

## **Specifying ESD**

This TECHreport outlines the principles of Ecologically Sustainable Development (ESD) and their application to building specifications. It includes guidance for incorporating ESD provisions into each NATSPEC worksection.

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**Updating this TECHreport**

This TECHreport reflects the status of ESD issues in NATSPEC at the time of its issue. NATSPEC updates this TECHreport periodically to reflect changes in NATSPEC worksections, regulations, standards, rating schemes and related developments.

If you have any comments or suggestions, please email to [mail@NATSPEC.com.au](mailto:mail@NATSPEC.com.au)

SPECIFYING ESD WITH NATSPEC

1 INTRODUCTION

1.1 ESD: An Australian definition

In 1992 the Council of Australian Governments<sup>1</sup> endorsed the following definition of Ecologically Sustainable Development (ESD):

.....using, conserving and enhancing the community's resources so that ecological processes, on which life depends, are maintained, and the total quality of life, now and in the future can be increased<sup>1</sup>.

This broad definition of ESD is applied equally to painting walls and catching tuna. It has two goals:

- Improving environmental quality today.
- Acting, so that future generations enjoy an improved environmental quality.

In the building industry, ESD is also used as an abbreviation for Environmentally Sustainable Design. NATSPEC adopts the broader meaning of ESD, using the term 'development', to cover issues beyond design, such as construction, demolition and maintenance.

This TECHreport outlines how a NATSPEC-based specification can be used to give effect to ESD principles and opportunities in the building context.

1.2 ESD principles

The Australian Government *ESD Design Guide* identified the following principles of sustainable building design:<sup>2</sup>

- Client commitment.
 

'The single most important principle for achieving ecologically sustainable building design is client commitment.'<sup>3</sup>
- Whole of life thinking.
 

'[thinking] about the life cycle of the building; that is, its design, construction, use, refurbishment and demolition.'<sup>4</sup>
- Design influence.
 

'... it is at the design stage that many of the impacts of a building are locked in.'<sup>5</sup>
- Life Cycle Assessment (LCA):
 

'... the whole of life impact of various initiatives on the environment.'<sup>6</sup>

From these, it identifies a number of opportunities for ESD in building design:

  - Integrated design and process management.
  - Social sustainability and occupant satisfaction.
  - Indoor environment quality.
  - Energy management.
  - Commissioning and operations.
  - Transport.
  - Ozone layer depletion.
  - Choice of materials.
  - Waste minimisation.
  - Water use reduction.

These principles include not only the more familiar environmental factors such as energy and waste reduction, but also broader social factors such as accessibility by the whole community and provision of public space.

A brief recent history of ESD

1992	UN Framework Convention on Climate Change (The Earth Summit) produces the <i>International Environment Treaty</i> , Rio de Janeiro, Brazil.
	Australian Government produces a <i>National strategy for ecologically sustainable development</i> .
1995	(Australian) Building Design Professionals publishes <i>Environmental Design Guides</i> .
1997	United Nations - Kyoto Protocol – agreed an amendment to the Framework Convention on Climate Change Treaty – Kyoto, Japan.
1999	NATSPEC publishes <i>Sustainable Specifying – a plan for the greening of the national building specification</i> .
2000	Australian Building Greenhouse Rating (ABGR) Scheme goes national.
2003	Green Building Council of Australia (GBCA) launches the <i>Green Star</i> scheme.
	Australian Building Codes Board (ABCB) introduces energy efficiency measures in NCC - BCA Volume Two.
2004	ABCB introduces energy efficiency measures in NCC - BCA Volume One.
2005	Department of Environment and Heritage, (DEH), through RMIT, produces <i>ESD Design Guide for Australian Government Buildings</i> .
	NSW Department of Energy, Utilities and Sustainability (DEUS) are selected by DEH to roll out NABERS.
2006	DEH, through RMIT, produces a <i>Scoping study into improving the environmental sustainability of building materials</i> .
2007	Australian Government ratifies Kyoto Protocol.
2010	Building Energy Efficiency Disclosure Act passed.
2014	Building Energy Efficiency Amendment Bill introduced aimed at improving the program.
2015	United Nations – Paris Agreement signed by 195 UNFCCC members, ratified by 160.

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**1.3 The role of ESD in specifications**

A basic principle of building contract documentation is that the specification puts into effect design decisions. In order to produce an ESD specification, appropriate design decisions must first be made. A non-sustainable design cannot be transformed into a sustainable one just by specifying. For example, it is not possible to achieve thermal efficiency through the specification alone, it must be designed in. The role of the specification, in this instance, is to enable the full ESD potential of the design to be achieved.

It is, however, possible to improve on the environmental impact of any design through the specification by mandating low toxicity materials, energy and water efficient appliances, and so on.

In summary, an ESD specification focuses on:

- Giving effect to ESD design decisions not shown on the drawings.
- Specifying ESD appropriate materials and methods of construction.
- Specifying components and products that permit the implementation of ESD.

Addressing barriers to effective action to reduce environmental impacts, the Department of the Environment and Energy notes that the problem is 'exacerbated by the lack of any standardised or independently developed "green" specification'.<sup>7</sup> NATSPEC, as a national master specification system, is not written as an exclusively green specification. It is a specification system that can be customised to give effect to a green design for specific projects.

**1.4 NATSPEC's approach to ESD**

The NATSPEC national specification system:

- Provides the design, build, construct and property industry with a comprehensive specification system that can be used in a variety of ways to cater for varying means of sustainable building procurement. Reference should be made to AS ISO 20400:2018 *Sustainable procurement – Guidance*.
- Recognises that most aspects of ESD relating to buildings are design issues and that a primary function of the specification is to give effect to design decisions.
- Does not mandate ESD but provides options for specifiers to choose and adopt ESD principles. Most worksections incorporate ESD provisions or the opportunity to specify ESD provisions through choices of materials, energy and water conservation measures and so on. The ESD relevance of a NATSPEC based specification will depend on options and values chosen by the designer.
- Does not attempt to arbitrate on competing claims made for the sustainability or otherwise of materials or methods. Instead NATSPEC aims to present specifiers with impartial information that they can use to make informed decisions.
- Provides material that can be used to specify ecologically sustainable, non-traditional construction materials and methods.
- Provides a means for meeting mandatory ESD requirements to the extent that these can be handled through the specification process.

**1.5 ESD and the NCC**

The NCC incorporates a number of mandatory environmental provisions. These primarily relate to energy conservation, reduction of greenhouse gases and water efficiency but also include improvement of comfort and amenity for building occupants.

This TECHreport indicates worksections that can be used to document provisions necessary to conform to the NCC and related ESD commitments made by designers to meet the NCC objectives. This is particularly relevant when the design is for a verification-based alternative solution, rather than the deemed-to-satisfy provisions of the NCC.

**National Construction Code (NCC) - Building Code of Australia (BCA) Volumes 1-3**

NATSPEC references ESD provisions in NCC Volumes 1, 2 and 3 where appropriate.

ESD references in NCC Volume 1 include:

**Section F - Health and amenity**

Part F1 – Damp and weatherproofing.

Part F4 – Light and ventilation.

Part F5 – Sound transmission and insulation.

**Section J – Energy efficiency**

Part J1 – Building fabric:

J1.2 Thermal construction - general.

J1.4 Roof lights.

J1.5 Walls and glazing.

Part J3 – Building sealing.

J3.3 Roof lights.

J3.4 Windows and doors.

J3.5 Exhaust fans.

J3.7 Evaporative coolers.

Part J5 – Air-conditioning and ventilation systems.

J5.4 Fan systems

J5.5 – Ductwork insulation

J5.12 Heat rejection equipment

Part J6 – Artificial lighting and power.

Part J8 – Facilities for energy monitoring.

Specification J6 – Lighting and power control devices.

The NCC is produced by the Australian Building Codes Board (ABCB). The ABCB is established by agreement between the Australian Government and each state and territory government. It is a cooperative arrangement between the signatories, local government and the building industry.

[www.abcb.gov.au](http://www.abcb.gov.au)

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1.6 ESD and environmental rating schemes

Incorporating ESD into a project starts with the client’s commitment, either initiated by the client or suggested by the designers.

Although ESD can be on an ad hoc basis, a more structured approach, such as the adoption of an established voluntary environmental rating schemes, is more likely to result in the desired outcome. With the latter approach, designers make appropriate ESD design decisions to conform to the chosen scheme (and consequently the NCC ESD provisions).

NATSPEC TECHnote DES 014 outlines some voluntary environmental rating schemes. The schemes include:

• **The National Australian Built Environment Rating Scheme (NABERS)**

The Australian Building Greenhouse Rating scheme (ABGR) was renamed NABERS Energy in May 2008.

NABERS is a performance-based rating system for existing buildings. NABERS rates a building on the basis of its measured operational impacts on the environment, and provides a simple indication of how well these environmental impacts are being managed compared with equivalent buildings.

The NABERS Energy Commitment Agreement allows developers and building owners to promote and market greenhouse performance of new and refurbished buildings. The Commitment Agreement states the commitment to design, build and commission a building to 4, 4.5, 5, 5.5 or 6 star rating.

NCC - BCA Volume 1 Section J accepts obtainment of a minimum 5.5 stars NABERS Energy for offices base building Commitment Agreement as a verification method for Class 5 buildings.

• **Green Star**

Green Star is a voluntary rating system administered by the Green Building Council of Australia (GBCA) for evaluating the environmental design and performance of buildings based on a number of criteria including management, indoor environmental quality, energy, transport, water, materials, land use and ecology, and emissions.

NCC - BCA Volume 1 Section J allows the use of the Green Star Design & As-Built rating tool for Classes 2 (common areas) 3, 5, 6, 7, 8 or 9 as a verification method.

A 2010 memorandum of understanding between GBCA, Department of the Environment and Energy (formerly the Commonwealth Department of the Environment, Water, Heritage and the Arts (DEWHA)) and the NSW Government Office of Environment and Heritage (formerly NSW Department of Environment, Climate Change and Water (DECCW)), which administers NABERS, outlines a commitment to share information on rating tool development, calculators, benchmarks and methodologies to strengthen both rating systems.

This TECHreport indicates worksections that can be used to document design decisions and contractor submissions aimed at achieving rating scheme targets.

1.7 Commercial Building Disclosure (CBD)

The CBD Program requires energy efficiency information be provided in most cases when commercial office space of 1000 m<sup>2</sup> or more is offered for sale or lease. It was established by the *Building Energy Efficiency Disclosure Act 2010* and managed by the Department of the Environment and Energy. The CBD Program requires most sellers and lessors of office space to obtain a Building Energy Efficiency Certificate (BEEC) before the building goes on the market for sale, lease or sublease. BEECs include:

- The building’s National Australian Built Environment Rating System (NABERS) Energy for offices star rating.
- A tenancy lighting assessment of the relevant area of the building.

Not all buildings are required to have a BEEC when they are sold or leased. For example, new buildings with a certificate of occupancy less than two years old, strata-titled buildings, leases and subleases of 12 months or less or buildings where ownership is transferred through the sale of shares do not require a BEEC.



The **National Australian Built Environment Rating System (NABERS)** measures an existing building’s overall environmental performance during operation.

It provides separate ratings for commercial office buildings (including commercial office tenancies), hotels, shopping centres, data centres, hospitals (public) and apartments (including multi-unit residential common property).

NABERS rates performance on a 6 star scale. NABERS rating for office buildings covers the environmental impacts of the activities and services traditionally supplied by, or within, the control of building owners, facility managers, or tenants.

NABERS covers:

- Energy use and greenhouse gas emissions.
- Water use.
- Waste and toxic materials.
- Indoor environmental quality.

It is expected that NABERS will be extended to cover the following:

- Refrigerant use.
- Stormwater runoff and pollution.
- Sewage.
- Landscape diversity.
- Transport.

NABERS is managed nationally by the NSW Department of Planning, Industry and Environment

[www.nabers.gov.au](http://www.nabers.gov.au)

**Commercial Building Disclosure (CBD)**

CBD is a national program designed to improve the energy efficiency of Australia’s large office buildings that is being managed by the Australian Government Department of Industry, Science, Energy and Resources.

[www.cbd.gov.au](http://www.cbd.gov.au)

**NABERS Energy rated project**



St Georges Terrace, Perth – 4 star energy rated (ABGR)

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2 INCLUDING ESD CONCEPTS IN SPECIFICATIONS

2.1 Overview

The ways in which the specification can be used to implement specific ESD principles can be divided into a number of broad categories:

- Energy conservation and greenhouse gas reduction.
- Conservation of other consumables (like water).
- ESD appropriate materials e.g. materials with low volatile organic compounds (VOC) emissions, materials with recycled content materials or which can be recycled.
- Quality environment, both inside and outside the building, using ESD principles.
- Sustainable procurement by integrating sustainability requirements into the specification that address the following: mining of raw materials; material production; manufacturing; packaging; transportation and storage; emissions; waste; energy usage; and recycling. See AS ISO 20400:2018 *Sustainable procurement – Guidance*.

2.2 Energy conservation and greenhouse gas reduction

Reducing building energy consumption reduces operating costs and the greenhouse gas emissions from the energy use. Initially this involves appropriate design to reduce energy dependence through thermally efficient, passive design. The most direct way in which a specification can enhance this is by including energy efficient equipment such as for lighting, water heating and mechanical plant. The specification can also be used to document design decisions for reducing energy consumption, such as glazing and insulation performance, and air leakage.

As the application is broad and because not all clients require ESD provisions, NATSPEC does not impose ESD. Instead, it provides clients and designers a framework for incorporating ESD principles including life cycle costing but also allowing for provisions based on lowest initial cost. For example:

- *0461 Glazing* can be used to document minimum performance required by the BCA, performance to meet verification-based alternative solutions under the BCA, or ESD performance that exceeds BCA minimum requirements.
- *0731 Fans* can be used to specify a quieter fan with higher efficiency or a cheaper fan with lower efficiency and higher noise level. What is achieved will depend on the performance criteria documented in the fan schedule by the designer/specifier.

2.3 Water conservation

There is considerable potential for conserving water by specifying water efficient fixtures and equipment. *0811 Sanitary fixtures* and *0812 Tapware* contain provisions for specifying fixtures based on water efficiency ratings to AS/NZS 6400. Provisions for low water use cooling towers, reducing water use by increasing cycles of concentration and non-water consuming alternatives to cooling towers, are also included in *0713 Cooling towers*. Like most other ESD provisions, appropriate design is the first step in water conservation.

Where authorities permit the use of recycled water and rainwater, NATSPEC includes *0826 Greywater systems* and *0825 Rainwater storage systems* for specifying these systems.

2.4 Materials

The most frequent use of a specification is to prescribe specific materials to meet design objectives, including ESD objectives. The Department of Agriculture, Water and the Environment notes that:

*The extent of knowledge gaps [about environmental impact] means that it is currently not possible to say that a given material is 'sustainable'.<sup>8</sup>*

It consequently recommends use of the term 'environmentally preferable'. The specifier needs to select the materials to suit their particular design objectives. ESD issues to consider are:

- Toxic and hazardous materials: If used, their use must conform to the

Current NABERS rating types

NABERS for Offices incorporates NABERS Energy for Offices (formerly the ABGR system) for greenhouse gas emission and energy rating, NABERS Water for Offices for rating water consumption, and NABERS Waste for Offices and NABERS Indoor Environment for Offices, reflecting the performance of the building relative to the market.

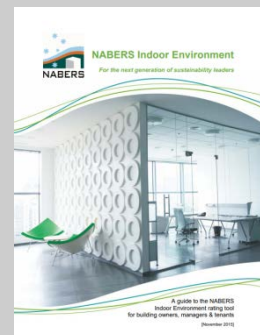
NABERS for Hotels is for rating all types of hotels and incorporates NABERS Energy for Hotels and NABERS Water for Hotels.

NABERS for Shopping centres is for rating shopping centres of more than 15,000 m<sup>2</sup> of Gross Lettable Area (Retail) and incorporates NABERS Energy for Shopping Centres and NABERS Water for Shopping Centres. It is for rating common areas, not individual retail tenancies.

NABERS for Data centres includes NABERS Energy for data centres to measure and benchmark the IT equipment, infrastructure services and the whole data centre.

NABERS for Apartments is for rating common areas including lifts, lobbies, carparks, gyms, pools and water features.

NABERS for Indoor environments is for measuring and benchmarking the indoor office environment of the base building, tenancies and the whole building.



WELS

AS/NZS 6400 forms a basis for the rating and labelling of a range of products under the mandatory Water Efficiency Labelling and Standards (WELS) scheme, as required by the Australian Water Efficiency Labelling and Standards Act 2005 (the WELS Act)

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manufacturer's recommendations, usually shown in the manufacturer's Safety Data Sheets (SDS).

- Regional/local materials: Select renewable materials sources close to site.
- Alternatives: It should not be assumed that alternative materials are safer or more environmentally preferable, consider all environmental impacts, e.g. materials with recycled content may not be recyclable.
- Durability of materials: Premature failure of materials can be a significant determinant of the useful life of a building. NATSPEC provides many options for specifying materials for greater durability, e.g. corrosion resistance.
- Ongoing maintenance.

## 2.5 Alternative construction methods

In addition to alternatives for materials and methods for conventional construction, NATSPEC includes worksections for a number of alternative construction methods:

- 0361 Monolithic stabilised earth walls.
- 0362 Mud brick walls.
- 0363 Straw bale walls.

## 2.6 Recycled materials, materials with recycled content and recyclability of materials

A key issue in building sustainably is the extent of recycled materials used, use of materials with recycled content, and the selection of materials that can be effectively recycled at the end of their functional life. Arguably there is considerably less ESD merit in using recycled materials initially if they cannot be later recycled or re-used. A new, non-recycled, material that can be recycled at the end of the building's life may be a better ESD choice.

As part of the life cycle assessment, consider what percentage of material can be recycled, whether recycling facilities exist at a reasonable distance from the site, and whether the proposed construction method enhances or hinders recyclability. Nail fixing, for example, may make otherwise recyclable timber unsuitable for recycling.

Specifiers also have the option of specifying the reuse of materials and equipment reclaimed/salvaged on site (in 0201 Demolition).

## 2.7 Ozone depleting substances

The most common ozone depleting substances are chlorofluorocarbon (CFC) refrigerants, which are now prohibited and hydrochlorofluorocarbon (HCFC), which is in the process of being phased out. There are, however, other substances of lower (but not zero) ozone depletion potential that remain in use. NATSPEC generally prohibits their use in the manufacture of insulation materials. NATSPEC TECHnote PRO 007 Refrigerants provides advice on choosing ESD refrigerants.

NATSPEC also includes provisions for responsible management and recovery of ozone depleting substances during demolition of existing plant and appliances.

## 2.8 Indoor air quality

Indoor air quality can be affected by the following:

- Contaminants originating within the building such as:
  - Off-gassing from building materials and furnishings.
  - Carbon dioxide generated by the occupants.
  - Microbial contaminants including bacteria and moulds.
- Contaminants originating outside the building such as carbon/pollen particulates.
- Temperature and humidity.

These can be addressed by the following:

- Contaminants caused by building materials and furnishings can be reduced by

### GBCA Green Star

Green Star is a national, voluntary rating system for evaluating the environmental design and/or as built performance of buildings based on a number of criteria, including energy and water efficiency, indoor environmental quality and resource conservation.

#### Green Star rating tools

Green Star - Design & As Built  
Green Star - Interiors  
Green Star - Communities  
Green Star - Performance

Green Star was developed by the Green Building Council of Australia (GBCA) in conjunction with the Property Council of Australia.

[www.gbca.org.au](http://www.gbca.org.au)

### Green Star rated projects



The Gauge, Melbourne – achieved 6 Star Green Star – Office As Built v2 in 2008.



Global Change Institute (GCI), St Lucia, Queensland – achieved 6 Star Green Star – Education Design V1 in 2014



Nishi Commercial, Canberra – achieved 6 Star Green Star – Office As Built v3 in 2014.

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- specifying materials with low/zero volatile organic compound (VOC), e.g. paints and adhesives.
- Contaminants originating from other sources can be reduced by a combination of appropriate design and specification. For example, carbon dioxide levels due to occupants can be reduced by appropriate fresh air ventilation levels (design) while particulate levels can be reduced by efficient filtration (a combination of design and specification).
- Microbial contaminants (including Legionella) inside the building can be reduced by designing and specifying systems to reduce or eliminate potential microbial breeding conditions.
- Mould can be reduced by designing and specifying to prevent moisture accumulation, rain infiltration and condensation.

Measures to improve indoor air quality are primarily dealt with in the 05 INTERIOR, 06 FINISHES and 07 MECHANICAL SERVICES workgroups.

**2.9 Outdoor air quality**

NATSPEC contains many provisions for improving outdoor air quality in the immediate vicinity of the building and in the wider environment:

- Reducing the risk of microbial contamination, particularly Legionella (a combination of design and specification).
- Reducing emissions from plant (e.g. boilers).
- Reducing dust and other emissions during demolition and construction.

**2.10 Lighting**

*Artificial*

Artificial lighting represents a major energy load in buildings and designers can minimise its impact by:

- Designing illuminance and luminance levels to suit the application.
- Selecting lamps and ballasts to minimise energy consumption.
- Designing lighting control systems to minimise energy use, particularly in unoccupied spaces.
- Providing lighting controls to reduce lighting levels in day-lit spaces.

The NATSPEC *Electrical services* worksections include clauses for specifying energy efficient lighting products and control systems to reduce lighting energy use.

*Natural*

Commensurate with daylight and sun glare constraints, the building fenestration design should optimise both the level and penetration of natural lighting within the building.

*Daylight controls*

NATSPEC worksections cover controls to reduce artificial lighting and make use of available daylight. Include internal and external sun control devices for natural lighting and thermal control.

**2.11 Noise and vibration**

NATSPEC includes provisions for specifying building elements that reduce the transmission of impact and airborne noise. For noise-generating equipment, it includes provisions for specifying limits on noise generated and, if appropriate, noise reducing equipment such as acoustic louvres.

In general, if a building is designed and documented by others, the contractor's liability for meeting specific noise targets is limited to complying with the documents. Specifying both the detailed performance of components and acoustic performance to be achieved is likely to be fruitless contractually. The building and its systems must have either the required acoustic performance designed in, or if performance is specified, the contractor must be allowed to make changes to meet it.

In addition to covering noise generated after the building is completed, NATSPEC also provides a framework for specifying limits on construction noise.

**Green Star rated projects**

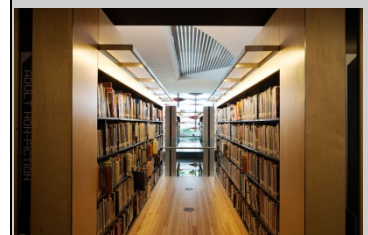
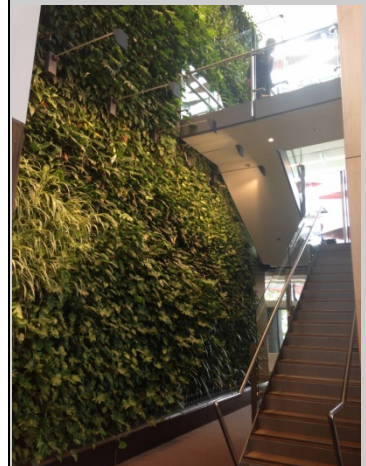


Dandiiri Contact Centre, Zillmere, Brisbane – achieved 6 Star Green Star – Office Design V2 in 2010.



8 Chifley Square, Sydney – achieved 6 Star Green Star - Office As Built v2 in 2015.

**Other projects with ESD provisions**



Bankstown Library, Sydney.

Includes Living wall and a combination of adaptive re-use with use of salvaged materials. 95% of the building's new timber floor is from salvaged materials.



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2.12 Living roofs and walls

Living roofs and walls can be included in projects to provide the following benefits for building owners and occupants:

- Reduced energy consumption and greater temperature control.
- Noise reduction when combined with insulation.
- Indoor walls can improve indoor air quality.
- Increased usable open space and comfort.
- Increase biodiversity.
- Reduce heat island effect.

See TECHnote DES 026 for other benefits and guidance on using NATSPEC to specify living walls and roofs.

2.13 Other environmental concerns

As part of NATSPEC's broad scope, it specifies a number of other environmentally enhancing measures including:

- Termite management.
- Control of electromagnetic radiation.
- Remediation of soils.
- Corrosion resistance and durability.
- Vapour transmission.
- Weed management.
- Services commissioning.
- Maintenance. See *NATSPEC Maintenance reference*.

NATSPEC 0172 *Environmental management* calls for the preparation of plans for waste and weed management, soil erosion and sediment control, and the incorporation of actions and follow-up monitoring of environmental issues.

3 ESD INFORMATION IN NATSPEC

3.1 Worksections

This TECHreport includes several appendices identifying ESD provisions in NATSPEC worksections.

- Appendix A is a guide for incorporating ESD provisions into NATSPEC worksections.
- Appendix B lists the ESD related provisions in NATSPEC worksections.
- Appendix C lists BCA ESD provisions covered in NATSPEC arranged by BCA clause number. It can be used as a specification check list for BCA ESD compliance within NATSPEC.
- Appendix D lists standards related to ESD.

3.2 Guidance notes

All NATSPEC worksections include *Guidance* text which provide suggestions on available ESD options and explain implications of requirements in NATSPEC worksections.

3.3 TECHnotes

NATSPEC provides a number of brief TECHnotes covering ESD related matters. See the following TECHnotes:

- DES 011 for rainwater harvesting.
- DES 013 for NCC energy efficiency protocol and software for housing.
- DES 014 for environmental rating schemes for buildings.

Life Cycle Assessment (LCA)

Included among the many transactions that buildings relate to are:

Resource use

- Concrete
- Steel
- Timber
- Renewable energy
- Non-renewable energy

Air pollution

- VOCs – volatile organics
- NOx – nitrogen oxides
- SOx – sulfur oxides

Water pollution

- Manufacturing process
- Heavy metals
- Faecal matter

Solid waste

- Construction
- Demolition

Economics

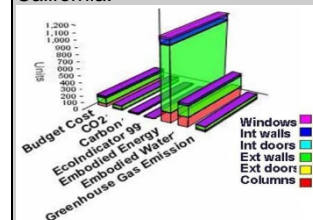
- Transport
- Material – salvage value
- Durability
- Maintenance
- Operation – energy consumption level

Human impact

- Carcinogens
- Greenhouse gas
- Climate change

LCADesign software

Developed by the Sustainable Built Environment National Research Centre (SBE nrc), formerly the Australian Cooperative Research Centre for Construction Innovation (CRCCI), LCADesign assists designers to make quantitatively informed decisions on the full spectrum of operational and embodied environmental impacts of commercial buildings. LCADesign allows environmental assessments to be made in real time, directly and automatically from 3D CAD Building Information models. Building product life cycle inventory (LCI) databases are available for the supply chains of Australia, Netherlands, Belgium, Luxembourg, Germany and California.



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- DES 015 for NCC – BCA Volume One: Energy efficiency provisions.
- DES 016 for NCC – BCA Volume Two: Energy efficiency provisions.
- DES 024 for water sensitive urban design (WSUD).
- DES 026 for living walls and roofs.
- GEN 028 for specifying recycled materials for road works using AUS-SPEC.
- PRO 001 for CCA (copper chrome arsenate) treated timber.
- PRO 005 for formaldehyde - indoor air quality.
- PRO 007 for refrigerant options.

## REFERENCES

AIRAH Refrigerant Selection Guide (2003)

[www.airah.org.au/Content\\_Files/TechnicalPublications/AIRAH\\_RSG2003.pdf](http://www.airah.org.au/Content_Files/TechnicalPublications/AIRAH_RSG2003.pdf)

AS/NZS 6400 (2016) Water efficient products - Rating and labelling

Ecologically Sustainable Development Steering Committee, *National Strategy on Ecologically Sustainable Development* (1992) (Council of Australian Governments)

Green Star rating tools:

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<sup>1</sup> Ecologically Sustainable Development Steering Committee, *National Strategy on Ecologically Sustainable Development* (1992) (Council of Australian Governments) <<http://www.deh.gov.au/esd/national/nsesd/strategy/index.html>> [accessed 20 March 2009] (9)

<sup>2</sup> Sustainable Built Environments and Centre for Design at RMIT University, *ESD Design Guide for Australian Government Buildings* (2nd) (2006) (Commonwealth of Australia).

<sup>3</sup> Ibid. (09)

<sup>4</sup> Ibid.

<sup>5</sup> Ibid.

<sup>6</sup> Ibid. (10)

<sup>7</sup> The Centre for Design at RMIT University et al., 'Scoping Study into Improving the Environmental Sustainability of Building Materials,' (Canberra: Australian Greenhouse Office, 2006).

<sup>8</sup> Ibid.