# HT B2

## USER MANUAL

# HTB2

A MODEL FOR THE THERMAL ENVIRONMENT OF BUILDINGS IN OPERATION
release 2

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# HTB2 - A MODEL FOR THE THERMAL ENVIRONMENT OF BUILDINGS IN OPERATION

# <u>USER MANUAL</u>

This manual is presented in  3 sections and appendices;

Section 1 is a general background to HTB2 which describes how it is structured, what facilities it provides and what data is needed to run it.

Section 2 is a basic guide on how to use HTB2 to model a building and is intended for the first time user.  It is essentially a description of how to set up the data files - what information they need to contain and the format to be used - and gives an example of a data file for a simple bungalow.

Section 3 describes the support software for HTB2; utilities, pre- and post-processors.

Appendix A comprises a set of data files for simulating a bungalow with two spaces - ground floor and loft - and is an example of a full operational package for a building.  The relevant sections of this data set are used as examples for individual data files in Section 2.

Appendix B is a complete set of the format conventions that must be followed in setting up these data files and acts as a reference for them.

Appendix C is a glossary of the names and terms used in this manual.

The intent of this document is to explain to a person who has  a) some prior experience of using computers and (b) some knowledge of the thermal behaviour of buildings, how to use HTB2 to model the dynamic thermal behaviour of a building.

This document refers to HTB2 release 2.10  (March 2008).

# IMPORTANT NOTICE

# CONTENTS

# INTRODUCTION

## GENERAL DESCRIPTION OF HTB2 - CONCEPTS AND IMPLEMENTATION

This section will provide an overview to the concepts and structure of the model HTB2 and to its capabilities and data requirements.  Further detail on the technical aspects of HTB2; algorithms, assumptions etc., can be found in the HTB2 Technical Reference Manual.

HTB2 has been designed as an investigative model of the thermal performance of buildings.  It was developed in the light of many years research, in both modelling and monitoring, on the thermal environment of modern low energy buildings.  It encompassed a general shift in emphasis from gross energy usage to the performance of the built environment and the operation of the building as an interacting system.  The model was developed to investigate the detailed workings of a building, incorporating the many aspects of thermal transport and gain (i.e. fabric conduction, ventilation, insolation, heating and incidental systems) providing data on short time-scales of minutes and weeks, rather than hours and years.

HTB2 is intended primarily as an investigative research tool, rather than a simple design model. It is envisaged in use in the development of the understanding of the operation of the building system and as a test bed for future model development.  It is anticipated that the main user of HTB2 will be the scientist/programmer, perhaps working in conjunction with a research architect or design team.

However, so as to make the use of HTB2 easier for design or teaching use, a PC version based on the Windows environment has been produced.  This product (the calculation engine and various pre- and post-processors) is known as HTB2 for Windows.  The machine independent core calculation code is still known as HTB2.  This manual will discuss issues common to both.

A summary of features and aspects of HTB2 follows;
> . portable coding (standard Fortran-77)
> . designed for easy alteration and extension
> . investigation of both long and short time-scale phenomena
> . external meteorological data
> . convective and radiant gains and exchange
> . internal fabric temperature and heat fluxes
> . provision for imposed internal temperature patterns
> . inter-space air movement
> . water vapour gains and transport
> . provision for zoning of spaces
> . provision for shading
> . provision for placement of solar gains
> . flexible glass transmission specification
> . flexible specification of operating schedules
> . flexible output intervals and details.

Additionally, the HTB2 for Windows version provides visual tools to simplify the management and monitoring of simulations, the preparation of the building description, and the inspection of results.  It is important to note that the common core version and the Windows version of HTB2 contain identical calculation code, thus ensuring compatibility of results.

# CONCEPT AND STRUCTURE OF HTB2

## CONCEPT

HTB2 is a computer program designed for simulating the thermal performance of energy efficient occupied buildings. It is aimed at providing scientists/programmers, perhaps working with a research architect or design team, with a flexible tool for studying the detailed operation of a building on a short time scale, of minutes rather than hours.

In order to achieve these aims, HTB2 has been written in a modular format in which, as far as possible, each subsystem has been isolated and localised in specific subroutines. This means that the section(s) of code which deal with any particular aspect may be quickly identified. In addition, the programming has been made as explicit as possible to enable easier understanding of the model's internal operation. The combination of a modular structure with explicit coding should allow the user to alter and extend the capabilities of the model with the minimum of difficulty.

These properties have inevitably been achieved at the cost of some loss in efficiency of computation but it is felt that, in the research environment, CPU time is less important than development time. Practical experience has borne out the proposition that increases in hardware performance can exceed that available from software optimization.

The model is written in a standard language, FORTRAN 77, with the minimum of machine dependent features so that it is highly portable between machines with the minimum of modification. The code has thus far been installed on a wide range of machines; from MSDOS PCs through DEC and SUN minis, to a CRAY mainframe.

The reader is referred to the Technical Manual for further information on this and other points outside the scope of a User Manual.

## PRINCIPLES OF THE MODEL

### Representation of building

As far as HTB2 is concerned, a building consists of a series of spaces linked to each other and to the outside by elements (walls, windows) and ventilation paths. This building is driven by the external climate, by heating system(s) operating under control system(s), and by a network of incidental heat sources.

The result of these thermal forces acting on the building is to generate a set of heat fluxes, air movements and moisture movements which in turn produce a set of temperatures and moisture levels in each space.

### Representation of processes : partitioning of time

The problem of how to represent the complex set of interactions which constitute the thermal behaviour of a building (figure 1.1) is central to all thermal models of buildings. The approach adopted in HTB2 is to divide time into discrete intervals and to assume that, within a time interval or 'time-step', each heat transport mechanism remains constant and independent of the others (figure 1.2).

At the end of every time step, a new set of conditions are calculated based on the accumulative effects of these heat transports. In addition, any changes to the boundary conditions, plant status etc. are implemented. These new values are in turn held constant for the duration of the next time interval and the cycle repeated for the duration of the simulation run.

The time interval used must be small enough so that the sub-processes affected interact over time scales of interest. The length of this time step is effectively dictated by the requirements of the fabric transport procedure and would normally be less than one minute. The structure of HTB2 has been developed to take advantage of this short timestep so that, for instance, heat sources may be altered or data can be output at this time scale.

The calculations that take place for each time step are as follows:
- determine new space temperatures
- determine radiative transfers between internal surfaces
- update external conditions (at times determined by met data)
- determine radiative fluxes due to insolation

- calculate fabric heat transport
- calculate ventilation heat and moisture transport
- determine response of controls and heating systems
- calculate incidental gains of heat and moisture
- refer to building operation schedule and modify parameters as required
- output data as required
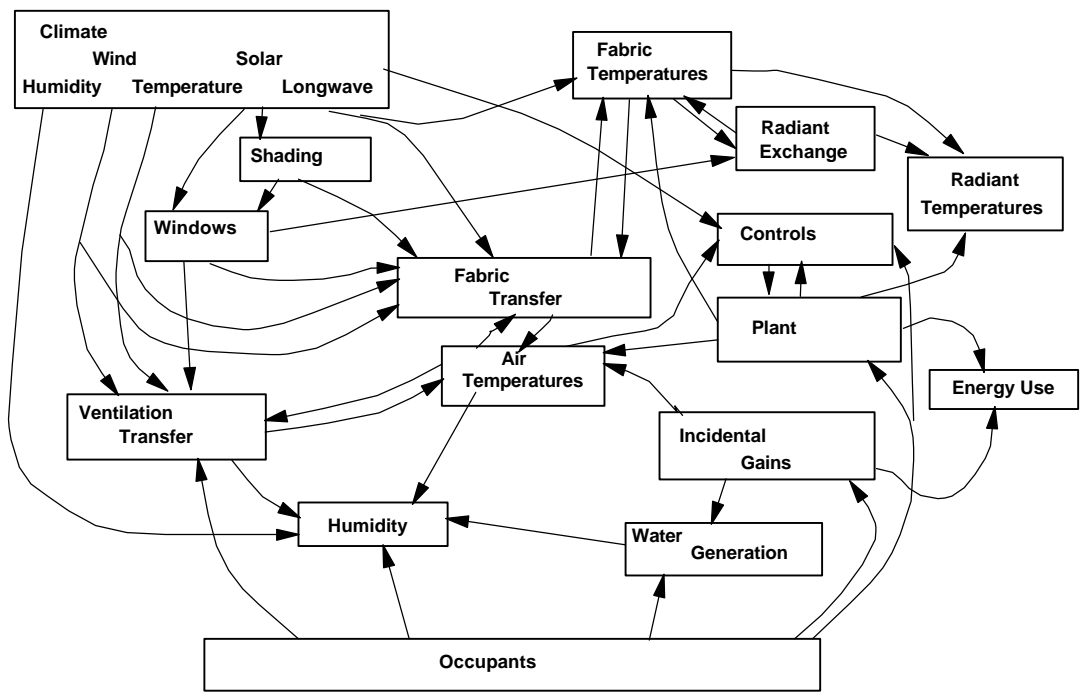


figure 1.1  Fundamental Building Processes and Interactions
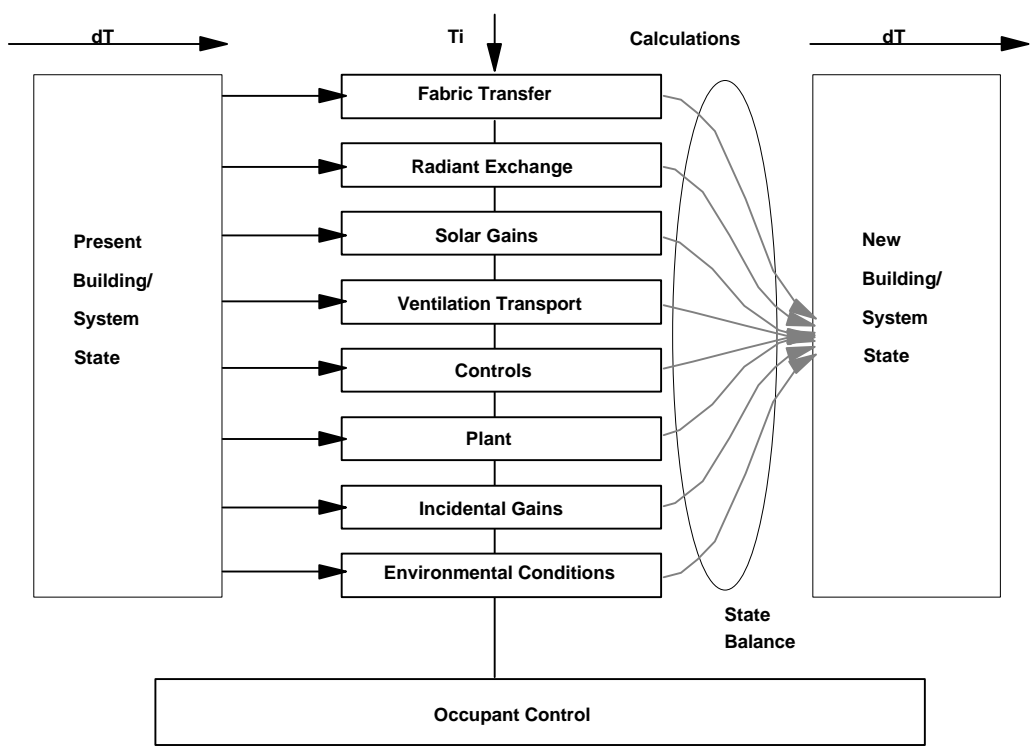


figure 1.2  Partitioning of Time and Processes

## STRUCTURE OF THE MODEL

The subroutines/modules of HTB2 are organised into three levels:

The top level module is the overall operating programme of the model and is responsible for managing the data input, the simulation itself, and the output modules.

The second level subroutines are divided into two groups. The first group reads the input data files, sets initial values, maintains the clock and updates the data base at the end of each time step. They are executed in every run.

The second group cover the processes indicated in figure 1.2;
- fabric transport
- internal radiative exchange
- meteorological conditions
- insolation
- ventilation
- heating system operation
- incidental gains
- scheduling of events
- space heat balance and temperature
- water content balance and humidity

The routines in this group are only executed when specifically requested by the user, however the standard condition will be for all routines to be included in the calculation chain. For certain research investigations some modules may be "turned off" to improve efficiency.

Third level subroutines are called from the Second Level and generally contain specific algorithms for the calculation parts of the operation for which the calling subroutine is responsible. One of the strengths of HTB2 in a research environment is the ability to easily alter or replace these components.

Again the user is referred to the Technical Manual for a full description of these program elements and the algorithms used therein.

## STRUCTURE OF INPUT DATA FILES

The input data files associated with HTB2 are summarised in figure 1.3. It can be seen that there are three levels of file, reflecting broadly the three levels of subroutines in the program itself.

The top level file contains the information necessary for the management of the simulation run: the run parameters e.g. length of time step, the subsystems to be used e.g. heating system, the names of the data files and the output required.

The second level files contain general data on each of the main subsystems ( building, services, diary of events and meteorological conditions) and the names of the third level files.

The third level files contain the bulk of the problem definition data for the subsystems required for the run. That is the parameters and properties of wall, heaters, etc.

These data files can either be built from scratch or, more conveniently, can be obtained by editing existing standard files or files that have previously been developed by the user. All data files (apart from the standard materials library) are simple ASCII text files and may therefore be manipulated (created, altered, edited) by a simple text editor. Suitable standard editors are Notepad in Windows, and Edit in DOS. Word processors may be used to alter the HTB2 data files, but the files must be saved in simple ASCII text form, not in the native format of the word processor (most packages will have a save option for this).

A library file of standard building materials is provided to assist in setting up the description of the constructional aspects of the building. This is saved in a special format for computer efficiency, there is a separate preprocessor available to allow changes to be made to this file.
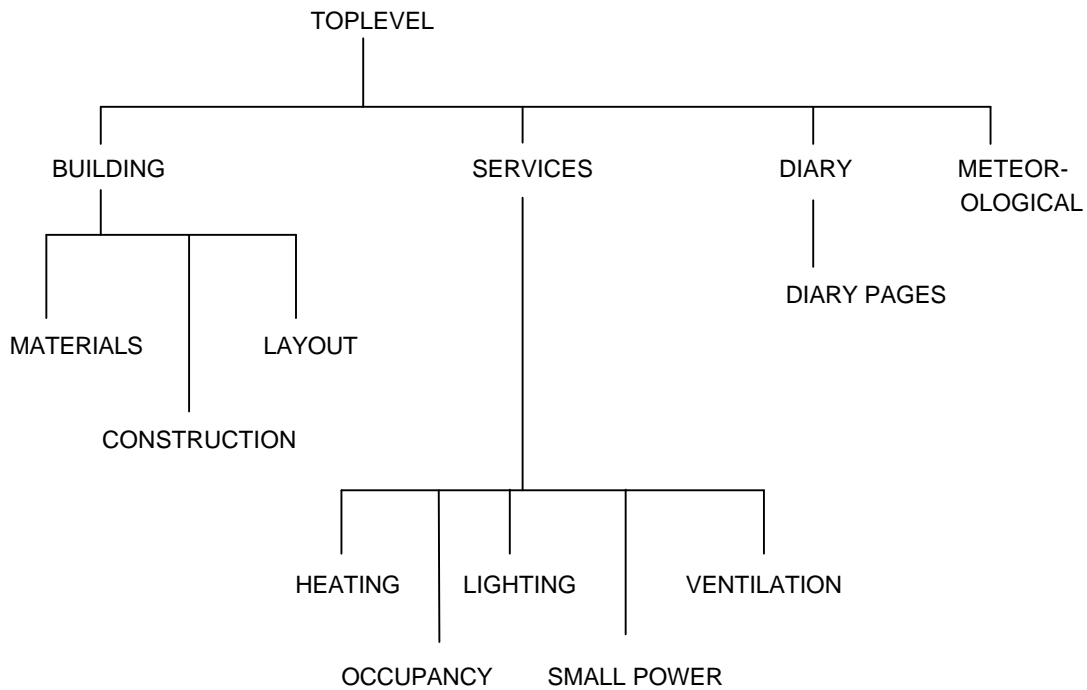
figure 1.3 HTB2 hierarchical file structure

The format and content of these files are illustrated in Section 2. A complete description of the content and format of these data files is provided in Appendix B.

In the Windows version of HTB2 there are preprocessors available to assist in the creation and modification of the Building chain of files; these are intended to clarify and speed the use of HTB2. The results of using these preprocessors are still standard HTB2 text data files, and can therefore still be altered by text editors; earlier HTB2 data files can also be read by the new preprocessor. These utility programmes are described in section 3.

## OUTPUT DATA

HTB2 has provision for six types of output data. Two are always produced as standard, and simply record and note the progress of a run. The final four are optional, and record, in different formats designed to meet different data requirements, run results. Each of these latter types is selected as an option in the top level file and the specific data in each type can also be specified.

The output types are as follows:

LOG          - typically the screen output created during the run, this output type warns of errors during the input and run stages, and marks the progress of a run.

INFO          - contains run information, such as filenames, space volumes, element types. It is created immediately after the input stage, and is useful in checking input integrity. For instance a standard U-value is calculated for each construction type, which can then be compared against expectations. This file is also useful in documenting runs, as it contains a log of all files and key data used within a run. Postprocessor programs may use this file to aid interpretation of data in the other output files.

REPORT          - records interval averages of key data resulting from the simulation. The default condition stores the basic information required to construct an energy balance for each space of the building. The default interval is hourly, although this can be altered to any interval from one timestep to one day.

PROFILE          - records instantaneous temperature and heat flux profiles (slices) through selected building elements at selected intervals, or as triggered snapshots.

LOGGER          - records instantaneous data asynchronously, when the value of (user) selected variables change by more than a specified amount. This allows the time-history of a variable to be recorded, to a resolution

of one timestep, without generating enormous file sizes.

SAVE STATE        - records the fabric temperature conditions each midnight.  This file is not meant to be an "output" as such, but rather to be a means of restarting a simulation from a known point, with the !DEFINE RESTART command of the Top-level file.

The overall aim is to allow the user to tailor his data output on each run to meet the specific requirements of that run, storing no more data than is necessary.

The REPORT, PROFILE and LOGGER data files are recorded in a machine coded format, post-processors are required to extract information and translate it to readable text, or to text data files suitable for inclusion in other software (e.g. spreadsheets or graphics packages).  These are described in section 3.

In the Windows version of HTB2 there are post-processors available to assist in this translation for the REPORT data files.  Due to changes in  storage format, these new utilities may not work correctly with older versions of HTB2.

# SECTION 2

# CHAPTER 1

# BASIC OPERATION OF HTB2

This section will provide an simple example of the usage of HTB2 by following the construction of a dataset for a simple dwelling-type building.

Running HTB2 consists essentially of carrying out the following five stages :

Stage 1  Collect information on building, pertaining to the materials, structures, services and operating schedules. Organise a conceptual 'model' of the building in spaces and partitions to reflect the concerns and interests of the simulation exercise.

Stage 2  Set up the second and third level data files containing the information required to implement these run selections under four headings:
- building
- services
- operating schedule (diary)
- external conditions.

Stage 3  Set up a 'top level' file containing information on how the run is to be carried out and the output required e.g. whether there will be a heating system, lighting, occupancy etc.

Stage 4  Submit the run.

Stage 5  Peruse, print or otherwise process the output data.

Depending on the intents of the investigation, and the results obtained, Stages 2-5 may be reiterated many times.

These stages will be presented for the simulation of a simple dwelling type building in the remainder of this section. The building is based on a small, detached, single story bungalow.

The data files required for this example will be treated individually in following chapters. These are based on an example tutorial data set provided with HTB2 (see HTB2 tutorial 1). Each section will provide an opportunity for the explanation and discussion of the concepts and capabilities of HTB2 in that area. Explanatory notes will be keyed to the computer file by lower case letters in the leftmost column (note that these keys are not part of the data file itself). The terminology used is described in the glossary in Appendix C. These chapters will deal with the basic HTB2 data files, not with the views provided by the Windows preprocessors. They are described in Section 3 of this manual, and in the tutorials. It is felt that all users of HTB2 should ultimately become familiar with the underlying file formats of HTB2 even though the availability of easy user interfaces may make these transparent. Should error conditions occur, the data files themselves may need to be consulted.

The basic relationship between components of HTB2 and the data files are shown in figure 1.1
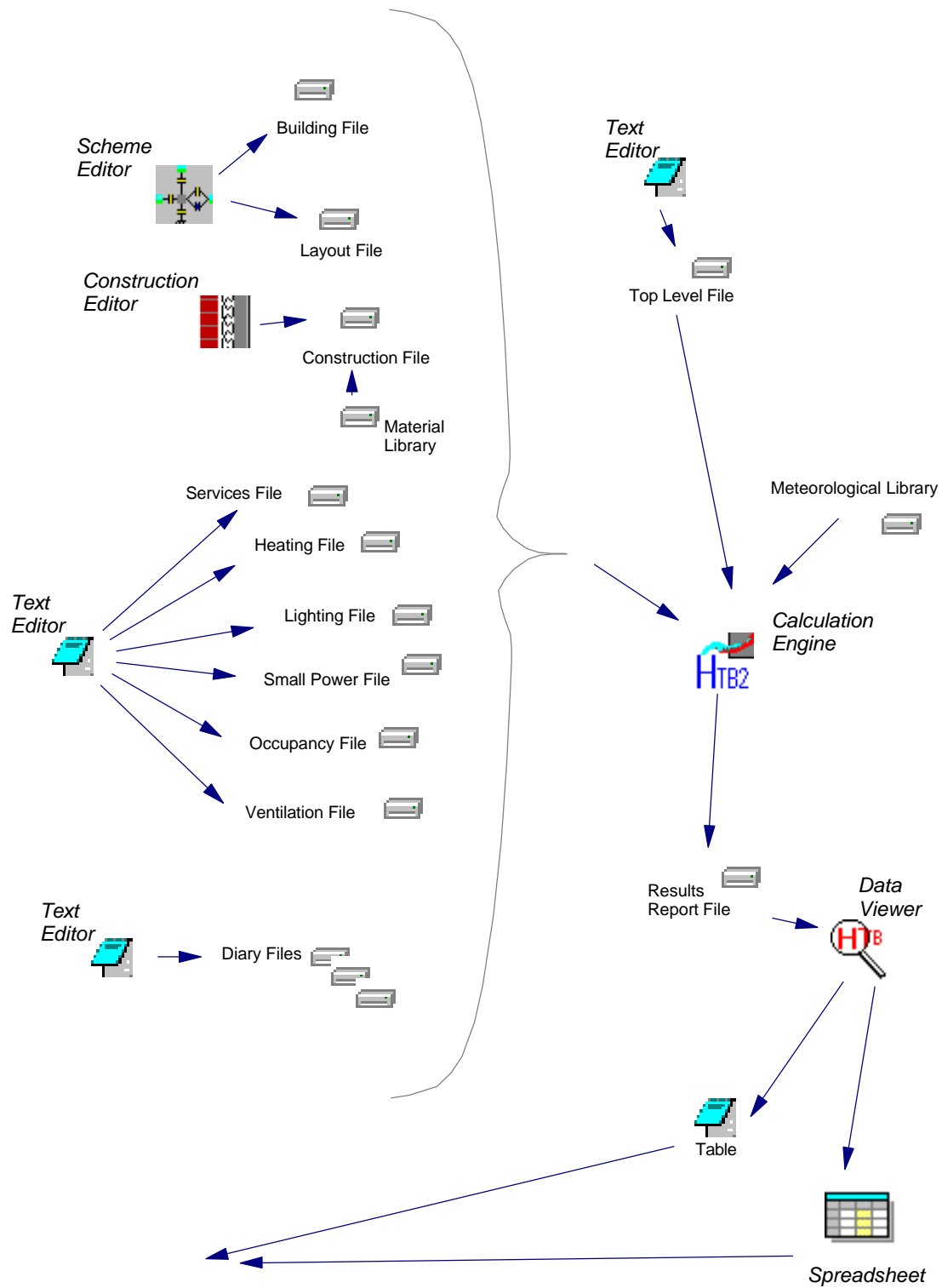
figure 1.1 Relationship of Files and Utilities

# CHAPTER 2

# DATA REQUIRED FOR SIMULATION RUN

## 2.1 OVERVIEW

Operating HTB2 requires that the following data must be available (or generated), or decisions must have been taken:-

As to the building;
> . The geographical LOCATION of the building : latitude and longitude.
> . The SPACES and ZONES into which the building is to be divided.
> . The partitions or ELEMENTS separating the spaces.
> . The physical LAYOUT of these elements in terms of connections to their surfaces.
> . The number and specifications of CONSTRUCTIONS used in creating the partitions.
> . The thermo-physical and transparency properties of the MATERIALS used in these constructions.
> . The external site SHADING of facades.

As to the services provided;
> . The number, type, and control characteristics of HEATING SYSTEMS in the building, i.e. their maximum output and response characteristics, their radiative/convective output splits and the output connections, the set-points and control strategy of thermostats, automatic time control.
> . The number, heat output, control and connections of LIGHTING CIRCUITS.
> . The number, type, heat output and connections of SMALL POWER sources.
> . The number, heat output and locations OCCUPANTS.
> . The VENTILATION characteristics (rates, flow patterns, control strategies) of the building and its spaces.

and as to the operation of the building and/or the test parameters;
> . The time dependant operating schedule DIARY of the building will be operated with respect to time.
> . The external METEOROLOGICAL conditions for the test.
> . The configuration of the simulation, i.e. simulation length, election of alternate solution algorithms.
> . The selection of DATA OUTPUT types and intervals.

This chapter will introduce many of the concepts and component of an HTB2 simulation through discussion of a simple example. Further information on individual aspects may be found in Chapters 3 through 9.

## 2.2 BUILDING DESCRIPTION

### 2.2.1 HTB2 View of Building

The calculation engine of HTB2 views a building only as a network of thermodynamic connections. That is, rooms are simply volumes of air (a "Space"), and walls are simply thermal connections between air pockets (an "Element"). HTB2 contains the usual simplifying assumptions in the representation of these concepts; a Space is considered to be at a uniform temperature throughout (e.g. no temperature stratification within a zone), and the heat flow through an Element is considered to be 1-dimensional (e.g. there are no edge effects and no explicit thermal bridging within an Element, and only 2 sides or surfaces).

A Space, at its simplest, has an attribute as to its contained air volume. An Element, again in its simplest form, has attributes describing which Spaces its two surfaces "see" (the outside is considered a special Space), a (single side) surface area, a construction type (a pointer to one of a library of available constructions: a construction is a sequential list of materials and thicknesses that may make a partition), a tilt (e.g. horizontal or vertical) and orientation (e.g. north or south facing) and a surface treatment (e.g. colour). In HTB2 an Element may be an external wall, floor, ceiling, internal partition, or a window.

Apart from limited information as to the orientation and tilt angles of a Element, there is no 3-dimensional information of the structure of layout within (or required by ) HTB2. This means that there is no information, for

instance, as to which element is adjacent to any other, only to which Spaces they are attached to. This means that a full 3-D description of a building (as may be produced by a CAD package) is neither required nor used by HTB2. This can be a disadvantage in that some preprocessing is required outside of HTB2 to produce the required data (such as surface areas) but it can be advantages in that some nonrepresentational shorthand may be achieved to simplify modelling. That is two physically separate structures need not be described as two elements if they share the same construction type, connections orientation and tilt; a single "super" element with the total area would provide the same result foe less computational effort. Thus for instance a series of rooflights on a large hall may be simplified to one of the equivalent total area.

The HTB2 view of a building as a thermal network is summarised in figures 2.1-2.4. The simulation of a real
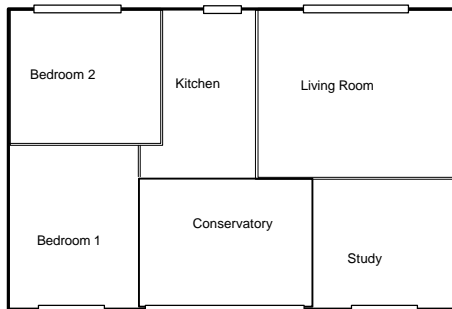


building will always require some simplification, following both the limitations of the modelling procedure and the desire for rapid calculations. This summary also illustrates this simplification path.

Figure 2.1 illustrates a simple floor plan for a single story

house. The house has two bedrooms and an inbuilt conservatory. In the following discussion the floor, ceiling and roof will be disregarded. In the interest of simplicity it can be assumed that all internal rooms will have similar temperatures (apart from the conservatory of course).
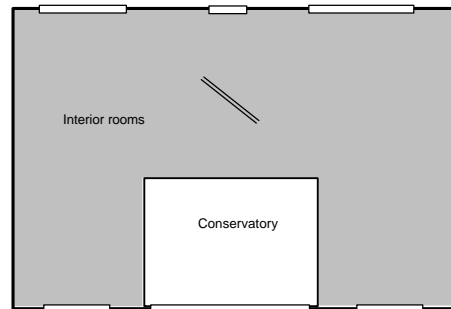
This leads to figure 2.2, the simplified zoning of the house. As all internal partition walls are now bounded by the same temperatures either side, the internal walls will act only as a thermal store.
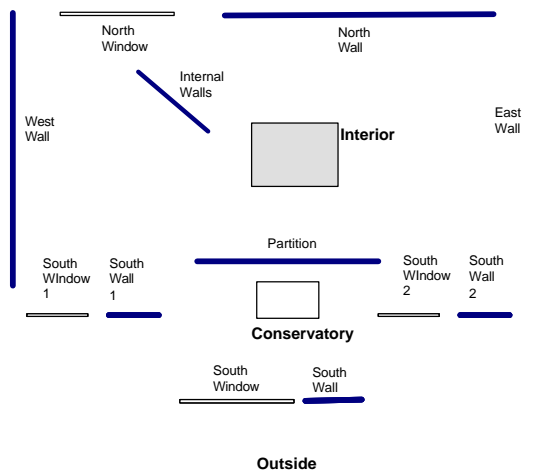


However they should not be ignored as should they be of significant mass their presence would effect the space conditions. So as to reduce the calculation load, assuming that they are all made the same way (e.g. brick and plaster), then a single internal element of the total area of the individual partitions may be assumed.

Figure 2.3 continues the simplification of the building structure. For instance the two windows on the north facade may now, because there is only one internal space, be reduced to one window element with the
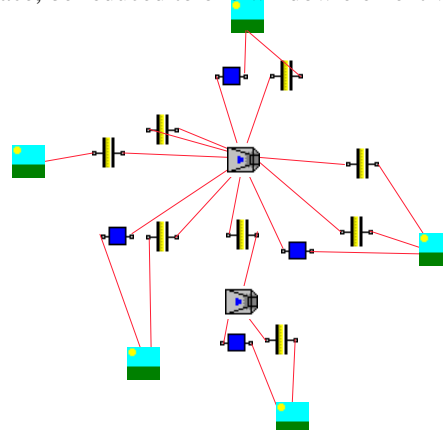




combined area. This of course assumes that they are both of the same construction. Not that this has not been done for the south windows; in this illustration this was done to allow different shading characteristics to be provided for the two windows (perhaps one is shaded by a tree for instance).

Finally in figure 2.4, the total network in HTB2 terms is displayed, showing the interconnections of the elements and spaces. This figure uses the symbolic convention of the Windows Scheme Editor, with unique symbols for walls, windows, spaces etc.

### 2.2.2 Example Building Description

As an example, consider a simple small bungalow dwelling, similar to the case above, but with no conservatory.

This is a small bungalow, in the London area, of approximately 66 m² floor area. There are 7 rooms; Hall, Living room, Dining room, Kitchen, Master bedroom, second bedroom and WC. There is also a single loft space above. The average floor-ceiling height for downstairs rooms is 2.35 m.

The house is not particularly well insulated; external walls are brick/cavity/brick construction and single glazing is used throughout. Internal walls are made of a single leaf of brick, plastered either side. There is a solid, uninsulated, ground floor, but the ceiling is insulated with a layer of glassfibre. The roof is tiled. There is no specific energy strategy in the orientation or placement of glazing, and there is no significant shading by devices, reveals, or external objects.

The HTB2 data files for a sample simulation of this building are described from Chapter 3 on. The following will provide a background to the information contained therein.

### 2.2.3 Data Required

#### 2.2.3.1 Building

The Building definition includes site specific data (e.g. location, site shading) and the number and sizes of spaces to be simulated.

Location:   The site location is needed as Latitude and Longitude. Latitude (degrees North of Equator) is required to define the solar geometry of the site. The southern hemisphere may be specified by using a negative Latitude. Time definitions in HTB2 refer to local time, therefore Longitude (degrees West of Greenwich) is needed to correctly determine the displacement of solar noon from local noon (if set to 0 then the two will be the same). Greenwich time zone is assumed; if a Longitude outside of Britain is entered then the location (longitude) of the appropriate timezone must also be defined. That timezone must be East of the location.

Site Shading: At this level, site shading is treated as a global Skyline, an angle below which direct solar radiation does not impinge on the building. This skyline is a constant for the entire compass. HTB2 defaults to a zero skyline (i.e. no site blockage). A five degree skyline is often assumed to be reasonable as a general value for many "real" sites.

Spaces:   HTB2 views a Space as a parcel of air of a uniform (or average) temperature. The outside is a special (predefined) Space, referred as space 0. Spaces communicate (thermally) via elements and ventilation and are concerned (again thermally) only with the effect of the convective heat production and exchange of the processes within it (e.g. these processes may be lighting, heating, fabric etc.). A space may represent a room, a collection of rooms, or even a small sub-volume of a room. In terms of HTB2 the prime data required is the enclosed air volume (in m³) of the space to simulate.

The selection of the zoning of a simulation model (i.e. deciding the number and complexity of the spaces to simulate) depends on a number of considerations; e.g. the intent of the simulation, the disparity of expecting conditions, gains, fabric construction or use of rooms may determine whether rooms may be grouped or treated individually.

In this example, it was decided that in the interest of simplicity and efficiency all the downstairs rooms could be combined to one simulation space. The loft will appear as a second space. This assumption implies that the temperatures of all the rooms would be similar. This would perhaps be a reasonable assumption for a insulated dwelling with central heating and moderate glazing; for a case with less regular heating, or large glazing areas in some rooms (a passive solar design perhaps) this simplification would be less suitable and more simulation spaces would be required. Alternatively if conditions in individual rooms were to be investigated then again, more simulation spaces would be required.

<u>2.2.3.2 Construction</u>

The HTB2 Construction files defines a library of fabric types for use in the elements of a building.  This file may be treated as a library of components, there is no penalty for having more constructions defined than are used in the building.

> <u>Construction type:</u> Each Construction, or fabric type, defines the thermophysical properties (thermal resistance and capacity) of the fabric in terms of a sequence (layers) of materials and thicknesses.  As an initial guide, this sequence would travel from the outside to the inside surfaces.

A Construction is a concept, to be used in a "concrete" Element.  Any number of Elements may use a single Construction.   The initial task in defining an HTB2 model is to determine the number and description of these common fabric types. For instance a common construction type is Brick/Cavity/Block/Plaster.  This may be a single Construction regardless of which Elements it may be used in, independent of orientation, tilt etc.  However, a wall of Brick/Cavity/Insulation/Blockwork/Plaster would require a second Construction.

It is when a Construction is used that surface properties (e.g. colour) are assigned.  The Elements defined using the construction type above, Brick/Cavity/Block/Plaster, may have different surface finishes (e.g. one wall whitewashed).

In defining construction, reference must be made to the materials used within.  It is the materials that determine the thermal resistance and heat capacity of the fabric defined.  Common material properties are found in the Materials library, if the desired material or properties required are not to be found there, then information as to the Thermal Conductivity (W/m/C), Density (Kg/m$^3$) and Specific Heat Capacity (J/kg/C) will be required.

> <u>Glazing:</u> In HTB2 windows are treated as fabric elements.  However as windows, they require extra information to determine how Solar energy travels through the glazing.  This extra information is also described in the Construction file.

Basically the amount of solar radiation transmitted through, and absorbed into, the glazing system must be described as a function of the angle the solar beam makes with the glass surface.  This information is sometimes published by glazing manufacturers, or may be determined from theoretical calculations.  Data for a number of glazing types is provided in the file GLASS.HLP found in the HTB2 data subdirectory.   Where the desired glazing cannot be matched with these examples, the transmission and absorption characteristics if the glazing must be otherwise determined.

<u>2.2.3.3 Layout</u>

The Layout file describes the Elements that make up the physical structure of the building to be simulated.  An Element may be a wall window, floor or ceiling.  Like Spaces, an Element may represent a single wall, a collection of similar walls, or a subsection of a wall.  The key factor influencing the breakdown of a building fabric to elements should be:-
> - an element represents only 2 surfaces, each of which has a uniform (or average ) surface temperature (e.g. the assumptions of the 1-dimensional heat transport model will not allow variation of temperature across a surface).
> - each surface can connect to only 1 Space (e.g. a physical run of walling that extend through several rooms must be broken down into smaller component elements)
> - an element may be made of only 1 construction type (e.g. a wall containing a door should be described as two elements).
> - an element may connect both surfaces to the same space (i.e. an internal partition)
> - an element may represent more than one physical partition (e.g. a number of internal partitions added together to provide a single element with the aggregate surface area).
> - the more elements described, the longer the calculations will take.

As noted each Element has two surfaces.  There must be some way to distinguish these; the nomenclature for these surfaces in HTB2 is "First" and "Last".  This is applied according to the way the construction type for an element has been defined; the First surface becomes that associated with the first layer of the construction, the Last with the last.  Thus the ordering of the construction layers is significant.

For each Element described, some data is mandatory, while some will have default values which may be

acceptable.

Mandatory data for Elements are:

Construction type: for each Element necessary to describe the building simulation, the appropriate construction from the Construction Library must be chosen.

Area: The physical surface area of the Element must be provided, in m$^2$. This represents the area of one side of the element, e.g. a 2.5m x 5m wall will have an area of 12.5 m$^2$.

Orientation: To determine position relative to the sun and wind, the Orientation for all Elements which connect to the outside is required. This is described as the azimuthal angle of the First surface, expressed in degrees clockwise from South. Thus a south facing wall would have an Orientation of 0. Internal Elements do not require an Orientation to be defined, if one is defined it will be ignored.

Tilt: To determine position relative to the sun and wind for external Elements, and to determine heat flow characteristics for all Elements, the tilt angle is required. This is described as the angle of the First surface varying from the vertical. Thus a vertical wall has a tilt of 0, while a floor or flat roof would have a tilt of 90. A tilt of -90 is possible, this would typically represent an overhanging section of fabric.

If the element is a window, there are two extra mandatory items of data required.

Glass Type: To allow the calculation of solar gains through windows the solar transmission characteristic must be described.. These are defined in the construction file, here the appropriate type for this Element is chosen.

Solar Patching: To allow the determination of the surfaces on which the solar radiation falls, once it has entered through a window.

There are also many parameters which have default values which are generally acceptable but may be overridden for individual Elements

Surface colour: For each surface of each Element, a solar absorption coefficient may be described, to distinguish between light, medium and dark coloured surfaces. By default, surfaces are assumed to be medium absorption, for instance middle beige colours.

Shading: For each external Element, a shading description may be provided that determines when and from where solar radiation may impinging on a wall or window. The description may combine the effect of shading devices (overhangs), treatments (filters) or obstructions (trees and buildings). By default no shading is assumed for any surface.

Ground Reflectance: For each external element, an appropriate value for adjacent ground reflectance (or albedo) may be applied. By default this value is 0.2, appropriate for grass or asphalt surroundings.

This is an incomplete list of an Elements parameters; other factors include emissivity, surface roughness and local heat transfer characteristics. These are described in more detail in Appendix B.

**2.3 Services Description**

**2.3.1 HTB2 view of Services**

Services in HTB2 provide a "catch-all" for energy sources and sinks beyond those of the fabric of a building. The services include the functions and phenomena of;
- Heating,
- Lighting,
- Small Power,
- Occupancy,
- Ventilation.

In all aspects, HTB2 considers Services as a means of heat (and possibly water vapour) gains or losses to the building interior.  Thus, for instance, the Lighting Service is only concerned with the sensible heat produced by a lighting system, not with the visual environment it may produce.  In a similar vein, Occupancy is concerned only with the number and activity of the occupants of the building, so as to determine their sensible (and latent) heat gains.  The other, considerable, effect of occupants namely the manipulation or operation of the fabric of other services is taken into account in the time scheduling of events (the Diary or timeclocks).

Ventilation is included in the Services definition, but this does not imply that only mechanical ventilation systems can be considered in HTB2.  Natural (or hybrid) ventilation systems can be equally well described.

The scope and capability of each of the services will be described in Chapter 4.

It should be noted that the distinction between the Lighting, Small Power and Occupancy services is largely for convenience only; that is to HTB2 they are all just sources of heat to the building interior.  It is therefore not required that all three be used; it is feasible to setup a realistic incidental gain pattern solely through the use of the small power system for instance.  In doing so, some flexibility and simulation power will be lost, but some simplicity may be gained.  However in this discussion, the full simulation package will be used.

### 2.3.2 Example Services Description

In relation to the bungalow used as the example, the building is provided with all services accounted by HTB2.

There is gas central heating, serving wet radiators in all rooms.  The maximum heating capacity (output) is approximately 7 kW.   A simple thermostat and time clock controller are provided.  The central heating boiler also provides indirect DHW through a standard storage cylinder.

The house has typical tungsten lighting, one or more fittings in each room.  Total installed lighting load (electrical rating) is approximately 500W.

There are a number of electrical appliances in the house which may provide a significant contribution to the overall energy balance of the system.  These are:

> Television/Radio : 150 W maximum,
> Electric Cooker : 1700 W maximum,
> Fridge/Freezer : 100 W maximum.

There is a further source of non-electric incidental heat that may be considered, the losses from the DHW cylinder.

Other small power sources are likely to be insignificant in this case.

The house is naturally ventilated, and not particularly well draft-stripped.

Although the house is small, the occupants number there are two adults and two children.  While in the house they, of course, undertake only the normal range of activities associated with dwellings.

### 2.3.3 Data Provided

> Heating:  A Heating System provides heat (or may extract heat) to provide desired temperature conditions.  The capabilities of Heating systems in HTB2 extend from IDEAL systems, which will always succeed in providing the desired conditions, to more realistic descriptions, with deadbands, time constants, and limits which may prevent the expected conditions from occurring.

In specifying the heating options for the simulation, the "IDEAL" system was chosen.  This is the simplest option, and is generally suitable for determining long term energy balances, typical conditions or plant sizing.  As it does not allow for the realistic characteristics of heat emitters or controllers, it is not suited for investigating short term comfort effects (e.g. temperature cycling), or the subtle interactions between systems (i.e. control location and solar gains).

As there is only one living space (all rooms lumped together), all radiators are lumped together into a single Heating system.  This is controlled by a single thermostat, sensing (effectively) the average internal temperature.  The controller will be set to maintain a 19C internal air temperature, when enabled.  The system is also controlled

by a time-clock; this will determined when the system is enabled. The time clock will be discussed in the section below (Scheduling).

Lighting: A Lighting Circuit produces heat while it is lighting the building. Lighting use is generally controlled by "On/Off" switching, though it may be dimmed proportionately or affected by the outside conditions. There may be a number of independently controlled circuits in each space ( or alternatively one circuit may serve a number of spaces). HTB2 only considers the heat output from the lighting circuits, not the visual conditions produced.

As for the heating, all the lights will be aggregated to one "Lighting circuit". The form of the output heat from the circuit will be considered as largely radiant.

Small Power: As for lighting small power sources (typically electric appliances) produce heat while they are in use.

Three individual small power sources will be described to cover the incidental electric usage in the house. This will help in simplifying the scheduling of the operation of these sources. The TV/radio source will encompass most incidental sources, electrical appliances used throughout the house. The Cooker source accounts for a major, if less often used, source of incidental heat gains, and the Background source will encompass those gains that are generally continuous; i.e. freezer, or DHW losses.

Occupants: Occupancy heat gains in HTB2 are determined from the product of the number of occupants (adult equivalent) in a space, and the average metabolic rate chosen for the space. For each occupied space for which occupant gains are to be used, the metabolic rates (sensible heat gain per adult in W) appropriate for the activities held in the space must be defined. There may be three activity types defined for each space. Scheduling options will determine the activity and number of occupants at any time in the simulation.

Ventilation: Ventilation and Infiltration (HTB2 makes no distinction between them) are important factors in the energy transport in buildings. There are a number of options for specifying ventilation in HTB2; from specifying air change rates for spaces, through specifying space to space air flows, to specifying individual openings.

The simplest option for specifying ventilation is the air-change rate. In this each space is considered in isolation, e.g. they do not communicate between themselves by air movement. Then ventilation is concerned only with the exchange for room air to outside. With little further information a basic average ventilation rate of the downstairs spaces has been estimated (guessed) as 1.24 Air change per hour. There will be no consideration of night/day differences or of occupant intervention in case of high temperatures.

### 2.4 Operating Schedule

HTB2 has no occupant as such, no one responding to internal condition or external influences. All that happens in building must be scheduled. It is usefule to consider the building as being occupied by robots.

There are to levels of scheduling in HTB2 affecting the operation of the building and the systems inside:-
-Time clocks attached to services
-Diary

### 2.4.1 HTB2 Scheduling (Services)

All services (excluding vent) may be simply controlled by a timeclock; the simulation analogy of a simple tappet driven time clock controller, but applied to heating, lighting, small power sources, and occupancy gains. Each system, source, circuit or space has an independent timeclock. This is programmable through a series of up to 5 on/off periods, to a minute resolution (e.g. on at 11:05, off at 12:15). The timeclock is 7-day programmable i.e. different programmes for Sunday from a Monday is possible. These timeclocks are specified in the associated services data, and control their associated services only.

Heating: For heating systems, the time clock affects the system status i.e. on/off, and also an optional programmable thermostat setback.

Lighting: For lighting circuits, the time clock affects the circuit status i.e. on/off (or enable/disable) and also the circuit output (as a fraction of the declared maximum).

Small Power: For small power sources, the time clock affects the source status (on/off) and the source output (as a fraction of the declared maximum).

Occupants: For occupancy, the time clock affects the number of occupants and activity type for a space.

### 2.4.2 HTB2 Scheduling (Diary)

The HTB2 Diary provides a more flexible form of scheduling than that of the time clock. In general it circumvents the limitation on the number of on/off periods, so that it is possible to specify a schedule of arbitrary complexity. It is also possible to assign a different schedule to each day of the simulation.

The diary also provides access to more aspects of the simulation. The diary can for instance alter ventilation and fabric aspects of the simulation. It can also reprogramme the services time clocks, perhaps to allow seasonal variation to operation.

### 2.4.3 Example Scheduling

The heating for the example case is to be intermittent, two periods per day weekdays, 1 period weekends. Weekday heating is to extend from 06:00 to 09:00 and 16:00 to 23:00. Weekend heating will be continuous from 08:00 through to 23:00. This schedule may be completely specified within the Heating definition, no diary intervention is required.

The general occupancy pattern will be :-
    4 occupants at activity 1 from 23:00 through to 07:00
    2 occupants at activity 2 from 07:00 to 12:00
    1 occupant at activity 2 from 12:00 to 18:00
    4 occupants at activity 2 from 18:00 to 23:00.

Again this is specified entirely within the Occupancy file.

After a number of days, the occupancy profile will alter for weekdays, it will be (changes are in italics):-
    4 occupants at activity 1 from 23:00 through to 0*5*:00
    2 occupants at activity *3* from 0*5*:00 to 12:00
    1 occupant at activity 2 from 12:00 to 18:00
    4 occupants at activity 2 from 18:00 to 23:00.

This modification to the occupancy schedule is made via the Diary. Once data is altered through the Diary, it will remain until reset or altered again.

### 2.5 External Conditions

### 2.5.1 HTB2 view of Conditions

The external conditions are the driving forces for the thermal response of the building. The meteorological conditions determine the external air temperature, ground temperature deep beneath the floor, wind, humidity and the longwave and shortwave (solar) radiation exchanges of the external surfaces.

HTB2 generally accepts hourly records of the outside conditions (it can accept shorter intervals if available)

the values are held to be constant over the interval.

Values read in (or otherwise determined) include:-

outside air temperature C - this is used to determine the convective heat exchange from the external surfaces of the building, and from ventilation,

outside air humidity % (or dewpoint C) - this is used to determine the moisture exchange through ventilation

deep ground temperature C - this is used to determine the heat transfer through solid floors in contact with ground.  If not available then HTB2 can be set to estimate ground temperature.

windspeed and direction m/s and degrees from North - this is used to determine the convective exchange for external surfaces, and optionally to estimate ventilation air exchange.

solar irradiance W/m2 (global horizontal, diffuse horizontal and direct normal) - these are used to determine the shortwave energy exchange at external surfaces and to determine the solar gains through glazing to the interior of the building.  HTB2 may be set to estimate direct normal solar irradiance if the other two parameters are available.

cloud cover (tenths obscured) - this is used to estimate the longwave radiant exchange for external surfaces. It accounts for the fact that surfaces will cool faster on clear nights than cloudy nights.  If unavailable, cloud cover may be estimated from the observed solar irradiance through a preprocessor.

The choice of external conditions used for simulations will depend on a number of parameters, none the least being the availability of the data.  Primarily however, the choice will be on site, season, and intent of the simulation.  For instance a simulation to assess peak summer conditions may utilise only a few weeks of severe summer conditions.  Some tests may require standard design data, others may require filed measured data.

HTB2 currently does not supply meteorological data.  Contact WSA for information on translation programmes for the conversion of different source data to HTB2 form.

### 2.5.2 Example  Conditions

The example meteorological data for this test comprises one month of Winter data.

### 2.6 Output data

### 2.6.1 HTB2 Output Data

Data is produced by HTB2 in different forms and in differing quantity and depth.  The output procedures are very flexible and without initial planning HTB2 may produce enormous amount of data, filling disks with information of little concern to the intended use.  HTB2 output is discussed further in chapter 9.

The key results produced by a simulation fall into three groups:-

Interval Report: Periodic recording of averages and totals of key simulation data, e.g. space air temperatures, ventilation heat exchange.  Typically this is produced hourly for most uses.  By default it provides data grouped by Space at hourly intervals, producing sufficient information to generate a simple space heat balance (energy in and energy out broken down by process) as well as environmental parameters such as temperature and humidity.  Optionally further data is available; surface temperatures and heat flows, or greater detail in the operation of energy systems.

Element Profile: Periodic recording of the temperatures and energy flows in selected Elements.  As well as recording surface conditions, this section will also produce snapshots of conditions internal to the construction of the Element.

Parameter Logging: Detailed recording of significant changes to simulation parameters (e.g. surface temperature of a specific wall), to a very fine timescale, without recording redundant information.

### 2.6.2 Example Output Data requirements

For the example being used, it is sufficient to require only the standard Interval Report.

# CHAPTER 3

# DESCRIPTION OF SIMPLE DATA-SET: BUILDING

### 3.1 FILE FORMAT AND SYNTAX CONVENTIONS

HTB2 input data are stored simple text files. They may be created altered by simple text editors (DOS Edit or Windows Notepad for instance). In HTB2 for Windows, there are also interface software which may manipulate these files.

In general each file contains a series of commands to HTB2. These commands define data (which may be numeric or alphabetic) for use by the program in determining the characteristics of the building being simulated.

Such a command takes the form [Attention][Command] [Data] where;
> [Attention] is the HTB2 attention character !,
> [Command] is a command keyword, always UPPER CASE
> [Data] is the data value supplied by the user.

For instance, !VOLUME = 124.0 defines the volume of a Space.

Common errors in producing HTB2 data files are misspelling the command, forgetting the command character, or not using upper case for the command keywords. HTB2 will attempt to report command lines it cannot interpret, but caution is always required, as some errors will be undetectable.

For instance the following are incorrect;
> !volume = 124.0        - not uppercase
> VOLUME=124.0        - no attention character
> !VOLUME 124.0        - missing "="

and can be detected by HTB2. However, the following may be incorrect
> !VOLUME = 1240        - missing decimal point
> !VOLUME =        - missing value

but may be passed by HTB2. The first will obviously provide the incorrect volume, the second, due to the action of FORTRAN, will produce a volume of zero. In general HTB2 will not place a value judgement on data provided unless it is obviously erroneous. For instance the first of the above could not be detected, as it represents a valid space, it is just not the value the user expected. The second in this example would be detected, a zero or negative volume is not allowed; however for many parameters zero is an allowable value and this type of error may not be detected.

Some HTB2 objects are require a number of data parameters, these are generally described by blocks of commands. These blocks begin with a opening specific to the object, and are closed by the command !END. An example follows for an element;
> !ELEMENT = 'South Pitched Roof'
> > !AREA = 12.5
> > !ORIENTATION = 0.0
> > !TILT = 60.0
> !END.

All the data within the block (the indentation is not required but improves user readability) relates to one element. The block must be closed by the !END command; it would produce an error if data for a new element was started in the middle of an unclosed block.

Other HTB2 objects may contain data of indeterminate length, for example the number of layers in a construction. Lists are used for these data structures; again started by a keyword associated with the object, the list data may be extended until ended by the **}** character (close curly bracket). An example such lists follow, taken from a construction file

```
!CONSTRUCTION
      !PARTS
      *      layer  material    thickness
             _1 =   1           0.100 0
             _2 =   -1          0.020 0
             _3 =   28          0.050 0
             _4 =   2           0.100 0
             _5 =   35          0.035 0
      }
!END
```

In this example the !PARTS list is ended by the } signal.  Other data lines should not be inserted within the list structure.

Note also in the preceding example, that comments may be freely distributed through the data files for self documentation.  Comments start with the character **\***.  They may be isolated lines of comment or words added to the end of data lines.  Comments should not be added in the data stream of the command however.  Thus the following would be in error;

      !VOLUME = * this is the volume 124.0

Other pre- and post-processor software may utilise HTB2 data files.  Data required for those programmes (for instance the SCHEME editor) use different Attention characters - **%** and **$**.  HTB2 ignores information following that signal, treating it like a comment.  However the support software may require that data (SCHEME uses it for screen positions of objects etc.) so they should be left unchanged if the HTB2 files are edited by manually.

HTB2 uses SI units for data.

## 3.2 BUILDING DATA SET STRUCTURE

Information on the building itself, how it is divided up into spaces and the thermal properties of its walls, floor(s) and roof, are contained in four files, one at the second level - the BUILDING file - and three at the third level - the LAYOUT, CONSTRUCTION and MATERIALS files.
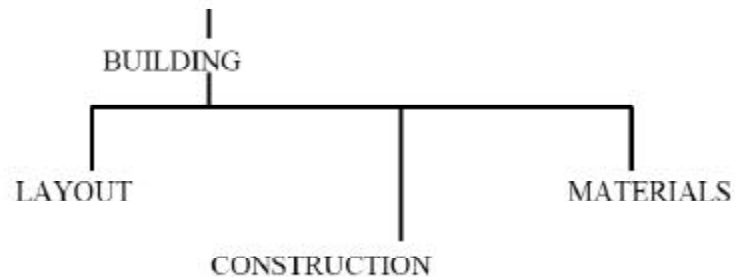


figure 3.1 Building File tree

## 3.3 BUILDING FILE

### 3.3.1 Overview

This file defines the location of the building, the modelled spaces it contains and points to definition files for the layout of the spaces, the constructions of the walls and windows dividing these spaces and the materials used.

### 3.3.2 Scope and Defaults

Parameters which are described in this file are;
- a building identification string . There is no default.
- site location. The default is London, England.
- site time zone offset. The default is Greenwich.
- site skyline. The default is an clear horizon.
- the number and volumes of the modelled spaces in the building.
- the names of files defining the materials, the constructions, and the partitions used to describe the building.

### 3.3.3 The Bungalow File

The bungalow was determined to be best modelled ( for these purposes) as two spaces: the main living space and the loft space.
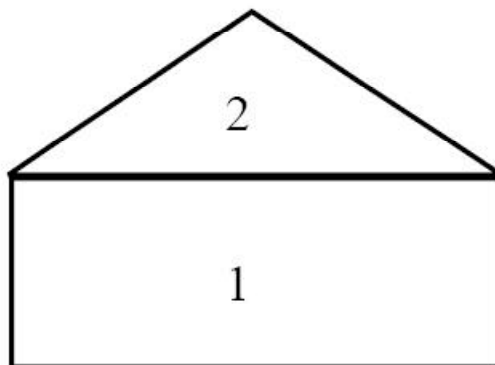


figure 3.2 Bungalow example

```
a       !PROJECTID BRE type bungalow
b       !LOCATION = 51.5 0.3
c       !DEFINE SPACE = '1 -living area'
d        !VOLUME = 148.0
e         $POSITION X = 288 Y = 234
f         $ICON = 305
g       !END
h       !DEFINE SPACE = '2 -loft'
i        !VOLUME = 70.0
j         $POSITION X = 444 Y = 231
k         $ICON = 305
l       !END
m       !MATERIALS FILE = 'STDMAT.LBY'
n       !CONSTRUCTION FILE = 'BREBUNGL.CON'
O       !LAYOUT FILE = 'BREBUNGL.LAY'
```

notes

*a*     Identification code for the building, as for that of the run identification declared in the Top-level, and the services identification declared in the Services file, it will be prepended to all output files.

*b*     Defines the geographical location of the building as 51.5 degrees latitude (N), 0.3 degrees longitude(W). These are interpreted as being north of the equator and west of Greenwich respectively. For eastern longitudes or southern hemisphere, negative numbers should be used. If the true longitude is not within one time zone of Greenwich, the longitude of the nearest time zone east of the location should be declared using the TIME ZONE command.

*c-g*   Define a space (or room) in the building. Note that any "virtual" spaces which may be used are automatically defined and are not included here. As this is the first space declaration, it defines Space 1.

*c*     starts the space definition. It must be paired with an !END command. There may be many such space definition blocks, as many as required to define the problem. Each space may have a character name associated with it (the string contained in the single quotes before the "="), this may be used in preprocessors for HTB2. It will be useful to define meaningful names for the spaces (there is a constraint of ?? characters maximum for each name).

*d*     defines the volume (air content) of the space in $m^3$. This is the minimum data required to define a Space. It specifies the volume of each space in turn, one line to each space. The "_" character at the start of the line is mandatory. Spaces are identified by index numbers which are assigned sequentially (from 1) as they are defined in this file. The space volume is defined in $m^3$.

*e-f*   are optional data created and recorded by the HTB2 preprocessor SCHEME. HTB2 does not require these commands, but if present should not be altered directly by the user.

*h-l*   Define a second Space for the simulation.

*m-o*   Nominate the third level files containing data on the layout of the building, the constructions and the materials used.

## 3.4 CONSTRUCTION FILE

### 3.4.1 Overview

The construction file sets out the name, sequence and thickness of the materials which make up each of the types of elements and windows used in the building.  The same construction can be used in any number of elements. This file thus sets up a database of construction techniques, which are picked out as appropriate for physical structures within the layout file.

There are pre-defined "materials" for cavities:

"Material" -1  is a high emission cavity, using CIBSE values,

"Material" -2  is a low emission  e.g. foil lined cavity, using CIBSE values,

"Material" -3  is a simple resistance layer, the resistance of which is coded in the width specified.

Window constructions require additional transmission and absorption data compared with opaque constructions.

Materials used in constructions may be selected from a standard materials library (as nominated in the BUILDING file) or from a user supplied library.

A typical construction might be as illustrated in figure 4.3.  The placement of the calculation nodes are determined within the model itself.   Although the node density is under control of the user, it  is generally best to accept the default values.

### 3.4.2 Scope and Defaults

Parameters which are described in this file are;

- the dimensions and material layers of a construction type which may be use in the partitioning elements of the Layout file. There are no defaults construction, apart from a "virtual" boundary (coded as construction -1) which acts as a pure air-air resistance.
- the optional definition of the calculation node density of that construction type.  The default (signified by 0) is the maximum number of nodes which will guarantee calculation stability.  This option overrides internal checks for numerical stability, and so should be used with caution.
- the solar transmission and absorption characteristics of glazing types which may be used in the Layout file.  There are no default glazing types.
- a pointer to an optional user's library of material thermo-physical properties.
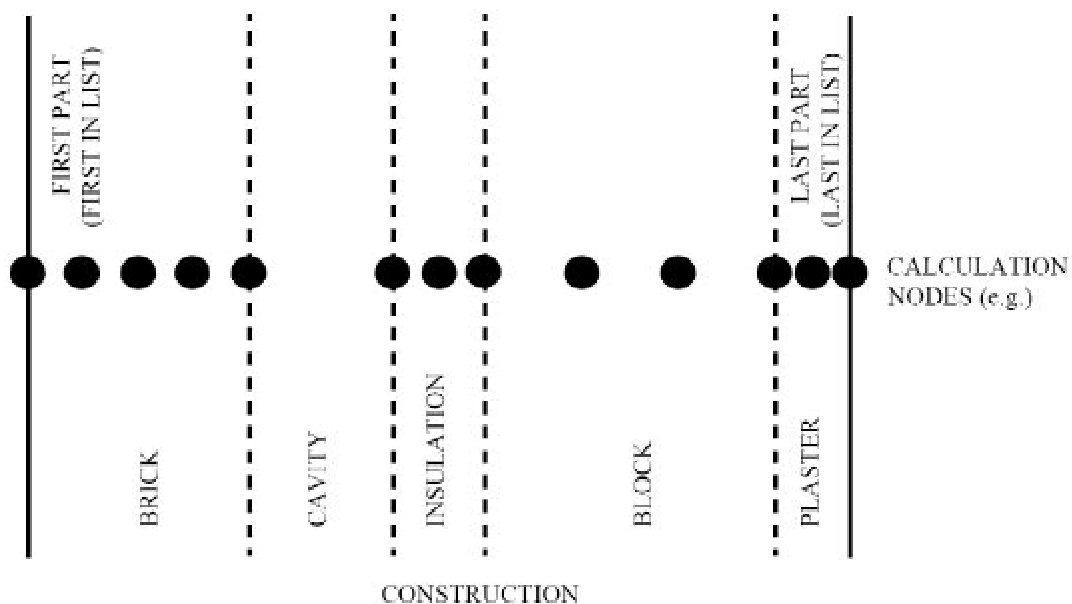


figure 3.3  Construction Section

3-5

### 3.4.3 The Bungalow File

Six construction types and 1 window type were required to describe the simple partitioning of the bungalow. As in the case of the spaces and the element descriptions, code numbers are automatically assigned sequentially to the construction definitions as they are entered in this file.

```
a      * construction definition file for bre bungalow
b      *   uses user defined materials list
c      !MATERIALS USER FILE = 'BREMATS.LBY'
d      *   and standard library
e
f
g      !CONSTRUCTION '1 external cavity wall'
h      !TYPE OPAQUE
i      !PARTS
j      * part    material    width      slices
k      *        :           :          :            :
l      _ 1   =  @1          0.105      0            * brick outer
m      _ 2   =  -1          0.065      0            * normal cavity
n      _ 3   =  @2          0.105      0            * brick inner
o      _ 4   =  @3          0.016      0            * plaster
p      }
q      !END
r
s      !CONSTRUCTION '2 single glazing'
t      !TYPE TRANSPARENT
u      !PARTS
v      * part    material    width      slices      absorp
w      *        :           :          :            :
x      _ 1   =   65         0.006      0            1.00    * window glass
y      }
z      !END
aa
ab     !CONSTRUCTION '3 solid ground floor '
ac     !TYPE OPAQUE
ad     !PARTS
ae     * part    material    width      slices
af     *        :           :          :            :
ag     _ 1   =  @10         0.015      0            * carpet
ah     _ 2   =  @11         0.100      0            * concrete
ai     _ 3   =  @12         1.600      0            * earth
aj     }
ak     !END
```

//// File Section Omitted ///

```
al     * window type definitions
am
an     !WINDOW  = '6MMFLOAT'
ao     !TRANSMISSION =
ap      0.64 , 0.80 , 0.80 , 0.80, 0.80, 0.78, 0.75, 0.71, 0.60, 0.36, 0.0
aq     !ABSORPTION =
ar      0.134 , 0.12, 0.12, 0.12, 0.12, 0.14, 0.14, 0.14, 0.14, 0.15, 0.15
as     !END
```

note

c       nominates a user defined materials definition file to supplement the standard library. The user's materials will be used when the code prefix "@" is used.

g-q      defines the first construction. Construction code numbers are allocated sequentially as the constructions are defined, starting from 1, these index numbers will be required if the Layout file is created by hand. The construction name defined here as '1 external cavity wall' is used within the HTB2 preprocessors SCHEME and CONSTRUCT, it will be helpful to provide meaningful names for constructions.

h       sets the construction to be an opaque type (this is also the default so that this command is not strictly necessary). A "TRANSPARENT" construction is thermally identical but needs extra information to define

the transmission characteristics.

*i*  starts a list of parts (or layers of materials) for the construction. Parts are to be defined in the order of their occurrence in the construction from the "FIRST" surface to the "LAST" surface. Each part would normally be a homogeneous material layer of the actual construction. By convention, the external surface of a wall (or roof) is always the "FIRST" surface. The exception is the external surface of a ground floor slab (i.e. that in contact with the ground) which is always the "LAST" surface.

*j-m* defines the properties of each part, or layer, in turn, one line of data for each layer. Each line must start with the "_" character. The index number following the "_" is for the users convenience only. The data in the line defines the layer material, width, and (optionally) number of calculation nodes:

   - The material code refers to materials drawn either from the standard library materials file or from the user's own file. Materials from the user's library are signified by a '@' preceding the code.

   - The width represents the complete width of the part in metres. If the special material "-3" is used, this width defines the layers thermal resistance; the resistance is coded as width (m)= resist(W/m$^2$C)/1000.

   - The number of calculation nodes (or "slices") represents the number of discrete, equal distance steps used in the finite difference fabric calculations for that part of that construction. If the value specified is 0 then the number of slices will be chosen internally (to a previously specified maximum) to provide calculation stability. This is the case here. (Note: If stability cannot be achieved within the required timestep an error message will be produced and the run aborted.)

*p*  The "}" character closes the list of parts for that construction.

*q*  closes the definition of properties for a that construction.

*s-z* define a transparent type construction, for use as a window. This is of the same format for the opaque type, however an extra item of information is required in the layer data...

*x*  ...that is the amount of the total solar energy absorbed within the construction that is to be directed to each layer. This is specified as a proportion (0-1) of the total. In this case all absorbed energy goes to the first (and only) layer. Should this construction have been double glazing, for instance, then the specification may have been 0.6 to the first layer, 0.0 to the second (cavity) layer, and 0.4 to the third layer.

*al-as* These commands define a window transmission characteristic. These characteristics are independent of the thermal properties of constructions defined above. The two properties are joined together as a physical window in the Layout file.

*an*  defines a name for the characteristic. This name will be used to access the characteristic within the Layout file. Up to 10 characters may be used in the name.

*ao-ap* these 11 values set the transmission coefficients for the characteristic. The first defines the net diffuse transmission coefficient. The next 10 define the direct beam transmission coefficients for incidence angles from 0 to 90 degree (i.e. in 10 degree steps).

*aq-ar* these 11 values set the reflectance coefficients for the characteristic, the format is as that for the transmission coefficient.

*as*  closes the list of properties for a window characteristic.

## 3.5 MATERIALS FILE

### 3.5.1 Overview

Materials definition files provide the definition of the thermal properties of the materials chosen for the constructions. The properties defined are the thermal conductivity (W/m/°C), the density (kg/m³), and the heat capacity (J/kg/°C).

There are two materials lists available to each run of the model:

(a) a standard library file, such as STDMAT.LBY which contains a list of common materials in a direct access file, and

(b) a users library file which is created and altered by a standard editor to include the properties of any material required that is not in the standard library. It is a simple text sequential file.

The materials present in the standard library included in HTB2 (the file "stdmat.lby") are given in appendix A. They are numbered sequentially and are referred to in the construction file simply by this number. Within the HTB2 preprocessor CONSTRUCT, materials may be addressed by name.

Materials required for a specific use are entered in the users materials file in a simple text format. The materials do not need to be numbered sequentially in this file. Each material has 2 records. The data is read in free format and there can be no comments between records.

The format is:

Code (integer)      * material name (char)

Conductivity (W/m/C)   Density (Kg/m³)   Specific heat (J/Kg/C)

Only the thermo-physical properties are of the materials are required. Other parameters, such as colour or vapour resistivity are either assign to the element using the materials, in the Layout file, or are not used within the model.

### 3.5.2 Scope and Defaults

Parameters which are described in this file are;

- the thermal conductivity, density, and thermal capacity for materials which may be used in the Construction file. There is a default library containing a range of common materials. This user's library allows non-standard properties to be used easily.

### 3.5.3 The Bungalow File

This has been given the name BREMATS.LBY. It contains 9 materials with the properties specified in the BRE bungalow data set.

```
a       1                       * outer brick
b       0.840    1700.0    800.0
c       2                       * inner brick
d       0.62     1700.0    800.0
e       3                       * plaster
f       0.26      800.0    1000.0
g       4                       * plasterboard
h       0.16      950.0     840.0
i       5                       * quilt
j       0.040     12.0      840.0
k       8                       * roofing tile
l       0.84     1900.0     800.0
m       10                      * carpet
n       0.055     160.0    1000.0
o       11                      * concrete
p       1.40     2100.0      840.0
q       12                      * earth
r       1.40     1900.0     1700.0
notes
```

*a*      define user material 1 ( denoted @1), called outer brick

*b*      with conductivity = 0.840 W/m²/C, density = 1700.0 kg/m3,  capacity = 800.0 J/kg/ C.

## 3.6 LAYOUT FILE

### 3.6.1 Overview

The layout of the building is defined in terms of the elements (walls, sub-sections of walls, ceilings etc.) which partition the building into spaces and zones.

The layout file defines the surface connections and properties of those elements and assigns pointers to thermo-physical properties defined in the construction and materials files. The layout file also defines shading masks for elements, should those be required ( the default shading is unshaded).

An element may connect at most two spaces. Only one space may be connected to each side. Each element surface is treated as being a uniform area, that is heat transport is treated one-dimensionally. Thus an element is composed of a single construction type, its surface is at an uniform temperature, and heat transport (convective or radiative) occurs uniformly across the area. These considerations will influence the choice of partitioning areas for the "break-down" of the building into a model data-set.

Elements are automatically given identification code numbers sequentially (from 1) as they are defined in this file. The space and construction code numbers used here are those assigned in the definition files for those items.
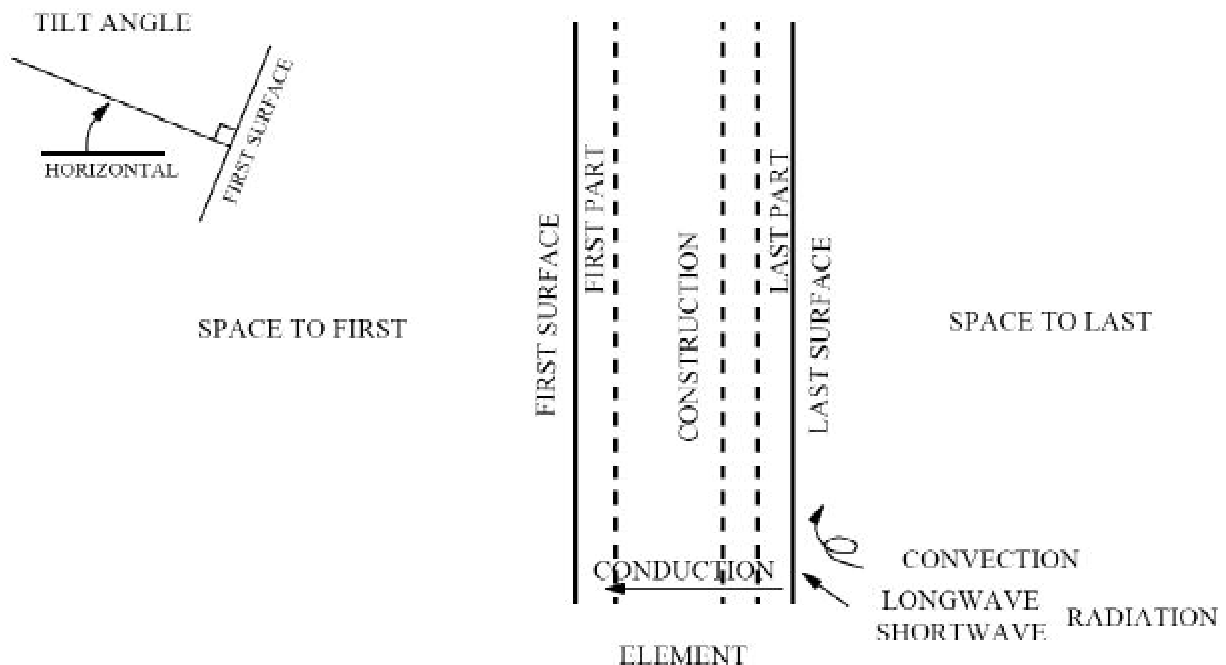


### 3.6.2 Scope and Defaults

Parameters which are described in this file are;
- the existence of a physical and virtual partition, across which heat flow will take place.
- the construction type surface connectivities of that element. There is no default.
- the surface connectivities of that elements. There is no default.
- the geometrical area of that element. Again there is no default.
- the orientation and tilt angles of the element. There are no defaults for exterior connecting elements. Elements which are totally interior have a default tilt appropriate for a simple wall.
- the surface absorptivity (colour), emissivity, and reflectance of nearby surfaces. The defaults are for typical, medium coloured, building materials.
- the shading applied to the (external) surface.
- for elements which are windows, the glazing type, sun-patching, frame blockage, and cavity losses. There are no default glazing types or sun-patching. Frame blockage and cavity losses (or back-reflection) default to nil.

### 3.6.3 The Bungalow File

The bungalow, for simplicity, was chosen to be modelled with large areas of common constructions on each facade. I.e. the North facade will be made of 2 elements corresponding to the total masonry area, and the total

```
a      !ELEMENT = '1 south wall'
b       !CONSTRUCTION = 1
c       !AREA = 16.3
d       !ORIENTATION = 0.0
e       !TILT = 0.0
f       !GROUND REFL = 0.2
g       !SPACE TO FIRST = 0
h       !SPACE TO LAST = 1
i       !ABSORPTION FIRST = 0.8
j       !ABSORPTION LAST = 0.5
k       !CLASS = 1
l          $POSITION X = 105  Y = 61
m          $ICON = 306
n          $EXTERNALPOS X = 31  Y = 214
o      !END
p
q      !ELEMENT = '2 south windows'
r       !CONSTRUCTION = 2
s       !AREA = 6.6
t       !ORIENTATION = 0.0
u       !TILT = 0.0
v       !GROUND REFL = 0.2
w       !SPACE TO FIRST = 0
x       !SPACE TO LAST = 1
y       !ABSORPTION FIRST = 0.8
z       !ABSORPTION LAST = 0.5
aa      !WINDOW TYPE = '6MMFLOAT'
ab      !PATCH TO #8 FIRST = 1.00
ac      !CLASS = 2
ad         $POSITION X = 98  Y = 202
ae         $ICON = 307
af         $EXTERNALPOS X = 31  Y = 214
ag     !END
                  //// File Section Omitted ///

ah     !ELEMENT = '8 ground floor'
ai      !CONSTRUCTION = 3
aj      !AREA = 66.0
ak      !TILT = 90.0
al      !GROUND REFL = 0.2
am      !SPACE TO FIRST = 1
an      !SPACE TO LAST = 0
ao      !ABSORPTION FIRST = 0.8
ap      !ABSORPTION LAST = 0.5
aq      !CLASS = 3
ar         $POSITION X = 277  Y = 320
as         $ICON = 306
at         $EXTERNALPOS X = 288  Y = 380
au     !END

                  //// File Section Omitted ///
av       !ELEMENT = '14 internal partiti'
aw        !CONSTRUCTION = 6
ax        !AREA = 23.0
ay        !TILT = 0.0
az        !GROUND REFL = 0.2
ba        !SPACE TO FIRST = 1
bb        !SPACE TO LAST = 1
bc        !ABSORPTION FIRST = 0.8
bd        !ABSORPTION LAST = 0.8
be        !CLASS = 4
bf           $POSITION X = 410  Y = 346
bg           $ICON = 306
bg        !END
```

glazing area.

notes

*a-o*     define an element, in this case all south facing opaque walls are lumped together. Elements are code numbered sequentially from the order they are defined in this file.

*a*     opens the element definition. The element name defined here is not used within HTB2, but is used by the pre-processor SCHEME and should be provided as it allows a degree of self documentation.

*d*     defines the construction type for this element. This defines this relevant thermal properties of the element. The index code used refers to those required construction's position within the construction definition file.

*c*     defines the (single-sided) surface area in $m^2$.

*d*     defines the azimuthal angle of the "FIRST" surface normal of the element, specified in degrees clockwise from south. This is required information only for externally connecting elements. This element faces south.

*e*     defines the tilt angle (in degrees clockwise) between the horizontal and the normal to the FIRST surface. This is required for all elements. This element is a vertical wall.

*f*     defines the total reflectance or albedo of all adjacent surfaces and/or the ground, to this element's external surface. This value is typical, and is in fact the default value. A such, this line could be removed without affecting the element definition. As with most default values in HTB2, global redefinition of the default is allowed in the Top-Level file; any values entered in th Layout file will override the default value.

*g-h*     define the spatial connections of the element surfaces. The "FIRST" surface is that of the first layer of the appropriate construction. By convention an ordinary external surface is a "FIRST" surface, that is the "FIRST" surface of the element is connected to space 0 (which acts as the exterior). For totally internal elements the surface connections are arbitrary, but must reflect any asymmetry in the construction type.

*i-j*     define the absorption coefficients to shortwave (i.e. solar) irradiance on the "FIRST" and "LAST" surfaces respectively. This definition effects opaque elements only. The default values are equivalent to typical, medium-coloured wall surfaces. These values set values to slightly darker, and lighter, for the external and internal surfaces respectively.

*k*     declares this element to belong to Class 1. This is a command affecting output data rather than calculation parameters. Classes are optional; all elements in a class will be aggregated in the output procedure to provide data on total heat flows through a fabric type thus defined. In this example all opaque external walls will be in class 1, all windows in class 2. If class are defined, not all elements need to be assigned to a class.

*l-n*     are optional data created and recorded by the HTB2 preprocessor SCHEME. HTB2 does not require these commands, but if present should not be altered by the user.

*o*     ends the definition list for the element. Any definition command not explicitly used will either produce a default value or an error condition. Thus for this particular element the surface emissivity will default to 0.9.

*q-ag*     define an element corresponding to all south facing windows. The data to be provided is similar to that for an opaque wall, but three further pieces of information are required for a window.

*aa*     selects the glass transmission characteristic for the window. The characteristic used is that defined in the construction file.

*ab*     indicates to which surfaces inside the building, the solar energy entering through this window will fall. Currently this is a fixed (i.e. not time- or seasonally- dependant, and so should reflect an average or typical sun-patch. In most cases directing the solar energy to the nearby floor surface will be sufficient, as in this case.

*ah-au* define the ground floor slab for the space.

*am-an* A ground floor "external" surface is extraordinary, in that it must be connected to a deep ground temperature, and not to external air. This is signified by assigning space 0 to the "LAST" surface, rather than the "FIRST".

*ak* This tilt angle describes a horizontal element.

*al, ap* A ground floor has it's "LAST" surface in contact with the ground. It therefore has no radiant exchange and so there is no need to specify an absorption coefficient or ground reflectance for that surface. These values will therefore be ignored.

*av-bg* define an internal partition. In this case as there is only one "downstairs" space, all partitions have been aggregated to one surface area.

*ba-bb* note that space 1 is connected to both surfaces of the element. Thus there will be no net heat flow <u>through</u> the element, but it will still absorb and release heat as an internal thermal mass.

# CHAPTER 4

## DESCRIPTION OF SIMPLE DATA SET: SERVICES

### 4.1 OVERVIEW

Information on the plant and operation of the building is contained in up to six files, one at the second level - the SERVICES file - and five at the third level - the HEATING, LIGHTING, SMALLPOWER, OCCUPANCY and VENTILATION files.
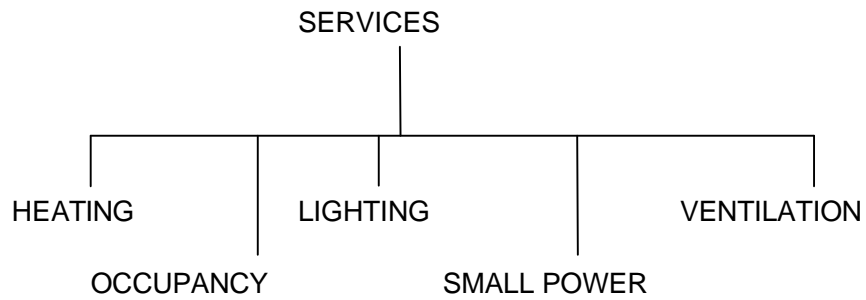


figure 5.1 Services File Tree

## 4.2 SERVICES FILE

### 4.2.1 Overview

The SERVICES file acts to nominate the definition files for the services required.  Note that defining the services at this stage will not necessarily include them in the simulation unless the appropriate routines are also enabled in the top-level.  On the other hand enabling a service routine without declaring an input file will result in an error condition.

The possible routines which this section deals with are:
- Heating system(s)
- Lighting system(s)
- Small power system(s)
- Ventilation
- Occupancy

These may be used in any combination, but the appropriate option must have been enabled in the run's Top-level file.

### 4.2.2 Range and Defaults

Parameters which are described in this file are;
- a services identification string .  There is no default.
- the names of files defining the properties of the services chosen for the run.

### 4.2.3 The Bungalow File

All services are to be used for this example.  Therefore there are 5 definition files to nominate.

```
a      * services file for bre bungalow
b      !SERVICEID full systems
c
d      !HEATING FILE = 'BREBUNGL.HTR'
e      !LIGHTING FILE = 'BREBUNGL.LGT'
f      !SMALL POWER FILE = 'BREBUNGL.SPW'
g      !OCCUPANCY FILE = 'BREBUNGL.OCC'
h      !VENTILATION FILE = 'BREBUNGL.VNT'
```

notes

*a*      Comment line, ignored by HTB2, for self documentation, comment lines (text preceded by * may appear freely in most HTB2 data files.

*b*      Identification code for the systems, output to all files.

*d-h*    Nominate files defining the service systems parameters.  As directory information has not been supplied, these files will be expected within the directory from which HTB2 was started, or within the directory containing the Top-level file supplied to HTB2.

## 4.3 HEATING FILE

### 4.3.1 Overview

HTB2 treats the heating of a building in terms of a set of heating systems. A heating system is treated as a "black-box" with predetermined responses to the building environment. Each system is essentially a pairing of emitter and controller characteristics, as in figure 4.2.

Any number of heating systems are allowed (up to the maximum set in the program code prior to compilation and linking). These systems may all operate independently or be orchestrated by a central control. Each system may be concerned with only one space or with several, or there may be several systems seeking to control a single space.

The parameters used to define a system may describe the characteristics of (for instance);
-an "ideal", fast response room-based system which will maintain a space air temperature regardless of heating load.
-a typical wet central heating system, with associated time delays and warm-up times, and with local TRV type control, and a central timeclock and thermostat.
-an electric off-peak storage heating system.

As an option to the "ideal" heating system, "flat-top" cooling may also be used to estimate a cooling load. That is, as well as injecting heat, the system will remove heat to maintain a room's air-temperature at the desired set-point.

### 4.3.2 Scope and Defaults

Each heating system is described in terms of:

1. The heating system itself, in terms of its maximum heat output (and water vapour output if required), the proportion given out as convective, radiative and direct (e.g. underfloor) heat, and its warm-up and cool-down time constants. There is no default output, but the other parameters default to a simple convective output, immediate response "ideal" emitter. Note that the radiant output of an emitter may be considered as either diffuse, wherein radiant output is spread over all surfaces of a zone, or
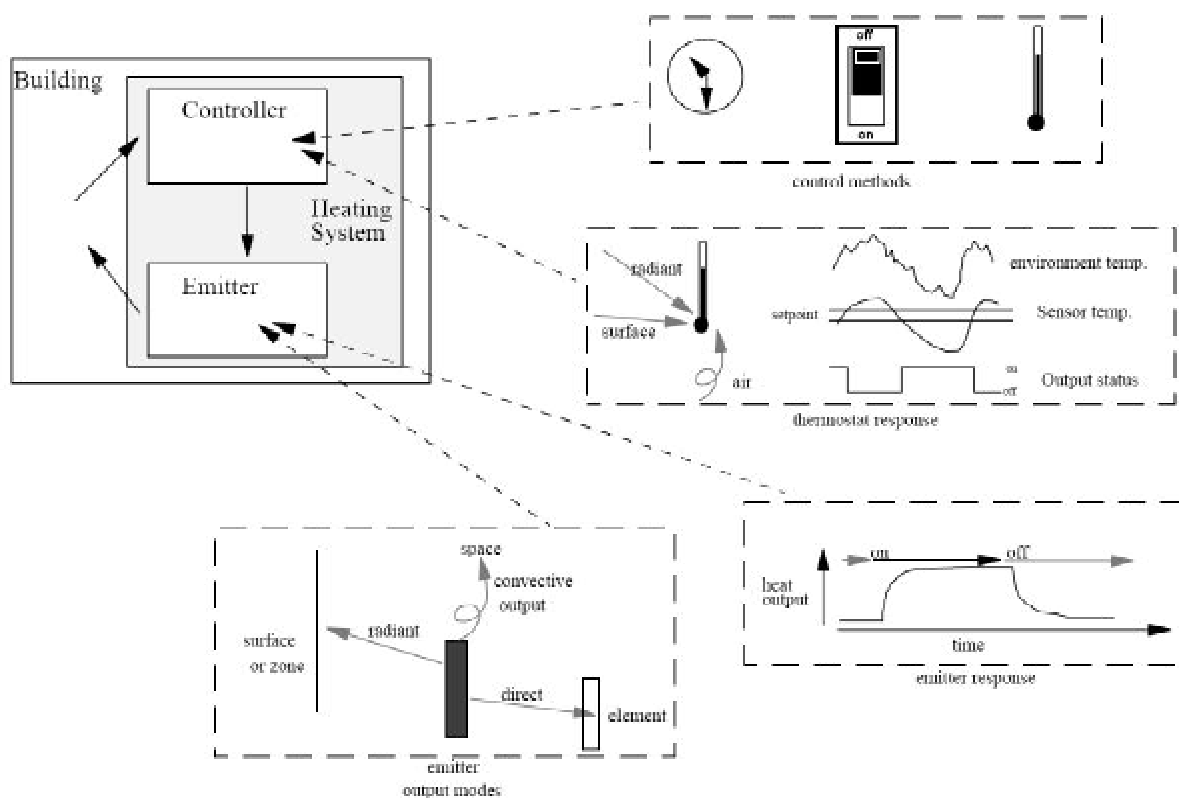


figure 5.2 Heating System

direct, where the radiant output is directed to specified surfaces.

2. The spaces (zones or surfaces) heated, in terms of the number and identity codes of spaces, zones or elements to receive heat, the proportions of the total system output received by each. There are no default connections pre-defined for a system.

3. The control system characteristics, in terms of automatic on/off times of the system (up to five periods, note that the systems may also be controlled directly through the "diary" for greater flexibility), the type of thermostat and its characteristics (i.e. a thermostat may have a time-lag, a time constant. It may sense any specified combination of air/radiant/surface temperatures and also have a coupled accelerator, and it may control the heat emitter by simple on/off signals or by unlimited, or limited bandwidth, proportional control). This version of HTB2 also has a 7-day timeclock function, that is each on-off period may be programmed for days of the week independently. The default control characteristic is for an ideal proportional air temperature control, however there are no defaults for set-points, time periods or spatial connections.

### 4.3.3 The Bungalow File

A simple convective system with 'ideal' proportional control (i.e. the set temperature will be maintained within the limits of the system rating) with air sensing, and immediate response has been selected. It will serve space 1 only

```
a     !HEATSYS 'Living Space'
b     * heating system for bre bungalow  , main space (1) only
c     *    7 kW simple convective heater
d     *    2 time clock periods
e     *    19oC  set point
f      !POWER OUTPUT = 7.0
g      !SPLIT =   1.0    ,  0.0    ,   0.0
h      !CONVECTIVE CONNECTIONS
i       _#1 = 1.0
j        }
k      !CLOCK START TIME #1 = 06:00:00  | mtwtf--   * weekday schedule
l      !CLOCK STOP TIME #1  = 09:00:00  | mtwtf--
m      !CLOCK START TIME #1 = 08:00:00  | -----ss   * weekend schedule
n      !CLOCK STOP TIME #1  = 23:00:00  | -----ss
o      !CLOCK START TIME #2 = 16:00:00            * both
p      !CLOCK STOP TIME #2  = 23:00:00
q      !STAT TYPE IDEAL
r      !SETPOINT = 19.0
s      !STAT AIR CONNECTIONS
t       _#1=1.0
u        }
v     !END
```

and be run automatically to two "on" periods per day.

notes

*a*      Opens a system definition. System identification codes are numbered sequentially as they are defined in this file. The system name is currently only for the users identification.

*f*      Maximum heat output available for this system, in kW. If maximum is unknown or unimportant (for sizing exercises for instance) a value of -1 may be entered; then there will be an unlimited supply of heat from this emitter. It is sensible only to use this option for the "IDEAL" control option.

*g*      Specifies a purely convective output for this emitter, no radiative, and no direct heat output modes. This is the default condition, so this line could have been omitted.

*h-j*    define the output connections for the system as one convective connection, connecting to space 1, with 100% of the convective output going to that space. Output from a system may be sent, in any proportion, to any number of spaces (thus one system could serve several spaces, controlled by one thermostat in one zone, e.g. a simple central heating system); this list is closed by the "}" character.

*k-p*    define the settings of the Timeclock controller. Two "on" periods are defined.

*k-l*   the first such period, for Monday through Friday inclusive, is from 06:00 to 09:00 inclusive (i.e. the heating will be "off" at 09:00:01).

*m-n*   the first period, for Saturday and Sunday, is from 08:00 to 23:00 inclusive.

*o-p*   the second period, for any day, is from 16:00 to 23:00 inclusive. Note that the first and second periods overlap for weekends, with no conflict.

*q-u*   define the thermostat/control characteristics. Heating controllers may be quite complex, this example is the simplest definition of a controller.

*q*   declares the 'stat type to be ideal proportional, that is the set point will be maintained (if the load is within the specified heating capacity) during the heating periods. By default it will be totally air-sensing (the only sensible option for the "IDEAL" controller).

*r*   sets that 'stat set-point to 19 °C. As an "IDEAL" controller, the system will endeavour to maintain this air temperature regardless (affected only by the maximum heat output declared). More realistic options (such as "ON/OFF") may hunt around a desired temperature.

*s-u*   defines the sensing connections of the controller. The format is similar to that of the emitter output connections. The 'stat is wholly connected to air temperature of space #1.

*v*   Ends the heating system description.

The entire block from position flag a-v would be repeated for each required system.

## 4.4 LIGHTING FILE

### 4.4.1 Overview

HTB2 treats lighting systems only as sources of heat. There is at the current release no illumination evaluation model. HTB2 treats the control and output of the lighting of a building in terms of sets of lighting circuits.

Any number of lighting circuits are allowed (within the constraints of the compiled array sizes), each operating independently with a separate specification of heat output, output connections, and operating schedules. A code number for each circuit is assigned sequentially in the order defined in this file. Each lighting system may be concerned with only one space or with several, or there may be several systems seeking to light a single space.

The parameters used to define a lighting circuit may describe the characteristics of (for instance);
-an simple local source, operating on a complex switching pattern dictated in a "diary".
-a fluorescent tube installation, with an associated timeclock control, stretching over several spaces.

As an option, a simple photocell control characteristic may be specified. This will switch the lighting circuit load between two levels (termed "day" and "night") according to the external solar irradiance level.

### 4.4.2 Scope and Defaults

Each circuit is described in terms of:

1. The lighting circuit itself; its maximum heat output, and the proportion of that output given out as convective and radiative heat. There is no default for output level, but the default output mode is purely convective.

2. The spaces treated; i.e. the number and identity of the spaces served by the circuit, and the proportion of the output received by each space. There are nor defaults for connections.
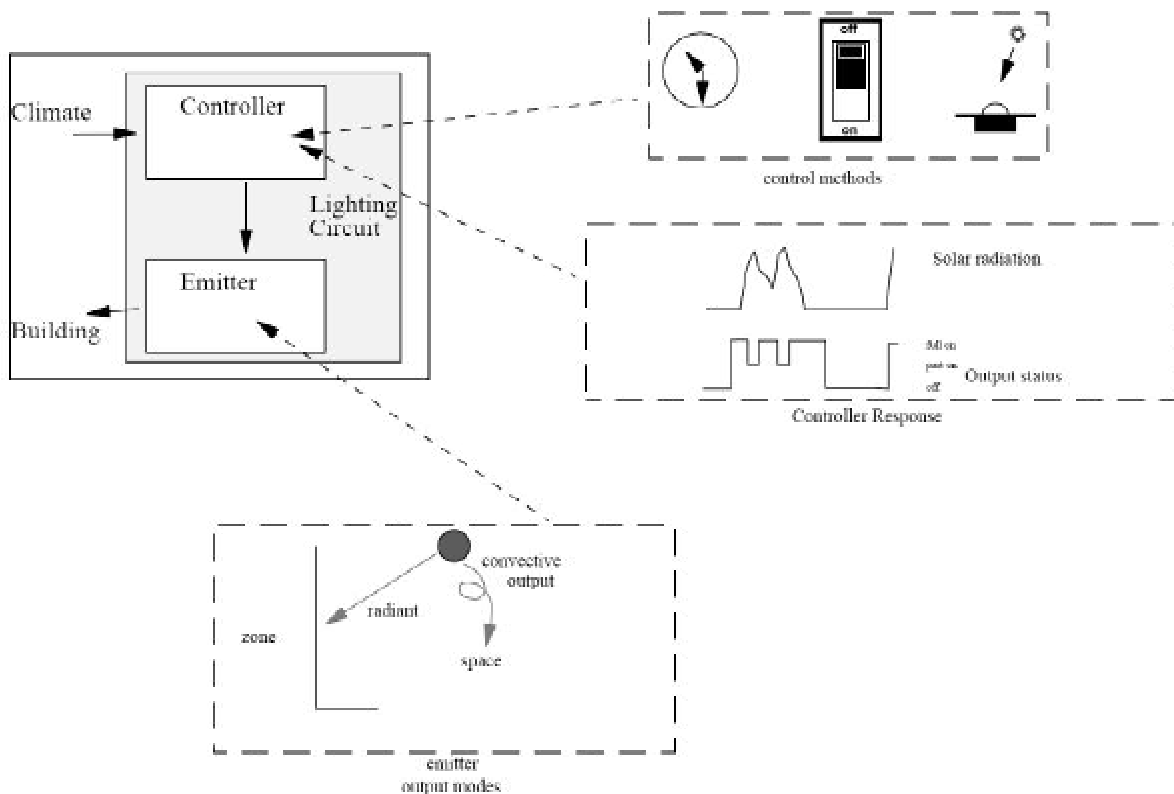


figure 5.3 Lighting System

3. The control system (if present); timeclock on/off times of the circuit (up to three periods).  Note that full 'manual' control of the lighting output available through the diary.  The default condition assumes that the circuit will be controlled through the diary.  The initial state is always "off".

4. As an option, the lighting load may be controlled from the external solar irradiance, using a simple switching model.

```
a      !LIGHTSYS 'living space'
b      *                         simple clock controlled lighting circuit
c       !HEAT OUTPUT = 500.0
d       !SPLIT =   0.20 ,   0.80
e       !CONVECTIVE CONNECTIONS
f        _#1 = 1.0
g         }
h       !RADIANT CONNECTIONS
i       _#1 = 1.0
j         }
k      *                            set up clock,
l      *                              4 switched periods
m      *                      1st on time depends on weekday/end
n       !CLOCK START TIME #1 = 06:00:00 | mtwtf--
o       !CLOCK START TIME #1 = 07:00:00 | -----ss
p       !CLOCK STOP TIME #1 = 08:00:00  | mtwtfss
q       !CLOCK PROPORTION #1 = 1.0
r      *                            rest are for every day
s       !CLOCK START TIME #2 = 08:00:00
t       !CLOCK STOP TIME #2 = 11:00:00
u       !CLOCK PROPORTION #2 = 0.7
v       !CLOCK START TIME #3 = 15:00:00
w       !CLOCK STOP TIME #3 = 18:00:00
x       !CLOCK PROPORTION #3 = 0.7
y       !CLOCK START TIME #4 = 18:00:00
z       !CLOCK STOP TIME #4 = 23:00:00
aa      !CLOCK PROPORTION #4 = 1.0
ab     !END
```

### 4.4.3 The Bungalow File

For this example a single simple circuit of 500 W was sufficient.  Control would be achieved entirely through the diary scheduler.

notes

*a*      Opens  a lighting circuit description

*c*      defines the maximum circuit output, in watts.

*d*      defines the output mode as 20% convective, 80% radiative output split.  This is appropriate for a high temperature light source.  Note that the radiant output is considered to be diffuse, that is it is spread evenly over all surfaces in the appropriate zone.

*e-g*      defines the convective output connections.  In this case, the proportion 1.0 (or 100%) of the convective output (i.e. 20% of the total cf. line *c*) goes to space 1.

*h-j*      similarly defines the output connections of the radiant component.  That is all radiant output is sent to zone 1 (usually zone 1 will be identical to space 1).  The radiant connections would not need definition if there were no radiant output split (cf. line *d*).

*n-aa*      define the automatic clock control for this circuit.   As with heating, a more complex switching pattern could be manages through the Diary.  The definition of the clock control periods are the same as for the heating system (cf. 4.3).  In addition, the amount of lighting used in a clock "on" period must be defined:-

*q*      sets the circuit output to be 100% of the stated maximum, during clock period 1.

*ab*     Ends the circuit description.

Further lighting circuits would repeat the block a-ab.

## 4.5 OCCUPANCY FILE

### 4.5.1 Overview

Within the model occupants are treated only as sources of heat and (optionally) water vapour.  Occupant interventions and control actions are dealt with in the "DIARY" scheduler. There is no behavioural model of occupancy control (though the effects of occupants may be simulated in a deterministic manner through the diary scheduler).

The occupancy file specifies the heat and water-vapour output of individual occupants of the building.  Three different occupant types (which may be considered as different levels of activity) are definable for each space. Each space may be defined and operated independently.

The occupancy level (i.e. numbers of occupants) and the choice of type (i.e. how many people, of which type are in each space for what period of time) is controlled by means of the diary.  There is no automatic scheduling.

Each space that is to experience occupant gains must have an entry in this file.

### 4.5.2 Scope and Defaults

The thermal properties of a occupancy of a space are described in terms of;

1. The  heat output (metabolic rate) in watts, and the water vapour generated by the occupant in gram/sec,  for each of three activity levels.  The default condition defines the three levels as 80 , 130 and 190 watts per person respectively.  There is no water vapour output defined by default.

2. The  convective/radiative split of the heat output, as fractions.  The default is a 50/50 split.

3. The initial number of occupants in the space.  The default is nil.
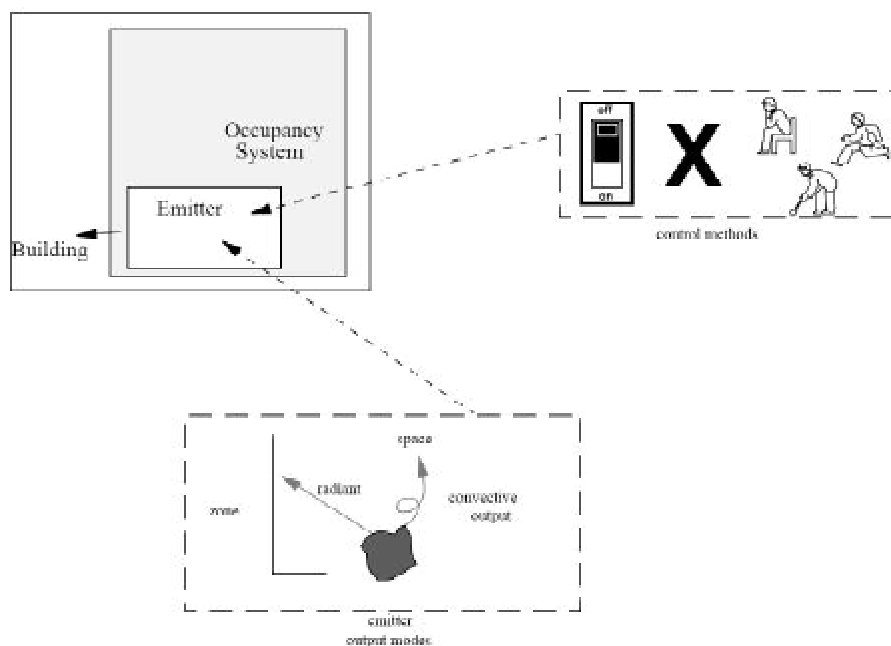


figure 5.4 Occupancy  System

4-9

Note that is water vapour generation is to be used, then the water calculation routine must be enabled in the Top-level file.

```
a     !OCCUPANCY SPACE = 1
b      !ACTIVITY LEVEL #1 = 50.0      , 0.0
c      !ACTIVITY LEVEL #2 = 90.0      , 0.0
d      !ACTIVITY LEVEL #3 = 150.0     , 0.0
e      !SPLIT   =    0.80   , 0.20
f      !INITIAL = 0.0
g      !CLOCK START TIME #1 = 00:00:00
h      !CLOCK STOP TIME #1 = 07:00:00
i      !CLOCK ACTIVITY LEVEL #1 = 1
j      !CLOCK OCCUPANCY #1 = 4
k      !CLOCK START TIME #2 = 07:00:00
l      !CLOCK STOP TIME #2 = 12:00:00
m      !CLOCK ACTIVITY LEVEL #2 = 2
n      !CLOCK OCCUPANCY #2 = 2
o      !CLOCK START TIME #3 = 12:00:00
p      !CLOCK STOP TIME #3 = 18:00:00
q      !CLOCK ACTIVITY LEVEL #3 = 2
r      !CLOCK OCCUPANCY #3 = 1
s      !CLOCK START TIME #4 = 18:00:00
t      !CLOCK STOP TIME #4 = 23:00:00
u      !CLOCK ACTIVITY LEVEL #4 = 2
v      !CLOCK OCCUPANCY #4 = 4
w      !CLOCK START TIME #5 = 23:00:00
x      !CLOCK STOP TIME #5 = 24:00:00
y      !CLOCK ACTIVITY LEVEL #5 = 1
z      !CLOCK OCCUPANCY #5 = 4
aa    !END
```

### 4.5.3  The Bungalow File

Three occupant types will be defined, corresponding to different activity levels expected.  The occupancy of the building will be selected in multiples of this nominal occupant.

notes

*a*       Opens an occupancy definition for space 1

*b*       declares occupant type 1  to generate 0 W heat output, and 0 g/s water output per occupant.

*c*       declares occupant type 2  as 50 W heat output, 0 g/s water output (assuming no water gain calculations will take place).

 *d*       declares occupant type 3 as 100 W heat output, 0 g/s water output.

 *e*       defines the occupant convective/radiant output split to be 80% convective, 20% radiative.  Note that the radiant output is considered to be diffuse, i.e. spread evenly through the appropriate zone.

*f*       declares the initial occupancy of space to be 0 persons.

*g-z*     define the automatic "clock control" for occupancy in this space.   As with heating, a more complex switching pattern could be managed through the Diary.  The definition of the clock control periods are the same as for the heating system (cf. 4.3).   In addition, the occupancy activity and amount of people present in a clock "on" period must be defined:-

*i*       sets the occupant activity level to be level , during clock period 1.

*j*       sets the number of occupants to 4 , during clock period 1.

*aa*    Ends the definition for the space.

Further occupancies for other spaces would repeat lines a to aa.

## 4.6 SMALL POWER FILE

### 4.6.1  Overview

This file specifies the small power sources to be used in the simulation.  Any number of sources may be specified. Note that the term "small" is not meant to be prejudicial on the actual heat output of the source, which may be as large as desired.  The sources are individually controlled from the diary.  The source code number is assigned in the order as they are defined in this file.

### 4.6.2 Scope and Defaults

Each small power source is defined by:

1.  its maximum output of heat, in watts (and optionally of water vapour, in gram/s).  There is no default value.

2.  the convective/radiative split of the heat output.  The default is a totally convective output.    Note that the radiant output of an emitter may be considered as either diffuse, wherein radiant output is spread over all surfaces of a zone, or direct, where the radiant output is directed to specified surfaces.
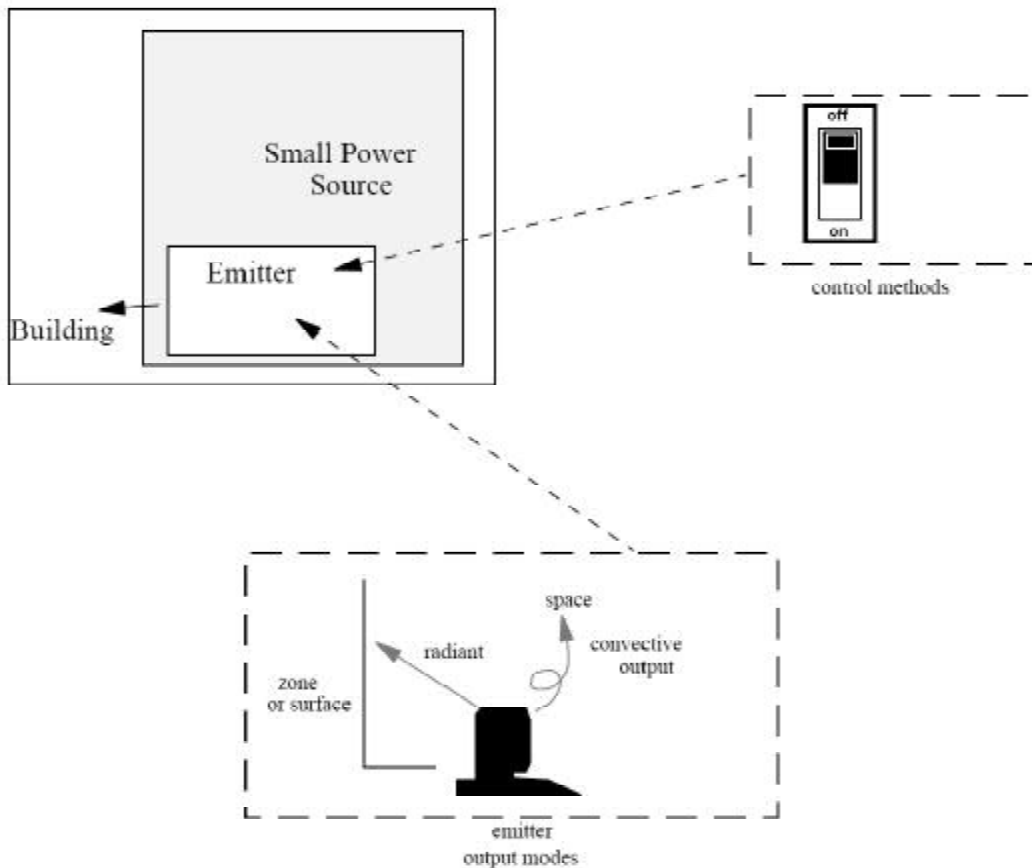


figure 5.5 Small Power  System

3. The spaces (or zones or surfaces) affected by the source, in terms of the number and identity codes of spaces, zones or surfaces to receive heat, the proportions of the total source output received by each. There are no default connections pre-defined for a source.

```
a       !SMALL POWER 'TV'
b       !HEAT OUTPUT = 150.0
c       !SPLIT       =    0.6    , 0.4
d       !INITIAL FRACTION = 1.0
e       !CONVECTIVE CONNECTIONS
f          _#1 = 1.0
g             }
h       !RAD DIFFUSE
i        !RADIANT CONNECTIONS
j          _#1 = 1.0
k            }
l        !CLOCK START TIME #1 = 08:00:00 | -----ss
m        !CLOCK STOP TIME #1 = 10:00:00
n        !CLOCK START TIME #2 = 18:00:00
o        !CLOCK STOP TIME #2 = 19:00:00
p        !CLOCK START TIME #3 = 22:00:00
q        !CLOCK STOP TIME #3 = 23:00:00
r       !END
s
t       !SMALL POWER 'COOKER'
u       !HEAT OUTPUT = 1700.0
```

### 4.6.3 The Bungalow File

Three small power sources were needed to cover the range of outputs and operating schedules. They cover the TV. (150 W), the cooker (1700 W), and a continuous background source (fridge and hot water tank, 210 W).

 notes

*a*      Opens the first small power source description, the name is not currently used, but should be defined for self documentation.

*b*      defines the sources maximum output as 150W.

*c*      defines the heat output as 60% convective, 40% radiative.

*d*      sets the initial output as 100% of the sources maximum.

*e-g*    defines the connections for the convective output. In this case 100% (i.e. 60% of the total output, cf. note *c* ) goes to space 1.

*h*      declares the radiant output to be of diffuse type. That is the radiant output will be evenly distributed over the surfaces of the connecting zones.

*i-k*    defines the connections for the radiant output. In this case 100% of the radiant output goes to zone 1.

*l-q*    define the automatic "clock control" for this source. As with heating, a more complex switching pattern could be managed through the Diary. The definition of the clock control periods are the same as for the heating system (cf. 4.3). In addition, the amount of output as a proportion of the maximum may also be defined for each clock period. Here the default value of 1.0 will be used.

*i*      sets the occupant activity level to be level , during clock period 1.*r*    Ends source 1 description.

The block a-r would be repeated for each desired source.

## 4.7 VENTILATION FILE

### 4.7.1 Overview

Ventilation in HTB2 encompasses both infiltration and purpose provided air movement.  Several options are available which allow varying degrees of sophistication in specifying or calculating ventilation airflows.

Ventilation is modelled only as a transport mechanism for heat and, optionally, moisture.  There is currently no pollutant model.

This file specifies the ventilation characteristics to be used in the simulation, according to the ventilation model used.

These (mutually exclusive) ventilation models are currently available:

Model:      Description:

<u>1.</u>      simple air change rate.  Three fixed rates are available for each space, according to space temperature and/ or status as set via the diary.  This is the simplest model, it allows some programmed response to the internal environment, but considers exchange to the outside only;  inter-space air-flows are not specified.

<u>2.</u>      specified space-space air flow networks.  Three fixed patterns are available on a building wide basis.  This is a more flexible model, allowing exchange between spaces as well as between a space and the outside, but there is no guidance as to the parameters of the networks.  This must be derived elsewhere. The choice between network is only made through the diary, there is no environmental control model.

<u>3.</u>      calculation of an empirical air change rate equation for each space.   This mode requires an externally derived model for the space ventilation rate as a function of site wind and temperature conditions.

<u>8.</u>      calculation of a ventilation network from a description of each opening in the system.   This mode requires a high level of detail to determine openings (e.g. windows, doors, cracks, etc.) but allows for the responsive calculation of internal flows, rather than the simpler air change rates.

<u>11.</u>    as model 1. but allowing for greater control capabilities..

<u>12.</u>    as model 2. but allowing for greater control capabilities, and specification of airflows in kg/s..

In the present release, the ventilation data is not entered in a flexible format.  The file is read as pure numeric data, each line must be as shown.  At specific places within the file, marker characters are inserted so that if data is miss-typed read, an error condition will occur.  There are no default data assumed in these files, all values must be explicitly stated.

The model option is chosen, numerically, by the first line of the file.

### 4.7.2  Scope and Defaults

<u>4.7.2.1 Ventilation Model 1</u>

In the case of model type 1, the required data is;
      1) the space under consideration
      2) 3 levels of ventilation, in air-changes per hour, ACR1, ACR2, ACR3.
      3) a ventilation thermostat setting, in degrees C.

There are no defaults, a space which has no ventilation parameters defined for it will have no ventilation transfer.

This model may be considered as representing either a natural or a mechanical ventilation system, according to the meanings associated with the terminology.

The selection of which one of the 3 possible ventilation rates to be used at any time, is made either via the diary or by automatic temperature control. The three rates are:

ACR 1 (which may be considered infiltration) is used when ventilation system status is OFF,

ACR 2 (which may be considered as either a normal occupied ventilation rate, or a "low" mechanical rate) is used when the ventilation status is ON and space temperature is less than the vent 'stat set-point,

ACR 3 (which may be considered as either a window open, or a high mechanical rate) is used when ventilation status in ON and space temperature is greater than the vent 'stat set-point.

Automatic selection may be overridden via manual control through the diary, so as to programme any ventilation pattern.

Note that there is no restriction on ACR2 being actually lower than ACR3. Thus in hot climates, the response to high temperatures would be to close windows, and this could be accommodated.

### 4.7.2.2 Ventilation Model 2

In the case of model type 2, the required data is;

1) three matrices of space to space flow rates, specified in $m^3/s$. This is defined in terms of the flow from a "source space" to a "sink space". There is no default flow pattern. Any space to space link not explicitly set will have nil flow. Note that the outside is always considered to be space 0 (zero).

For the model type 2 the choice of which flow pattern is occurring at any one time, is made through the diary. There is no control model, reacting to the environment, available in this type.

### 4.7.2.3 Ventilation Model 3

The empirical model within type 3 relates a space ventilation rate (as exchange to the outside only) to a function of space and external air temperature, and site wind speed and direction (as taken from the Meteorological file). The type 3 model is of limited use unless the empirical relation can be produced. Such a relation may be determined for instance, by a regression analysis of actual, measured data.

The equation has the form;

ACR (air change rate) = $C_d * (C_a*u + C_b* ÿ\sqrt{\Delta t} + C_c)$,

where $C_d$ is a multiplier coefficient, which may be altered via the diary.

$\quad\quad\quad$ u $\quad\quad$ is the site wind speed m/s.
$\quad\quad\quad$ $C_a$ $\quad\quad$ is a wind speed coefficient,
$\quad\quad\quad$ $\Delta t$ $\quad\quad$ is the inside-outside temperature difference °C,
$\quad\quad\quad$ $C_b$ $\quad\quad$ is a temperature difference coefficient,
$\quad\quad\quad$ $C_c$ $\quad\quad$ is a constant.

The coefficients $C_a$ ,$C_b$ ,$C_c$ are specified for each of 8 wind direction sectors.

### 4.7.2.4 Ventilation Model 8

The network model within type 8 relates ventilation flow rates to the specification of opening parameters. These parameters include details on open area, opening type, external pressure coefficients, and fan flow rates. Further detail in found in chapter ????.

<u>4.7.2.5 Ventilation Model 11</u>

This type is similar to type 1, but there are more control options.  Type 1 unchanged is left for consistency, but as this type is functionally identical, it is recommended that new cases use type 11.  The main difference is that, to select between ACr2 and ACR3, the control signal can be any one of:
> a) the current space air temperature (as in type 1), the default;
> b) the air temperature of a nominated space (any space, including the outside, not just the one for which the ventilation is being defined);
> c) the humidity of a nominated space;
> d) the difference in temperature between any two spaces;
> e) the difference in humidity between any two spaces;
> f) the absolute value of the difference in temperature between any two spaces;
> g) the absolute value of the difference in humidity between any two spaces.


<u>4.7.2.6 Ventilation Model 12</u>

This type is similar to that of type 2.  It differs in two aspects:

> 1) the flow pattern can be altered by the state of the problem, as with a thermostat.  The control signal can be any one of:
>> a) the current space air temperature (as in type 1), the default;
>> b) the air temperature of a nominated space (any space, including the outside, not just the one for which the ventilation is being defined);
>> c) the humidity of a nominated space;
>> d) the difference in temperature between any two spaces;
>> e) the difference in humidity between any two spaces;
>> f) the absolute value of the difference in temperature between any two spaces;
>> g) the absolute value of the difference in humidity between any two spaces;
>> h) a surface temperature.

> 2) flows in  the network are specified in mass flow rates, rather than volumetric rates; kg/s.

Similar to that of types 1 and 11, the selection of which one of the 3 possible ventilation patterns to be used at any time, is made either via the diary or by automatic control.  The three patterns are:

PAT 1  (which may be considered infiltration)  is used when ventilation system status is OFF,

PAT 2  (which may be considered as either a normal occupied ventilation rate, or a "low" mechanical rate) is used when the ventilation status is ON and control signal is less than the  'stat set-point,

PAT 3  (which may be considered as either a window open, or a high mechanical rate) is used when ventilation status in ON and control signal is greater than the vent 'stat set-point.

Automatic selection may be overridden via manual control through the diary, so as to programme any ventilation pattern.

Note that there is no restriction on PAT2 being actually lower than PAT3.  Thus in hot climates, the response to high temperatures would be to close windows, and this could be accommodated.

**4.7.3 The Bungalow File**

The data available for the bungalow simulation requires the use of the simple air change rate model, with constant infiltration in the living and loft spaces.

According to the requirements of the ventilation option chosen, the format of the data file may vary considerably, refer to appendix B.

```
a    1                                 * simple acr ventilation.
b    *********
c    1                                 * main space 1
d    1.24  , 0.0  , 0.0               * just use infiltration rate
e    20.0                              *   vent stat setting not used but needed
f    ____
g    2                                 * loft space 2
h    1.0   , 0.0  , 0.0
i    20.0
j    ____
k    0
l
m    * ventilation description for bre bungalow, constant infiltration
```

note

*a*     choose vent option 1 (simple air change rate)

*b*     position flag (separate option choice from data)

*c-f*   define the ventilation data for space 1

*c*     selects space 1 to define

*d*     sets the  infiltration rate (ACR1) to 1.24 vol./hr, ignores others

*e*     the vent 'stat will not be used but a data record is needed anyway.  In this case any numeric is suitable.

*f*     position flag (separate space definitions)

*k*     the end of file (and of the definitions) is marked with 0 (zero)

*m*     comments may appear at the end of a line, or at the end of the file, but not interspersed with the data as in the other formats..

# CHAPTER 5

# DESCRIPTION OF SIMPLE DATA SET: DIARY

## 5.1 STRUCTURE

The diary facility of HTB2 is designed to provide a flexible and powerful method of scheduling events within a simulation run. It allows many data values and run parameters to be altered within a run at any timestep.

The "diary list" is a second level file which contains the sequence of individual diary pages to be used on consecutive days of the simulation run.

"Diary pages" are third level files, each containing the sequence of events (listed chronologically) that are to be activated within one simulated day. Any number of events may be assigned in any one day.

Every day within a run must have a diary page assigned to it, although any one page may be assigned to more than one day. A page is changed to the next at midnight.

There is no "reset" function in the diary mechanism. All states remain until explicitly altered. That is, a service switched to "manual off" will remain off, overriding any preset timeclock information, until explicitly set to either "manual on", of "automatic". There may be null diary pages, i.e. files which contain no commands, in which case all services will carry on as they were last set.

Note that HTB2 may overrun the expected run length by one timestep, so that one extra diary page must always be specified even though it will never actually be executed.

## 5.2 DIARY LIST FILE

### 5.2.1 Overview

This file contains the names of files which will act as the "diary pages" for the daily scheduling commands. There must be a filename for each day of the simulation run (plus, it is recommended, one dummy name to allow for possible overrun). The list will be read sequentially. Filename conventions of the particular operating system in use must be met.

Comment line starting with the character "*" are allowed in this file.

### 5.2.2 The Bungalow File

The bungalow is to be run for 9 days (including 3 day run up) as set in the top-level file. Therefore the file must contain a total 10 entries, one page for each simulated day plus one for a possible overrun. A standard daily operating schedule was chosen for the simulation.

It was decided that only the final two days of the simulation were desired for output.

```
a     *  DIARY pages for bre bungalow full systems,
b     *    9 days total, run up for 3 days
c
d     *            run up period, just heating, no output
e     BREDAY0.DRY
f     BREDAY0.DRY
g     BREDAY0.DRY
h     *               standard day pattern
i     BREDAY.DRY
j     BREDAY.DRY
k     BREDAY.DRY
l     BREDAY.DRY
m     *       switch on output
n     BREDAY1.DRY
o     BREDAY.DRY
```

```
p            *                    extra for possible overrun
q            DRYNUL.DRY
```

notes

*e-g*   3 identical pages which cover the simulation warm-up period, all systems are left running on automatic settings.

*i-l*   4 identical pages which define the standard day operation schedule, simulating a full occupant intervention.

*n*     a page similar to that used above but which also switches on the output procedure.

*o*     the final day is again back to the standard operating schedule.

*q*     a dummy page to allow for overrun at end of run.

## 5.3 DIARY PAGES

### 5.3.1 Overview

These files contain the time dependant scheduling commands to alter either data values or model parameters. The commands within each file must refer to one "day" of the simulation (from 00:00 to 23:59:59) and must be presented in chronological order.

Each diary entry takes the form:

hh:mm:ss    COMMAND (= parameters)   (*optional comment).

The given command will be executed at the given time (within a calculation timestep). That is, scheduling information is not restricted to hour boundaries. The diary commands override information defined in the input files (e.g. automatic on/off settings for heating periods). If automatic control is later desired, as defined in the input files, it must be explicitly reset with a diary command. The commands must be entered in time order.

A complete list of all commands that can be changed in the diary is given in the appropriate section of Appendix B.

Comment lines may appear in these files.

### 5.3.2 The Bungalow Files

#### 5.3.2.1 Diary for 'warm up' day : BREDAY0.DRY

```
a       * on run up days initialise systems and just let cycle on auto
b       00:00:00 !SET HEATER STATUS #1 = AUTO
c       00:00:00 !SET LIGHTING STATUS #1 = AUTO
d       00:00:00 !SET SPOWER STATUS #1 = AUTO
e       00:00:00 !SET SPOWER STATUS #2 = AUTO
f       00:00:00 !SET SPOWER STATUS #3 = AUTO
g       00:00:00 !SET OCCUPANCY STATUS #1 = AUTO
h
i       * reuse first met day during run-up
j       23:59:00 !SET MET REWIND
```

The initial instructions (b-g) set all automatic systems onto a known condition (this should be done at the start of every run. Once set these will continue on automatic for a days of the simulation, unless explicitly set "off". The last instruction in the file rewinds the met tape at the end of the day and therefore allows the selected met day to be rerun. This may be useful for preconditioning the thermal state of the building. Note that although the met day is repeated, the date and day of the week will be incremented as usual.

Since no parameters are overridden, all systems operate according to the information defined in the input files.

#### 5.3.2.2 Diary for 'standard' day: BREDAY.DRY

```
a       *       'standard' day for bre bungalow
b       *                       all on automatic
```

Due to the automatic time clocks defined in the services, no intervention is required by the diary for normal operation of the simulation. Thus the file shown here has no command actions. The empty file DRYNUL.DRY coul dhave been specified to the same effect., but a file must be specified for each day, even if it is empty.

#### 5.3.2.3 Diary for 'standard' day with block output:  BREDAY1.DRY

```
a       *       'standard' day for bre bungalow
b       *                       all on automatic
c       *                           start output
d       00:00:00  !ENABLE BLOCK OUTPUT
e       *                       re-program occupancy pattern
f       00:00:00  !SET OCCUPANCY CLOCK STOP #1 @1 = 05:00:00 | mtwtf--
g       00:00:00  !SET OCCUPANCY CLOCK START #1 @2 = 05:00:00 | mtwtf--
h       00:00:00  !SET OCCUPANCY LEVEL #1 @2 = 3 | mtwtf--
```

This file is identical to the standard day file preceding with exception that the following commands have been added;

line *d* switches "on" the output module. As this was not set "on"in the Top level file (only provided with a filename), no output will have been produced to this point. From this point HTB2 will process and store on disc the simulation results.

Lines *f-h* alter the starting setup for the timeclock for Occupancy. These commands reset the first time period to end at 5:00 AM for weekdays only (weekend schedules will be unaffected). Period 2 is now set to start at 05:00 AM and during that period, the activity level in the space number 1 will become level 3 (again for weekdays only).

### 5.3.2.4 Diary for null day: DRYNUL.DRY

This file is included simply to accommodate the possible overrun. Alternatively, it may be necessary where no actions are to be taken in a day. The file contains no command lines.

### 5.3.2.5 Example Diary for Weekday, full diary control

As an example of the use of a Diary page the following commands represent a typical, but detailed, occupancy pattern (this file is not used in the example being discussed):-

```
*       'standard' day for bre bungalow
*                       heating system on automatic
*                       lighting and small power under manual control
00:00:00  !SET OCCUPANCY USAGE #1 = 2
00:00:00  !SET OCCUPANCY LEVEL #1 = 4.0          * 4 people @ level 1 (50 W)
00:00:00  !SET SPOWER STATUS #3 = ON             * background source (fridge HW)
00:00:00  !SET LIGHTING STATUS #1 = MANUAL OFF
07:20:00  !SET OCCUPANCY LEVEL #1 = 5.0
07:24:00  !SET MANUAL LIGHTING OUTPUT #1 = 0.20
07:24:00  !SET LIGHTING STATUS #1 = MANUAL ON
07:40:00  !SET OCCUPANCY LEVEL #1 = 4.0
07:42:00  !SET MANUAL LIGHTING OUTPUT #1 = 0.36
07:45:00  !SET SPOWER STATUS #2 = ON             * cooker on
08:00:00  !SET OCCUPANCY USAGE #1 = 3            * up to high 100W/person rate
08:00:00  !SET MANUAL LIGHTING OUTPUT #1 = 0.72
08:20:00  !SET SPOWER STATUS #2 = OFF            * breakfast is ready!
08:24:00  !SET MANUAL LIGHTING OUTPUT #1 = 0.36
08:30:00  !SET OCCUPANCY LEVEL #1 = 1.0
08:42:00  !SET LIGHTING STATUS #1 = MANUAL OFF
08:45:00  !SET OCCUPANCY LEVEL #1 = 0.0          * all gone !

17:20:00  !SET OCCUPANCY LEVEL #1 = 2.0          * home from work
17:00:00  !SET MANUAL LIGHTING OUTPUT #1 = 0.20
17:00:00  !SET LIGHTING STATUS #1 = MANUAL ON
17:22:00  !SET SPOWER STATUS #1 = ON             * TV goes straight on ...
17:24:00  !SET MANUAL LIGHTING OUTPUT #1 = 0.68
17:42:00  !SET MANUAL LIGHTING OUTPUT #1 = 0.48
18:00:00  !SET MANUAL LIGHTING OUTPUT #1 = 0.64
18:00:00  !SET OCCUPANCY LEVEL #1 = 3.0
18:00:00  !SET SPOWER STATUS #1 = OFF            * TV off again
18:18:00  !SET MANUAL LIGHTING OUTPUT #1 = 1.00
18:30:00  !SET SPOWER STATUS #2 = ON             *  supper in oven
19:30:00  !SET SPOWER STATUS #2 = OFF            *     and ready
19:30:00  !SET MANUAL LIGHTING OUTPUT #1 = 0.84
20:12:00  !SET MANUAL LIGHTING OUTPUT #1 = 0.64
20:15:00  !SET OCCUPANCY LEVEL #1 = 4.0
20:15:00  !SET SPOWER STATUS #1 = ON             * TV back on after meal
20:45:00  !SET OCCUPANCY LEVEL #1 = 2.0
20:48:00  !SET MANUAL LIGHTING OUTPUT #1 = 0.48
21:00:00  !SET MANUAL LIGHTING OUTPUT #1 = 0.70
21:24:00  !SET MANUAL LIGHTING OUTPUT #1 = 0.48
22:30:00  !SET OCCUPANCY LEVEL #1 = 3.0
22:30:00  !SET SPOWER STATUS #1 = OFF            * dad back from pub, tv goes off
22:42:00  !SET MANUAL LIGHTING OUTPUT #1 = 1.00
22:45:00  !SET OCCUPANCY LEVEL #1 = 4.0
23:00:00  !SET OCCUPANCY USAGE #1 = 2            * shift into low rate for night
23:00:00  !SET LIGHTING STATUS #1 = MANUAL OFF
23:25:00  !SET OCCUPANCY USAGE #1 = 3
23:50:00  !SET OCCUPANCY USAGE #1 = 2
```

# CHAPTER 6

# METEOROLOGICAL DATA FILE

## 6.1 STRUCTURE

The meteorological file consists of records of data read sequentially at the interval selected on the top level file.

Each record contains 11 fields which give the data values for the meteorological conditions to be applied during the subsequent interval. The values read are assumed to represent mean values over the met. interval.

The file is a sequential formatted ASCII file which is read in free format. The eleven fields in each record are as follows:

      interval - a dummy integer value for user identification only,
      external dry bulb temperature, °C,
      external dewpoint, °C,
      deep ground temperature, °C,
      external humidity, %,
      windspeed, m/s
      wind direction, degrees clockwise from north,
      total horizontal solar irradiation, $W/m^2$
      diffuse horizontal solar irradiation - $W/m^2$
      direct normal solar irradiation - $W/m^2$
      cloud cover, total sky cloud cover as a fraction (1= total cover, 0 = clear sky).

Each field should be separated by a comma; ",".

The format of the met. file is intended to be flexible to accommodate different availability of meteorological data. Not all items of data will be necessary in all cases. Some combinations of fields are redundant, i.e. external humidity and dewpoint; both may be supplied in the file, in which case those values will be taken without further check (i.e. the supplied values of humidity and dewpoint may be inconsistent). Optionally either may be supplied, in which case the other will be calculated internally. If no value is supplied, a value supplied in the TOP-level file, or in a DIARY file will be used. Those combinations where this applies are listed below.

A field may be skipped in the data line through the use of commas, i.e. " a , , c " skips the field 'b'. The last field (cloud cover) may be skipped by placing a single "/" character in it's place. Ordinary spaces should be used, tabs between field may cause problems.

There can be no comments within the datafile.

The met. file may be 'rewound' to the start at any time via the diary. It is possible to position the start point of a simulation to a point within a met. file using the !SET START MET command in the Top-level file. Thus an annual met. file may be used for short periods without the need for multiple copies or extracts.

Note that there is no time, date or site specifications contained in this file. The starting date and site location (as used in the determination of the solar geometry) must be specified at the top-level.

The starting time of a simulation is always considered to be midnight.

### 6.1.1 Scope and Missing Data Behaviour.

In the current release, the following data must be supplied;

      1) external dry bulb temperature, degree C,
      2) total (or global) horizontal solar irradiance $W/m^2$, and
      3) one of diffuse horizontal <u>or</u> direct normal solar irradiance, $W/m^2$

All other data may or may not be supplied, if supplied they are taken and used without further check.

The following actions will be used to handle missing data;

> 1) Dewpoint - if external humidity has been specified, then dewpoint is calculated from that. Otherwise the default value as set in either the Top-level or Diary files will be applied.
>
> 2) Deep Ground Temperature - if calculations have been enabled in the Top-level file, then a ground temperature will be determined from a weighted time-history of external air temperature. Otherwise the default value as set in either the Top-level or Diary files will be applied.
>
> 3) Humidity - if external dewpoint has been specified, then humidity is calculated from that. Otherwise the default value as set in either the Top-level or Diary files will be applied.
>
> 4) Windspeed - the default value as set in either the Top-level or Diary files will be applied.
>
> 5) Wind Direction - the default value as set in either the Top-level or Diary files will be applied.
>
> 6) Diffuse Horizontal Solar Irradiance - calculated from Total and Direct Normal Irradiance.
>
> 7) Direct Normal Solar Irradiance - calculated from Total and Diffuse Horizontal Irradiance.
>
> 8) Cloud Cover - the default value as set in either the Top-level or Diary files will be applied.

### 6.1.2 The Bungalow File

Data was chosen from a winters period for this test. Only the first 2 days of the file are shown here.

```
 1      0.70 ,,    0.70   50.0  0.0   0.     0.0     0.0 ,,    0.00
 2      0.90 ,,    0.90   50.0  0.0   0.     0.0     0.0 ,,    0.00
 3     -0.40 ,,   -0.40   50.0  0.0   0.     0.0     0.0 ,,    0.00
 4     -1.40 ,,   -1.40   50.0  0.0   0.     0.0     0.0 ,,    0.00
 5      0.80 ,,    0.80   50.0  1.5 230.     0.0     0.0 ,,    0.40
 6     -0.30 ,,   -0.30   50.0  0.0   0.     0.0     0.0 ,,    0.00
 7      1.10 ,,    1.10   50.0  0.0   0.     0.0     0.0 ,,    0.90
 8      1.50 ,,    1.50   50.0  1.5 200.     0.0     0.0 ,,    0.70
 9      1.70 ,,    1.70   50.0  0.0   0.     0.0     0.0 ,,    0.50
10      2.10 ,,    2.10   50.0  0.5 110.    22.5    16.3 ,,    0.70
11      4.20 ,,    4.20   50.0  2.1 240.   111.5    62.1 ,,    0.50
12      7.20 ,,    7.20   50.0  4.1 230.   183.3    87.4 ,,    0.40
13      7.40 ,,    7.40   50.0  2.1 190.   206.5    96.7 ,,    0.40
14      7.60 ,,    7.60   50.0  3.1 210.   132.6    83.3 ,,    0.70
15      8.50 ,,    8.50   50.0  5.7 230.    51.8    41.1 ,,    0.90
16      8.60 ,,    8.60   50.0  6.2 220.    16.5    13.7 ,,    0.90
17      7.50 ,,    7.50   50.0  4.6 200.     0.0     0.0 ,,    0.90
18      7.10 ,,    7.10   50.0  4.6 190.     0.0     0.0 ,,    0.90
19      6.80 ,,    6.80   50.0  3.6 200.     0.0     0.0 ,,    0.90
20      6.70 ,,    6.70   50.0  3.1 200.     0.0     0.0 ,,    0.90
21      6.60 ,,    6.60   50.0  3.6 200.     0.0     0.0 ,,    0.90
22      6.20 ,,    6.20   50.0  3.1 210.     0.0     0.0 ,,    0.90
23      4.90 ,,    4.90   50.0  3.6 200.     0.0     0.0 ,,    0.10
24      4.40 ,,    4.40   50.0  3.6 190.     0.0     0.0 ,,    0.50
25      4.90 ,,    4.90   50.0  4.1 190.     0.0     0.0 ,,    0.10
26      4.30 ,,    4.30   50.0  3.6 190.     0.0     0.0 ,,    0.10
27      4.30 ,,    4.30   50.0  3.1 200.     0.0     0.0 ,,    0.00
28      4.80 ,,    4.80   50.0  4.1 200.     0.0     0.0 ,,    0.00
29      5.60 ,,    5.60   50.0  4.6 210.     0.0     0.0 ,,    0.00
30      4.10 ,,    4.10   50.0  2.6 230.     0.0     0.0 ,,    0.00
31      3.70 ,,    3.70   50.0  3.1 200.     0.0     0.0 ,,    0.10
32      3.90 ,,    3.90   50.0  3.1 190.     0.0     0.0 ,,    0.90
33      4.20 ,,    4.20   50.0  3.6 190.     0.0     0.0 ,,    0.10
34      3.90 ,,    3.90   50.0  3.6 200.    32.1    19.6 ,,    0.40
35      6.30 ,,    6.30   50.0  3.6 180.    48.8    38.9 ,,    0.90
36      7.80 ,,    7.80   50.0  3.1 180.    74.2    58.1 ,,    0.90
37      9.60 ,,    9.60   50.0  6.2 220.   208.0    97.3 ,,    0.40
38      9.40 ,,    9.40   50.0  6.7 220.   205.9    73.2 ,,    0.20
39      9.10 ,,    9.10   50.0  6.2 230.    52.6    41.8 ,,    0.90
40      8.70 ,,    8.70   50.0  4.6 210.    30.3    21.5 ,,    0.70
41      8.50 ,,    8.50   50.0  4.6 210.     0.0     0.0 ,,    0.70
42      8.70 ,,    8.70   50.0  5.1 220.     0.0     0.0 ,,    0.90
43      8.90 ,,    8.90   50.0  5.1 220.     0.0     0.0 ,,    0.90
44      8.70 ,,    8.70   50.0  4.6 210.     0.0     0.0 ,,    0.70
```

# CHAPTER 7

# RUNNING THE MODEL

The basic, portable, version of HTB2 may be run either in batch or at an interactive terminal (although in the latter mode there is no input control, interactive display, and no terminal output of primary interest after the input error checking).

The Windows version of HTB2 provides a screen and graphical display of the simulation status, as well as providing interactive control of the running of the program. This software will be discussed in chapter 10.

The actual mechanism of operation will depend on the operating system HTB2 is used under.

The key action, however, is to connect the required Top-level file to HTB2. The Top-level file then takes full control of the run.
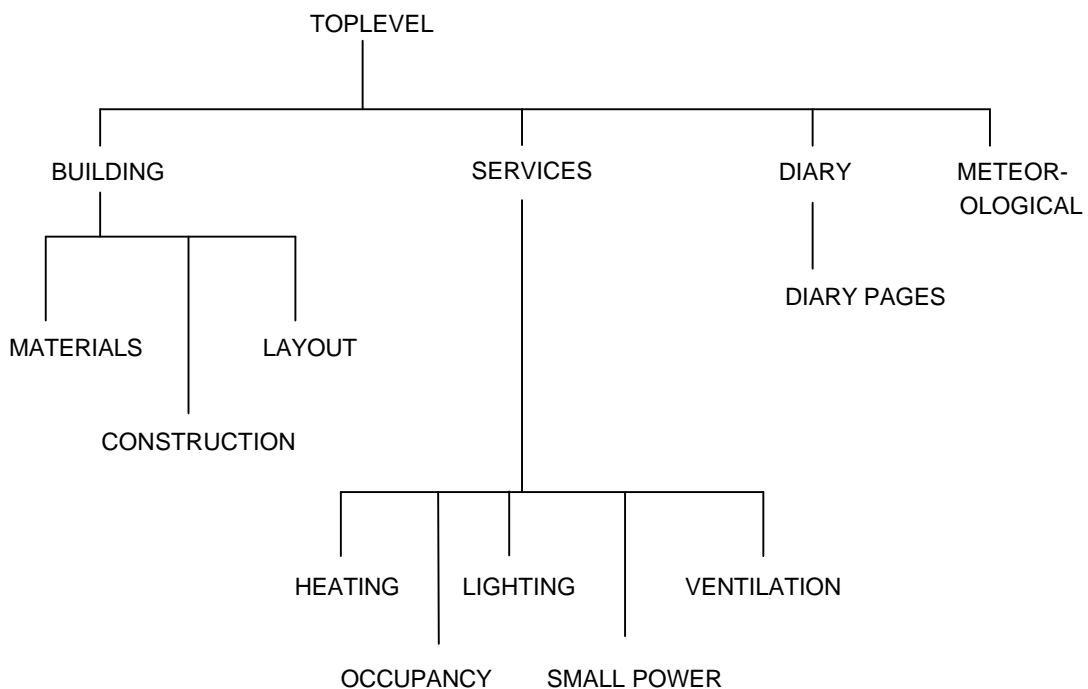
## 7.1 TOP LEVEL FILE

### 7.1.1 OVERVIEW

The information which controls the overall execution of the simulation run is contained in the 'top level' file. It is the Top-level file that configures the programme, selecting calculation options, set the input and output parameters, and provides pointers to the other data files required for the simulation.

### 7.1.2 Scope and Defaults

The Top-level file defines:
      - the name/identity of the run
          e.g. "Test Run for New Windows"
      - the facilities/modules/algorithms of the model to be used in the simulation
          e.g. use calculated rather than fixed heat transfer coefficients
      - run specific parameters
          e.g. starting day of week, date, or numbers of days to simulate
      - the output data required, the frequency of reporting and the selection of the output file names

e.g. select to record optional element data, every 5 minutes
- the names of the 'second level' files which contain information on the building, services, external climate and a diary of events/changes to be made during the course of the run.

The Top-level file may be used to alter several default values used throughout the model, e.g. ground reflectance coefficient (standard default of 0.2 applied to each element which does not have a ground reflectance specified for it, could be altered to 0.45 (say)).

This file is in a flexible format i.e. commands may appear in any order and blank lines and comments (preceded with a '*') may appear throughout the file.

### 7.1.3 The Bungalow File

This is a fairly typical example of a Top-level file, allowing for all standard algorithms and data.

```
a      * Top top evel file for bre bungalow
b      !RUNID BRE bungalow test 1, v2.0 standard
c
d      * configure model...
e      !ENABLE STANDARD SETUP
f
g      *                        calc ground temp
h      !ENABLE GROUND TEMP CALCS
i      !SET GROUND FACTOR = 0.001
j
k      * set up run parameters
l      !SET TIMESTEP = 90.0
m      !SET RUNLENGTH = 010,00
n      *                        allow 1st 3 days for runup
o
p      * chose output files and data
q      !OUTPUT INFO = 'BREBa.INF'
r      !OUTPUT BLOCK FILE = 'BREBa.BLK'
s
t
u      * connect to further files
v      !DEFINE BUILDING FILE = 'BREBUNGL.BLD'
w      !DEFINE SERVICES FILE = 'BREBUNGL.SRV'
x      !DEFINE DIARY FILE = 'BREBUNGL.DYL'
y      !DEFINE METEOR FILE = 'JANTEST.MET'
```

notes

*a*     comments within a data file are preceded by a "*".

*b*     sets the run identification string to "BRE bungalow test 1". This acts as a header to all output data files.

*e*     select the desired calculation modules for the run. This particular spec. would be usual for normal simulation requirements.

*g-i*   select the ground temperature to be calculated from the air temperature, rather than as taken from the meteorological file, with a time constant of 0.001 meteorological intervals (in this case hours).

*l*    sets the calculation timestep of 90 sec. Timesteps will typically be 30-120 seconds. The timestep must be chosen to reflect the stability requirements of fabric transport calculations. A very long timestep would reduce calculation time, but would cause calculation errors (calculations will not normally proceed if the timestep chosen is too long). A very short timestep will increase the calculation time required by the model. See the Technical Reference Manual for more detail.

*m*     sets a total run length of 10 days 0 hours. The run length will normally include an allowance for the "warming-up" or run-up of the simulation from its arbitrary initial conditions. The choice of the extent of this run-up is a matter of experience, generally from a few days to a few weeks, depending on the thermal mass of the building

simulated.

*q*        nominates the filename for the "information output file" for the run.  Filenames used will be subject to the naming conventions of the specific operating system for the computer installation.

*r*        nominates the filename for the fixed interval report output routine.  Note that the output routine itself has not yet been enabled.  Thus, without further intervention, no output would be produced by this run. In this run the output routine will be "switched-on", via a DIARY command, at the start of the 4th day of the simulation, thus skipping unwanted data from the run-up period.  The default interval, hourly, will be used.

*v-y*      nominate the 2nd level files to describe the building, services, conditions and schedules

# CHAPTER 8

# OUTPUT DATA FILES

HTB2 has provision for six types of output data. Two are always produced as standard, and simply record and note the progress of a run. The final four are optional, and record, in different formats designed to meet different data requirements, run results. Each of these latter types is selected as an option in the top level file and the specific data in each type can also be specified.

The output types are as follows:

LOG   - typically the screen output created during the run, this output type warns of errors during the input and run stages, and marks the progress of a run.

INFO  - contains run information, such as filenames, space volumes, element types. It is created immediately after the input stage, and is useful in checking input integrity. For instance a standard U-value is calculated for each construction type, which can then be compared against expectations. This file is also useful in documenting runs, as it contains a log of all files and key data used within a run. Postprocessor programs may use this file to aid interpretation of data in the other output files.

REPORT   - records interval averages of key data resulting from the simulation. The default condition stores the basic information required to construct an energy balance for each space of the building. The default interval is hourly, although this can be altered to any interval from one timestep to one day.

PROFILE   - records instantaneous temperature and heat flux profiles (slices) through selected building elements at selected intervals, or as triggered snapshots.

LOGGER   - records instantaneous data asynchronously, when the value of (user) selected variables change by more than a specified amount. This allows the time-history of a variable to be recorded, to a resolution of one timestep, without generating enormous file sizes.

SAVE STATE - records the fabric temperature conditions each midnight. This file is not meant to be an "output" as such, but rather to be a means of restarting a simulation from a known point, with the !DEFINE RESTART command of the Top-level file.

The overall aim is to allow the user to tailor his data output on each run to meet the specific requirements of that run, storing no more data than is necessary. This is exemplified best by the LOGGER option which produces very little data when changes are slow but records data as frequently as required to record the progress of changes that are happening quickly.

## 8.1 LOG FILE

The Log File records information and warning and error messages, generally during the input phase of a simulation.

This log file was generated by the Brebungl run, captured from the screen display, of the DOS version of HTB2. The Windows version produces the same information, but in a different form; the information, warning and error messages as below appear in the Log window, whilst the module identification names appear in a separate window.

```
a        HTB2/BG  v2.00 nov-95
b        Copyright (c) 1995 Welsh School of Architecture, UWCC
c           Storage System Copyright (c) 1995 British Gas
d        WHTSIZ V2.0  oct-92
e        ─────────────────────────────────────
f     The following data maximums apply:
g        25 modelled, and    3 unmodelled spaces .
h        25 construction types, using  100 parts total.
i     10 window types, and   25 shading masks.
j     200 elements, with   3000 fabric nodes.
k        25 heating systems with 125 connections  ,maximum delay  60 timesteps .
l        25 lighting circuits with 125 connections.
```

```
m      25 misc sources with 125 connections.
n       3 occupancy usage levels.
o      ──────────────────────────────
p       OPNTOPpc  V2.0  oct-92
q       MSGFIL V1.0  oct-92
r       info:  OPNTOP: Opening File Named: brebungl.top
s       VALDLN V2.2  nov-95
t       INPUTB bg V2.1  mar-94
u       INPUTA V2.2  mar-95
v       GET1R  V2.1  mar-94
w       SCLEAN V2.1  mar-94
x       STRIM  V2.1 mar-94
y       GET2I  V2.1 mar-94
z       DEFBLD V2.6  jan-96
aa      OPNTXTf V2.0  oct-92
ab      info:  OPNTXT: Opening File Named: BREBUNGL.BLD
ac      GET2R  V2.1 mar-94
ad      RDLAY  V2.4  nov-95
ae      info:  OPNTXT: Opening File Named: BREBUNGL.LAY
af      GET1I  V2.1 mar-94
ag      RDCON  V2.4  jan-96
ah      info:  OPNTXT: Opening File Named: BREBUNGL.CON
ai      GETMP3 V2.1 mar-94
aj      GETMP4 V2.1 mar-94
ak      OPUMATp V2.0  oct-92
al      info:  OPUMAT: Opening File Named: BREMATS.LBY
am      OPNMATp V2.0  oct-92
an      info:  OPNMAT: Opening File Named: STDMAT.LBY
ao      DEFSRV V2.0  oct-92
ap      info:  OPNTXT: Opening File Named: BREBUNGL.SRV
aq      RDHTR bg1.12 apr-94
ar      info:  OPNTXT: Opening File Named: BREBUNGL.HTR
as      GET3R  V2.1 mar-94
at      RDLGT  V2.1  mar-94
au      info:  OPNTXT: Opening File Named: BREBUNGL.LGT
av      RDSPW  V2.0  oct-92
aw      info:  OPNTXT: Opening File Named: BREBUNGL.SPW
ax      RDOCC  V2.1  mar-94
ay      info:  OPNTXT: Opening File Named: BREBUNGL.OCC
az      RDVENT x02  oct-92
ba      info:  OPNTXT: Opening File Named: BREBUNGL.VNT
bb      RDVNT1 x02  oct-92
bc      OPNMETp V2.0  oct-92
bd      info:  OPNMET: Opening File Named: JANTEST.MET
be      OPNDYLp V2.0  oct-92
bf      info:  OPNDYL: Opening File Named: BREBUNGL.DYL
bg      MSGGEN V1.1  nov-95
bh      info:   INPUT: checking Diary Pages
bi      DRYCHK  V1.1  nov-95
bj      OPNDRYp V2.0  oct-92
bk      info:  OPNDRY: Opening File Named: BREDAY0.DRY
bl      DRYNXT V2.1  mar-94
bm      DRYIN  V2.0  oct-92
bn      DIARY  bg2.4 nov-95
bo      info:  OPNDRY: Opening File Named: BREDAY.DRY
bp      info:  OPNDRY: Opening File Named: BREDAY1.DRY
bq      info:  OPNDRY: Opening File Named: DRYNUL.DRY
br      info:  OPNDRY: Opening File Named: BREDAY0.DRY
bs      info:   INPUT: opening output files
bt      OPBLK1p V2.0  oct-92
bu      info:  OPBLK1: Opening File Named: BREBa.BLK
bv      ──────────────────────────────
bw     The following data totals have been read:
bx       2 modelled spaces, and    2 radiant zones.
by       6 construction types, using   14 parts total.
bz      1 window types, and    0 shading masks.
ca      14 elements, with    129 fabric nodes.
cb      1 heating systems with   1 connections  ,maximum delay   0 timesteps .
cc      1 lighting circuits with   1 connections.
cd      3 misc sources with   3 connections.
ce      ──────────────────────────────
cf      info:   INPUT: starting calculations
cg      INIT   V2.1 nov-95
ch      DSTAMPS V2.0  mar-94
ci      INFO   V2.1  mar-94
```

```
cj      OPNINF V2.0  oct-92
ck      info:  OPNINF: Opening File Named: BREBa.INF
cl      RH2WC  V2.0  oct-92
cm      T2SVP  V2.0  oct-92
cn      VP2WC  V2.0  oct-92
co      CLOCK  V2.0  oct-92
cp      NEWDAY V2.0  oct-92
cq      TEMPSP V2.0  oct-92
cr      TEMPRD V2.2  jan-96
cs      MRTCLC V2.0  oct-92
ct      METBAS V2.0  oct-92
cu      RH2VP  V2.0  oct-92
cv      RH2DP  V2.0  oct-92
cw      EXTRHT V2.0  oct-92
cx      LNGWAV V2.0  oct-92
cy      SOLAR  V2.2  jan-96
cz      SKYVW  V2.0  oct-92
da      TRFNCT V2.0  oct-92
db      FABRIC V2.3  nov-95
dc      HTCE   V2.0  oct-92
dd      HTCF   V2.1  feb-95
de      CAVTRN V2.1  nov-92
df      VENTL  V2.0  oct-92
dg      VENT1  V2.0  oct-92
dh      CASUAL V2.0  oct-92
di      OCCUPD V2.2  nov-95
dj      LIGHTS V2.1  mar-94
dk      SPOWER V2.1  mar-94
dl      HTSERV bg1.12 apr-94
dm      MSTAT  V2.1  mar-94
dn      HTSYS  V2.2  apr-94
do      TSTAT  V2.1  mar-94
dp      UPDATE V2.0  oct-92
dq      MSGDAY V1.0  nov-92
dr      info:  NEWDAY: on date  2/ 1/1992
ds      info:  OPNDRY: Opening File Named: BREDAY0.DRY
dt      info:  NEWDAY: on date  3/ 1/1992
du      info:  OPNDRY: Opening File Named: BREDAY0.DRY
dv      info:  NEWDAY: on date  4/ 1/1992
dw      info:  OPNDRY: Opening File Named: BREDAY.DRY
dx      info:  NEWDAY: on date  5/ 1/1992
dy      info:  OPNDRY: Opening File Named: BREDAY.DRY
dz      info:  NEWDAY: on date  6/ 1/1992
ea      info:  OPNDRY: Opening File Named: BREDAY.DRY
eb      warn:  METBAS: Direct Solar value is out of allowable range at:
ec             : hour    10
ed             : continuing with default
ee      info:  NEWDAY: on date  7/ 1/1992
ef      info:  OPNDRY: Opening File Named: BREDAY.DRY
eg      info:  NEWDAY: on date  8/ 1/1992
eh      info:  OPNDRY: Opening File Named: BREDAY1.DRY
ei      REPORT  v2.2bg  apr-94
ej      info:  NEWDAY: on date  9/ 1/1992
ek      info:  OPNDRY: Opening File Named: BREDAY.DRY
el      info:  NEWDAY: on date 10/ 1/1992
em      info:  OPNDRY: Opening File Named: DRYNUL.DRY
en      TIDYUP V2.1  mar-94
eo      ENDREP  bg2.3 nov 95
```

notes:

*a-c*    As each routine or module is used for the first time, it declares itself for identification.

*d-n*    These numbers reflect the array sizes defined at compile time.

*p-q*    An information message from the routine OPNTOP, declaring which file it is attempting to use.

*ac-aq*  Warning messages from the routine RDLAY, complaining that important information is missing from the Layout file.  For these cases, default values were used, hence these are only warnings, and the run continues.  Should vital information be missing, i.e. an element area, the message would be an error, and the run would not continue.

*ci-cr*    After all input files have been processed, the data totals are summarised here.  If there are inexplicable simulation problems, check these totals against those of *d-n,* they should always be less.

*ef*    The routine NEWDAY is displaying the run progress as the current date of the simulation.

*eu*    The routine METBAS is complaining that the value for direct normal solar irradiance at 10:00 is abnormal. In this case, direct normal irradiance was not supplied, so that the value was calculated from the supplied total and diffuse horizontal values.  There is therefore an inconsistency in those values.  Usually this warning is not severe, and the calculations proceed as normal.

*fb-fd*    The output procedures have started, enabled at this point through the diary.

*fk*    Routine TIDYUP is the last normal routine to run.  If there is simulation problem during a run, such as insufficient met. data, or a numerical problem, the routine CRASHR is used to stop the programme.

## 8.2 INFO FILE

The Info File contains run information, such as filenames, space volumes, element types. It is created immediately after the input stage, and is useful in checking input integrity. For instance a standard U-value is calculated for each construction type, which can then be compared against expectations. This file is also useful in documenting runs, as it contains a log of all files and key data used within a run. Postprocessor programs may use this file to aid interpretation of data in the other output files.

This info file was generated by the Brebungl run, as BREB1.INF.

```
a      DOS486 HTB2/BG v2.00                   22/02/96  09:41:54
b         RUN: BRE bungalow test 1, v2.0 standard
c      PROJID: BRE type bungalow
d      SERVID: full systems
e      TOPFIL: E:\HTB2R2\112\TEST\BREB\BREBUNGL.TOP
f      BLDFIL: E:\HTB2R2\112\TEST\BREB\BREBUNGL.BLD
g      MATFIL: E:\HTB2R2\112\TEST\BREB\STDMAT.LBY
h      AMTFIL: E:\HTB2R2\112\TEST\BREB\BREMATS.LBY
i      CONFIL: E:\HTB2R2\112\TEST\BREB\BREBUNGL.CON
j      LAYFIL: E:\HTB2R2\112\TEST\BREB\BREBUNGL.LAY
k      SRVFIL: E:\HTB2R2\112\TEST\BREB\BREBUNGL.SRV
l      HTRFIL: E:\HTB2R2\112\TEST\BREB\BREBUNGL.HTR
m      COOFIL: _
n      VNTFIL: E:\HTB2R2\112\TEST\BREB\BREBUNGL.VNT
o      LGTFIL: E:\HTB2R2\112\TEST\BREB\BREBUNGL.LGT
p      SPWFIL: E:\HTB2R2\112\TEST\BREB\BREBUNGL.SPW
q      OCCFIL: E:\HTB2R2\112\TEST\BREB\BREBUNGL.OCC
r      METFIL: E:\HTB2R2\112\TEST\BREB\JANTEST.MET
s      DY1FIL: E:\HTB2R2\112\TEST\BREB\BREBUNGL.DYL
t      ZP1FIL: _
u      ZP2FIL: _
v      BLKFIL: E:\HTB2R2\112\TEST\BREB\BREBA.BLK
w      LGRFIL: _
x      PROFIL: _
y      LCLCWT= F LCLCMT= T LCLCSR= T LCLCFB= T LCLCVT= T LCLCHT= T LCLCCL= F
z      LCLCIN= T LOCCUO= T LLGHTO= T LSPOWO= T LDRYWR= T
aa     LCLCRD= 1 VNTOPT= 1
ab        DT=   90.00
ac      NSP=    2   NRZN=    2   NSPU=    3   NELE=   14   NHTR=    1
ad     NMSC=    3   NLCT=    1
ae
af
ag     Constructions :
ah        code            resistance     Standard "U"
ai                        m2-C/W)          W/m2-C
aj
ak        -1              (virtual element - transfer value as set in top or diary)
al         1                0.5359         1.3969
am         2                0.0057         5.3846
an         3                1.4870         0.5999
ao         4                2.5625         0.3646
ap         5                0.0119         5.2109
aq         6                0.2924         2.1167
ar
as
at     Element and surface data:
au     ELEMENT   AREA   CON     "U"     "UA"    SPACE   SPACE   ZONE    ZONE    GLASS
av      CODE      m2   CODE    W/m2C    W/C     FIRST   LAST    FIRST   LAST    TYPE
aw        1      16.30   1     1.397    22.77     0       1       0       1     _NA_
ax        2       6.60   2     5.385    35.54     0       1       0       1     6MMFLOAT
ay        3      15.90   1     1.397    22.21     0       1       0       1     _NA_
az        4      14.00   1     1.397    19.56     0       1       0       1     _NA_
ba        5       9.00   2     5.385    48.46     0       1       0       1     6MMFLOAT
bb        6      14.90   1     1.397    20.81     0       1       0       1     _NA_
bc        7       1.00   2     5.385     5.38     0       1       0       1     6MMFLOAT
bd        8      66.00   3     0.600    39.59     1       0       1       0     _NA_
be        9      66.00   4     0.365    24.07     2       1       2       1     _NA_
bf       10      28.00   5     5.211   145.91     0       2       0       2     _NA_
bg       11      15.00   5     5.211    78.16     0       2       0       2     _NA_
bh       12      28.00   5     5.211   145.91     0       2       0       2     _NA_
bi       13      15.00   5     5.211    78.16     0       2       0       2     _NA_
bj       14      23.00   6     2.117    48.68     1       1       1       1     _NA_
bk
```

```
bl
bm      Spaces data:
bn       SPACE     VOLUME     IN ZONE:
bo
bp         -3        n/a          -3
bq         -2        n/a          -2
br         -1        n/a          -1
bs          1      148.00          1
bt          2       70.00          2
bu
bv
bw      Zones data:
bx       ZONE      BOUNDED BY ELEMENT, SIDE   (* - exterior)
by
bz        -3  :
ca
cb        -2  :
cc
cd        -1  :
ce
cf         1  : 1*L,   2*L,   3*L,   4*L,   5*L,   6*L,   7*L,   8*F,   9 L,   14 F,   14 L,
cg
ch         2  : 9 F,  10*L,   11*L,   12*L,   13*L,
ci
cj
ck
cl      Element Class data:
cm       Class    Elements:                                total area
cn
co         1  :  1    3    4    6    =          61.10
cp
cq         2  :  2    5    7    =        16.60
cr
cs         3  :  8    =         66.00
ct
cu         4  :  9    =         66.00
```

notes:

*a*      a system and time stamp for the run.

*b-d*    the identification strings defined in the Top-level, Building, and Services files.

*e-x*    the full specification of all files used in the run (apart from diary pages).

*y-aa*   a summary of the configuration options selected for the run;
            water, meteorological, solar, fabric, ventilation, heating, cooling, small power, occupancy, lighting,
            diary, radiant exchange, and ventilation option, respectively.  'T ' indicated enabled, 'F' disabled.

*ab*     the calculation timestep, in seconds.

*ac-ad*  the data totals for; spaces, zones, unmodelled spaces, elements, heating systems, small power systems,
lighting circuits, respectively.

*ag-aq*  An echo table of U-values calculated, by standard CIBSE method, for the construction types defined in the
Construction file.  This is useful for checking against input errors, i.e. misplaced decimal places in layer widths.
Note however, that the U-value for a ground floor slab is <u>not</u> calculated correctly in this summary.

*at-bj*  An echo table of key values describing the elements defined in the Layout file.

*bm-bt*  An echo table of key values describing the spaces defined in the Building file.

*bw-cd*  An echo table of key values describing the radiant exchange zones as implied from the Building and Layout
files.  This lists the element surfaces making up each zone. The "first" surface is denoted L, the "last" as R, for
arcane historical reasons.

## 8.3 REPORT FILE

### 8.3.1 OVERVIEW

The report file (or "block report") contains a time-series of interval averaged state values of results of the simulation. By default, the file is written in a machine specific binary format, and as such is not directly readable by humans. Post processing programmes are required to read and format the information contained in this file into an intelligible form. One such postprocessor is the programme 'htable', supplied with this release.

Report files are not automatically produced by each run of the model, the reporting module must be both primed with a target file name, and enabled for execution by the Top-level or Diary files.

In the current release, HTB2 will not over-write an existing report file, the programme will stop execution if a new run is attempted with an old filename.

By default, the data stored in a report file is a summary of conditions and energy balance on a space by space basis. The default report interval is one hour; this may be changed to between one timestep and one day.

Further information may be optionally written to the file. Firstly, if element classes have been assigned in the Layout file, records of the total heat fluxes through those classes are included in the Report file. Secondly, in the Top-level file, further block of additional data may be selected to appear in this file. These are summaries of; meteorological data, convective transport data, radiant transport data, element state data, heating system operation data, water transport data, ventilation data.

### 8.3 .2 FILE SCOPE AND FORMAT

The standard Report file is a fixed record length, binary encoded file. Optionally, the output may be written in ASCII text format, through this is almost as opaque to the eye as the binary format (the text format may be useful as a debugging tool). Binary representation of data is unfortunately a machine dependant feature, as each machine has small, but significant, differences in the binary format. However as the HTB2 output is generally only in real numbers, it has been possible to provide translation routines between different machine formats. That is output files generated on a DEC mainframe can be ported to a PC, for analysis.

The general file format is detailed in the Technical Reference.

### 8.3.3 BREBUNGL RESULT

The Report file resulting from the Brebungl run, BREB1.BLK, was passed through the htable postprocessor to provide the following report of the 1st day's results for space 1. The htable postprocessor is described in section 3.

The Windows post processor HTB2VIEW produces data in a more flexible format, it is discussed in chapter 10.

```
BREB1.BLK
Data created by    : REPORT v1.9   jul-90
on                 : SUNos4 HTB2 v1.10
run identity       : BRE bungalow test 1
building identity  : BRE type bungalow
services identity  : full systems
information file   : BREB1.INF
```

Fri May 15 09:33:37 1992

```
BREB1.BLK
DATA FOR    1 DAYS FROM   8/ 1/1990
```

| TIME OF REPORT DATE | AIR TEMP oC | MEAN SURF. TEMP oC | MEAN RAD. TEMP oC | calc. GLOBE TEMP oC | HUMIDITY % | HEATING GAIN kWh | COOLING GAIN kWh | CASUAL GAIN kWh | SOLAR GAIN kWh | VENTIL GAIN kWh | FABRIC GAIN kWh | GAIN TO FABRIC kWh | LOSS FROM FABRIC kWh |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1/ 1: 0 | 14.7 | 14.3 | 14.4 | 14.5 | 50.0 | 0.000 | 0.000 | 0.653 | 0.000 | -0.328 | -0.191 | 0.366 | -1.441 |
| 1/ 2: 0 | 14.4 | 14.0 | 14.0 | 14.2 | 50.0 | 0.000 | 0.000 | 0.670 | 0.000 | -0.315 | -0.203 | 0.375 | -1.381 |
| 1/ 3: 0 | 14.2 | 13.8 | 13.8 | 14.0 | 50.0 | 0.000 | 0.000 | 0.670 | 0.000 | -0.297 | -0.217 | 0.386 | -1.235 |
| 1/ 4: 0 | 14.0 | 13.6 | 13.6 | 13.8 | 50.0 | 0.000 | 0.000 | 0.670 | 0.000 | -0.292 | -0.224 | 0.394 | -1.337 |
| 1/ 5: 0 | 13.8 | 13.4 | 13.5 | 13.6 | 50.0 | 0.000 | 0.000 | 0.670 | 0.000 | -0.281 | -0.232 | 0.401 | -1.254 |
| 1/ 6: 0 | 13.6 | 13.2 | 13.3 | 13.5 | 50.0 | 0.000 | 0.000 | 0.670 | 0.000 | -0.283 | -0.231 | 0.400 | -1.290 |
| 1/ 7: 0 | 18.8 | 14.5 | 14.6 | 16.7 | 50.0 | 3.272 | 0.000 | 1.174 | 0.000 | -0.600 | -2.909 | 3.015 | -1.585 |
| 1/ 8: 0 | 19.0 | 15.2 | 15.3 | 17.2 | 50.0 | 2.390 | 0.000 | 1.431 | 0.000 | -0.648 | -2.527 | 2.880 | -2.040 |
| 1/ 9: 0 | 19.0 | 15.5 | 15.7 | 17.4 | 50.0 | 2.076 | 0.000 | 0.150 | 0.000 | -0.648 | -2.293 | 2.887 | -2.012 |
| 1/10: 0 | 14.3 | 14.3 | 14.4 | 14.4 | 50.0 | 0.074 | 0.000 | 0.150 | 0.135 | -0.355 | -0.093 | 0.339 | -1.365 |
| 1/11: 0 | 13.2 | 13.5 | 13.9 | 13.6 | 50.0 | 0.000 | 0.000 | 0.150 | 0.476 | -0.278 | 0.183 | 0.351 | -0.367 |
| 1/12: 0 | 13.2 | 13.5 | 13.9 | 13.6 | 50.0 | 0.000 | 0.000 | 0.150 | 0.701 | -0.269 | 0.180 | 0.575 | -0.183 |
| 1/13: 0 | 13.2 | 13.5 | 14.0 | 13.6 | 50.0 | 0.000 | 0.000 | 0.150 | 0.796 | -0.252 | 0.163 | 0.690 | -0.267 |
| 1/14: 0 | 14.5 | 14.7 | 16.6 | 15.5 | 50.0 | 0.000 | 0.000 | 0.150 | 2.858 | -0.309 | 0.304 | 2.509 | 2.722 |
| 1/15: 0 | 15.2 | 15.5 | 17.6 | 16.4 | 50.0 | 0.000 | 0.000 | 0.150 | 3.036 | -0.357 | 0.291 | 2.784 | 2.031 |
| 1/16: 0 | 14.8 | 15.2 | 16.6 | 15.7 | 50.0 | 0.000 | 0.000 | 0.150 | 2.144 | -0.392 | 0.263 | 1.986 | -1.735 |
| 1/17: 0 | 18.9 | 14.9 | 14.9 | 16.9 | 50.0 | 3.579 | 0.000 | 0.650 | 0.000 | -0.732 | -2.721 | 2.834 | -6.686 |
| 1/18: 0 | 19.0 | 15.1 | 15.3 | 17.1 | 50.0 | 3.028 | 0.000 | 1.966 | 0.000 | -0.801 | -2.595 | 2.860 | -4.750 |
| 1/19: 0 | 19.0 | 15.5 | 15.8 | 17.4 | 50.0 | 2.115 | 0.000 | 2.075 | 0.000 | -0.844 | -2.387 | 3.200 | -4.463 |
| 1/20: 0 | 19.0 | 15.7 | 16.0 | 17.5 | 50.0 | 1.938 | 0.000 | 1.209 | 0.000 | -0.856 | -2.255 | 3.183 | -4.736 |
| 1/21: 0 | 19.0 | 15.4 | 15.7 | 17.3 | 50.0 | 2.637 | 0.000 | 0.964 | 0.000 | -0.924 | -2.432 | 2.931 | -4.911 |
| 1/22: 0 | 19.0 | 15.2 | 15.4 | 17.2 | 50.0 | 3.057 | 0.000 | 1.053 | 0.000 | -1.028 | -2.570 | 2.999 | -5.723 |
| 1/23: 0 | 19.0 | 15.2 | 15.4 | 17.2 | 50.0 | 2.972 | 0.000 | 0.671 | 0.000 | -1.003 | -2.579 | 3.013 | -4.117 |
| 9/ 1/1990 | | | | | | | | | | | | | |
| 2/ 0: 0 | 14.1 | 13.9 | 14.0 | 14.0 | 50.0 | 0.069 | 0.000 | 0.790 | 0.000 | -0.738 | -0.233 | 0.511 | -4.591 |
| Grand Mean/Totals : | 16.1 | 14.5 | 14.9 | 15.5 | 50.0 | 27.207 | 0.000 | 17.186 | 10.147 | -12.831 | -25.510 | 41.869 | -52.718 |

notes:

*b-g*  echo of the data filename, and the run identification strings defined in the Top-level, Building, and Services files.

*h*  pointer to the information file for further information on the run.

*i-k*  page header, including full date of start of the data printout.

*m-p*  data header :-

The data contained in the formatted table  is as follows;

> **Time of Report**: (days from start/hour:minute)
> HTB2 records are averages (totals for energy) <u>from</u> the last report <u>to</u> the current time.
> **Air Temp:** (°C)
> a true air temperature  based on the energy content of the space air.
> **Mean Surf Temp**: (°C)
> an area weighted mean temperature of all surfaces enclosing the space.
> **Mean Rad. Temp**: (°C)
> as the mean surface temperature, but  including a temperature term to account for the presence of radiant gains to the space.
> **Globe Temp**: (°C)
> a simple weighted combination of air and radiant temperatures, akin to the globe thermometer.
> **Humidity**: (%)
> the relative humidity level of the space (valid only if water  transport calculations were enabled in the simulation).
> **Heating Gain**: (kWh)
> the total output of all heating systems to the space during this period.
> **Cooling Gain**: (kWh)
> total "output" of all cooling system to the spaces during this period.  A cooling load would appear as a negative number (i.e. a "loss").
> **Casual Gain**: (kWh)
> summation of all gains from Occupancy, Lighting, and Small Power energy sources.
> **Solar Gain**: (kWh)
> the total physical solar entry through transparent openings.
> **Ventilation Gain**:  (kWh)
> total energy movement due to infiltration and ventilation.  Again, a negative number denotes a "loss" from the space.
> **Fabric Gain**:
> the convective part of the fabric transfer <u>only</u>, across "internal" surfaces of space.
> **Gain to Fabric**:
> the net energy transport across the "internal" surfaces of space.  Signing is different from preceding items, a positive number denotes a gain to the fabric (i.e. a loss from the space).
> **Loss from Fabric**:
> Net energy transport across the "external" surfaces of space.  Arguably, some of the energy transfer across the "internal" surfaces may be returned to the space at a later time.  The energy transfer across the "external" surfaces is lost forever.

The total energy balance of the space is therefore; (heating)+(cooling)+(casual)+(solar)+(ventilation)-(gain to fabric).

*q-ao*  the data for the first day.

*aq-ar*  the average (temperatures) and totals (energy) for the printout period.

## 8.4 PROFILE FILE

### 8.4.1 OVERVIEW

The profile file contains a time-series of interval spot state values of results of the simulation.  By default, the file is written in a machine specific binary format, and as such is not directly readable by humans.  Post processing programmes are required to read and format the information contained in this file into an intelligible form.  One such postprocessor is the programme 'ptable', supplied with this release.

Profile files are not automatically produced by each run of the model, the reporting module must be both primed with a target file name, and enabled for execution by the Top-level or Diary files.

In the current release, HTB2 will not over-write an existing profile file, the programme will stop execution if a new run is attempted with an old filename.

The data stored in a profile file is a snap-shot of temperature and energy conditions through specified elements. The default report interval is one hour; this may be changed to between one timestep and one day.

### 8.4.2 FILE SCOPE AND FORMAT

The standard Profile file is a fixed record length, binary encoded file.  Optionally, the output may be written in ASCII  text format, through this is almost as opaque to the eye as the binary format (the text format may be  useful as a debugging tool).  Binary representation of data is unfortunately a machine dependant feature, as each machine has small, but significant, differences in the binary format.  However as the HTB2 output is generally only in real numbers, it has been possible to provide translation routines between different machine formats. That is output files generated on a DEC mainframe can be ported to a PC, for analysis.

Data recorded in this file include (for each element chosen);
      surface temperatures and heat fluxes,
      radiation incident at the surfaces,
      heat absorption and transmission,
      temperature and heat flux at the calculation nodes through the element profiled.

The general file format is detailed in the Technical Reference.

### 8.4.3 BREBUNGL RESULT

The Profile file resulting from the Brebungl run, BREB1.PRF, was passed through the ptable postprocessor to provide the following report of the 1st hour's results for element 1.  The ptable postprocessor is described in section 3.

```
a        Profile ForMatter on BREB1.PRF
b     page   0
c      Data created by        : PRFOUT v1.9  jul-90
d         on                  : SUNos4 HTB2 v1.10            Fri May 15 09:33:37 1992
e       run identity          : BRE bungalow test 1
f      building identity : BRE type bungalow
g      services identity : full systems
h      information file  : BREB1.INF
i
j
k       Element no.  1 at  8/ 1/1990   1: 0: 0
l
m      Net heat absorbed     -14.22 W/m2      Solar power absorbed        0.00 W/m2
n      Solar transmission, diffuse :      0.00 W     , direct :      0.00 W
o
p        Surface data                      FIRST          LAST
q
r      Surface Temperature oC                10.22          14.37
s      Air Temp oC                            9.20          14.48
t      Mean Rad Temp oC                       0.00          14.17
u      Mean Surface Temperature Seen oC       0.00          14.10
v      Effective Temperature Seen oC          9.51          14.20
w      Radiant Flux  W/m2                    -3.29          -0.84
x      Net Surface Flux W/m2                -13.76           0.46
```

```
y
z       Depth from FIRST    Temp     Flux
aa      +++++++++++++++++++FIRST++++++++++++++++++++
ab        0.0000             10.22    -13.76
ac        0.0105             10.39
ad        0.0210                      -12.80
ae        0.0315             10.71
af        0.0420                      -12.09
ag        0.0525             11.01
ah        0.0630                      -11.29
ai        0.0735             11.29
aj        0.0840                      -10.46
ak        0.0945             11.56
al      _____
am        0.1050             11.68     -9.59
an        0.1375             12.54
ao      _____
ap        0.1700             13.40     -9.59
aq        0.1805             13.56
ar        0.1910                       -8.32
as        0.2015             13.84
          0.2120                       -6.86
          0.2225             14.08
          0.2330                       -5.10
          0.2435             14.25
          0.2540                       -3.01
          0.2645             14.35
        _____
          0.2750             14.37     -0.65
          0.2790             14.37
          0.2830                       -0.10
          0.2870             14.37
        _____
          0.2910             14.37      0.46
        ++++++++++++++++++++LAST+++++++++++++++++++++
```

notes:

*c-g*    echo of the data filename, and the run identification strings defined in the Top-level, Building, and Services files.

*h*      pointer to the information file for further information on the run.

*k-bg*   data printout for one interval, repeated for as many intervals as requested.

*k*      element number and time of interval.

*m-n*    total heat absorbed in element, and if a window, solar absorption and transmission data.

*r-x*    surface data, for both first and last surfaces. This particular element is an external wall; the "mean radiant temperature" and "mean surface temperature" of the "outside" are not calculated, hence they are 0 in this printout. Where applicable these two terms refer to the means of surfaces surrounding the element in question. The "effective temperature seen" is calculated as the equivalent mean surface temperature of a black-body enclosure containing the element, which provides the same radiant flux (including longwave sources) at the elements surface.

*w-x*    surface heat flows, in $W/m^2$ are signed positive when travelling from the "FIRST" to the "LAST" surfaces, i.e. **positive** when flowing **into** the "first" surface, and when flowing **out** of the "LAST" surface. In this case 12.4 $W/m^2$ is leaving the first, external surface, and 1.3 $W/m^2$ is leaving the internal surface.

*z-bg*   snapshot of temperatures and heat fluxes through the element. Presented as a table of depths (in m.) from the "FIRST" surface, temperatures (°C) and heat flux ($W/m^2$). Note that the nodes for temperature and fluxes are not generally in the same positions. The solid lines (*am*) denote an interface between material layers. The flux signing is as described above.

## 8.5 LOGGER FILE

### 8.5.1 Overview

The profile file contains spot state values of results of the simulation.  These values are not recorded, however, at fixed intervals but only when the value has changed by a certain preset tolerance.  Thus the complete time series may be reconstructed to a time resolution of one calculation time-step, and a value resolution of the tolerance (by default 0.5°C and 10 Watt).  This format is intended to allow the recording of quickly changing parameters without undue file storage requirements.  By default, the file is written in a machine specific binary format, and as such is not directly readable by humans.  Post processing programmes are required to read and format the information contained in this file into an intelligible form.  One such  postprocessor is the programme 'ltable', supplied with this release.

Logger files are not automatically produced by each run of the model, the reporting module must be both primed with a target file name, and enabled for execution by the Top-level or Diary files.

In the current release, HTB2 will not over-write an existing profile file, the programme will stop execution if a new run is attempted with an old filename.

### 8.5.2 File Scope and Format

The standard Logger file is a fixed record length, binary encoded file.  Optionally, the output may be written in ASCII  text format, through this is almost as opaque to the eye as the binary format (the text format may be  useful as a debugging tool).  Binary representation of data is unfortunately a machine dependant feature, as each machine has small, but significant, differences in the binary format.  However as the HTB2 output is generally only in real numbers, it has been possible to provide translation routines between different machine formats. That is output files generated on a DEC mainframe can be ported to a PC, for analysis.

Data recorded in this file may include (depending on options chosen);
> surface temperatures and heat fluxes,
> space air temperatures
> zone mean surface and mean radiant temperatures,
> solar transmission through elements,
> ventilation rates
> heating system output and duty cycles.

The general file format is detailed in the Technical Reference.

### 8.5.3 Brebungl Result

The Logger file resulting from the Brebungl run, BREB1.LGR, was passed through the ltable postprocessor to provide the following report of the 1st day's results of air temperatures for space 1.  The ltable postprocessor is described in section 3.

```
 BREB1.LGR
page   0
 Data created by     : LOGGER V1.9 jun-90
   on                : SUNos4 HTB2 v1.10                    Fri May 15 09:33:37 1992
   run identity      : BRE bungalow test 1
   building identity : BRE type bungalow
   services identity : full systems
   information file  : BREB1.INF
 Timestep:    90.0000


 BREB1.LGR
page   1
 DATA FOR    1 DAYS FROM  8/ 1/1990 FOR EVENT   1 INDEX    1


 DATE      TIME            OLD        NEW


                        VALUE      VALUE
                 SPACE AIR TEMP     oC
 8/ 1/90  0: 1:30    -999.        15.0
 8/ 1/90  0:54: 0     14.5        14.5
```

8-13

```
8/ 1/90  3:13:30     14.0      14.0
8/ 1/90  6: 1:30     13.5      17.1
8/ 1/90  6: 3: 0     17.1      19.0
8/ 1/90  9: 3: 0     19.0      17.5
8/ 1/90  9: 4:30     17.5      16.6
8/ 1/90  9: 6: 0     16.6      16.0
8/ 1/90  9: 9: 0     15.5      15.2
8/ 1/90  9:13:30     14.7      14.5
8/ 1/90  9:21: 0     14.1      14.0
8/ 1/90  9:42: 0     13.5      13.5
8/ 1/90 13: 9: 0     13.9      14.1
8/ 1/90 13:25:30     14.5      14.6
8/ 1/90 14: 7:30     15.0      15.1
8/ 1/90 16: 1:30     14.6      18.1
8/ 1/90 16: 3: 0     18.1      19.0
8/ 1/90 23: 3: 0     19.0      17.4
8/ 1/90 23: 4:30     17.4      16.4
8/ 1/90 23: 6: 0     16.4      15.8
8/ 1/90 23: 9: 0     15.3      14.9
8/ 1/90 23:12: 0     14.6      14.4
8/ 1/90 23:18: 0     13.9      13.8
8/ 1/90 23:43:30     13.3      13.3
9/ 1/90  0: 0: 0     12.8      12.8
9/ 1/90  0:27: 0     12.3      12.3
```

notes:

*b-h*  echo of the data filename, and the run identification strings defined in the Top-level, Building, and Services files.

*i*  pointer to the information file for further information on the run.

*j*  the calculation timestep for the run, which is also the time resolution of the recorded data.

*p-s*  data header for one logged parameter.

*t*  a logged record. Data is presented as the date and time of the significant change, the value of the parameter in the immediately preceding timestep, and the value now.  The preceding value is recorded so that rates of change may be determined.

*ad-ae*  i.e. the air temperature stayed at 14.2 °C (±0.5°C)  for 24 minutes.

# SECTION 3

# CHAPTER 9

# HTB2 CALCULATION, UTILITY AND SUPPORT PROGRAMMES

HTB2 release 2 has several software components, categorised as Calculation, Preprocessors, Postprocessors and Utilities.

There are two calculation components; HTB2 and WHTB2. These are the calculation engines, executing the simulations for DOS and Windows respectively.

Preprocessors aid in the development and editing of the input data for HTB2. These are only available under the Windows environment.

Postprocessors aid in the formatting and analysis of the HTB2 results. There are programs available for both DOS and Windows.

Utilities aid in the more esoteric areas of HTB2; translating data files form other sources for instance.

The software will be described below, in these four groups.. Each program will be described in its function, method of use, and interaction with the user.

## 9.1 CALCULATIONS - HTB2

**Program name:** *HTB210.EXE*

**Description:** HTB210.EXE is the DOS console version of the calculation program for HTB2. It manages data file input, simulation calculations, and data output. It may be useful for batch run situations, where multiple simulations may be required to be run unattended.
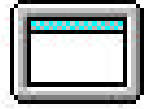
**Command Line:** at the console prompt:
    HTB210 *filename*

The program accepts 1 command argument, the name of the Top Level File. This file should reside in the directory from which HTB2.EXE is started. If no filename is provided, HTB2.EXE will use the file *HTBCMD* if it exists. If no Top-level file is found, or the filename given is incorrect, HTB2.EXE will exit and unload.

**Facilities:** HTB210.EXE manages the thermal simulation of the building described in the input data files, as described in the initial section of this manual.

**User Interaction:** The is no user interactive I/O in this program. Once the calculations have started they will proceed as specified in the Top-level file, or until an error condition is reached.

## 9.2 CALCULATIONS - WHTB2

**Program name:** *WHTB2.EXE*

**Description:** WHTB2.EXE is the Windows (Windows95, NT, XP) version of the calculation program for HTB2. It manages data file input, simulation calculations, and data output; and allows limited user interaction and data display during calculations.

**Command Line:** through the Windows Program Manager File Properties, the Windows File Manager Association or the Windows Run option:

WHTB2 *-options filename1 filename2*

The program accepts up to 3 optional command arguments;

The first is a series of option characters, started with the minus character "-". The following characters are allowed

*f* -file -the argument following (filename1) is the name of the Top-level file. The working directory will become that containing the Top-level file. Normally WHTB2 uses windows menus to select the Top-level file.

*c* -config -the argument following (filename1 or filename2 if the f option above is used) is the name of the WHTB2 configuration file. The configuration file specifies various screen display options for WHTB2. Normally WHTB2 uses windows menus to select the configuration file, if the default condition is not required.

*r* -run -start simulation calculations immediately on start-up. This option requires the f option to determine the Top-level file. Normally WHTB2 requires user input to start calculations once an input file has been chosen.

*q* -quit -exit program when simulation run is completed. Normally WHTB2 will not exit after a simulation, but wait for the user to exit or start a further run.

*i* -icon -start-up program in "minimized" form (i.e. as an icon). Normally WHTB2 starts up full screen. Running as an icon, suppresses screen display overheads and will speed calculations.

*s* -screensaver -suppress WHTB2 screen saver function. Normally WHTB2 will disable Windows screen-saver software whilst it is running, so as to optimise processor usage. This may be turned off by this option if problems arise from this.

The first command option should be presented with no white space after the "-". The filename options should each be separated by a space. For example the command line

**whtb2 -rifq test.top**

would load WHTB2, use TEST.TOP as the main input data file (selected from the default directory specified in program properties), run immediately as an icon, and exit and unload on conclusion of the calculations.

The standard configuration (double clicking on the wHTB2 icon in Program Manager) loads wHTB2 in idle mode (fullscreen, no Top-level file, no calculation).

**Facilities:** wHTB2.EXE manages the thermal simulation of the building described in the input data files, as described in the initial section of this manual.

**User Interaction:** wHTB2 uses several screens and menus to allow user interaction.

## Screens

*MAIN Screen*:

Menu

System

Running Display

Status
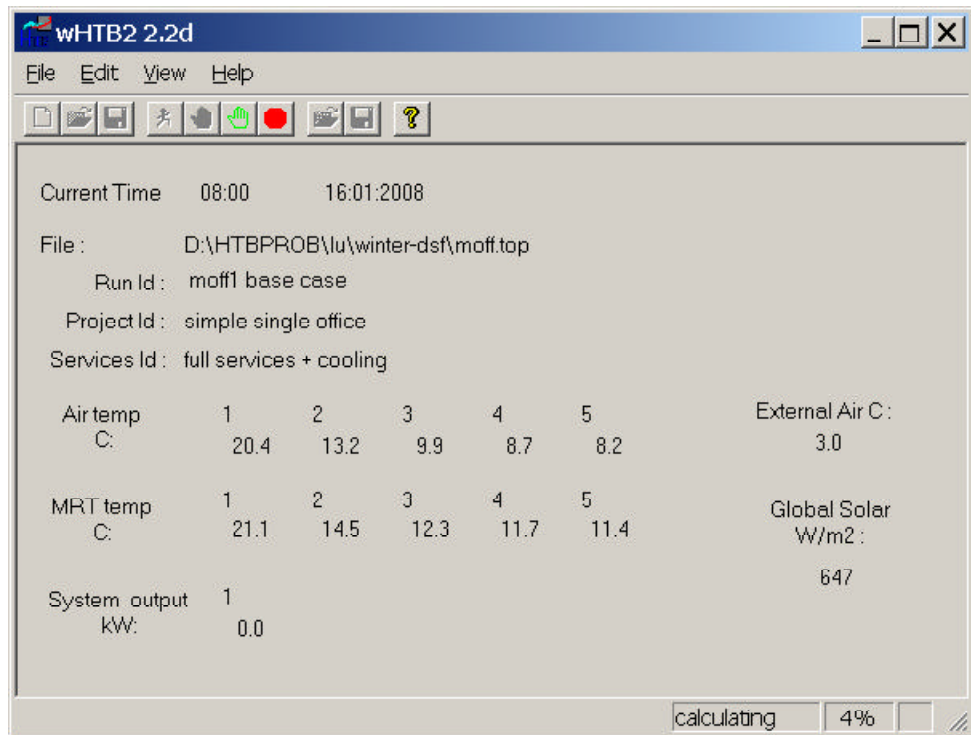


Menus provide access to functions that open files, manage the simulation, and display status and simulation progress and results.

System menus provide access to standard Windows Minimize, Restore and Exit functions. Note that this screen may not be altered in size (beyond minimisation) but may be moved within the Windows desktop.

The running display indicates the progress and partial results of a simulation.

The status bar shows program status and the name and location of the Top-level file. The bar to the right indicates progress as the proportion of days simulated of the total desired.

*ICON Screen :*

Displayed when minimised, wHTB2 indicates the simulation progress in the icon title:
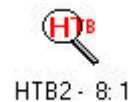


*INFO Screen:*

The Info Screen displays run information; progress and error messages. During the Input phase, problems in input files will be highlighted here.
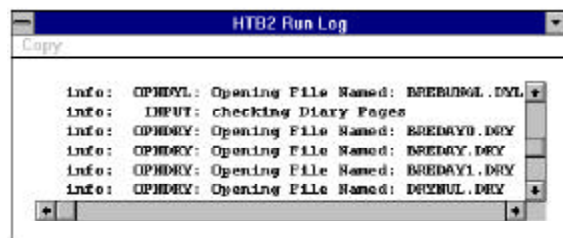


*Stripchart Screen:*

The stripchart screen provides a view of simulation results, displayed as a rolling stripchart at approximately calculation timestep resolution. wHTB2 parameters that may be shown are: air temperature, heating output, and solar gains of a selected space, fabric temperatures of a selected element, and external temperature. Up to 3 such stripcharts may be displayed independently.
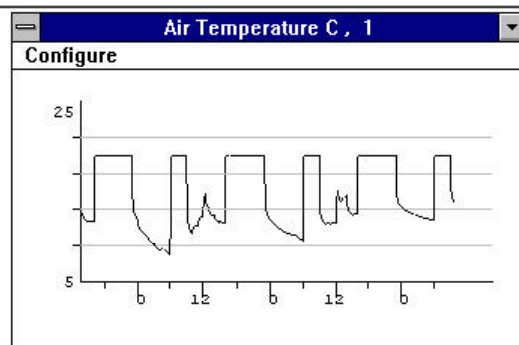
**Main Window Menus**

The following describe the menu system available from the Main Window. Not all menu options are available a all times, choices are greyed when not available/appropriate.

**File**

> **Open** : Starts a file dialog in order to find and select the Top-level file. The default file ending is .TOP. wHTB2 will use the location of the Top-level file as the working directory. Available only when wHTB2 is not calculating.

> **Run** : Start a simulation calculation, using the Top-level file nominated. Available only when a Top-level file has been selected.

> **Pause** : Suspends calculations (perhaps to allow other Windows programs to have full access to the computer). Available only when calculations are running.

> **Continue** : Continue calculations after a pause. Available only when Paused.

> **Stop** : Stop calculations. An error condition, the run cannot be continued, but may be restarted. Available only when calculations are running.

> **Load Config** : Starts a file dialog in order to find, select, and load a wHTB2 configuration file. Configuration files determine the location and visibility of wHTB2 screens, and the style and content of the main and stripchart screens. Configuration files may be used to set up display or demonstration sets for instance. Available only when calculations are not running or paused.

> **Save Config** : Starts a file dialog in order to nominate and create a wHTB2 configuration file, using the current screen conditions. Available only when calculations are not running or paused.

> **Quit** : Stops the wHTB2 program and removes it from memory. Available only when calculations have finished or have been stopped with the STOP menu.

**Edit**

> **Top Level File**

> > **Panel** : (not available)

> > **Text** : ( not available in this release )

> **Configuration** : Starts a dialog to allow aspects of the screen status display to be altered.

**View**

> **Info** : Makes visible the INFO screen ( for instance if that screen had been closed by its close button).

> **Stripchart** : Initialises a new, or makes visible and old stripchart screen ( for instance if that screen had been closed by its close button).

**Help** : Raises the Windows Help system, with information relating to wHTB2.

There are no functioning menus for the INFO screen.

**Stripchart screen Menu**

**Configure** :   Raises the stripchart Configuration dialog.

**Dialogs**

*Configuration Dialog* :  Alters display properties for the main screen display of simulation calculations.

The display may be updated at three frequencies; Medium (the default) updates every 15 minutes (in simulation time). Slow updates hourly and Fast updates every timestep.  The more often the update, the slower in general will be the progress of the simulation.

Screen crawl slows down the simulation significantly, so that the screen display may be read more easily.  This may be useful for debugging a problematic data set.
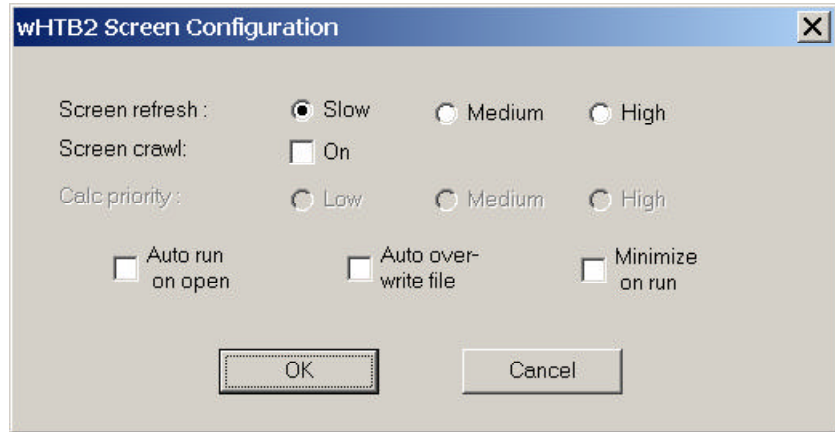
This dialog can also be used to alter some run options; "Auto run on open" will start calculations as soon as a problem file is loaded, "Auto overwrite file" will suppress the check on existing output files, and "minimize on run"  will cause the software to reduce to an icon while calculations are in progress.  These option may be useful in a production scenariom but for most purposes the default condition will be satisfactory.

"OK" accepts the new values and closes the dialog.  "Cancel" closes the dialog leaving the previous values unaltered.

*Stripchart Configuration Dialog*: Alters the display parameters for the stripchart <u>from which it was raised</u>.  The data item to be charted is selected from the list to the left; only one item at a time may be charted on each chart.  The appropriate index (space number for air temperature, heating output and solar gains, element number for element profile) and the scale maximum and minimum are to be entered in the right hand boxes.

"OK" accepts the new values and closes the dialog. "Reset" sets the values to the default and closes the dialog.  "Cancel" closes the dialog leaving the previous values unaltered.
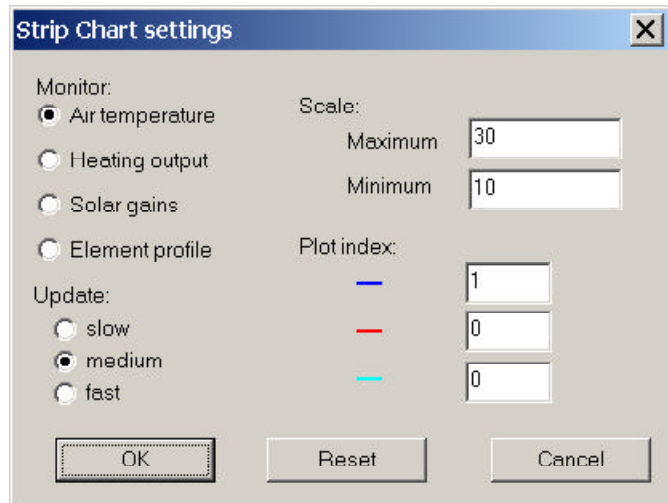
## 9.3 PRE PROCESSOR - SCHEME EDITOR

**Program name:** *SCHEME.EXE*

**Description:** SCHEME.EXE is the Windows preprocessor intended to aid the creation and alteration of HTB2 Building and Layout data files.
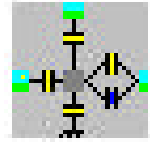
**Command Line:** through the Windows Program Manager File Properties, the Windows File Manager Association or the Windows Run option:

SCHEME -*f filename*

The program accepts 2 optional command arguments;

The first is a single character, started with the minus character "-". The following character is allowed

*f*        -file   -the argument following (filename) is the name of an existing Building file. This will be loaded and displayed on start-up. The Building file defines it's associated Layout file.

The first command option should be presented with no white space after the "-". The filename options should each be separated by a space. For example the command line

**scheme -f test.bld**

would load SCHEME, and use TEST.BLD as the main input data file (selected from the default directory specified in program properties).

The standard configuration (double clicking on the SCHEME icon in Program Manager) loads SCHEME with no building or layout data defined.

**Facilities:** SCHEME.EXE manages the definition of the Building and Layout data files (see chapter 3). As well as allowing creation and naming of Spaces and Elements, and allowing the definition of parameters such as area construction type, SCHEME displays a non-representation diagram of the relationships between spaces and elements; a connection network   Dialog panels are used to edit parameters, some parameters will have allowable items to choose from (e.g. a list of known construction types). Display options allow complex data files to be simplified visually. SCHEME reads and creates HTB2 compatible Building and Layout files.

SCHEME, and WHTB2 do not communicate apart from files. Therefore, for a simulation with WHTB2 to relate to the latest changes made in SCHEME, then the changes must be saved to a HTB2 data file by the user before the simulation is started.

**User Interaction:** SCHEME uses several screens and menus to allow user interaction.

**Screens**

*MAIN Screen*:

Menu

System

ToolBar

WorkSpace
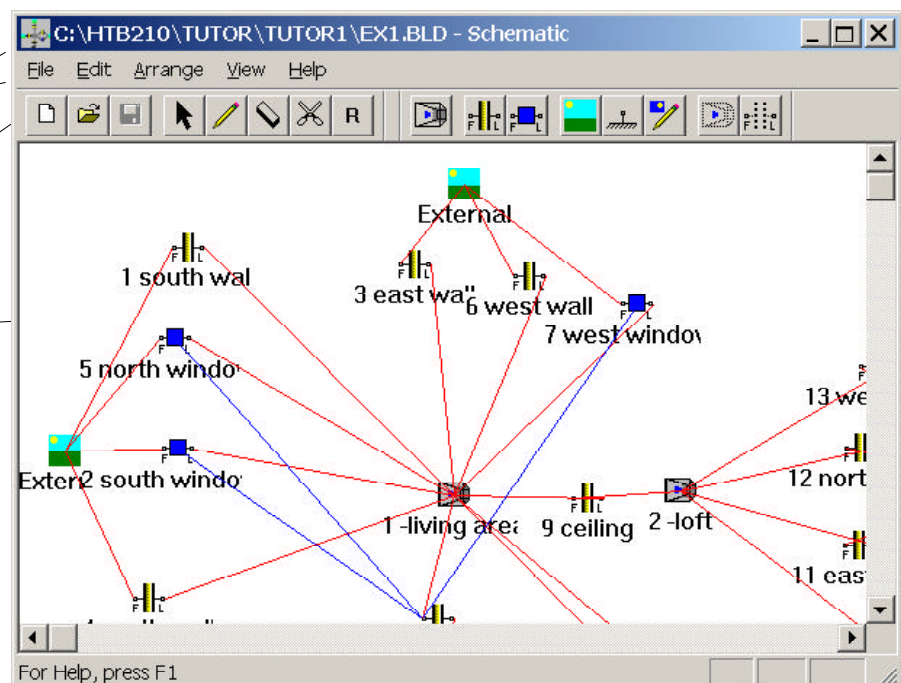
Menus provide access to functions that open files, edit properties, and manage the display.

System menus provide access to standard Windows Minimize, Restore and Exit functions.

The ToolBar provides selection icons for selection, creation and editing of spaces, elements and connections.

The workspace is the drawing area. It is scrollable, depending on the extent of the network contained within it. It uses a series of icons to represent objects; an object in SCHEME is a space, element, etc. Double-clicking on an object allows attributes to be defined for that object; an attribute of an element for instance would be its area or construction type, for instance. The connection of a surface to a space is an attribute of an element.

SCHEME uses a layer analogy; Spaces, Elements, The Outside, Connections and Window Patching are displayed on independent layers; each layer may be made visible or invisible to aid clarity of the workspace. Colour is used in SCHEME to denote connection type; a red line is a connection between a surface and a space, a blue line is a patch between a window and a surface.

To further aid clarity, selected objects may be made visible or invisible; thus for instance only the elements connected to a certain space may be visible.

The SCHEME workspace is used to create and define (by placing an icon) spaces and elements, and by drawing connection lines, define their interconnections. Cut, Copy and Paste may be used to build up a complex building description.

### Main Window Menus

The following describe the menu system available from the Main Window. Not all menu options are available at all times, choices are greyed when not available/appropriate.

**File**

  **New** : Clears the workspace and memory of any previous data.

  **Open** : Starts a file dialog in order to find, select, and load an HTB2 Building file (default file type is .BLD). The Building and Layout files between them define the schematic.

  **Save** : Saves the current information in the HTB2 Building file and Layout file previously opened.

  **Save As** : Starts a file dialog in order to nominate and create an HTB2 Building file (default file type is .BLD) and HTB2 Layout file (default type .LAY).

  **Load Construction File** : Starts a file dialog in order to find, select, and load an HTB2 Construction file (default file type is .CON). Makes the constructions defined in that file available for use in the building element descriptions.

  **Run Construction File Editor** : Starts the construction editor to allow manipulation of the HTB2 Construction data.

  **Load Mask File** : Starts a file dialog in order to find, select and load a text file (or HTB2 Layout file) containing Shading mask descriptions. Makes those masks available for use in the building element descriptions.

  **Exit** : Stops the SCHEME program and removes it from memory.

**Edit**

  **Cut** : Remove the selected object(s), but leave in memory. Note also that cut and paste are internal to SCHEME only, i.e. they do not function with the Windows Clipboard. Selection is made with the mouse. A single object is selected by a single mouse right-click on its icon. Multiple objects may be selected by shift-right-clicking on a number of icons or holding the right button down and dragging a box across the objects desired.

**Copy** : Copy the selected object(s) to memory. A copy has all the attributes (i.e. surface area) of the original.

**Paste** : Paste the object(s) in memory into the workspace.

**Delete** : Delete the selected object(s) from the workspace. They cannot be recovered when deleted. Note there is no UNDO function in SCHEME.

**Edit Selection** : Globally alter certain attributes of the selected objects. These attributes are: Construction type, Window Type, Area, Orientation, and Tilt. A dialog box is raised to provide the options of attributes to alter, and to enter the new values.

**Select Like** : Selects a number of objects that match the currently selected object. A dialog box is raised to allow the attributes required to be matched to be selected; Construction type, Window Type, Orientation and Tilt are the options available.

**Select All** : Selects all "visible" objects in the workspace.

**Site Details** : Raises a dialog box to allow site data to be entered. This data includes site Latitude and Longitude for instance.

**Edit Shading** : Raises a dialog box to allow shading masks to be defined or edited.

## Arrange

**Group** : Make selected object as one grouped object. This will be displayed as a single icon, and so can be used to simplify complex schemes.

**Ungroup** : Revert the selected object into its component objects.

**Expand** : Zoom into the scheme. Icon sizes do not change, but the displayed spacing between objects is increased.

**Contract** : Zoom out of the scheme. Icon sizes do not change, but the displayed spacing between objects is decreased.

**Rotate** : Adjust the Orientations of all selected objects by the stated amount.

**Flip** : Mirror the Orientations of the selected objects along the selected axis.

## View

**Toolbars** : Toggle the visibility of the selected toolbars.

**Status Bar** : Toggle the visibility of the status bar at the bottom of the main window.

**Connection check** : Start a logical check of the Element data, raises a dialog box listing those element that have incomplete or logically incorrect connections specified.

**Detail Check** : Start a logical check of the Element and Space data, raises a dialog box listing those element that have incomplete or logically incorrect data specified. Note that not all Element or Space data errors can be found in a simple check. It is the users responsibility to provide accurate data.

**Show Selection** : Display only the selected object, and any objects to which it is directly connected. This may be used to simplify a complex scheme.

**Building** : Display only the certain types of objects, as selected by:

**Walls and Windows** :    Make visible or invisible all Elements (walls, windows, floors etc.).  This is a checkbox option; reselecting it on the menu will toggle the function to its other mode.

**Spaces** :    Make visible or invisible all Spaces.  This is a checkbox option; reselecting it on the menu will toggle the function to its other mode.

**Connections** :    Make visible or invisible Surface-Space connections between objects.

**Help** : Raises the Windows Help system, with information relating to SCHEME.


### Dialogs

Dialog boxes provide access to most of the information describing the building and its components.  The following are raised by double clicking on an object (Space or Element).

*Space Dialog*:    Defines or alters the attributes of a space, including its Volume, and the name (any string of characters) by which it will be known within SCHEME.

*Opaque Element Dialog*:   There are 3 levels of data for Elements, according to the priority of the data and the general acceptability of defaults.  The first dialog (raised by double clicking on the Element icon) defines required data for an Element, data for which no valid defaults could be used e.g. surface area and construction type.

 The second (raised from the "Advanced" button on the first dialog) allows access to data for which there are acceptable defaults, but which may commonly be altered (e.g. surface absorption coefficient).

The third (raised from the "More" button on the second dialog) allows access to data that should not required alteration often (e.g. surface emissivity).

*Window Element Dialog*:   This is similar to the Opaque Element, apart from the extra data required by a Window; the Window Type and access to patching information.

Other Dialogs are raised through menus or buttons on dialogs.

*Site Dialog* : Raised by the Edit Site menu, this allows site data to be entered. Default values for TimeZone (0: Greenwich) and Skyline (0) are available.  Where the default value is taken, the appropriate dialog box is left clear.

*Check Dialog* :	Raised by the Check Connections or Check Details menus, this presents a list of Object for which there is missing or erroneous data.



*Shade Dialog*:	Raised by the Edit Shading button on the Element Dialog this dialog shows the list of available Masks (those defined in the Layout, NONE, the default, is always available).  It also allows new shading names to be added to the list, or to remove redundant names.   The data describing the new mask can be imported or calculated from simple parameters.

*Patch Dialog*:	Raised by the Edit Patch button on the Window Element Dialog this dialog allows checking and specification of the sun patching information required by Windows. The SCHEME workspace allows definition of Patching connections (i.e. which surfaces the solar energy through a window reaches); this dialog allows proportions to be attributed to each such connection. Thus for instance, by the 3-D geometry of the space (of which HTB2 is not aware) 80% of the solar energy may fall on the adjacent floor, 20% on a back wall.



**Notes:**	The SCHEME workspace grows with the complexity of the network.  Not all the workspace may be visible, the scrollbars are used to move the users screen over the workspace.  As an object is dropped or moved near a far margin, the workspace is increased slightly.

## 9.4 PREPROCESSOR - CONSTRUCTION EDITOR

**Program name:** *CONSTR.EXE*
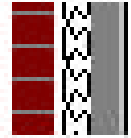
**Description:** CONSTR.EXE is the Windows preprocessor intended to
aid the creation and alteration of HTB2 Construction data files.

**Command Line:** through the Windows Program Manager File Properties, the Windows File
Manager Association or the Windows Run option:
        CONSTR *-options filename*

The program accepts 2 optional command arguments;

The first is a single character, started with the minus character "-". The following characters are allowed
      *f*     -file   -the argument following (filename) is the name of an existing Construction file. This will
      be loaded and displayed on start-up.

The first command option should be presented with no white space after the "-". The filename options should each
be separated by a space. For example the command line
      **constr -f test.con**
would load CONSTR, and use TEST.CON as the main input data file (selected from the default directory specified
in program properties).

The standard configuration (double clicking on the CONSTR icon in Program Manager) loads CONSTR with no
construction data defined.

**Facilities:** CONSTR.EXE manages the definition of the Construction data file (see chapter 3). It allows the
creation, inspection, alteration and naming of Constructions, estimates the "U-value" of the constructions[*], contains
a list of standard material properties. This programme also allows Glass Type properties to be created, named and
altered. CONSTR reads and creates HTB2 compatible Construction files.

CONSTR, SCHEME, and WHTB2 do not communicate apart from files. Therefore, for a simulation with WHTB2 to
relate to the latest changes made in CONSTR, then the changes must be saved to a HTB2 data file by the user before the
simulation is started.

[*]the estimate of U-value is strictly valid only for vertical walls, horizontal constructions would require a correction
factor to be applied to the surface coefficients, and the U-value calculations are inappropriate for solid floor slabs.
Note that HTB2 does not use this U-value; the fabric heat flow is calculated more explicitly.

**User Interaction:** CONSTR uses several screens and menus to allow user interaction.

      **Screens**

*MAIN Screen*:

Menu

System

WorkSpace

Construction Panels

Materials Panel

Menus provide access to functions that open files, edit construction, manage the data and display.

System menus provide access to standard Windows Minimize, Restore and Exit functions.

The workspace is simply a background area. It contains panels; the Materials panel and one or more Construction panels. The workspace scrollable, depending on the extent of the information contained within it. Any or all panels may be minimized (made an icon) to aid display clarity.

*Materials Panel* :

The Materials panel is a scrollable display of the material thermo-physical properties available to constructions. Those properties are loaded from the HTB2 materials library file(s) specified in the Construction file. For a new construction a new materials library may be loaded and associated with a Construction file. As in HTB2, there are up to two materials libraries available; the Standard and the User. The User file is intended to supplement the standard library should required properties not be found there.

| Select Material | | | |
|---|---|---|---|
| Name of component | Conductivity W/m/°C | Density Kg/m3 | Specfic Heat J/Kg/°C |
| OUTER BRICK | 0.840 | 1700 | 800 |
| INNER BRICK | 0.620 | 1700 | 800 |
| PLASTER | 0.260 | 800 | 1000 |
| PLASTERBOARD | 0.160 | 950 | 840 |

◉ Standard File     ○ User File

The data in the materials panel is displayed according to the current sort setting (see the Sort menu). An individual material may be inserted into the current Construction by double-clicking on its name.

The material properties may not be edited through this program; alterations or additions to the User library must be made externally, through a text editor (i.e. Notepad). Note that if changes are made to the User materials file, it must be reloaded before CONSTR will find the modifications.

*Construction Panel* :

There may be a number of construction panels (or their icons) in the workspace, each one represents on HTB2 Construction type. The construction panel shows the layers of materials associated with a construction. For each layer, the material name, and thermal conductivity are taken from the materials file, the layer thickness is supplied by the user.

The active construction is the last one that had the "Windows focus", i.e. had a mouse click within it or on its title bar. The active layer is the layer highlighted by a mouse click on its material name.

The active layer may have its width altered in the dialog box below the layer list, or it may be copied, cut or pasted. Pasted layers generally enter after the active layer. More that one layer may be selected (by multiple shift-clicking) for cutting or copying.

| 1 external cavity wall | | |
|---|---|---|
| Construction Name 1 external cavity wall | | Type Opaque |
| Name of Component First | Conductivity W/m/°C | Material Thickness mm |
| OUTER BRICK | 0.840 | 105 |
| CAVITY NORMAL | 0.591 | 65 |
| INNER BRICK | 0.620 | 105 |
| PLASTER | 0.260 | 16 |

Last

PLASTER                                          Thickness 16

**Calculated U Value     1.55**

Layers may be copied and pasted between construction panels, but only with the CONSTR program; the Windows clipboard is not used.

A new (empty) construction panel may be created through the File New menu. New materials layers are entered by double clicking on the required material in the Materials panel. A new construction must have a name associated with it; this may be entered in the top middle of the panel. The construction type (currently only Opaque or Transparent) should also be set as appropriate. Following the HTB2 naming convention, the First layer at the top of the list.

**Main Window Menus**

The following describe the menu system available from the Main Window.  Not all menu options are available at all times, choices are greyed when not available/appropriate.

**File**

**New Construction** : Create a new, empty, Construction.

**Remove Construction** :     Delete the active Construction.  This is not recoverable.

**New Construction File** :     Starts a new, empty, workspace with the standard Materials library, and one new, empty Construction.

**Open Construction File** :   Starts a dialog to find, select and load an HTB2 construction file into the workspace.  This will remove all existing Constructions from the workspace.

**Save Construction File** :    Saves the Constructions in the workspace to the current  Construction file.

**Save Construction File As** :          Starts a dialog to nominate a new filename, and to saves the Constructions in the workspace as an HTB2 compatible Construction file.

**Load User Material File** : Starts a dialog to find, select and load an HTB2 user materials library.

**Load Standard Material File** :     Starts a dialog to find, select and load an HTB2 standard materials library.

**Import Glass Definitions** : Starts a dialog to find, select and load Glass Type data.  CONSTR can extract this data from a simple text file (see the example GLASS.HLP in the data subdirectory), or from an HTB2 construction file.

**Exit** : Stops the CONSTR program and removes it from memory.

**Edit**

**Cut** :  Remove the selected layer(s), but leave in memory.    Selection is made with the mouse.  A single layer is selected by a single mouse right-click on its name.  Multiple layers may be selected by shift-right-clicking on a number of layers.

**Copy** :Copy the selected layer(s) to memory.

**Paste** :Paste the layer(s) in memory into the current active Construction panel, after the current active layer.

**Paste Before** :        Paste the layer(s) in memory into the current active Construction panel, before the current active layer.

**Delete** :        Delete the selected layer(s) from the construction.  They cannot be recovered when deleted. Note there is no UNDO function in CONSTR.  To delete an entire construction, use the File Delete Construction menu.

**Edit Glass Types** :   Raise a dialog to alter the Glass Types list and data.

**Sort**

**Name** :        Sort the Materials list alphabetically.

**Conductivity**  :      Sort the Materials list by conductivity.

**Density** :     Sort the Materials list by density.

**Specific Heat** :      Sort the Materials list by specific heat capacity.

**Windows**

      **Cascade** :     Arrange all open Construction panels neatly

      **Make All Icons** :     Close, or minimise, all Construction panels.

      **Arrange Icons** :     Arrange all closed Construction panels neatly.

      **(panels)** :     Select and make active the panels by name.

**Help** : Raises the Windows Help system, with information relating to UVAL.

      **Dialogs**

Dialog boxes provide access to other information described in the HTB2 Construction file. In particular dialogs give access to the Glass Types information.

*Glass Types List*:     This dialog presents a list of Glass Types currently known to UVAL (i.e. defined in the Construction file). There are four controls:

     *Add*, will allow a new Glass Type to be entered into the list. Note that this only declares a name acceptable for use in SCHEME. It does not define the properties of a Glass Type. Use the Edit function to add properties to a new glass type.
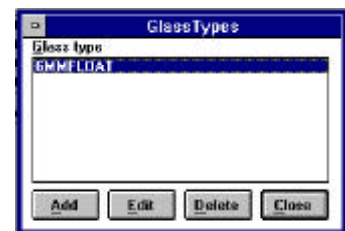
     *Edit*, raises a dialog to allow the transmission and absorption properties of the selected Glass Type to be displayed and altered. See the description of the Glass Properties dialog below.

     *Delete*, removes a Glass Type from the list.

     *Close*, ends the dialog.

*Edit Glass Type Properties*: This dialog allows the transmission and absorption properties of the selected Glass Type to be displayed and altered. The Glass Type properties (transmission coefficient or absorption coefficient as selected at the bottom of the dialog) are displayed as a Graph; the value for diffuse, then for direct beam in 10 steps, starting from 0. Each point may be selected by clicking on the point; a new value may be entered in the dialog box, or by dragging the point with the mouse. There are two controls;
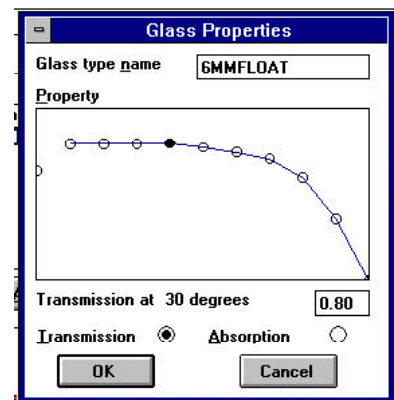
     *OK* accepts any changes to the parameters and closes the dialog, while

     *Cancel* discards any changes and reverts to the original parameters, before closing the dialog.

Note that new Glass Types may be imported into the Construction file through the File Import Glass Types menu. This will read in a text file containing the complete definition of a Glass Type in HTB2 Construction file format. See the description of the construction file in chapter 3 for information as to the format of the import file.

## 9.6 POSTPROCESSOR - DATA VIEWER

**Program name:**    *HTB2VIEW.EXE*

**Description:** HTB2VIEW.EXE is a Windows postprocessor intended to aid the translation and formatting of HTB2 Block Report Output files (as produced by the !ENABLE BLOCK OUTPUT Top-level command).

**Command Line:**    through the Windows Program Manager File Properties, the Windows File Manager Association or the Windows Run option:

        HTB2VIEW  *filename1 filename2*

The program accepts up to 2 optional command arguments;  either is a filename, representing an HTB2 report file and an HTB2VIEW configuration file.  They may be in any order.  If files are specified in the command line, they will be loaded automatically.  The filename options should each be separated by a space. For example the command line

        **htb2view test.blk myview.cfg**

would load htb2view, load and display the data in TEST.BLK (assuming there was valid data to display) according to the setup defined in MYVIEW.CFG.

The standard configuration (double clicking on the HTB2VIEW icon in Program Manager) loads HTB2VIEW with a blank view.

**Facilities:**    HTB2VIEW.EXE allows the translation, display and formatting (for printing or export to further analysis software) of HTB2 Block Report results files.  In general HTB2VIEW is intended to achieve two aims;

    allow a quick view of results, for a check of validity of simulation, and

    translate HTB2 results into a form suitable for use in analysis software, e.g. spreadsheets.

It is felt that software generally available (such as Lotus 123, or Microsoft Excel) provides sufficient power and flexibility to produce high quality graphics and results tables.  The capabilities, power and flexibility of support software specific HTB2 may therefore acceptably be less than those commercial products.  However HTB2VIEW does provide a limited means to produce simple graphics and printed tables of results.  It is our position that a good analysis package, such as 123 or Excel is a vital but external component to the HTB2 software.

HTB2VIEW provides a view onto the data contained in the results file*.   That view may be thought of as a simple spreadsheet.  There a number of vertical columns; each column contains an item of data produce by HTB2, i.e. Space Air Temperature.  The first two columns are always present and cannot be altered; these are date and time. The other columns are defined by the user; the program supports up to 255 columns (but there may be a limitation on the capability of the target analysis package in the maximum width of an imported file).  Horizontal rows are sequential time records taken from the HTB2 output data file.  The view may be scrolled up and down to scan through a long simulation, or the start and stop dates may be specified.  Scrolling across data items is also possible, if the view cannot be contained entirely on the computer screen; in scrolling, date and time are always visible.

Data viewed in such a manner may be exported as a simple text file; this may be specified as one suited to printing (i.e. all columns line up), or for use as a data file for other software (columns separated by commas "comma-delimited format").  A number of columns may be selected for viewing as a simple graph; that graph may be saved as a computer file.

A "view" (the definition of column contents, start and stop positions, and graphic format) may be saved as a named configuration file.  Thus a number of different standard views may be built up and reused as appropriate.

There are no facilities for arithmetic (i.e. heat loss / temperature difference) in the view, nor can data be compared between different simulations.  External analysis software will be required for those uses.

    * Note that the calculation engine must have finished a simulation for the results file to be valid.
        HTB2VIEW cannot be used to inspect results as the are being calculated.

**User Interaction:**   HTB2VIEW uses several screens and menus to allow user interaction.

   **Screens**

*MAIN Screen*:

Menu

System

View

Menus provide access to
functions that open files,
edit and manage the data
and display.

System menus provide
access to standard
Windows Minimize,
Restore and Exit
functions.



The View shows columns
of data in sequential time order.  The view area is scrollable, depending on the extent of the information defined.

*GRAPH Screen*:

Menu

System

Graph
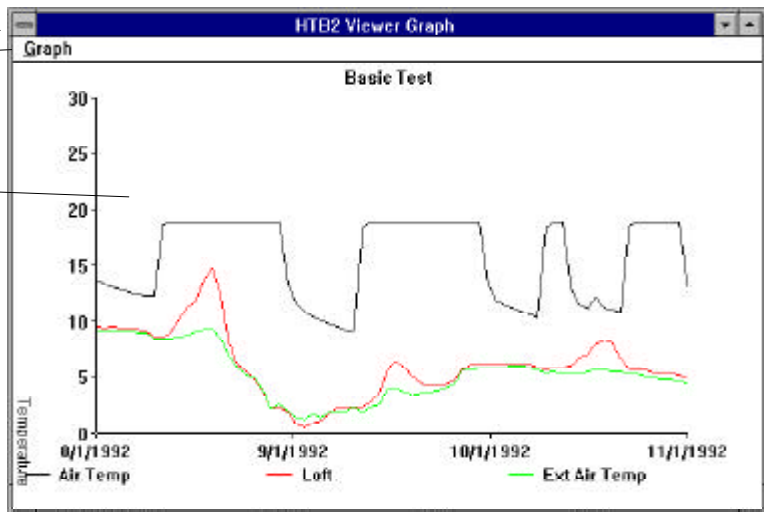
Menus provide access to functions that
alters graph settings.

System menus provide access to standard
Windows Minimize, Restore and Exit
functions.

The graph presents a simple line graphic
of the data selected.  The X axis is always
time.



   **Main Window Menus**

The following describe the menu system available from the Main Window.  Not all menu options are available at
all times, choices are greyed when not available/appropriate.

**File**

   **Open Data File** :   Starts a dialog to find, select and load an HTB2 Block Report results file (default type
      .BLK).  If a different file type, or an older version of the Report file is chosen, an error message will
      be raised.  If a view is defined, the view will be initialised.  If no view is defined (the default start up
      condition) only the time fields will be shown.

   **Close Data File** :   Closes the Results file, and removes the view from the screen.  The HTB2 data file is

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not deleted from the computer disk.

**Load Configuration File** :        Starts a dialog to find, select and load an HTB2VIEW configuration file (default type .CFG).   If a valid Data file is loaded, the view will be initialised.  If no Data file is loaded, only the column titles will be shown.

**Save Configuration File** : Starts a dialog to nominate a new filename, and save the current view state as a HTB2VIEW configuration file. All aspects of the view apart from the actual results data, or the results data filename, will be saved.

**Reset Configuration** :            Initialised the configuration to the start-up state, a blank view.

**Export** :        Starts a dialog to nominate a new filename, and save the current view data as a text file. According to the setup, this may be suitable for printing or incorporation into other software.

**Exit** : Stops the HTB2VIEW program and removes it from memory.

## Configuration

**Edit Column** :        Raise a dialog to allow definition of the number and content of columns.  See the information following for further details.

**Page** : Raise a dialog to allow definition of the type of export, and start and stop dates.  See the information following for further details.

**Edit Filters** : Raise a dialog to allow definition of display filters for the data.  This might be used to, for instance, display only data for times in working hours.

## Graph

**New Graph** : Display the selected columns as a simple line graphic.  Columns may be selected (or de-selected) by clicking on the column title.  There are two y-axis available, with independent scales; right click selects columns for the right hand scale, left for left.

There can be only one graph active.

### Edit Column Window Menus

The following describe the menu system available from the Edit Column Window.  Not all menu options are available at all times, choices are greyed when not available/appropriate. This window is raised by from the Edit Edit Columns menu of the main window.

## Column

**Insert After** :        Insert a new, blank, column after the current active column.  The active column is selected through a control in the dialog, see the discussion of the Edit Column Window below.

**Insert Before** :        Insert a new, blank, column before the current active column.

**Delete** :        Delete the active column.  All columns and their parameters will be shifted left.

**Clear** : Clear the active column; remove the column parameter, leaving a blank column.

### Graph Window Menus

The following describe the menu system available from the Graph Window. Not all menu options are available at all times, choices are greyed when not available/appropriate. This window is raised by from the Graph New Graph menu of the main window.

## Graph

**Graph Settings** : Raise a dialog allowing alteration to graph properties. See the discussion of the Graph setting dialog below.

**Export graph to File** : Raise a dialog to nominate a new filename, and save the current graph as a Windows Bitmap (BMP). The current graph window size will become the size of the bitmap.

**Copy Graph to Clipboard** : Place a bitmap copy of the current graph into the Windows clipboard. This may be pasted into other applications (e.g. Paintbrush, or a word processor).

**Graph Size** : Allows selection of one of two standard graph sizes (in pixels); 600x400 and 1000x600. The graph windows is sizable by dragging the window frame, but as a graph copy bitmap takes on the size of the window, to achieve comparable sizes between runs,, chose one of the standard sizes. The 600x400 size can just be contained within the standard VGA screen.

### Dialogs

Dialog boxes provide access to data describing the column contents and extent of data.



*Edit Column*: This dialog allows definition of the column contents. New columns are added through the Column menu, as described earlier.

*Column* : The active column is selected through column control; a column number may be entered, or the left/right buttons may be pressed to change the active column.

*Name* : The column title may be changed through the next control.

*Variable*: The column contents may be selected from a list of available data. This list comprises the complete set of data stored in an HTB2 Block Result file. According to the options selected for the HTB2 simulation, not all of the data in the list may be available; those items are marked "n/a". If no Data file is loaded when this dialog is raised, all data type are considered available and may be selected; if when a Data file is loaded and a particular data item is not available, a "missing" code (-999) will be displayed in the column.

*Space* : This control may be named Space, Element, etc. as appropriate; it represents an index number for the data item selected. For instance when Air temperature is selected, this control is enabled; the number of the space for which temperature is required should be entered. The arrow to the side will show a list of available index numbers. Currently, the indexing is numeric only; names of the spaces supplied in SCHEME are not used. Index numbers are available through SCHEME.

If an Element related data item is selected (e.g. surface temperature) a further control is enabled to the right of the index number. This allows the face or surface desired to be selected.

*Apply*, accepts the new data as altered, but does not close the dialog; further columns may be set up. Note

that the active column must be manually altered before new selections are made, or the last column choices will be over-written.

*Close*, ends the dialog.

*Page Configuration*: This dialog is raised from the Configuration Page menu. It allows alterations to the format of the Export file type, and to the extent of the data formatted.

*Title*: A title sentence may be entered here, this will be added to the top of the export file, perhaps to identify the simulation contained.

*Format*: There are two formats available for the Export file. Both are simple text files. In the Table option, all columns will align properly (using a fixed pitch type); thus the exported file may be printed or imported into a word processor. In the Text Export option, all columns are separated by commas, and words are contained in quotes ("); this is a "comma-delimited" format, suitable for importation into spreadsheets (e.g. Lotus 123 or Excel). (NB. to read such a file into Excel, select Text Comma in the Text File Options of the Excel File Open menu.)

*Print From*: and

*Days From Start Date*: these coupled controls allow selection of the starting point of the view. The screen display, graph and export file functions will use this as the starting point. The controls are coupled, as one is altered, the other will update. Print From accepts a calendar date, Days From Start accepts a numeric number. Note that if no Data file is loaded, the date content of the data will not be known, and days from start should be used. These values may also be incremented by the left/right arrows to the right hand side. By default, HTB2VIEW starts at the first record in the Results file.

*Print Until*: and

*Days To Print*: these coupled controls allow selection of the Finishing point of the view. The screen display, graph and export file functions will use this as the finishing point. The controls are coupled, as one is altered, the other will update. Print Until accepts a calendar date, Days To Print accepts a numeric number. Note that if no Data file is loaded, the date content of the data will not be known, and days to print should be used. These values may also be incremented by the left/right arrows to the right hand side. By default, HTB2VIEW will view the entire content of the file. Note, setting Days to Print to 0 will set the finish point to the end of the Results file.

*Apply*, accepts the new data as altered, but does not close the dialog.

*Return*, accepts the new data and ends the dialog.

*Filter Configuration*: This dialog is raised from the Configuration Filter menu. This allows definition of display filters. These include averaging and totaling over different periods (daily, Monthly, or for the whole simulation). Heat related values can be displayed as power (e.g. kW) or energy (e.g. kWh). In addition, this dialog offers control over which values to display (or include in the summation). The example opposite sets filters to use only values from times between 8AM and 6PM.

*Accumulation*: The default setting "OFF", displays all records in the data file. When set to one of "Daily", "Monthly", or "All in file", the data displayed is accumulations (averages or summations as appropriate) over the period chosen.

*Show*: When Accumulation is selected, energy values can be shown in equivalent average power (W) or total energy (Wh) over the period.
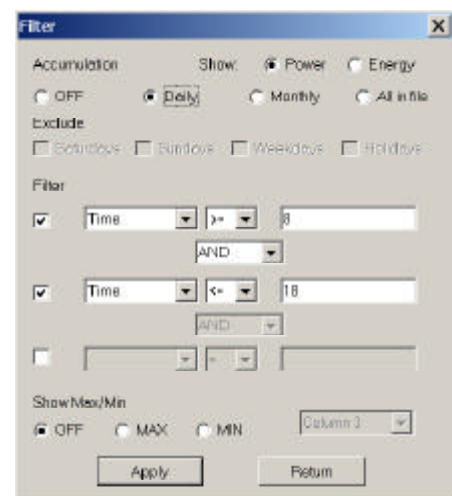
*Exclude*: this function is not yet implemented in this release version.

*Filter*: When a Filter is selected, each record is checked against the criteria before it is displayed or added to the accumulators. Three filters are available.

*Apply*, accepts the data as altered and updates the view, but does not close the dialog.

*Return*, accepts the new data and ends the dialog.

*Graph Setting*: This dialog is raised from the Graph Window Graph menu. It allows the settings for the graph Y axes scaling and titles to be altered (the X axis is always time). By default, there are no graph axes labels or titles, and the first Y axis scale goes from -10 to 40 (suitable for temperatures), the second Y axis from -30000 to +30000 (suitable for energy flows). The graph function does not attempt to scale the graph according to the data selected; the user must set appropriate values using this dialog if the defaults are not acceptable.

*OK*, accepts the new data as altered, and closes the dialog.

*Cancel*, discards the new data, recovers the initial values and ends the dialog.

**Notes:**

### 9.7 Postprocessor : htable

**Program name:**     HTABLE.EXE
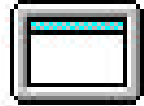
**Description:**  The DOS post-processor htable is text based, question_and_answer driven programme.  It can be used on any machine or terminal.

This programme reads and translates the block Report file, formatting the data for use as a printed table or as input to a spreadsheet programme.  htable is based on spaces. The table or data resulting from its use is essentially a summary of the environmental conditions and thermodynamic heat balance of a space or group of spaces.

There are options available to :-
>     select the space or spaces on which to operate. Multiple spaces can be chosen to produce averaged
>          temperatures (and summated energies) for groups of spaces.
>     select the starting date and duration of the report.
>     select the level of information produced in the report.
>     select the output format for the report.

**Command Line**:     at the DOS prompt;
>          htable

There are no command line options.

**User Interaction** :   htable is a simple text based program.  htable prompts the user for all required information, through a simple question and answer interface.  At several points in this interface the user may enter a code to skip backwards to a previous point (eventually to **EXIT** the programme).  This might be required to correct erroneous inputs, for instance.

Unfortunately, this code (which signals "END OF INPUT", and is usually a control-character)  is system dependant.

The actual code required may be entered here:-

| installation  :- | DOS | UNIX | VAX/VMS |
|---|---|---|---|
| **EOD** code      :- | ^Z | ^D (i.e. control+D) | ^Z |

The interface is illustrated below, using the data file produced by the Brebungl test run, discussed in chapter 8.  A DOS version of the programme was used for this discussion.  The user inputs are highlighted in **bold.**

Note that **"EOD"** is the end of data code, typically (**control+Z**) or (**control+D**), it is not meant to be entered verbatim.

This procedure produces the formatted file BREB1.TBL, described in chapter 8.

notes:
```
a       A:>HTABLE
b       SPACE SUMMARY TABLE  1.9 - fixed format space report of HTB2 summary output
c       What is the HTB2 block report filename? > BREB1.BLK
d       The report file contains data from a run on
e       PCDOS  HTB2 v1.9                 1/ 2/1991  11:12
f       BRE bungalow test 1
g       BRE type bungalow
h       full systems
i        Further run information is contained in
j       BREB1.INF
k       Data starts on  8/ 1/1990   1: 0: 0
l       Do you want to continue with this report file ? [Y/N] Y
m        What is the required output filename?> BREB1.TBL
n         Do you want the information file at the top of the output ? [Y/N] N
o         Do you want period sub-totals/averages ? [Y/N] N
p         Do you want to restrict output/averageing to set times ? [Y/N] N
q         Do you want only total/subtotals printed ? [Y/N] N
r         Do you want max/mins printed ? [Y/N] N
s         Do you want paged output format ? [Y/N] Y
```

```
t              You may either request output for a single space
u                  or for a number of spaces aggregated.
v           How many spaces do you want?
w           1
x           Which space do you require?:         -3 through          2 available
y           1
z           Current time of processing; enter new values as appropriate:
aa          Starting on: day month year, output for n days
ab                        8    1    1990                    1
ac                 8,,1990,1
ad          Current time of processing; enter new values as appropriate:
ae          Starting on: day month year, output for n days
af                        8    1    1990                    1
ag          "EOD"
ah           You may either request output for a single space
ai                  or for a number of spaces aggregated.
aj           How many spaces do you want?
ak          "EOD"
al           Do you want period sub-totals/averages ? [Y/N]  "EOD"
am           What is the HTB2 block report filename? >  "EOD"
an
ao          Stop - Program terminated.
ap
aq          A:>
```

*a*      start the htable programme from the system prompt.

*c*      user enters the name of the input file, the file produced by the block report routine during an HTB2 run.  Note that some systems, i.e. UNIX, are case sensitive, and the file name must be entered correctly.  The programme may be safely **quit** or stopped at this point by entering an EOD code.

*d-k*    the programme echos the time-stamp, and identification strings of the run, as contained in the Report file.

*l*      the user decides to continue ("Y") with this file or to skip backward to point*c* ("N") perhaps to select a new file. The default is "N".

*m*      for each new input file, a new output file is produced.  The user must enter a valid name for that file here.  If a name of a file that already exists is given, that file will be over-written (without warning).  There is no default. "EOD" returns to point *c*.

*n-s*    configure the output format, specifying the type and amount of information to be output.

*n*      lines *e-h* are normally prefixed to the output file ("N"), if required the contents of the Info file in its entirety may be prefixed to the output ("Y").  The default is "N".  "EOD" returns to point *m.*

*o*       the input records are normally printed as they are read ("N"), Optionally these records may be sub-totalled, and extra data output at regular intervals ("Y").  If this option is chosen, a further question requests the sub-totalling interval (a numeric : as numbers of output intervals). For instance, to produce daily averages/totals with the standard hourly report, enter "Y", then "24".  The default is "N".  "EOD" returns to point *n.*

*p*      all input records are normally printed as they are read ("N"). Optionally only those records that fall within a given time window will be printed (and if sub-totalling is enabled, will be sub-totalled) ("Y").  If this option is chosen, a further question requests the starting and stopping times (in whole hours) of the window to include in the processing.  For instance to print only records from 9 AM to 5 PM, enter "Y"  then  9 , 17.  Note that this option is only applicable if the reporting interval is less than the required window, i.e. the windowing is not possible for a Report output set to a daily rate.   The default is "N".  "EOD" returns to point *n.*

*q*      all input records are normally printed as they are read ("N"). Optionally no input records will be printed, only the sub-totalling records will be output (sub-totalling must be selected) ("Y").  For instance, an hourly input file can be printed as a daily average/total report.  The default is "N".  "EOD" returns to point *n.*

*r*      all input records are normally printed as they are read ("N"). Optionally extra information for the maximum and minimum values for temperatures and heating energy, within the report period, may also be printed ("Y").  This may be valuable information, but makes the table less readable.  The default is "N".  "EOD" returns to point *n.*

*s*      Normally the output of the programme is formatted as a printable table ("N").  Optionally the printout may be made in a form suitable for importing into standard spreadsheet analysis programmes.  The default is "N".  "EOD" returns to point *n*.

*t-y*      configure the space or spaces to be processed.  The report table may be produced for a single space, or a number of spaces aggregated.  If an aggregation is chosen a specifiable weighting is applied to each space to produce weighted average temperatures/humidities. Energies are always summed.

*u*      the user selects the number of spaces to aggregate.  If only a single space is to be reported, 1 is entered. There is no default value.  "EOD" returns to point *o*.

*y*      the code index of the space(s) required are entered here.  The index is the position of the space in the Building file declaration, and as used in the Layout file.  Space names are not currently recognised.   Output of Meteorological information may be achieved through entering space 0 (note space 0 may not be aggregated with other spaces).  If an aggregation has been chosen, a weighting factor is also entered with the space code, and a newline is required for every space in the aggregation.  For instance a 3 space aggregation might be:-

```
        1 , 10.0
        2 , 5.0
        5 , 1.0
```

Note that the weightings are automatically normalised to a total of 1.0, i.e. in the above example, the actual weightings would be 0.625, 0.3125, 0.0625 respectively.  There are no defaults for spaces or weightings.  "EOD" returns to point *v*.

*z-ac*      select the starting date, and duration in days, of the report table.  Initially the default is the start of the data, for a 1 day report.

*ac*      The default starting date is displayed.  This may be accepted in its entirety without re-typing by entering a "/", alternatively individual components may be accepted by skipping the item with commas (this operation is a Fortran "feature").  "EOD" returns to point *t*.

*ad-aq* Multiple passes through a report file are possible, with each pass appended to the output report.  Thus a number of individual spaces may be reported from the same date, for instance.  In this case, "EOD" is repeatedly entered to end the programme cleanly, and to return to the operating system.

### 9.8 Postprocessor : ectable
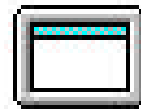
**Program name**:    ECTABLE.EXE

**Description**:  The DOS post-processor ectable is text based, question_and_answer driven programme.  It can be used on any machine or terminal.

This programme reads and translates the block Report file, formatting the data for use as a printed table or as input to a spreadsheet programme.  ectable is based on element classes, as defined in the Layout file. The table or data resulting from its use is essentially a summary of the surface heat flows of the classes defined for the run.

There are options available to :-
     select the starting date and duration of the report.
     select the level of information produced in the report.
     select the output format for the report.

**Command Line**:     At the DOS prompt:

     ectable

There are no command line options.

**User Interaction**:     ectable is a simple text based program.  ectable prompts the user for all required information, through a simple question and answer interface.  At several points in this interface the user may enter a code to skip backwards to a previous point (eventually to **EXIT** the programme).  This might be required to correct erroneous inputs, for instance.  Unfortunately, this code (which signals "END OF INPUT", and is usually a control-character) is system dependant.

The actual code required may be entered here:-

```
installation   :-        DOS        UNIX            VAX/VMS


EOD code       :-        ^Z         ^D (i.e. control+D)     ^Z
```

The interface is illustrated below, using the data file produced by the Brebungl test run, discussed in chapter 8.  A DOS version of the programme was used for this discussion.  The user inputs are highlighted in **bold.**

Note that **"EOD"** is the end of data code, typically (**control+Z**) or (**control+D**), it is not meant to be entered verbatim.

```
a      >ectable
b      ELEMENT CLASS TABLE - fixed format report of HTB2 class summary output
c      What is the HTB2 block report filename? > BREB1.BLK
d      The report file contains data from a run on
e      SUNos4 HTB2 v1.9                 Fri May 15 10:10:45 1992
f      BRE bungalow test 1
g      BRE type bungalow
h      full systems
i       Further run information is contained in
j      BREB1.INF
k
l      Data starts on  8/ 1/1990   1: 0: 0
m       Do you want to continue with this report file ? [Y/N]Y
n      What is the required output filename?>BREB1.TBE
o       Do you want the information file at the top of the output ? [Y/N]N
p       Do you want period sub-totals/averages ? [Y/N]Y
q        enter subtotalling period (in records) ?24
r       Do you want to restrict output/averageing to set times ? [Y/N]N
s       Do you want only total/subtotals printed ? [Y/N]Y
t       Do you want paged output format ? [Y/N]Y
u      Current time of processing; enter new values as appropriate:
v      Starting on: day month year, output for n days
w                 8    1    1990                 1
x      /
y       Current time of processing; enter new values as appropriate:
```

```
z             Starting on: day month year, output for n days
aa                         8     1     1990                    1
ab          "EOD"
ac            Do you want period sub-totals/averages ? [Y/N]"EOD"
ad            What is the HTB2 block report filename? > "EOD"
ae
af          >
```

notes:

*a*     start the ectable programme from the system prompt.

*c*     user enters the name of the input file, the file produced by the block report routine during an htb2 run.  Note that some systems, i.e. UNIX, are case sensitive, and the file name must be entered correctly.  The programme may be safely **quit** or stopped at this point by entering an EOD code.

*d-j*   the programme echos the time-stamp, and identification strings of the run, as contained in the Report file.

*m*     the user decides to continue ("Y") with this file or to skip backward to point *c*  ("N") perhaps to select a new file. The default is "N".

*n*     for each new input file, a new output file is produced.  The user must enter a valid name for that file here.  If a name of a file that already exists is given, that file will be over-written (without warning).  There is no default. "EOD" returns to point *c*.

*o-t*   configure the output format, specifying the type and amount of information to be output.

*o*     lines *e-h* are normally prefixed to the output file ("N"), if required the contents of the Info file in its entirety may be prefixed to the output ("Y").  The default is "N".  "EOD" returns to point *c*.

*p-q*    the input records are normally printed as they are read ("N"), Optionally these records may be sub-totalled, and extra data output at regular intervals ("Y").   If this option is chosen, a further question requests the sub-totalling interval (a numeric : as numbers of output intervals). For instance, to produce daily averages/totals with the standard hourly report, enter "Y", then "24".  The default is "N".  "EOD" returns to point *c*.

*r*     all input records are normally printed as they are read ("N"). Optionally only those records that fall within a given time window will be printed (and if sub-totalling is enabled, will be sub-totalled) ("Y").  If this option is chosen, a further question requests the starting and stopping times (in whole hours) of the window to include in the processing.  For instance to print only records from 9 AM to 5 PM, enter "Y" then  9 , 17.  Note that this option is only applicable if the reporting interval is less than the required window, i.e. the windowing is not possible for a Report output set to a daily rate.   The default is "N".  "EOD" returns to point *p*.

*s*     all input records are normally printed as they are read ("N"). Optionally no input records will be printed, only the sub-totalling records will be output (sub-totalling must be selected) ("Y").  For instance, an hourly input file can be printed as a daily average/total report.  The default is "N".  "EOD" returns to point *p*.

*t*     Normally the output of the programme is formatted as a printable table ("N").  Optionally the printout may be made in a form suitable for importing into standard spreadsheet analysis programmes.  The default is "N".  "EOD" returns to point *p*.

*u-x*   select the starting date, and duration in days, of the report table.  Initially the default is the start of the data, for a 1 day report.  All classes contained in the report will be processed.

*w*     The default starting date is displayed.  This may be accepted in its entirety without re-typing by entering a "/", alternatively individual components may be accepted by skipping the item with commas (this operation is a Fortran "feature").  "EOD" returns to point *p*.

*y-af*  Multiple passes through a report file are possible, with each pass appended to the output report.  Thus a number of individual spaces may be reported from the same date, for instance.  In this case, "EOD" is repeatedly entered to end the programme cleanly, and to return to the operating system.

### 9.9 Postprocessor : ptable

**Program name** :    PTABLE.EXE

**Description**:  The DOS post-processor <u>ptable</u> is a text based, question_and_answer driven programme.  It can be used on any machine or terminal.

This programme reads and translates the element Profile file, formatting the data for use as a printed table or as input to a spreadsheet programme.  <u>ptable</u> is based on elements. The table or data resulting from its use is essentially a summary of the surface conditions and internal state of an element.

There are options available to :-
      select the element on which to operate.
      select the starting date and duration of the report.
      select the level of information produced in the report.
      select the output format for the report.

**Command Line**:      at the DOS prompt;

      ptable

There are no command line options.

**User Interactions**:    ptable is a simple text based program.  ptable prompts the user for all required information, through a simple question and answer interface.  At several points in this interface the user may enter a code to skip backwards to a previous point (eventually to **EXIT** the programme).  This might be required to correct erroneous inputs, for instance.  Unfortunately, this code (which signals "END OF INPUT", and is usually a control-character) is system dependant.

The actual code required may be entered here:-

```
installation   :-        DOS        UNIX            VAX/VMS

EOD code       :-        ^Z         ^D (i.e. control+D)      ^Z
```

The interface is illustrated below, using the data file produced by the Brebung1 test run, discussed in chapter 8.  A DOS version of the programme was used for this discussion.  The user inputs are highlighted in **bold.**

Note that **"EOD"** is the end of data code, typically (**control**+**Z**) or (**control**+**D**), it is not meant to be entered verbatim.

This procedure produces the formatted file BREB1.PPP, described in chapter 8.

```
a               > ptable
b               PROFILE FORMATTER - fixed format element report of HTB2 profile output
c               What is the HTB2 profile report filename? >BREB1.PRF
d               The report file contains data from a run on
e               SUNos4 HTB2 v1.9                    Fri May 15 10:10:45 1992
f               BRE bungalow test 1
g               BRE type bungalow
h               full systems
i                Further run information is contained in
j               BREB1.INF
k
l               Data starts on  8/ 1/1990   1: 0: 0
m                Do you want to continue with this report file ? [Y/N]Y
n               What is the required output filename?>BREB1.PPP
o                Do you want the information file at the top of the output ? [Y/N]N
p                Do you want complete node data (or just surfaces)? [Y/N] ? [Y/N]Y
q                Do you want paged output format ? [Y/N]Y
r               What element?   [num] or ? >1
s               Current time of processing; enter new values as appropriate:
t               Starting on: day month year, output for n days
u                         8   1   1990                1
v           /
```

```
w      Current time of processing; enter new values as appropriate:
x      Starting on: day month year, output for n days
y                   8    1   1990                    1
z      "EOD"
aa     What element?   [num] or ? >"EOD"
ab      Do you want complete node data (or just surfaces)? [Y/N] ? [Y/N]"EOD"
ac     What is the HTB2 profile report filename? >"EOD"
ad
ae     >
```

notes:

*a*      start the ptable programme from the system prompt.

*c*      user enters the name of the input file, the file produced by the profile report routine during an htb2 run.  Note that some systems, i.e. UNIX, are case sensitive, and the file name must be entered correctly.  The programme may be safely **quit** or stopped at this point by entering an EOD code.

*m*      the user decides to continue ("Y") with this file or to skip backward to point *c*  ("N") perhaps to select a new file. The default is "N".

*n*      for each new input file, a new output file is produced.  The user must enter a valid name for that file here.  If a name of a file that already exists is given, that file will be over-written (wthout warning).  There is no default. "EOD" returns to point *c*.

*o-q*    configure the output format, specifying the type and amount of information to be output.

*o*      lines *e-h* are normally prefixed to the output file ("N"), if required the contents of the Info file in its entirety may be prefixed to the output ("Y").  The default is "N".  "EOD" returns to point *c*.

*p*       generally only the data for the surfaces of the element are printed ("N"), optionally the entire record, detailing the temperatures and heat fluxes at points <u>through</u> the element are also printed ("Y").  The default is "N". "EOD" returns to point *c*.

*q*      Normally the output of the programme is formatted as a printable table ("N").  Optionally the printout may be made in a form suitable for importing into standard spreadsheet analysis programmes.  The default is "N".  "EOD" returns to point *p*.

*r*      the user selects the number code of the element to process.   A list of the elements recorded in the file is available by entering a "?" at this point.  Only a single element may be tabled at one time.  There is no default value. "EOD" returns to point *p*.

*s-v*    select the starting date, and duration in days, of the report table.  Initially the default is the start of the data, for a 1 day report.

*u*      The default starting date is displayed.  This may be accepted in its entirety without re-typing by entering a "/", alternatively individual components may be accepted by skipping the item with commas (this operation is a Fortran "feature").  "EOD" returns to point *r*.

*w-ae* Multiple passes through a report file are possible, with each pass appended to the output report.  Thus a number of individual spaces may be reported from the same date, for instance.  In this case, "EOD" is repeatedly entered to end the programme cleanly, and to return to the operating system.

## 9.10 Postprocessor : ltable

**Program Name**:     LTABLE.EXE

**Description**:  The DOS post-processor <u>ltable</u> is a text based, question_and_answer driven programme.  It can be used on any machine or terminal.

This programme reads and translates the Logger file, formatting the data for use as a printed table or as input to a spreadsheet programme.  <u>ltable</u> is based on events. The table or data resulting from its use is essentially a time-series record of the state of a single item.

There are options available to :-
        select the event and item on which to operate.
        select the starting date and duration of the report.
        select the output format for the report.

**Command Line**:     at the DOS prompt;

        ltable

There are no command line options.

**User Interaction**:     ltable is a simple text based program.  Ltable prompts the user for all required information, through a simple question and answer interface.  At several points in this interface the user may enter a code to skip backwards to a previous point (eventually to **EXIT** the programme).  This might be required to correct erroneous inputs, for instance.  Unfortunately, this code (which signals "END OF INPUT", and is usually a control-character)  is system dependant.

The actual code required may be entered here:-

```
installation   :-          DOS        UNIX              VAX/VMS


EOD code        :-          ^Z         ^D (i.e. control+D)        ^Z
```

The interface is illustrated below, using the data file produced by the Brebungl test run, discussed in chapter 8.  A DOS version of the programme was used for this discussion.  The user inputs are highlighted in **bold.**

Note that **"EOD"** is the end of data code, typically (**control+Z**) or (**control+D**), it is not meant to be entered verbatim.

This procedure produces the formatted file BREB1.LLL, described in chapter 8.

```
a          >ltable
b          LOGGER FORMATTER 1.9 - fixed format event report of HTB2 logger output
c          What is the HTB2 logger report filename? >BREB1.LGR
d          The report file contains data from a run on
e          SUNos4 HTB2 v1.9                  Fri May 15 10:10:45 1992
f          BRE bungalow test 1
g          BRE type bungalow
h          full systems
i           Further run information is contained in
j          BREB1.INF
k
l          Data starts on  8/ 1/1990   0: 1:30
m           Do you want to continue with this report file ? [Y/N]Y
n          What is the required output filename?>BREB1.LLL
o           Do you want the information file at the top of the output ? [Y/N]N
p           Do you want paged output format ? [Y/N]Y
q          What event data type?   [num] or ?1
r          What index?   [num] or ? >1
s          Current start time ; enter new values as appropriate:
t          Starting on: day month year, output for n days
u                       8    1    1990                1
v        /
```

```
w       Current start time ; enter new values as appropriate:
x       Starting on: day month year, output for n days
y                    8    1    1990                    1
z       "EOD"
aa      What event data type?   [num] or ?"EOD"
aa       Do you want paged output format ? [Y/N]"EOD"
ab      What is the HTB2 logger report filename? >"EOD"
ac
ad      >
```

notes:

*a*    start the ltable programme from the system prompt.

*c*    user enters the name of the input file, the file produced by the logger routine during an htb2 run.  Note that some systems, i.e. UNIX, are case sensitive, and the file name must be entered correctly.  The programme may be safely **quit** or stopped at this point by entering an EOD code.

*d-j*    the programme echos the time-stamp, and identification strings of the run, as contained in the Logger file.

*l*    the user decides to continue ("Y") with this file or to skip backward to point *c*  ("N") perhaps to select a new file. The default is "N".

*m*    for each new input file, a new output file is produced.  The user must enter a valid name for that file here.  If a name of a file that already exists is given, that file will be over-written (wthout warning).  There is no default. "EOD" returns to point *c*.

*n-u*    configure the output format, specifying the type and amount of information to be output.

*n*    lines *e-h* are normally prefixed to the output file ("N"), if required the contents of the Info file in its entirety may be prefixed to the output ("Y").  The default is "N".  "EOD" returns to point *c*.

*o*    Normally the output of the programme is formatted as a printable table ("N").  Optionally the printout may be made in a form suitable for importing into standard spreadsheet analysis programmes.  The default is "N". "EOD" returns to point *c*.

*p*    the user selects the number code of the event to process.  An event is, for instance "Space Air Temperature".  A list of the events logged in the file is available by entering a "?" at this point.  Only a single event may be tabled at one time.  There is no default value.  "EOD" returns to point *o*.

*q*    the user selects the code index of the item required (i.e. the space number, or element number as appropriate) within the event.  That is several spaces may have been recorded under the "Space Air Temperature" event. Unfortunately, in the current release, there is no help as to selection of these index codes, they must be related to those defined in the Building and Layout files, for instance.  There are no defaults.  "EOD" returns to point *p*.

*r-u*    select the starting date, and duration in days, of the report table.  Initially the default is the start of the data, for a 1 day report.

*t*    The default starting date is displayed.  This may be accepted in its entirety without re-typing by entering a "/", alternatively individual components may be accepted by skipping the item with commas (this operation is a Fortran "feature").  "EOD" returns to point *p*.

*v-ad*    Multiple passes through a report file are possible, with each pass appended to the output report.  Thus a number of individual spaces may be reported from the same date, for instance.  In this case, "EOD" is repeatedly entered to end the programme cleanly, and to return to the operating system.

## 9.11 OTHER MISCELLANEOUS UTILITIES

Other utilities are available with this release of HTB2. These are programmes that are irregularly required, generally for the translation of one data format to another. They can be obtained from WSA on request.

The utilities provided fall into three categories; materials, output conversion, and meteorological conversion.

### 9.11.1 Materials Conversion

The standard materials library used by HTB2 is a direct formatted ASCII file. As such it is not possible to directly alter that file through a simple editor or word processor. The utility **makmat** is provided to translate an ordinary text file into an HTB2 materials library file, so that alterations or additions may be made to the materials library.

**makmat** has no command line options, and does not interact directly with the user. It searches for the text file STDMAT.TXT in the current directory, and produces an HTB2 library file STDMAT.LBY in that directory. An existing STDMAT.LBY file will be completely over-written.

The file STDMAT.TXT must be in the following format;

```
     MATERIALS PROPERTIES FILE - STANDARD - nov/84
     code material name             conductivity  density   spec. heat
                                      W/m/C        Kg/m3      J/Kg/C
                                    :         :          :           :
     1  'BRICK (OUTER LEAF)'          0.840     2000.0      680.0
     2  'BRICK (INNER LEAF)'          0.620     1800.0      840.0
     3  'BREEZE BLOCK'                0.440     1500.0      650.0
     4  'VERMICULITE INSULATING BLOCK' 0.270     700.0      837.0
     5  'ASBESTOS CEMENT'             0.500     1500.0     1000.0
     6  'ASBESTOS CEMENT SHEET'       0.360     700.0      1050.0
     7  'BITUMEN FELT'                0.500     1700.0     1000.0
     8  'ROOFING FELT'                0.190     960.0       837.0
     9  'MASTIC ROOFING'             1.150     2325.0      1946.0
    10  'CONCRETE (HEAVY MIX)'        1.400     2100.0      653.0
    11  'CONCRETE (LIGHT MIX)'        0.380     1200.0      653.0
```

Each line is at most 80 characters long. The first four lines may contain any information, but most usefully a header similar to above. The actual materials definitions start on line 5, and extend for as many materials as desired. Note that only one such library is available to each run of HTB2 ( the users materials file is a different format) and so should contain the materials most likely to be repetitively used. The materials data is provided as conductivity (W/m/°C), density (Kg/m$^3$), and specific heat capacity (J/Kg/°C). The numerical data <u>must</u> start at character position 37 and be contained in three 12 character wide columns. The first 36 characters of each line are ignored by HTB2, and can therefore be used for information and labels. The material properties in the library are accessed by the position in the file (the first material being found at line 5, the 10th at line 14 etc.), not by a index code typed within the file.

### 9.11.2 Input Conversion

There have been considerable changes in the HTB2 data formats since the initial release 1. There are available simple translator programs to alter the original HTB2r1 services data files into the newer format. These translators will not be required by users with HTB2 release 1.9 or greater.

### 9.11.3 Output Conversion

It can be useful to have HTB2 working on one (hopefully) high-powered computer, while analysis and reporting are done on another. For instance the simulation may be carried out on a distant mainframe, and the analysis on a desktop PC communicating via a network. However, various computers have different methods for storing numerical information in files. This can prevent the results file form one machine being analysed on another. The output files of HTB2 are formatted in such a way that a translation can often be achieved.

The HTB2 run log, and info output files are simple ASCII text files, and should transfer readily between machines. The standard output formats for the block Report, Profile, and Logger files will generally require translation. The utility **convout** is provided which enables translation between VAX or UNIX systems, and PCs. The source code of the programme should provide a model for translation to other systems.

**convout** has no command line arguments.  It has a simple question and answer interface.  It requires the name of the input file to translate and the of the output pc format file to produce.  It also requires whether the input file contains Report, Profile, or Logger data, and whether the file was produced on a VAX or UNIX system.  Translation is provided in one direction only, to a PC.

### 9.11.4 Meteorological Conversion

Meteorological data can be acquired in many formats.  These utilities translate some common formats into that understood by HTB2.  Most of these utilities have arisen out of a particular need.  They have not all been well tested and are provided as-is.  It is hoped that they will provide a useful starting point for individual requirements.

All these utilities assume hourly input data in ASCII text files, 1 line per hour.

The utilities supplied are:-

methtb1        - translates from the original HTB2 release 1 format.

metmon2 - translates from commonly monitored meteorological data;
          date, external dry bulb, wind speed and direction, global horizontal solar irradiation.  It determines
          other solar parameters from the site location and the date and time of day.

metcib2 - translates from a CIBSE  example year format;
          external dry and wet bulb, global horizontal, global diffuse and direct normal solar irradiations, cloud
          index, wind speed and direction, pressure and date.

mettry2 - translates from a type 4 "Test Reference Year" tape format;
          direct normal and global horizontal solar irradiations, external dry bulb, dew point, and wind speed.

mettmy2 - translates from a type 1 "Test Mean Year" tape format;
          direct normal and global horizontal solar irradiations, external dry bulb, dew point, and wind speed.

methoyt - translates from a "tenf" tape format, calculating solar data from algorithms attributed to Hoyt;
          date, external dry bulb, humidity, wind speed, and global horizontal solar irradiation.
          direct normal and global horizontal solar irradiations, external dry bulb, dew point, and wind speed.

# APPENDIX A


# BREBUNGL DATA SET

This appendix contains a listing of the complete set of files for the test BREBUNGL simulation (apart from the lengthy meteorological data file).


# A1   THE TOP-LEVEL FILE :                    BREBUNGL.TOP

```
* Top top evel file for bre bungalow
!RUNID BRE bungalow test 1, v2.0 standard

* configure model...
!ENABLE STANDARD SETUP

*                       calc ground temp
!ENABLE GROUND TEMP CALCS
!SET GROUND FACTOR = 0.001

* set up run parameters
!SET TIMESTEP = 90.0
!SET RUNLENGTH = 010,00
*                       allow 1st 3 days for runup

* chose output files and data
!OUTPUT INFO = 'BREBa.INF'
!OUTPUT BLOCK FILE = 'BREBa.BLK'


* connect to further files
!DEFINE BUILDING FILE = 'BREBUNGL.BLD'
!DEFINE SERVICES FILE = 'BREBUNGL.SRV'
!DEFINE DIARY FILE = 'BREBUNGL.DYL'
!DEFINE METEOR FILE = 'JANTEST.MET'
```

## A2  THE BUILDING FILE :                    BREBUNGL.BLD

```
!PROJECTID BRE type bungalow
!LOCATION = 51.5 0.3
!DEFINE SPACE = '1 -living area'
 !VOLUME = 148.0
  $POSITION X = 288 Y = 234
  $ICON = 305
!END
!DEFINE SPACE = '2 -loft'
 !VOLUME = 70.0
  $POSITION X = 444 Y = 231
  $ICON = 305
!END
!MATERIALS FILE = 'STDMAT.LBY'
!CONSTRUCTION FILE = 'BREBUNGL.CON'
!LAYOUT FILE = 'BREBUNGL.LAY'
```

## A3  THE CONSTRUCTION FILE :               BREBUNGL.CON

```
* construction definition file for bre bungalow
*   uses user defined materials list
!MATERIALS USER FILE = 'BREMATS.LBY'
*   and standard library


!CONSTRUCTION '1 external cavity wall'
!TYPE OPAQUE
!PARTS
* part    material    width       slices
*      :           :           :           :
_ 1  =  @1          0.105       0           * brick outer
_ 2  =  -1          0.065       0           * normal cavity
_ 3  =  @2          0.105       0           * brick inner
_ 4  =  @3          0.016       0           * plaster
}
!END

!CONSTRUCTION '2 single glazing'
!TYPE TRANSPARENT
!PARTS
* part    material    width       slices      absorp
*      :           :           :           :
_ 1  =     65       0.006       0           1.00    * window glass
}
!END

!CONSTRUCTION '3 solid ground floor '
!TYPE OPAQUE
!PARTS
* part    material    width       slices
*      :           :           :           :
_ 1  =  @10         0.015       0           * carpet
_ 2  =  @11         0.100       0           * concrete
_ 3  =  @12         1.600       0           * earth
}
!END
```

```
!CONSTRUCTION '4 internal ceiling'
!TYPE OPAQUE
!PARTS
* part    material    width        slices
*      :           :            :             :
_ 1  =  @5           0.100        0            * insulation quilt
_ 2  =  @4           0.010        0            * plasterboard
}
!END


!CONSTRUCTION '5  roof'
!TYPE OPAQUE
!PARTS
* part    material    width        slices
*      :           :            :             :
_ 1  =  @8           0.010        0            * tiles
}
!END


!CONSTRUCTION '6 internal partition'
!TYPE OPAQUE
!PARTS
* part    material    width        slices
*      :           :            :             :
_ 1  =  @3           0.016        0            * plaster
_ 2  =  @2           0.105        0            * brick (inner)
_ 3  =  @3           0.016        0            * plaster
}
!END


* window type definitions

!WINDOW  = '6MMFLOAT'
!TRANSMISSION =
 0.64 , 0.80 , 0.80 , 0.80, 0.80, 0.78, 0.75, 0.71, 0.60, 0.36, 0.0
!ABSORPTION =
 0.134 , 0.12, 0.12, 0.12, 0.12, 0.14, 0.14, 0.14, 0.14, 0.15, 0.15
!END
```

```
!ELEMENT = '1 south wall'
 !CONSTRUCTION = 1
 !AREA = 16.3
 !ORIENTATION = 0.0
 !TILT = 0.0
 !GROUND REFL = 0.2
 !SPACE TO FIRST = 0
 !SPACE TO LAST = 1
 !ABSORPTION FIRST = 0.8
 !ABSORPTION LAST = 0.5
 !CLASS = 1
    $POSITION X = 105  Y = 61
    $ICON = 306
    $EXTERNALPOS X = 31  Y = 214
!END

!ELEMENT = '2 south windows'
 !CONSTRUCTION = 2
 !AREA = 6.6
 !ORIENTATION = 0.0
 !TILT = 0.0
 !GROUND REFL = 0.2
 !SPACE TO FIRST = 0
 !SPACE TO LAST = 1
 !ABSORPTION FIRST = 0.8
 !ABSORPTION LAST = 0.5
 !WINDOW TYPE = '6MMFLOAT'
 !PATCH TO #8 FIRST = 1.00
 !CLASS = 2
    $POSITION X = 98  Y = 202
    $ICON = 307
    $EXTERNALPOS X = 31  Y = 214
!END

!ELEMENT = '3 east wall'
 !CONSTRUCTION = 1
 !AREA = 15.9
 !ORIENTATION = 270.0
 !TILT = 0.0
 !GROUND REFL = 0.2
 !SPACE TO FIRST = 0
 !SPACE TO LAST = 1
 !ABSORPTION FIRST = 0.8
 !ABSORPTION LAST = 0.5
 !CLASS = 1
    $POSITION X = 261  Y = 73
    $ICON = 306
    $EXTERNALPOS X = 306  Y = 28
!END

!ELEMENT = '4 north wall'
 !CONSTRUCTION = 1
 !AREA = 14.0
 !ORIENTATION = 180.0
 !TILT = 0.0
 !GROUND REFL = 0.2
 !SPACE TO FIRST = 0
```

```
 !SPACE TO LAST = 1
 !ABSORPTION FIRST = 0.8
 !ABSORPTION LAST = 0.5
 !CLASS = 1
    $POSITION X = 78  Y = 306
    $ICON = 306
    $EXTERNALPOS X = 31  Y = 214
!END

!ELEMENT = '5 south windows'
 !CONSTRUCTION = 2
 !AREA = 9.0
 !ORIENTATION = 180.0
 !TILT = 0.0
 !GROUND REFL = 0.2
 !SPACE TO FIRST = 0
 !SPACE TO LAST = 1
 !ABSORPTION FIRST = 0.8
 !ABSORPTION LAST = 0.5
 !WINDOW TYPE = '6MMFLOAT'
 !PATCH TO #8 FIRST = 1.00
 !CLASS = 2
    $POSITION X = 96  Y = 125
    $ICON = 307
    $EXTERNALPOS X = 31  Y = 214
!END

!ELEMENT = '6 west wall'
 !CONSTRUCTION = 1
 !AREA = 14.9
 !ORIENTATION = 90.0
 !TILT = 0.0
 !GROUND REFL = 0.2
 !SPACE TO FIRST = 0
 !SPACE TO LAST = 1
 !ABSORPTION FIRST = 0.8
 !ABSORPTION LAST = 0.5
 !CLASS = 1
    $POSITION X = 340  Y = 81
    $ICON = 306
    $EXTERNALPOS X = 306  Y = 28
!END

!ELEMENT = '7 west windows'
 !CONSTRUCTION = 2
 !AREA = 1.0
 !ORIENTATION = 90.0
 !TILT = 0.0
 !GROUND REFL = 0.2
 !SPACE TO FIRST = 0
 !SPACE TO LAST = 1
 !ABSORPTION FIRST = 0.8
 !ABSORPTION LAST = 0.5
 !WINDOW TYPE = '6MMFLOAT'
 !PATCH TO #8 FIRST = 1.00
 !CLASS = 2
    $POSITION X = 414  Y = 101
    $ICON = 307
    $EXTERNALPOS X = 306  Y = 28
!END
```

```
!ELEMENT = '8 ground floor'
 !CONSTRUCTION = 3
 !AREA = 66.0
 !TILT = 90.0
 !GROUND REFL = 0.2
 !SPACE TO FIRST = 1
 !SPACE TO LAST = 0
 !ABSORPTION FIRST = 0.8
 !ABSORPTION LAST = 0.5
 !CLASS = 3
    $POSITION X = 277  Y = 320
    $ICON = 306
    $EXTERNALPOS X = 288  Y = 380
!END

!ELEMENT = '9 ceiling'
 !CONSTRUCTION = 4
 !AREA = 66.0
 !TILT = 90.0
 !GROUND REFL = 0.2
 !SPACE TO FIRST = 2
 !SPACE TO LAST = 1
 !ABSORPTION FIRST = 0.8
 !ABSORPTION LAST = 0.5
 !CLASS = 4
    $POSITION X = 380  Y = 236
    $ICON = 306
!END

!ELEMENT = '10 south roof'
 !CONSTRUCTION = 5
 !AREA = 28.0
 !ORIENTATION = 0.0
 !TILT = 50.0
 !GROUND REFL = 0.2
 !SPACE TO FIRST = 0
 !SPACE TO LAST = 2
 !ABSORPTION FIRST = 0.8
 !ABSORPTION LAST = 0.8
 !CLASS = 4
    $POSITION X = 568  Y = 334
    $ICON = 306
    $EXTERNALPOS X = 681  Y = 234
!END

!ELEMENT = '11 east roof'
 !CONSTRUCTION = 5
 !AREA = 15.0
 !ORIENTATION = 270.0
 !TILT = 52.0
 !GROUND REFL = 0.2
 !SPACE TO FIRST = 0
 !SPACE TO LAST = 2
 !ABSORPTION FIRST = 0.8
 !ABSORPTION LAST = 0.8
 !CLASS = 4
    $POSITION X = 567  Y = 269
    $ICON = 306
    $EXTERNALPOS X = 681  Y = 234
```

A-6

```
!END

!ELEMENT = '12 north roof'
 !CONSTRUCTION = 5
 !AREA = 28.0
 !ORIENTATION = 180.0
 !TILT = 50.0
 !GROUND REFL = 0.2
 !SPACE TO FIRST = 0
 !SPACE TO LAST = 2
 !ABSORPTION FIRST = 0.8
 !ABSORPTION LAST = 0.8
 !CLASS = 4
    $POSITION X = 568   Y = 201
    $ICON = 306
    $EXTERNALPOS X = 681   Y = 234
!END

!ELEMENT = '13 west roof'
 !CONSTRUCTION = 5
 !AREA = 15.0
 !ORIENTATION = 90.0
 !TILT = 52.0
 !GROUND REFL = 0.2
 !SPACE TO FIRST = 0
 !SPACE TO LAST = 2
 !ABSORPTION FIRST = 0.8
 !ABSORPTION LAST = 0.8
 !CLASS = 4
    $POSITION X = 578   Y = 144
    $ICON = 306
    $EXTERNALPOS X = 681   Y = 234
!END

!ELEMENT = '14 internal partiti'
 !CONSTRUCTION = 6
 !AREA = 23.0
 !TILT = 0.0
 !GROUND REFL = 0.2
 !SPACE TO FIRST = 1
 !SPACE TO LAST = 1
 !ABSORPTION FIRST = 0.8
 !ABSORPTION LAST = 0.8
 !CLASS = 4
    $POSITION X = 410   Y = 346
    $ICON = 306
!END
```

## A5  THE MATERIALS FILE :                STDMAT.LBY

```
MATERIALS PROPERTIES FILE - STANDARD - nov/84
code material name                 conductivity  density   spec. heat
                                   W/m/C         Kg/m3     J/Kg/C
                                        :            :          :           :
1   'BRICK (OUTER LEAF)'            0.840         2000.0     680.0
2   'BRICK (INNER LEAF)'            0.620         1800.0     840.0
3   'BREEZE BLOCK'                  0.440         1500.0     650.0
4   'VERMICULITE INSULATING BLOCK'  0.270          700.0     837.0
5   'ASBESTOS CEMENT'              0.500         1500.0    1000.0
6   'ASBESTOS CEMENT SHEET'         0.360          700.0    1050.0
7   'BITUMEN FELT'                  0.500         1700.0    1000.0
8   'ROOFING FELT'                  0.190          960.0     837.0
9   'MASTIC ROOFING'                1.150         2325.0    1946.0
10  'CONCRETE (HEAVY MIX)'          1.400         2100.0     653.0
11  'CONCRETE (LIGHT MIX)'          0.380         1200.0     653.0
12  'AERATED CONCRETE'              0.160          500.0     840.0
13  'AERATED CONCRETE BLOCK'        0.240          750.0    1000.0
14  'REFACTORY INSULATING CONCRETE' 0.250           10.0     837.0
15  'VERMICULITE AGGREGATE CONCRETE' 0.170         450.0     837.0
16  'LIGHT CONCRETE SCREED'         0.410         1200.0     840.0
17  'CAST CONCRETE SCREED'          1.280         2100.0    1007.0
18  'GRANOLITHIC SCREED'            0.870         2085.0     837.0
19  'WHITE RENDER'                  0.500         1300.0    1000.0
20  'CEMENT SCREED'                 1.400         2100.0     650.0
21  'CLAY TILES'                    0.850         1900.0     837.0
22  'CONCRETE TILES'                1.100         2100.0     837.0
23  'SLATE TILES'                   2.000         2700.0     650.0
24  'PLASTIC TILES'                 0.500         1050.0     837.0
25  'RUBBER TILES'                  0.300         1600.0    2000.0
26  'CORK TILES'                    0.080          530.0    1800.0
27  'ASPHALT/ASBESTOS TILES'        0.550         1900.0     837.0
28  'P.V.C./ASBESTOS TILES'         0.850         2000.0     837.0
29  'CEILING TILES MINERAL'         0.030          290.0    2000.0
30  'CEILING TILES PLASTER'         0.380         1120.0     840.0
31  'SANDSTONE'                     1.830         2200.0     712.0
32  'GRANITE '                      2.900         2650.0     900.0
33  'MARBLE'                        2.000         2500.0     880.0
34  'PLASTER DENSE'                 0.500         1300.0    1000.0
35  'PLASTER LIGHT'                 0.160          600.0    1000.0
36  'GYPSUM PLASTERBOARD'           0.190          950.0     840.0
37  'PERLITE PLASTERBOARD'          0.180          800.0     837.0
38  'GYPSUM PLASTERING'             0.420         1200.0     837.0
39  'PERLITE PLASTERING'            0.080          400.0     837.0
40  'VERMICULITE PLASTERING'        0.200          720.0     837.0
41  'WOOD BLOCK'                    0.160          800.0    2093.0
42  'MEDIUM HARDBOARD '             0.080          600.0    2000.0
43  'STANDARD HARDBOARD'            0.130          900.0    2000.0
44  'FIR (20% moist)'               0.140          419.0    2720.0
45  'FLOORING BOARD'                0.140          600.0    1210.0
46  'CORK BOARD'                    0.040          160.0    1888.0
47  'CHIPBOARD'                     0.150          800.0    2093.0
48  'WEATHERBOARD'                  0.140          650.0    2000.0
49  'OAK (radial)'                  0.190          700.0    2390.0
50  'PLYWOOD'                       0.150          560.0    2500.0
51  'WILTON CARPET'                 0.060          186.0    1360.0
52  'SYNTHETIC CARPET'              0.060          160.0    2500.0
53  'WOOL FELT UNDERLAY'            0.040          160.0    1360.0
```

```
54 'RUBBER UNDERLAY'                    0.100       400.0      1360.0
55 'UREA FORMALDEHYDE FOAM'             0.030        30.0      1674.0
56 'FIBREBOARD'                         0.060       300.0      1000.0
57 'WOODWOOL'                           0.100       500.0      1000.0
58 'GLASSWOOL'                          0.040       250.0       840.0
59 'THERMALITE'                         0.030       753.0       837.0
60 'POLYURETHANE FOAM BOARD'            0.030        30.0       837.0
61 'SIPOREX'                            0.120       550.0      1004.0
62 'PVC'                                0.160      1379.0      1004.0
63 'POLYSTYRENE'                        0.030        25.0      1380.0
64 'C & CA POLYSTYRENE'                 0.040        13.6      1380.0
65 'WINDOW GLASS'                       1.050      2500.0       750.0
66 'EARTH'                              1.280      1460.0       879.0
```

# A6  THE MATERIALS USER FILE :                     BREMATS.LBY

```
1                       * outer brick
0.840   1700.0    800.0
2                       * inner brick
0.62    1700.0    800.0
3                       * plaster
0.26     800.0   1000.0
4                       * plasterboard
0.16     950.0    840.0
5                       * quilt
0.040     12.0    840.0
8                       * roofing tile
0.84    1900.0    800.0
10                      * carpet
0.055    160.0   1000.0
11                      * concrete
1.40    2100.0    840.0
12                      * earth
1.40    1900.0   1700.0
```

## A7  THE SERVICES FILE :                           BREBUNGL.SRV

```
* services file for bre bungalow
!SERVICEID full systems

!HEATING FILE = 'BREBUNGL.HTR'
!LIGHTING FILE = 'BREBUNGL.LGT'
!SMALL POWER FILE = 'BREBUNGL.SPW'
!OCCUPANCY FILE = 'BREBUNGL.OCC'
!VENTILATION FILE = 'BREBUNGL.VNT'
```

## A8  THE HEATING FILE :                            BREBUNGL.HTR

```
!HEATSYS 'Living Space'
* heating system for bre bungalow  , main space (1) only
*    7 kW simple convective heater
*    2 time clock periods
*    19oC  set point
 !POWER OUTPUT = 7.0
 !SPLIT =   1.0    ,  0.0    ,   0.0
 !CONVECTIVE CONNECTIONS
  _#1 = 1.0
  }
 !CLOCK START TIME #1 = 06:00:00  | mtwtf--   * weekday schedule
 !CLOCK STOP TIME #1  = 09:00:00  | mtwtf--
 !CLOCK START TIME #1 = 08:00:00  | -----ss   * weekend schedule
 !CLOCK STOP TIME #1  = 23:00:00  | -----ss
 !CLOCK START TIME #2 = 16:00:00              * both
 !CLOCK STOP TIME #2  = 23:00:00
 !STAT TYPE IDEAL
 !SETPOINT = 19.0
 !STAT AIR CONNECTIONS
  _#1=1.0
  }
!END
```

## A9  THE LIGHTING FILE :                    BREBUNGL.LGT

```
!LIGHTSYS 'living space'
*                             simple clock controlled lighting circuit
 !HEAT OUTPUT = 500.0
 !SPLIT =   0.20 ,   0.80
 !CONVECTIVE CONNECTIONS
  _#1 = 1.0
  }
 !RADIANT CONNECTIONS
 _#1 = 1.0
  }
*                                 set up clock,
*                                   4 switched periods
*                           1st on time depends on weekday/end
 !CLOCK START TIME #1 = 06:00:00 | mtwtf--
 !CLOCK START TIME #1 = 07:00:00 | -----ss
 !CLOCK STOP TIME #1 = 08:00:00  | mtwtfss
 !CLOCK PROPORTION #1 = 1.0
*                             rest are for every day
 !CLOCK START TIME #2 = 08:00:00
 !CLOCK STOP TIME #2 = 11:00:00
 !CLOCK PROPORTION #2 = 0.7
 !CLOCK START TIME #3 = 15:00:00
 !CLOCK STOP TIME #3 = 18:00:00
 !CLOCK PROPORTION #3 = 0.7
 !CLOCK START TIME #4 = 18:00:00
 !CLOCK STOP TIME #4 = 23:00:00
 !CLOCK PROPORTION #4 = 1.0
!END
```

## A10 THE OCCUPANCY FILE :                    BREBUNGL.OCC


```
!OCCUPANCY SPACE = 1
 !ACTIVITY LEVEL #1 = 50.0      , 0.0
 !ACTIVITY LEVEL #2 = 90.0     , 0.0
 !ACTIVITY LEVEL #3 = 150.0     , 0.0
 !SPLIT   =   0.80  , 0.20
 !INITIAL = 0.0
 !CLOCK START TIME #1 = 00:00:00
 !CLOCK STOP TIME #1 = 07:00:00
 !CLOCK ACTIVITY LEVEL #1 = 1
 !CLOCK OCCUPANCY #1 = 4
 !CLOCK START TIME #2 = 07:00:00
 !CLOCK STOP TIME #2 = 12:00:00
 !CLOCK ACTIVITY LEVEL #2 = 2
 !CLOCK OCCUPANCY #2 = 2
 !CLOCK START TIME #3 = 12:00:00
 !CLOCK STOP TIME #3 = 18:00:00
 !CLOCK ACTIVITY LEVEL #3 = 2
 !CLOCK OCCUPANCY #3 = 1
 !CLOCK START TIME #4 = 18:00:00
 !CLOCK STOP TIME #4 = 23:00:00
 !CLOCK ACTIVITY LEVEL #4 = 2
 !CLOCK OCCUPANCY #4 = 4
 !CLOCK START TIME #5 = 23:00:00
 !CLOCK STOP TIME #5 = 24:00:00
 !CLOCK ACTIVITY LEVEL #5 = 1
 !CLOCK OCCUPANCY #5 = 4
!END
```


## A11 THE SMALL POWER FILE :                    BREBUNGL.SPW


```
!SMALL POWER 'TV'
!HEAT OUTPUT = 150.0
!SPLIT       =   0.6    , 0.4
!INITIAL FRACTION = 1.0
!CONVECTIVE CONNECTIONS
    _#1 = 1.0
     }
!RAD DIFFUSE
 !RADIANT CONNECTIONS
    _#1 = 1.0
    }
 !CLOCK START TIME #1 = 08:00:00 | -----ss
 !CLOCK STOP TIME #1 = 10:00:00
```

```
 !CLOCK START TIME #2 = 18:00:00
 !CLOCK STOP TIME #2 = 19:00:00
 !CLOCK START TIME #3 = 22:00:00
 !CLOCK STOP TIME #3 = 23:00:00
!END


!SMALL POWER 'COOKER'
!HEAT OUTPUT = 1700.0
!SPLIT        =    0.6    , 0.4
!INITIAL FRACTION = 1.0
!CONVECTIVE CONNECTIONS
  _#1 = 1.0
    }
!RAD DIFFUSE
!RADIANT CONNECTIONS
 _#1 = 1.0
   }
 !CLOCK START TIME #1 = 08:00:00
 !CLOCK STOP TIME #1 = 08:15:00 | mtwtfs-
 !CLOCK STOP TIME #1 = 09:00:00 | ------s
 !CLOCK START TIME #2 = 12:00:00
 !CLOCK STOP TIME #2 = 12:30:00 | mtwtfs-
 !CLOCK STOP TIME #2 = 13:30:00 | ------s
 !CLOCK START TIME #3 = 18:00:00
 !CLOCK STOP TIME #3 = 18:30:00
!END


!SMALL POWER 'BACKGROUND'
!HEAT OUTPUT = 150.0
!SPLIT        =    0.6    , 0.4
 !INITIAL FRACTION = 1.0
!CONVECTIVE CONNECTIONS
    _#1 = 1.0
      }
 !RAD DIFFUSE
 !RADIANT CONNECTIONS
    _#1 = 1.0
     }
 !CLOCK START TIME #1 = 00:00:00
 !CLOCK STOP TIME #1 = 24:00:00
!END
```

## A12 THE VENTILATION FILE :             BREBUNGL.VNT

```
1                                    * simple acr ventilation.
*********
1                                    * main space 1
1.24  , 0.0  , 0.0                   * just use infiltration rate
20.0                                 *   vent stat setting not used but needed
------------
2                                    * loft space 2
1.0  , 0.0  , 0.0
20.0
------------
0


* ventilation description for bre bungalow, constant infiltration
```

## A13 THE DIARY LIST FILE :             BREBUNGL.DYL

```
*  DIARY pages for bre bungalow full systems,
*    9 days total, run up for 3 days

*           run up period, just heating, no output
BREDAY0.DRY
BREDAY0.DRY
BREDAY0.DRY
*             standard day pattern
BREDAY.DRY
BREDAY.DRY
BREDAY.DRY
BREDAY.DRY
*     switch on output
BREDAY1.DRY
BREDAY.DRY
*               extra for possible overrun
DRYNUL.DRY
```

## A14 THE DIARY PAGE FILE :             BREDAY0.DRY

```
* on run up days initialise systems and just let cycle on auto
00:00:00 !SET HEATER STATUS #1 = AUTO
00:00:00 !SET LIGHTING STATUS #1 = AUTO
00:00:00 !SET SPOWER STATUS #1 = AUTO
00:00:00 !SET SPOWER STATUS #2 = AUTO
00:00:00 !SET SPOWER STATUS #3 = AUTO
00:00:00 !SET OCCUPANCY STATUS #1 = AUTO

* reuse first met day during run-up
23:59:00 !SET MET REWIND
```

## A15 THE DIARY PAGE FILE :                    BREDAY1.DRY

```
*       'standard' day for bre bungalow
*                             all on automatic
*                               start output
00:00:00  !ENABLE BLOCK OUTPUT
*                             re-program occupancy pattern
00:00:00  !SET OCCUPANCY CLOCK STOP #1 @1 = 05:00:00 | mtwtf--
00:00:00  !SET OCCUPANCY CLOCK START #1 @2 = 05:00:00 | mtwtf--
00:00:00  !SET OCCUPANCY LEVEL #1 @2 = 3 | mtwtf--
```

## A16 THE DIARY PAGE FILE :                    BREDAY.DRY

```
*       'standard' day for bre bungalow
*                             all on automatic
```

## A17 THE DIARY PAGE FILE :                    DRYNUL.DRY

(is empty)

# APPENDIX B

# HTB2 INPUT DATA FORMAT

This appendix presents the descriptions of, and the format conventions of, the input files for HTB2.

HTB2 input data is organised into a file hierarchy, each file responsible for a logically separate field of data. This organisation can be illustrated as;
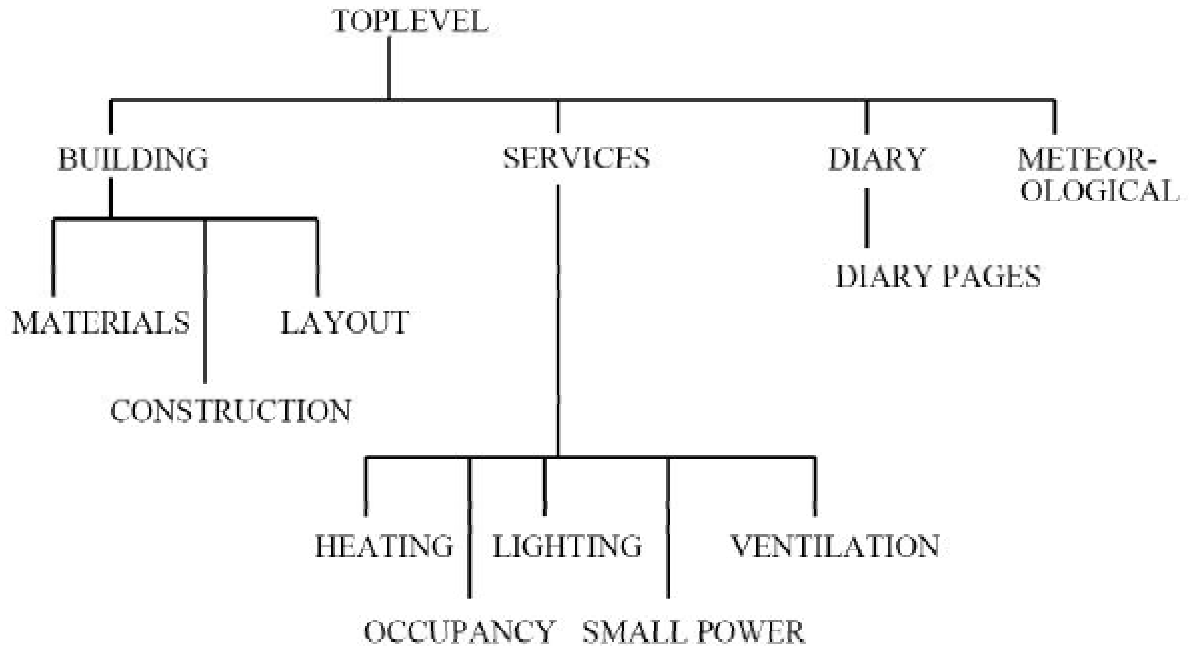


Where;

| | |
|---|---|
| TOPLEVEL | defines run parameters |
| BUILDING | defines the physical building |
| SERVICES | defines the building services and incidental gains |
| DIARYLIST | defines the scheduling information |
| METEOROLOGICAL | defines the external conditions |
| MATERIALS | defines the material thermal properties |
| CONSTRUCTION | defines the methods of assembly of materials |
| LAYOUT | defines the building partitioning |
| HEATING | heating system characteristics |
| LIGHTING | defines lighting gain characteristics |
| SMALL POWER | defines small incidental sources of heat |
| OCCUPANCY | defines occupancy characteristics |
| VENTILATION | defines ventilation properties |
| DIARYPAGES | defines daily usage patterns |

In most instances input data is provided in 'commands'. Each command identifies the data identifier and its' new data value. The format convention indicates whether an integer (i) or real (r) numeric value, or a character string (c) is expected as data. Where applicable, a built-in default value will be used by the model; this value is indicated in [square brackets]. If a default value is available and acceptable to the user, the command line need not be included in the data file.

## B.1 TOP-LEVEL FILE

The TOP-LEVEL File is the key file for HTB2 simulations. It contains commands which configure and control the simulation model, as well as providing pointers (file names) to those data files defining the simulation problem; the building and services definitions, and the scheduling and external conditions for the simulation test. The Top-Level file also defines the amount and detail of the results output from a simulation run.

The Top-Level file is provided to a simulation run of HTB2 as a command line option. The mechanism of this may alter between computer systems; refer to the release notes for your implementation. By default HTB2 will always search for the file named 'HTBCMD' if no further information is supplied. Thus copying the required top-level file to that name will work on any implementation ( i.e. in MSDOS: `copy test.top HTBCMD`).

The command descriptions which follow show the syntax required, and the default values prevailing (if any). If the default values are acceptable for the application, the command need not be used. Where there is no default value (i.e. [] is shown), the command MUST be used (if that operation option is required).

_____

This section describes option commands, enabling or disabling model or run features. The default will apply if command is not used. Any 'ENABLE' may also be 'DISABLE'. The description gives the action in the enabled state.

COMMAND FORMAT
        DEFAULT VALUE
                DESCRIPTION

_____

This command defines a sentence which will appear in all output files. It is recommended to use this command to define a unique sentence for each simulation, this will aid future understanding and tracing of results. The sentence is limited to one line, of 80 characters maximum length.

!RUNID c
        []
                This command defines a run identification string which will appear in output files. The string is taken from the first space after the command.

_____

These general commands affect the operation of the input phase. They may be generally required.

!EOF
        []
                Stops the input phase no matter what follows in the Top-Level file. This command should be used routinely in all files as some computing system editors place spurious symbols at the end of a file, and these can be interpreted as errors by HTB2.

!ENABLE DIARY CHECK
        [ENABLED]
                Allow the scanning of all diary page files that will be used in a simulation at input stage. If not used, an error in a diary page file could stop a simulation at any time during calculations.

!ENABLE IDENTIFY
        [ENABLED]
                Allow individual module routines to identify themselves to a log file (or the

screen) when they are first called. This can aid debugging in a development environment.

!ENABLE WARNINGS
     [ENABLED]

     Allow warning messages to appear during input phase. Typical warning messages caution of the use of defaults. Often once a data set has been tested, these warnings may become obtrusive, their use is however recommended during data set development.

---------------------------------------------------------------------------------------------

Less commonly used options are:

!ENABLE COMPRESS
     [DISABLED]

     Creates an archive of all input data files used in a simulation.
     *Currently unsupported in DOS/Windows version of HTB2.*

!ENABLE CONTINUE
     [DISABLED]

     Continue program execution if I/O errors (i.e. in reading diary page data) are been encountered. Abort after number of errors set by !SET ERROR command. If disabled (default condition) program aborts on first error. Note that this refers to errors found after the input stage, HTB2 attempts to find all possible errors at input stage regardless. Not all errors may be recoverable, according to the constraints of the computing platform, so that continuation cannot be guaranteed.

!SET ERROR = i
     [50]

     Define the number of run-time input data errors encountered before abort. these errors would typically be inability to parse a diary entry. This count is significant only if !ENABLE CONTINUE has been used.

!STOP
     []

     When used model execution will be aborted after input phase. Used for checking data sets without creating output files.

_____

These commands configure the calculation core of HTB2, determining which routines and algorithms will be used in the simulations.

Some of these commands set model parameter values, set initial values or alter default data values. As before, the default value indicated applies if the command is not used. Where data needs to be supplied to a command, the form of the data is indicated by a letter code:-

     - r : a "real" numerical value i.e. 1.5

     - i : an integer value i.e. 5

     -c : a word or sentence i.e. SHADE

     -'c' : a word contained in single quote marks i.e. 'WEST'

Note that some commands require numeric data in to be in a specific fixed format (i.e. date as 'dd/mm/yyyy').

!ENABLE STANDARD
     [DISABLED]

     This is a shortcut to the commonly used HTB2 configuration. It is equivalent to

entering :-
            !ENABLE METEOROLOGICAL
            !ENABLE FABRIC
            !ENABLE RADTRAN STAR
            !ENABLE SOLAR
            !ENABLE VENTILATION
            !ENABLE LIGHTING
            !ENABLE HEATING
            !ENABLE SMALL POWER
            !ENABLE OCCUPANCY
            !ENABLE DIARY INPUT

!ENABLE DIARY INPUT
        [DISABLED]
                Turn on routine to input scheduling data from diary. Diary list file must be speci-
                fied separately.

!ENABLE FABRIC
        [DISABLED]
                Turn on fabric heat transfer calculation engine.

!ENABLE HEATING
        [DISABLED]
                Enables heating system routine.

!ENABLE LIGHTING
        [DISABLED]
                Enables lighting system routine.

!ENABLE METEOR
        [DISABLED]
                Read and maintain meteorological database (external temperature, humidity, wind,
                solar irradiance, surface transfer coefficients) from an external file.

!ENABLE OCCUPANCY
        [DISABLED]
                Enables occupancy gain routine.

!ENABLE RADTRAN STAR
        [DISABLED]
                Enables determination of internal radiant transport through routine assuming a
                central "star" radiant temperature, and acceptance of external source irradiance on
                internal surfaces (i.e. solar, small power).

!ENABLE SMALL POWER
        [DISABLED]
                Enables small power (incidental) gain routine.

!ENABLE SOLAR
        [DISABLED]
                Enables calculation of solar irradiance and transmission gains to interior.

!ENABLE VENTILATION
        [DISABLED]
                Enable calculation of ventilation heat and water transfer. Method of ventilation
                (i.e. option choice) is made in the "ventilation" definition file.

!ENABLE WATER
        [DISABLED]
                Enable maintenance of water transport, gain and space humidity data.

!ENABLE GROUND TEMP

[DISABLED]
Enables calculation of ground temp from air temp. rather than accepting value in met. file. !SET GROUND command sets parameter to use in calculation.

!SET AIR REFERENCE = r
[10.0]
Define the initial fabric and space temperatures (in degree C) to this value. It is helpful to set this to approximately the mean temperature expected, as this will speed up the initialisation period.

!SET BST = ii/ii ii/ii
[25/05 , 28/10]
Define the start and stop date of summer time (for the alteration of the internal model clock). The summer time feature will alter the internal simulation clock according to British Summer Time practice, that is add one hour in Spring and loose one hour in the Autumn. All solar calculations will be made using GMT, but scheduling will be made with regard to this local time. If the summer time feature is not required then enter arbitrary dates in a "13th" month, i.e. !SET BST = 01/13 31/13. The default is unlikely to match any one particular actual year, and so should be altered when dealing with monitored data.
This command requires strict format as day/month day/month, leading zeros for days and months are required as in the example.

!SET DATE = ii/ii/iiii
[01/01/1984]
Sets the start date of the run. This date is used in calculation of solar geometry and so must be set to reflect the intent of the run. Date data is NOT taken from the meteorological file (if used). This command must be in strict format, day/month/ year, as shown in the default value. Leading zeros will be required.

!SET DAY = c
[SUNDAY]
Sets the start day of the run. HTB2 uses this information in the services time-clocks, so it is may be required to be set as appropriate to the users schedule and meteorological period. The day word must be one of SUNDAY , MONDAY , TUESDAY , WEDNESDAY , THURSDAY , FRIDAY , SATURDAY.

!SET GROUND FACTOR = r
[0.0001]
Defines the parameter used in the calculation of the deep ground temperature from external air temperature. This value is significant only if !ENABLE GROUND TEMP has be used. The value represents an exponential time constant of the ground temperature response to changes in air temperature. The time constant is given by {1/value * meteor. interval}, i.e. the default value gives a 10,000-hour time constant for the standard 1-hour meteorological interval.

!SET FRAME = r
[0.0]
Sets the initial value of frame blockage for windows. A blockage of 0.3 would mean that 30% of the specified area of a window is opaque to solar transmission.

!SET GROUND TEMP = r
[10.0]
Set initial value of deep ground temperature, in degree C.

!SET RUNLENGTH = iii,ii
[]
Defines the run length of the simulation on days and hours (hours in 0-24 only). This command requires strict format as days,hours , for example a 9 day run would be specified as 009,00. Leading zeros are required.

!SET SOLAR LOST = r
      [0.0]

> Defines the general back reflectance for all windows. This is the fraction of calculated solar transmission which is immediately lost from the building due to reflectance back through windows. This proportion is assumed to have no effect on the building energy balance.

!SET START DIARY = i
      [1]

> Sets position at the start of a run, to the $i^{th}$ day in the diary list file. Must be used in conjunction with the !SET DATE command.

!SET START MET = i
      [1]

> Sets position at the start of a run, to the $i^{th}$ day in the meteorological file. Must be used in conjunction with the !SET DATE command.

!SET TIMESTEP = r
      []

> Defines the calculation timestep for the run in seconds, this would typically be 60-150 seconds. The longer the timestep, the shorter the simulation will be, but the less accurate the calculations. An initial timestep of 90 seconds is recommended in most cases.

----------------------------------------------------------------------------

Less commonly used configuration items, for which the default value is generally appropriate, follow:

!ENABLE ANISOTROPIC
      [DISABLED]

> Enable the use of an anisotropic sky model, as opposed to the default isotropic sky..

!ENABLE FROST
      [DISABLED]

> Enable frost protection thermostat(s) (as specified in "heating" file) to control building temperature when heating system is "off".

!ENABLE INTERPOLATE SHADING
      [DISABLED]

> Enable the interpolation of shading mask data..

!ENABLE LGTMDL
      [DISABLED]

> Utilise the lighting usage model, which determines lighting load from external illuminance. Requires further data to be specified in "lighting" definition file when selected.

!ENABLE OLD c
      [DISABLED]

> Apply older versions of code, for compatibility sake. These older versions have been replaced because they were faulty or inefficient, but comparisons with previous simulation may require their temporary recovery. This command is not recommended for general use, and these compatibility issues will be removed at the next release.
> The word c may be :-
> - LONGWAVE          - use version 1.1 longwave algorithm
> - FABRIC          - use version 1.10 fabric calculation order.
> - CLOCK          - use version 1.10 clock logic
> - ALL          - all of the above (reverts to version 1.1 generally)

!ENABLE NSOL
    [DISABLED]

        When enabled model will NOT calculate sun position from time and location data, i.e. sun becomes fixed in sky.  Sun position may be specified by !SET SUNPOS command.

!ENABLE ZIPR1
    [DISABLED]

        Allow execution of routine ZIPR1, see Tech. Reference manual for further information.

!ENABLE ZIPR2
    [DISABLED]

        Allow execution of routine ZIPR2, see Tech. Reference manual for further information.

!ENABLE ZIPR3
    [DISABLED]

        Allow execution of routine ZIPR3, see Tech. Reference manual for further information.

!ENABLE ZIPR4
    [DISABLED]

        Allow execution of routine ZIPR4, see Tech. Reference manual for further information.

!ENABLE ZIPR5
    [DISABLED]

        Allow execution of routine ZIPR5, see Tech. Reference manual for further information.

!SET AIR SPECIFIC HEAT = r
    [1006.0]

        Define the specific heat of air in j/kg/k.

!SET CLOUD COVER = r
    [0.5]

        Set initial cloud cover index.  Cloud cover is used to determine the net radiant loss from a surface to the sky. Values are in the range 0-1, where 0 represents clear sky, 1 represents full cloud.  Cloud cover may be changed in the run from either the met. file or from the diary.

!SET EXTRH = r
    [50.0]

        Set the initial value of external humidity, in %. This value is significant only if water transport is enabled.  The value may be altered within a run by the meteorological file, or by the diary.

!SET EXTT = r
    [10.0]

        Set the initial value of external air temperature, in degree C. The value may be altered within a run by the meteorological file, or by the diary.

!SET GROUND REFLECTANCE = r
    [0.2]

        Defines the default ground reflectance (albedo) for external surfaces.

!SET HTC TRANSFER = c
    [FIXED]

        Defines the default algorithm for the determination of internal surface convective

heat transfer coefficients; FIXED for fixed CIBSE transfer coefficients, or VARI-ABLE for numerically calculated coefficients.

!SET HTCE =  i     r        r        r
         []

         Defines, for an individual element I, the fixed external surface convective heat transfer coefficients, in $W/m^2/C$ for heat flow horizontal, upwards, and downwards respectively.  The choice of the appropriate coefficient is made by HTB2 using the surface tilt and adjacent temperature data.  Alternatively if ALL is used in place of I, all external elements will recieve these values.

!SET HTCI =  r      r        r
         [3.08 , 4.04 , 0.92]

         Defines the internal surface convective heat transfer coefficients, in $W/m^2/C$ for heat flow horizontal, upwards, and downwards respectively.  The choice of the appropriate coefficient is made by HTB2 using the surface tilt and adjacent temperature data.  Applies only for the FIXED Transfer option.

!SET HTCS =   i      r      r        r
         [ as set in HTCI ]

         Defines, for an individual element I, the internal surface convective heat transfer coefficients, in $W/m^2/C$, for heat flow horizontal, upwards, and downwards respec-tively.  The choice of the appropriate coefficient is made by HTB2 using the surface tilt and adjacent temperature data.  Applies only for the FIXED Transfer option.

!SET HTCX =   i      r      r        r
         [10.0 , 15.0, 10.0  for all virtual elements]

         Defines the convective heat transfer coefficients, in $W/m^2/C$, for heat flow across virtual element i.  These correspond to air-air transfer for heat flow horizontal, upwards, and downwards respectively.  The choice of the appropriate coeff. is made by HTB2 using the surface tilt and adjacent temperature data. This command may be repeated for as many virtual elements as required.  Alternatively if ALL is used in place of I, all external elements will recieve these values.  The values presently supplied for the default have no theoretical or empirical basis.

!SET HUMIDITY = r
         [50.0]

         Set the initial value of internal humidity, in %.  This value is significant only if water transport is enabled.

!SET MET CALC INTERVAL = i
         [10]

         Define the interval between meteorological recalculations in minutes.  This is primarily to update solar positions and shading functions.

!SET MET INTERVAL = i
         [60]

         Define the meteorological interval in minutes.  This will be the interval between reads from the met. file.

!SET MT OFFSET = i
         [0]

         Define the meteorological data offset in minutes.  This represents the time shift required on the met data; an offset of 0, and an interval of 1-hour, implies that met data is read on the hour an applies over the next hour while an offset of 30 would read the met data at the half hour.

!SET ORIENTATION = r
         [0.0]

Defines a global orientation shift to the building as specified in the layout file, in degrees clockwise. Note that shading masks are NOT shifted by this command.

!SET SLICES = i
      [5]

Defines the maximum number of slices HTB2 may use for a part in response to a 0 entered as the slice count in the construction file.

!SET STATION HEIGHT = r
      [0.0]

Defines the altitude (m above MSL) of the site.

!SET SUNPOS = r      r
      [-10.0, 270.0]

Set the initial sun position as altitude (degree above horizon), and azimuth (degree west of south). Used in conjunction with !ENABLE NSOL the sun may be fixed in the sky, or altered by use of the diary. In normal use the sun position is determined form the date, time and location of the building.

!SET SUNRAD = r      r
      [0.0, 0.0]

Sets the initial irradiance of the sun, in $W/m^2$, for total and diffuse respectively. This may be arbitrarily altered by the diary, or more normally, through the meteorological file.

!SET WIND = r      r
      [ 0.0 , 0.0 ]

Set initial value of wind speed (m/s) and direction.

!SET ZIPVAR #i = r
      [0.0]

Set initial value of zipper variable i. See Tech. Reference manual for information on zippers.

_____

This section nominates output file names. Nominating an output file does not trigger or enable the appropriate output routine. Note that the required output procedure must also be enabled, either in this file or within the run via the diary. The single quotes around the filename are required. Filenames must comply with the conventions of the operating system in use.

!OUTPUT INFO = 'c'
      []

Nominate run information output filename.

!OUTPUT BLOCK = 'c'
      []

Nominate interval block report output filename.

!OUTPUT LOGGER = 'c'
      []

Nominate event logger output filename.

!OUTPUT PROFILE = 'c'
      []

Nominate element profile output filename.

In each of the latter 3 cases the form "!OUTPUT TEXT ....." will produce a human readable output file for debugging purposes, otherwise direct access machine-code files will be produced and post-processors required to interpret the data.

!DEFINE SAVEFILE = 'c'
> []
>> Nominates a filename prefix for saving daily building states.  Do not specify a file name extension.

_____

These commands deal with choosing and preparing common output data types.

!ENABLE BLOCK OUTPUT
> [DISABLED]
>> Enable the interval block report routine and the default report block.  Optional extra detail output selections may be chosen using any of the following commands. Note that the output routine may be enabled at any time in the run by using the diary, but the output file and report sections must be selected here.

!ENABLE PROFILE OUTPUT
> [DISABLED]
>> Enable interval element profile output routine. Elements to be profiled must be selected in following command.  Note that the output routine may be enabled at any time in the run through the diary, but the output filename and the element selections must be done at top-level.

!ENABLE REPORT PROFILE #i
> [DISABLED]
>> Select element number code i for profiling. ENABLE PROFILE OUTPUT must also be selected in the TOP or DIARY PAGE file for output to occur.

!ENABLE REPORT PROFILE ALL
> [DISABLED]
>> Select all elements for profiling. ENABLE PROFILE OUTPUT must also be selected in the TOP or DIARY PAGE file for output to occur.

!ENABLE SAVE STATE
> [DISABLED]
>> Enable dump facility to store building state at midnight, so as to allow rerun from specific dates.

!SET BLOCK REPORT INTERVAL = i
> [60]
>> Define the block report interval in minutes.

!SET PROFILE INTERVAL = i
> [60]
>> Define the profile output interval in minutes.

!SET PRO OFFSET = i
> [0]
>> Define the profile output offset in minutes. The default values for interval and offset produce hourly reports, on the hour (though only if the routine has been enabled).

!SET RP OFFSET = i
> [0]
>> Define the block report output offset in minutes. The default values for interval and offset produce hourly reports, on the hour (though only if the routine has been enabled).

--------------------------------------------------------------------------------

The following are less common output data commands.

!ENABLE REPORT MET
       [DISABLED]

> Enable block report section for meteorological data. ENABLE BLOCK OUTPUT must also be selected in the TOP or DIARY PAGE file for output to occur.

!ENABLE REPORT SPACE
       [DISABLED]

> Enable block report section for space temp and gains data. ENABLE BLOCK OUTPUT must also be selected in the TOP or DIARY PAGE file for output to occur.

!ENABLE REPORT RADIANT
       [DISABLED]

> Enable block report section for zone radiant temp and gains data. ENABLE BLOCK OUTPUT must also be selected in the TOP or DIARY PAGE file for output to occur.

!ENABLE REPORT ELEMENT PRIMARY
       [DISABLED]

> Enable block report section for element surface temperature and gains data. ENABLE BLOCK OUTPUT must also be selected in the TOP or DIARY PAGE file for output to occur.

!ENABLE REPORT ELEMENT SECONDARY
       [DISABLED]

> Enable block report section for element surface temperature and gains data. ENABLE BLOCK OUTPUT must also be selected in the TOP or DIARY PAGE file for output to occur.

!ENABLE REPORT HEATING
       [DISABLED]

> Enable block report section for heating system output and performance data. ENABLE BLOCK OUTPUT must also be selected in the TOP or DIARY PAGE file for output to occur.

!ENABLE REPORT WATER
       [DISABLED]

> Enable block report section for space humidity and water gains. ENABLE BLOCK OUTPUT must also be selected in the TOP or DIARY PAGE file for output to occur.

!ENABLE REPORT VENT
       [DISABLED]

> Enable block report section for space ventilation transfer. ENABLE BLOCK OUTPUT must also be selected in the TOP or DIARY PAGE file for output to occur.

!ENABLE REPORT ALL
       [DISABLED]

> Enable all above block report sections. ENABLE BLOCK OUTPUT must also be selected in the TOP or DIARY PAGE file for output to occur.

!ENABLE EVENT LOGGER
       [DISABLED]

> Enable event logging output routine. Items to be logged must be selected by the following commands. Note that the output routine may be enabled at any time in the run through the diary, but the output filename and the logged items must be done at top-level.

In the following, the code #i may be replaced by ALL to the obvious effect.

!ENABLE LOG TSP #i
    [DISABLED]
        Select air temperature of space i for logging

!ENABLE LOG SRT #i
    [DISABLED]
        Select surface temperatures (both "left" and "right") of element i for logging.

!ENABLE LOG SRF #i
    [DISABLED]
        Select surface heat fluxes (both "left" and "right") of element i for logging.

!ENABLE LOG MRT #i
    [DISABLED]
        Select mean radiant temperatures of zone i for logging.

!ENABLE LOG URT #i
    [DISABLED]
        Select mean surface temperatures of zone i for logging.

!ENABLE LOG TSN #i
    [DISABLED]
        Select effective temperatures seen by surfaces of element i for logging.

!ENABLE LOG RDN #i
    [DISABLED]
        Select radiant gains to surfaces of element i for logging.

!ENABLE LOG SOL #i
    [DISABLED]
        Select solar transmission through element i for logging.

!ENABLE LOG CON #i
    [DISABLED]
        Select net convective heat gain to space i for logging.

!ENABLE LOG HUM #i
    [DISABLED]
        Select humidity of space i for logging.

!ENABLE LOG DEW #i
    [DISABLED]
        Select air dew point temperature of space i for logging.

!ENABLE LOG FAC #i
    [DISABLED]
        Select fresh air change rate (exchange to exterior only) of space i for logging.

!ENABLE LOG TAC #i
    [DISABLED]
        Select total air change rate (exchange to interior and exterior) of space i for logging.

!ENABLE LOG DUT #i
    [DISABLED]
        Select duty cycle of heating system i for logging.

!ENABLE LOG OUT #i

[DISABLED]
Select heat output of heating system i for logging.

!ENABLE LOG INPUT #i
[DISABLED]
Select core energy input of storage heating system i for logging.

!SET LOG CON = r
[10.0]
Define logging of net convective gain tolerance, W.

!SET LOG DEW = r
[0.5]
Define logging of air dew point temp tolerance, $^{o}$C.

!SET LOG FAC = r
[0.1]
Define logging of fresh air change rate tolerance, Vol/hr.

!SET LOG HUM = r
[2.5]
Define logging of air humidity tolerance, %.

!SET LOG MRT = r
[0.5]
Define logging of mean radiant temp tolerance, $^{o}$C.

!SET LOG OUT = r
[10.0]
Define logging of heating system output tolerance, W.

!SET LOG RDN = r
[0.5]
Define logging of surface radiant gain tolerance, W/m$^2$.

!SET LOG SOL = r
[1.0]
Define logging of solar transmission tolerance, W.

!SET LOG SRF = r
[1.0]
Define logging of surface heat flux , W/m$^2$.

!SET LOG SRT = r
[0.5]
Define logging of surface temp tolerance, $^{o}$C.

!SET LOG TAC = r
[0.1]
Define logging of total air change rate tolerance, Vol/hr.

!SET LOG TSN = r
[0.5]
Define logging of effective temp seen tolerance, $^{o}$C.

!SET LOG TSP = r
[0.5]
Define logging of air temp tolerance, $^{o}$C.

!SET LOG URT = r
[0.5]

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Define logging of mean surface temp tolerance, ºC.

!SET VIRT REPORT = i
       [0]

Sets the upper limit of number of virtual spaces to be included in the BLOCK REPORT output. Normally none of the inbuilt virtual spaces are reported, so as to reduce output file size.

!ENABLE ZNFILE
       [DISABLED]

Enable the optional HKBEAM/BECON output.

_____

These commands nominate files containing the descriptions of the dataset to be modelled. The single quotes around the filename are required. Filename conventions of the operating system in use must be followed.

!DEFINE BUILDING = 'c'
       []

Nominates the building description file.

!DEFINE SERVICES = 'c'
       []

Nominates the services description file.

!DEFINE METEOR = 'c'
       []

Nominates the meteorological data file.

!DEFINE DIARY = 'c'
       []

Nominates the diary page list file.
Nominates a file for use by user supplied zipper routines.

!DEFINE RESTART = 'c'
       []

Nominates a filename for a previously stored building state to be recovered and run. Use in conjunction with !SET DATE, and !SET START.

------------------------------------------------------------------------

Less commonly used file nominations are:

!DEFINE ZIPFIL1 = 'c'
       []

Nominates a file for use by user supplied zipper routines.

!DEFINE ZIPFIL2 = 'c'
       []

!DEFINE CONSTRUCTION = 'c'
       []

Overrides the construction file name declared in Building file.

!DEFINE LAYOUT = 'c'
       []

Overrides the layout file name declared in the Building file.

!DEFINE MATERIAL LIBRARY = 'c'
     []
                    Overrides the material library file declared in the Building or Construction files.

!DEFINE MATERIAL USER = 'c'
     []
                    Overrides the users material file declared in the Building or Construction files.

!DEFINE HEATING = 'c'
     []
                    Overrides the heating file name declared in the Services file.

!DEFINE LIGHTING = 'c'
     []
                    Overrides the lighting file name declared in the Services file.

!DEFINE SMALL POWER = 'c'
     []
                    Overrides the small power file name declared in the Services file.

!DEFINE OCCUPANCY = 'c'
     []
                    Overrides the occupancy file name declared in the Services file.

!DEFINE VENTILATION = 'c'
     []
                    Overrides the ventilation file name declared in the Services file.

_____

These commands are deprecated in this version, and will be not appear in later versions. Their functionality has been replaced.

!SET AIR DENSITY = r
     [1.2929]
                    Define the density of air in kg/m$^3$. This will only be used for initialisation, density is now calculated internally.

!SET AIR HEAT = r
     [1200.0]
                    Define the specific heat of air in j/m$^3$/C. This will only be used for initialisation, specific heat is now calculated internally.

## B.2 BUILDING FILE

The BUILDING File defines both some site specific information i.e., the location of the project, and the definition of the number and size of spaces (i.e. rooms).

It also points to further definition files for the materials, constructions and layout of the partitioning elements describing these spaces.

Only modelled spaces need be defined in this file, virtual spaces (to the number allowed at compile time) are always available.

Commands available are;

COMMAND FORMAT  DEFAULT VALUE
                         DESCRIPTION

!PROJECT ID c
            []
                    Sets the project id. string to the characters following the command. The string will be placed in all output files for identification of run. Quotes are not required around the string.

!EOF
            []
                    Stops the input phase no matter what follows in the Building file. This command should be used routinely in all files as some computing system editors place spurious symbols at the end of a file, and these can be interpreted as errors by HTB2.

_____

The site specific data is provided with these commands;

!LOCATION = r    r
            [52.0,0.0]
                    Sets the site location as latitude (north of equator) and longitude (west of Greenwich) respectively. Negative numbers may be used to indicate locations south and east.

!TIME ZONE = r
            [0.0]
                    Longitude (west of Greenwich) of the nearest time zone division to the east of the site location. If this is not known, enter 0.0 for this AND the site longitude in the !LOCATION command; local time will then be equivalent to solar time.

!SKYLINE = r
            [0.0]
                    Defines a global horizon (or obstruction) in degrees above the horizontal. No direct solar radiation will reach the building once the sun goes below that horizon.

!STATION HEIGHT = r
            [0.0]
                    Defines height of the site in meters above MSL..

_____

These commands define the subdivision of the building into spaces. A space may be a room, part of a room or a conglomeration of a number of adjacent rooms.

Each such space will be defined by a !DEFINE SPACE and !END block.  There may be several such blocks. The ordering of those block affects the index numbers associated with the spaces thus defined; the first block in the file defines space 1, the second space 2 etc.

Most HTB2 simulations will require the definition of one or more spaces.  Where a space is defined, a volume must be provided.

!DEFINE SPACE = 'c'
      []

           Starts an space definition list and defines a character name from the string between the single quotes.  The name is not yet of significance.  Spaces are assigned code numbers sequentially from the order defined in this file. Must be paired with an !END command.

!END
      n/a

           Ends an space definition.

!VOLUME = r
      []

           Sets the air volume of the space, in $m^3$.

----------------------------------------------------------------------------------------------

Less commonly used space data commands are listed below.

!VELOCITY = r
      [0.1]

           Sets the typical air speed in the space, in m/s.  This is used in the calculation of a variable heat transfer when that is enabled in the top level.

_____

These commands point to further files in the building definition chain.

!CONSTRUCTION FILE = 'c'
      []

           Nominates the construction definition file. The filename must be enclosed in single quotes.

!LAYOUT FILE = 'c'
      []

           Nominates the partitioning layout definition file. The filename must be enclosed in single quotes.

!MATERIALS FILE = 'c'
      []

           Nominates the standard materials file. The filename must be enclosed in single quotes.

!MATERIALS USER FILE = 'c'
      []

           Nominates the alternate user materials file. The filename must be enclosed in

single quotes.

---------------------------------------------------------------------------------------

The previous release format is still acceptable, but will not be supported in future releases, nor by allied pre- or post-processing programmes for HTB2.  The two formats should NOT be mixed.

!SPACES
       n/a

            Starts the definition list of modelled spaces.  Must be followed by the space definitions as below and be paired with a "}" at the end of the definition.

- 'name' = r
       [no modelled spaces are defined by default]

            Defines a space and associated volume in $m^3$. Repeat for the number of spaces required. All must be contained within a !Space and a } command pair. Space number codes, which are used in most other data files, are assigned sequentially as spaces are entered in this list.

}
       n/a

            The "}" character ends the space definition list started by the !SPACE command.

## B.3 CONSTRUCTION FILE

The CONSTRUCTION File specifies the construction methods that may be used to create an element (a wall, window, floor, roof etc.).   A Construction may be used in any number of elements.  Window solar transmission characteristics are also defined in this file.

As the fabric model of HTB2 is one-dimensional, the construction method defines a simple planar sequence of material layers; no explicit description of edge detailing is possible.  Each construction type is a record of the layering of materials making up that construction.  Thus a exterior wall type may be, for instance, be defined as an 100mm layer of facing brick, 50mm cavity, 30mm polythene insulation, and 100mm blockwork.   The thermo-physical properties of materials used are those specified in the chosen Materials File; the materials are indexed by code numbers to that file.  Due to calculation limitations, material layers that have little or no impact on thermal behaviour of  the construction are often omitted.  These are often thin layers of high conductance; for instance the mathematical requirements of calculating the heat flow through a layer of vapour check material (say 2mm polythene sheet) are disproportionately large compared to its' thermal effect, that layer could safely be ignored.

The order of the definition of Constructions is significant.  Constructions are applied to Elements by an index number; the order of the Construction in this file determines the index number.  Thus Construction index number 1 is the first construction to be defined in this file, index 2 the second etc.

The order of the definition of layers is significant to HTB2.  It is recommended practice to define the first layer of the Construction as the outside layer (where that is applicable).  Where the Construction is to be used in a tilted (i.e. not vertical) Element, such as a floor partition, the first layer should be the uppermost layer. Where the Element is to be in contact with earth (e.g. a floor slab) again the first layer should be the uppermost.  Where a Construction is being defined for a totally internal Element (a partition), the order is immaterial but still significant, particularly for asymmetrical constructions.  In defining an Element using a Construction, some indication of the connection of surfaces to spaces must be made.  This is done through a naming convention for the surfaces of the Construction: the FIRST SURFACE of a Construction is that of the first layer in its definition, similarly the LAST SURFACE is that of the last.

The data required for a Construction layer is generally the material number, and the width of the layer (in meters).  Optional information (Slices in the example below) can be applied to determine the number of thermal nodes to use in the thermal calculations.  Apply a value of 0 to allow HTB2 to determine the optimal number of nodes.

Constructions may be Transparent of Opaque; that is both windows and walls are treated equally in the thermal calculations.  The assignment of a particular Construction to an Element is done in the Layout specification file.  Construction specifications are not generally concerned with surface detailing, for instance colour (as relating to surface solar absorption).  That is determined in the layout, when instances of Construction types are used.  Thus a common Construction type may be used in a number of different instances, each with different surface properties.

This file also defines the solar transmission characteristics of glazing types that may be used in the simulation. These are defined (and treated) independently of the material layering of the appropriate window construction. Thus a layer of glass may be used to specify an 'Opaque' element (i.e. one that does not transmit solar radiation, this may be useful in interior partitions, as HTB2 does not explicitly consider the internal distribution of solar gains via internal transparent partitions).  Equally a transmission characteristic could be applied to a 'Transparent' element made of brick!.   The assignment of a particular glazing characteristic to a particular transparent element is done in the layout specification.  This allows a common construction type (e.g. double glazing) to have a number of transmission types (e.g. clear, or solar control film).  A glazing type is named and accessed by than 'name', thus these are not positionally dependent.  A glazing type is defined by a specification of the transmission and absorption coefficients for angles of incidence in ten degree steps, plus the appropriate coefficients for the diffuse solar component.  These coefficients are for the glazing system as a whole, not for its separate component panes.

Thus Transparent Constructions require one further item of information for each layer; the proportion of the total glazing absorption that is to be attributed to that layer.  Thus a double glazing system may have an absorb-

ing ratio (at a particular angle of incidence) of 0.25. That is defined for the whole system, of that absorption, typically a greater amount will be absorbed in the first layer (pane of glass) than in the last layer, and this is specified in the layering.

The specifications here of constructions and glazing types can be considered to define a library of types available for later use. That is a large number of constructions and glazing types may be defined, that are not used in a particular building instance. This will have no impact on the storage requirement for a particular simulation.

There are some special internally defined "materials" for use in constructions, which cover layers types such as cavities. These are coded as;

    -1 is a normal cavity,
    -2 is a low emissivity (i.e. foil lined) cavity ,
    -3 is a pure resistance layer, or a cavity of a nonstandard resistance. The required resistance of the layer is coded in the declared width of the layer as {width = resistance(m²/W/°C)/1000}. That is a layer of thermal resistance 0.5 m²/W/°C would be coded as material = -3, width = 0.0005 m.
    -5 is a ventilated cavity,
    -11 is a cavity with thermal resistance calculation to procedures set out in ISO 15099.

None of these special "materials" may be used as a surface layers.

COMMAND FORMAT    DEFAULT VALUE
                            DESCRIPTION

!CONSTRUCTION 'c'
        []
                        Starts a definition list for a construction type. Construction name will be taken as string between single quotes. Construction codes will be assigned sequentially as defined in the file. Must be paired by an !END command.

!EOF
        []
                        Stops the input phase no matter what follows in the Construction file. This command should be used routinely in all files as some computing system editors place spurious symbols at the end of a file, and these can be interpreted as errors by HTB2.

!TYPE c
        [OPAQUE]
                        Defines the type of construction, OPAQUE or TRANSPARENT types only allowed.

!PARTS
        n/a
                        Starts a part definition list for a particular construction. Must be followed by one or more lines describing the layers of the construction. The first layer described becomes the "FIRST" surface of the construction, the final layer becomes the "LAST" surface. Most constructions should follow the convention of the FIRST surface being the outside, or uppermost side. The layer data is codes as...

_  i  =  i      r      i      (r)
        []
                        Defines data for each part or layer as:
                The part number (for identification only, not used within HTB2, parts are numbered sequentially as entered in this list).
                The material code index, relative to the Material File, (if prefixed by "@" relative to the Material User File),
                The width (m.) of the part,
                The number of finite difference slices to calculate for the part ( if 0, HTB2 will

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determine "best" or stable slice count),

For "transparent" constructions only, the parts relative absorption (i.e. the fraction of the total construction absorption going to this layer).

The prefix "_" character is required syntax.

This line will be repeated for as many parts as required in the construction.

}

n/a

Ends the parts list started by !PARTS.

!WINDOW = 'c'

[]

Starts a glazing type definition and defines name of type as string in single quotes. This command starts a block containing the TRANSMISSION and ABSORPTION commands.

!TRANSMISSION =

r, r, r, r, r, r, r, r, r, r, r

[]

Defines the transmission coefficient of a glazing type in terms of a single diffuse and 10 direct beam transmission fractional values (between 0.0 and 1.0). The direct beam values are to be specified in 10 degree steps of incidence angles (0-90). The values must be on a separate line after the !TRANSMISSION = command.

!ABSORPTION =

r, r, r, r, r, r, r, r, r, r, r

[]

Defines the absorption characteristic of a glazing type in terms of a single diffuse and 10 direct beam transmission fractional values. The direct beam values are to be specified in 10 degree steps of incidence angles (0-90). The values must be on a separate line after the !ABSORPTION = command.

!DIFFUSION =

r, r, r, r, r, r, r, r, r, r, r

[]

Defines the diffusing characteristic of a glazing type in terms of the fraction of direct beam converted to diffuse energy (between 0.0 and 1.0) for steps of incidence angle in 10 degree steps.

!WINDOW 2D = 'c'

[]

Starts a bi-directional glazing type definition and defines name of type as string in single quotes. This command starts a block containing the TRANSMISSION 2D and ABSORPTION 2D commands.

!TRANSMISSION 2D =

r, r, r, r, r, r, r, r, r, r, r , r, r, r, r, r, r, r, r
r, r, r, r, r, r, r, r, r, r, r , r, r, r, r, r, r, r, r
r, r, r, r, r, r, r, r, r, r, r , r, r, r, r, r, r, r, r
...

[]

Defines the transmission coefficient of a bi-directional glazing type in terms of transmission coefficients (between 0.0 and 1.0) for steps of altitude and azimuth in 10 degree steps. This data is provided as 19 lines of 19 values. Each line is a set azimuth, from -90 to +90 degrees, within each line is altitude from -90 to +90

degrees (both with respect to the surface normal).

!ABSORPTION 2D =

r, r, r, r, r, r, r, r, r, r, r ,r, r, r, r, r, r, r, r
r, r, r, r, r, r, r, r, r, r, r ,r, r, r, r, r, r, r, r
r, r, r, r, r, r, r, r, r, r, r ,r, r, r, r, r, r, r, r
...

[]

Defines the absorption characteristic of a bi-directional glazing type in terms of absorption coefficients (between 0.0 and 1.0) for steps of altitude and azimuth in 10 degree steps. This data is provided as 19 lines of 19 values. Each line is a set azimuth, from -90 to +90 degrees, within each line is altitude from -90 to +90 degrees (both with respect to the surface normal).

!DIFFUSION 2D =

r, r, r, r, r, r, r, r, r, r, r ,r, r, r, r, r, r, r, r
r, r, r, r, r, r, r, r, r, r, r ,r, r, r, r, r, r, r, r
r, r, r, r, r, r, r, r, r, r, r ,r, r, r, r, r, r, r, r
...

[]

Defines the diffusing characteristic of a bi-directional glazing type in terms of the fraction of direct beam converted to diffuse (between 0.0 and 1.0) for steps of altitude and azimuth in 10 degree steps. This data is provided as 19 lines of 19 values. Each line is a set azimuth, from -90 to +90 degrees, within each line is altitude from -90 to +90 degrees (both with respect to the surface normal).

!END

n/a

Ends a construction or glazing type definition and must be paired with them.

!MATERIALS FILE ='c'

[as defined in "building" file]

Nominates the standard materials file. The filename must be enclosed in single quotes. This overrides a specification made in the "building" file.

!MATERIALS USER FILE = 'c'

[as defined in "building" file]

Nominates the alternate user materials file. The filename must be enclosed in single quotes. This overrides a specification made in the "building" file.

## B.4 LAYOUT FILE

The LAYOUT FILE defines the Elements (walls ,ceilings etc) partitioning the building in terms of their construction type, surface properties, and connections.

An Element has two surfaces ('FIRST' and 'LAST', see discussion in the Construction File description, Appendix b3), and may connect at most two spaces. This may mean that one notional wall may need to be spearated into many Elements. Each surface of an Element is considered to have a uniform surface temperature. Where several partitions share a Construction type and spatial connections, it is sensible to combine them into one Element, so long as the uniform surface temperature condition can be considered applicable. Where for instance one surface receives solar radiation while another does not, their temperatures will be different, and so they should not be combined.

An Element may have both surfaces connected to the same space. This would act as a thermal store to that space. Note that in this case, there would be twice the declared surface area active for heat transfer in that space.

Elements are referred to by index code numbers. These numbers are assigned, starting from 1, in the order they are defined in the layout file. Thus the description and manipulation of Elements layout file is positionally dependent.. There are no predefined elements.

Spatial connections and construction selection for an Element are achieved also by index number. The outside is denoted by Space 0. Depending on how Space 0 is used, will select whether external air, or deep ground temperature is connected to the surface of the Element. If the Space 0 is connected to the First surface, this is assumed to be external air. Where it is connected to the Last surface, this is considered to be deep ground temperature.

The surface naming convention for "FIRST" and "LAST" refers to that used in the construction file where layers were defined sequentially from the first layer denoted to the last layer. An external surface (which connects to space code 0) and the internal face of a solid floor slab must be "FIRST". It is a useful convention that all upper surfaces of tilted elements should also be FIRST.

There is one internally defined construction type, termed "virtual", which is denoted by construction code -1. This construction type does not produce a physical partition, but simply acts as a purely resistive thermal connection between spaces. Heat is then transported between spaces according to their temperature difference.

Each Element is defined between a !ELEMENT and !END command pair. There are many optional parameters available for elements which have generally appropriate default values (e.g. absorption and emissivity). Often these default values may be altered globally in the Top Level file. Those parameters that are required to be defined are its construction type, area, surface connections, and if an external Element, its orientation.

This file also defines any Shading Masks which may be used by the elements. Shading Masks define the 'view' of the surface from different points in the sky vault, these points are in a pattern of 36x9 sectors, each separated by 10 degrees. During calculation, the sector the sun is currently in will determine the fraction of the potential direct solar radiation reaching the surface; diffuse radiation will also be affected (but not ground reflected radiation) as the mean proportion of the sky vault left unshaded. A shading factor will be a fraction between 0 and 1, at 0 no radiation form that sky sector will reach the surface. The default shading for an Element is 'None', i.e. unshaded. Note that if a user defined shading mask is applied to an Element, that mask must be explicit, that is for instance all sectors notionally 'behind' the surface must be set as 0 or radiation will reach the surface; HTB2 will not check for this. This 'feature' may be useful in some circumstances, but not generally.

Shading Masks may be attached to any external Element, Transparent or Opaque. A single Mask may be attached to many Elements, but as the Mask definition is related to absolute direction (i.e. South) and not to relative direction (i.e. the orientation of a surface) thsi must be done with care. A mask for a overhang on a

south window will be different than one for an east window.

Each Mask between a !MASK and !END pair.

Commands available are;

COMMAND FORMAT   DEFAULT VALUE
                             DESCRIPTION

Those commands which must be used to define an Element are listed below.

_____

!ELEMENT = 'c'
          []
                    Starts an element definition list and defines a character name from the string
                    between the single quotes.  The name is not yet of significance.  Elements are
                    assigned code numbers sequentially from the order defined in this file. Must be
                    paired with an !END command.

!END
          n/a
                    Ends an element definition.

!EOF
          []
                    Stops the input phase no matter what follows in the Building file.  This command
                    should be used routinely in all files as some computing system editors place
                    spurious symbols at the end of a file, and these can be interpreted as errors by
                    HTB2.

!AREA = r
          []
                    Defines area of a single surface of the element in m$^2$.

!CONSTRUCTION = i
          []
                    Defines the construction code number (re those produced by the "construction"
                    definition file) to be used for this element. A "virtual element" may be defined by
                    using code -1.

!SPACE TO FIRST = i , and

!SPACE TO LAST = i
          []
                    Defines space code number to connect to "FIRST" and "LAST" surfaces of element
                    respectively.  Space codes are those generated in the "building" definition file.
                    Virtual spaces may be connected by prefixing these with a "-", i.e. by a -ve space
                    number.

For externally connecting elements the following are required.

!ORIENTATION = r
          [0 for internal, no default for external elements]
                    Required only for externally connected elements.  Defines the azimuth angle
                    between the element's "FIRST" surface normal to south.  A +ve angle is clockwise.
                    (i.e. a North facing wall would have an orientation of 180°)

For transparent Elements (those using Transparent Constructions) the following are required.

!WINDOW TYPE = 'c'
          []

> Required only for "transparent" elements. Selects a glazing transmission characteristic from those defined in the "construction" file by the !WINDOW command. The characteristic name must be enclosed in single quotes.

!PATCH TO #i FIRST = r , and

!PATCH TO #i LAST = r
          []

> Define a proportion (r:0-1) of the transmitted direct solar energy of current element which will be directed to the "FIRST" or "LAST" surface of the nominated element i. This command may be repeated within an element definition if the transmitted beam is to go to many other elements (there is no check that the combined proportion = 1.0). This command acts as a static sun patching specification, the sunpatch is not determined dynamically.

----------------------------------------------------------------

The following are optional but commonly used commands to override default parameters for Elements

!ABSORPTION FIRST = r , and

!ABSORPTION LAST = r
          [0.7]

> Defines the shortwave absorption of the "FIRST" and "LAST" surfaces respectively. This is an indication of surface colour, and is significant only for "opaque" elements, as "transparent" elements have a transmission and absorption characteristic defined separately.

!GROUND REFL = r
          [0.2]

> Used only for externally connected elements. Defines the adjacent ground (or nearby surface) reflectance for that element.

!SET FRAME = r
          [as set in TOP]

> Sets the initial value of frame blockage for windows. A blockage of 0.3 would mean that 30% of the specified area of a window is opaque to solar transmission.

!SET SOLAR LOST = r
          [as set in TOP]

> Defines the back reflectance for this window. This is the fraction of calculated solar transmission which is immediately lost to the building due to reflectance back through the window. That proportion is assumed to have no effect on the building energy balance.

!SHADING = 'c'
          [NONE]

> Required for external elements only. Selects a shading template for the external surface of external elements. The template name (referring to those defined by the !MASK commands in this file) must be enclosed in single quotes. The standard template (unshaded) NONE does not need quotes.

!SITE SHADE = 'c'
          [NONE]

> Optional for external elements. Selects a shading template for the external surface of all external elements. The template name (referring to those defined by the !MASK commands in this file) must be enclosed in single quotes. Site shading is applied before individual surface shading, and the effect is cumulative.

!TILT = r

    [0.0 (vertical)]

        Required only for externally connected elements. Defines tilt angle from the "FIRST" surface normal to the horizon. A +ve angle is tilting up. ( i.e. a ground floor would have a tilt of 90°)

This command is for output information only. It does not affect the thermodynamic specification of the element.

!CLASS = i

    []

        Nominates this element for inclusion in output class i. Classing can be used as a means of summarising element data within the output file. A class could be all south facing windows for instance. The data summarised for a class is the total heat flow through the surfaces (first and last independently) that comprise that class. The element areas that make up the class are taken into account; the output value is in kWh. There are up to 10 classes available. No elements belong to a class by default. Not all elements need to be associated with a class.

The following removes an element from the calcultion chain, but does not affect any indexing. Thus a wall may be changed or removed without the need to re-index the entire layout file.

!SKIP

    []

    Removes an element from the calculation chain, without altering other elements indexing codes.

--------------------------------------------------------------------------

The following are less commonly commands.

!EMISSIVITY FIRST = r, and

!EMISSIVITY LAST = r

    [0.9]

        Defines the longwave emissivity of the "FIRST" and "LAST" surfaces respectively.

!ZONE TO FIRST = i

!ZONE TO LAST = i

    [as space connection]

        Defines a radiant zone (i.e. a network of interconnecting surfaces) connection for "FIRST" and "LAST" surfaces respectively. The default condition is that Spaces and Zones are identical, and this is generally sufficient. A Zone in HTB2 is a radiant enclosure, i.e. one bounded by physical surfaces. A Space however, may be declared as having "virtual" surfaces (i.e. connecting directly to other Spaces). A Zone may contain many such Spaces, however as no radiant transfer occurs by default across virtual connections, explicit declaration of Zone connections may be required. Zones are defined when radiant transfer must occur across elements, or between spaces.
        Zone numbers are defined here as used. If no zones are defined then the default condition is used; Zones and Spaces are identical. If any zone is defined then all zone connections must be defined. The number of zones is always less or equal to the number of spaces.

!PATCH DIFFUSE TO #i = r

    []

        Define a proportion (r:0-1) of the transmitted diffuse solar energy of current

element which will be directed to the  nominated zone i.  This command may be repeated within an element definition if the transmitted energy is to go to many other zones (there is no check that the combined proportion = 1.0).  This command overrides the default action, which is to send diffuse energy to the zone connecting to th eelement in question.

-------------------------------------------------------------------

The following affect the method of the calculation of surface heat transfer from the Element.

!SURFACE AREA FACTOR FIRST = r   , or

!SURFACE AREA FACTOR LAST = r
[1.0]

Determines a correction factor applied to the appropriate surface to modify the convective transfer coefficients for that surface.  Thus for a notional wall area, a factor >1can be applied to allow for corrugations on one side (for instance on a waffled ceiling structure.

!SURFACE AIR MOVEMENT FIRST = r   , or

!SURFACE AIR MOVEMENT LAST = r
[1.0]

Determines a correction factor applied to the appropriate surface to modify the convective transfer coefficents calculated for that surface by the VARIABLE option.  That option requires a local air speed; this is notionally taken as the mean space air speed (see teh Building definition file description) times this multiplier factor..  Thus one surface of  wall may be expected to have a higher than average local air movement ( a large cold surface, or  a wall near a ventilating outlet for instance.

!SURFACE HTCS FIRST = r , r , r   , and

!SURFACE HTCS LAST = r , r , r
[HTC defaults as defined in Top Level]

Applies convective transfer heat coefficients to appropriate surface of this Element.  Applicable only when the Fixed coeffcient option is selected (the default).  Through this command, different transfer coefficents may be applied idependantly to the two surfaces of an Element.  The commands available in the Top Level apply to both sides.  Not thatvalues applied here will not affect the extrnal transfer coefficients.

!SURFACE SCALE FACTOR = r
[3.0 m for a wall, √AREA for a floor or ceiling]

Determines the scale factor used when calculating convective transfer coefficients using the VARIABLE option.

!SURFACE SHELTER = r , r , r , r , r , r , r , r
[1.0 for all]

Applies a shelter fraction for 8 wind sectors (starting south and in 45 degree steps clockwise).  The shelter fraction will moderate the meteorlgical wind speed used in the calculation of windward external convective heat transfer.

!SURFACE TRANSFER FIXED  , or

!SURFACE TRANSFER VARIABLE
[defaults as defined in Top Level]

Determines the algorithm used to calculate convective transfer coefficients for this Element.

!CAVITY VENT FACTOR = r , r , r , r

[]

> Sets the coefficients A,B,C,D for a ventilated cavity. These will be used to determine the flow rate through the cavity. The flow will be determined as:
>
> $$Q \text{ (m3/s)} = [A + B*(windspeed) + C*(sqrt(temp\ diff)) ] *D, \text{ where}$$
>
> > the parameter A is a fixed background infiltration flow rate,
> > B is the wind component and
> > C the stack component of the cavity flow rate,
> > D is a multiplier, that can be varied in the Diary.
>
> > If D is set to 0 there is no ventilation, and the cavity behaves as a standard type -1.

An error message will be generated if an element using a ventilated cavity construction does not define these data. There are no default values.

!CAVITY VENT CONNECTION = i

[]

> Sets the space to which a ventilated cavity will communicate.

_____

The following define a shading mask for use in the Element descriptions.

!MASK 'c'

[]

> Starts definition of a shading mask. Mask name is taken from the string enclosed in single quotes (up to 10 characters). Must be paired with an !END command and must be followed by a mask table made up from transmission values (i.e. fraction of solar allowed through to fall on surface) in 10 degree sectors, from azimuth = 0 to 360° (clockwise from south), and altitude = 0 to 90° (horizon to zenith). The table comprises 36 lines of 9 values, i.e. one line refers to the 9 altitude values for the appropriate azimuth. No comments may be included within !MASK/!END block.

!END

n/a

> Ends a mask definition.

## B.5 MATERIALS FILES

There are two materials lists available to each run of the model, a standard library file, such as STDMAT.LBY, which contains common materials in a direct access file, and a users library file which may contain data for the properties of any material required by the user in a file which may be altered by a standard editor.

### b.5.1 STANDARD MATERIALS LIBRARY

The materials at present in the standard materials library, (STDMAT.LBY as supplied with HTB2) are:

MATERIALS PROPERTIES FILE - STANDARD - nov/84

| code | material name | conductivity W/m/C | density Kg/m³ | spec. heat J/Kg/C |
|------|---------------|-------------------|---------------|-------------------|
| | | : | : | : | : |
| 1 | 'BRICK (OUTER LEAF)' | 0.840 | 2000.0 | 680.0 |
| 2 | 'BRICK (INNER LEAF)' | 0.620 | 1800.0 | 840.0 |
| 3 | 'BREEZE BLOCK' | 0.440 | 1500.0 | 650.0 |
| 4 | 'VERMICULITE INSULATING BLOCK' | 0.270 | 700.0 | 837.0 |
| 5 | 'ASBESTOS CEMENT' | 0.500 | 1500.0 | 1000.0 |
| 6 | 'ASBESTOS CEMENT SHEET' | 0.360 | 700.0 | 1050.0 |
| 7 | 'BITUMEN FELT' | 0.500 | 1700.0 | 1000.0 |
| 8 | 'ROOFING FELT' | 0.190 | 960.0 | 837.0 |
| 9 | 'MASTIC ROOFING' | 1.150 | 2325.0 | 1946.0 |
| 10 | 'CONCRETE (HEAVY MIX)' | 1.400 | 2100.0 | 653.0 |
| 11 | 'CONCRETE (LIGHT MIX)' | 0.380 | 1200.0 | 653.0 |
| 12 | 'AERATED CONCRETE' | 0.160 | 500.0 | 840.0 |
| 13 | 'AERATED CONCRETE BLOCK' | 0.240 | 750.0 | 1000.0 |
| 14 | 'REFACTORY INSULATING CONCRETE' | 0.250 | 10.0 | 837.0 |
| 15 | 'VERMICULITE AGGREGATE CONCRETE' | 0.170 | 450.0 | 837.0 |
| 16 | 'LIGHT CONCRETE SCREED' | 0.410 | 1200.0 | 840.0 |
| 17 | 'CAST CONCRETE SCREED' | 1.280 | 2100.0 | 1007.0 |
| 18 | 'GRANOLITHIC SCREED' | 0.870 | 2085.0 | 837.0 |
| 19 | 'WHITE RENDER' | 0.500 | 1300.0 | 1000.0 |
| 20 | 'CEMENT SCREED' | 1.400 | 2100.0 | 650.0 |
| 21 | 'CLAY TILES' | 0.850 | 1900.0 | 837.0 |
| 22 | 'CONCRETE TILES' | 1.100 | 2100.0 | 837.0 |
| 23 | 'SLATE TILES' | 2.000 | 2700.0 | 650.0 |
| 24 | 'PLASTIC TILES' | 0.500 | 1050.0 | 837.0 |
| 25 | 'RUBBER TILES' | 0.300 | 1600.0 | 2000.0 |
| 26 | 'CORK TILES' | 0.080 | 530.0 | 1800.0 |
| 27 | 'ASPHALT/ASBESTOS TILES' | 0.550 | 1900.0 | 837.0 |
| 28 | 'P.V.C./ASBESTOS TILES' | 0.850 | 2000.0 | 837.0 |
| 29 | 'CEILING TILES MINERAL' | 0.030 | 290.0 | 2000.0 |
| 30 | 'CEILING TILES PLASTER' | 0.380 | 1120.0 | 840.0 |
| 31 | 'SANDSTONE' | 1.830 | 2200.0 | 712.0 |
| 32 | 'GRANITE ' | 2.900 | 2650.0 | 900.0 |
| 33 | 'MARBLE' | 2.000 | 2500.0 | 880.0 |
| 34 | 'PLASTER DENSE' | 0.500 | 1300.0 | 1000.0 |
| 35 | 'PLASTER LIGHT' | 0.160 | 600.0 | 1000.0 |
| 36 | 'GYPSUM PLASTERBOARD' | 0.190 | 950.0 | 840.0 |
| 37 | 'PERLITE PLASTERBOARD' | 0.180 | 800.0 | 837.0 |
| 38 | 'GYPSUM PLASTERING' | 0.420 | 1200.0 | 837.0 |
| 39 | 'PERLITE PLASTERING' | 0.080 | 400.0 | 837.0 |
| 40 | 'VERMICULITE PLASTERING' | 0.200 | 720.0 | 837.0 |
| 41 | 'WOOD BLOCK' | 0.160 | 800.0 | 2093.0 |
| 42 | 'MEDIUM HARDBOARD ' | 0.080 | 600.0 | 2000.0 |
| 43 | 'STANDARD HARDBOARD' | 0.130 | 900.0 | 2000.0 |
| 44 | 'FIR (20% moist)' | 0.140 | 419.0 | 2720.0 |
| 45 | 'FLOORING BOARD' | 0.140 | 600.0 | 1210.0 |

```
46 'CORK BOARD'                        0.040      160.0    1888.0
47 'CHIPBOARD'                         0.150      800.0    2093.0
48 'WEATHERBOARD'                      0.140      650.0    2000.0
49 'OAK (radial)'                      0.190      700.0    2390.0
50 'PLYWOOD'                           0.150      560.0    2500.0
51 'WILTON CARPET'                     0.060      186.0    1360.0
52 'SYNTHETIC CARPET'                  0.060      160.0    2500.0
53 'WOOL FELT UNDERLAY'                0.040      160.0    1360.0
54 'RUBBER UNDERLAY'                   0.100      400.0    1360.0
55 'UREA FORMALDEHYDE FOAM'            0.030       30.0    1674.0
56 'FIBREBOARD'                        0.060      300.0    1000.0
57 'WOODWOOL'                          0.100      500.0    1000.0
58 'GLASSWOOL'                         0.040      250.0     840.0
59 'THERMALITE'                        0.030      753.0     837.0
60 'POLYURETHANE FOAM BOARD'           0.030       30.0     837.0
61 'SIPOREX'                           0.120      550.0    1004.0
62 'PVC'                               0.160     1379.0    1004.0
63 'POLYSTYRENE'                       0.030       25.0    1380.0
64 'C & CA POLYSTYRENE'                0.040       13.6    1380.0
65 'WINDOW GLASS'                      1.050     2500.0     750.0
66 'EARTH'                             1.280     1460.0     879.0
```

This data is created as a formatted, direct access file. Each record is 80 characters long. Each material is indexed by its position in this file with the first materials data starting at record 5. Thus material #2 is "BRICK (INNER LEAF)" and is found at record 6. The first four records may be used for information text as in the standard file. The number in the first 3 columns, and the material name is for information only, they are not used by HTB2. The numeric data starts at column 37 and is contained in 12 character wide columns. The data is read by the format (BN,36X,3F12.3) and is conductivity (W/m$^2$/$^o$C), density (kg/m$^3$) and specific heat (J/kg/$^o$C).

### b.5.2 USER MATERIALS FILE

The user materials file is a simple text sequential file which may be created by an editor. The file is to be formatted as follows;

(for each material in file)

        a record(line) with the material code number , and
        a record with the materials conductivity (W/m/$^o$C), density (Kg/m$^3$) and specific heat capacity (J/Kg/$^o$C).

The file is read in a free format, but the material code number must be found in an odd numbered record with the properties immediately following. There can be no comments between records

As an example:

```
1              * special material X
0.003    1200.0      800.0
12             * special material Y
10.000   200.0        50.0
```

note that the users material code numbers need not be sequential.

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## B.6 SERVICES FILE

The services file starts the defininition of the services (heating, lighting, etc.) to be included in the simulation. These services are described as pointers to data files for each service type.

Note that the appropriate module must be enabled in the top-level file before any calculations will be carried out.

COMMAND DEFAULT    DESCRIPTION

!SERVICEID c
         []
                  Defines a job identification string to be used in output files.

!HEATING FILE = 'c'
         []
                  Nominates the heating definition data file.

!LIGHTING FILE = 'c'
         []
                  Nominates the lighting definition data file.

!SMALL POWER FILE = 'c'
         []
                  Nominates the small power definition data file.

!OCCUPANCY FILE = 'c'
         []
                  Nominates the occupancy definition data file.

!VENTILATION FILE = 'c'
         []
                  Nominates the ventilation definition data file.

!EOF
         []
                  Stops the input phase no matter what follows in the Services file.  This command should be used routinely in all files as some computing system editors place spurious symbols at the end of a file, and these can be interpreted as errors by HTB2.

## B.7 HEATING FILE

This file defines the heating (and simple cooling) systems servicing the spaces of the building. There may be many systems, with different characteristics, operating within the building, and a space may be served by more than one system.

Heating systems are described in terms of their maximum output capacity, their output form and connections (e.g. convective or radiant output, and the spaces and zones receiving the output), their output characteristic (e.g. warm-up and cool-down time constants, and their controls (timeclocks and thermostats). Each system is assigned a code number sequentially in the order as specified in this file.

Each system so defined may be operated independently; each has its own specification, time clock controller, thermostat controller, and connections list. Alternatively, a number of heating systems may be controlled by a single 'super' thermostat, termed a Master Stat.

By default, the heating system module provides an 'Ideal' heating system, that is one that, within its' heat output capability, will maintain the desired setpoint within a space. It will also have purely convective output. By definition of suitable parameters, more realistic system and control characteristics may be defined, for instance as in a wet central heating system, a heat emitter within a lounge, with a definite time constant for warm up and cool-down and a control thermostat sensing a temperature of a second space (perhaps the hall). Thus a perfect setpoint cannot be guaranteed, but the system will hunt around the desired temperature, according to the interactions of the fabric, solar and internal spaces, and the heating system.

The standard heating system module of HTB2 calculates only the emitter end of a system, that is there is no central boiler model. Thus only energy requirements rather than fuel use are calculated. Estimates of correction factors for system efficiency must be applied to calculate fuel use.

An explicit storage heater module is available within this version of HTB2, developed and supplied by British Gas.

Each heating system is defined between a !HEATSYS and an !END pair.

Commands available are;

COMMAND FORMAT DEFAULT VALUE
                        DESCRIPTION

_____

Commonly used heating system commands are:

!HEATSYS 'C'
            []
                        Starts a system definition list. System name is taken as the string between single
                        quotes. Must be paired with an !END statement.

!END
                         Ends and closes a system definition.

!EOF
            []
                        Stops the input phase no matter what follows in the Heating file. This command
                        should be used routinely in all files as some computing system editors place
                        spurious symbols at the end of a file, and these can be interpreted as errors by
                        HTB2.

The following commands detail the heat emitter characteristics, and are generally required;

!POWER OUTPUT = r
            [unlimited ]

Defines the maximum heat output available, in kW. The default, when used with the ideal 'stat, will always maintain the setpoint. The default value should not be used with any other 'stat option; in those cases more realistic values must be supplied.

!CONVECTIVE CONNECTIONS

n/a

Starts the definition list of convective output (if any). Must be followed by output spaces and proportions, as follows, and paired with a "}" at the end of the list. The command may be omitted if there are no convective connections. There is no check that the complete output list totals to 1.0.

_#i = r

[]

Defines proportion r (0-1) of system convective output (i.e. after the split has been applied) directed to space i. Line is repeated for as many output connections as required. This command will also apportion any water generation that has been specified, by the same proportions.

The following commands detail the control characteristics, and are generally required;

!CLOCK START TIME #i = hh:mm:ss | c          , and

!CLOCK STOP TIME #i = hh:mm:ss | c

[25:00:00]

Defines time for Switch ON and OFF respectively,  for controlled period i.  Times are in 24 hr clock format, must follow the format shown. There are up to 5 control periods available.  Multiple control periods must be specified in time order. Multiple control periods (up to 3 in standard version) must be specified in time order.  The default value effectively disables time clock action for all periods.  If no time clock is described for a system, it will always be OFF unless switched via the diary.

The optional word c after the vertical bar symbol | determines a 'day of week' application of this time clock setting.  The is in the form of 7 letters, each corresponding to the first letter of the day of week that this control is to apply to, starting with Monday, (if not applicable the dash is used).  Thus

!CLOCK START TIME #3 = 18:30:00 | MTWTF--

denotes the 3rd clock period will start at 18:30 for mondays through fridays.

!SETPOINT HEATING = r

[20.0]

Defines the required sensed temperature during system "ON" time.  Any deadband will be centered on that value.

!SETPOINT COOLING = r

[]

Enables and defines setpoint for the optional "flattop" cooling system. If used air temperature will not be allowed to raise above value; cooling system capacity is assumed to be infinite.

----------------------------------------------------------------

These commands may be required for more realistic heating system simulation.

!SPLIT = r , r , r

[1.0,0.0,0.0]

Defines system output splits to CONVECTIVE, RADIANT, and INFRASTRUC-TURE output types, each as a fraction of 1. There is no internal check on the sum of these fractions.  N.B. the IDEAL 'stat requires a 100% convective system.

!TIME CONSTANT = r , r

[0.0,0.0]

Defines exponential time-constants, in seconds, for response of system output after a control change. There are separate time-constants for warm-up and cool-down. Default values correspond to an ideal immediate response characteristic.

!DELAY LAG = r
[0.0]

Defines any time lags in the response of the system to control changes, in seconds.

!RADIANT DIFFUSE, or

!RADIANT DIRECT
[direct]

Selects the radiant output type of a system. A diffuse source irradiates all surfaces in a zone on a area weighting basis. A direct source irradiates only selected surfaces.

!RADIANT CONNECTIONS
n/a

Starts the definition list of radiant output (if any). Must be followed by output surfaces (or zones if diffuse source specified) and proportions, as follows, and paired with a "}" at the end of the list. The command may be omitted if there are no radiant connections. There is no check that the complete output list totals to 1.0.

_FIRST #i = r, or _LAST #i = r
[]

Defines proportion r (0-1) of system radiant output (i.e. after the split has been applied) directed to FIRST {LAST} surface of element i. Line is repeated for as many output connections as required. This form is for use only with systems declared RADIANT DIRECT.

_ZONE #i = r
[]

Defines proportion r (0-1) of system radiant output (i.e. after the split has been applied) directed to ZONE i. Line is repeated for as many output connections as required. This form is for use with systems declared as RADIANT DIFFUSE.

!DIRECT CONNECTIONS
n/a

Starts the definition list of infrastructure (i.e. underfloor) output (if any). Must be followed by output elements and proportions, as follows, and paired with a "}" at the end of the list. The command may be omitted if there are no direct connections. There is no check that the complete output list totals to 1.0.

_#i AT r1 = r2
[]

Defines proportion r2 (0-1) of system direct output (i.e. after the split has been applied) directed to element i, at a depth of r1 from the FIRST surface. Line is repeated for as many output connections as required.

These commands detail the temperature sensing and control characteristics of the system.

!STAT TYPE IDEAL, or

!STAT TYPE ON/OFF, or

!STAT TYPE PROPORTIONAL
[IDEAL]

Defines system thermostat strategy. "ON/OFF" type either asks for maximum or no heat from system. "IDEAL" type selects a perfect proportional control, 'stat

asks system for exact amount of heat required to maintain set point (the ability of system to provide heat is controlled by its time-constants and maximum output). "PROPORTIONAL" selects a band proportional control, the 'stat asks system for heat according to the shortfall from setpoint temperature, proportional to the specified bandwidth.

N.B. the "IDEAL" controller requires a fully convective system, with fully convective sensors, and each system may be connected to only one space.

!DEADBAND = r
     [0.0]

Defines a deadband about the heating system setpoint. The setpoint will be at the centre of the deadband.

!BANDWIDTH = r
     [0.0]

Defines proportional bandwidth ($^o$C); Required for 'stat type 3 only, else should be left at 0.0. Refers to the control range of 'stat, i.e. if set to 5 degree, 100% system output would be demanded if sensed temp was 5 degrees less than setpoint, 50% if 2.5 degree below setpoint, or 0% if at or higher than setpoint.

!STAT CONSTANT = r
     [0.0]

Defines a time constant (seconds) for response of stat sensor. Applies to both warm-up and cool-down. Default corresponds to an immediate response ideal 'stat.

!STAT DELAY = r
     [0.0]

Defines any time lag (seconds) in sensor response to environment changes.

!SETPOINT SETBACK ON = r @ hh:mm:ss | c
     [0.0]

Defines an amount of setback (in degree C) to apply to the thermostat at the time defined by hh:mm:ss. As in the timeclock control, a 7day option is available, defined by the word c (see the !CLOCK command description).

!SETPOINT SETBACK OFF @ hh:mm:ss | c
     []

Defines the time the night setback feature will be turned off (i.e. 'stat returned to its defined setpoint). See !SETPOINT SETBACK ON above. As in the timeclock control, a 7day option is available, defined by the word c (see the !CLOCK command description).

!ACCELERATOR ADDS = r
     [0.0]

Defines maximum temperature ($^o$C) increase accelerator adds to sensed temperature, when system is on and providing heat. Default value disables accelerator option.

!ACCELERATOR TC = r
     [0.0]

Defines time constant (seconds) for growth to maximum of additional temperature derived from 'stat accelerator.

!STAT RAD DIFFUSE, or

!STAT RAD DIRECT
     [DIFFUSE]

Determines the nature of the radiant response of the thermostat. The DIFFUSE type will refer to the determined net radiant temperature of zones, while the DIRECT type will refer to the effective radiant temperature "seen" by specific

surfaces.

!STAT COUPLING =  r  ,  r  , r
       [1.0,0.0,0.0]

          Defines coupling coefficients (0-1) of 'stat sensor to CONVECTIVE, RADIANT and SURFACE temperature sources. Sensed temperature will be determined from a weighted sum of these temperatures.  The thermostat's equivalent of the system output SPLIT.

!STAT AIR CONNECTIONS
       n/a

          Starts the definition list of sensed air temperatures (if any).  Must be followed by sensed spaces and weightings, as follows, and paired with a "}" at the end of the list. The command may be omitted if there are no air connections.  There is no check that the complete weighting totals to 1.0.

_#i  =  r
       []

          Defines weighting r (0-1) of space i air temperature in the sensed air component (i.e. before the coupling coefficients are applied). Line is repeated for as many space connections as required.

!STAT RAD CONNECTIONS
       n/a

          Starts the definition list of sensed radiant temperatures (if any).  Must be followed by surfaces (or zones if diffuse stat specified) and coefficients, as follows, and paired with a "}" at the end of the list. The command may be omitted if there are no radiant connections.  There is no check that the complete weighting list totals to 1.0.

_FIRST #i  =  r, or _LAST #i  =  r
       []

          Defines weighting r (0-1) of radiant temperature "seen" by FIRST {LAST} surface of element i. Line is repeated for as many output connections as required.  This form is for use with DIRECT sensors.

_ZONE #i  = r
       []

          Defines weighting r (0-1) of radiant temperature of ZONE i. Line is repeated for as many output connections as required. This form is for use with sensors declared as DIFFUSE.

!STAT SURFACE CONNECTIONS
       n/a

          Starts the definition list of sensed surface temperatures (if any).  Must be followed by surface and weightings, as follows, and paired with a "}" at the end of the list. The command may be omitted if there are no surface connections.  There is no check that the complete weighting totals to 1.0.

_FIRST #i  =  r, or _LAST #i = r
       []

          Defines weighting (0-1) of surface temperature of element i. Line is repeated for as many output connections as required.

!WATER OUTPUT = r
       [0.0]

          Defines an optional water vapour generation maximum in g/s.  Water generation rate is proportionately coupled to the system heat output.

!FROST SETPOINT = r

[0.0]

Defines lower limit setpoint for optional frost protection system (selected in top-level). Frost protection may be used to maintain a minimum air temperature when the system status is "off". The frost thermostat is separate from the main 'stat and can only be connected to air temperature (note that it can be connected to external air temperature by specifying space 0 as a connection).

!FROST OUTPUT = r
[0.0]

Defines the proportion of the heating system maximum output (cf. POWER OUTPUT) available for frost protection (0-1). The frost system will only work when it is "ENABLED" in the Top-level file.

!FROST CONNECTIONS
n/a

Starts the definition list of sensed air temperatures for frost system (if any). Must be followed by sensed spaces and weightings, as follows, and paired with a "}" at the end of the list. The command may be omitted if there is no frost system. There is no check that the complete weighting totals to 1.0.

_#i = r
[]

Defines weighting r (0-1) of space i air temperature in the sensed air component Line is repeated for as many space connections as required.

_____

These commands define <u>Master Thermostats</u>, that is thermostats which may be controlling a number of heating systems, overriding the heating system's own thermostat. An example might be a hall thermostat controlling a number of individual radiators with TRVs. The radiators are then the individual heating systems, the TRVs are the local system 'stat controls, and the hall thermostat the master; the systems can supply heat only when enabled by the master 'stat but may be individually restricted by the local 'stat.

Master 'stats may have all the characteristics available for heating system thermostats, apart from !STAT DELAY, !STAT BANDWIDTH, !SETPOINT COOLING, and !STAT TYPE. Master stats are always of the "ON/OFF" type.

!MASTER STAT 'c'
[]

Starts a master 'stat definition list. The 'stat name is taken as the string between single quotes. Must be paired with an !END statement, and may not appear within a heating system definition list. There are no master 'stats by default.

!END

Ends and closes a system definition.

!SYSTEMS CONTROLLED
[]

Starts the definition list of the system index codes (allocated sequentially by the !HEATSYS commands within the heating file) that are to be controlled by this master 'stat. Must be followed by system indices, and paired with a "}" to end the list. There are no default connections.

_____

These commands in this file define the Storage Heating systems servicing the spaces of the building. There may be many such systems, with different characteristics, operating within the building, and a space may be served by more than one system.

Each system defined operates independently, each has its own specification, time clock controller, thermostat controller, and connections list. Each system is assigned a code number sequentially in the order specified in this file. They may be intermixed with standard HTB2 heating systems.

Commands available are;

COMMAND FORMAT
         DEFAULT VALUE
                DESCRIPTION

!STORAGESYS 'C'
        []

                Starts a storage system definition list. System name is taken as the string between single quotes. Must be paired with an !END statement. Characteristics of storage systems will be determined with the BG1.1 storage system algorithms.

The following commands detail the storage system characteristics, many of these parallel options available in standard HTB2 heating systems:

These configure the output characteristics of the storage heater;

!TYPE c
        [FAN]

                Where c may be one of FAN, MANUAL DAMPER, AUTOMATIC DAMPER or SIMPLE. Selects storage system control type. The SIMPLE option for the storage system type sets a system that has no output other than from the case, i.e. there is no damper, fan or additional heater.

!POWER DIRECT = r
        [0.0]

                Defines the maximum heat output available, in kW, from the optional direct heater.

!POWER INPUT = r
        [0.0]

                Defines the maximum charging heat input, in kW, available to the storage core.

!POWER ADDITIONAL = r
        [0.0]

                Defines the output potential for the additional heater for a storage system. This is similar to the !POWER DIRECT command, but that set both the additional and damper outputs to the same level. Using !POWER ADDITIONAL = 0.0, rather than !POWER DIRECT = 0.0, allows heat output from a damper circuit, but not from an additional (i.e. peak rate) heater.

!SPLIT DIRECT = r.r , r.r , or

!SPLIT CASE = r.r , r.r
        [1.0, 0.0]

                Defines, for the storage heater option, the output splits in convective, and radiant components, for the the additional heater output, and the case output respectively. The core (or damper/fan) output, is always assumed to be convective.

!RADIANT DIFFUSE, or

!RADIANT DIRECT
       [direct]

              Selects the radiant output type of a system. A diffuse source irradiates all surfaces in a zone on a area weighting basis. A direct source irradiates only selected surfaces.

!CONVECTIVE CONNECTIONS
       n/a

              Starts the definition list of convective output (if any).  Must be followed by output spaces and proportions, as follows, and paired with a "}" at the end of the list. The command may be omitted if there are no convective connections.  There is no check that the complete output list totals to 1.0.

_#i = r
       []

              Defines proportion r (0-1) of system convective output (i.e. after the split has been applied) directed to space i. Line is repeated for as many output connections as required.  This command will also apportion any water generation that has been specified, by the same proportions.

!RADIANT CONNECTIONS
       n/a

              Starts the definition list of radiant output (if any).  Must be followed by output surfaces (or zones if diffuse source specified) and proportions, as follows, and paired with a "}" at the end of the list. The command may be omitted if there are no radiant connections.  There is no check that the complete output list totals to 1.0.

_FIRST #i = r, or _LAST #i = r
       []

              Defines proportion r (0-1) of system radiant output (i.e. after the split has been applied) directed to FIRST {LAST} surface of element i. Line is repeated for as many output connections as required.  This form is for use only with systems declared RADIANT DIRECT.

_ZONE #i = r
       []

              Defines proportion r (0-1) of system radiant output (i.e. after the split has been applied) directed to ZONE i. Line is repeated for as many output connections as required. This form is for use with systems declared as RADIANT DIFFUSE.

These define the thermophysical characteristics of the unit;

!CHARGE CAPACITY = r
       [42.0]

              Defines the total heat storage capacity of the system, in kWh.

!THERMAL CAPACITY = r
       [0.0575]

              Defines the thermal storage coefficient of the system core, in kWh/C.

!CONDUCTIVITY CASE = r
       [0.1712]

              Defines the thermal conductivity, in W/C, of the system case.  This reflects the construction of the casing.  The heat transfer takes place between the space air temperature and the core material temperature.

!CONDUCTIVITY FAN = r
       [3.2534]

              Defines the effective "thermal conductivity", in W/C, of the fan/damper system. This reflects the maximum ability of the system to transfer heat in "boost" mode.

In a fan system this would be related to the fan flow, in a damper system to the maximum convective heat exchange due to buoyancy. The heat transfer takes place between the space air temperature and the core material temperature.

The following define the heat <u>output</u> control characteristics. Note that only the fan/damper and additional heater are controlled, the casing heat losses are uncontrolled and continuous, depending only on the charge state of the core.

!CLOCK START TIME #i = hh:mm:ss | c     , or

!CLOCK STOP TIME #i = hh:mm:ss | c
      [25:00:00]

> Defines time for Switch ON and OFF (in 24 hr clock format, must follow format shown) for controlled period i. Multiple control periods (up to 5 in standard version) must be specified in time order. Default value effectively disables time clock action.
> The optional word c after the vertical bar symbol | determines a 'day of week' application of this time clock setting. The is in the form of 7 letters, each corresponding to the first letter of the day of week that this control is to apply to, starting with Monday, (if not applicable the dash is used). Thus
> > !CLOCK START TIME #3 = 18:30:00 | MTWTF--
> denotes the 3rd clock period will start at 18:30 for mondays through fridays.

!SETPOINT OUTPUT = r
      [20.0]

> Defines the required sensed temperature (C) during system output "ON" time. Any deadband will be centered on that value.

!DEADBAND OUTPUT = r
      [0.0]

> Defines a deadband about the output system setpoint. The setpoint will be at the centre of the deadband.

!STAT OUTPUT CONSTANT = r
      [0.0]

> Defines a time constant (seconds) for response of stat sensor. Applies to both warm-up and cool-down. Default corresponds to an immediate response ideal 'stat.

!STAT OUTPUT AIR CONNECTIONS
      n/a

> Starts the definition list of sensed air temperatures (if any). Must be followed by sensed spaces and weightings, as follows, and paired with a "}" at the end of the list. The command may be omitted if there are no air connections. There is no check that the complete weighting totals to 1.0.

_#i = r
      []

> Defines weighting r (0-1) of space i air temperature in the sensed air component (i.e. before the coupling coefficients are applied). Line is repeated for as many space connections as required.

The following define the charge <u>input</u> strategy;

!CHARGE CLOCK NIGHT START TIME = hh:mm:ss   , and
      [23:00:00]

!CHARGE CLOCK NIGHT STOP TIME = hh:mm:ss
     [06:00:00]

> Define times for charging (in 24 hr clock format, must follow format shown) for the evening economy rate charge period.


!CHARGE CLOCK DAY START TIME = hh:mm:ss   , and
     [06:00:00]

!CHARGE CLOCK DAY STOP TIME = hh:mm:ss
     [06:00:00]

> Define times for charging (in 24 hr clock format, must follow format shown) for an optional day-time economy rate charge period.


The following define an optional input charge control thermostat, varying charge according to building conditions.

!INPUT STAT ENABLE

> Enables the optional input charge control thermostat.

!STAT INPUT TYPE  = c
     [CORE]

> Where c may be one of CORE, ON/OFF, or PROPORTIONAL .  Selects storage system input control type.  The CORE option always charges the core to its maximum capacity (if there is sufficient time and input power).  ON/OFF and PROPORTIONAL types vary the charge according to the action of the charge 'stat.

!CHARGE STAT NIGHT = r  @ hh:mm:ss
     [20.0]

> Define critical point for charge stat as r (C) at time given. Up to 21 such (different) times may be defined. Must be in sequential time order.   If the sensed 'stat temperature is greater than this value, the core will not be charged for that period. Note that the 'stat sensor cannot be connected to the core state.

!CHARGE STAT DAY = r  @ hh:mm:ss
     [0.0]

> Define critical point for charge stat as r (C) at time given. up to 9 such (different) times may be defined. Must be in sequential time order.

!DEADBAND INPUT = r
     [0.0]

> Defines a deadband about the output system setpoint.  The setpoint will be at the centre of the deadband.

!BANDWIDTH  INPUT = r
     [0.0]

> Defines proportional bandwidth ($^o$C) for input charge stat. Used for  proportional 'stat type only.

!STAT INPUT CONSTANT = r
     [0.0]

> Defines a time constant (seconds) for response of stat sensor. Applies to both warm-up and cool-down. Default corresponds to an immediate response ideal 'stat.

!STAT INPUT COUPLING =  r  ,  r   , r
     [1.0,0.0,0.0]

> Defines coupling coefficients (0-1) of 'stat sensor to CONVECTIVE, RADIANT and SURFACE temperature sources. Sensed temperature will be determined from a weighted sum of these temperatures.  The thermostat's equivalent of the system

output SPLIT.

**!STAT INPUT AIR CONNECTIONS**
> n/a
>> Starts the definition list of sensed air temperatures (if any).  Must be followed by sensed spaces and weightings, as follows, and paired with a "}" at the end of the list. The command may be omitted if there are no air connections.  There is no check that the complete weighting totals to 1.0.

**_#i = r**
> []
>> Defines weighting r (0-1) of space i air temperature in the sensed air component (i.e. before the coupling coefficients are applied). Line is repeated for as many space connections as required.

**!STAT INPUT RAD DIFFUSE,** or

**!STAT INPUT RAD DIRECT**
> [DIFFUSE]
>> Determines the nature of the radiant response of the thermostat.  The DIFFUSE type will refer to the determined net radiant temperature of zones, while the DIRECT type will refer to the effective radiant temperature "seen" by specific surfaces.

**!STAT INPUT RAD CONNECTIONS**
> n/a
>> Starts the definition list of sensed radiant temperatures (if any).  Must be followed by surfaces (or zones if diffuse stat specified) and coefficients, as follows, and paired with a "}" at the end of the list. The command may be omitted if there are no radiant connections.  There is no check that the complete weighting list totals to 1.0.

**_FIRST #i = r,** or **_LAST #i = r**
> []
>> Defines weighting r (0-1) of radiant temperature "seen" by FIRST {LAST} surface of element i. Line is repeated for as many output connections as required.  This form is for use with DIRECT sensors.

**_ZONE #i = r**
> []
>> Defines weighting r (0-1) of radiant temperature of ZONE i. Line is repeated for as many output connections as required. This form is for use with sensors declared as DIFFUSE.

**!STAT INPUT SURFACE CONNECTIONS**
> n/a
>> Starts the definition list of sensed surface temperatures (if any).  Must be followed by surface and weightings, as follows, and paired with a "}" at the end of the list. The command may be omitted if there are no surface connections.  There is no check that the complete weighting totals to 1.0.

**_FIRST #i = r,** or **_LAST #i = r**
> []
>> Defines weighting (0-1) of surface temperature of element i. Line is repeated for as many output connections as required.

The following commands, from the standard HTB2 heating system, are <u>not</u> available for a storage system.

**!POWER OUTPUT**

!WATER OUTPUT

!SPLIT

!TIME CONSTANT

!DELAY LAG

In addition, MASTER STATs can not be used to control storage input charge systems.

## B.8 LIGHTING FILE

This file defines the lighting circuits provided in the building. Lighting circuits are perceived by HTB2 to be heat sources. There are no calculations of lighting level or quality.

Each source has an independent time clock. Each clock may now have up to 5 switched periods (start/stop pairs and output fraction). Each period may be prescribed to occur on any of 7 days; Monday, Tuesday, Wednesday, Thursday, Friday, Saturday, Sunday in any combination (that is M-W-FSS would denote the clock period active for Monday, Wednesday, Friday, Saturday and Sunday). The output fraction for any clock period may also be specified for a 7 day clock. The command format is otherwise similar to that used for heating systems. The circuit must be set in "Automatic" mode for these clock controls to apply. "Automatic" mode is the default for lighting circuits, but this may be altered through the diary.

Each such circuit may operate independently, each has its own output spec., time clocks, and heat output connection lists. Each circuit is assigned a code number sequentially as it is defined in this file.

Commands available are;

COMMAND FORMAT DEFAULT VALUE
        DESCRIPTION

!LIGHTSYS 'C'
        []
                Starts a circuit definition list. Circuit name is taken as the string between single quotes. Must be paired with an !END statement.

The following commands detail the heat emission characteristics:

!HEAT OUTPUT = r
        []
                Defines the maximum heat output produced by the circuit, in Watts.

!SPLIT = r , r
        [1.0,0.0]
                Defines system output splits to CONVECTIVE, and RADIANT output types, each as a fraction of 1. There is no internal check on the sum of these fractions. Radiant output is assumed to be diffuse.

!CONVECTIVE CONNECTIONS
        n/a
                Starts the definition list of convective output (if any). Must be followed by output spaces and proportions, as follows, and paired with a "}" at the end of the list. The command may be omitted if there are no convective connections. There is no check that the complete output list totals to 1.0.

_#i = r
        []
                Defines proportion r (0-1) of circuit convective output (i.e. after the split has been applied) directed to space i. Line is repeated for as many output connections as required.

!RADIANT CONNECTIONS
        n/a
                Starts the definition list of radiant output (if any). Must be followed by output zones and proportions, as follows, and paired with a "}" at the end of the list. The command may be omitted if there are no radiant connections. There is no check that the complete output list totals to 1.0.

_ #i = r
                []
                        Defines proportion r (0-1) of circuit radiant output (i.e. after the split has been
                        applied) directed to ZONE i. Line is repeated for as many output connections as
                        required.


The following commands detail the time control stagies (if any.. omit if control is purely from the diary.)

!CLOCK START TIME #i = hh:mm:ss | c    , or

!CLOCK STOP TIME #i = hh:mm:ss | c
                [25:00:00]
                        Defines time for Switch ON (in 24 hr clock format, must follow format shown) for
                        controlled period i.  Should be paired with !CLOCK STOP TIME command below.
                        Multiple control periods (up to 5 in standard version) must be specified in time
                        order. Default value effectively disables time clock action.
                        The optional word c after the vertical bar symbol | determines a 'day of week'
                        application of this time clock setting.  The is in the form of 7 letters, each corre-
                        sponding to the first letter of the day of week that this control is to apply to,
                        starting with Monday, (if not applicable the dash is used).  Thus
                                !CLOCK START TIME #3 = 18:30:00 | MTWTF--
                        denotes the 3rd clock period will start at 18:30 for mondays through fridays.


!CLOCK PROPORTION #i = r  | c
                [0.0]
                        Defines the circuit output, as  a fraction of the maximum circuit output, for the
                        controlled period i.
                        The optional word c after the vertical bar symbol | determines a 'day of week'
                        application of this time clock setting.  The is in the form of 7 letters, each corre-
                        sponding to the first letter of the day of week that this control is to apply to,
                        starting with Monday, (if not applicable the dash is used).  See !CLOCK command
                        above.


These commands detail the optional lighting control module, which switches lighting loads according to
external light availability. This option must be enabled in the top-level file.

!DAY LOAD = r
                [1.0]
                        Defines proportion of maximum circuit load available during "daylight" conditions,
                        i.e. when external solar irradiation is > threshold set below.

!NIGHT LOAD = r
                [1.0]
                        Defines proportion of maximum circuit load available during "night" conditions,
                        i.e. when external solar irradiation is < threshold set below.

!THRESHOLD = r
                [0.0]
                        Defines threshold external horizontal irradiance (W/m$^2$) for light load switching.
                        N.B. External daylight levels are approximately related to solar irradiance by an
                        average luminous efficacy of the sky.

!END
                n/a
                        Ends and closes a circuit definition.

### B.9 SMALL POWER FILE

This file defines the small power sources. These are perceived as sources of incidental heat gain by HTB2.

Each source may have an independent time clock. Each clock may have up to 5 switched periods (start/stop pairs and output fraction). Each period may be prescribed to occur on any of 7 days; Monday, Tuesday, Wednesday, Thursday, Friday, Saturday, Sunday in any combination (that is M-W-FSS would denote the clock period active for Monday, Wednesday, Friday, Saturday and Sunday). The output fraction for any clock period may also be specified for a 7 day clock. The command format is otherwise similar to that used for heating systems. The circuit must be set in "Automatic" mode for these clock controls to apply.

Each such source may operate independently, each has its own output spec. and connection lists. A source is controlled through the diary, or optionally through a time clock control as in heating and lighting systems. Each source is assigned a code number sequentially as it is defined in this file.

Commands available are;

COMMAND FORMAT DEFAULT VALUE
  DESCRIPTION

!SMALL POWER 'C'
  []
  Starts a circuit definition list. Circuit name is taken as the string between single quotes. Must be paired with an !END statement.

The following commands detail the heat emission characteristics:

!HEAT OUTPUT = r
  []
  Defines the maximum heat output produced by the source, in Watts.

!WATER OUTPUT = r
  []
  Defines the optional maximum water vapour generation of the source, in g/s. Actual water generation is proportional to the source heat output.

!INITIAL FRACTION = r
  [0.0]
  Defines the initial output setting as a proportion of the declared maximum. Note that small power sources are considered to be OFF, unless manually swithced on via the diary, or switched on via the time clock controls.

!SPLIT = r , r
  [1.0,0.0]
  Defines system output splits to CONVECTIVE, and RADIANT output types, each as a fraction of 1. There is no internal check on the sum of these fractions.

!RAD DIFFUSE, or

!RAD DIRECT
  [DIFFUSE]
  Selects the radiant output type of the source. A diffuse source irradiates all surfaces in a zone on a area weighting basis. A direct source irradiates only selected surfaces.

!CONVECTIVE CONNECTIONS
  n/a
  Starts the definition list of convective output (if any). Must be followed by output spaces and proportions, as follows, and paired with a "}" at the end of the list. The command may be omitted if there are no convective connections. There is no

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check that the complete output list totals to 1.0.

_#i  =  r

[]

Defines proportion r (0-1) of source convective output (i.e. after the split has been applied) directed to space i. Line is repeated for as many output connections as required.

!RADIANT CONNECTIONS

n/a

Starts the definition list of radiant output (if any).  Must be followed by output zones and proportions, as follows, and paired with a "}" at the end of the list. The command may be omitted if there are no radiant connections.  There is no check that the complete output list totals to 1.0.

_  #i  = r

[]

Defines proportion r (0-1) of source radiant output (i.e. after the split has been applied) directed to ZONE i. Line is repeated for as many output connections as required. For use with DIFFUSE sources.

_FIRST  #i  =  r, or

_LAST #i  =  r

[]

Defines proportion r (0-1) of system radiant output (i.e. after the split has been applied) directed to FIRST {LAST} surface of element i. Line is repeated for as many output connections as required.  This form is for use with DIRECT systems.

The following commands detail the time control stategies (if any.. omit if control is purely from the diary.)

!CLOCK START TIME #i = hh:mm:ss | c   , or

!CLOCK STOP TIME #i = hh:mm:ss | c

[25:00:00]

Defines time for Switch ON (in 24 hr clock format, must follow format shown) for controlled period i. Should be paired with !CLOCK STOP TIME command below. Multiple control periods (up to 5 in standard version) must be specified in time order. Default value effectively disables time clock action.
The optional word c after the vertical bar symbol | determines a 'day of week' application of this time clock setting.  The is in the form of 7 letters, each corresponding to the first letter of the day of week that this control is to apply to, starting with Monday, (if not applicable the dash is used).  Thus
        !CLOCK START TIME #3 = 18:30:00 | MTWTF--
denotes the 3rd clock period will start at 18:30 for mondays through fridays.

!CLOCK PROPORTION #i = r  | c

[0.0]

Defines the circuit output, as  a fraction of the maximum circuit output, for the controlled period i.

!END

n/a

Ends and closes a source definition.

## B.10 OCCUPANCY FILE

This file defines the occupancy heat gain parameters. Occupancy gains are declared and managed by space. A spaces associated activity level (i.e. metabolic rate) and occupancy (i.e. number of occupants) can be changed at any time. This file defines the heat and water output associated with each activity level (3 available) for a nominal occupant, within each space. Each space is defined independently.

Occupancy is controlled either through the diary, or through optional "time-clock" controls. Each such time-clock may now have up to 5 switched periods (start/stop pairs for occupancy level and activity). Each period may be prescribed to occur on any of 7 days; Monday, Tuesday, Wednesday, Thursday, Friday, Saturday, Sunday in any combination (that is M-W-FSS would denote the clock period active for Monday, Wednesday, Friday, Saturday and Sunday). The activity level and number of occupants associated with any clock period may also be specified for a 7 day clock. The command format is otherwise similar to that used for heating systems. Note that for backwards compatibility, Occupancy is set for control through Diary only, to allow the time-clocks to control, set the occupancy to "Automatic" through the diary.

Commands available are;

COMMAND FORMAT DEFAULT VALUE
                         DESCRIPTION

!OCCUPANCY SPACE = i
            []
                         Starts an occupancy definition for space i. Must be paired with an !END statement.

!ACTIVITY LEVEL #i  = r   ,   r
            [1 :   80.0   0.0]
            [2 : 130.0   0.0]
            [3 : 190.0   0.0]
                         Defines the metabolic rate (W), and water vapour generation (g/s), per occupant,
                         for each activity level option.

!INITIAL LEVEL = r
            [0.0]
                         Defines the initial number of occupants in the space. Activity level 1 is assumed.

!SPLIT  =  r   ,   r
            [0.5,0.5]

                         Defines output splits to CONVECTIVE, and RADIANT output types, each as a
                         fraction of 1. There is no internal check on the sum of these fractions. Radiant type
                         is diffuse. All heat output goes to the space named in the declaration, or the zone
                         containing it.

The following commands detail the time control stagies (if any.. omit if control is purely from the diary.)

!CLOCK START TIME #i = hh:mm:ss | c    , or

!CLOCK STOP TIME #i = hh:mm:ss | c
            [25:00:00]
                         Defines time for Switch ON (in 24 hr clock format, must follow format shown) for
                         controlled period i. Should be paired with !CLOCK STOP TIME command below.
                         Multiple control periods (up to 5 in standard version) must be specified in time
                         order. Default value effectively disables time clock action.
                         The optional word c after the vertical bar symbol | determines a 'day of week'
                         application of this time clock setting. The is in the form of 7 letters, each corre-
                         sponding to the first letter of the day of week that this control is to apply to,
                         starting with Monday, (if not applicable the dash is used). Thus
                              !CLOCK START TIME #3 = 18:30:00 | MTWTF--

denotes the 3rd clock period will start at 18:30 for mondays through fridays.

!CLOCK ACTIVITY LEVEL #i = i | c
       [1]

           Defines the activity level (metabolic rate) for the space, 1,2 or 3, for the controlled period i.

!CLOCK OCCUPANCY #i = r | c
       [0.0]

           Defines the occupancy (number of adult equivalents), for the controlled period i. Note that "fractional" adults (i.e. 1.5) are permitted.

!END
       n/a

           Ends and closes an occupancy definition.

### B.11 VENTILATION FILE

This file defines the ventilation parameters. It is read as free formatted numeric data and must follow the format given below. The particular format of the file, and the data requirements, will depend on the ventilation option chosen.

There are 6 ventilation models currently available, selected in this file. They are;

| Code | Description |
|------|-------------|
| 1 - | Assign simple air change rate to spaces. Three such rates are specified for each space, the choice being made either through the diary, or by a ventilation 'thermostat'. Option 1 is now deprecated and will be removed in a following release. Use Option 11 in its place. |
| 11 - | Assign simple air change rate to spaces. Three such rates are specified for each space, the choice being made either through the diary, or by a ventilation 'thermostat'. This thermostat can be configured to be sensitive to any space temperature or humidity, external temperature or humidity, or a differential temperature or humidity between spaces or between a space and the outside |
| 2 - | Specify space-space air flow networks, as a complex pattern of air flows. Three such patterns for the building may be specified. The choice between patterns is made through the diary. Option 2 is now deprecated and will be removed in a following release. Use Option 12 in its place. |
| 12 - | Specify space-space air flow networks, as a complex pattern of air flows. Three such patterns for the building may be specified. The choice between patterns is made through the diary, or through a ventilation 'thermostat'. This thermostat can be configured to be sensitive to any space temperature or humidity, external temperature or humidity, a surface temperature, or a differential temperature or humidity between spaces or between a space and the outside |
| 3 - | Define empirical space air change rate equations. The form of the equation used is; $\underline{Acr = D*(A + B*t^.5 + C*u)}$ where A,B,C are specified for each wind sector, D is controllable from diary, and u is windspeed, t is inside/outside temp difference . |
| 8 - | Define a network of openings and imposed flows, from which air flow patterns will be calculated according to external and internal conditions. |

No comment lines (e.g. those beginning with a * character) are allowed within the data, but comments may follow data on a line, or at the end of the file.

As these files are read numerically, there are character position flags interspersed to allow some detection of missing data. These flags must be in the format and position shown. All parameters must be specified, there are no defaults. Many features may be disabled however by setting them to 0.

### b.11.1 Vent option 1

Ventilation option 1 assigns simple air change rate to spaces. The rate is specified in space volumes per hour. Ventilation exchange in each space is with the outside only and each space operates independently. Three such rates are specified for each space, the choice being made either through the diary, or by a ventilation 'thermostat'.

Under automatic thermostat control the choices are made as;
- ACR 1 (e.g. infiltration) is used when the ventilation status is "OFF",
- ACR 2 (e.g. mechanical low) is used when ventilation status is "ON" and the space temperature. is less than the ventilation thermostat setpoint,
- ACR 3 (e.g. mechanical high) is used when ventilation status is "ON" and space temperature is greater than the ventilation thermostat setpoint.

The ventilation "status" is altered through the diary. Alternatively this strategy may be over-ridden via manual control through the diary, the appropriate rate being chosen at the desired time.

There is no internal judgement made on the actual rates assigned to ACR1, ACR2, or ACR3. Although it may be useful to considered these as "Infiltration", "Mechanical Low", and "Mechanical High" in the context of a simple mechanical extract fan, there is no requirement for ACR3 to be higher than ACR2.

Spaces may be defined in arbitrary order. If a space does not have a ventilation characteristic defined, it will default to 0 ventilation.

```
DATA FORMAT                                    note
     i                                           a
     *********                                   b
     i                                           c
     r    , r      , r                           d
     r                                           e
     ————                                        f
     0                                           g
```

note     description

a        SELECT vent option ( 1 for option 1)

b        POSITION flag A, denotes start of ventilation data.

c        SPACE code number to which this specification refers. Space codes are those defined in the "building" file.

d        ACR1, ACR2, ACR2 rates for this space, in space volumes per hour.

e        Ventilation THERMOSTAT setting, in degree C.

f        POSITION flag B denotes end of a space specification. The block c - f would be repeated for each space as required. The file is ended by a 0.

g        END of file marker.

Example:

```
     1
     *********
     1
     0.20    , 1.0      , 2.0
     25.0
     ————
     3
     3.5    , 3.5      , 5.0
     20.0
     ————
     0
```

This example chooses option 1. It sets space 1 to have ACR1 = 0.20 air changes per hour, ACR2 = 1.0 air changes per hour, and ACR3 = 2.0 air changes per hour. The setpoint to switch between ACR2 and ACR3 will be 25C. Space three will have ACR1, ACR2 and ACR3 set to 3.5, 2.5 and 5.0 air changes per hour respectively, with a setpoint at 20C. Space two (and any others in the simulation) will have no ventilation.

### b.11.2 Vent option 11

Ventilation option 11 is similar to option 1 as it assigns simple air change rate to spaces. However the control specification for the ventilation "thermostat" is more flexible.

As in option 1 the rate is specified in space volumes per hour. Ventilation exchange in each space is with the outside only and each space operates independently. Three such rates are specified for each space, the choice being made either through the diary, or by a ventilation 'thermostat'.

Under automatic thermostat control the choices are made  as;
- ACR 1 (e.g. infiltration) is used when the ventilation status is "OFF",
- ACR 2 (e.g. mechanical low) is used when ventilation status is "ON" and the monitored parameter is less than the ventilation thermostat setpoint,
- ACR 3 (e.g. mechanical high) is used when ventilation status is "ON" and the monitored parameter is greater than the ventilation thermostat setpoint.

The monitored parameter can be one of:
- the air temperature of any space in the simulation
- external air temperature
- the relative humidity of any space in the simulation
- external relative humidity
- the difference in air temperature between any space and the outside, or any two spaces
- the difference in relative humidity between any space and the outside, or any two spaces
- the absolute difference in air temperature between any space and the outside, or any two spaces
- the absolute difference in relative humidity between any space and the outside, or any two spaces

The ventilation "status" is altered through the diary. Alternatively this strategy may be over-ridden via manual control through the diary, the appropriate rate being chosen at the desired time.

There is no internal judgement made on the actual rates assigned to ACR1, ACR2, or ACR3. Although it may be useful to considered these as "Infiltration", "Mechanical Low", and "Mechanical High" in the context of a simple mechanical extract fan, there is no requirement for ACR3 to be higher than ACR2.

Spaces may be defined in arbitrary order. If a space does not have a ventilation characteristic defined, it will default to 0 ventilation.

DATA FORMAT                                                    note

```
    i                                                         a
    * * * * * * * *                                           b
    i                                                         c
    r      , r      , r                                       d
    i                                                         e
    r                                                         f1
    i    , r                                                  f2
    i    , i    , r                                           f3
    ____                                                      g
    0                                                         h
```

note    description

a       SELECT vent option ( 11 for option 11)

b       POSITION flag A, denotes start of ventilation data.

c       SPACE code number to which this specification refers. Space codes are those defined in the "building" file.

d       ACR1, ACR2, ACR2 rates for this space, in space volumes per hour

e       Stat type (0-6)

        Stat type 0: space air control as in option 1

        Stat type 1: space air temperature control using nominated space

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Stat type 2: space humidity control using nominated space

Stat type 3: differential space air temperature,  Space A – Space B

Stat type 4: differential space humidity,  Space A – Space B

Stat type 5: differential space air temperature, | Space A – Space B |

Stat type 6: differential space humidity, | Space A – Space B |

f      Ventilation 'STAT settings, format and units depend on stat type:

  f1      Stat type 0: Air temperature setpoint C

  f2      Stat type 1: Control Space index,  Air temperature setpoint C

  f2      Stat type 2: Control Space index,  Relative humidity setpoint %

  f3      Stat type 3, 5: Control Space index A, Control Space index B,  Air temperature setpoint C

  f3      Stat type 4, 6: Control Space index A, Control Space index B,  Relative humidity setpoint %

g      POSITION flag B denotes end of a space specification. The block c - f would be repeated for each space as required. The file is ended by a 0.

h      END of file marker.

In the data for line f, external temperature or humidity is detected by using Control space index  = 0.

Example:

```
11
* * * * * * * *
1
0.20    , 1.0      , 2.0
1
2   , 25.0
————
3
3.5    , 3.5      , 5.0
4
3   ,   0,   5.0
————
0
```

This example chooses option 11.  It sets space 1 to have ACR1 = 0.20 air changes per hour, ACR2 = 1.0 air changes per hour, and ACR3 = 2.0 air changes per hour.  A type 1 'stat is chosen (air temperature of nominated space), and the switch between ACR2 and ACR3 (when Ventilation Status is "ON") will be when the air temperature of Space 2 is above 25C.  Space three will have ACR1, ACR2 and ACR3 set to 3.5, 2.5 and 5.0 air changes per hour respectively.  A type 4 'stat is chosen (differential temperature)  and the switch between ACR2 and ACR3 will be when the air temperature of Space 3 is more than 5C greater than the external temperature.  Space two (and any others in the simulation) will have no ventilation.  ACR1 can only be selected through the Diary, by setting the Ventilation Status to "OFF".

N.B. The Ventilation Status is "OFF" by default.

### b.11.3 Vent option 2

Ventilation option 2 assigns flow patterns between spaces and between spaces and the outside. This is in comparison to options 1 and 11, where only flows from a space to the outside were specified; no internal flows were considered. Three such patterns for the building may be specified. The choice between patterns is made through the diary using a pattern code (1-3). Each pattern is static, i.e. it does not take meteorological conditions into account. The flows are specified in m³/s and are defined in terms of space to space connections. Any connections not specified default to 0 flow. There is no check on volumetric or mass continuity, it is left to the use to ensure a valid flow pattern is specified.

```
line                                          note
i                                             a
* * * * * * * *                               b
i   , i  , i  , r                             c
0   , 0  , 0  , 0.0                           d
```

note    description

a       SELECT vent option  ( 2 for option 2)

b       POSITION flag A denotes start of ventilation data

c       Define PATTERN number (1,2,3), SPACE code number A, SPACE code number B, FLOW (m³/s) from
        Space B to Space A*. Space codes are those defined in the "building" file. This line will be repeated
        as required to describe the flow network. There is no checking that the patterns defined represent
        closed systems, i.e. that mass flow is conserved. The full definition is ended when a 0 is read for the
        pattern code. Space A must always be >0. Flows to or from the outside are signified by Space B set
        to 0. Virtual spaces may be included in the pattern and coded into Space B by prefixing the virtual
        space number with a "-", i.e. making it a -ve number.

d       END the patterns definition and file.

* A positive flow goes FROM space B TO space A

Example:

```
2
* * * * * * * *
1 ,   4   , 0,   10.0
1 ,   4   , 2,  -10.0
1 ,   1   , 2,   10.0
1 ,   1   , 0,  -10.0
2 ,   4   , 0,   10.0
2 ,   2   , 4,   10.0
2 ,   1   , 2,   10.0
2 ,   1   , 0,   -5.0
2 ,   3   , 1,    5.0
2 ,   3   , 0,   -5.0
0
```

This example chooses option 2. It defines 2 flow patterns. Pattern 1 sets 10 m3/s to flow in the order: Outside -> Space 4 -> Space 2 -> Space 1 -> Outside. Note that the full path must be explicitly stated; continuity must be established by having as much leaving a space as entering. As space 3 does not appear in this pattern, it will have no ventilation. Pattern 2 adds space 3 to the ventilation path, half of the air leaving Space 1 now goes through Space 3. Pattern 3 is not defined, so defaults to zero flows through all spaces.

### b.11.4 Vent option 12

Ventilation option 12 assigns flow patterns between spaces and between spaces and the outside.  It is similar to option 2, but provides control over the switching between patterns in the manner of option 11. In addition, with this option, flows are specified as mass-flow; kg/s.

 Three patterns for the building may be specified.  The choice between patterns is made through the diary using a pattern code (1-3),  or by a ventilation 'thermostat'.

Under automatic thermostat control the choices are made  as;
- Pattern 1 is used when the ventilation status is "OFF",
- Pattern 2 is used when ventilation status is "ON" and the monitored parameter is less than the ventilation thermostat setpoint,
- Pattern 3 is used when ventilation status is "ON" and the monitored parameter is greater than the ventilation thermostat setpoint.

The monitored parameter can be one of:
- the air temperature of any space in the simulation
- external air temperature
- the relative humidity of any space in the simulation
- external relative humidity
- a surface temperature
- the difference in air temperature between any space and the outside, or any two spaces
- the difference in relative humidity between any space and the outside, or any two spaces
- the absolute difference in air temperature between any space and the outside, or any two spaces
- the absolute difference in relative humidity between any space and the outside, or any two spaces

The ventilation "status" is altered through the diary. Alternatively this strategy may be over-ridden via manual control through the diary, the appropriate rate being chosen at the desired time.

Each pattern is static, i.e. it does not take meteorological conditions into account. The flows are specified in **kg/s** and are defined in terms of space to space connections.  Any connections not specified default to 0 flow. There is no check on volumetric or mass continuity, it is left to the use to ensure a valid flow pattern is specified.

Use the 'stat switching option with care; automatic switching between significantly different flow patterns may lead to oscillations and instability in the simulation calculations.

```
        line                                        note
        i                                              a
        ********                                       b
        i   , i  , i  , r                              c
        i   , i  , i  , r                              c
        i   , i  , i  , r                              c
        i   , i  , i  , r                              c
        0   , 0  , 0  , 0.0                            d
        i                                              e
                                                       f1
        i    , r                                       f2
        i    , i     , r                               f3
        ————                                           g
        0                                              h
```

note    description

a       SELECT vent option  ( 12 for option 12)

b       POSITION flag A denotes start of ventilation data

c       Define PATTERN number (1,2,3), SPACE code number A, SPACE code number B, FLOW (kg/s) from
        Space B to Space A*. Space codes are those defined in the "building" file. This line will be repeated
        as required to describe the flow network. There is no checking that the patterns defined represent
        closed systems, i.e. that mass flow is conserved. The full definition is ended when a 0 is read for the
        pattern code. Space A must always be >0. Flows to or from the outside are signified by Space B set
        to 0. Virtual spaces may be included in the pattern and coded into Space B by prefixing the virtual
        space number with a "-", i.e. making it a -ve number.

        * A positive flow goes FROM space B TO space A

d       END the patterns definition

e       Stat type (0-7)

        Stat type 0: no control apart from diary

        Stat type 1: space air temperature control using nominated space

        Stat type 2: space humidity control using nominated space

        Stat type 3: differential space air temperature,  Space A – Space B

        Stat type 4: differential space humidity,  Space A – Space B

        Stat type 5: differential space air temperature,  | Space A – Space B |

        Stat type 6: differential space humidity,  | Space A – Space B |

        Stat type 7: surface temperature

f       Ventilation 'STAT settings, format and units depend on stat type:

  f1    Stat type 0: no data needed

  f2    Stat type 1: Control Space index,  Air temperature setpoint C

  f2    Stat type 2: Control Space index,  Relative humidity setpoint %

  f3    Stat type 3, 5: Control Space index A, Control Space index B,  Air temperature setpoint C

  f3    Stat type 4, 6: Control Space index A, Control Space index B,  Relative humidity setpoint %

  f3    Stat type 7: Control Element index A, Surface index B (1 First, 2:Last),  Temperature setpoint C


g       POSITION flag B denotes end of a space specification. The block c - f would be repeated for each
        space as required. The file is ended by a 0.

h       END of file marker.

In the data for line f, external temperature or humidity is detected by using Control space index = 0.

Example:

```
12
* * * * * * * *
1 ,   4   , 0,   1.0
1 ,   4   , 2,  -1.0
1 ,   1   , 2,   1.0
1 ,   1   , 0,  -1.0
2 ,   4   , 0,   1.0
2 ,   2   , 4,   1.0
2 ,   1   , 2,   1.0
2 ,   1   , 0,  -0.5
2 ,   3   , 1,   0.5
2 ,   3   , 0,  -0.5
3 ,   4   , 0,   2.0
3 ,   2   , 4,   2.0
3 ,   1   , 2,   2.0
3 ,   1   , 0,  -1.0
3 ,   3   , 1,   1.0
```

```
3  ,  3   , 0, -1.0
0  ,  0   , 0,  0
4
3   ,  0,  5.0
0
```

This example chooses option 12.  It defines 2 flow patterns.  Pattern 1 sets 1 kg/s to flow in the order: Outside -> Space 4 -> Space 2 -> Space 1 -> Outside.  Note that the full path must be explicitly stated; continuity must be established by having as much leaving a space as entering.  As space 3 does not appear in this pattern, it will have no ventilation.  Pattern 2 adds space 3 to the ventilation path, half of the air leaving Space 1 now goes through Space 3.   Pattern 3 has a similar pattern to 2, but at twice the flow rate.

A type 4 'stat is chosen (differential temperature),  and the switch between Pattern 2 and Pattern 3 (when the Ventilation Status is "ON") will be when the air temperature of Space 3 is more than 5C greater than the external temperature.  Pattern 1 can only be selected through the Diary, by setting the Ventilation Status to "OFF".

N.B. The Ventilation Status is "OFF" by default.

### b.11.5 Vent option 3

Ventilation option 3 defines empirical space air change rate equations. Ventilation exchange in each space is with the outside only and each space operates independently. The rate determined reflects the external and internal conditions. The form of the equation used is; $Acr = D*(A + B*t^{1/2} + C*u)$ where A,B,C are specified for each wind sector, D is controllable from diary, and u is windspeed, t is inside/outside temp diff . Wind direction is divided into 8 sectors of 45 degrees, centered on the compass points. The windspeed is in m/s and the inside-outside temperature difference is in degree C.

The specification is made for appropriate spaces in arbitrary order. Any space not specified will default to 0 values.

```
 Line                                                          note
      i                                                          a
      ********                                                   b
      i                                                          c
      r   ,r   ,r   ,r   ,r   ,r   ,r   ,r                        d
      r   ,r   ,r   ,r   ,r   ,r   ,r   ,r                        e
      r   ,r   ,r   ,r   ,r   ,r   ,r   ,r                        f
      r                                                          g
      _____                                                     h
      0
```

 note    description

a     SELECT vent option ( 3 for option 3)

b     POSITION flag A denotes start of ventilation data

c     SPACE code number for which this equation set applies. Space codes are those defined in the "building" file.

d      DEFINE 8 wind sector values for coefficient A of the equation.

e      DEFINE 8 wind sector values for coefficient B of the equation.

 f      DEFINE 8 wind sector values for coefficient C of the equation.

g      Define INITIAL value for coefficient D.  This overall multiplier may be altered at any time through the diary, to simulate window opening for example.

h       POSITION flag B denotes end of a space specification. Block from c to h will be repeated as required to define the ventilation of spaces in the building. Spaces not defined will have zero ventilation coefficients.  End of definitions is denoted by a 0.

i     END of definitions and file.

### b.11.6 Vent option 8

These commands in this file define the ventilation pathways for the ventilation option 8.
This option is in development and correct operation cannot be guaranteed for all cases.

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Commands available are;

COMMAND FORMAT
    DEFAULT VALUE
        DESCRIPTION

!OPENING 'C'
    []

Starts an opening area definition list. Opening name is taken as the string between single quotes. Must be paired with an !END statement.

!FAN 'C'
    []

Starts an mechanical fan definition list. The Fan name is taken as the string between single quotes. Must be paired with an !END statement.

!END

Closes the definition block for the current opening or fan.

!EOF

Signals the End of File for the Software. It is recommended that this be used as the last line of each data file, as some systems may insert extraneous characters at the end of a file, causing the software to report errors in the file.

The following commands detail an openings' flow characteristics, and must be contained within an !OPENING…!END block;

!SPACE TO = i
!SPACE FROM = i
    []

Define the space connections for this opening. Space code indices are as those used in HTB2 Building definition file. Space 0 is the outside. Air flowing TO a space will be positive in sign when entering that space. There is no need to mirror an opening (e.g. an opening from 1 to 2 is automatically also an opening from 2 to 1).

!TYPE = C
    []

Defines the opening type. The opening type determines the nature of the flow characteristic (Flow vs. Pressure) of that opening. The options available are "I", "L", "Z", "O", "U", or "E"; (quotes not needed in command)

    O denotes an orifice opening, e.g. a large open area, an open window.
        $Q = CdA (2rDP)^{0.5}$
        Orifice equation used, n = 0.5
        Area required, COD optional (def = 0.6)
    E denotes a general opening,
        $Q = KA (DP)^n$
        General equation used, n to be defined
        Area required, COD optional (def = 0.6)

    I denotes a straight through opening , e.g. the crack under a door.
    L denotes a single bend opening, e.g. the crack between the window frame

and casement.

Z denotes a complex opening, e.g. "background" leakage cracks.

U denotes a complex opening, with user defined coefficients.

Quadratic flow equation used;

$$DP = b1Q + b2\ Q\char`^2$$

For opening types I, L and Z, the opening must be described in terms of area, depth and perimeter.

For type U, crack parameters P1 P2 must be supplied.

(needs further explanation of crack flow equations)

!AREA = r

[]

Defines the physical (quadratic or orifice) or effective (general) open area, in m², for this opening.

!DEPTH =r

[]

Defines the depth dimension (or thickness) through the opening, in meters.
Types ILZ only

!PERIMETER =r

[]

Defines the perimeter (or edge length) around the opening, in meters.
Types ILZ only

!HEIGHT =r

[]

Defines the central height (or vertical position) for the opening, in meters. All openings should be referred to the same datum level (e.g. ground level).

!ORIENTATION =r

[]

Defines an orientation angle (degrees clockwise from South) for an external opening. This is required only for an opening to the outside, and is used to deter-mine the correct wind pressure coefficient for the case wind direction. An orienta-tion will be required for a notionally horizontal opening.

!COPS = r , r , r , r , r , r , r , r

[]

Defines, for each of 8 wind direction sectors, a pressure coefficient for the current opening. This data is required only for external openings.
The 8 wind direction sectors are each 45 degrees wide. The first is centred on South, and then proceed clockwise, e.g.: S, SW, W, NW, N, NE, E, SE.
The surface pressure on an opening is determined from:

$$P = Cp * \tfrac{1}{2}\ \rho\ U^2, \text{ where}$$

Cp is the pressure coefficient,

$\rho$ is the external air density,

U is the local wind speed.

!CLOSED

[open]

Sets the current opening to be considered as closed or sealed. There will be no flow calculated through a closed opening. By default all openings are "Open".

!COD =r

[0.6]

Defines Coefficient of Discharge for an opening.. This parameter is used only for an "Orifice" type opening. The default value is appropriate for a standard sharp edged orifice.

!WIND SHADING = r , r , r , r , r , r , r , r
      [1.0]

    Defines, for each of 8 wind direction sectors (see description of !COPS), a wind speed attentuation factor. This factor adjusts the site wind speed, perhaps to take localised wind shadowing into account, or to correct for remote wind speed sites. The default factor is 1.0 (e.g. unaffected The value may be any number > 0. ). A shadow factor of 0.5 halves the apparent wind speed. N.b. shading factors > 1 will produce a localised increase in mean site wind.

!PARAMETERS = r , r
      []

    Defines, for type U openings, the flow parameters P1, P2. There are no default values.

!EXPONENT = r
      [0.6]

    Defines, for type E openings, the flow exponent n.

!KFACTOR = r
      []

    Defines, for type E openings, the flow K factor.

!STAT OPENING = i , r , r
      [disabled]

    Sets the thermostat setpoints for the current opening; arguments are:
Zone number to sense; Lower setpoint C; Upper setpoint C. The thermostat determines whether the opening is to be considered open or closed.
If the sensed space air temperature is less than the lower setpoint then the opening is "Open". If the sensed space air temperature is between the lower and upper setpoints (incusive) then the opening is "Closed". If the sensed space air temperature is above the upper setpoint then the opening is "Open".

    The default state is disabled, providing the opening "Open".

    The external temperature may be sensed by using zone number 0.

!RHSTAT OPENING = i , r , r
      [disabled]

    Sets the humistat setpoints for the current opening; arguments are:
Zone number to sense; Lower setpoint %; Upper setpoint %. The stat determines whether the opening is to be considered open or closed.
If the sensed space air humidity is less than the lower setpoint then the opening is "Open". If the sensed space air humidity is between the lower and upper setpoints (incusive) then the opening is "Closed". If the sensed space air humidity is above the upper setpoint then the opening is "Open".

    The default state is disabled, providing the opening "Open".

    The external humidity may be sensed by using zone number 0.

!DTSTAT OPENING = i , i , r , r
      [disabled]

    Sets the opening differential thermostat setpoints for the current opening; arguments are:
Zone number A to sense; Zone number B to sense; Lower setpoint C; Upper setpoint C. The thermostat determines whether the opening is to be considered Open or Closed.
If the difference between the sensed space air temperatures (A-B) is less than the

lower setpoint then the opening is "Open". If the difference between the sensed space air temperatures (A-B) is between the lower and upper setpoints (incusive) then the opening is "Closed". If the difference between the sensed space air temperatures (A-B) is above the upper setpoint then the opening is "Open".

The default state is disabled, providing the opening "Open".

The external temperature may be sensed by using zone number 0.

The following commands detail a fan' flow characteristics, and must be contained within a !FAN…!END block;
!SPACE TO = i
!SPACE FROM = i
       []

> Define the space connections for this opening. Space code indices are as those used in HTB2 Building definition file. Space 0 is the outside. Air flowing TO a space will be positive in sign when entering that space. There is no need to mirror an opening (e.g. an opening from 1 to 2 is automatically also an opening from 2 to 1).

!FLOW RATE = r , r , r
       []

> Sets the air flow rates through the fan, Flow1, Flow2, Flow3, in kg/s. Three values are provided, corresponding to three possible flow settings selected by an air, differential air, or humidity setpoints (e.g. see !STAT FAN description). If no 'stat is to be considered, Flow1 will be used in the calculations (though values must be provided for Flow2 and Flow3).
> The flow is considered to be directional, related to the connections defined for the fan. A positive rate (>0) denotes flow from the zone denoted as "Space From", to the zone denoted as "Space To". A negative rate is allowed, and denotes a floe opposite that above.
> Flow rate through the fan is otherwise fixed, e.g it does not vary with back pressure.

!OFF
       [on]

> Sets the current Fan to be considered as off and closed. There will be no flow calculated through a closed fan. By default all fans are "On".

!STAT FAN = i , r , r
       [disabled]

> Sets the fan thermostat setpoints for the current fan; arguments are:
> Zone number to sense; Lower setpoint C; Upper setpoint C. The thermostat determines which of the three flow rates defined for a fan will be used.
> If the sensed space air temperature is less than the lower setpoint then flow rate 1 is used. If the sensed space air temperature is between the lower and upper setpoints (incusive) then flow rate 2 is used. If the sensed space air temperature is above the upper setpoint then flow rate 3 is used.

> The default state is disabled, providing Flow rate 1.

> The external temperature may be sensed by using zone number 0.

!RHSTAT FAN = i , r , r
       [disabled]

> Sets the fan humistat setpoints for the current fan; arguments are:
> Zone number to sense; Lower setpoint %; Upper setpoint %. The thermostat determines which of the three flow rates defined for a fan will be used.
> If the sensed space air humidity is less than the lower setpoint then flow rate 1 is

used.  If the sensed space air humidity is between the lower and upper setpoints (incusive) then flow rate 2 is used.  If the sensed space air humidity is above the upper setpoint then flow rate 3 is used.

The default state is disabled, providing Flow rate 1.

The external humidity may be sensed by using zone number 0.

!DTSTAT FAN = i , i , r , r
       [disabled]

Sets the fan differential thermostat setpoints for the current fan; arguments are: Zone number A to sense; Zone number B to sense; Lower setpoint C; Upper setpoint C.  The thermostat determines which of the three flow rates defined for a fan will be used.
If the difference between the sensed space air temperatures (A-B)  is less than the lower setpoint then flow rate 1 is used.  If the difference between the sensed space air temperatures (A-B) is between the lower and upper setpoints (incusive) then flow rate 2 is used.  If the difference between the sensed space air temperatures (A-B) is above the upper setpoint then flow rate 3 is used.

The default state is disabled, providing Flow rate 1.

The external temperature may be sensed by using zone number 0.

!LAW OF FAN = r , r , r , r , r , r , r , r
      []

Defines a polynomial fan pressure/flow law for the current fan.  If undefined, the default is for a perfect fan, e.g. delivers the rated flow against any pressure differential.
The fan law is defined by the eight parameters; X1,X2,X3,X4,X5,X6,X7,X8
The polynomial is third order, so for a given pressure difference across the fan (DP), the flow is calculated as
      $Q = Q_{rated} * (X1 + X2 *DP + X3* DP^2 + X4 * DP^3$
The remaining parameters place bounds on the flow law.  If the pressure difference is less than X5, flow rate is Qrated * X6.  If the pressure difference is greater than X7, flow rate is Qrated * X8.

Note that the fan characteristic is normalised to the rated flow (!FLOW)**Appendix II : Example data files**

The following is an example data set, describing a simple 3-bedroom house.

```
8
* * * * * * * * * *
*               3 bed semi,
!WIND  =  0.8  , 0.8, 0.8, 0.8, 0.8, 0.8, 0.8, 0.8

!OPENING  =  'LR  win/door'
   !AREA  =  0.008
   !SPACE  FROM  =  0
   !SPACE  TO  =  1
   !TYPE = L
   !DEPTH = 0.2
   !PERIMETER  =  15.0
   !HEIGHT = 1.2
    !COPS  =   0.569,0.274,-0.535,-0.529,-0.302,-0.529,-0.535,0.274
   !ORIENTATION  =  0.0
! END

!OPENING  =  'LR  backgnd'
   !AREA  =  0.030
   !SPACE  FROM  =  0
   !SPACE  TO  =  1
   !TYPE = L
```

```
      !DEPTH = 0.2
      !PERIMETER = 7.0
      !HEIGHT = 0.0
       !COPS =  0.569,0.274,-0.535,-0.529,-0.302,-0.529,-0.535,0.274
      !ORIENTATION = 0.0
!END

!OPENING  =  'LR/lnd  hatch'
   !AREA = 0.0033
   !SPACE FROM = 1
   !SPACE TO = 8
   !TYPE = L
   !DEPTH = 0.1
   !PERIMETER = 1
   !HEIGHT = 4.8
!END

!OPENING  =  'lnd  backgnd'
   !AREA = 0.007
   !SPACE FROM = 0
   !SPACE TO = 1
   !TYPE = L
   !DEPTH = 0.2
   !PERIMETER = 3.0
   !HEIGHT = 4.8
    !COPS =  0.569,0.274,-0.535,-0.529,-0.302,-0.529,-0.535,0.274
   !ORIENTATION = 90.0
!END

!OPENING  =  'LR/DR  door'
   !AREA = 0.02
   !SPACE FROM = 1
   !SPACE TO = 2
   !TYPE = I
   !DEPTH = 0.05
   !PERIMETER = 1.0
   !HEIGHT = 0.0
!END

!OPENING  =  'LR/KT  door'
   !AREA = 0.02
   !SPACE FROM = 1
   !SPACE TO = 3
   !TYPE = I
   !DEPTH = 0.05
   !PERIMETER = 1.0
   !HEIGHT = 0.0
!END

!OPENING  =  'lnd/B1  door'
   !AREA = 0.02
   !SPACE FROM = 1
   !SPACE TO = 4
   !TYPE = I
   !DEPTH = 0.05
   !PERIMETER = 1.0
   !HEIGHT = 2.6
!END

!OPENING  =  'lnd/B2  door'
   !AREA = 0.02
   !SPACE FROM = 1
   !SPACE TO = 5
   !TYPE = I
   !DEPTH = 0.05
   !PERIMETER = 1.0
   !HEIGHT = 2.6
!END

!OPENING  =  'lnd/B3  door'
   !AREA = 0.02
   !SPACE FROM = 1
   !SPACE TO = 6
   !TYPE = I
   !DEPTH = 0.05
```

```
      !PERIMETER = 1.0
      !HEIGHT = 2.6
   !END

   !OPENING = 'lnd/Bth  door'
      !AREA = 0.02
      !SPACE FROM = 1
      !SPACE TO = 7
      !TYPE = I
      !DEPTH = 0.05
      !PERIMETER = 1.0
      !HEIGHT = 2.6
   !END


   !OPENING = 'DR  win'
      !AREA = 0.0046
      !SPACE FROM = 0
      !SPACE TO = 2
      !TYPE = L
      !DEPTH = 0.2
      !PERIMETER = 5.0
      !HEIGHT = 1.2
       !COPS = 0.569,0.274,-0.535,-0.529,-0.302,-0.529,-0.535,0.274
      !ORIENTATION = 180.0
   !END

   !OPENING = 'DR  backg'
      !AREA = 0.015
      !SPACE FROM = 0
      !SPACE TO = 2
      !TYPE = L
      !DEPTH = 0.2
      !PERIMETER = 5.0
      !HEIGHT = 0.0
       !COPS = 0.569,0.274,-0.535,-0.529,-0.302,-0.529,-0.535,0.274
      !ORIENTATION = 180.0
   !END

   !OPENING = 'DR/kit  door'
      !AREA = 0.02
      !SPACE FROM = 2
      !SPACE TO = 3
      !TYPE = I
      !DEPTH = 0.05
      !PERIMETER = 1.0
      !HEIGHT = 2.6
   !END


   !OPENING = 'Kit  win/door'
      !AREA = 0.0051
      !SPACE FROM = 0
      !SPACE TO = 3
      !TYPE = L
      !DEPTH = 0.2
      !PERIMETER = 10.0
      !HEIGHT = 1.2
       !COPS = 0.569,0.274,-0.535,-0.529,-0.302,-0.529,-0.535,0.274
      !ORIENTATION = 180.0
   !END

   !OPENING = 'Kit backg'
      !AREA = 0.015
      !SPACE FROM = 0
      !SPACE TO = 3
      !TYPE = L
      !DEPTH = 0.2
      !PERIMETER = 5.0
      !HEIGHT = 0.0
       !COPS = 0.569,0.274,-0.535,-0.529,-0.302,-0.529,-0.535,0.274
      !ORIENTATION = 180.0
   !END

   !OPENING = 'Kit  vent'
```

```
           !AREA = 0.007
           !SPACE FROM = 0
           !SPACE TO = 3
           !TYPE = I
           !DEPTH = 0.3
           !PERIMETER = 0.5
           !HEIGHT = 2.0
            !COPS = 0.569,0.274,-0.535,-0.529,-0.302,-0.529,-0.535,0.274
           !ORIENTATION = 180.0
     !END


     !OPENING = 'B1 win'
           !AREA = 0.0031
           !SPACE FROM = 0
           !SPACE TO = 4
           !TYPE = L
           !DEPTH = 0.2
           !PERIMETER = 5.0
           !HEIGHT = 3.7
            !COPS = 0.569,0.274,-0.535,-0.529,-0.302,-0.529,-0.535,0.274
           !ORIENTATION = 180.0
     !END

     !OPENING = 'B1 backg'
           !AREA = 0.0130
           !SPACE FROM = 0
           !SPACE TO = 4
           !TYPE = L
           !DEPTH = 0.2
           !PERIMETER = 5.0
           !HEIGHT = 4.8
            !COPS = 0.569,0.274,-0.535,-0.529,-0.302,-0.529,-0.535,0.274
           !ORIENTATION = 180.0
     !END

     !OPENING = 'B2 win'
           !AREA = 0.0031
           !SPACE FROM = 0
           !SPACE TO = 5
           !TYPE = L
           !DEPTH = 0.2
           !PERIMETER = 5.0
           !HEIGHT = 3.7
            !COPS = 0.569,0.274,-0.535,-0.529,-0.302,-0.529,-0.535,0.274
           !ORIENTATION = 0.0
     !END

     !OPENING = 'B2 backg'
           !AREA = 0.0130
           !SPACE FROM = 0
           !SPACE TO = 5
           !TYPE = L
           !DEPTH = 0.2
           !PERIMETER = 5.0
           !HEIGHT = 4.8
            !COPS = 0.569,0.274,-0.535,-0.529,-0.302,-0.529,-0.535,0.274
           !ORIENTATION = 0.0
     !END

     !OPENING = 'B3 win'
           !AREA = 0.0031
           !SPACE FROM = 0
           !SPACE TO = 6
           !TYPE = L
           !DEPTH = 0.2
           !PERIMETER = 5.0
           !HEIGHT = 3.7
            !COPS = 0.569,0.274,-0.535,-0.529,-0.302,-0.529,-0.535,0.274
           !ORIENTATION = 0.0
     !END

     !OPENING = 'B3 backg'
           !AREA = 0.0130
           !SPACE FROM = 0
```

```
       !SPACE TO = 6
       !TYPE = L
       !DEPTH = 0.2
       !PERIMETER = 5.0
       !HEIGHT = 4.8
        !COPS  =  0.569,0.274,-0.535,-0.529,-0.302,-0.529,-0.535,0.274
       !ORIENTATION = 0.0
    !END

    !OPENING = 'Bth win'
       !AREA = 0.0031
       !SPACE FROM = 0
       !SPACE TO = 7
       !TYPE = L
       !DEPTH = 0.2
       !PERIMETER = 5.0
       !HEIGHT = 3.7
        !COPS  =  0.569,0.274,-0.535,-0.529,-0.302,-0.529,-0.535,0.274
       !ORIENTATION = 180.0
    !END

    !OPENING = 'Bth backg'
       !AREA = 0.0130
       !SPACE FROM = 0
       !SPACE TO = 7
       !TYPE = L
       !DEPTH = 0.2
       !PERIMETER = 5.0
       !HEIGHT = 4.8
        !COPS  =  0.569,0.274,-0.535,-0.529,-0.302,-0.529,-0.535,0.274
       !ORIENTATION = 180.0
    !END

    !OPENING = 'Bth vent'
       !AREA  = 0.007
       !SPACE FROM = 0
       !SPACE TO = 7
       !TYPE = I
       !DEPTH = 0.3
       !PERIMETER = 0.5
       !HEIGHT = 4.5
        !COPS  =  0.569,0.274,-0.535,-0.529,-0.302,-0.529,-0.535,0.274
       !ORIENTATION = 180.0
    !END


    !OPENING = 'roof lo n'
       !AREA  = 0.03
       !SPACE FROM = 0
       !SPACE TO = 8
       !TYPE = I
       !DEPTH = 0.05
       !PERIMETER = 10.0
       !HEIGHT = 5.0
        !COPS  =  -0.13,-0.22,-0.30,-0.38,-0.46,-0.38,-0.3,-0.22
       !ORIENTATION = 180.0
    !END
    !OPENING = 'roof lo S'
       !AREA  = 0.03
       !SPACE FROM = 0
       !SPACE TO = 8
       !TYPE = I
       !DEPTH = 0.05
       !PERIMETER = 10.0
       !HEIGHT = 5.0
        !COPS  =  -0.13,-0.22,-0.30,-0.38,-0.46,-0.38,-0.3,-0.22
       !ORIENTATION = 0.0
    !END

    !OPENING = 'roof hi n'
       !AREA  = 0.02
       !SPACE FROM = 0
       !SPACE TO = 8
       !TYPE = I
       !DEPTH = 0.05
```

```
      !PERIMETER = 10.0
      !HEIGHT = 7.0
       !COPS  =  -0.13,-0.22,-0.30,-0.38,-0.46,-0.38,-0.3,-0.22
      !ORIENTATION = 180.0
!END
!OPENING = 'roof hi S'
      !AREA = 0.02
      !SPACE FROM = 0
      !SPACE TO = 8
      !TYPE = I
      !DEPTH = 0.05
      !PERIMETER = 10.0
      !HEIGHT = 7.0
       !COPS  =  -0.13,-0.22,-0.30,-0.38,-0.46,-0.38,-0.3,-0.22
      !ORIENTATION = 0.0
!END

!FAN  = 'press'
      !SPACE FROM = 8
      !SPACE TO   = 1
      !FLOW = 0.0 , 0.035, 0.05
      !STAT = 8 21.0 25.0
!END

!EOF
```

## B.12 METEOROLOGICAL FILE

The meteorological file consists of records of data read at the interval selected in the toplevel file. Each record is a specification of the external conditions to apply over that interval. The file is a sequential formatted ascii file in the following format for each record, read in free format:

```
 i   r   r   r   r   r   r   r   r   r
```

In the order as above , the parameters specified are:

>  interval        - an integer value for record identification, for user only, value not significant to HTB2,
>  airtemp        - external dry bulb air temperature ºC,
>  dewpoint        - external dewpoint temperature ºC,
>  groundtemp        - deep earth temperature ºC,
>  humidity        - external air relative humidity %,
>  windspeed        - site windspeed in m/s.
>  winddir        - wind direction in degree cw from north,
>  total        - total horizontal solar irradiation $W/m^2$,
>  diffuse        - diffuse horizontal solar irradiation $W/m^2$,
>  direct normal    - direct normal solar irradiation $W/m^2$,
>  cloud        - total sky cloud cover (0-1).

There can be no comments in the data, either at the start of the file, or between records.

The met file may be rewound to the start at any time via the diary.

Note that there is no time or date information in this file. All simulation runs start at midnight, and the start date for the run must be provided in the TOP file. This date should be appropriate for the meteorological data used, or there will be unpredictable (but repeatable!) inconsistencies between solar values and soalr position. If the start date of the run is to be after the start of the meteorological data, met records may be skipped over at the start, to the correct place, via the TOP command !SET START MET.

Not all data values described above may be available or needed; those values may be skipped over by adjacent commas in the data line, i.e. "a , b, , d" skips over the value c. In many cases HTB2 can calculate the missing value from other parameters.

Those values which may be calculated are:

>  .ground temp may be determined from air temp,
>  .wind velocity and direction may be ommited, in which case fixed values as set in TOP will be used.,
>  .humidity and dewpoint may both be omitted, in which case fixed values as set in TOP will be used;Alternatively if one of the pair is provided, the other will be calculated from it.
>  .cloud cover may be omitted, in which case a fixed value as set in TOP will be used.
>  .diffuse AND direct normal solar irradiance may be omitted, in which case they will be calculated from the total solar and cloud cover supplied.
>  .direct normal solar irradiance may be omitted, in which case they will be calculated from the total diffuse solar irradiance supplied.

As a minimum external temperature, total horizontal solar and cloud cover are required.

## B.13 DIARY FILES

### b.13.1 DIARY STRUCTURE

The DIARY provides a flexible method for scheduling events within a simulation. These events may be altering a data value, or altering (selected) run parameters.

The diary is specified as a file containing a list of "page", or file names. This list is connected in the toplevel file. There must be one page for each day run in the simulation. Any page may be used on more that one day. Note that each separate page is a separate file.

There may be comments (starting with a "*") in both diary list and page files.

The format for the Diary List is ;
>            filenameforday1
>            filenameforday2
>            filenameforday3
>            ...etc...

The filenames must conform to the naming conventions of the operating system in use. The names are NOT enclosed in quotes.

Note that HTB2 may overrun the expected number of days by one timestep, so that one extra diary page file should always be specified though it will never actually be executed.

A diary page is a sequentially ordered list of commend to execute on the appropriate day. These commands MUST be ordered in time sequence. A useful page is the "null" diary, which is a page having no commands, no intervention is carried out on that day therefore.

The general format for the page command is ;
>            ii:ii:ii   c

where the first field is the required time of action, in the format hh:mm:ss,  and the second is the command string. Available commands strings are detailed below. The time specification is in the 24 hour clock.  HTB2 will execute the command to the resolution of the timestep used in the run, within the timestep immediately following the required time. That is , for a specified command time of 11:23:45, and a time step of (say) 300 seconds, the command would actually be implemented at 11:25:00.  Multiple commands may be specified for a single time; they will all be executed within one timestep at the required time.

Input checking of the diary page files is not done before the entry of the simulation stage.  Errors encountered in the reading or parsing of the data line will normally cause a fatal error and abort the simulation.

There are no defaults in the diary commands, as such.  Not using a command means that the current value is unchanged.

Note that many of the commands which alter "automatic/manual" states must be explicitly reset at a later time, i.e. after turning the heating system to manual control it must be returned to automatic time-clock control when that mode of operation is desired.

### b.13.2 AVAILABLE COMMANDS

#### b.13.2.1 DIARY FILES

This section describes option commands, enabling or disabling model or run features.  Any 'ENABLE' may also be 'DISABLE'. The description gives the action in the enabled state.

COMMAND STRING FORMAT
>               DESCRIPTION

!ENABLE BLOCK OUTPUT

> Turns on block reporting at the required time. Note that for data to be output, a file and output types must have been selected in the top-level file.  When enabled the first report will occur after one reporting interval has elapsed.  When disabled a report will be forced at the current time even if an interval has not elapsed.

!ENABLE PROFILE OUTPUT

> Turns on element profile reporting at the required time. Note that for data to be output, a file and output types must have been selected in the top-level file.  When enabled the first report will occur after one reporting interval has elapsed.  When disabled a report will be forced at the current time even if an interval has not elapsed.

!ENABLE EVENT LOG

> Turns on the event logger at the required time.  Note that for data to be output, a file and output types must have been selected in the top-level file.  When disabled a log of all watched items is forced.

!ENABLE ZIPR1

> Turns on user supplied routine ZIPR1, see Tech. Ref. Manual for information on zippers.

!ENABLE ZIPR2

> Turns on user supplied routine ZIPR2, see Tech. Ref. Manual for information on zippers.

!ENABLE ZIPR3

> Turns on user supplied routine ZIPR3, see Tech. Ref. Manual for information on zippers.

!ENABLE ZIPR4

> Turns on user supplied routine ZIPR4, see Tech. Ref. Manual for information on zippers.

!ENABLE ZIPR5

> Turns on user supplied routine ZIPR5, see Tech. Ref. Manual for information on zippers.

!CALL ZIPR6

> Turns on user supplied routine ZIPR6 for a one-shot execution this timestep. Routine will return to inactive for the next timestep.  Values may be passed through the zipper variables.  See Tech. Ref. Manual for information on zippers.

!CALL ZIPR7

> Turns on user supplied routine ZIPR7 for a one-shot execution this timestep. See !CALL ZIPR6.

!CALL ZIPR8

> Turns on user supplied routine ZIPR8 for a one-shot execution this timestep. See !CALL ZIPR6.

!ENABLE SAVE STATE

> Turns on the save state output procedure, saving the building thermal state at midnight of each day.  Later runs may optionally pick this state up as a starting point, thus removeing the need for a lengthy run-up period.

These commands alter data values within a run.  A parameter field is usually required, and follows a "=" character. Some parameters will be required in strict format.  The execution of these commands assumes that the

appropriate routine has been enabled and supplied with its required specification data.

COMMAND STRING FORMAT
        DESCRIPTION

!SET BLOCK REPORT INTERVAL = i
        Set new reporting interval (minutes). A current report will be produced immediately.

!SET CAVVENT MULTIPLIER #i = r
        Set factor D for a ventilated cavity in element i.

!SET CLOUD COVER = r
        Set new cloud cover fraction (0-1), 0 represents clear sky conditions.

!SET CONDUCT #i PART j = r
        Set new layer conductance ($W/m^2/^{\circ}C$) for the j layer (from left) of construction type i. This provides a method for altering the thermal characteristics of a construction type during a run. I.e. the conductance of the inner layer of a window construction can be increased to emulate the thermal effect of curtains (the solar effect of curtains is treated by altering the glazing characteristic).

!SET COOLER SETPOINT #i = r
        Set a new cooling system thermostat set-point. First parameter i the system code number.

!SET EXT HUMIDITY = r
        Set new external air humidity in %.

!SET EXT TEMP = r
        Set new external air temperature in degree C.

!SET FRAME #i = r
        Sets a new frame blockage for a window element i (as a fraction of 1).

!SET FROST SETPOINT #i = r
        Set frost thermostat for heating system code i, in degree C. Assumes frost system has been enabled and described at input stage. System codes are those defined in the heating system file.

!SET GROUND TEMP = r
        Set deep ground temperature in degree C.

!SET HEATER CLOCK c #i @i = ii:ii:ii | mtwtfss
        Set new heating system time clock markers. First parameter is either ON or OFF to set appropriate action at the required time. Second parameter is prefixed by a # and is the heating system code number (as defined in the heating definition file). Third parameter is prefixed by @ and refers to the desired clock period (1,2 or 3). Fourth parameter is new clock action time, in strict format hh:mm:ss. Optional fifth parameter defines the day of week section of the clock timer.

!SET HEATER DAMPER #i = r
        Set new manually controlled damper setting for storage heating system i. Damper setting is a fraction of 1, with 0 = fully closed, 1 = fully open.

!SET HEATER OUTPUT #i = r
        Set new heating system maximum output in kW. First parameter is prefixed by # and is the heating system code number.

!SET HEATER STATUS #i = c
        Alters the heating system operation. First parameter is system code number. Second parameter is either MANUAL ON or MANUAL OFF to override the clock controller, or AUTO to re-establish the time-clock control.

**!SET HEATER SETPOINT #i = r**

        Set a new heating system thermostat set-point. First parameter is the system index code number.

**!SET HTCX #i = r , r , r**

        Set new values for the heat transfer coefficients (horizontal, up, down: $W/m^2/{}^oC$) across the virtual element i.

**!SET HTCS #i = r , r , r**

        Set new values for the internal surface heat transfer coefficients (horizontal, up, down: $W/m^2/{}^oC$) for the element i.

**!SET LIGHTING CLOCK c #i @j = ii:ii:ii |mtwtfss**

        Set new lighting circuit time clock markers. First parameter is either START or STOP to set appropriate action at the required time. Second parameter is prefixed by a # and is the lighting circuit code number (as defined in the lighting definition file). Third parameter is prefixed by @ and refers to the desired clock period (1,2 or 3). Fourth parameter is new clock action time, in strict format hh:mm:ss.

**!SET LIGHTING OUTPUT MANUAL #i = r**

        Set new lighting circuit output while under manual control. First parameter, prefixed by #, is the circuit code number. Second parameter is new output as proportional fraction (0-1) of specified maximum circuit output.

**!SET LIGHTING OUTPUT #i @i = r |mtwtfss**

        Set new lighting circuit output while under automatic clock control. First parameter is lighting circuit code number, second is the appropriate clock control period (1,2,3) for this new output. Output is proportion (0-1) of previously specified maximum circuit load.

**!SET LIGHTING STATUS #i = c**

        Alter lighting control mode. First parameter is the circuit code number, second is either MANUAL ON or MANUAL OFF for manual override of clock of AUTO for reversion to clock control.

**!SET MASTER SETPOINT #i = r**

        Set a new master thermostat set-point. First parameter is the master 'stat index number.

**!SET MET REWIND**

        Informs HTB2 to rewind meteorological data file to start, so as to repeat weather pattern.

**!SET OCCUPANCY CLOCK START TIME #i @j = hh:mm:ss | mtwtfss , and**

**!SET OCCUPANCY CLOCK STOP TIME #i @j = hh:mm:ss | mtwtfss**

        These alter the automatic time-clock settings for the small power source i, and clock period j.

**!SET OCCUPANCY LEVEL #i = r**

        Set number of occupants in space denoted by space code number i to desired multiple (>0) of previously defined nominal occupant.

**!SET OCCUPANCY LEVEL #i @j = r.r | mtwtfss**

        This redefines the occupancy activity level (1-3) for the space i, for clock period j, respectively.

**!SET OCCUPANCY USAGE #i = i**

        Select occupancy activity level for a space. First parameter is space code number as defined in building file. Second parameter selects predefined activity level (1,2,3).

**!SET OCCUPANCY USAGE #i @j = i | mtwtfss**

        This redefines the occupancy rate (number of adults) for the space i, for clock period j, respectively.

**!SET OCCUPANCY STATUS #i = c**

This sets the control strategy for the occupancy module for space i, where the word c is one of AUTOMATIC, MANUAL ON, MANUAL OFF. "AUTOMATIC" runs under time clock control, and "MANUAL ON" applies the diary prescribed conditions. "MANUAL OFF" applies zero occupancy gains to the space.

!SET PROFILE INTERVAL = i
> Set new reporting interval (minutes). A current report will be produced immediately.

!SET SHADING #i = 'c'
> Select a new shading mask for an element. First parameter is element code number, as defined in layout file. Second is a character name for desired mask template, enclosed in single quotes. Mask template name and data must have been defined in the layout file.

!SET SPACE TEMP #i = r
> Set virtual space i air temperature to new value (°C).

!SET SPOWER CLOCK START TIME #i @j = hh:mm:ss | mtwtfss , and

!SET SPOWER CLOCK STOP TIME #i @j = hh:mm:ss | mtwtfss
> These alter the automatic time-clock settings for the small power source i, and clock period j.

!SET SPOWER STATUS #i = c
> Alter output status of small power source. First parameter is small power source code number, as defined in small power file. Second is either ON or OFF or AUTOMATIC.
> These set the control strategy for the small power module for source i. "AUTOMATIC" runs under time clock control, and "MANUAL ON" applies the diary prescribed conditions. "MANUAL OFF" applies zero gains to the space.

!SET SPOWER OUTPUT #i = r
> Set new small power source output as fraction of maximum power specified (0-1).

!SET SPOWER OUTPUT #i @j = r.r | mtwtfss
> This redefines the output fraction for the source i, for clock period j, for the lighting and small power systems respectively.

!SET SUN IRRAD =    r        r
> Alter solar irradiance values, overriding those taken from the meteorological file (if in use and only until next met update). Values are total and diffuse horizontal irradiance in W/m². Data must be within 12 character wide columns.

!SET SUN POSITION =  r        r
> Set new sun position as altitude (90 degree = zenith), and azimuth (0-360 cw from S). Used in conjunction with !ENABLE NSOL at toplevel, to position sun independently of time and geographical location.

!SET VENT FACTOR #i = r
> VENT OPTION 3 ONLY. Set empirical equation coefficient "D" for space code number i.

!SET VENT LEVEL #i = c
> VENT OPTIONS 1, 11 ONLY. Select ventilation level when vent status is "on", infiltration rate is used when "off". First parameter is space code number. Second is either INFIL, LOW, or HIGH to override standard operation, or AUTO to return to normal, thermostat control.

!SET VENT OVERRIDE #i = c
> VENT OPTIONS 1, 11 ONLY. Select ventilation level regardless of vent status. First parameter is space code number. Second is either INFIL, LOW, or HIGH to override standard operation, or AUTO to return to normal, thermostat control.

!SET VENT PATTERN = i
> VENT OPTIONS 2, 12 ONLY. Select predefined air-flow pattern code (1,2,3).

!SET VENT RATE #i = r, r, r

        VENT OPTIONS 1, 11 ONLY. Select ventilation rates.  First parameter is space code number. Three numbers following define ACR1, ACR2, ACR3.

!SET VENT STATUS #i = c

        VENT OPTIONS 1, 11 ONLY. Select ventilation operation status.  First parameter is space code number.  Second is either OFF for infiltration rate or ON for choice of low or high mechanical rates, according to air temp.

!SET VENT STATUS = c

        VENT OPTION 12 ONLY. Select ventilation operation status.  First parameter either OFF for pattern 1 to apply, or ON for choice of patterns 2 or 3, according to the chosen control signal.

!SET WIND =   r        r

        Alter wind speed (m/s) , and direction (degree CW from N), overriding data taken from met file (if in use and only to next met read). Data must be in 12 character wide columns.

!SET WINDOW #i = 'c'

        Select a new window transmission characteristic for an element, which is transparent. First parameter is element code number, as defined in layout file.  Second is a character name for desired characteristic, enclosed in single quotes.  Characteristic name and data must have been defined in the construction file.

!SET ZIPVAR #i = r

        Set new value of user assigned zipper variable i.  See Tech. Ref. Manual for information on zippers.

# APPENDIX C

# HTB2 GLOSSARY

BLOCK REPORT : an output summary of average data values at specific intervals.

CONSTRUCTION : a construction is an ordered list of MATERIAL layers and thicknesses defining a method of construction for complete physical partitions. The ordering of layers precedes from the FIRST surface to the LAST surface. Generally, the FIRST surface is expected to be the external surface.

DIARY : A method of specifying a schedule of events (alteration of either data values or model operation) occurring at any time of day in simulation time.

ELEMENT :an element is a physical or imaginary boundary between SPACES, across which heat transport takes place due to convection, radiation, and conduction. An elements properties are described by an appropriate CONSTRUCTION type (and possibly a WINDOW characteristic). An element has two surfaces. Each surface is considered to be isothermal (i.e. only one-dimensional heat flow is considered), and may be connected to only one space and zone. (see also VIRTUAL ELEMENT)

EVENT LOGGING : output reporting of selected data items when their values change significantly from their previous reports. This allows high time resolution output without redundant information storage.

GROUND TEMPERATURE : a nominal deep ground temperature to which the LAST surface of a ground floor connects (denoted by space 0). The temperature is either input from the meteorological data, specified in a DIARY entry, or calculated from the external air temperature within HTB2, as selected by option.

FIRST SURFACE : a naming convention for the specification of connections between ELEMENT surfaces and SPACEs or ZONEs. The FIRST surface of the CONSTRUCTION used in the element specification is that of the first named part of the construction list. An externally connected element has its FIRST surface to the exterior, while an element used as a ground floor (i.e. connected to the GROUND TEMPERATURE) has its FIRST surface connected to the interior. A completely interior partition may have any space connected to the FIRST surface, however where the partition construction is asymmetrical the FIRST surface must be connected to the appropriate space.

MATERIAL : a material is a definition of the thermo-physical properties (conductivity, density, and specific heat capacity) of a distinct layer of a CONSTRUCTION.

MODELLED SPACE : A modelled space is a SPACE in which heat transported across the bounding ELEMENTS is applied to the air within so that the air temperature varies accordingly. This is the normal space used in building modelling. (see VIRTUAL SPACE)

PROFILE REPORT : an output summary of temperatures and heat fluxes through elements at specific intervals.

LAST SURFACE : side of an ELEMENT opposite to the FIRST SURFACE.

SHADING CHARACTERISTIC : defines the site and component shading of an element in relation to direct and diffuse solar irradiance.

SPACE : A space is a volume of air which is to be considered as being at a uniform temperature and well mixed in respect to heat gains. A space need not necessarily be completely bounded by surfaces (or ELEMENTs). Further, any space may have individual, controllable heat inputs (for instance from heating system, or incidental sources), or selectable data outputs (for instance recording the heat gains or ventilation rate).

A space may thus be a room of a building, a part of a room, or a collection of rooms. In practice a building will be divided into the largest spaces where the above considerations apply.

The exterior may be considered as a special space denoted by space 0.

SUN PATCHING : a (fixed) specification of the surfaces that a transmitted direct solar beam irradiates.

TIME-STEP : simulation time interval between calculation rounds. Maximum timestep governed by mathematical considerations of explicit finite-difference calculations and minimum governed by computer time usage.

UNMODELLED SPACE : (see VIRTUAL SPACE)

VIRTUAL ELEMENT : an imaginary partition which has no thermal mass or thermal resistance. Heat transport is determined in terms of air to air transfer coefficients.

VIRTUAL SPACE : A virtual space is a SPACE which acts as an infinite source or sink of heat to the bounding ELEMENTS. Its temperature does not change except by explicit command from a DIARY input. A virtual space is used to impose controlled boundary conditions on elements. (see MODELLED SPACE)

WINDOW CHARACTERISTIC : defines a transmission and absorption characteristic for direct and diffuse irradiance to be used by a transparent ELEMENT.

ZONE : a zone is defined by a collection of surfaces which partake in common radiant exchange. Radiant exchange may occur across VIRTUAL ELEMENTS which act as spatial boundaries, so that zones may be made up of more than one SPACE. Normally however a zone and a space will be identical.