
7	0.0	13.1	0.0	0.0	0.0	0.0	0.0
8	2.6	0.4	0.0	0.0	0.0	0.0	0.0
9	23.1	0.0	0.0	0.0	0.0	0.0	0.0
10	121.5	0.0	0.0	0.0	0.0	0.0	0.0
11	212.4	0.0	0.0	0.0	0.0	0.0	0.0
12	239.1	0.0	0.0	0.0	0.0	0.0	0.0
Total	1359.0	13.7	0.0	0.0	0.0	0.0	0.0

Test 4:

Month	Zone heating	Zone cooling	AHU heating	AHU cooling	Heat re-covery	Cold re-covery	Humidi-fication
1	171.2	0.0	0.0	0.0	0.0	0.0	0.0
2	86.3	0.1	0.0	0.0	0.0	0.0	0.0
3	15.9	51.8	0.0	0.0	0.0	0.0	0.0
4	1.9	52.9	0.0	0.0	0.0	0.0	0.0
5	0.0	177.9	0.0	0.0	0.0	0.0	0.0
6	0.0	274.0	0.0	0.0	0.0	0.0	0.0
7	0.0	365.6	0.0	0.0	0.0	0.0	0.0
8	0.0	229.8	0.0	0.0	0.0	0.0	0.0
9	0.0	116.3	0.0	0.0	0.0	0.0	0.0
10	14.2	18.4	0.0	0.0	0.0	0.0	0.0
11	117.7	1.7	0.0	0.0	0.0	0.0	0.0
12	158.6	0.0	0.0	0.0	0.0	0.0	0.0
Total	565.8	1288.4	0.0	0.0	0.0	0.0	0.0

Test 5:

Month	Zone heating	Zone cooling	AHU heating	AHU cooling	Heat re-covery	Cold re-covery	Humidi-fication
1	122.8	4.9	0.0	0.0	0.0	0.0	0.0
2	83.4	4.3	0.0	0.0	0.0	0.0	0.0
3	44.3	5.1	0.0	0.0	0.0	0.0	0.0
4	29.1	5.0	0.0	0.0	0.0	0.0	0.0
5	5.3	12.5	0.0	0.0	0.0	0.0	0.0
6	3.1	41.3	0.0	0.0	0.0	0.0	0.0
7	3.3	80.7	0.0	0.0	0.0	0.0	0.0
8	3.4	52.3	0.0	0.0	0.0	0.0	0.0
9	3.1	16.8	0.0	0.0	0.0	0.0	0.0
10	18.8	5.7	0.0	0.0	0.0	0.0	0.0
11	87.2	4.8	0.0	0.0	0.0	0.0	0.0
12	103.6	4.5	0.0	0.0	0.0	0.0	0.0
Total	507.5	237.9	0.0	0.0	0.0	0.0	0.0

Test 6:

Month	Zone heating	Zone cooling	AHU heating	AHU cooling	Heat re-covery	Cold re-covery	Humidi-fication
1	136.5	5.2	0.0	0.0	0.0	0.0	0.0
2	92.7	4.6	0.0	0.0	0.0	0.0	0.0
3	45.0	5.4	0.0	0.0	0.0	0.0	0.0
4	30.5	5.2	0.0	0.0	0.0	0.0	0.0
5	4.3	10.9	0.0	0.0	0.0	0.0	0.0
6	3.1	38.9	0.0	0.0	0.0	0.0	0.0
7	3.3	81.3	0.0	0.0	0.0	0.0	0.0
8	3.4	47.2	0.0	0.0	0.0	0.0	0.0
9	3.0	14.9	0.0	0.0	0.0	0.0	0.0
10	20.8	6.0	0.0	0.0	0.0	0.0	0.0
11	98.3	5.1	0.0	0.0	0.0	0.0	0.0
12	114.9	4.8	0.0	0.0	0.0	0.0	0.0
Total	555.9	229.5	0.0	0.0	0.0	0.0	0.0

Test 7:

Month	Zone heating	Zone cooling	AHU heating	AHU cooling	Heat re-covery	Cold re-covery	Humidi-fication
1	203.3	4.6	0.0	0.0	0.0	0.0	0.0
2	157.9	4.1	0.0	0.0	0.0	0.0	0.0
3	119.6	4.7	0.0	0.0	0.0	0.0	0.0
4	102.8	4.6	0.0	0.0	0.0	0.0	0.0
5	39.4	5.7	0.0	0.0	0.0	0.0	0.0
6	7.6	5.9	0.0	0.0	0.0	0.0	0.0
7	3.3	12.2	0.0	0.0	0.0	0.0	0.0
8	5.9	7.5	0.0	0.0	0.0	0.0	0.0
9	22.3	5.2	0.0	0.0	0.0	0.0	0.0
10	99.3	5.2	0.0	0.0	0.0	0.0	0.0
11	169.0	4.6	0.0	0.0	0.0	0.0	0.0
12	178.7	4.2	0.0	0.0	0.0	0.0	0.0
Total	1109.1	68.6	0.0	0.0	0.0	0.0	0.0

Test 8:

Month	Zone heating	Zone cooling	AHU heating	AHU cooling	Heat re-covery	Cold re-covery	Humidi-fication
1	111.1	4.8	0.0	0.0	0.0	0.0	0.0
2	51.0	4.4	0.0	0.0	0.0	0.0	0.0
3	8.6	39.2	0.0	0.0	0.0	0.0	0.0
4	3.6	41.8	0.0	0.0	0.0	0.0	0.0
5	3.4	137.1	0.0	0.0	0.0	0.0	0.0
6	3.1	209.9	0.0	0.0	0.0	0.0	0.0
7	3.2	282.1	0.0	0.0	0.0	0.0	0.0
8	3.4	201.4	0.0	0.0	0.0	0.0	0.0
9	3.0	99.9	0.0	0.0	0.0	0.0	0.0
10	6.3	21.5	0.0	0.0	0.0	0.0	0.0
11	69.7	6.0	0.0	0.0	0.0	0.0	0.0
12	93.0	4.4	0.0	0.0	0.0	0.0	0.0
Total	359.2	1052.7	0.0	0.0	0.0	0.0	0.0

Test9:

Month	Zone heating	Zone cooling	AHU heating	AHU cooling	Heat re-covery	Cold re-covery	Humidi-fication
1	178.7	4.9	0.0	0.0	0.0	0.0	0.0
2	126.2	4.4	0.0	0.0	0.0	0.0	0.0
3	66.5	5.2	0.0	0.0	0.0	0.0	0.0
4	45.8	5.1	0.0	0.0	0.0	0.0	0.0
5	6.2	10.5	0.0	0.0	0.0	0.0	0.0
6	3.1	39.5	0.0	0.0	0.0	0.0	0.0
7	3.3	88.9	0.0	0.0	0.0	0.0	0.0
8	3.4	47.3	0.0	0.0	0.0	0.0	0.0
9	3.1	13.8	0.0	0.0	0.0	0.0	0.0
10	37.7	5.7	0.0	0.0	0.0	0.0	0.0
11	134.1	4.9	0.0	0.0	0.0	0.0	0.0
12	152.0	4.5	0.0	0.0	0.0	0.0	0.0
Total	760.1	234.5	0.0	0.0	0.0	0.0	0.0

Test10:

Month	Zone heating	Zone cooling	AHU heating	AHU cooling	Heat re-covery	Cold re-covery	Humidi-fication
1	144.0	4.7	0.0	0.0	0.0	0.0	0.0
2	96.1	4.2	0.0	0.0	0.0	0.0	0.0
3	50.9	5.0	0.0	0.0	0.0	0.0	0.0
4	36.1	4.9	0.0	0.0	0.0	0.0	0.0
5	6.0	15.0	0.0	0.0	0.0	0.0	0.0
6	3.1	44.9	0.0	0.0	0.0	0.0	0.0
7	3.3	87.1	0.0	0.0	0.0	0.0	0.0
8	3.5	52.0	0.0	0.0	0.0	0.0	0.0
9	3.3	15.7	0.0	0.0	0.0	0.0	0.0
10	29.0	5.5	0.0	0.0	0.0	0.0	0.0
11	103.5	4.7	0.0	0.0	0.0	0.0	0.0
12	119.8	4.3	0.0	0.0	0.0	0.0	0.0
Total	598.5	248.1	0.0	0.0	0.0	0.0	0.0

Test 11:

Month	Zone heating	Zone cooling	AHU heating	AHU cooling	Heat re-covery	Cold re-covery	Humidi-fication
1	229.6	4.5	0.0	0.0	0.0	0.0	0.0
2	191.1	4.1	0.0	0.0	0.0	0.0	0.0
3	142.4	4.9	0.0	0.0	0.0	0.0	0.0
4	120.7	4.8	0.0	0.0	0.0	0.0	0.0
5	35.6	6.1	0.0	0.0	0.0	0.0	0.0
6	4.5	7.0	0.0	0.0	0.0	0.0	0.0
7	3.3	21.6	0.0	0.0	0.0	0.0	0.0
8	5.2	8.4	0.0	0.0	0.0	0.0	0.0
9	21.6	5.5	0.0	0.0	0.0	0.0	0.0
10	123.6	5.3	0.0	0.0	0.0	0.0	0.0
11	202.1	4.6	0.0	0.0	0.0	0.0	0.0
12	207.4	4.2	0.0	0.0	0.0	0.0	0.0
Total	1287.0	80.9	0.0	0.0	0.0	0.0	0.0

Test 12:

Month	Zone heating	Zone cooling	AHU heating	AHU cooling	Heat re-covery	Cold re-covery	Humidi-fication
1	169.6	4.9	0.0	0.0	0.0	0.0	0.0
2	89.8	4.5	0.0	0.0	0.0	0.0	0.0
3	15.2	22.8	0.0	0.0	0.0	0.0	0.0
4	4.0	16.2	0.0	0.0	0.0	0.0	0.0
5	3.4	121.0	0.0	0.0	0.0	0.0	0.0
6	3.1	205.9	0.0	0.0	0.0	0.0	0.0
7	3.2	289.9	0.0	0.0	0.0	0.0	0.0
8	3.4	188.3	0.0	0.0	0.0	0.0	0.0
9	3.0	82.3	0.0	0.0	0.0	0.0	0.0
10	11.3	9.0	0.0	0.0	0.0	0.0	0.0
11	117.9	4.9	0.0	0.0	0.0	0.0	0.0
12	142.8	4.5	0.0	0.0	0.0	0.0	0.0
Total	566.7	954.1	0.0	0.0	0.0	0.0	0.0