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Workshop outcomes– Non residential energy simulation tool protocol harmonization

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1. Introduction

There has been some discussion to date amongst a number of parties regarding the needs to streamline the building simulation modelling protocols used in Australia to reduce unnecessary rework when models are used for multiple purposes.
The Modelling Protocol Harmonisation Workshop held at the IBPSA conference in Sydney in 2011 drew on the expertise of a selected number of participants to develop a number of Industry led recommendations in regards to standardizing modelling protocols in Australia.
This report summarised the findings of that workshop, and makes recommendations for the prioritisation of harmonisation work.

2. Background

Commercial thermal simulations are most often carried out to meet the needs of NABERS commitment agreements, Green Star submissions and for the JV3 section of the National Construction Code as well as general analysis and design work. Each of these has an associated modelling protocol which sets out how the model should be developed and used to meet the needs of the scheme in question.
It is fairly common for modellers to have a brief covering two or three schemes. Unfortunately, as each scheme has a different modelling protocol, the modeller is forced to rework the same basic model with often trivial adjustments to comply with each separate protocol. This creates considerable time waste with associated costs which could be avoided if the modelling protocols adopted a more harmonised approach.
At the simplest level, such a harmonisation is no more than the standardisation of default assumptions for items such as occupancy and equipment schedules and other assumed inputs such as infiltration. At this stage, this simple harmonisation is all that is being considered as the three schemes have significantly different needs in terms of results assessment. It is also this simple harmonisation that would have the greatest impact towards the reduction of necessary rework.
An addition to this simple harmonisation is the improvement and standardisation of quality control. In this respect the modelling of fans and pumps is of critical importance as these dominate building energy use in many instances and yet their characteristics are modelled quite inconsistently. Similarly, the process of demonstrating that the building as modelled actually achieves an acceptable level of climate control is critical to model validity and yet no standardised reporting format exists, with the risk that building models are being used in spite of significant failures to achieve proposed levels of comfort control.
On this basis, the Department of Climate Change and Energy Efficiency facilitated a discussion between affected parties (notably NABERS, GreenStar, ABCB, AIRAH and IBPSA) which led to the development of a workshop agenda. This workshop was held on Tuesday 15 November at the Novotel at Brighton-le-Sands in Sydney as an adjunct to the IBPSA conference being held there at the time.
The workshop had over 50 attendees, the vast majority of whom were Australian. A small number of overseas attendees were present, including some very highly regarded members of the international simulation community.

3. Inputs discussed

3.1. Space types and associated schedules

The occupancy, lighting, equipment and air-conditioning schedules (including load and occupancy densities) for various space types are defined by NABERS for offices and by Green Star and the NCC for other spaces uses. There are also UK and US schedules for many space types. It should be possible to have an over-arching Australia space list of space schedules to be used as defaults.

Workshop discussion

A wide range of sample schedules are available already including ASHRAE 90.1, LEED, www.comnet.org[1], UK Part L, the typical building types developed by US DOE[2], GreenStar and possibly other work from NREL[3]. It was also pointed out that there are some post occupancy study results available that may inform the formulation of schedules[4].

3.2. Metabolic rates

The metabolic rate of occupants determines the thermal and latent heat load for HVAC plant when combined with the occupancy density and space schedule. Given that the associated parameters and inevitably an estimate it should be possible to agree on default values.

Workshop discussion

- The key international references are ISO 7730 and ASHRAE 55.
- There is a need to consider whether to keep it simple or have varying metabolic rates for different room temperatures as well as activities

3.3. Climate data

The correct climatic data is essential for reliable modelling. Climate files may be included in the software. They may take the form of TRY (test reference year – a year that happened) or RMY (reference meteorological year – made up of typical months).

Workshop discussion

- The widely used ACADS data is TRY. These files are getting old and also tend to lack realistic seasonal extremes.
- The ABCB has 69 locations of data in RMY format that are used for NatHERS calculations. It may be possible to convert this for broader use.
- Work has been undertaken recently for the production of a set of updated RMY files based on more recent data. This is due for release before the end of 2011.

[1] Contact: Joel Neymark
[2] Contact: Dru Crawley
[3] Contact: Joel Neymark/Ron Judkoff
[4] Contact: Veronica Soebarto

- Some modellers are using IWEC data which is internationally rather than locally sourced. The status of IWEC files was unclear to some participants.
- RMY data may be better for commercial modelling purposes than TRY. UK however uses TRY plus Design Summer Year to capture both typical and extreme conditions.
- Data quality for any agreed weather file set is critical which should include a publically disclosed basis for the files and the associated assumptions and limitations.
- Industry needs a clear understanding of the climate data being used.

3.4. DHW representation

The impact of domestic hot water (DHW) on overall energy consumption varies in importance with building type. NABERS uses a simple default figure plus losses whilst Green Star has developed its own protocols – see, for example, the Retail Centre Energy Calculator Guide.

Workshop discussion

- One consultant uses a detailed build up of DHW pipe losses in their calculation.
- BSRIA, ASHRAE, CIBSE, NCC and AIRAH all have various figures or rules of thumb that may inform calculations.
- Hotels and Hospitals – where use is higher – there may be data available from IHEA (hospital engineers) or AIHE (hotel engineers).
- There is not very much data to work with.

3.5. Lifts representation

The lift energy in a building may be quite significant as a part of overall base energy consumption. It depends on the number of lifts, the height of the building, its area and crucially on the lift drive. The energy may range from 2 to 25 kWh/m²/annum so whilst the lift energy does not impact directly on modelling – unless through the simulation of lift motor room cooling – for overall energy assessment it may be a large unknown variable. NABERS uses a very simple default and Green Star a very simple calculator. An agreed way to handle lift energy is clearly needed.

Workshop discussion

- The CIBSE Guide was generally recognised as under-predicting lift energy use, particularly due to the lack of representation of base loads.
- Exergy/DCCEE empirical data for lifts was identified as useful in offices but not necessarily elsewhere.
- There may be data available at www.comnet.org.
- There needs to be methodologies available to cover escalators and moving walkways as well as lifts.

- There may be particular issues with lifts in hospitals[5].
- A calculation method like CIBSE would be useful but would need to cover all building types.

3.6. Assumed temperature control and control validation

The choice of the temperature bands and control has a large effect on HVAC consumption.
Standardisation of operating temperatures would allow more reliable comparison between models. The importance of temperature bands is underscored by the fact that many off-axis scenarios seek to model a building with a changed control – for example zero dead band.
Related to this is the extent to which the simulation actually achieves the proposed control bands. Once control bands have been stated, it is important that the simulation demonstrates achievement of the proposed control, as otherwise the energy consumption results are not valid. Only the NABERS protocol specifies a test of this, and it is not well complied with.

Workshop discussion

Temperature control band requirements:

- Current requirements are discretionary
- There are challenges in applying any fixed criteria when some building, such as mixed mode buildings, may be seeking to vary temperature control as a efficiency measure.
- The current requirements under each protocol are either unstated or ambiguous, e.g. the meaning of the NCC requirements in this area is not 100% clear.
- There was a general view that desired control bands need to be stated and explicit for each project but otherwise not necessarily uniform across different projects.

Temperature/comfort control reporting

There is a need to define some form of common format of unmet hours report. This needs to be flexible enough to permit different methods of evaluation, as drybulb temperature is only one – and indeed not that good – measure of thermal comfort. GreenStar uses PMV reporting; there is potential to define a common report format that allows a range of different comfort related variables to be assessed in a common format. This would enable simulation packages to produce standardised report formats that would ease the tasks of reporting considerably. A flexible and painless process is required to encourage this to be adopted as a general reporting feature. ASHRAE 90.1 2010 was noted as having a process but that this may be too complicated
Two other points raised in this respect were that:

- It is important for zones that have temperature/comfort control problems to be clearly identified; and
- Temperature/comfort reports are only valid while they are based on simulations with actual plant sizing rather than autosized plant

[5] Contact: Ken Thompson at SKM

3.7. Infiltration

NABERS makes no mention of infiltration. Green Star sets defaults. The NCC also sets values. Given the large impact that infiltration may have for particular buildings – dependent upon climate, internal loads and humidity control – a reliable estimation of infiltration is required.

Workshop discussion

- The importance of infiltration varies significantly with building type and location. Infiltration is an important issue for homes in most climates but is relatively unimportant for internal load dominated buildings (e.g. offices) in temperature climates – except where those buildings need to maintain active humidity control, such as with chilled beam systems.
- Infiltration levels in typical office building construction was reviewed by Annie Egan in a paper presented at the conference. There has been other work conducted (University of South Australia), and there may be results available from some commercial buildings that have actually undertaken tests as part of the commissioning process[6].
- Commercial facades are subject to specification and testing for infiltration in some cases. However the balance of the building generally is not.
- Internationally, the UK has done much work in this area having introduced mandatory pressure testing into Part L of its building regulations. There is a BSRIA Guide (10/98) to pressure testing and work done by the AIVC (www.aivc.org). There may also be material that was presented at the IBPSA Boston Webinar, and it was suggested that there may have been an IEA research task on the topic in the past, which would have significant data if it exists.

3.8. Fan/pump power modelling

There are no set protocols for the modelling of pumps and fans although these items consume a large fraction of commercial building energy. A consistent approach is needed that specifies a methodology for calculating full load energy use and the appropriate turndown. The total pressure across a fan is often very difficult to ascertain.

Workshop discussion

- It was agreed that the ideal process would be mapping of the fan/pump curves against the system curve to get a genuine design specific characteristic. However it was also agreed that this process is not necessarily practical and in many cases not possible, particularly where final fan selections are not available.

[6] Contact: Francesca Muskovic at the GBCA may be able to obtain release on some of this data

- Two potential data sources were identified, being ASHRAE appendix G 90.1 and empirical data reported in CADDETT. ASHRAE was identified as being potentially conservative.

4. Priorities

The workshop participants were asked to make an assessment of:

- Whether standardisation of the parameter was a good idea
- Its relative importance
- Its urgency, and
- The degree of difficulty to implement.

A scale was used as follows

- -5=terrible idea, unimportant, waste of time, impossible
- 0 = don't know, don't care
- +5 = Fantastic idea, very important, very urgent, very easy

A summary of the results is given in

Table 1: Results summary

	Good Idea	Importance	Urgency	Easy
Schedules	4.3	3.2	2.6	2.8
Metabolic Rate	3.6	2.7	1.8	2.8
Climate Data	4.6	4.3	3.7	0.2
DHW	3.2	2.0	1.3	0.2
Lift	3.3	2.5	1.6	0.9
Temp Bands	4.0	4.0	2.1	-1.9
Infiltration	4.1	3.7	2.2	-1.7
Pump&fan power	4.1	3.9	3.1	-1.2

The results were based on an average of 38 respondents. All the topics were considered to be good ideas. Those lowest on the list were the DHW and the lifts – possibly because they fall outside the usual domain of the modeller.

As might be expected items seen as important were also seen as urgent, so in the subsequent analysis we have averaged these. Note however that temperature bands and infiltration were to some extent exceptions to this, in that their urgency rating was lower than average relative to their importance rating. Average importance/urgency is plotted below together with the perceived ease of realisation in Figure 1below.

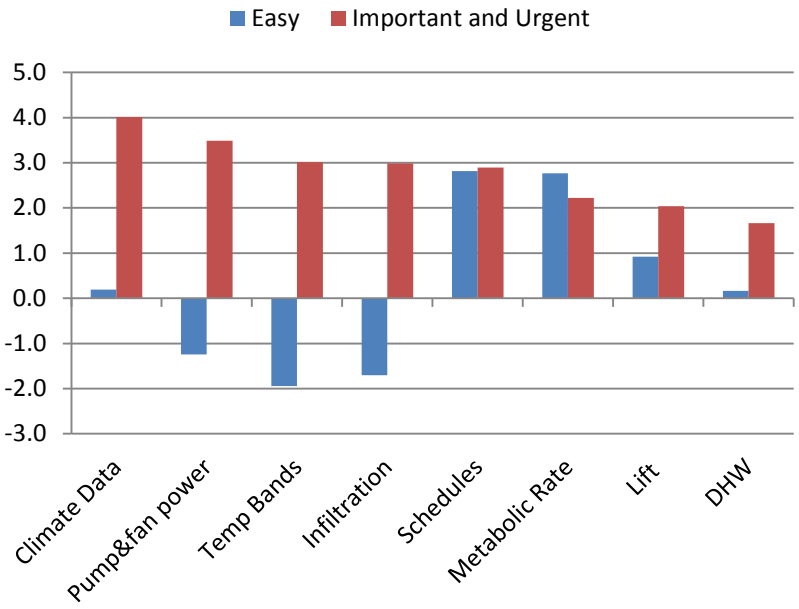

Figure 1. Importance and urgency compared to perceived ease of implementation

The top two priorities indicated by the workshop are Climate Data and Pump and Fan Power protocols. The latter is perceived as harder to achieve than the former. Agreement also supported the next four categories although two of these – Schedules and Metabolic Rates are perceived as easy to achieve whilst Temperature Bands and Infiltration rates are seen as much harder. Lifts and Domestic Hot Water are seen as lower priorities.

5. Recommended action plan

The workshop has demonstrated support for harmonisation of the all the proposed protocols indicating that they are all 'good ideas'. However in implementing harmonisation, a realistic timeline needs to be adopted accounting for both the perceived importance of changes and the ability to conduct these on a reasoned and evidenced basis.
On this basis the following action plan is recommended:

6. Immediate Actions

The following should be addressed as immediate priorities, with at least a first cut at harmonisation being attempted in time for the February 2012 PFC close-off:

- Schedules
- Metabolic Rates

In both cases it is recommended that the proposed methodology is developed with reference to available existing local and international standards. In order to avoid downstream problems caused by the current short timeframe, it is recommended that schedule changes are limited to offices in the immediate PFC, while a longer term and less hurried approach is used for other building types.

7. First Priority Actions during 2012

Projects should be initiated to thoroughly research and propose robust solutions to the following:

- Climate data
- Temperature bands
- Infiltration
- Pump and fan power

8. Second Priority Actions during 2012

The following should preferably be actioned in 2012:

- Lifts
- DHW