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 ..... Tas Building Designer
Version 9
Date of current release ..... Febuary 2004
Vendor's name ..... EDSL, Environmental Design Solutions Ltd
Contact name ..... ALAN JONES
Vendor's address ..... 13-14 Cofferidge Close, Stony Stratford
..... MILTON KEYNES, UK
..... MK11 1BY
Tel 01908 261461
Fax 01908 566553
E-mail ..... alan@edsl.net

Program type*

Thermal analysis:
Load calculation ☑ Plant and controls ☑ Energy simulation ☑

Lighting and visualisation:
Electric lighting ☐ Daylighting [✓ ☐] Combined ☐

via lightscape or VIZ

Air movement ☑

Specialist tool ☐

Further description ..... Response factor based dynamic building simulation
..... With plant simulation and natural ventilation

Program history†

Description ..... Originally developed at Cranfield University UK.
..... Commercially developed and supported since 1984
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* 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.

† 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® ☑ 98 ✓ Windows NT® ☑ 2000 ✓ xP ✓

PS2 ☐ OS2 ☐

UNIX® Yes ☐ No ☐

Apple Macintosh® Yes ☐ No ☐

Comment no special hardware requirements

Processor, storage and peripherals

Processor speed 200 + MHz

Minimum RAM 64 MB

Minimum disk space 500 MB

Other devices:

Floppy disk Yes ☐ No ☑

CD-ROM drive Yes ☑ No ☐

Printer Yes ☑ No ☐

Plotter Yes ☐ No ☑

Digitising table Yes ☐ No ☑

Other All data exported to standard Microsoft Office products

Other requirements*

Suitable machines† Any standard office PC or laptop

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* Consider screen size, video RAM, Internet connection, local area network connection, etc.

† 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 Simulation engine in FORTRAN and user interface in C++
Source code is available for inspection

B1.4 Modelling methods

See section B2 to document thermal simulation programs.

B1.5 Input interface

Type of interface

GUI ☑ Menu-driven ☐ Command line ☐

Other Includes a 3D geometry modeller

Digital data file

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

Data checking

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

Within very broad bands

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* 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.

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

‡ 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*	Yes	☑	No	☐

Other CAD system(s) (name) DXF or DWG floor plans may be used as template backdrops

Comments Full 3D data import via IFC

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† Data bases on occupation schedules

Weather data	Yes	☑	No	☐
Worldwide	Yes	☑	No	☐

Number of sites 500

Also able to import climate data from METEONORM which has 2500 weather sites world wide

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* Check that the modules are available and working; consult vendors about likely future releases.

† Ask how many entries are in each database; ask to see some of their contents.

Comment There are facilities for generating synthetic climate data to the users specification

Other databases (description) schedules, heat gains, emitter types, controls

B1.9 User support

Manuals

User manual Yes ☑ No ☐

Hard copy Yes ☑ No ☐

On-line Yes ☑ No ☐

Date of the latest copy Feb 2004

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* On-line interactive tutorials with videos of software in use. Extensive theory manual

Technical manual Yes ☑ No ☐

Hard copy Yes ☑ No ☐

On-line Yes ☑ No ☐

On-line help Yes ☑ No ☐

Comments Describes all aspects of building dynamic simulation with integrated bulk air flow. Gives equations used in the methodology

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 ☐

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* 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 £ 250 per day per person

Length 2 days.

Frequency Monthly, or on demand

B1.10 User base

Numbers

Users in UK 200+ Users worldwide 300

Sites in UK 100+ Sites worldwide 250

UK building services engineers All users are engineers

UK architects ......

UK builders ......

UK others ......

Is there a user club? Yes ☑ No ☐

Contacts

1 Name Sinisa Stankovic
Address BDSP Summit House
27 Sale Place
London W2 1YR
Tel 0207 29 88 383
Fax ......
E-mail ......

2 Name Matt Kitson
Address Hilson Moran Partnership
16 Armstrong Mall, Farnborough
Hampshire GU14 0NR
Tel 01252 550 500
Fax ......
E-mail ......

3 Name ....

Address ....

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Tel..........

Fax ....

E-mail..........

B1.11 Cost

Software and associated databases

Core program		Tas Building Designer	£ ....
Modules	Name	All modules included and databases	£ ....
	Name		£ ....
	Name		£ ....
Databases	Name		£ ....
	Name		£ ....
First year user /licence fee		....	£ ....
Total software and data			£ 1600 annual or £3500 perpetual

Annual maintenance and support £1000

Computer

Name	N/A	£ ....
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 ☐

Describe testing regime All software developments are checked against CIBSE, ASHRAE and CEN standards

New software is BETA tested by selected users before full release

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
1994	I	E	INTERNATIONAL ENERGY AGENCY	Validation against monitored building data
1998	I	E	IWU Germany	German Government validation against monitored Building data
1998	I	E	BRE	Validation against monitored test room data
2000	V	E	BRE/EDSL	Validation against monitored data, new BRE offices
2002	V	A	CEN	Compliance with CEN standards
2004	V	A	CIBSE	Compliance with CIBSE software accreditation procedures
2004	V	C	ASHRAE	Compliance with ANSI/ASHRAE Standard 90.1 BESTEST
1999	I	C	VDI Germany	Inter model comparison

A Analytical verification, C Intermodel comparison, E Empirical validation

The CEN, CIBSE and ASHRAE standard tests are performed on all new releases to ensure compliance.

These tests with associated models are available to users for in-house checking of compliance.

B2 Thermal simulation programs: theoretical basis

B2.1 Conduction and thermal storage*

Solution method

Explicit finite difference ☐ Implicit finite difference ☐

Response factor ☑ Weighting factors ☐

Other……………………………………………………………………………………

……………………………………………………………………………………………

Time-step length

User specified ☐ Calculated by program ☑ 1 hour

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 Detailed, first principles, simulation of multi-layer glazing systems with blinds and shade

Air gaps

User specified resistance ☑ Program calculated resistance ☑

Other The user can specify cavity resistance, ventilation rates and controls, or select from database

Initial node temperature

User specified ☐ Program calculated ☑

Notes……………………………………………………………………………………

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Preconditioning time

User specified ☑ Program recommended ☑

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* 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*

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

Ground reflection of radiation†

Considered ☑ Not considered ☐

Diffuse radiation sky model‡

Isotropic ☑ Anisotropic ☐

Notes: sky longwave radiation calculated

Window transmission — direct§

User specified ☑ Program calculated ☑

Other/notes: The characteristic of the glass can be user defined or selected from databases

Window transmission — diffuse

User specified ☑ Program calculated ☑

Other/notes: As above

Internal solar distribution¶

User specified (fixed) to one or more surfaces ☐ Calculated once by program ☐

Calculated at each time-step ☑

Notes: Detailed internal solar distribution across and between zones

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* Solar radiation and its reflection are best calculated if the direct and diffuse radiation components are separated.

† Ground reflection must be calculated, especially for more highly glazed spaces (such as atria).

‡ Anistropic diffuse solar radiation models are generally considered superior.

§ 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.

¶ 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*

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

Internal combined coefficients†

Fixed user defined ☑ Program calculated once ☐

Calculated at each time-step ☑

Notes Longwave radiation exchange calculated. Convective coefficient can be fixed or calculated by the program at each time step.

Internal convection coefficients‡

Fixed user defined ☑ Program calculated once ☐

Calculated at each time-step ☑

Notes As above

Internal longwave exchange§

Star network ☐ Intersurface exchange network ☑

Notes

External surfaces#

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

External combined coefficients†

Fixed user defined ☐ Program calculated once ☐

Calculated at each time-step ☑

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* 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.

† Ignore if separate convective and radiant exchange networks are employed.

‡ 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.

§ 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.

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.

External convection coefficients*

Fixed user defined ☐ Program calculated once ☐

Calculated at each time-step ☑

Notes external convective coefficients calculated on wind speed and temperature

External longwave exchange†

User or program calculated coefficient ☐ Detailed algorithm ☑

Notes Full longwave exchange model with sky backloss calculated

B2.4 Heating, cooling and casual gains

Heat input‡

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

Notes The ratio of radiant output can be specified and the direct impact on occupants calculated ie high temperature radiant heating can be simulated

Cooling§

Sensible cooling only ☐ Sensible and latent cooling ☑

Notes As above chilled ceilings can be simulated

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* 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.

† 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.

‡ 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.

§ 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*

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........Also able to control humidity........

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Schedules†

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

Notes........Schedules also control plant, window opening

........and blinds..

Sensor types

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

Notes........Also able to sense humidity........

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* 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.

† 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*

Tas Building Designer combines dynamic thermal simulation of the building structure with natural ventilation air flow. This includes control functions on apetures and mixed mode operation

The software has heating and cooling plant sizing procedures, which include optimum start

Part L2 procedures are included for the Elemental Method, Whole Building Method and CECM

Tas has 20 years of commercial use in the UK and around the world. It has a reputation for robustness, accuracy and a comprehensive range of capabilities

The software is regularly updated and is well supported.

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* 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.