Umow Lai

Indoor Environment Quality Credit Review

Discussion Paper

greenstar

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REPORT AUTHORISATION

PROJECT: **INDOOR ENVIRONMENT QUALITY CREDIT REVIEW DISCUSSION PAPER**

REPORT NO: **GBC-0102/D001R01**

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11-03-14	00	Draft for GBCA comment	CLP/AW	EAS/SRE	SRE
13-03-14	01	Updated draft for internal use	CLP	AW/EAS	SRE
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EXECUTIVE SUMMARY

This discussion paper collates and evaluates feedback from various parties into the Indoor Environment Quality credits for the new Design and As-Built 2014 tool. This paper seeks to identify the key issues, the industry best practice and a consensus on the preferred solution for the credit, including a Deemed-to-Satisfy (DTS) pathway.

The paper accompanies the final drafts of the following revised credits:

- Quality of Indoor Air
- Thermal Comfort

The feedback process, taking comment from expert advisors and Technical Assessment Groups, was undertaken prior to preparation of this report. Accordingly, the revision of the credits is discussed in this paper with relation to a full review of this feedback, where a consensus and desired direction for the credit development was determined.

The updated credits, issued separately, take into account and attempt to incorporate a considered view of this feedback alongside industry best practice and reasonable implications on buildings and systems design.

The paper also examines counterpart credits from newly developed tools (Performance and Interiors) and relevant existing Technical Clarifications (TCs), Credit Interpretation Requests (CIRs) and other rulings.

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1.0 INTRODUCTION

This discussion paper collates and evaluates feedback from various parties into the Indoor Environment Quality credits for the new Design and As-Built 2014 tool. This paper seeks to identify the key issues, the industry best practice and a consensus on the preferred solution for the credit, including a Deemed-to-Satisfy (DTS) pathway. The paper also examines counterpart credits from newly developed tools (Performance and Interiors) and relevant existing Technical Clarifications (TCs), Credit Interpretation Requests (CIRs) and other rulings.

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1.1 EXPLANATORY INFORMATION

1.1.1 Scope

This discussion paper encompasses a review of existing Green Star documentation (including that publicly available), feedback from technical working groups and assembled panels. We have relied on the information obtained from the provided documents and accept no liability for the accuracy or otherwise of this information, except where Umow Lai expressly indicates in the report that it has verified the information to its satisfaction.

Nothing in this report shall be read or applied so as to purport to exclude, restrict or modify, or have the effect of excluding, restricting or modifying the application of all or any of the provisions of the Trade Practices Act 1974 or any other legislation which by law cannot be excluded, restricted or modified.

1.1.2 Compliance with Current Building Codes, Regulations and Standards

Building Codes, Regulations and Standards (Regulations), particularly with respect to fire safety systems, should be reviewed to ensure proposed requirements are not contradictory.

This discussion paper may identify areas of non-compliance with current Regulations but it does not purport to provide a comprehensive analysis of compliance with current Regulations. Accordingly Umow Lai recommends that the Client should seek specialist regulatory/building code advice to confirm any non-conformances.

1.1.3 Accuracy

If the reader should become aware of any inaccuracy in or change to any of the facts, findings or assumptions made in this report, the reader is requested to inform Umow Lai so that we may assess its significance and review the report's comments and recommendations.

2.0 QUALITY OF INTERNAL AIR

The Quality of Internal Air credit aims to recognise projects that provide high quality air to occupants. The means for this may be through appropriate design of ventilation infrastructure, supply of sufficient quantities and effective distribution of outside air, and removal of internally-generated pollutants at source.

The revised Quality of Internal Air credit combines the existing credits in the areas of increased ventilation rates, air change effectiveness (distribution of air), removal of pollutants (CO_2, VOCs, equipment exhausts), air distribution systems maintenance and outdoor pollutant control.

2.1 PROPOSED CREDIT

The final draft of this credit, for public comment, is separately distributed.

2.2 REVIEW OF FEEDBACK

Feedback has been obtained from both expert groups and Technical Advisory Groups as assembled for the purpose of revising the IEQ credits for the Green Star 2014 tool update. Feedback is noted here with no corrections.

2.2.1 Key Issues:

General:

- Relevant Rulings: Isn't the key purpose of the revised tool to remove requirements for rulings and incorporate them in the credit? This section must be redundant.

1. Ventilation System Attributes

- No pathway has specifically been nominated for naturally ventilated or MANV spaces, or systems without ductwork. The obvious pathway is the Performance Method, being the only method available (Prescriptive Method is precluded as there would be no 'air intakes' as defined). Filtration on some naturally ventilated systems can range from very difficult to impossible. DTS for natural ventilation is also not appropriate, as outdoor pollutants may exist close by;
- Outdoor air intakes: where exactly does this refer to? E.g. plant rooms can be outdoor air plenums, or does this refer to the ductwork inlets?
- "In accordance with a recognised standard": The acceptable standards must be articulated. E.g. AS1668.2 and ASHRAE 62.1 both include some requirements, but are not consistent;
- ASHRAE 62.1 Addendum A does not provide guidance or methodology, merely compliance for underfloor air supply systems. This reference does not provide a pathway for compliance for project teams.
- Maintenance:
    - Could this part of the credit be moved into a Management credit, e.g. extension of Commissioning or Maintainability. The application of AIRAH technical manual (unclear which) or DA19, AS 3666.1 & 2 and AS1470 have been suggested;
    - The incorporation of advice from ICAs and/or maintenance staff should be sought. Access to all relevant system components should be examined for feasibility;

- Extracts from agreements demonstrating the FM agreement and understanding of requirements should be sought;
- Exhaust-only systems are not covered. Do exhausts need to be cleaned?

2. Provision of Outside Air

- 'Provision of Outside Air' should not be a prerequisite for 'Distribution of Air';
- Recommend 2 points to recognise cost and effort of compliance compared to credit criteria 1 and 4, and also to align with previous credits *IEQ-1 Outside Air Rates* and *IEQ-3 CO_2 Monitoring and Control*, and previous background reasoning for relative weighting. Alternatively, criteria could be dropped to 50% increase on outside air provision over AS1668.2 or 800ppm CO_2;
- Where a DTS solution is introduced for Ene-1, improved GHG emissions are more likely to be realised by application of Option B – modulation to achieve ppm CO_2.
- Further clarification must be given on locations and spacing of CO_2 sensors (e.g. per return air duct or m^2 area), to allow for inexperienced design teams and Assessors OR statement of sufficient design from a Mechanical Engineer (e.g.) must be considered sufficient. "Well served" is currently insufficient;
- Natural ventilation (Option C) is not sufficiently developed. Adverse weather conditions operation justification is left very wide open and requires refinement based on researched solutions or industry experience of such conditions and input;
- Mixed mode ventilation is not covered in any requirements;

3. Distribution of Air

- Some feel that this element of the credit should be deleted entirely;
- Recommend 2 points to recognise additional effort and cost of compliance compared to credit criteria 1 and 4;
- Suggest the "for at least 95% of the relevant area" to allow for some flexibility in an inconsequential amount of spaces;
- Option A:
  - Workstation supply systems should generally be excluded as this should be considered a supplementary system to the general air supply system. Workstation systems do not necessarily deliver good displacement, and can be at levels too high above FFL to effect good ACE. Refer TC#3 for potential issues;
  - Generally, an investigation or expert advice into the types of compliant systems should be undertaken to inform the development of credit criteria. Underfloor is not the only method of compliance and may disrupt delivery of other services or architectural solutions in some projects. E.g. consider major renovations;
  - The 'Letter from the Mechanical Engineer' method of compliance should be included under the DTS methodology, with a more robust form of checking compliance, e.g. Expert Assessor review;
- Option B: retains existing credit, thereby not simplifying credit or removing documentation or cost barriers for projects that are not DTS. Refer above re Letter from Mech Eng;
- Option C:

- Credit compliance is far too open-ended and does not consider ventilation in adverse weather conditions, in which case doors are unlikely to be used. Thermally efficient trickle vent-type solutions with shut-off should still be considered.
- For residential spaces other systems should be considered; these may not fall into full mechanical ventilation but be just as effective, e.g. look at ceramic sink type solutions from Stiebel Eltron and Lunos.
- '10% free area' is twice that required under the BCA for natural ventilation. Though this is pushing for best practice, this amount can be excessive or potentially impossible to provide.

4. Exhaust of Pollutants

- There are likely to be other internal pollutants that must be addressed, e.g. in healthcare or laboratory buildings;
- 'Kitchens' must be defined to include those with ovens and stove tops. Tea points without applicable facilities should be excluded;
- It can be counter-productive to separate kitchens from living areas, particularly in residential applications (e.g. consider natural ventilation). The focus should be on effectiveness of rangehoods.

Documentation

- CFD modelling guidelines and/or empirical calculation guideline/spreadsheet tool is required.

2.2.2 Industry Best Practice:

1. Ventilation System Attributes

AIRAH DA19 HVAC&R Maintenance

2. Provision of Outside Air

AS1668.2 for outside air rates

AS1668.4 for natural ventilation

* Note that AS 1668.2 assumes an ACE of 0.8

3. Distribution of Air

CFD as per outdated standards (from 1994 and 1997): ASHRAE 129-1997 Measuring Air Change Effectiveness

Reliance on good technical designer – Mechanical Engineer

ASHRAE Handbook – Fundamentals

4. Exhaust of Pollutants

Best practice involves separation of equipment from occupied space and/or dedicated exhaust.

AS 1668/2 considers external pollutants.

2.2.3 Other suggestions:

General

- 'Aim of Credit' is too broad; suggested expansion to include description of provision high quality air to "To recognise projects that provide high quality air to occupants *through appropriate design of ventilation infrastructure, supply of sufficient air quantities and effective distribution of outside air and removal of internally-generated pollutants at source*".
- Terminology should be consistent – e.g. compliance options should be called 'Compliance Pathways' for consistency with other credits;
- Definitions to be included: Project Area, Space, Primary Space, Secondary Space, Breathing Zone;
- Are there standards not noted in the credit that might be used to meet the acceptance criteria?

1. Ventilation System Attributes

- A nominated area definition is required, e.g. to exclude non-relevant areas such as plant rooms. Varying application to differing areas within buildings should also be conveyed, e.g. common areas vs living spaces in residential buildings;
- Diagrammatic representation of points claim flow, i.e. 'Distribution of Air' cannot be claimed without firstly attaining credit for 'Ventilation System Attributes' and 'Provision of Outside Air'.
- Include criteria that further introduce pollutant source control, such as the LEED IEQc5 credit criteria for employment of permanent entryway systems, removing dirt and particulates from entering the building at main entrances. Such simple systems have high effect for very low cost.

2. Provision of Outside Air

- Some space types, e.g. Healthcare, can be superseded by design standards other than AS1668.2, in this case local Department of Health guidelines. Can the prescribed performance criteria credit still apply?
- AS1668.2 should be applied in all cases except where it does not cover a specific space type or an overriding standard can be demonstrated to apply;
- Application of 'default occupancy' should be allowed where demonstrated that there is no design occupancy;
- Locations of CO2 sensors is critical and should be further stipulated;
- AS 1668.4-2012 will not be included in the BCA until at least 2014.

3. Distribution of Air

- Side wall supply air should be included, with something such as a height criteria, e.g. below 300mm above FFL;
- Regarding spacing of diffusers, the clarification of the spacing confuses the issue – what does this then mean? Should this include "on average"?
- For Option C: "The maximum distance from a wall" criterion makes little sense.
- A general requirement for the Mechanical Engineer, or a Mechanical Engineer in a review role, to sign off on a HVAC system generally may be introduced. There may be a

minimum qualification level required for the Mechanical Engineer, such as Registered Building Practitioner (RBP) status, or national equivalent. Where this is used, the 'Distribution of Air' element would be collapsed/deleted and this generic requirement would become a prerequisite for the whole credit.

4. Exhaust of Pollutants

- "Located throughout the project" needs to be tightened up; i.e. could include car parks.
- Can a combination of Option B and C be used to comply? Should these be 'Options'?
- Additional compliance requirements should be clarified as regarding Option C only. Currently appear to apply to all options;
- In a speculative base building provision there would be no known location or provision of photocopy and/or printing facilities. How would the credit deal with this? What about desktop printers?
- Can the specification for all systems to be selected in line with given low-emission standards be used for compliance where FF&E not yet known? I.e. as per current materials, VOC credits.

2.3 REVIEW OF COUNTERPART CREDITS

2.3.1 Interiors Pilot: *Quality of Internal Air*

Four points are awarded in the Interiors credit. The 'Provision of Outside Air' point is in addition to 'Ventilation system attributes'. The 'Distribution of air' point is in addition to 'Provision of outside air'. The 'Exhaust of pollutants' point is independent of any other criterion.

Ventilation system attributes: One point is awarded where the entry of outdoor pollutants is mitigated, the system is designed for ease of maintenance and cleaning, and the system has been cleaned prior to occupation and use.

Provision of outside air: An additional point is awarded where the nominated area is provided with sufficient outside air to ensure levels of indoor pollutants are maintained at acceptable levels.

Distribution of air: A further additional point is awarded where the nominated area is provided with effective distributed air ventilation.

To consider this criterion met, each space in the nominated area must be provided with uniformly distributed air ventilation. There are a number of options available for demonstrating compliance.

Option A: A displacement ventilation system with evenly distributed low-level supply and high level exhaust points. For open plan spaces, supply air diffusers must be placed at every $20m^2$ or less; exhaust diffusers at rate of at least one per $50m^2$.

Option B: CFD modelling that shows AGE > 0.95, as per ASHRAE 129-1997.

Exhaust of pollutants: One point is awarded where pollutant arising from printing equipment, cooking processes and equipment and vehicle exhaust is limited by either removing the source of pollutants from the nominated area, or exhausting the pollutants directly to the outside of the project while limiting their entry into other areas.

2.3.2 Performance Pilot: *Quality of Indoor Air*

The Performance tool credit evaluates and awards points where there is a process in place for the monitoring and management of pollutants entering the building throughout the performance period, and capacity for the levels of outdoor pollutants to be maintained at acceptable levels.

Points are also awarded where there are processes in place to monitor outside air intake and manage levels of carbon monoxide. Processes must also be in place to monitor and measure the levels of fresh air in regularly occupied spaces during the performance period, and to maintain carbon dioxide concentrations at best practice levels.

Outdoor Pollutants Mitigation: Maintenance, Cleaning and Hygiene:

1 point is awarded where the process to monitor and manage the entry of outdoor pollutants into regularly occupied spaces maintains them at acceptable levels during the performance period.

Outdoor Pollutants Control: Filtration Media and CO Concentration:

1 point is awarded where the process to monitor outside air intakes manages levels of carbon monoxide as required during the performance period.

Indoor Pollutant Control: Fresh Indoor Air and CO_2 Concentration:

2 points are awarded where the process to monitor and measure levels of fresh air in regularly occupied spaces maintains levels of carbon dioxide concentrations at best practice levels during the performance period.

2.3.3 Notes on other tool approaches

The Interiors tool approach is very much the same as the credit initially proposed for the Green Star 2014 tool.

The Performance tool considers the same three elements retained as part of the proposed Green Star 2014 credit, with the fresh (outside) air and CO_2 measurements being relied upon as indicators of/a proxy for good air distribution. This approach has been maintained in the new credit, and, as such, will transition well to the Performance tool.

2.4 CONSENSUS AND CREDIT DEVELOPMENT DIRECTION

The credit will largely retail the same scope and content. A significant change, and one that has proven contentious during consultation, is the removal of the air change effectiveness element. A DTS pathway may be introduced whereby effective design in this respect is implied.

1. Ventilation System Attributes

The introduction of an analytical model, and the likelihood that naturally ventilated and MANV spaces would need to use this method, to demonstrate compliance with the 'Entry of Outdoor Pollutants' section, has complicated this credit. The credit, as with all credits, should avoid modelling for the sake of Green Star compliance and not as a design tool. This is unlikely to be achieved in this instance, with outdoor pollutants not generally considered in this depth in industry.

The comparable existing criteria (IEQ-18 Outdoor Pollutant Control), or a similar local standard, would bring this back to being more reasonably documented. It is noted that AS 1668.2 has some guidance, but thorough investigation of available standards will be undertaken.

Residential projects, for example, are predominantly naturally ventilated. A solution must be sought that includes consideration for these types of spaces.

Regarding system maintenance, it is generally agreed that this section might be better served if moved to the Management section of the tool. E.g. this could be included, in parts, under credits such as Man-2 Commissioning and Man-11 Maintainability. If included here, the general content would not change.

2. Provision of Outside Air

This element of the credit for 'Provision of Outside Air' should not be a prerequisite for 'Distribution of Air'. The two are not inextricably linked, and a system with good ACE may have just the minimum OA provision and excellent IAQ. Conversely, a system with high levels of OA may not have good ACE.

One point will be kept for this credit for 100% outside air. More guidance should be included in the effectiveness of CO_2 sensors, such as the potential for significant energy savings, as well as guidance on placement of sensors. Placement in return air ducts is not necessarily sufficient. The description of 'well served' is grossly deficient and would be impossible to and/or haphazardly policed.

Natural ventilation (Option C) is not sufficiently developed; more research will be required into the preferred and accepted solutions. Adverse weather conditions operation is far too unclear, and, as such, impossible to adjudicate.

3. Distribution of Air

Opinion reflected in feedback is split on whether ACE should be retained or deleted from the revised credit. What is clear, from both industry and experts in the field, is that the application of ASHRAE Standard 129 is inappropriate, and that this standard should be removed from the tool. This standard is nominated in many instances, including within its own text, as being "suitable only for experimental tests in well-controlled laboratories, and should not be applied directly to real buildings". The traditional Green Star 'Air Change Effectiveness' methodology represents a misapplication of the standard.

CFD modelling in general is also widely accepted to be an imperfect tool for application in this manner; and in many instances the modelling can be prepared or manipulated in such a way that compliance is shown for systems that may potentially be non-compliant in practice.

It is also widely accepted that modelling for ACE, when undertaken, is often performed only for the purposes of attaining Green Star credits and very rarely for validation of HVAC design. This is adverse to the desires of Green Star to advance the industry and avoid costly, wasted effort. It is noted that the prevalence of design *without* ACE modelling has not resulted in systems that do not provide good ACE.

While the consideration of ACE remains relevant for modern conditioned buildings, general research indicates the other building tools internationally (LEED, BREEAM, DGNB) do *not* utilise ACE, whether as a long-standing norm or by deletion over time and tool iteration. It has been established that IAQ is just as effectively served by stipulation of other requirements, including increasing outdoor air supply rates or enforcing requirements for CO_2 monitoring (including sensor placement). Competent mechanical systems design should also ensure appropriate distribution of air.

The direction of the credit, in line with the above, will be to delete the requirements for ACE assessment. Without an appropriate standard to apply, and with an inequitable deemed-to-satisfy solution for displacement systems, it is not possible to determine applicable requirements for this element of the credit. This change is not envisaged to result in the deterioration of mechanical systems design.

4. Exhaust of Pollutants

There are likely to be other internal pollutants that must be addressed, e.g. in healthcare or laboratory buildings. Identification of these pollutants and methodology to abate them may be difficult, and may already be incorporated into nationally enforced standards. Thus, a credit dealing with them would be redundant.

The consideration of speculative buildings, with no fitout for photocopy/print rooms is currently missing from the credit. This should be included.

'Kitchens' will be defined to exclude tea points and the like without relevant facilities, thus removing onerous standards that are unnecessary and reflecting current design standards for kitchen exhaust.

The consideration of kitchens in residential applications will be reconsidered. The separation of kitchens from living areas in this type of development can be counter-productive (e.g. consider natural ventilation). The focus should be on effectiveness of rangehoods or similar exhaust systems. Energy efficiency of ventilation and thermal envelope should not be compromised.

Integration of TCs and CIRs

Every effort has been made to incorporate existing TCs and CIRs into the updated credit. We recognise that it is not possible to include all possible scenarios and instances within the credit without making it unwieldy and confusing. Thus, there will still be some technical clarifications and the possibility for some CIRs.

3.0 THERMAL COMFORT

Thermal comfort is based on a wide range of parameters which include air temperature, mean radiant temperature, humidity, air movement, clothing and metabolic rates. In practice, a high level of thermal comfort is considered to occur when a high proportion of building occupants are predicted to be satisfied with thermal conditions, based on consideration of the above factors.

3.1 PROPOSED CREDIT

The final draft of this credit, for public comment, is separately distributed.

3.2 REVIEW OF FEEDBACK

Feedback has been obtained from both expert groups and Technical Advisory Groups as assembled for the purpose of revising the IEQ credits for the Green Star 2014 tool update. Feedback is noted here with no corrections.

3.2.1 Key Issues:

General:

- The credit needs more development and testing to see how it can appropriately apply to different building types and spaces;
- Language and formatting needs to be revised to enable the credit to be understood with ease. Current layout is too long and jumbled.

Thermal Comfort

- The credit needs to recognise that people have different expectations, and perhaps tolerance, for comfort in naturally ventilated environments. Current criteria for PMV are too strict and discourage natural ventilation solutions. Clothing (clo) values are likely to be different for naturally ventilated spaces, and should be able to be adjusted.
- the requirement for a ceiling fan in residential spaces is too simplistic. Why can this not be undertaken in other types of spaces? The requirement for where fans must be located should be included somewhere here also;
- Is the two point criteria applicable to all building types, e.g. retail?
- residential spaces benchmarks (<30MJ/m^2) must be adjusted to account for different climates. This threshold is near impossible to achieve in major centres outside Sydney and Brisbane. For example, a 10 Star home in Darwin uses nearly 4 times this much (i.e. impossible to achieve). The benchmark should be in Stars, e.g. 8 Stars, making this more meaningful as an improvement on average performance in the region.
- Where is the inclusion of NLA in the space definitions? This is a commonly used commercial term, and changing the use of definitions to suit the purposes of Green Star is not helpful.
- The credit should include provision or at least consideration for adaptability of buildings, in reference to extreme weather events and changing environmental conditions. ‘Comfort” may not be provided in the future, and buildings are designed for 50+ years.
- The use of ASHRAE 55 vs ISO 7730. Clarity is required to specify under what circumstances each standard should be used, i.e. ASHRAE 55 for adaptive thermal comfort, and either standard for PMV.

- 'Standard hours of occupancy' must be flexible, and justifiable depending on space type, e.g. hospitals are 24/7. Perhaps definitions could be given for a variety of space types.
- The references CLO and MET figures can be drawn from ASHRAE 55, as well as ISO 7730.
- Guidance should be given on what air velocity should be used, or how to utilise mechanical specifications to justify other figures;
- Justification must be given to the use of 4m perimeter zones, or this should be removed or allowed to match air conditioning zones.
- The use of average or point predictions for comfort allow a huge scope for variation. This should be restricted to one or the other.
- Requirements to assess comfort at differing heights adds complexity that is not required. Include just one level and do not vary – there is no real benefit to the listed variation as air would mix sufficiently in most spaces to make this discretion redundant. Can also be problematic in spaces where heights are adjustable or highly varied throughout, as is becoming more common.

Individual Comfort Control

- Additional 1 point for Individual Comfort control should be n/a for non-office areas, or scope should be expanded to address other compliance methods noted. This short paragraph does not capture all credit compliance pathways;
- 'Work Areas' does not adequately address many building types, e.g. retail and healthcare (inpatient spaces);
- Individual comfort control should require two of the given variable parameters.

Thermal Comfort in Residential Spaces

- Change terminology for NatHERS to include reference as "software currently approved for use in BCA compliance modelling for NatHERS", without referring to 'second generation'. This would remove risk of inaccurate references in the technical manual and also prevent two different tools being required and two sets of work. Note: FirstRate6 is not the correct tool, should be FirstRate5.
- NatHERS: Reference should be made to "all relevant protocols and regulatory requirements".

Documentation

- A better definition is required for the summary of hourly thermal comfort results – the current stipulation is too extensive and seemingly requires excessive data (hourly). A reference to the example table in Additional Guidance would be useful here;

3.2.2 Industry Best Practice:

Industry regards Best Practice in this area to include the consideration of Predicted Mean Vote (PMV), whether through a modelling methodology or appropriately simplified DtS solution.

3.2.2.1 Predicted Mean Vote Methodology (Buildings other than Multi-Unit Residential)

Fanger PMV is not necessarily the gold standard in thermal comfort. It does take a large range of factors into account, but in the end it is a mathematical model that includes a range of assumptions – some more accurate than others.

The PMV formula (EnergyPlus, 2013) is as follows:

$$PMV = (0.303e^{-0.036M} + 0.028)(H - L)$$

The critical parameters are M, H and L:

- M = metabolic rate per unit area (W/m²),
- H = Internal heat production rate of occupant per unit area (W/m²), and
- L = All modes of energy loss from the body (W/m²).

A DTS solution that allowed for two levels of comfort bands (PMV < ±0.5, PMV < ±1.0) may review the following factors, as necessary:

- Internal temperature control
- Humidity control
- Mean radiant temperature
- Air velocity
- Building fabric properties, i.e. insulation and glazing
- Direct solar gains – reduction and control
- Thermostat (individual) controls

Further study and testing would be necessary.

3.2.2.2 NatHERS

NatHERS is well regarded and accepted by the industry as the best tool to streamline and rate residential spaces. While there are critics and many reasons for criticism, the simple tools used nationwide provide a readily accessible and comparable methodology for rating buildings.

The most significant note to make with regards to the historical and proposed benchmarks with regards to Green Star for Multi-Unit Residential buildings is that they are not equitable across climate zones. The NatHERS tool is necessarily adjusted depending on climate zone to represent best practice and improved performance on the basic building standard. A 5 Star rating in Melbourne is not equivalent – in terms of predicted energy use – to a 5 Star rating in Sydney or Darwin. The benchmarks set for the credit would require the following average ratings:

Location	*Energy Use Allowance*	*Equivalent Star Rating**
Sydney	30 MJ/m^2	7 Stars
Melbourne	30 MJ/m^2	8.7 Stars
Darwin	30 MJ/m^2	11.5 Stars
Hobart	30 MJ/m^2	9 Stars

**Note: scale officially ends at 10 Stars, results beyond this are extrapolated.*

Or alternately:

Location	*Equivalent Star Rating*	*Energy Use Allowance*
Sydney	7 Stars	30 MJ/m^2
Melbourne	7 Stars	83 MJ/m^2
Darwin	7 Stars	285 MJ/m^2
Hobart	7 Stars	113 MJ/m^2

The reasoning for including the MJ/m^2 space heating and cooling allowances as a criteria threshold is not clear, and, for the reasons outlined above, the credit should be rewritten to allow for a Star rating instead.

3.2.3 Other Suggestions:

- Natural ventilation in ASHRAE 55 precludes the use of mechanical cooling. This should be stipulated.
- 'Mean monthly outdoor temperature' should be defined as average daily maximum, if this is intended. This would avoid confusion with average daily temperature.
- The definition of 'mixed mode' requires a tidy-up;
- Correct any use of US spelling (e.g. 'meter' vs 'metre').
- The credit is quite spread out and it is not clear on first look that there are separate sections for various building types, e.g. residential buildings.
- In 'Residential spaces' shading devices should refer to 'external shading devices';
- The term 'suitable professional' should be defined or removed;
- Documentation should provide more detail on the individual comfort control requirements, including one of the following: specifications for mechanical:
    - Mechanical specification

3.3 Review of Counterpart Credits

3.3.1 Interiors Pilot

The 'Thermal Comfort' credit references relevant standards for thermal comfort modelling calculations. The calculations and modelling undertaken by project teams, to estimate the overall thermal comfort of a fitout, forms the basis of compliance for the first 'Thermal Comfort' credit point.

The second credit point rewards projects that provide individual occupants with a level of control over the thermal comfort of their immediate environment. For example, individual control over thermal comfort can be achieved where individuals can adjust the ventilation openings and shading devices around their works setting.

Two points are available in this credit. Each point is independent of each other.

Thermal comfort: One point is awarded where the nominated area has acceptable levels of thermal comfort for most occupants in the primary area. This is demonstrated through modelling of the space and results showing PMV (range: ±1) .

Individual control: One point is awarded where work setting occupants have the ability to control the thermal comfort levels in their immediate environment.

The internal temperatures in the primary area are within 80% of Acceptability Limit detailed in figure 5.3 of ASHRAE Standard 55-2004 during standard hours of occupancy AND occupants must have control over opening and closing of windows.

In certain circumstances the 'Individual Control' point can be claimed as Not Applicable and excluded from the Indoor Environmental Quality Category score. See Compliance Requirements

Innovation points are available in this credit where either PMV is shown to be ±0.5 OR internal temperatures are within 90% of the acceptability limit of ASHRAE Std 55.

3.3.2 Performance Pilot

3.3.2.1 Thermal Comfort

The 'Thermal Comfort' credit rewards the monitoring of each of the critical factors (temperature, relative humidity and air speed) throughout the performance period.

Acceptable temperature range standards for many types of spaces and building uses (offices, classrooms, industrial facilities etc.) as outlined in recognised standards are considered best practice. Points are awarded where processes are in place to monitor, measure and maintain indoor temperature, relative humidity and air speed within acceptable best practice ranges in a building's regularly occupied spaces.

Temperature measurements must be taken and recorded in each HVAC zone in regularly occupied spaces at least four times during the performance period. These measurements should fall within the designated temperature range. If measurements are outside this range, plans and processes should be in place to adjust or repair HVAC systems to ensure that temperatures are maintained at appropriate levels.

Similar measurement and monitoring processes should be implemented for relative humidity and air speed, with relative humidity measurements taken within each humidity zone, and air speed measurements taken at the riser ducts within each regularly occupied space.

3.4 Consensus and Credit Development Direction

For residential projects, the NatHERS energy allowance thresholds that have previously been used will be removed, and replaced with a Star band. This will remove the inequitable requirement for significantly varying relative performance dependent on location, representing best practice rather than an idealised energy target. Thus, the credit will be made available to projects in more locations around the country.

It is recognised that the NatHERS compliance methodology relates more to energy efficiency rather than thermal comfort, although there is currently no better, more widely recognised methodology that offers a compliance pathway. Residential properties should not be required to install complex systems to control comfort, and the NatHERS compliance methodology recognises the effect of the building envelope in providing the basic mechanism for good internal conditions. The introduction of the requirement to use a certified HERS Assessor will move to tighten the quality of ratings.

Regarding other building typologies, there has been no significant issue with the use of ASHRAE Standard 55 or ISO 7730 and thus these two standards have been retained for assessment of most spaces.

Most respondents requested a workable and robust DTS approach to be developed, in order for simple projects to avoid complex and costly modelling or alternative assessment. It was noted that was critical for this pathway to be low-cost and straightforward, while being sure to prevent potentially non-conforming solutions to attain points. Even where compliance with the required PMV levels would require a set of criteria that are strict and exclusive, this would not be adverse to the purpose of the DTS methodology. Thermal modelling may still be required for the bulk of projects.

The proposed methodology for the DTS pathway has been established with reference to the existing methodology in the Office tool, and thoroughly tested by way of thermal comfort simulation. This modelling tested a number of building and occupancy types across all climate zones (as defined in the BCA), identifying the extremes for ambient temperature and solar gains. Clear results from the modelling confirmed the DTS requirements, as well as ruling out a number of scenarios and excluding Climate Zone 8 from the one-size-fits-all criteria.

The determination of the DTS parameters necessarily consider the factors influencing local thermal discomfort:

- Air temperature, including zoning and controls;
- Mean radiant temperature, by way of inclusion of building fabric requirements;
- Relative humidity;
- Air velocity; and
- Direct solar gains.

The factors beyond the control of the building designer include ambient temperature, CLO and MET values for occupants and miscellaneous internal gains; these factors were included conservatively.

The DTS requirements have been clearly defined for the PMV levels of ±1.0. Similarly, the DTS parameters could be defined for ±0.5, although this has been avoided at this stage. Thermal comfort modelling is predicted to be a more appropriate for this level of comfort provision, and the anticipated DTS parameters would be so restrictive as to be rarely adopted or met by default.

Integration of TCs and CIRs

Every effort has been made to incorporate existing TCs and CIRs into the updated credit. We recognise that it is not possible to include all possible scenarios and instances within the credit without making it unwieldy and confusing. Thus, there will still be some technical clarifications and the possibility for some CIRs.

4.0 REFERENCES

Green Building Council of Australia, Green Star tools, calculators and Technical Manuals as follows:

- Green Star Education version 1, 2008
- Green Star Healthcare version 1, 2009
- Green Star Office Design and Office As-Built version 3, 2008
- Green Star Industrial v1 Technical Manual 2010
- Green Star Multi-Unit Residential version 1 2009
- Green Star Public Building v1
- Green Star Retail Centre version 1
- Green Star Interiors v1.1
- Green Star Interiors PILOT, 2012
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Green Building Council of Australia, 2014, *Green Star Rulings Design and As Built 20140206.xlsx*, online published database, GBCA, Sydney, http://www.gbca.org.au/green-star/queries-and-rulings/green-star-rulings/34661.htm

US Green Building Council, 2009, *Green Building Design And Construction, LEED Reference Guide for Green Building Design and Construction*, USGBC, Washington, U.S.

BRE Global, 2010, *BREEAM Scheme Document SD5069*, BRE Global Limited, Watford, UK

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Various standards as referred to throughout this discussion paper, as included in the updated credits.