Construction of Buildings in Flood Hazard Areas

2012

VERSION 2012.2

STANDARD

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Preface

The Australian Government and State and Territory Government Building Ministers responsible for building regulatory matters directed the ABCB to develop a standard for the design and construction of certain new buildings *in flood hazard areas* (the Standard). The Standard aims to reduce the risk of death or injury of building occupants as a result of buildings subjected to certain flood events.

The Standard is not a stand-alone solution to mitigating life safety risk due to flooding. Reducing life safety risk due to flooding requires a comprehensive set of measures that consider flood hazard and function and aim to reduce risk to a manageable level. This may be achieved by limiting development within both hazardous areas and areas (such as floodways) where it may impact on flood behaviour for other developments. Within areas allowable for development, development controls or protection works may be used to reduce risk. This requires a suite of measures which generally involve a combination of effective land use planning considering flood hazard, flood mitigation measures, flood warning and emergency response strategies for flooding, and building standards. The balance of these measures will vary from new development areas to infill or redevelopment areas. Sufficient awareness of the flood risk and the safety measures required by the occupants and those assisting them during a flood emergency are essential pre-requisites.

Therefore, with the application of this Standard within *flood hazard areas*, in the absence of supporting measures, it is not possible to guarantee that a building constructed in accordance with the Standard will eliminate the risk of serious injury or fatality even in the *defined flood event* (*DFE*).

In addition, larger floods than the *DFE* can occur and even floods of the scale of the *DFE* can vary in behaviour and could exceed the design parameters and limitations of this Standard. Availability of assistance from emergency services or other avenues are important considerations not dealt with in this Standard.

Note: terms in *italics* are defined in Clause 1.7 of this Standard.

Acknowledgements

The ABCB acknowledges the contribution of members of an expert Reference Group that assisted the development of the Standard.

The following organisations were represented on the Reference Group –

- Australian Government Attorney-General's Department
- Brisbane City Council
- Bureau of Meteorology
- Geoscience Australia
- Gold Coast City Council
- Hawkesbury City Council
- Housing Industry Association
- Insurance Australia Group
- Master Builders Australia
- NSW Department of Planning and Infrastructure
- NSW Office of Environment and Heritage
- Queensland Department of Local Government and Planning
- Risk Frontiers
- Tasmania Department of Justice

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1 Scope and General

1.1 General

The National Construction Code (NCC) Series is an initiative of the Council of Australian Governments (COAG) developed to incorporate all on-site construction requirements into a single code. The NCC comprises the Building Code of Australia (BCA), Volume One and Two; and the Plumbing Code of Australia (PCA), as Volume Three.

The BCA is produced and maintained by the ABCB on behalf of the Australian Government and each State and Territory Government.

The BCA is a uniform set of technical provisions for the design and construction of buildings and other structures throughout Australia whilst allowing for variations in climate and geological or geographic conditions.

The BCA contains requirements to ensure new buildings and structures and, subject to State and Territory legislation, alterations and additions to existing buildings located in *flood hazard areas* do not collapse during a flood when subjected to flood actions resulting from the *defined flood event*.

The Standard provides additional requirements for buildings *in flood hazard areas* consistent with the objectives of the BCA which primarily aim to protect the lives of occupants of those buildings in events up to and including the *defined flood event*. *Flood hazard areas* are identified by the relevant State/Territory or Local Government authority ie the *appropriate authority*.

Section 2 of the Standard contains basic design requirements for the construction of buildings *in flood hazard areas*.

Section 2 also contains provisions for the design of buildings *in flood hazard areas*. These provisions only apply if certain limits such as maximum flow velocity and depth of submersion, are not exceeded. This does not mean that buildings cannot be constructed if they fall outside these limits if it is permissible under a planning scheme or planning instrument to do so. It means that such a proposal would need to be considered as an Alternative Solution under the relevant Performance Requirements and must be assessed accordingly.

The Standard also does not contain provisions that specify particular materials or design solutions which comply with the relevant BCA Performance Requirement. Therefore, in all instances, designers are required to use professional judgment in order to develop designs intended to comply with the BCA Performance Requirement.

It must also be emphasised that the Standard is not a stand-alone solution to mitigating life safety risk due to flooding. Mitigating risk to life in flooding requires a comprehensive set of measures that consider flood hazard and aim to reduce residual flood risk to a manageable level. This set of measures generally involves a combination of effective land use planning considering flood hazard, flood mitigation measures, emergency response strategies for flooding, and building standards.

Therefore, with application of this Standard within *flood hazard areas*, in the absence of supporting measures, it is not possible to guarantee that a building constructed in accordance with the Standard will eliminate the risk of serious injury or fatality even in the *DFE.*

In addition, larger floods than the *DFE* can occur and even floods of the scale of the *DFE* can be unpredictable and could exceed the design parameters and limitations in this Standard. Also, assistance from emergency services or other avenues may not be available to individual properties.

It is important to understand that flood is a local hazard whose parameters, including depth and velocity, vary significantly within the flood hazard area. Modelling of flood hazard generally provides information on average velocities across an area for an event rather than velocities at all points across a location. It is possible to have strong local flow velocities not being shown by such modelling.

In addition, there are significant variations in the information available on flooding between areas within a local authority and between local authorities within Australia. This may result from the age of studies, the type of modelling undertaken, the information available to understand flood behaviour, or the reliance of historical flood information or estimates used to provide an understanding of flood risk. This will mean that the information available is not uniform.

Flood investigations may have also resulted in mitigation works which may alter flood behaviour. These are local by nature and their benefits would generally be considered in studies on flooding for the area and considered by the local authority in determining the *flood hazard area*.

Existing development in more active flow areas, including floodways, is more likely to be subjected to higher velocities of flow than provided for in the Standard and is also more likely to impact upon flood behaviour elsewhere. Any additional development or redevelopment in these areas is also likely to be exposed to more hazardous conditions and therefore would require careful consideration and assessment. Also note that the flow velocities could also be expected to exceed those specified in this Standard in many areas subject to local overland flooding.

The local authority may need to rely upon its own judgement upon where the Standard applies or request specific information from the proponent. This may limit the application of the

Standard by the local authority to *backwater and inactive flow areas* in the *DFE* where it is less likely the velocity nominated in the Standard would be exceeded.

In many cases detailed information on the depth of inundation at the development in question will rely upon the provision of survey advice from the proponent relative to flood level information determined in the *DFE*.

In some cases the local authority may require the proponent to engage a suitably qualified professional to determine the *DFE* and/or to gain a more detailed understanding of flood behaviour at the location. This may include ascertaining the specific design criteria necessary to enable consideration of the development in relation to the Standard and meeting other requirements established by the local authority.

1.2 Scope

The Standard specifies requirements for flood-resistant design and construction of buildings that are subject to the BCA requirements and that are located, in whole or in part, in *flood hazard areas*.

The ABCB has also prepared an Information Handbook which provides additional information relating to the construction of buildings in *flood hazard areas*. The Handbook is available on the ABCB website www.abcb.gov.au.

1.3 Application

1.3.1 Identification of applicable *flood hazard areas*

A *flood hazard area* is an area subject to flooding during the *DFE* as determined by the *appropriate authority*, or where this information is not available, by the proponent in accordance with standards set, or referred to, by the *appropriate authority*.

This Standard does not apply to parts of *flood hazard areas* with the following characteristics:

(a) The part of the *flood hazard areas* is subject to mudslide or landslide during periods of rainfall and runoff.

(b) The part of the *flood hazard areas* is subject to storm surge or coastal wave action.

1.3.2 Identification of applicable buildings

This Standard only applies to new Class 1, 2, 3, 9a health care and 9c buildings and Class 4 parts of buildings and, subject to State and Territory legislation, alterations and additions to existing buildings of these classifications.

1.4 Limitations

The Standard is not intended to –

(a) override or replace any legal rights, responsibilities or requirements; or

(b) override any land use planning controls imposed by the *appropriate authority*; or

(c) address administrative requirements for construction of buildings *in flood hazard areas*.

1.5 Normative References

The following documents are referred to in this Standard:

(a) AS/NZS 1170.0: General principles

(b) AS/NZS 1170.1: Permanent, imposed and other actions

(c) AS/NZS 1170.2: Wind actions

(d) AS 2870: Residential slabs and footings

1.6 Units

Except where specifically noted, this Standard uses the SI units of kilograms, metres, seconds, Pascals and Newtons (kg, m, s, Pa, N).

1.7 Definitions

Defined terms used within the text of the Standard are printed in italics. For the purposes of the Standard the following definitions apply:

Appropriate authority: the relevant authority with the statutory responsibility to determine the particular matter.
Note NSW BCA variation.

Defined flood level (DFL): the flood level associated with a *defined flood event (DFE)* relative to a specified datum. The *DFL* plus the *freeboard* determines the extent of the *flood hazard area*.

Defined flood event (DFE): the flood event selected for the management of flood hazard for the location of specific development as determined by the *appropriate authority*.

Finished floor level: the uppermost surface of the finished floor, not including any floor covering such as carpet, tiles and the like.

Flood hazard area: the area (whether or not mapped) encompassing land lower than the *flood hazard level* which has been determined by the *appropriate authority.* The area relates to that part of the allotment on which a building stands or is to be erected.

Flood hazard level (FHL)*:* the flood level used to determine the height of floors in a building and represents the *defined flood level* (*DFL)* plus the *freeboard*.

Freeboard: the height above the *defined flood level* (*DFL)* as determined by the *appropriate authority*, typically used to compensate for effects such as wave action and localised hydraulic behaviour.

Habitable room: a room used for normal domestic activities, and-

(a) includes a bedroom, living room, lounge room, music room, television room, kitchen, dining room, sewing room, study, playroom, family room, home theatre and sunroom; but

(b) excludes a bathroom, laundry, water closet, pantry, walk-in wardrobe, corridor, hallway, lobby, photographic darkroom, clothes-drying room, vehicle parking area, storage area and other spaces of a specialised nature occupied neither frequently nor for extended periods.

Hydrodynamic action: the action caused by a fluid in motion.

Hydrostatic action: the pressure exerted by a fluid at equilibrium due to the force of gravity.

Inactive flow or backwater area: the part of the *flood hazard area* where the maximum flow velocity is not greater than 1.5 m/s. The area does not include areas within or directly adjacent to a river, stream or floodway, where the maximum flow velocity is likely to exceed 1.5 m/s.

Wet flood proofing: includes permanent or contingent measures applied to a building that prevent or provide resistance to damage from flooding while allowing floodwaters to enter and leave the building.

1.8 Notation

The following letters and symbols have the following meanings:

G permanent action (dead load) (AS/NZS1170.1

Q imposed action (live load) (AS/NZS 1170.1)

F_I flood action, resulting from the *DFE*

W_u ultimate wind action (AS/NZS 1170.2)

Ψ_c combination factor for imposed action (AS/NZS 1170.0)

D_e equivalent surcharge depth in metres

C shape factor

V velocity of moving water in m/s

g gravitational acceleration in m/s^2

Pa Pascal

N Newton

m metre

s second

kg kilogram

1.9 Performance-Based Standards

The Standard is part of the NCC performance-based regime. Buildings to be constructed in *flood hazard areas* must be designed to comply with the NCC Performance Requirements in –

(a) BCA Volume One, BP1.4; or

(b) BCA Volume Two, P2.1.2.

The Performance Requirements lists various provisions that must be met during the design process.

The Performance Requirement enables the design of a building to be constructed in *flood hazard areas* to be developed from first principles to maximise its potential to meet specific occupant needs for a specific site.

1.10 Design Pathways

The Standard provides two pathways for compliance as follows:

(a) Compliance with Clauses 2.3 to 2.10 of this Standard.

(b) Formulating an Alternative Solution which complies with the NCC Performance Requirements. This involves the application of engineering practice from first principles in combination with appropriate design considerations as an alternative to the requirements of Clauses 2.3 to 2.10 of this Standard. An Alternative Solution requires designers to apply professional judgment on all design issues.

2 Basic Design Requirements

Limitations:

This standard only applies to Class 1, 2, 3, 9a health care and 9c buildings, and Class 4 parts of buildings.

2.1 Compliance Requirements

A Building Solution must comply with either –

(a) Clauses 2.3 to 2.10 of this Standard; or

(b) BCA Volume One, BP1.4 or BCA Volume Two, P2.1.2 as appropriate.

2.2 Application

(a) Clauses 2.3 to 2.10 of this Standard only apply to *flood hazard areas*-

(i) that are not subject to landslip, mudslide, storm surge or coastal wave action; and

(ii) where the maximum flow velocity is not greater than 1.5 m/s.

(b) Where the *appropriate authority* is not able to determine whether the maximum flow velocity is not greater than 1.5 m/s, the Deemed-to-Satisfy Provisions of this Standard can only apply to *inactive flow or backwater areas*.

2.3 Flood Actions

2.3.1 General

(a) Values of flood actions for use in design must be established that are appropriate for the type of structure or structural element, its intended use and exposure to flood action.

(b) The flood actions must include, but not limited to, the following as appropriate: *hydrostatic actions*, *hydrodynamic actions*, debris actions, wave actions, erosion and scour.

(c) The flood actions must be based on the *DFE*.

2.3.2 Hydrostatic Actions

(a) *Hydrostatic actions* caused by a depth of water to the level of the *DFL* must be applied to all surfaces, both above and below ground level. These actions include lateral pressures, and uplift pressures or buoyancy effects.

(b) Reduced uplift and lateral actions on surfaces of enclosed spaces below the *DFL* must apply only if provisions are made for entry and exit of flood water.

2.3.3 Hydrodynamic Actions

(a) Dynamic effects of moving water must be determined by a detailed analysis based on the principles of fluid mechanics.

(b) Where water velocities do not exceed 1.5 m/s, the hydrodynamic actions can be approximated into equivalent hydrostatic actions by increasing the *DFL* by an equivalent surcharge depth D_e, equal to

$$D_e = (C\ V^2)/2g$$

Where

V = velocity of moving water in m/s

g = gravitational acceleration (9.8 m/s^2)

C = shape factor (1.25)

Note: This formula is only valid for slow moving water (flow velocity less than 3 m/s) and building aspect ratio (width to height) less than 12. For situations outside these limits, a full engineering analysis should be carried out.

(c) This surcharge depth must be added to the *DFL* and applied to the vertical projected area of the building or structure that is perpendicular and upflow to the flow. Surfaces parallel to the flow or downflow will be subjected to the *DFL* hydrostatic pressures only.

2.3.4 Debris Actions

Impact actions caused by objects transported by flood waters striking against buildings and structures must be determined using engineering principles as concentrated loads acting horizontally at the most critical location at or below the *DFL*.

2.3.5 Wave Actions

Wave actions caused by water waves propagating over the water and striking a building or other structure must be determined using engineering principles. Wave actions include wash and wind generated waves. The Standard does not cover coastal waves.

2.3.6 Erosion and Scour

The effects of erosion and scour must be included in the calculation of actions on building foundations and other structures *in flood hazard areas*. The Standard does not cover coastal erosion.

2.3.7 Combinations of Actions

In addition to the combinations specified in AS/NZS 1170.0, the following combinations must be considered for structures located in a *flood hazard area*-

(a) $[1.2G, \psi_c Q, Y_F F_l]$; and

(b) $[0.9G, 0.5W_u, Y_F F_l]$.

Where F_l represents the flood related actions for the *DFE*, including hydrostatic (including buoyancy), hydrodynamic, wave and debris actions as appropriate; and

Y_F is the flood load factor as given in Table 2.3.7.

Table 2.3.7

Defined Flood Event (DFE)	**Flood load factor Y_F**
DFE based on annual probability of exceedance of not more than-	
1:100	1.0
1:50	1.2
1:25	1.4
DFE based on maximum recorded flood with record length of not less than-	
100 years	1.1
50 years	1.3
25 years	1.5

2.4 Floor Height Requirements

Unless otherwise specified by the *appropriate authority*-

(a) the *finished floor level* of *habitable rooms* must be above the *FHL;* and .

(b) the *finished floor level* of enclosed non-*habitable rooms* must be no more than 1.0 m below the *DFL*.

Note: The structural provisions of this Standard are based on the DFL being a maximum of 1.0 m above the finished floor level of enclosed rooms. Therefore, if the appropriate authority permits more than 1.0 m, additional structural analysis should be undertaken.

2.5 Footing System Requirements

2.5.1 General

The footing system of a structure must provide the required support to prevent flotation, collapse or significant permanent movement resulting from the flood actions specified in Section 2.3.

2.5.2 Geotechnical Considerations

The footing system design must account for instability and decrease in structural capacity associated with soil properties when wet, erosion and scour, liquefaction, and subsidence resulting from the flood actions specified in Section 2.3, depending on the geotechnical characteristics of the site.

2.5.3 Footing System Depth

The footing system depth must be adequate to provide the support required in 2.5.1 taking into account the geotechnical considerations of 2.5.2.

2.5.4 Piers, Posts, Columns and Piles

Piers, posts, columns and piles used to elevate buildings to the required elevation must take account of-

(a) the potential erosion action due to flood; and

(b) the potential debris actions.

2.5.5 Use of Fill

Fill providing support to the footing system must be designed to maintain that support under conditions of flooding, including rapid rise and draw-down of flood waters, prolonged inundation,

erosion and scour, without exceeding the maximum design differential movement of the footing system as specified in AS 2870.

2.5.6 Use of Slabs

(a) Slabs must-

(i) be installed on fill in accordance with 2.5.5, or on undisturbed soil of adequate bearing capacity; and

(ii) have adequate strength to resist the design actions even if the supporting soil under the slab is undermined by erosion.

(b) The bottom of the slab edge (usually the edge beam or edge footing) must be at or below the depth of expected scour.

2.6 Requirements for Enclosures Below the *Flood Hazard Level (FHL)*

(a) Any enclosure below the FHL must have openings to allow for automatic entry and exit of floodwater for all floods up to the FHL.

(b) The openings must meet the following criteria-

(i) doors and windows must not be counted as openings but openings can be installed in doors and windows; and

(ii) there must be a minimum of two openings on different sides of each enclosed area; and

(iii) the total net area of all openings must be at least 1% of the enclosed area; and

(iv) openings must permit a 75 mm sphere to pass through; and

(v) any opening covers must not impede the flow of water.

2.7 Requirements for Structural Attachments

(a) Erosion control structures that are attached to the foundation or superstructure of the building must be structurally adequate and not reduce the structural capacity of the building during the *DFE*.

(b) Decks, patios, stairways, ramps and the like below the *FHL* that are attached to the building must be structurally adequate and not reduce the structural capacity of the building during the *DFE*.

2.8 Material Requirements

(a) Materials used for structural purposes and located below the *FHL* must be capable of resisting damage, deterioration, corrosion or decay taking into account the likely time the material would be in contact with flood water and the likely time it would take for the material to subsequently dry out.

(b) For the purposes of (a), materials used for structural purposes include loadbearing columns, bracing members, structural connections, fasteners, wall framing members and the like.

2.9 Requirements for Utilities

2.9.1 General

(a) Utilities and related equipment, other than an electrical meter for the building, must not be placed below the *FHL* unless they have been designed specifically to cope with flood water inundation.

Note: The location of electrical meters is regulated by the electrical authority.

(b) Buried systems must be placed at a depth sufficient to prevent damage due to scour and erosion during the *DFE*.

(c) Exposed systems must be designed to withstand the flood related actions (buoyancy, flow, debris and wave).

2.9.2 Electrical

Unless the electrical supply authority determines otherwise-

(a) Electrical switches must be placed above the *FHL*.

(b) Electrical conduits and cables installed below the *FHL* must be waterproofed or placed in waterproofed enclosures.

2.9.3 Mechanical and HVAC systems, tanks and the like

Ductwork, tanks, gas storage cylinders and the like must be placed above the *FHL* or designed, constructed, installed and anchored to resist all flood-related actions and other actions during the *DFE* with appropriate load factors as given in 2.3.7. Potential buoyancy and other flood related actions on the empty tank during the *DFE* condition must be considered.

2.10 Requirements for Egress

Egress from a balcony, verandah, deck, door, window or the like must be available to allow a person in the building to be rescued by emergency services personnel, if rescue during a flood event up to the *DFE* is required.

2.11 Additional State or Territory requirements

State or Territory agencies may have a range of requirements for the location, construction and use of buildings to be constructed *in flood hazard areas*. It is also necessary to determine whether legislation requires –

(a) approval for construction; or

(b) conditions of approval: or

(c) limitations on use.

The ABCB Information Handbook 'Construction of Buildings in Flood Hazard Areas' presents an outline of requirements in each State and Territory.

3 References

Australian Building Codes Board, Information Handbook, *Construction of Buildings in Flood Hazard Areas*, www.abcb.gov.au, 2012.

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