CIBSE Guide A Environmental Design Calculations

Producing equivalent standard Guide A Section 5 winter and summer design calculations with TAS dynamic simulation software.

How do the procedures compare?

The main difference between the CIBSE steady state heat loss / admittance procedures and dynamic simulation is the ability dynamic simulation to take account of variations in weather over a number of days.

Steady state heat loss is the equivalent of running a 24 hour heated building with no internal heat gains for a long period of weather at a constant outside air temperature and no solar income. Remove the internal heat gains from a TAS dynamic simulation model. Run the model using a weather file with constant outside air temperature and no sunshine. At the end of a 30 day period the simulated heating load is exactly the same as the steady state heat loss calculation.

The admittance procedure uses a 24 hour harmonic to predict summer design day performance using idealised weather data for the design day. The procedure does not have the ability to carry forward the influence on performance of previous days. In fact, the procedure assumes that the design day has been preceded by an infinite number of identical days. To reproduce this type of analysis with TAS dynamic simulation software an extended period of weather data is used. This weather data contains repeated days of the same idealised weather used in the admittance procedure. At the end of a 30 day simulation on repeated day weather the simulated performance is very close to that predicted by the admittance method.

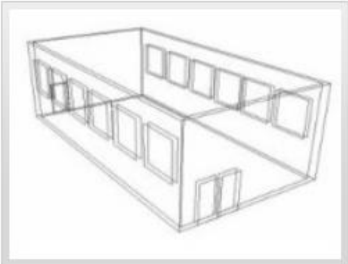
It is therefore possible using idealised weather to perform the equivalent of standard heat loss / admittance calculations.

The following examples from Guide A Section 5 show how closely simulation reproduces standard CIBSE calculations.

Heat Loss

Guide A Section 5 example 5.1 Calculation of steady state heat losses.

A small factory is heated to a resultant temperature of 19°C with an external air temperature of –1°C. Details of constructions and occupation can be found below.



Using simplified calculations, such as the admittance method, the peak summer temperature is predicted to be~35°C, some 10°C above the monitored peak of 25°C.

The TAS model has been set up with the same construction details and internal heat gains as the example building. A weather file has been specified with 30 days of constant –1°C outside air temperature and no sunshine.

The TAS model was run for the 30 days and the convective heating demand on the final day was a steady 8.56 kW. This compares with the example calculation of 8.72 kW.

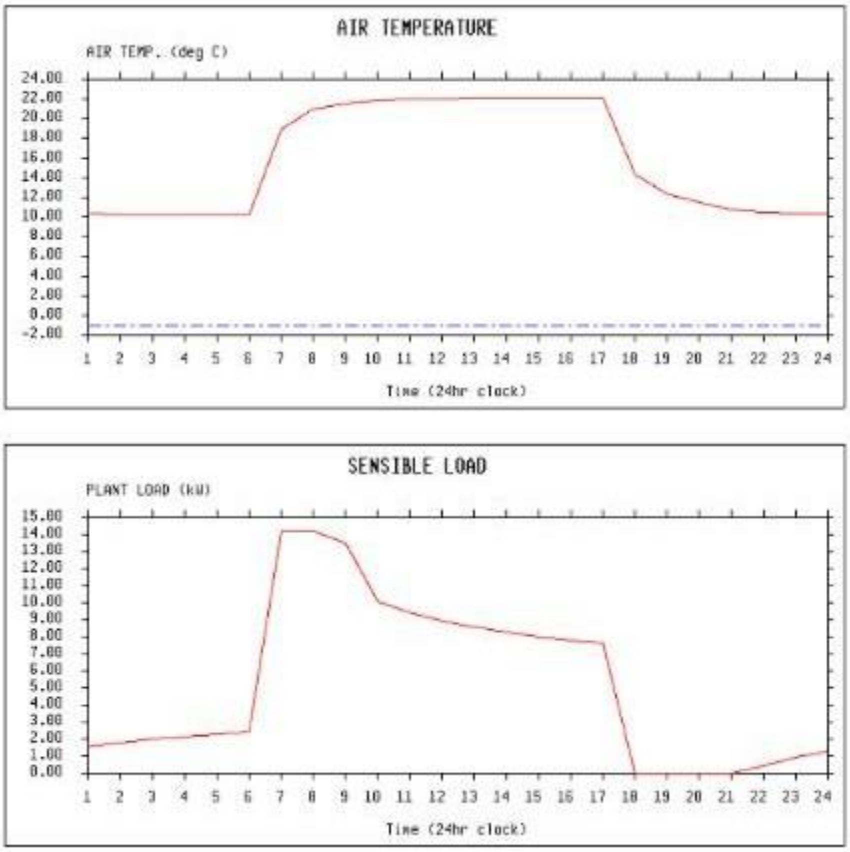
The model was re-run with radiant heating to give a heat loss of 8.76 kW. This compares with the example calculation of 8.81 kW

	Example 5.1 convective	**TAS simulation convective**	**Example 5.1 radiant**	**TAS simulation radiant**
Heat Loss kW	8.72	8.56	8.81	8.76
Resultant Temperature °C	19	19	19	19
Air Temperature °C	21.45	21.5	17.23	17.25
Mean Surface Temperature °C	16.55	16.54	20.77	20.77

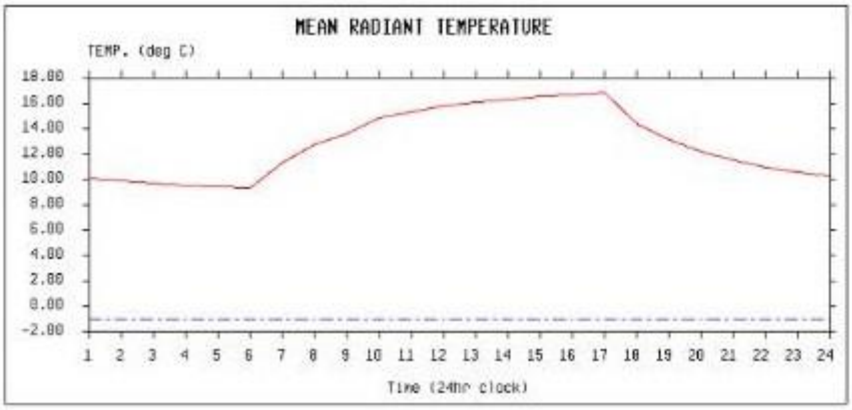
Correction for intermittent heating Example 5.4

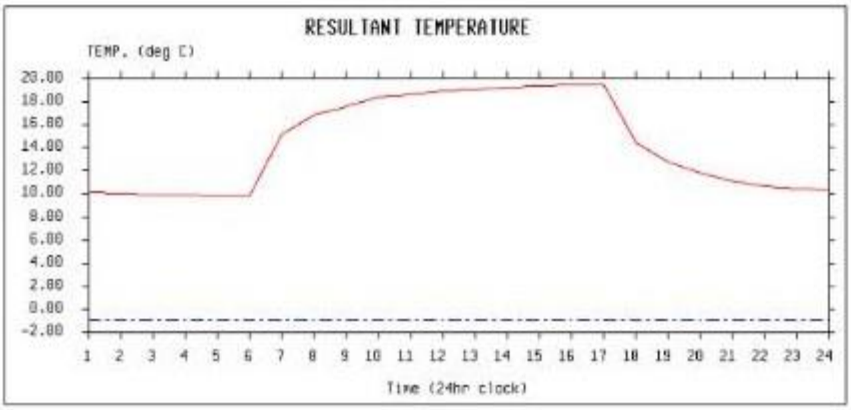
TAS has automatic procedures for sizing heating loads with optimum start control of intermittent heating. When the TAS model is set up to operate for 8 hours with a 3 hour preheat and night setback of 10oC, the performance is as shown in the following two sets of graphs.

In the example 5.4 the heating capacity required for intermittent operation is calculated to be 14.21 kW. The TAS simulation required 14.2 kW.



Air temperature and heating demand for - 1°C outside

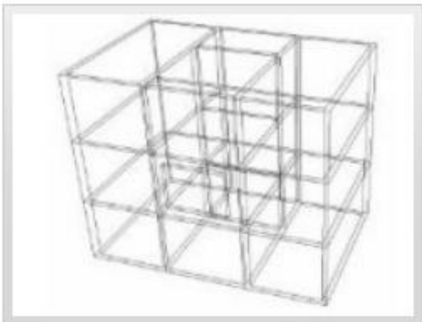


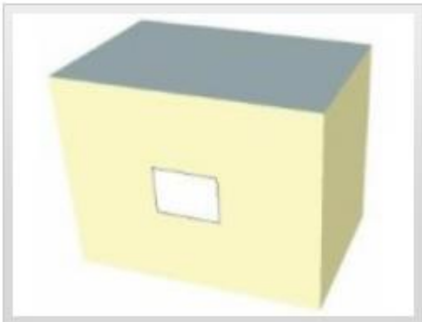


Mean radiant (surface) and resultant temperatures

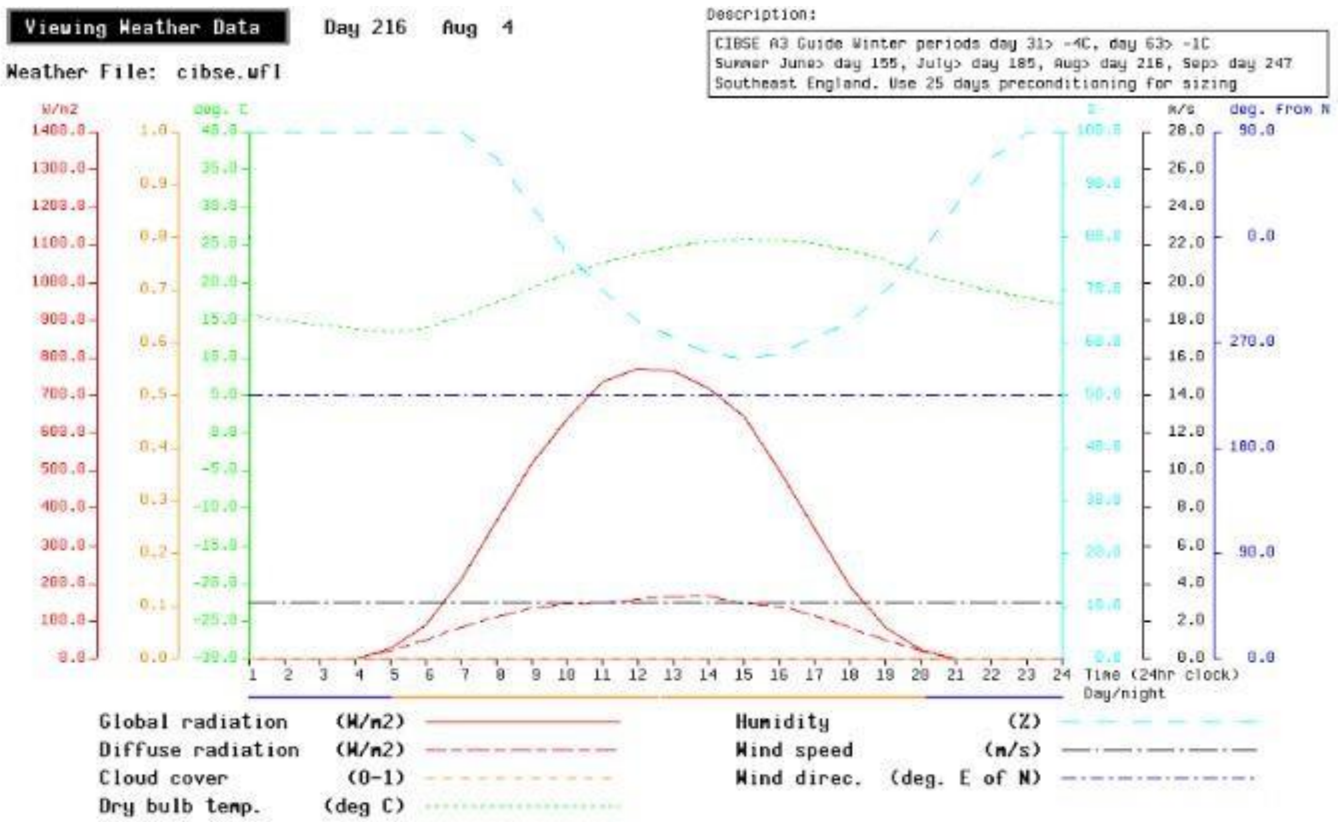
Summer temperatures and cooling loads

Guide A Section 5 example 5.1 Calculation of steady state heat losses.



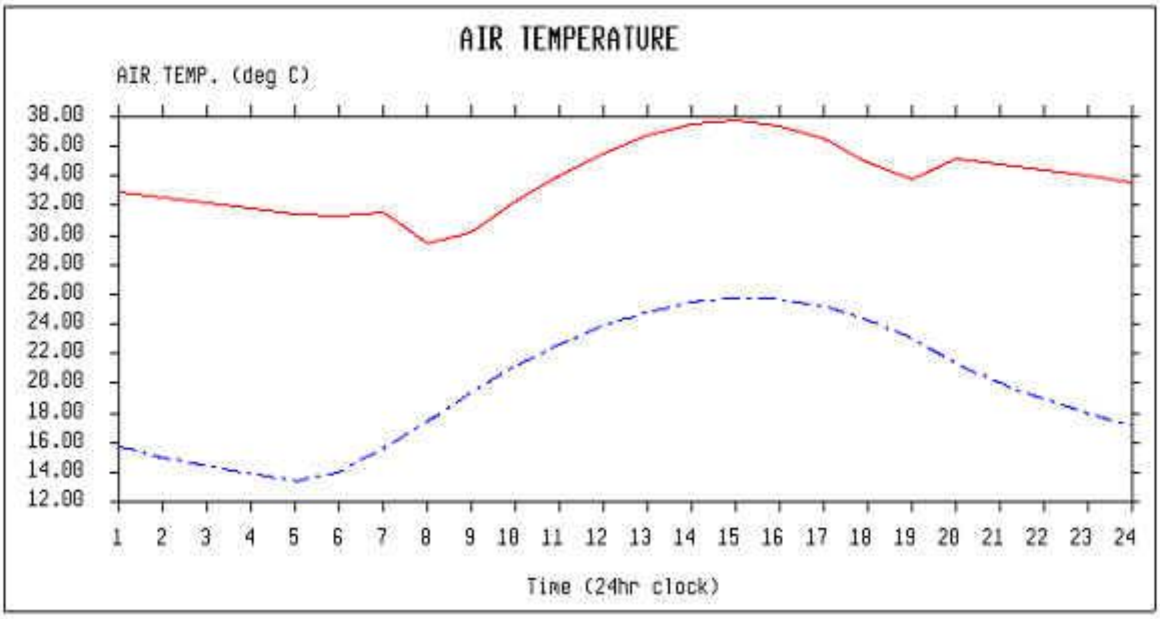


The TAS model has been set up with the same construction details and internal heat gains as the example building. A weather file has been specified with 30 days of repeated warm sunny weather as per the August design day specified in Guide A.

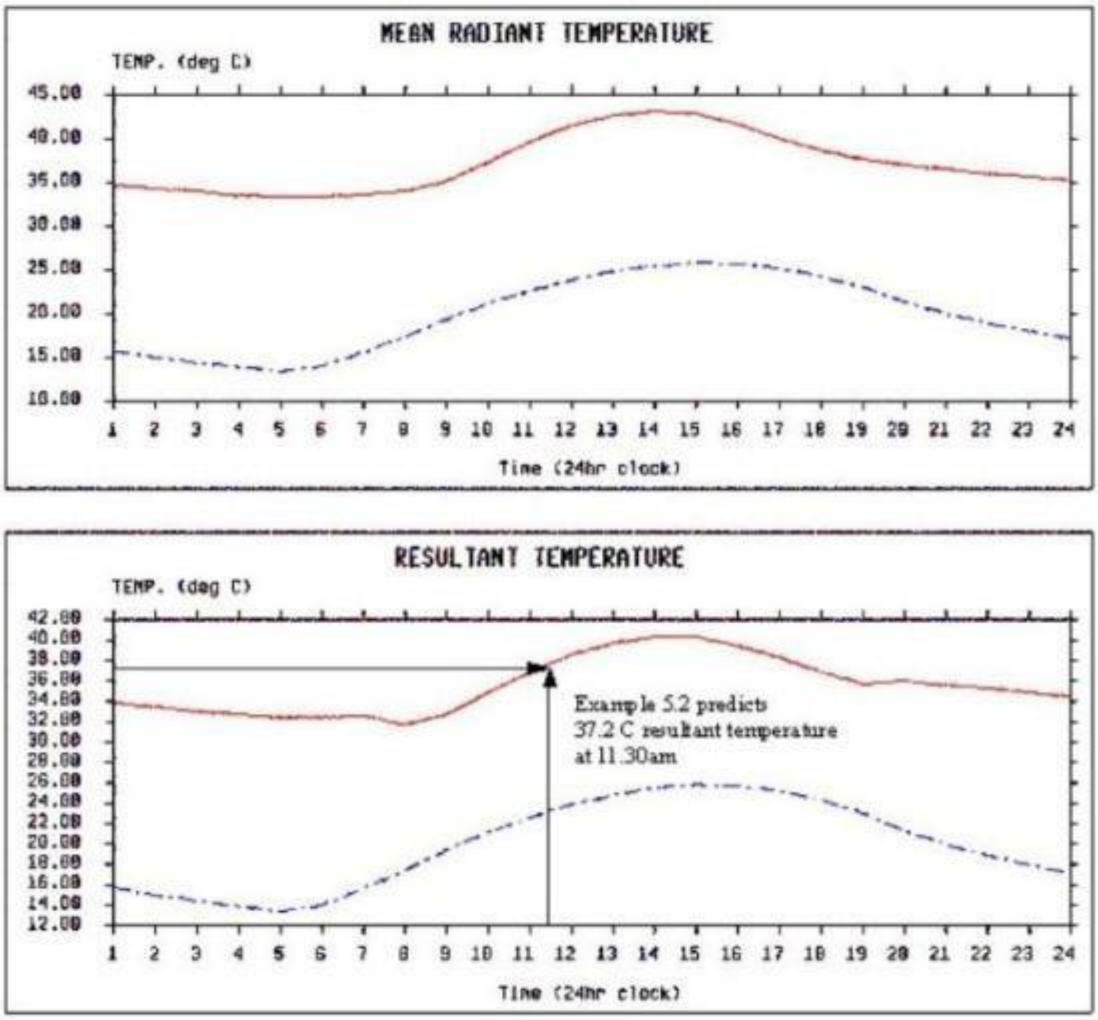


The TAS model was run for the 30 days and the 24 hour performance curves are shown below.

The predicted resultant temperature at 11.30 am was 37.2°C for the example and 37.68°C for TAS with the repeated hot day simulation.



Internal and external air temperatures



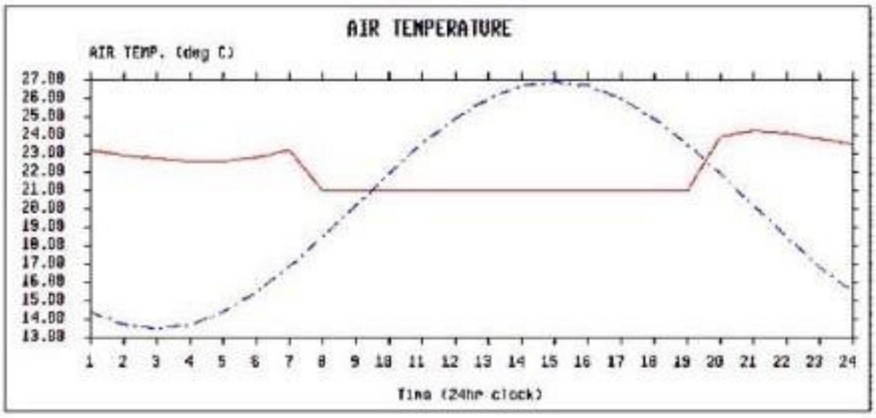
Mean radiant (surface) and resultant temperatures

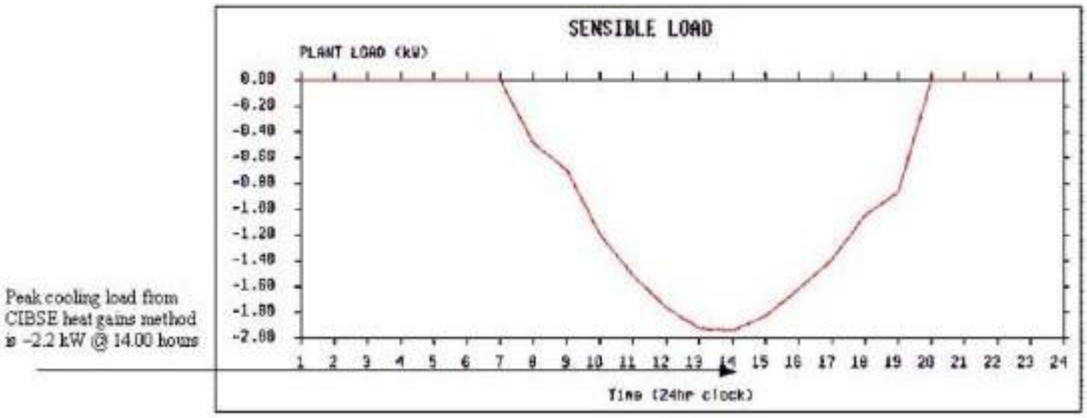
Guide A Section 5 cooling load calculations

These procedures are not yet implemented in design software such as Hevacomp or Cymap. To be of more direct value the comparison made here is between TAS predicted cooling loads using the repeated sequence of hot design days, and the heat gain method currently implemented in commonly used software.

The example office is used with cooling set to maintain 21°C internal air temperature.

The TAS simulation predicts a peak cooling load of 1.95 kW, whilst the CIBSE heat gain method predicts 2.2 kW. The simulation loads with repeated hot days is ~10% less than the standard heat gain method.





Conclusions

By using simulation with repeated design days the results for heating loads, cooling loads and summer temperatures closely match loads and temperatures predicted by the CIBSE steady state and admittance procedures.

This means that TAS models created for dynamic simulation based design analysis can also be used to generate standard heating and cooling loads. The procedures to do this, including the generation of repeated day weather data have been automated within Tas.