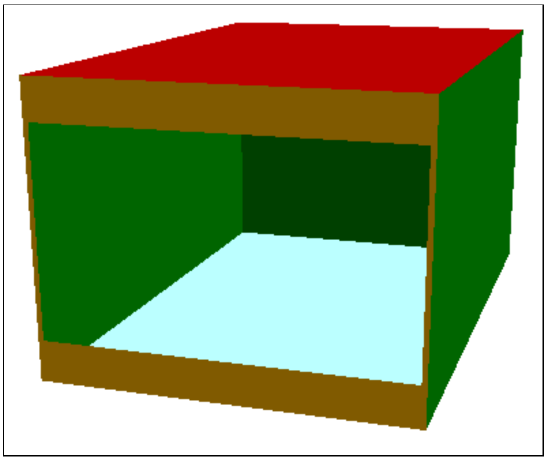
EDSL Tas 9.3.0 Compliance with BS EN 15255:2007

Fifteen test cases were modelled. In each case one day, July 15th (day 196), was repeatedly simulated in a cycle until a steady result was reached. For each case the maximum operative temperature, maximum cooling load, and average cooling load for the day were compared to the target values from the standard.

The operative temperature was calculated as the mean value of the room's dry bulb temperature and the mean radiant temperature of the room. Diffuse solar radiation flux was included in the calculation of the mean radiant temperature.

Input Data

Room Geometry



Geometry as seen in the Tas 3D modeller. The window faces west.

Element	Geometry area (m^2)
External Wall	3.08
Glazing	7.00
Partition wall (left)	15.40
Partition wall (right)	15.40
Partition wall (back)	10.08
Floor	19.80
Ceiling	19.80

The volume of the room was 55.44m^3. The latitude of the building was 52°N.

Construction Details

Opaque constructions were set up in accordance with table 6 of the standard. Details are given below in screenshots from Tas.

Type no. 1 (external wall)

Layer	M-Code	Width (mm)	Conductivity (W/m·°C)	Density (kg/m³)	Specific Heat (J/kg·°C)
Inner	Ext Wall Internal Plastering	15.0	0.7	1400.0	850.0
2	Ext Wall Masonry	175.0	0.79	1600.0	850.0
3	Ext Wall Insulation	60.0	0.04	30.0	850.0
4	Ext Wall Outer Layer	115.0	0.99	1800.0	850.0

Type no.2 (internal wall)

Layer	M-Code	Width (mm)	Conductivity (W/m·°C)	Density (kg/m³)	Specific Heat (J/kg·°C)
Inner	Int Wall Gypsum Plaster	12.0	0.21	900.0	850.0
2	Int Wall Mineral Wool	100.0	0.04	30.0	850.0
3	Int Wall Gypsum Plaster	12.0	0.21	900.0	850.0

Type no. 3 (ceiling / floor)

Layer	M-Code	Width (mm)	Conductivity (W/m·°C)	Density (kg/m³)	Specific Heat (J/kg·°C)
Inner	Type 3 Concrete	180.0	2.1	2400.0	850.0
2	Type 3 Insulation	40.0	0.04	50.0	850.0
3	Type 3 Concrete Floor	60.0	1.4	2000.0	850.0
4	Type 3 Covering	4.0	0.23	1500.0	1500.0

Note: order of layers is underside to topside.

Type no. 4 (ceiling / floor)

Layer	M-Code	Width (mm)	Conductivity (W/m·°C)	Density (kg/m³)	Specific Heat (J/kg·°C)
Inner	Type 4 Acoustic Board	20.0	0.06	400.0	840.0
2	Type 4 Mineral Wool	100.0	0.04	50.0	850.0
3	Type 4 Concrete	180.0	2.1	2400.0	850.0
4	Type 4 Insulation	40.0	0.04	50.0	850.0
5	Type 4 Concrete Floor	60.0	1.4	2000.0	850.0
6	Type 4 Covering	4.0	0.23	1500.0	1500.0

Note: order of layers is underside to topside.

The glazing construction was set up in accordance with table 5 of the standard.

Component	Solar transmittance	Solar reflectance	Solar absorptance
Inner Pane	0.84	0.08	0.08
Outer Pane	0.84	0.08	0.08
Shade	0.2	0.5	0.3

For some test the outer shade layer was omitted. The solar parameters were considered to be independent of the solar angle.

Weather

The values for external dry bulb temperature were given in the standard as instantaneous values at each hour. These were converted to average values over the course of the hour. As specified in the standard, the dry bulb temperature varies linearly from point to point, making it straightforward to calculate hourly values:

Weather data for day 196

Hour	external air dry bulb temperature (°C)	Total solar radiation on a horizontal surface (W/m^2)	Diffuse solar radiation on a horizontal surface (W/m^2)
00:00 – 01:00	14.48	0	0
01:00 – 02:00	13.68	0	0
02:00 – 03:00	12.96	0	0
03:00 – 04:00	12.40	0	0
04:00 – 05:00	12.08	34.5	17
05:00 – 06:00	12.16	147	53.5
06:00 – 07:00	12.72	306.5	83
07:00 – 08:00	13.84	463.5	98.5
08:00 – 09:00	15.60	604	107
09:00 – 10:00	17.84	718.5	112
10:00 – 11:00	20.40	799.5	115
11:00 – 12:00	23.04	841.5	116.5
12:00 – 13:00	25.28	841.5	116.5
13:00 – 14:00	26.88	799.5	115
14:00 – 15:00	27.76	718.5	112
15:00 – 16:00	27.76	604	107
16:00 – 17:00	26.96	463.5	98.5
17:00 – 18:00	25.52	306.5	83
18:00 – 19:00	23.60	147	53.5
19:00 – 20:00	22.00	34.5	17
20:00 – 21:00	20.08	0	0
21:00 – 22:00	17.92	0	0
22:00 – 23:00	16.48	0	0
23:00 – 24:00	15.36	0	0

As the solar gain on a west-facing vertical surface is the same in BS EN 15255 as it is for geometry B of BS EN 13792, the same solar radiation inputs were used in the weather data, with a ground solar reflectance of 0.39.

Other inputs

- **Heat transfer coefficients**
  - Section 5.3.3 of the standard specifies 13.5 W/(m^2K) for the external surface heat transfer coefficient (convective plus long wave).
    In the Tas model the external surface emissivities were set to zero and the wind speed was set to a constant 2.375 m/s, to give a total external heat transfer coefficient of 13.5 W/(m^2K) (4 + 4*windspeed).
  - Section 5.3.3 of the standard specifies 2.5 W/(m^2K) for the internal surface convective heat transfer coefficient and 5.5 W/(m^2K) for the internal long-wave radiative heat transfer coefficient.
    In the Tas model the convective heat transfer coefficient of all internal surfaces is set to 2.5 W/(m^2K). A figure of 0.7 W/(m^2K) was used for a cooled floor and 5 W/(m^2K) was used for a cooled ceiling, in accordance with the standard.). Tas calculates long wave radiation exchange based on emissivities, these values were set to get as close as possible to the required 5.5 W/(m^2K).
  - Section 7.2 of the standard specifies the following thermal resistances for the glazing:
    - 0.074 m^2K/W for the external surface of the blind (or outer pane, whichever is the outermost layer of the glazing system) – this is equivalent to the 13.5 W/(m^2K) heat transfer coefficient set on all external surfaces in the Tas model (see above).
    - 0.080 m^2K/W for the air gap between the blind and the outer pane – in the Tas model a convection coefficient of 12.5 W/(m^2K) was applied in the air gap with the surface emissivities set to zero.
    - 0.173 m^2K/W for the air gap between the outer and inner panes – in the Tas model a convection coefficient of 5.78 W/(m^2K) was applied in the air gap with the surface emissivities set to zero.
    - 0.125 m^2K/W for the internal surface of the inner pane – this is equivalent to the total 8 W/(m^2K) heat transfer coefficient set on all internal surfaces in the Tas model (see above).
- **Solar distribution**
  The distribution of the solar radiation on the internal surfaces of the room is time-independent. This was achieved by splitting the solar gain evenly over each of the internal opaque surfaces (weighted by surface area) on every hour. For the test with a cooled floor a different distribution pattern was used:

Solar distribution factors	Floor	Walls	Ceiling
Cooled floor model	(2 * floor area) / (total opaque area + floor area)	(wall area) / (total opaque area + floor area)	(ceiling area) / (total opaque area + floor area)
Other models	(floor area) / (total opaque area)	(wall area) / (total opaque area)	(ceiling area) / (total opaque area)

The solar distribution factor is the fraction of the total solar shortwave radiation coming into the room which is absorbed by the surface.

- **Solar-to-air factor**
  10% of the solar heat entering the room through the window was added directly into the internal air.
- **Solar loss factor**
  No solar radiation which entered the room was reflected back outside.
- **External Surface Solar Absorptances**
  The external wall had an external solar absorptance of 0.6.
- **Internal gains**
  The view coefficient for internal gains was set to zero.
- **Infiltration**
  No infiltration was allowed for in any of the test cases.

Test Case Setup

Test cases were set up in accordance with section 7.4 of the standard.

Tests 14 and 15 required significant modification of some of the input data to align the results with those given.

Constructions used in each case:

Test case	External wall	Internal walls	Ceiling	Floor	Glazing
1	Type 1	Adiabatic, type 2	Adiabatic, type 4	Adiabatic, type 4	Shaded
2	Type 1	Adiabatic, type 2	Adiabatic, type 3	Adiabatic, type 3	Shaded
3	Type 1	Adiabatic, type 2	Adiabatic, type 4	Adiabatic, type 4	Shaded
4	Type 1	Adiabatic, type 2	Adiabatic, type 4	Adiabatic, type 4	Unshaded
5	Type 1	Adiabatic, type 2	Adiabatic, type 4	Adiabatic, type 4	Shaded
6	Type 1	Adiabatic, type 2	Adiabatic, type 4	Adiabatic, type 4	Shaded
7	Type 1	Adiabatic, type 2	Adiabatic, type 3	Adiabatic, type 3	Shaded
8	Type 1	Adiabatic, type 2	Adiabatic, type 4	Adiabatic, type 4	Shaded
9	Type 1	Adiabatic, type 2	Adiabatic, type 4	Adiabatic, type 4	Unshaded
10	Type 1	Adiabatic, type 2	Adiabatic, type 4	Adiabatic, type 4	Shaded
11	Type 1	Adiabatic, type 2	Adiabatic, type 4	Adiabatic, type 4	Shaded
12	Type 1	Adiabatic, type 2	Adiabatic, type 4	Adiabatic, type 4	Shaded
13	Type 1	Adiabatic, type 2	Adiabatic, type 4	Adiabatic, type 4	Shaded 08:00 to 18:00, otherwise unshaded
14	Type 1	Adiabatic, type 2	Adiabatic, type 4	Cooled floor without thermal mass or external losses	Shaded
15	Type 1	Adiabatic, type 2	Cooled ceiling without thermal mass or external losses	Adiabatic, type 4	Shaded

Gains, ventilation, and system operation for each case:

Test case	Gains	Ventilation	System operation
1	50 W/m^2, 60% radiative, 08:00 to 18:00	None	Air system with dry bulb temperature control (26°C). Continuous. Unlimited capacity.
2	50 W/m^2, 60% radiative, 08:00 to 18:00	None	Air system with dry bulb temperature control (26°C). Continuous. Unlimited capacity.
3	20 W/m^2 convective, 08:00 to 18:00	None	Air system with dry bulb temperature control (26°C). Continuous. Unlimited capacity.
4	50 W/m^2, 60% radiative, 08:00 to 18:00	None	Air system with dry bulb temperature control (26°C). Continuous. Unlimited capacity.
5	50 W/m^2, 60% radiative, 08:00 to 18:00	None	Air system with operative temperature control (26°C). Continuous. Unlimited capacity.
6	50 W/m^2, 60% radiative, 08:00 to 18:00	None	Air system with dry bulb temperature control (26°C). 08:00 to 18:00. Unlimited capacity.
7	50 W/m^2, 60% radiative, 08:00 to 18:00	None	Air system with dry bulb temperature control (26°C). 08:00 to 18:00. Unlimited capacity.
8	20 W/m^2 convective, 08:00 to 18:00	None	Air system with dry bulb temperature control (26°C). 08:00 to 18:00. Unlimited capacity.
9	50 W/m^2, 60% radiative, 08:00 to 18:00	None	Air system with dry bulb temperature control (26°C). 08:00 to 18:00. Unlimited capacity.
10	50 W/m^2, 60% radiative, 08:00 to 18:00	2 ACH at external air temperature from 18:00 to 08:00	Air system with dry bulb temperature control (26°C). 08:00 to 18:00. Unlimited capacity.
11	50 W/m^2, 60% radiative, 08:00 to 18:00	None	Air system with dry bulb temperature control (26°C). 08:00 to 18:00. Max capacity 1,400 W.
12	50 W/m^2, 60% radiative, 08:00 to 18:00	None	Air system with operative temperature control (26°C). 08:00 to 18:00. Unlimited capacity.
13	50 W/m^2, 60% radiative, 08:00 to 18:00	None	Air system with dry bulb temperature control (26°C). 08:00 to 18:00. Unlimited capacity.
14	50 W/m^2, 60% radiative, 08:00 to 18:00	None	Floor constantly cooled to 18°C. Continuous. Unlimited capacity.
15	50 W/m^2, 60% radiative, 08:00 to 18:00	None	Cooled ceiling with dry bulb temperature control (26°C). Continuous. Unlimited capacity.

Results

Below: Target temperatures (°C) and cooling loads (W), Tas results, and the differences between them. For compliance, temperature results should be within 0.5°C of the target and cooling load results should be within 5% of the target. Difference in cooling load is shown below as a fraction of the target cooling load.

	Targets			Tas Results			Difference		
	Max OP	Max CL	Ave CL	Max OP	Max CL	Ave CL	Max OP	Max CL	Ave CL
1	28.7	1683	585	28.7	1641	581	0.005	0.025	0.007
2	28.1	1431	584	28.2	1413	587	0.095	0.013	0.005
3	27.6	1191	358	27.6	1157	354	0.030	0.028	0.012
4	32.6	3619	1259	32.7	3545	1263	0.065	0.020	0.003
5	26.0	1906	609	26.4	1815	598	0.440	0.048	0.018
6	28.8	1742	554	28.9	1745	553	0.125	0.002	0.002
7	28.6	1623	552	28.7	1623	554	0.055	0.000	0.004
8	27.8	1238	340	27.8	1217	340	0.040	0.017	0.000
9	33.3	3837	1125	33.4	3876	1140	0.090	0.010	0.014
10	28.6	1608	396	28.5	1568	411	0.065	0.025	0.038
11	31.5	1400	523	31.8	1400	534	0.250	0.000	0.021
12	26.0	1909	574	26.4	1897	578	0.435	0.006	0.007
13	28.7	1796	646	29.1	1836	620	0.425	0.022	0.040
14	30.5	1967	700	30.1	1965	705	0.450	0.001	0.008
15	25.9	2218	723	25.6	2125	709	0.300	0.042	0.020