Introduction

Bentley Hevacomps AM 11 document can be found below. Please note that AM 11 is a statement about simulation software, and is not an accredited item.

Appendix B Checklist for choosing BEEM software

This checklist complements section 4 of the CIBSE Applications Manual AM11:1998 Building Energy and Environmental Modelling

B1 General

B1.1 Program description

Name, vendor, origins

Program name	Design Simulation
Version	V2
Date of current release	Feb 2008
Vendor's name	Bentley Systems (UK) Ltd
Contact name	Stephen Brown
Vendor's address	Smithywood House, Smithywood Crescent Sheffield S8 0NU
Tel	0114 255 6680
Fax	0114 255 6638
E-mail	support@hevacomp.com

Program type[1]

Thermal analysis:

Load calculation	☑	Plant and controls	☑	Energy simulation	☑

Lighting and visualisation:

Electric lighting	☑	Daylighting	☑	Combined	☑

Air movement ☑

Specialist tool ☑

Further description -

[1] The classification of programs is explained in Section 2. A program may have a number of listed capabilities. Space is provided to elucidate the description.

Program history[2]

Description	Design simulation was first produced in 2007 and incorporates Hevacomp CAD input. The simulation engine is EnergyPlus.

[2] List previous names by which program known, significant advances in functionality and dates of these, changes of platform and changes of vendors. This information will help in the understanding of published literature, especially about validation studies.

B1.2 Computer specification

Platform and operating system

PC	Yes	☑	No	☐
	MS-dos®	☐	Windows 3.x®	☐
	Windows 95®	☐	Windows nt®	☑
	ps2	☒	os2	☒
Unix®	Yes	☐	No	☑
Apple Macintosh®	Yes	☐	No	☑

Comments Can be run from either the PC or the Server Machine with Control from a License Manager run from a server machine.

Processor, storage and peripherals

Processor speed	3	GHz, recommended quad core
Minimum RAM	1	GB, recommended 2 gig
Minimum disk space	10	GB

Other devices:

Floppy disk	Yes	☐	No	☑
cd-rom drive	Yes	☑	No	☐
Printer	Yes	☑	No	☐
Plotter	Yes	☑	No	☐
Digitising table	Yes	☐	No	☑

Other Plotter is optional. A LAN connection is required.

Other requirements[3] Screen resolution > 800x600, Internet connection required for update patches, network connection required for license manager

Suitable machines[4] Most modern PCs will have no trouble running the software.

[3] Consider screen size, video RAM, Internet connection, local area network connection, etc.
[4] List types of machine known to be suitable

B1.3 Program code

Type of code

Compiled code only	Yes	☑	No	☐
Source code available	Yes	☐	No	☑
Extra £ for source code	Yes	☐	No	☑
Programming language	Fortran	☑	C/C++	☒

Notes -

B1.4 Modelling methods

The Design Simulation program uses the EnergyPlus simulation engine

B1.5 Input interface

Type of interface

GUI	☑	Menu-driven	☐	Command line	☐
Other					

Digital data file

Program produces accessible and human readable digital data files?[5]	Yes	☑	No	☐		
Legibility of digital file	Good	☑	Poor	☐	Bad	☐
Is entire problem definition contained?[6]	Yes	☑	No	☐		
Are all simulation parameters included?‡[7]	Yes	☑	No	☐		

Data checking

Does program check for consistency and plausibility of input?	Yes	☑	No	☐

[5] Interfaces may generate files (e.g. binary files) which cannot be read by people but only by the program interface. These are much less useful and old (binary) files may cease to be readable by new versions of the interface.

[6] Check that all the data are included — e.g. geometry, construction and occupancy data — and that the weather file used is noted.

[7] Check that all the simulation control information — such as time-step length, length of preconditioning and convergence criteria — is given.

B1.6 Output interface

Type of interface

GUI	☑	Tabular	☐	Digital	☐

Digital data

Is digital output accessible?	Yes	☑	No	☐		
Legibility of digital file	Good	☑	Poor	☐	Bad	☐
Is all output contained?	Yes	☑	No	☐		
Are algorithm level outputs accessible?			Yes	☑	No	☐

B1.7 Linked modules

CAD input	Yes	☐	No	☑
Vendor's own interface[8]	Yes	☑	No	☐

Other cad system(s) (name) AutoCAD DXF files

Comments The software uses AutoCAD DXF files as a template for inputting data

B1.8 Associated databases

Thermophysical properties	Yes	☑	No	☐
Basic material properties	Yes	☑	No	☐
Properties of complete construction	Yes	☑	No	☐
Transmission of windows	Yes	☑	No	☐

Comment[9] -

Weather data	Yes	☑	No	☐
Worldwide	Yes	☑	No	☐
Number of sites	7900			

Comment -

Other databases -

[8] Check that the modules are available and working; consult vendors about likely future releases.
[9] Ask how many entries are in each database; ask to see some of their contents.

B1.9 User support

Manuals

User manual	Yes	☑	No	☐
Hard copy	Yes	☐	No	☑
On-line	Yes	☑	No	☐

Date of the latest copy: February 2009

Does it include example problems with the expected answers?	Yes	☑	No	☐
Do the problems exercise all program modules?	Yes	☐	No	☑
Does it explain how to use every module?	Yes	☑	No	☐

Comments[10] -

Technical manual	Yes	☑	No	☐
Hard copy	Yes	☐	No	☑
On-line	Yes	☑	No	☐
On-line help	Yes	☑	No	☐

Comments -

Case studies

Vendor's case study examples obtained?	Yes	☑	No	☐
Case studies of others obtained?	Yes	☐	No	☑

Hotline

Hotline support	Yes	☑	No	☐		
Turn round	Instant	☐	1 day	☑	>1 day	☐

[10] Ask to see the manual. Ensure that it contains all the useful features and that it is up to date.

Software

Updates provided	Yes	☑	No	☐		
Media for dissemination	Floppy disk	☐	CD	☑	Internet	☑

Training

Courses provided	Yes	☑	No	☐
Cost	from £350			
Length	Details available			
Frequency	Details available			

B1.10 User base

Numbers

Users in UK	**10,500**	Users worldwide	**11,800**
Sites in UK	**1,500**	Sites worldwide	**1,630**

UK building services engineers	-			
UK architects	-			
UK builders	-			
UK others	**10,500**			
Is there a user club?	Yes	☐	No	☑

Contacts

Name	Support and Sales
Address	Bentley Systems (UK) Ltd Smithywood House Smithywood Crescent Sheffield S8 0NU
Tel	0114 255 6680
Fax	0114 255 6638
E-mail	support@hevacomp.com

B1.11 Cost

Software and associated databases

Core program			£2000 first seat £1000 additional seats
Modules	Name		£
	Name		£
	Name		£
Databases	Name		£
	Name		£
First year user /licence fee			£
Total software and data			£

Computer

Name	£
Annual recurring licence fee after first year of use	£
Typical training course fees per year	£

B1.12 Accuracy

Has the program been evaluated? Yes ☑ No ☐

Does the vendor exercise routine in-house quality testing? Yes ☑ No ☐

Complete the table below to document the validation history

Date tested	Independently (i) or by vendor (v)	Type of test A, C, E	Source of information	Comments on the results
Aug 07	(i)	E	CLG Part L	Accreditation test
Nov 07	(i)	A	ASHRAE	HVAC Tests
Nov 07	(i)	A	ASHRAE	Fabric tests
Nov 07	(i)	A	ASHRAE 120	
Nov 07	(i)	A	BESTest	

A Analytical verification**, C** Intermodel comparison**, E** Empirical validation

B2 Thermal simulation programs: theoretical basis

B2.1 Conduction and thermal storage[11]

Solution method

Explicit finite difference	☑	Implicit finite difference	☐
Respnse factor	☑	Weighting factors	☐
Other	-		

Time-step length

User specified	☑	Calculated by program	☐

Opaque surface: conduction model

One-dimensional	☑	Three-dimensional	☐

Opaque layers: node placement

Fixed at (number)	☑	User specified	☐	Not applicable	☐
Other	-				

Glazing: conduction model

Resistance or U-value	☐	Multi-layer with nodes	☑
Other	-		

Air gaps

User specified resistance	☐	Program calculated resistance	☑
Other	-		

Initial node temperature

User specified	☐	Program calculated	☑
Notes	-		

Preconditioning time

User specified	☐	Program recommended	☑

[11] Validation work indicates that conduction and thermal storage are well modelled in the programs studied. Alternative approaches generally have little impact on results and a small impact on program run times. The ability to conduct three-dimensional analyses is rarely needed. For modelling a large area of glass, especially heat-absorbing glass, windows are best modelled as multi-layer constructions.

B2.2 Solar radiation

External solar radiation[12]

Direct and diffuse combined	☐	Separate treatment of direct and diffuse	☑

Ground reflection of radiation[13]

Considered	☑	Not considered	☐

Diffuse radiation sky model[14]

Isotropic	☐	Anisotropic	☑
Notes	-		

Window transmission — direct[15]

User specified	☑	Program calculated	☑
Other/notes	-		

Window transmission — diffuse

User specified	☑	Program calculated	☑
Other/notes	-		

Internal solar distribution[16]

User specified (fixed) to one or more surfaces	☐	Calculated once by program	☐
Calculated at each time step	☑		
Notes	-		

[12] Solar radiation and its reflection are best calculated if the direct and diffuse radiation components are separated.
[13] Ground reflection must be calculated, especially for more highly glazed spaces (such as atria).
[14] Anistropic diffuse solar radiation models are generally considered superior.
[15] Window transmission may be calculated by the program, or the user may specify incidence angle dependent values. For direct solar radiation, incidence angle dependent transmission and reflection (or absorption) properties are necessary; a single value is often used for diffuse radiation. Correct specification for direct radiation is most important. Software is available to calculate incidence angle dependent values if programs require users to specify these and databases are inadequate.
[16] The distribution of internal solar radiation is usually important only where glazed areas are large, surfaces have very different thermal mass or a number of surfaces are glazed. The retransmission through other glazed surfaces can be very important for modelling e.g. conservatories or atria— note the treatment of this effect.

B2.3 Surface heat exchange

Internal surfaces[17]

Combined convection and radiation coefficient	☐	Separate convection and radiation networks	☑

Internal combined coefficients[18]

Fixed user defined	☐	Program calculated once	☐
Calculated at each time-step	☐		
Notes	Not applicable		

Internal convection coefficients[19]

Fixed user defined	☐	Program calculated once	☐
Calculated at each time-step	☑		
Notes			

Internal longwave exchange[20]

Star network	☐	IntersuArface exchange	☑
Notes			

External surfaces[21]

Combined convection and radiation coefficient	☐	Separate radiation and convection networks	☑

External combined coefficients

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[17] Some programs calculate heat exchange between surfaces and the enclosed air using a coefficient which describes both the convective and longwave effects. With such an approach the calculated space temperature is not a true air temperature; it is often termed the enclosure temperature. The true effects of highly asymmetric radiant environments (e.g. a radiant ceiling panel) are poorly predicted. The approach is, however, adequate for most spaces and where long-term (energy use) predictions are required. Note whether the approach used for glazing is the same as that used for opaque surfaces.

[18] Ignore if separate convective and radiant exchange networks are employed.

[19] Ignore if combined coefficients used. In reality coefficients vary depending on the surface-to-air temperature difference, surface length (or height), roughness etc. Note the algorithm used to describe these effects.

[20] Ignore if combined coefficient used. A star network balances radiation exchange at a fictitious central node. Radiation actually occurs by intersurface exchange. A view factor calculation is needed to describe the intersurface visibility. Note whether exact or approximate view factors are used and whether the program calculates these.

[21] The heat exchange at external surfaces may be calculated using a simple combined surface heat transfer coefficient or by separating out convection and radiation and modelling each of these in detail. Note whether the approach used for glazing is the same as that used for opaque surfaces.

Fixed user defined	☐	Program calculated once	☐
Calculated at each time-step	☑		

External convection coefficients[22]

Fixed user defined	☐	Program calculated once	☐
Calculated at each time-step	☑		
Notes	-		

External longwave exchange[23]

User or program calculated coefficient	☐	Detailed algorithm	☑
Notes	-		

B2.4 Heating, cooling and casual gains

Heat input[24]

Combined radiant and convective	☐	Separate fixed radiant and convective components	☑
Notes	-		

Cooling[25]

Sensible cooling only	☐	Sensible and latent cooling	☑
Notes	-		

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[22] If a separate treatment is adopted for external convection, note whether a fixed coefficient is used or a more detailed algorithm which may account for wind speed, direction and surface orientation is used. Although a rigorous approach is theoretically preferable, wind speeds and directions close to surfaces are difficult to calculate.

[23] Longwave heat loss to surroundings has a significant impact on the temperature of external surfaces and, for glazed surfaces (and other poorly insulated areas), the temperature of the interior spaces. This has a significant impact on the comfort conditions, and perhaps the demands for heating, in highly glazed spaces such as atria. The exchange may be modelled by a single coefficient or a detailed algorithm may be adopted. The algorithm may calculate exchange to both the sky and surrounding surfaces (ground and buildings) or to just the sky. The method of calculating the sky temperature should be noted.

[24] Heat input from plant and casual sources (people, lights and equipment) may have fixed radiant and convective components or the user may be able to specify these. The ability to specify will be important if, for example, a highly radiant source is used or if highly radiant sources are combined with convective sources. The ability to specify the latent proportion of casual heat gains may be similarly important, particularly regarding cooking equipment. Some programs use detailed models (e.g. which incorporate a time delay and an exponential temperature rise) so that heating plant can be more accurately modelled. This is less important for long-term (energy) calculations than for short term temperature predictions.

[25] An ability to calculate the latent cooling load will be particularly important in humid environments. The ability to do this implies that the moisture content of the air is tracked by the program — few programs do this.

Controlling plant[26]

Free-float	Yes	☑	No	☐
Idealised control	Yes	☑	No	☐
Ideal preheat/cool	Yes	☑	No	☐
Fixed heat injection	Yes	☑	No	☐
On/off thermostat	Yes	☑	No	☐
Accelerator	Yes	☑	No	☐
Proportional	Yes	☑	No	☐
Proportional plus integral	Yes	☑	No	☐
Proportional plus integral plus derivative	Yes	☑	No	☐
Advanced (e.g. fuzzy logic, adaptive, self-tuning, neural network)	Yes	☐	No	☑
Other				

Schedules[27]

Repeated daily schedule	Yes	☑	No	☐
Repeated hourly schedule	Yes	☑	No	☐
Seasonal variations	Yes	☑	No	☐
Flexible hourly schedule	Yes	☑	No	☐
Notes				

Sensor types

Sensing air temperature	Yes	☑	No	☐
Mixed radiation and convection sensing	Yes	☑	No	☐
Surface temperature sensing	Yes	☐	No	☑
Intraconstruction sensing	Yes	☐	No	☑
Notes				

[26] Most programs assume perfect control is possible, i.e. that a specified set point can be quickly achieved (provided plant capacities are sufficient); this is usually adequate for long-term energy calculations. In some programs the impact on temperature of alternative forms of control can be explored.

[27] The ability to schedule heating and cooling plant and the occurrence of internal heat gains is important. Some programs are very flexible enabling minute-by-minute variations, others are less flexible.

B2.5 Observations[28]

[28] Record here any other general observations about the capabilities of the program which have not been covered elsewhere. For example, some programs impose geometric description limits on the maximum numbers of zones, surfaces per zone or windows per surface.