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Protocol:

Sustainability of Building Products

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Disclaimer
This Protocol is intended for use by suitably qualified and experienced engineers to determine the sustainability of building materials in the specified applications. The authors, publishers and distributors of this Protocol do not accept any responsibility for incorrect, inappropriate or incomplete use of this information.

Preface

The Building Products Innovation Council (BPIC) is currently participating in the Australian Life Cycle Inventory Database Initiative (Aus LCI), to collect life-cycle sustainability data for building products. However, the results are not yet available; nor are the LCA design tools that will use the data; nor are LCA-based ecolabels. The purpose of this Protocol is to describe a credible interim approach to classifying building products, such that their contribution to sustainability is easily identifiable, until such LCA-based design tools and ecolabels become readily available.

For purposes of this Protocol, sustainability is taken as those properties that lead to:

- Reduction in green-house gas generation, which causes global warming;
- Reduction in the use of non-renewable resources upon which our society depends; and
- Reduction in land, water or air pollution or degradation, which alienates the use of these resources.

The comparison of comprehensive life cycle analyses of competing products, is the most equitable basis of selecting sustainable products. Environmental Declarations should account for the sustainability impacts of the manufacture, transport, construction, demolition and re-use of building products, together with their in-service performance. They should be determined in accordance with ISO 14044 and comply with ISO/DIS 21930, as described in Part 1 of the Protocol. The following extracts from ISO/DIS 21930 provide context for Environmental Declarations.

> *If possible, Type III declarations for building products should account for all life cycle stages of the product. Omissions of life cycle stages shall be justified. Where not all the necessary information is available, the PCR shall state those stages that are to be addressed and how to deal with information gaps. The declarations may be based on generic data, as defined in the PCR. .... Environmental impacts, e.g. energy and materials used, resulting from the installation of the building product in the building shall be identified and included in the report. If it is not included, because data is not available, this fact shall be stated.*

Comprehensive life cycle analyses are controversial, because they involve numerous assumptions regarding the manufacture, transport, construction, demolition and re-use of the building products; and assumptions regarding their in-service performance in various applications. To date, Building Regulations have concentrated on only some aspects of in-service performance. The process of preparing such regulations has highlighted the problems of assessing the in-service performance of a range of products in a range of applications. Part 2 of this Protocol reflects the current approach of building regulators. It deals with the effects of building products on the sustainable operation of the building into which it is built, in the context of common practice and what is permissible under the Building Regulations. It provides for the collection of data for subsequent use in;

- Environmental Benchmarking (the comparison of a product's life-cycle analyses or other environmental data to those of the most common acceptable alternative "benchmark construction).

Protocol:
Sustainability of Building Products

1. Scope

This Protocol provides guidance on the performance criteria, specifications and the methods of demonstrating compliance, for building products in specific applications.

2. Part 1: Life-Cycle Analysis Environmental Declarations

Part 1 considers the preparation of environmental declarations based on Life-Cycle Analyses for manufacture, transport, construction, demolition and re-use of building products, together with their in-service performance. It requires environmental declarations to the prepared under a rigorous scheme complying with ISO 14044 and ISO/DIS 21930.

3. Part 2: Benchmarking Building Product Performance

Part 2 considers the special circumstances of benchmarking the sustainability features of building products against defined benchmark performance. This benchmarking process must account for in-service performance for a range of common applications, together with the manufacture, transport, construction, demolition and re-use considerations, which are normally prominent in ecolabelling. This deals with the effects of a building product on the sustainable operation of the building into which it is built, in the context of what is both common practice and what is permissible under the Building Regulations.

4. Sustainability Classification based on In-Service Performance

Limited sustainability classification may be based on Part 2 of this Protocol alone, in those applications where:

- It is apparent that the in-service aspects of a product far outweigh the manufacture, transport, construction, demolition and re-use aspects; and

- The basis and limitation of the classification is clearly stated, as provided for in ISO/DIS 21930.

  Notes:
  Those parts on Building Regulations that currently regulate on sustainability matters, do so principally on the basis of in-service performance. Consistent with this practice, this Protocol permits limited sustainability classification based on Part 2 of the Protocol alone, in applications where it is apparent that the in-service aspects of a product far outweigh the manufacture, transport, construction, demolition and re-use aspects.

  ISO/DIS 21930-2005 *Sustainability in building construction – Environmental declaration of building products* specifies the use of life cycle analysis as the basis for declaration and comparison. However, the Standard also concedes that, in some circumstances, it is permissible to omit some parts of the full life-cycle from the considerations. In such cases, it should be made clear that the assessment should not be used for comparison purposes.

Protocol:
Sustainability of Building Products
Part 1: Life-Cycle Analysis Environmental Declarations

1. Scope

This part of the Protocol provides a basis for rigorous environmental declarations for building products.

2. Environmental Declarations

Environmental declarations for building products shall be based on Life-Cycle Analyses of the manufacture, transport, construction, demolition and re-use of building products, together with their in-service performance. Such environmental declarations shall be prepared under a rigorous scheme complying with ISO 14044 and ISO/DIS 21930.

3. In-Service Performance

Considerations of the in-service performance aspects of environmental declarations (as per Clause 2) shall be carried out giving consideration to Part 2 of this Protocol.

Protocol:
Sustainability of Building Products
Part 2: Benchmarking Building Product Performance

1. Scope

This part of the Protocol defines the procedures for Environmental Benchmarking, whereby a product's sustainability contribution is compared to that of the most common acceptable alternative "benchmark construction". The process deals principally with the effects of building products on the sustainable operation of the buildings into which they are built. This consideration is made in the context of what is both common practice and what is permissible under the Building Regulations.

This process requires:

- Definition of Benchmark Construction for various applications; and
- Determination of the sustainability (including in-service performance) of building products in specific applications.

This part of the Protocol sets out sustainability criteria, specifications and the methods of demonstrating compliance.

> Note
> This part of the Protocol is compatible with the requirements of, and is intended for use with, the Building Regulations and the Standards referred to therein.
>
> This part of the Protocol does not deal in detail with the sustainability impacts of the manufacture, transport, construction, demolition and re-use of building products. These should be considered in the context of ISO/DIS 21930, noted in Part 1.
>
> If Environmental Benchmarking is carried out without recourse to a rigorous life cycle analysis implicit in ISO/DIS 21930, this shall be noted in the documentation.

2. Principle

Sustainability criteria are considerations, which, through their application, lead to:

a. Reduction green-house gas generation, which causes global warming, and/or

b. Reduction in the use of non-renewable resources upon which our society depends, and/or

c. Reduction in land, water or air pollution or degradation, which alienate the use of these resources.

3. Definitions

The following definitions shall apply in the application of this Protocol.

> Note
> To maintain consistency of definitions with other documents used in the building, environmental declarations and ecolabelling industries, some of the definitions below have been reproduced from, or adapted from, those in ISO 14024 and the Building regulations. These sources are acknowledged, and should be consulted for the context in which the definitions are commonly applied.

3.1. Benchmark construction – The form of building construction that is the most economic common solution permitted within the mandatory requirements of the Building Regulations and relevant Standards referrer to therein. See Appendix C.

3.2. Building class – Types of buildings for particular applications, as defined in the Building Regulations

3.3. Building product – Any goods or service used in the construction of buildings

3.4. Commonly used alternatives – Those forms of construction and constituent building products that are in common use in particular classes of building. They may be part of either, “Benchmark Construction”, or “Enhanced Construction”.

3.5. Enhanced Construction – Forms of construction, which, although not the basic construction defined as “Benchmark Construction” are still in common use, and are considered to be an enhancement. The contribution to sustainability could be:

- The use of the product, in general, could be lead to a form of construction that is more sustainable, or
- The use of one particular product could be more sustainable than their competitor products of the same type.

3.6. Environmental Benchmarking Statement – Document detailing the comparison of a product’s life-cycle analysis, and other environmental data, to those of the most common acceptable alternative **B**enchmark Construction.

3.7. Environmental Declaration - Document detailing a product’s life-cycle analysis, and other environmental data, in accordance with ISO/DIS 21930.

3.8. Environmental impact – Any change to the environment, whether adverse or beneficial, wholly or partially resulting from an organization's activities, products or services

3.9. Fitness for purpose – Ability of a product, process or service to serve a defined purpose under specific conditions

3.10. Product category – Group of products which have equivalent function

3.11. Product environmental criteria – Environmental requirements that the product shall meet in order to be awarded an environmental label

3.12. Product function characteristic – Attribute or characteristic in the performance and use of a product

3.13. Sustainability criteria – Considerations, which, through their application, lead to:

- Reduction green-house gas generation and/or
- Reduction in the use of non-renewable resources, and/or
- Reduction in land, water or air pollution or degradation.

3.14. Sustainability specification – A building specification that details, in addition to fitness for purpose requirements, the sustainability performance requirements relevant to that particular product in the context of its intended use.

3.15. Type I environmental labelling programs – Voluntary, multiple-criteria-based third party program that awards a licence which authorizes the use of environmental labels on products indicating overall environmental preference of a product within a particular.

4. Sustainability Criteria

The Sustainability Criteria, against which the sustainability performance shall be assessed, shall be determined in context of the following hierarchy.

4.1. Fitness for Purpose

The principal requirement shall be that products satisfy any relevant Fitness for Purpose criteria, related to their required general performance in the context of their intended use.

Note
Failure of building products to achieve the intended fitness for purpose may lead to unsafe construction, unserviceable construction or other structural, mechanical or aesthetic failures. This invariably leads to re-construction or repair and the associated waste. Therefore, the purposes of sustainability are served by products that are fit for purpose.

4.2. Statutory Requirements

The secondary requirement shall be that building products have the requisite properties necessary to meet any relevant requirements in the Building Regulations and the relevant Standards referred to therein.

Notes
Fitness for purpose is often defined in regulatory requirements. Therefore, the purposes of sustainability are most often served by products that meet relevant regulatory requirements. Compliance with other performance requirements and other regulatory requirements, apart from those specified in the Building Regulations and the Standards referred to therein may also be satisfied, but are outside the scope of this Protocol.

4.3. Sustainability Criteria

The tertiary requirement shall be that products satisfy particular Sustainability Criteria requiring an increase in sustainability over commonly used alternatives, as set out in Appendices D and E. Analysis of sustainability shall consider:

- The contribution of the product to the overall sustainability of the building during the building life cycle; and
- The sustainability of the product in respect of its life cycle.

The Sustainability Criteria for building products shall be as follows

(a) **Reduction green-house gas generation**
The use of the product shall lead to a reduction in the greenhouse gas generation, when compared to “Benchmark Construction”.

(b) **Reduction in the use of non-renewable resources**
The use of the product shall lead to a reduction in the consumption of non-renewable resources, when compared to “Benchmark Construction”.

(c) **Reduction in land, water or air pollution or degradation**
The use of the product shall lead to a reduction in land, water or air pollution or degradation, when compared to “Benchmark Construction”.

Note
In some circumstances, there could be conflict between competing sustainability objectives. In such cases, the considered importance of the particular properties should be ranked in order to determine whether any particular property increases or decreases the overall sustainability.

5. Demonstrating Compliance

(a) Compliance with the requirements of Part 4 may be demonstrated by Verification by Calculation and Analysis in accordance with Part 6.

(b) Contribution to compliance with the requirements of Part 4 may be demonstrated by compliance based on Deemed-to-Satisfy Provisions in accordance with Part 7.

When determining the sustainability of a building product, consideration shall be given to:

- Its effect on the sustainability of the building into which it is built. This consideration shall be made in the context of what is both common practice and what is permissible under the Building Regulations; and

- The sustainability impacts of the manufacture, transport, construction, demolition and re-use of the product.

Notes
This Protocol caters for three types of building product, whose sustainability contribution is

- Direct and Obvious;
- Direct, but Not Obvious; and
- Indirect.

For example:

Direct and Obvious includes:

- Thermal insulation batts, blanket and foil,
- Water tanks
- Water saving shower heads
- Special paints and coatings with very low Volatile Organic Compounds (VOCs)

Direct, but Not Obvious includes:

- Lightweight cladding material that has enhanced thermal insulation; and dense cladding material that has enhanced thermal mass. Depending on the building use, location and design, either one or the other could provide a net advantage
- Roof gutter systems, designed principally to convey water to the stormwater system, may also provide some degree of permanent water storage, or water detention.
- Paints and coatings for normal applications, but with lower than normal VOCs.

Indirect includes:

- Some products fulfil their intended primary function particularly efficiently, thus requiring less of the material to be used in the finished building.
- Other products are manufactured by processes that consume only low quantities of energy.
- Other products may be recyclable.

6. Compliance based on Verification by Calculation or Analysis

Where compliance with the requirements of Part 4 is to be demonstrated by Verification based on Calculation or Analysis, the following shall apply.

6.1. Fitness for Purpose

Compliance with the relevant Fitness for Purpose Criteria (See Part 4.1) shall be demonstrated by certification, based on inspection and/or test and/or engineering assessment, which confirms that the product complies with a clear and concise specification defining the required properties and/or performance of the product for its intended use.

6.2. Statutory Requirements

Compliance with the relevant Statutory Requirements (See Part 4.2) shall be demonstrated by certification, based on inspection and/or test and/or engineering assessment, which confirms that the product complies with the relevant Statutory Requirements for its intended use.

6.3. Sustainability Criteria

Compliance with the relevant Sustainability Criteria (See Part 4.3) shall be demonstrated by certification, based on inspection and/or test and/or engineering assessment in accordance with Appendix D, which confirms that the Product complies with the stated Sustainability Criteria for its intended use.

7. Contribution to Compliance based on Deemed-to-Satisfy Provisions

Where compliance with the requirements of Part 4 is to be demonstrated by Verification based on Deemed-to-Satisfy Provisions, the following shall apply.

7.1. Fitness for Purpose

Compliance with the relevant Fitness for Purpose Criteria (See Part 4.1) shall be demonstrated by certification, based on inspection and/or test and/or engineering assessment, which confirms that the product complies with a clear and concise specification defining the required properties and/or performance of the product for its intended use.

7.2. Statutory Requirements

Compliance with the relevant Statutory Requirements (See Part 4.2) shall be demonstrated by certification, based on inspection and/or test and/or engineering assessment, which confirms that the product complies with the relevant Statutory Requirements for its intended use.

7.3. Sustainability Criteria

Contribution to compliance with the relevant Sustainability Criteria (See Part 4.3) shall be demonstrated by certification, based on compliance with one or more parts of Appendix D, which confirms the Product:

(a) Has properties that are deemed to contribute to compliance with the stated Sustainability Criteria; and

(b) Does not have properties that diminish compliance with the stated Sustainability Criteria.

8. Sustainability Specifications

Sustainability Performance Criteria shall be stated clearly and concisely in a Sustainability Specification.

9. Environmental Declarations

Environmental Declarations shall comply with the requirements of ISO/DIS 21930, which shall take precedent over the requirements of this Protocol.

10. Environmental Benchmarking Statement

Environmental Benchmarking Statements shall be in a format consistent with Environmental Declarations and ISO/DIS 21930, and shall clearly define the in-service conditions for which they are applicable.

Normative Appendices

The following appendices form a normative part of this Protocol

Appendix A Certification Requirements
Appendix B Referenced Documents
Appendix C Benchmark Construction
Appendix D Verification of Sustainability Criteria

Appendix A
Certification Requirements
(Normative)

Certification
Unless overridden by regulatory authorities, the following are deemed to provide suitable certification of sustainability.

- Product Certification by a Third Party Certification Body, accredited by an internationally recognised accreditation authority.

  Australia - Accreditation by JAS-ANZ (Joint Accreditation Scheme – Australia and New Zealand), under the Australia Building Codes Board CodeMark scheme, is considered satisfactory.

- A written certificate of compliance with the relevant Fitness for Purpose Criteria, by a suitably qualified and experienced chartered professional engineer

  Australia - Registration on the National Professional Engineers Register is considered satisfactory

Format of Environmental Declaration
The assessment, report and environmental declaration shall comply with ISO 14044 and Draft ISO 21930.

The properties that shall be investigated and reported, and corresponding units, are:

- Use of non-renewable material resource kg
- Use of renewable material resources kg
- Use of non-renewable energy resources MJ
- Use of renewable energy resources MJ
- Climate change kg of CO_2
- Destruction of the ozone layer kg of CFK-11
- Formation of photochemical oxidants kg of ethene
- Acidification kg of SO_2
- Eutrophication kg of PO_4
- Waste to recycling/reuse or energy recovered kg
- Non-hazardous waste to disposal kg
- Hazardous waste to disposal kg
- Energy content of the product MJ.kg
- Water use m^3
- VOC emissions to indoor air $mg/m^3.h$
- HCOH emissions to indoor air $mg/m^3.h$
- Ammonia emissions to indoor air $mg/m^3.h$
- Carcinogenic compounds to indoor $mg/m^3.h$

The report shall identify the following, which enable the reported properties to be placed in context.

- Reference service life
- Details of the representative manufacturers, geographical covering, time covering, and special conditions
- The life cycle stages that are included in the environmental profile
- The life cycle stages not included in the environmental profile. This is most importance, since it is often convenient to omit in-service considerations from broad-based sustainability claims and ecolabelling. However, since in-service performance of products associated the building envelope often affect heat flow, such omissions are often erroneous and misleading.
- Reference conditions and maintenance specified for the reference service life
- Scenarios for transportation, construction, maintenance, replacements and demolition based on the reference service life
- Scenarios for relevant recycling, energy recovery and waste treatment processes
- Qualitative information related to environmental effect
- References, standards and relevant reports

In order to properly understand the relative significance of the “embodied” effects and the “in-service” effects, each of the impacts should be reported in the following stages. The difficulties of reporting the “in-service” effects for a range of climates and application are discussed in detail in the ENVIROSPEC Protocol.

- Product stage
- Building stage
- End of life stage
- Sub-total
- In-service stage
- Total

The report shall state for each of the properties in each of the stages, the following:

- Performance (in the units stated above)
- Benchmark (in the same unis as for performance)
- Comparison (Performance/Benchmark x 100) %
- Sustainability Statement

The following form, complying with ISO 14044 and Draft ISO 21930, shall be used for the reporting of environmental Declarations.

Environmental Declaration				
Company Name				
Address				
Contact				
Date of Issue				
Product				
Product description				
Relevant Standards	ISO 14044 and Draft ISO 21930			
	Performance	Benchmark	Comparison %	Sustainability Statement
Use of non-renewable material resource, kg				
Product stage				
Building stage				
End of life stage				
Sub-total				
In-service stage				
Total				
Use of renewable material resources, kg				
Product stage				
Building stage				
End of life stage				
Sub-total				
In-service stage				
Total				
Use of non-renewable energy resources, MJ				
Product stage				
Building stage				
End of life stage				
Sub-total				
In-service stage				
Total				
Use of renewable energy resources MJ				
Product stage				
Building stage				
End of life stage				
Sub-total				
In-service stage				
Total				
Climate change kg of CO2				
Product stage				
Building stage				
End of life stage				
Sub-total				
In-service stage				
Total				

Destruction of the ozone layer kg of CFK-11				
Product stage				
Building stage				
End of life stage				
Sub-total				
In-service stage				
Total				
Formation of photochemical oxidants kg of ethene				
Product stage				
Building stage				
End of life stage				
Sub-total				
In-service stage				
Total				
Acidification kg of SO_2				
Product stage				
Building stage				
End of life stage				
Sub-total				
In-service stage				
Total				
Eutrophication kg of PO4				
Product stage				
Building stage				
End of life stage				
Sub-total				
In-service stage				
Total				
Waste to recycling/reuse or energy recov kg				
Product stage				
Building stage				
End of life stage				
Sub-total				
In-service stage				
Total				
Non-hazardous waste to disposal kg				
Product stage				
Building stage				
End of life stage				
Sub-total				
In-service stage				
Total				
Hazardous waste to disposal kg				
Product stage				
Building stage				
End of life stage				
Sub-total				
In-service stage				
Total				

Energy content of the product MJ.kg				
Water use m^3				
VOC emissions to indoor air $mg/m^3.h$				
HCOH emissions to indoor air $mg/m^3.h$				
Ammonia emissions to indoor air $mg/m^3.h$				
Carcinogenic compounds to indoor air $mg/m^3.h$				
Reference service life years				
Representative for manufacturer, geographical covering, time covering, special conditions				
The life cycle stages that are included in the environmental profile				
The life cycle stages that are not included in the environmental profile				
Reference conditions and maintenance specified for the reference service life				
Scenarios for transportation, construction, maintenance, replacements and demolition based on the reference service life				
Scenarios for relevant recycling, energy recovery and waste treatment processes				
Qualitative information related to environmental effect				
References, standards & reports				

Appendix B
Referenced Documents
(Normative)

Part 1 - Australia

The following documents are referenced in this Protocol

Building Code of Australia

Australian Building Codes Board, BCA 2007 – Building Code of Australia Class 2 to Class 9 Buildings Volume One

Australian Building Codes Board, BCA 2007 – Building Code of Australia Class 1 and Class 10 Buildings Volume Two

International Standards

ISO 14024:1999 Environmental labels and declarations – Type I environmental labelling – Principles and procedures

ISO/CD2 14025:2004 Environmental labels and declarations – Type III environmental declarations

ISO 14044:2006 Environmental management – Life cycle assessment – Requirements and guidelines

ISO/DIS 21939-2005 Sustainability in building construction — Environmental declaration of building products

Australian Standards and Australian/New Zealand Standards

AS 3798 Guidelines on earthworks for commercial and residential developments

AS 3600 Concrete Structures
AS 3660.1 Termite management – New Building work
AS 2870 Residential slabs and footings - Construction

AS 4678 Earth retaining structures

AS/NZS 3500 (Compendium) National Plumbing Code Set
AS/NZS 3500.1 Water supply
AS/NZS 3500.2 Sanitary plumbing and sanitary drainage
AS/NZS 3500.2.2 Sanitary plumbing and sanitary drainage – Acceptable Solutions
AS/NZS 3500.3 Stormwater drainage
AS/NZS 3500.3.2 Stormwater drainage- Acceptable Solutions
AS/NZS 3500.4 Hot water supply
AS/NZS 3500.5 National Plumbing and Drainage – Domestic installations

AS 2047 Windows in buildings—Selection and installation
AS 1288 Glass in buildings—Selection and installation
AS 2208 Safety glazing materials in buildings

AS 4100 Steel structures

AS 1684.4 Residential Timber Framed Construction – Simplified – Non-cyclonic areas

AS 2049 Roof Tiles
AS 2050 Installation of roof tiles
AS/NZS 1562.1 Design and installation of sheet roof and wall cladding – Metal

AS 2179.1 Specifications for rainwater goods, accessories and fasteners - Metal shape or sheet rainwater goods, metal accessories and fasteners
AS 2180 Metal rainwater goods - Selection and installation

AS 3700 Masonry structures

AS 2588 Gypsum plasterboard
AS 2589 Gypsum linings in residential and light commercial construction - Application and finishing

AS/NZS 4859.1 Materials for the thermal insulation of buildings – General criteria and technical provisions

AS 3958.1 Ceramic tiles - Part 1 Guide to the installation of ceramic tiles
AS 3958.2 Ceramic tiles - Part 2 Guide to the selection of a ceramic tiling system
AS 3740 Waterproofing of wet areas within residential buildings

AS/NZS 3000 Electrical installations (known as the Australian /New Zealand Wiring Rules)

AS 4386.1 Domestic kitchen assemblies - Kitchen units
AS 4386.2 Domestic kitchen assemblies - Installation

AS/NZS 4505 Domestic garage doors

AS/NZS 2311 Guide to the painting of buildings

AS 1884 Floor coverings - Resilient sheets and tiles - Laying and maintenance practices

AS 1889.1 PVC floor tiles - Semi rigid

AS 1889.2 PVC floor tiles – Flexible

AS 3727 Guide to residential pavements

AS 1664 Aluminium structures – Limit state design

Other References

Australian Paint Approval Scheme (APAS)

Appendix C
Benchmark Construction
(Normative)

Part 1 - Australia

Benchmark construction is defined as the form of building construction that is the most economic common solution permitted within the mandatory requirements of the Building Code of Australia and relevant Standards referred to therein.

Particular state regulations, which impose additional sustainability requirements, shall not be considered as benchmarks, i.e. these shall be considered to have performance superior to the benchmarks.

The following forms of construction shall be used as benchmarks for purposes of assessing sustainability impact of alternatives.

Building Envelope Benchmark Construction					
Building Type	Houses up to two storeys	Residential buildings up to four storeys	Non-residential buildings up to four storeys	Buildings over four storeys high	Other Buildings
Typical Buildings	Detached and duplex housing	Row houses, townhouses, sole-occupancy units, motels	Factories, warehouses, stadiums, shopping centres	Offices, hotels	Open deck carparks, grandstands
Footings	Concrete slab-on-ground	Concrete beams & infill slab	Concrete piles, beams & infill slab	Concrete piles, beams & infill slab	Concrete piles, beams & infill slab
Structural frame	NA	Concrete	Concrete	Concrete	Steel
Ground floor	Concrete	Concrete	Concrete	Concrete	Concrete
Suspended floor	Timber	Concrete	Concrete	Concrete	Concrete
External wall	Clay brick & timber stud frame	Clay brick & concrete masonry	Precast concrete	Glass curtain wall	NA
Internal walls	Plasterboard on timber frame	Concrete masonry	Concrete masonry	Plasterboard on metal frame	NA
Roof	Concrete tiles on timber frames	Concrete tiles on timber frames	Steel sheet on steel purlins	Steel sheet on steel purlins	Steel sheet on steel purlins
Windows	Aluminium frames	Aluminium frames	Aluminium frames	Fixed glass	NA

Attributes of Benchmark Construction
Particular attributes of Benchmark Construction shall be as designed to the following documents.

- Building Code of Australia Volume 1 – Class 2 to 9 buildings – Designated "Other"
- Building Code of Australia Volume 1 – Class 1 and 10 buildings – Designated "Residential"

1 Site Establishment & Preliminaries

"Residential"	BCA Vol 2
"Other"	BCA Vol 1

Assumed Reuse on Demolition

Various	0% is re-used intact, 0% of material is recycled

2 Earthworks & Site Drainage

"Residential"	AS/NZS 3500.5 AS 2870, AS 3798 & BCA Vol 2
"Other"	AS/NZS 3500.3, AS 3798 & BCA Vol 1

Assumed Reuse on Demolition

Various	0% is re-used intact, 0% of material is recycled

3 Concrete

"Residential"	Concrete slab-on-ground & termite shields to AS 2870 & AS 3660.1
"Other"	Concrete columns, beams, slabs, stairs etc to AS 3600

Assumed Reuse on Demolition

Concrete	0% is re-used intact, 10% of material is recycled

4 Retaining Walls

"Residential"	Timber cantilever retaining walls to AS 4678
"Other"	Reinforced concrete masonry retaining walls to AS 4678

Assumed Reuse on Demolition

Timber	0% is re-used intact, 20% of material is recycled
Masonry	80% is re-used intact, 20% of material is recycled
Concrete	0% is re-used intact, 10% of material is recycled
Other	0% is re-used intact, 0% of material is recycled

5 Drainage & Plumbing –

"Residential"	to AS/NZS 3500.5
"Other" to	AS/NZS 3500
	AS/NZS 3500.1
	AS/NZS 3500.2
	AS/NZS 3500.2.2
	AS/NZS 3500.3
	AS/NZS 3500.3.2
	AS/NZS 3500.4

Assumed Reuse on Demolition

Various	0% is re-used intact, 0% of material is recycled

6 Windows, Doors & Glazing

"Residential"	Single glazed, aluminium sliding windows and doors to AS 2047
"Other"	Glass curtain wall to AS 1288

Assumed Reuse on Demolition

Aluminium	0% is re-used intact, 20% of material is recycled
Glass	0% is re-used intact, 30% of material is recycled
Other	0% is re-used intact, 0% of material is recycled

7 Structural Steelwork

"Residential" Miscellaneous beams to AS 4100
"Other" Portal frames to AS 4100

Assumed Reuse on Demolition

Steel	0% is re-used intact, 50% of material is recycled
Other	0% is re-used intact, 10% of material is recycled

8 Wall, Roof & Floor Framing

Timber wall floor and roof framing to AS 1684

Assumed Reuse on Demolition

Timber	0% is re-used intact, 20% of material is recycled
Other	0% is re-used intact, 0% of material is recycled

9 Carpentry & Joinery

Timber to AS 1684

Assumed Reuse on Demolition

Timber	0% is re-used intact, 20% of material is recycled

10 Roof Cladding

"Residential"	Concrete tiled roof to AS 2047 & AS 2050
"Other"	Steel sheeting to AS/NZS 1562.1

Assumed Reuse on Demolition

Tiles	20% is re-used intact, 20% of material is recycled
Sheeting	0% is re-used intact, 50% of material is recycled
Other	0% is re-used intact, 0% of material is recycled

11 Roof Plumbing

"Residential"	Steel gutters, downpipes etc to AS/NZS 3500.5, AS 2179.1 & AS 2180
"Other"	Steel gutters, downpipes etc to AS/NZS 3500.1 to 4, AS 2179.1 & AS 2180

Assumed Reuse on Demolition

Various	0% is re-used intact, 10% of material is recycled

12 Masonry

"Residential"	Clay brick veneer external walls to AS 3700.
"Other"	Cavity walls to AS 3700.

Assumed Reuse on Demolition

Bricks	10% is re-used intact, 20% of material is recycled
Other	0% is re-used intact, 0% of material is recycled

13 Ceiling & Wall Lining

"Residential" 10 mm plasterboard lining to AS 2588 & AS 2598
"Other" Plasterboard lining to AS 2588 & AS 2598 and BCA Vol 1

Assumed Reuse on Demolition
Various 0% is re-used intact, 0% of material is recycled

14 Insulation

"Residential" Wall and roof/ceiling insulation to AS/NZS 4859.1 & BCA Vol 2
"Other" Wall and roof/ceiling insulation to AS/NZS 4859.1 & BCA Vol 1

Assumed Reuse on Demolition
Various 0% is re-used intact, 0% of material is recycled

15 Floor & Wall Tiling

"Residential" Bathroom floor and wall tiling to AS 3958 & AS 3740
"Other" Bathroom floor and wall tiling to AS 3958 & AS 3740

Assumed Reuse on Demolition
Various 0% is re-used intact, 0% of material is recycled

16 Electrical Installation

"Residential" To AS/NZS 3000
"Other" To AS/NZS 3000

Assumed Reuse on Demolition
Various 50% is re-used intact, 0% of material is recycled

17 Kitchen

"Residential" Basic kitchen appliances to AS 4386.1 & AS 4386.2
"Other" Basic kitchen appliances to AS 4386.1 & AS 4386.2

Assumed Reuse on Demolition
Various 0% is re-used intact, 20% of material is recycled

18 Vehicular Doors

"Residential" Manually operated panel-lift door to AS/NZS 4505
"Other" Electrically operated roller doors to AS/NZS 4505

Assumed Reuse on Demolition
Various 0% is re-used intact, 20% of material is recycled

19 Painting & Coatings

"Residential" Internal & external acrylic paint systems to AS/NZS 2311 and APAS
"Other" Internal & external paint systems to AS/NZS 2311 and APAS

Assumed Reuse on Demolition
Various 0% is re-used intact, 0% of material is recycled

Australian Paint Approval Scheme (APAS) Requirements Regarding Volatile Organic Compounds (VOCs) in Paints			
APAS Spec	**Paint Type**	VOC content of wet paint (grams per litre)	
High Volume Architectural Products		**Average**	**Maximum**
0134	Latex primer for galvanised iron & Zincalume	45	50
0163/1	Exterior latex undercoat	55	65
0163/2	Interior latex undercoat	60	65
0172	Interior sealer	50	60
0183	Exterior timber primer	50	60
0260/1	Interior gloss	75	90
0260/2	Interior semi gloss	60	80
0260/3	Interior low sheen	50	75
0260/4	Interior flat – washable	60	70
0260/5	Interior flat – ceilings	50	60
0280/1	Exterior gloss	60	85
0280/2	Exterior semi gloss	60	80
0280/3	Exterior flat & low sheen	45	70
0280/4	Exterior gloss	65	80
0280/5	Exterior low sheen	50	80
Other Architectural Products		**Maximum**	
0011	Solvent borne roof paint for galvanised steel	450	
0012	Latex roof paint	100	
0015	Exterior/interior alkyd, gloss & semi gloss	450	
0016	Interior & exterior undercoat	450	
0024	Exterior oil & petrol resistant enamel	450	
0029	Undercoat (oil & petrol resistant)	450	
0032	Metal primer Buildings – excluding lead & chromates)	550	
0055	One pack exterior varnish (general purpose)	550	
0070/1	Chalkboard paint – solvent based	450	
0070/3	Chalkboard paint – water based	100	
0114	One pack interior varnish (general purpose)	500	
0115	Lightly pigmented ranch finish – exterior timber	450	
0162	Zinc phosphate metal primer	550	
0171	Interior solvent-based sealer	450	
0181	Primer	450	
0200	One pack pigmented solvent borne paving paint	550	
0202	One pack pigmented latex paving paint	80	
0215	Low odour/low environmental impact	5	
Industrial & Protective Coatings Products		**Maximum**	
0006	Army Olive Drab enamel	550	
0009	Undercoat for Army Olive Drab enamel	550	
0041/2	Road-making paint – solvent borne	450	
0041/5	Road-making paint – white water borne	60	
2901	Protective coatings for steel – latex	100	
2920	Polysiloxane coating	400	
2921	Protective coatings for steel – primers	450	
2922	Protective coatings for steel – modified alkyd finish	450	

2930	Single pack moisture cure urethane for steel	400
2940	MIO or aluminium subject to continuous condensation	350
2971	Epoxy primers, 2 pack	400
2972	Low build epoxy GP enamel, 2 pack	350
2973	Solvent borne epoxy to 400 µm, 2 pack	350
2974	Solventless epoxy to 400 µm, 2 pack	120
2975	Ultra high build epoxy, immersion, 2 pack	350
2976	Solvent borne epoxy mastic	180
2977	Solvent borne epoxy mastic, slow drying, high volume solids > 400 µm	180
Paints shall not have more than 25% by weight of total formulation of hydrocarbon solvents.		
Paints shall not include aromatic hydrocarbon solvents.		
Paints shall not include formaldehyde or release formaldehyde during use.		
Paints shall not include halogenated solvents.		
Paints shall not include mercury, arsenic or selenium or their compounds, pigments of lead, cadmium, chromium VI or antimony, except that impurities of the elements listed above which are contained in the raw materials and components and which do not exceed a combined total of 0.1% by weight of non-volatile content and which have individual element contents that do not exceed the limits specified.		
Paints shall not include more than the limits specified for any of the substances listed in the Toxic Substances Regulations, and with a cumulative total of not more than 0.5% by weight of these substances, based on the total formulations.		
Paints shall not include ethylene glycol as an integral part of the paint formulation.		
Notes 1. VOC specifications are summaries of APAS (Australian Paint Approval Scheme) Document D181, Tables 1, 2 and 3, applying in the period 1st January 2007 to 31st December 2001. 2. Other requirements are based on Environmental Choice New Zealand – Paints - Specification EC-07-O1		

20 Resilient Floor Coverings

"Residential" Vinyl floor coverings to AS 1884 and AS 1889
"Other" Vinyl floor coverings to AS 1884 and AS 1889

Assumed Reuse on Demolition
Various 20% is re-used intact, 0% of material is recycled

21 Carpets & Soft Furnishings

"Residential" Wool blend carpets
"Other" Heavy duty short pile wool blend carpets

Assumed Reuse on Demolition
Various 20% is re-used intact, 0% of material is recycled

22 Window & Door Shutters

"Residential" Not common
"Other" Not common

Assumed Reuse on Demolition
Various 20% is re-used intact, 20% of material is recycled

23 Mechanical Ventilation & Services

"Residential" Combination fan, light & heater. capable of achieving the following:
"Other" Air-conditioning capable of achieving the following:

Acceptable Indoor Air Quality in Residential and Commercial Buildings		
Pollutant	**Averaging Time**	**Air Quality Guideline value**
Carbon Dioxide	8 hours	3,500 ppm (1,000 ppm as body odour metric)
Carbon Monoxide	15 minutes 30 minutes 1 hour 8 hours	90 ppm 50 ppm 25 ppm 10 ppm
Formaldehyde	30 minutes	0.1 mg/m^3
Lead	1 year	0.5 $\mu g/m^3$
Nitrogen dioxide, NO_2	1 year 1 hour	40 $\mu g/m^3$ 200 $\mu g/m^3$
Ozone, O_3	8 hour, daily maximum	100 $\mu g/m^3$
Particulate matter, $PM_{2.5}$ Particulate matter, PM_{10}	1 year 24 hour (99^{th} percentile) 1 year 24 hour (99^{th} percentile)	10 $\mu g/m^3$ 25 $\mu g/m^3$ 20 $\mu g/m^3$ 50 $\mu g/m^3$
Sulfur dioxide, SO_2	24 hour 10 minute	20 $\mu g/m^3$ 500 $\mu g/m^3$
Total Volatile Organic Compounds	1 hour	500 $\mu g/m^3$

Notes:
1. This table is based on WHO/Europe Guidelines modified by CASANZ, and addition of CO_2 and Total VOCs.
2. Environmental tobacco smoke is excluded, assuming that indoor smoking is not permitted.

24 Cleaning

"Residential" Concrete & masonry - High pressure water, Other low pressure water
"Other" Concrete & masonry - High pressure water, Other low pressure water

Assumed Reuse on Demolition
Various 0% is re-used intact, 0% of material is recycled

25 Landscaping

"Residential" Turf, with minimal planting of native trees and shrubs.
"Other" Planting of native trees and shrubs.

Assumed Reuse on Demolition
Various 10% is re-used intact, 20% of material is recycled

26 Fencing

"Residential" Timber lap and cap fencing
"Other" Metal security fencing.

Assumed Reuse on Demolition
Timber 0% is re-used intact, 20% of material is recycled
Metal 0% is re-used intact, 50% of material is recycled
Other 10% is re-used intact, 0% of material is recycled

27 Paving

"Residential"	Stencilled concrete pavement to AS 3727
"Other"	Segmental concrete pavement to AS 3727

Assumed Reuse on Demolition

Concrete	0% is re-used intact, 10% of material is recycled
Pavers	80% is re-used intact, 10% of material is recycled
Other	0% is re-used intact, 0% of material is recycled

28 Metalwork & Balustrades

"Residential"	Aluminium balustrade to AS 1664
"Other"	Glass & aluminium balustrade to AS 1664, AS 1288 & AS 2208

Assumed Reuse on Demolition

Aluminium	0% is re-used intact, 20% of material is recycled
Glass	0% is re-used intact, 30% of material is recycled
Other	0% is re-used intact, 0% of material is recycled

29 Public Kerbs, Gutters, Footpaths & Crossovers

"Residential"	To "typical" local authority requirements
"Other"	To "typical" local authority requirements

Assumed Reuse on Demolition

Various	0% is re-used intact, 10% of material is recycled

Note
The values of "Assumed Reuse on Demolition" are estimates of the current re-use intact and materials recycling currently undertaken for the materials used in "benchmark construction".

Appendix D
Verification of Sustainability Criteria
(Normative)

Part 1 - Australia

D1.1 Use of non-renewable material resources

Criterion
The use of the product shall lead to a reduction in the consumption of non-renewable material resources (in kg), when compared to “Benchmark Construction”.

Compliance
Compliance may be demonstrated by the following process:

Soil
Determine, compare and report the Net Alienation of Fertile Soil (including the effects of salinity and erosion) caused by both Product and Benchmark Construction.

> Note
> Fertile soil is considered to be a non-renewable resource. Practices that encourage dry land salinity effectively degrade the soil rendering it infertile. In some cases, rising water table and the associated precipitation of salt within the building structure shorten the product life, thus requiring repair or replacement

Land, water or air pollution or degradation
The use of the product shall lead to a reduction in land, water or air pollution or degradation, when compared to “Benchmark Construction”, for any of the following properties:

- more easily bio-degradable
- less toxic and with lower concentrations of volatile organic compounds
- manufactured by processes that produce less air, water or land pollution and less toxic waste
- trap and treat contaminants rather than allowing them to run off or be dumped
- reduce soil salinity
- protect and promote tree and plant growth.

Compliance may be demonstrated by the following process:

1. Determine and quantify the particular property for the use of Benchmark Construction in the building.
2. Determine and quantify the particular property for the use of the Product in the building.
3. Calculate and report the Net Change in Degradation, together with full calculations.

D1.2 Use of renewable material resources

Criterion
The use of the product shall lead to a reduction in the consumption of renewable material resources (in kg), when compared to ¯Benchmark Construction..

Compliance
Compliance may be demonstrated by the process described in D1.1 Use of nonrenewable material resources., except that only renewable resources shall be considered.

Timber products
Timber products shall be sourced from forests which are sustainably and/or responsibly managed to agreed principles of stakeholders (contained in Standards) and for which compliance is verified by independent third parties.

Evidence of compliance with this requirement includes a Chain of Custody Certificate from the Forest Stewardship Council (FSC), Australian Forestry Certification Scheme (AFCS) or other Programme for Endorsement of Forest Certification (PEFC) endorsed schemes.

Notes:
1. Certification is carried out by accredited certification bodies. FSC, AFCS or other PEFC endorsed schemes do not certify forest operations or manufacturers. This maintains independence between Standards and their requirements, and operations seeking certification. There are two types of certificates available from certification bodies:

2. Forest Management (FM) Certificate
Forest management certification involves an inspection of the forest management unit by an independent certification body accredited by FSC, AFCS or other PEFC endorsed scheme to check that the forest complies with the agreed sustainability principles of stakeholders. If the forest complies with the relevant Standards, then the accredited certification body issues a certificate for the operation.
Certified forest operations can claim the forest products they produce come from a sustainably and/or responsibly managed forest. Before a certified forest operation can sell their products as FSC, AFCS or other PEFC certified scheme they must also obtain chain of custody certification.

3. Chain of Custody (COC) Certificate
Chain of custody certification provides an independent third party verified guarantee about FSC, AFCS or PEFC endorsed scheme certified products. From a customer perspective, the AFCS, FSC or PEFC endorsed scheme labels represent a promise that is being made to them. Chain of custody standards are the mechanism these schemes have to ensure that 'promise' is delivered. Operations that have been independently verified for FSC, AFCS or PEFC endorsed schemes chain of custody certification are eligible to label their products with the FSC, AFSC or other PEFC endorsed schemes logo.

External Links
Programme for the Endorsement of Forest Certification Schemes (PEFC)
Australian Forestry Certification Scheme (AFCS)
Forest Stewardship Council (FSC)

D1.3 Use of non-renewable energy resources

Criterion

The use of the product shall lead to a reduction in the non-renewable energy use (in MJ), when compared to "Benchmark Construction". It shall be assumed that non-renewable energy is used throughout the product life, unless there is evidence to the contrary.

Compliance Demonstrated by Life Cycle Analysis

Calculation of embodied energy shall take account of the energy used throughout the life-cycle to carry out the following processes.

- Procure and transport the raw materials to the manufacturing facility,
- Establish the manufacturing facility,
- Operate the manufacturing process,
- Transport the materials to a typical building site,
- Build the materials into a typical building,
- Demolish and dispose of the materials at the end of the building life, and
- Provide a credit for the proportion of the materials that may be recycled.

Calculation of operational energy shall take account of the climate characteristics of the intended location, acceptable comfort levels, use or otherwise of artificial heating and cooling and the characteristics of both the Product and Benchmark Construction. The verification methods set out in BCA Volume 1 JV1 and JV3, and BCA Volume 2 V2.6.2.2, are suitable methods of making the following comparisons. Compliance may be demonstrated by the following process:

1. Calculate the embodied energy of the Product throughout its life-cycle, E_{pe}.

2. Calculate the operational energy consumption of the building, incorporating the Product, throughout its life-cycle, E_{po}.

3. Calculate the embodied energy of the Benchmark Construction (that the Product is intended to replace) throughout its life-cycle, E_{be}.

4. Calculate the operational energy consumption of the building, incorporating Benchmark Construction, throughout its life-cycle, E_{bo}.

5. Determine the net increase or decrease in total energy use if the Product is used in lieu of Benchmark Construction, from the following.

   Net Energy = Total energy for Product – Total energy for Benchmark Construction
   $= (E_{peN} + E_{poN}) – (E_{beN} + E_{boN})$

6. Report the Net Energy (increase or decrease), together with full calculations.

Partial Compliance Inferred by Direct Comparison of Product Properties

Criterion: " have higher thermal resistance"

The Benchmark Construction is the values given in BCA Vol 2 Part 3.12 for the benchmark construction for walls, roofs and floors.

Member	**Reference**	**Construction**	**Thermal Resistance, R m^2.K/W**
Walls	BCA Vol 2 Figure 3.12.1.3(c)	110 mm clay masonry veneer (including internal & external air films)	R 0.55
Roof/Ceiling	BCA Vol 2 Figure 3.12.1.1(c)	Flat ceiling with pitched tiled roof	R 0.22 or R 0.73 Note2
Suspended Floors	BCA Vol 2 Figure 3.12.1.4(a)	Enclosed suspended timber floor	R 0.7
Notes 1. These values include the internal and external air films, but exclude added insulation. 2. R 0.73 should only be used as the benchmark where construction is restricts to Climatic Zone 1 and Climatic Zone 2 below 300 m altitude. For all other applications, 0.22 shall be used.			

Compliance with this criterion shall be substantiated by evidence that the product or system has a higher thermal resistance than the benchmark. This may be based on test results, or may be derived theoretically from published data.

Criterion: " have higher thermal mass"

For external walls, the Benchmark Construction is the BCA criterion of surface mass of 220 kg/m^2.

For external walls, compliance with this criterion shall be substantiated by evidence that the product or system has a higher thermal mass than the benchmark, 220 kg/m^2. This may be based on test results, or may be derived theoretically from published data.

Criterion: " have a higher albedo"

The Benchmark Construction is roof and wall products with a Solar Absorptance greater than 0.55, i.e. Relatively dark colours including Slate (dark grey), Red, Green, Yellow and Buff:

Compliance with this criterion shall be substantiated by certification that the colours (of roofs or similar applications) have solar absorptance values not more than 0.55 , and are intended for use in Climate Zones 1, 2 and 3 (Generally hot climates). In the absence of more precise information, the following may be used as a guide.

Typical Solar Absorptance Values	
Colour	*Value*
Slate (dark grey)	*0.9*
Red, green	*0.75*
Yellow, buff	*0.6*
Zinc aluminium – dull	*0.55*
Galvanised steel – dull	*0.55*
Light grey	*0.45*
Off white	*0.35*
Light cream	*0.3*

D1.4 Use of renewable energy resources

Criterion
The use of the product shall lead to a reduction in the use of renewable energy (in MJ), when compared to “Benchmark Construction”.

Compliance
Because it is not possible to predict the source of operational energy, this criterion shall be applied only to the manufacturing process.

- Establish the manufacturing facility,
- Operate the manufacturing process,
- Provide a credit for the proportion of the materials that may be recycled.

Compliance may be demonstrated by the following process:

1. Calculate the embodied energy of the Product during manufacture, E_{pe}.

2. Calculate the embodied energy of the Benchmark Construction (that the Product is intended to replace), E_{be}.

3. Determine the net increase or decrease in total energy use if the Product is used in lieu of Benchmark Construction, from the following.

   Net Energy = Total energy for Product – Total energy for Benchmark Construction
   $= (E_{pe} – E_{be})$

4. Report the Net Energy (increase or decrease), together with full calculations.

D1.5 Climate change

Criterion

The use of the product shall lead to a reduction in the greenhouse gas generation (indicated by kg of CO_2), when compared to "Benchmark Construction".

Compliance Demonstrated by Life Cycle Analysis

For the manufacture and use of the Product, determine whether energy consumption is an appropriate indicator of green-house gas generation.

- If so, proceed as follows.
- If not, proceed as follows, but, in addition, calculate the greenhouse gas emissions corresponding to each component of net energy, as determined below.

Calculation of embodied energy shall take account of the energy used throughout the life-cycle to carry out the following processes.

- Procure and transport the raw materials to the manufacturing facility,
- Establish the manufacturing facility,
- Operate the manufacturing process,
- Transport the materials to a typical building site,
- Build the materials into a typical building,
- Demolish and dispose of the materials at the end of the building life, and
- Provide a credit for the proportion of the materials that may be recycled.

Calculation of operational energy shall take account of the climate characteristics of the intended location, acceptable comfort levels, use or otherwise of artificial heating and cooling and the characteristics of both the Product and Benchmark Construction. The verification methods set out in BCA Volume 1 JV1 and JV3, and BCA Volume 2 V2.6.2.2, are suitable methods of making the following comparisons.

Compliance may be demonstrated by the following process:

1. Calculate the carbon liberated due to embodied energy of the Product throughout its life-cycle, C_{pe}.

2. Calculate the carbon liberated due to operational energy consumption of the building, incorporating the Product, throughout its life-cycle, C_{po}.

3. Calculate the carbon liberated due to embodied energy of the Benchmark Construction (that the Product is intended to replace) throughout its life-cycle, C_{be}.

4. Calculate the carbon liberated due to operational energy consumption of the building, incorporating Benchmark Construction, throughout its life-cycle, C_{bo}.

5. Determine the net increase or decrease in carbon liberated if the Product is used in lieu of Benchmark Construction, from the following.

   Net Carbon = Total carbon for Product – Total carbon for Benchmark Construction
   $= (C_{peN} + C_{poN}) – (C_{beN} + C_{boN})$

6. Report the Net Carbon liberated (increase or decrease), together with full calculations.

D1.6 Destruction of the ozone layer

Criterion
The use of the product shall lead to a reduction in the release of materials (CFK-11) that destroy the ozone layer, when compared to “Benchmark Construction”.

Compliance
Compliance may be demonstrated by the evidence comparing the release of CFK-11 for both the Product and the Benchmark Construction.

D1.7 Formation of photochemical oxidants

Criterion
The use of the product shall lead to a reduction in the release of photochemical oxidants (ethene), when compared to “Benchmark Construction”.

Compliance
Compliance may be demonstrated by the evidence comparing the release of photochemical oxidants for both the Product and the Benchmark Construction.

D1.8 Acidification

Criterion
The use of the product shall lead to a reduction in the release of acidic materials (kg of SO_2), when compared to “Benchmark Construction”.

Compliance
Compliance may be demonstrated by the evidence comparing the release of acidic materials for both the Product and the Benchmark Construction.

D1.9 Eutrophication

Criterion
The use of the product shall lead to a reduction in eutrophication of waterways (kg of PO_4), when compared to “Benchmark Construction”.

Compliance
Compliance may be demonstrated by the evidence comparing the release of materials that eutrophy waterways for both the Product and the Benchmark Construction.

D1.10 Waste to recycling/reuse or energy recovery

Criterion
The use of the product shall lead to a reduction in the quantity of material that is not recycled or reused, or from which energy is not recovered (kg), when compared to "Benchmark Construction".

Compliance
Compliance may be demonstrated by comparing the product "% re-use intact" and "% of material recycled" to that listed for "benchmark construction".

Compliance with this criterion shall be substantiated by evidence that the product has the properties similar to the following :

- Cladding - Is fixed by bolts or screw that can be easily removed and replaced during re-installation
- Cladding - Is not nailed or otherwise fixed such that nail holes are left in the material.
- Cladding and structural members - not fixed by adhesives, glues, mortars or grouts fixed to the body of the product.
- Mortar can be easily cleaned from masonry units (bricks and blocks).

Note:
The Benchmark Construction generally has a design life of at least 60 years. If the product has a shorter design life, this shall be considered in the assessment.

D1.11 Non-hazardous waste to disposal

Criterion
The use of the product shall lead to a reduction in the quantity of non-hazardous waste material (kg), when compared to "Benchmark Construction".

Compliance
Compliance may be demonstrated by the following process set out in D1.10 "Waste to recycling/reuse or energy recovery", modified to account for non-hazardous waste.

D1.12 Hazardous waste to disposal

Criterion
The use of the product shall lead to a reduction in the quantity of hazardous waste material (kg), when compared to "Benchmark Construction".

Compliance
Compliance may be demonstrated by the following process set out in D1.10 "Waste to recycling/reuse or energy recovery", modified to account for hazardous waste.

D1.13 Energy content of the product

Criterion
The use of the product shall lead to a reduction in the embodied energy content of the product (kg), when compared to “Benchmark Construction”.

Compliance
For external walls, the Benchmark Construction is as follows:
Clay masonry veneer walls, consisting of 230 x 76 x 110 mm extruded clay bricks, set in 1:1:6 mortar, supported by 70 mm MGP10 timber stud wall, with 10 mm plasterboard lining and incorporating bulk insulation nominated in BCA Volume 2 Part 3.12.

Climate Zone	Embodied Energy MJ/m^2 wall
	Clay Masonry Veneer
1 Hot humid warm winter	590
2 Warm humid summer, mild winter	590
3 Hot dry summer, warm winter	590
4 Hot dry, cool winter	590
5 Warm temperate	590
6 Mild temperate	590
7 Cool temperate	590
8 Alpine area	610

Compliance with this criterion shall be substantiated by evidence that the product has Embodied Energy less than the relevant benchmark clay masonry veneer walls.

D1.14 Water use

Criterion
The use of the product shall lead to a reduction in the use of water associated with the product (m^3), when compared to "Benchmark Construction".

Compliance
Compliance may be demonstrated by the following process:

Determine the Net Water Use, accounting for water from both renewable and non-renewable sources as follows.

1. Calculate the water used to produce the Product, W_{peN}

2. Calculate the water used during the operation of the building, incorporating the Product, throughout its life-cycle, W_{poN}.

3. Calculate the water used to produce the Benchmark Construction, W_{beN}

4. Calculate the water used during the operation of the building, incorporating the Benchmark Construction, throughout its life-cycle, W_{boN}.

5. Determine the net increase or decrease in total water use if the Product is used in lieu of Benchmark Construction, accounting for renewable sources, from the following.

   Net Water Use = Total water for Product – Total water for Benchmark Construction
   $= (W_{peN} + W_{poN}) – (W_{beN} + W_{boN})$

6. Report the Net Water Use accounting for renewable energy sources (increase or decrease), together with full calculations.

   Note
   The reuse of rainwater, either with or without treatment, generally leads to a reduction in energy used to pump treated water from the storage dams.

   In low rainfall areas, rainwater may be considered to be a non-renewable resource. The reuse of rainwater generally leads to a reduction in the land devoted to storage dams, and the associated loss of tree cover. Tree cover generally takes carbon dioxide out of the atmosphere and regenerates oxygen.

Compliance - Particular Applications - Water Saving Devices
Compliance shall be substantiated by evidence that the product more effectively save or recycle water, to some quantifiable extent, more than Benchmark Construction. The Benchmark Construction referred to in this statement is the common absence of any water saving or recycling devices.

D1.15 VOC emissions to indoor air

Criterion
The use of the product shall lead to a reduction in the emission of VOC to indoor air ($mg/m^2.h$), when compared to "Benchmark Construction".

Compliance
Compliance with t he following specifications is deemed to meet this criterion.
The following are deemed satisfactory:

- APAS Certification
- Evidence of test and certification.

Requirements Regarding the Volatile Organic Compounds (VOCs) in Paints
Paints shall be less toxic and have lower concentrations of volatile organic compounds than commonly used alternatives. This criterion is deemed to be achieved, if the particular paint complies with the Australian Paint Approval Scheme (APAS) specifications and has less than 80% of the VOCs permissible under the APAS requirements listed below.

APAS Spec	**Paint Type**	VOC content of wet paint (grams per litre)	
High Volume Architectural Products		**Average**	**Maximum**
0134	Latex primer for galvanised iron & Zincalume	45	50
0163/1	Exterior latex undercoat	55	65
0163/2	Interior latex undercoat	60	65
0172	Interior sealer	50	60
0183	Exterior timber primer	50	60
0260/1	Interior gloss	75	90
0260/2	Interior semi gloss	60	80
0260/3	Interior low sheen	50	75
0260/4	Interior flat – washable	60	70
0260/5	Interior flat – ceilings	50	60
0280/1	Exterior gloss	60	85
0280/2	Exterior semi gloss	60	80
0280/3	Exterior flat & low sheen	45	70
0280/4	Exterior gloss	65	80
0280/5	Exterior low sheen	50	80
Other Architectural Products		**Maximum**	
0011	Solvent borne roof paint for galvanised steel	450	
0012	Latex roof paint	100	
0015	Exterior/interior alkyd, gloss & semi gloss	450	
0016	Interior & exterior undercoat	450	
0024	Exterior oil & petrol resistant enamel	450	
0029	Undercoat (oil & petrol resistant)	450	
0032	Metal primer Buildings – excluding lead & chromates)	550	
0055	One pack exterior varnish (general purpose)	550	
0070/1	Chalkboard paint – solvent based	450	
0070/3	Chalkboard paint – water based	100	
0114	One pack interior varnish (general purpose)	500	
0115	Lightly pigmented ranch finish – exterior timber	450	
0162	Zinc phosphate metal primer	550	
0171	Interior solvent-based sealer	450	
0181	Primer	450	
0200	One pack pigmented solvent borne paving paint	550	
0202	One pack pigmented latex paving paint	80	
0215	Low odour/low environmental impact	5	
Industrial & Protective Coatings Products		**Maximum**	

0006	Army Olive Drab enamel	550
0009	Undercoat for Army Olive Drab enamel	550
0041/2	Roadmaking paint – solvent borne	450
0041/5	Roadmaking paint – white water borne	60
2901	Protective coatings for steel – latex	100
2920	Polysiloxane coating	400
2921	Protective coatings for steel – primers	450
2922	Protective coatings for steel – modified alkyd finish	450
2930	Single pack moisture cure urethane for steel	400
2940	MIO or aluminium subject to continuous condensation	350
2971	Epoxy primers, 2 pack	400
2972	Low build epoxy GP enamel, 2 pack	350
2973	Solvent borne epoxy to 400 µm, 2 pack	350
2974	Solventless epoxy to 400 µm, 2 pack	120
2975	Ultra high build epoxy, immersion, 2 pack	350
2976	Solvent borne epoxy mastic	180
2977	Solvent borne epoxy mastic, slow drying, high volume solids > 400 µm	180
Paints shall not have more than 25% by weight of total formulation of hydrocarbon solvents.		
Paints shall not include aromatic hydrocarbon solvents.		
Paints shall not include formaldehyde or release formaldehyde during use.		
Paints shall not include halogenated solvents.		
Paints shall not include mercury, arsenic or selenium or their compounds, pigments of lead, cadmium, chromium VI or antimony, except that impurities of the elements listed above which are contained in the raw materials and components and which do not exceed a combined total of 0.1% by weight of non-volatile content and which have individual element contents that do not exceed the limits specified.		
Paints shall not include more than the limits specified for any of the substances listed in the Toxic Substances Regulations, and with a cumulative total of not more than 0.5% by weight of these substances, based on the total formulations.		
Paints shall not include ethylene glycol as an integral part of the paint formulation.		
Notes 3. VOC specifications are summaries of APAS (Australian Paint Approval Scheme) Document D181, Tables 1, 2 and 3, applying in the period 1st January 2007 to 31st December 2001. 4. Other requirements are based on Environmental Choice New Zealand – Paints - Specification EC-07-O1		

D1.16 HCOH emissions to indoor air

Criterion
The use of the product shall lead to a reduction in the emission of HCOOH to indoor air ($mg/m^2.h$), when compared to “Benchmark Construction”.

Compliance
Compliance may be demonstrated by the evidence comparing the release of HCOOH to indoor air for both the Product and the Benchmark Construction. See also the procedure D1.18 “Carcinogenic compounds to indoor air”**.**

D1.17Ammonia emissions to indoor air

Criterion
The use of the product shall lead to a reduction in the emission of ammonia to indoor air ($mg/m^2.h$), when compared to “Benchmark Construction”.

Compliance
Compliance may be demonstrated by the evidence comparing the release of ammonia to indoor air for both the Product and the Benchmark Construction. See also the procedure D1.18 “Carcinogenic compounds to indoor air”**.**

D1.18 Carcinogenic compounds to indoor air

Criterion
The use of the product shall lead to a reduction in the emission of carcinogenic compounds to indoor air ($mg/m^2.h$), when compared to "Benchmark Construction".

Compliance
Compliance with t he following specifications is deemed to meet this criterion:

Acceptable Indoor Air Quality in Residential and Commercial Buildings		
Pollutant	**Averaging Time**	**Air Quality Guideline value**
Carbon Dioxide	8 hours	3,500 ppm (1,000 ppm as body odour metric)
Carbon Monoxide	15 minutes 30 minutes 1 hour 8 hours	90 ppm 50 ppm 25 ppm 10 ppm
Formaldehyde	30 minutes	0.1 mg/m^3
Lead	1 year	0.5 $\mu g/m^3$
Nitrogen dioxide, NO_2	1 year 1 hour	40 $\mu g/m^3$ 200 $\mu g/m^3$
Ozone, O_3	8 hour, daily maximum	100 $\mu g/m^3$
Particulate matter, $PM_{2.5}$ Particulate matter, PM_{10}	1 year 24 hour (99^{th} percentile) 1 year 24 hour (99^{th} percentile)	10 $\mu g/m^3$ 25 $\mu g/m^3$ 20 $\mu g/m^3$ 50 $\mu g/m^3$
Sulphur dioxide, SO_2	24 hour 10 minute	20 $\mu g/m^3$ 500 $\mu g/m^3$
Total Volatile Organic Compounds	1 hour	500 $\mu g/m^3$
Notes: 1. This table is based on WHO/Europe Guidelines modified by CASANZ, and addition of CO_2 and Total VOCs. 2. Environmental tobacco smoke is excluded, assuming that indoor smoking is not permitted. 3. Acknowledgement ABCB		

Compliance - Particular Applications - Timber Preservatives
Compliance shall be substantiated by evidence that the product meets these criteria.

- Copper chrome arsenate (CCA) shall not be used.
- Pentachlorophenol (PCP) shall not be used.
- The use of Creosote and Pigment Emulsified Creosote (PEC) shall be minimised where practical.
- The use of Light Organic Solvent Preservative (LOSP*)* shall be minimised where practical.

Notes
- The use of Copper Chrome Arsenate (CCA) is being phased out, although not yet universally banned.
- The use of Pentachlorophenol (PCP) is banned.
- Other timber preservatives are permitted, including Creosote, Pigment Emulsified Creosote (PEC) and Light Organic Solvent Preservative (LOSP*)*.