



IS YOUR PROPERTY READY?

WESTERN AUSTRALIA

Tropical Cyclone Preparedness Guide



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This guide was produced as a part of the Severe Wind Hazard Assessment project 2016-2017. This project acknowledges the funding contribution of the Commonwealth Government of Australia and support from the WA State Emergency Management Committee.

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What is a tropical cyclone?

Tropical cyclones (cyclones) are low-pressure systems that develop over the warm oceans off the northern coasts of Australia. They can produce very strong winds, storm surge, heavy rainfall and flooding. The severity of a tropical cyclone is described using a five-category system that is based on the strongest wind speeds generated near the centre of the cyclone.

Category	Maximum Mean Wind (km/h)	Typical Strongest Gust (km/h)	Typical Effects
1	63 - 88	< 125	Damaging winds. Negligible house damage. Damage to some crops, trees and caravans. Boats may drag moorings.
2	89 - 117	125 - 164	Destructive winds. Minor house damage. Significant damage to signs, trees and caravans. Heavy damage to some crops. Risk of power failure. Small craft may break moorings.
3	118 - 159	165 - 224	Very destructive winds. Some roof and structural damage. Some caravans destroyed. Power failures likely.
4	160 - 199	225 - 279	Significant roofing loss and structural damage. Many caravans destroyed and blown away. Dangerous airborne debris. Widespread power failures.
5	> 200	> 279	Extremely dangerous with widespread destruction.

What are the characteristics of a cyclone?

Strong winds and rain

Strong winds generated during severe cyclones can cause extensive property damage and create wind-borne debris that can cause injury to people and damage to buildings. Cyclones can also produce very heavy rainfall, which can cause both flash flooding and widespread flooding. Flooding can damage properties but will also cut roads and other infrastructure. The combination of damage from wind and rain can affect a community for many months.

Storm surge and storm tide

Storm surge is a rapid rise in sea level above the normal tide levels caused by strong onshore winds generated by an approaching cyclone. Storm surge has been responsible for more deaths during cyclones than strong winds. Storm surge is potentially most damaging when a cyclone's surge of water coincides with high tide – "storm tide". A 3 metre storm surge on top of a high tide that is 2 metres above the mean sea level will produce a storm tide that is 5 metres above mean sea level.

A severe storm surge can damage or destroy buildings and wash away roads. The extent of sea water flooding from a storm tide can last for several hours, extend up to 100 kilometres along the coastline and up to several kilometres inland in low-lying areas.

Important

If your property is in a storm surge-prone area (check with your local council), you must relocate ahead of an approaching cyclone as it may not be safe to stay in your property. Severe wind and rain may also make any rescue effort too dangerous to execute until after the event. Think ahead and prepare a cyclone plan for you and your family. By the time a cyclone is approaching, it will be too late. A cyclone plan will help you act appropriately before, during and after an event.

Further Information

Information on preparing a cyclone plan:

dfes.wa.gov.au/cyclone

Information on the formation, characteristics and impacts of cyclones, storm surges and storm tides:

bom.gov.au/cyclone/tropical-cyclone-knowledge-centre

When and where do cyclones occur?

Every year between November and April, coastal areas north of Denham are most at risk of being hit by cyclones.

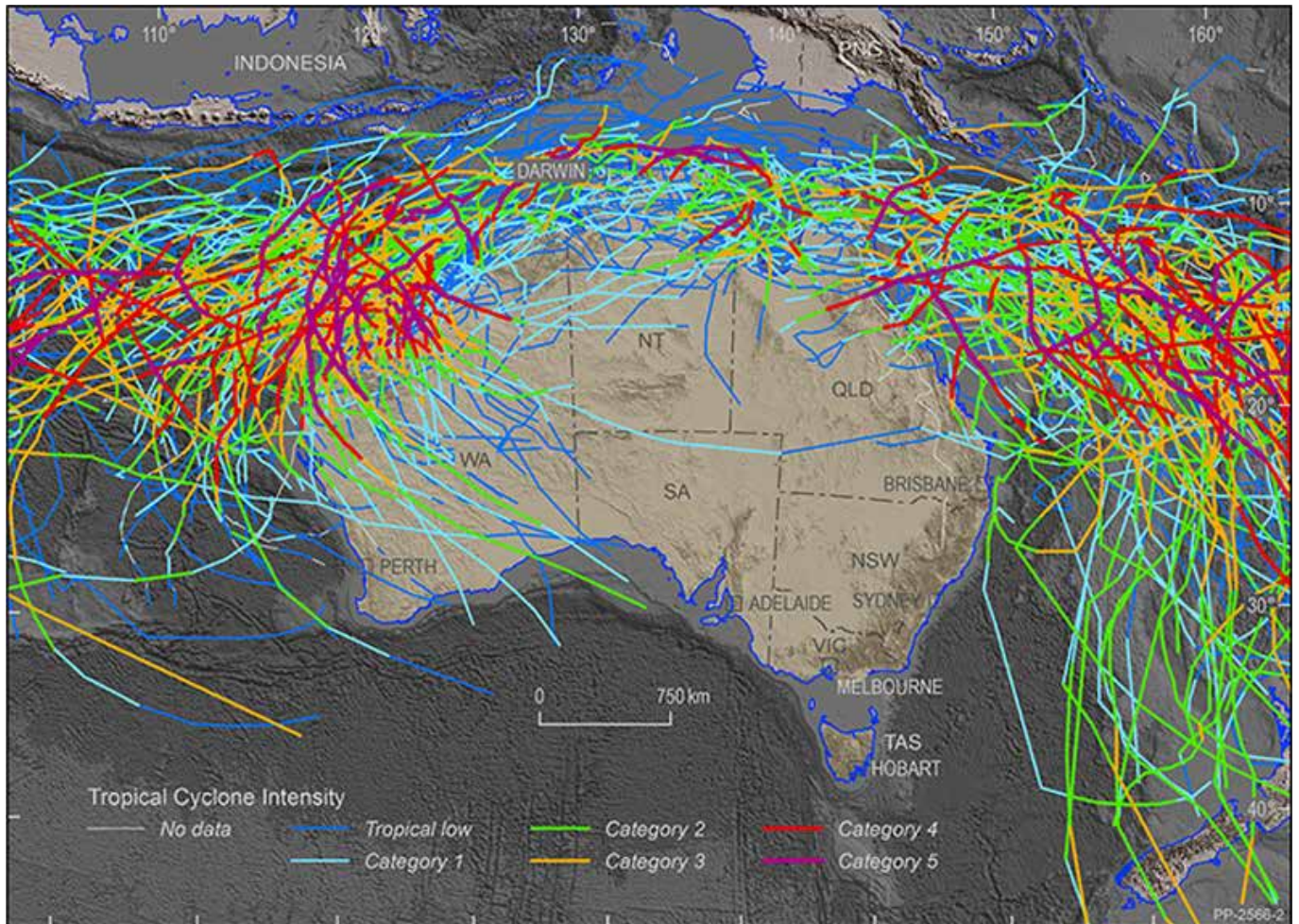


Figure 1:
Historical tropical cyclone activity across Australia between 1981 and 2017.
Image: Geoscience Australia via Bureau of Meteorology.

Wind loading regions

There are four wind loading regions in WA. Property owners in cyclone specific areas should inspect and maintain their properties to help reduce potential damage to both their home and the homes of their neighbours.

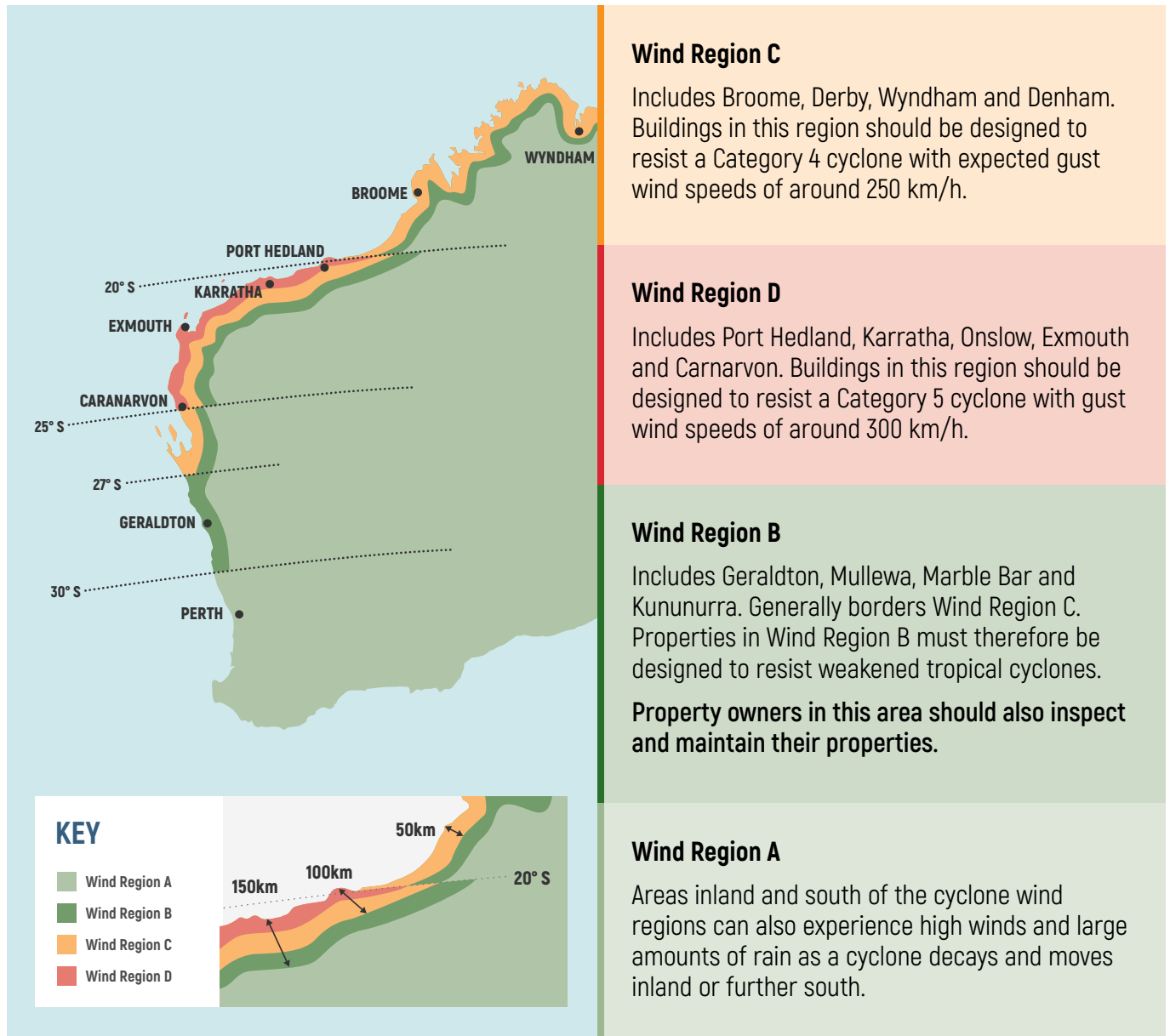


Figure 2:

AS/NZS 1170.2 2011 wind loading regions, with key locations marked (after AS/NZS 1170.2,2011)

Damage from cyclones

Previous cyclones, including Orson in 1989, Vance and John in 1999, Rosita in 2000, George in 2007, Olwyn in 2015 and Damien in 2020 caused significant damage to properties in several towns in North West WA. The most common types of damage included:

- Roofs blown away due to failure of rusted fasteners, connector plates, roof battens and other roof components. In some cases, houses that had been re-roofed were damaged because either over-battens were removed and not replaced, or the new tie-downs had inadequate strength.
- Damage to verandahs and roofs caused by failure of rot or termite-affected timber.
- Failure of inadequately secured gutters, flashings, fascia and eaves.
- Wind-driven rain entering buildings through vents, under flashings or through weep holes in windows and glass sliding doors, causing damage to floors, ceilings, walls and building contents.
- Broken doors and windows caused by wind-borne debris, which can let in more rain and wind.
- Doors and windows blown open due to inadequate fixing to walls or inadequate locks and door sets.
- Garage doors being blown in or out.
- Collapse of unreinforced masonry walls.
- Damage to buildings, fences, pools, patios, carports etc. caused by falling trees or wind-borne debris.
- Property inundation and damage caused by storm tide.

Important

Buildings that are older (pre-1980s), poorly maintained, or located in exposed positions such as near the top of hills, on the beach or next to open land are significantly more likely to experience damage.

Wind and debris damage to buildings

Severe winds generated by cyclones can cause structural damage to homes and other buildings. This damage may cause injury to occupants and place other members of the community at risk because the debris picked up by the wind can damage other buildings.



Figure 3:

Damage to a building during a previous tropical cyclone.

Wind damage to your property will expose occupants to wind, rain and risk of injury from debris. Take shelter in the small rooms of the building.

Damage from wind-driven rain

Even if there is no structural or debris damage to your roof or external walls, wind-driven rainwater can cause significant damage to ceilings, internal walls, carpets, furniture and belongings. Strong winds can drive large volumes of water into your property during a cyclone through:

- Weep holes (drainage slots at the bottom of frames) or seals in windows and glass sliding doors
- Roof vents
- Holes, cracks, gaps or wherever a pipe or cable pierces the wall or roof
- Flashings



Figure 4:

Water damage caused by wind-driven rain.

Strong winds will drive rain into buildings. There is a risk that wind-borne debris could break the glass and cause severe injuries. Stay away from windows and glass doors during a cyclone.

Damage from storm tides and storm surge

Storm tides are abnormally high sea levels that result from the combination of normal (astronomical) tide levels and the storm surge height. If the water level rises high enough that it floods infrastructure and buildings, it can cause significant damage and risk to life. Buildings close to the sea front can be damaged by waves and debris such as rocks, damaged building material, trees, furniture and even cars that can be swept along by the storm tide. Storm tides can also erode soil and expose building foundations. Inundation by salt water can also cause buildings and infrastructure to corrode more quickly than they otherwise would have, which can have longer-term social and economic consequences.



Figure 5:

Scour damage to a road from storm surge.

Few buildings can withstand the effects of storm surge, so do not stay in your property during a cyclone if it is in a storm surge area. Roads may become impassable when the seawater rises, so relocate before the cyclone arrives.

Check and maintain your property

It is important that you regularly inspect, maintain and repair your property to help protect people sheltering in it during a cyclone. This is just as important as servicing your car. Many building materials deteriorate over time; steel elements and reinforcement in concrete can corrode, and rot or termites can affect timber. The rate of deterioration will vary depending on factors such as the property's age; distance to the sea; exposure to other hazards such as earthquakes or flash flooding; and types of materials used. Even a building originally constructed according to building code requirements will need regular inspection and maintenance.

Regular inspection and maintenance will help minimise the chance that damaged parts of your property become wind-borne debris that could damage someone else's property, or seriously injure or even kill someone. You always need to have your property cyclone-ready. It will be too late to undertake work to your property as a cyclone is approaching.

Important

A thorough inspection and maintenance of key structural elements by a building professional should be undertaken for all properties:

- after any cyclone or other hazard, such as an earthquake, that has damaged buildings in your community; or
- whenever the roofing is removed (e.g. for replacement of roof sheeting). This is especially important if heavy roof materials are replaced with lighter materials; or
- every seven to ten years.

Rust

Check for signs of rust around your property. Check the outside of the roofing for signs of corrosion of fasteners or the roof cladding, especially at the laps of adjoining sheets. Look inside the roof space for rust on metal roof coverings, metal battens, batten straps, fixing bolts, fixing plates, screws, nails, etc. Properties close to the coast are at higher risk of corrosion. Corrosion resistant fixings such as heavily galvanized steel or stainless steel need to be used and installed in accordance with manufacturer's specifications. Check if metal components are showing signs of rust. These may need to be replaced.



Figure 6:

Roof failure occurred due to corroded roofing fasteners.



Figure 7:

Signs of rust at the bottom of a verandah post.

Important

Buildings with corrosion in roof fasteners, verandah posts or other building components are at greater risk of damage in cyclones.

Rot in timber

Timber can rot over time. There is a higher risk of timber rotting if it is often exposed to moisture, for example from a leaking gutter or water pipe. Rotten timber should be replaced.



Figure 8:

Timber rot in a rafter.

Termites

Termites are particularly active in the cyclone regions of WA. Timber and their termite protection systems should be regularly inspected and maintained to ensure they provide an effective barrier to termite attack. If termites have been detected in your property, seek expert advice on replacing the timber and restoring the termite management system.



Figure 9:

Termite damage to roof timbers.

Loose fittings

Alternating wet and dry seasons in cyclone areas can cause some structural components to shrink or expand, and some connections to become loose. Previous cyclones may also have loosened structural components. Thoroughly check for any loose fasteners and re-tighten them where possible, or install extra connections.



Figure 10:

Loose fixings resulting from a previous cyclone.

Check and upgrade your property

You can minimise the risk of cyclone damage to your property by upgrading key areas where wind and rainwater can cause damage, and by identifying any potential hazards around your property. These critical areas include the roof, doors and windows, garage doors, roof eaves, attachments to your buildings (e.g. verandahs and carports) and equipment including satellite dishes, aerials and solar panels. A building professional will evaluate the wind loads on your property using the appropriate Australian Standards, which will give wind pressures or a wind classification appropriate to your location. These will be used to determine the details and products required to upgrade your property.

Important

- Engage a qualified building practitioner such as a suitably qualified structural engineer, registered building surveyor, or registered builder to inspect your property and advise whether it has suitable structural details.
- The Cyclone Testing Station has produced several useful videos on building, maintaining and upgrading properties in cyclone areas: jcu.edu.au/cyclone-testing-station/videos-And-resources/for-the-home-owner-And-occupier

Roof

The roof is the most vulnerable part of a building during a cyclone because it is subjected to strong uplift forces. The size of these forces is influenced by many factors, including the shape of the roof; for example, a building with a near flat roof is subjected to larger uplift forces than one with a hip roof. The uplift forces near the edges and ridges of roofs are higher, so connections in these areas need to be even stronger.

Some properties built before the mid-1980s might not be constructed to current building standards; the connections and materials might not be strong enough to resist cyclonic winds. Roof battens that are poorly connected to rafters or trusses are a common weakness in older buildings.



Figure 11:

Roof failure following a cyclone.

Older properties are particularly vulnerable to damage.

If you are reroofing your building, also check the roof structure and tie-downs.

Important

The roofs of more recently constructed buildings should also be checked if a cyclone has caused damage to other buildings in the area; there could be damage to the internal roof structure that is not obvious from the outside.

Recommendations

The roof cladding and the roof structure underneath may need to be upgraded to meet current building standards.



Roof Cladding

Metal roofs must be fixed to battens with the correct type of screws and washers and at the spacings recommended by manufacturers. Every tile, including ridge capping in tiled roofs must be secured to the battens with the correctly rated clips or fixings.

Roof battens

Must be securely fixed to the rafters or trusses with the appropriate type, size and number of connectors (screws, or straps with correct nails).

Trusses or rafters

Must be the correct size, installed at the correct spacing and securely tied down to the top of the walls using appropriate details. Girder trusses (large trusses that support smaller trusses) require even stronger tie downs than regular trusses.

Doors and windows

Doors and windows are vulnerable to damage from wind forces and wind-borne debris. Strong winds entering your property through damaged windows or doors can cause high internal pressures inside the building, which can increase the risk of your roof blowing off. Large volumes of wind-driven rain can also enter through damaged doors and windows.

All glass needs to be the correct thickness and type for the wind classification of your property. Confirm with your builder that all window assemblies comply with Australian Standards, have the correct wind classification, and are securely fastened to the building structure.



Figure 12:

Wind-driven rain entering a property via the windows.

You can help minimise the amount of wind-driven rain entering your property through doors and windows by replacing any worn or damaged window or door seals. Sealing the gaps under doors will also help minimise the amount of rainwater entering your property during a cyclone.

Recommendations



- Ensure windows and doors are securely fixed to frames and walls: awa.org.au/resources/agwa-guide-series
- Ensure the hinges and latches on doors (particularly double doors) are large and strong enough to cope with strong winds.
- Protect windows and doors from wind-borne debris by installing either temporary or permanent impact-resistant screens¹ or shutters².

Notes

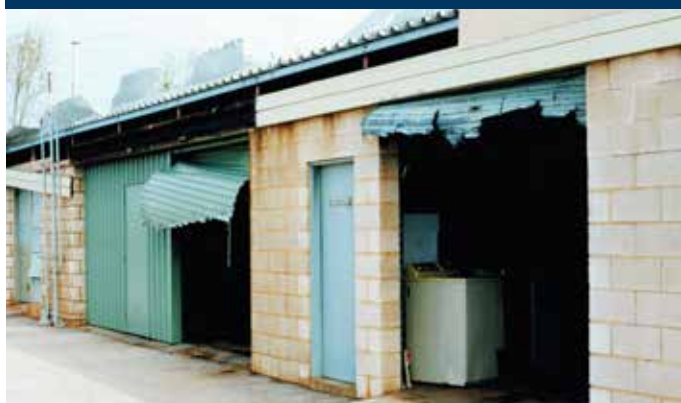
¹ Cyclone shutters are plates of metal or plywood that are mounted in front of windows and doors that can protect them from wind-borne debris and reduce the amount of wind-driven rain entering. Temporary shutters can be as simple as sheets of plywood securely fastened across windows.

² Debris screens are open and grid-like. When fitted on windows and glass doors they can absorb the impact of debris and reduce the chances of glass breaking but won't reduce the amount of rainwater entering your property. Debris screens can be permanently fixed and may double as security screens or can be temporary and need to be fitted before each cyclone.

Garage doors

Some garage doors can be pushed in or sucked out by strong winds. Damage to garage doors can let wind inside the property and increase the pressure on the underside of the ceiling and roof and lead to damage or loss of parts of the roof.

Recommendations



- Install garage doors that are adequately wind and debris rated (all new garage doors in cyclone regions must comply with AS/NZS 4505). In some cases, garage walls may need to be strengthened at the same time as the door is upgraded.
- Purchase a temporary bracing system that can be installed to support your garage door against inward or outward pressures as part of the preparation for an approaching cyclone.

Important

Products that have a debris rating have been tested to demonstrate their effectiveness against small or medium-sized debris.

Gutters and downpipes

Blocked, damaged or leaking gutters can lead to large volumes of rainwater entering a building during a cyclone. This can cause damage to ceilings, walls and personal belongings. Even gutters in good condition can be damaged if they are not securely fastened to the roof. Damaged gutters can also become wind-borne debris. The cost of repairing the guttering can be substantial if scaffolding is required.

Recommendations

- Clean gutters and downpipes regularly to prevent them from becoming blocked – this will enable water to drain away as quickly as possible during a cyclone.
- Repair or replace leaking gutters.
- Make sure gutters are securely fastened – install extra gutter clips if necessary.

Flashings

Flashings are thin sheets of metal that keep out water around windows and the edge of roof and wall panels. Wind pressure can rip them off if they are not properly fastened. Large amounts of rainwater can be blown into the building, damaging ceiling and wall linings.

Recommendations



- Securely fasten all faces of flashing with screws (not pop rivets) no more than 500mm apart.
- Check that any gaps between flashings and the roof and walls are adequately sealed.

Other items attached to buildings

Porches, verandahs, patios, pergolas, carports and screen enclosures attached to a building can significantly increase the wind uplift forces on the building. If they are damaged by strong winds, they could peel back the roof of the main part of the building. Aerials, satellite dishes and solar panels that are not fastened through the roof cladding to suitable roof structural elements are likely to fail in a cyclone. Damaged building additions or attachments can become wind-borne debris that could further damage your property or other neighbouring properties.

Recommendations

- Engage a qualified building practitioner to check the connections between these structures and the main building and upgrade them if necessary.
- Check that the structures and connections, particularly those at the base of columns, are in good condition.
- Fasten aerials, satellite dishes and solar panels to the roof structure through the roof cladding.

Other items on and around your property

Recommendations	
<p>Fencing</p> <p><i>It is difficult to design fencing that can resist wind loads.</i></p>	<ul style="list-style-type: none"> • The base of any fence posts can be designed to ensure they remain attached to the footings, even if they fail. In these cases, if your fence is blown over, it will not become wind-borne debris causing further damage to your property. • Wind forces on open mesh fencing are significantly lower than on paling or sheet fences.
<p>Sheds</p> <p><i>Sheds are light and often become wind-borne during cyclones if they are not adequately anchored to the ground.</i></p>	<ul style="list-style-type: none"> • Install ground anchors beside sheds so that cables or slings can be fitted over the shed as part of the preparation for an approaching cyclone. • For more information on how to make sheds resilient to cyclonic winds visit: shedsafe.com.au
<p>Boats and caravans</p> <p><i>Boats and caravans can be picked up by the wind, overturned or smashed into nearby buildings.</i></p>	<ul style="list-style-type: none"> • Store boats and caravans under cover if possible or install ground anchors so that cables or slings can be fitted over the boat or caravan as part of the preparation for an approaching cyclone.
<p>Trees</p> <p><i>Trees can be blown over and fall on roofs, or branches can become wind-borne debris that can break windows or damage roof and wall cladding.</i></p>	<ul style="list-style-type: none"> • Trim trees and branches that hang over your roof and remove loose or weak branches from any trees on your property.

Choose a safe place to shelter

As part of your preparation for the cyclone season, decide whether you will feel safe sheltering in your property during the cyclone or whether you need to go elsewhere. Consider the possibility that you may need to remain in the building for several days after the cyclone has passed.

- Inspect, maintain, and upgrade the key areas of your property if necessary. Engage a building professional to provide advice and undertake any work required to ensure your property is safe to shelter in during a cyclone.
- If you are in a storm tide prone area, you will need to relocate to a safer place BEFORE the cyclone arrives. Prepare a cyclone plan. It will help you decide, what to do, when to go and where to relocate to.
- You should also find a safer place to shelter if you DO NOT have confidence that your property will resist the expected winds.
- If you choose not to relocate, you will need to decide where you will take shelter during a cyclone. This should be a secure part of the building; in a small room with small windows such as the bathroom, or a small room or hallway in the middle of your building.
- Also consider making your bathroom a 'strong room' in which your family can safely shelter during a cyclone by installing a 'strong door' that is slid across to reinforce the standard door, reinforcing the walls and ceiling with plywood or metal to make it resistant to damage from debris and wind forces.

Important

There is no such thing as a cyclone-proof property. However, if you understand the effect of strong winds on your property and plan ahead to maintain and protect it, you can reduce the likelihood of it being damaged in a cyclone and keep your property and occupants safe.

Further information

For more information on cyclones, cyclone preparedness and ways to protect your property, please visit your local council and the following websites:

- **Department of WA Fire and Emergency Services:** dfes.wa.gov.au/cyclone
- **Cyclone Testing Station:** jcu.edu.au/cyclone-testing-station
- **Bureau of Meteorology:** bom.gov.au/cyclone
- **Department of Mines, Industry Regulation and Safety:** <https://www.commerce.wa.gov.au/building-and-energy/building-or-renovating-your-home> (other relevant publications available soon)
- **Geoscience Australia:** ga.gov.au/scientific-topics/community-safety/severe-wind
- Reports on damage investigations: jcu.edu.au/cyclone-testing-station/research/reports/technical-reports
- Videos for homeowners and builders: jcu.edu.au/cyclone-testing-station/videos
- **Local councils** – storm tide maps

For up-to-date information during a cyclone:

Emergency WA Website: emergency.wa.gov.au

Local ABC Radio

DFES Public Information Line: 13 DFES (13 33 37)

DFES Facebook page: facebook.com/dfeswa

DFES twitter feed: twitter.com/dfes_wa

Bureau of Meteorology Cyclone Warning Line: 1300 659 210

Road Closures: 138 138

Appendix A: Inspection and Maintenance Checklist

As the property owner, it is your responsibility to help minimise damage to your property during a cyclone by inspecting your property **annually, before the cyclone season and after a cyclone**. If you have any doubts about the condition of your property, contact a qualified building practitioner to have your property professionally inspected.

The following is a list of items on your property that should be checked regularly and repaired or replaced as necessary.

Roofs	Completed ✓
Sheet metal roofing and fasteners are in good condition.	
Roof tiles are in good condition i.e. not broken, dislodged or missing. Mortar between tiles is in good condition i.e. not missing or broken, especially at ridges and hips or along the edges of the roof. Tile tie down clips are not missing.	
Roof sarking membrane is in good condition.	
There are no signs of corrosion in any metal components including nails and screws.	
There are no signs of rot or termite activity in any timber components.	
All connections are tight.	
Gaps and/or cracks around the dryer, bathroom and range hood vents have been sealed.	
If a building professional has not recently checked your roof, engage one to check that:	
Battens are securely fixed to the rafters or trusses with connections that are appropriate for the wind classification of your property.	
Connectors holding down the trusses/rafters to the walls are the appropriate size and in good condition.	

Doors and windows	Completed ✓
Window and door seals are in good condition.	
Any gaps around windows or door frames have been sealed.	
If a building professional has not recently checked your doors and windows, engage one to check that:	
Entry doors have locks and hinges to resist the wind pressure.	
Sliding glass doors and windows are correctly rated for the wind classification or pressure at your particular location.	
Window and door frames are securely fixed to the building structure.	
Garage doors	Completed ✓
The garage door complies with AS/NZS 4505 and is correctly rated to resist wind pressure or has a bracing system that can be installed as part of the preparation for an approaching cyclone.	

Other items on your property	Completed ✓
Freestanding carports, pergolas and patios are in good condition and well secured to the ground.	
Carports, verandahs or patios attached to buildings are in good condition and are well secured to the building and to the ground.	
The pool fence is securely attached to the ground and/or wall.	
Roof attachments such as air conditioning compressor units, satellite dish antennas, outdoor hot water tanks, hot water or solar panels are securely fastened to structural roof members and there are no signs of deterioration.	
Sheds have appropriate anchorage to the ground.	
The fence is in good condition i.e. there is no corrosion in metal, rot in timber, and no loose fasteners, etc.	
If a building professional has not recently checked the following items, engage one to check that:	
Carports, verandahs or patios attached to buildings are strong enough to carry wind loads to the ground without endangering your buildings.	
All roof attachments are secured to the roof structure (not the roof cladding only).	

Additional recommended actions for properties in storm-tide prone areas	Completed ✓
Consider replacing carpet or timber flooring in ground level storeys with tiles.	
Consider relocating circuit breakers, electrical junction boxes, air conditioners, and power points to well above storm tide level.	
Use corrosion resistant connections such as stainless-steel fittings and connections. Any existing galvanised connections that have changed colour to red or brown need to be replaced.	
Consider replacing less resilient materials below the storm tide level with more resilient materials that can cope with flooding and wave action.	
Protect the edge of concrete slabs and posts to prevent erosion. This can be achieved by placing extra concrete in critical locations. (In some cases, this can be achieved using grout injection by suitably qualified professionals i.e. geotechnical engineer.)	

Appendix B: Checklist to Prepare your Property

For more information, visit dfes.wa.gov.au/cyclone

	Completed ✓
Fit temporary debris shutters or screens.	
Clean out gutters and downpipes.	
Take down shade sails.	
Securely store or tie down all loose items such as outdoor furniture, trampolines, toys, garden pots, etc.	
Move caravans and boats under cover or securely anchor to the ground.	
Put heavy duty close-fitting plastic bags over old style single-unit wall or window-mounted air conditioners and whirly birds. Cover any gable vents.	
Decide on a strong small room to shelter in.	
Be prepared for all persons who 'shelter in place' to survive independently for several days following a cyclone impact.	
Prepare a cyclone emergency kit and make sure all occupants know where it's stored.	

If you live in a storm tide prone area	Completed ✓
Make plans to relocate early.	
Identify which indoor items you will need to raise or relocate to a higher property.	
Store all poisons well above ground level.	

Myth Busters	
Myth	Busted
Tape an 'X' on your window	Taping an 'X' on your window won't prevent them from breaking. Taping a sheet of plastic inside the frame to reduce water entry is a better use of the tape.
Open windows on the lee side and close them on the windward side of the property	This means that you are continually monitoring the wind direction (wind direction will change during the cyclone) and moving around your property during the cyclone instead of sheltering in a small room – you are risking injury if debris breaks a door or window and you are near it at the time.
Debris screens are only needed on the side of the property facing the ocean	The wind direction will change during the cyclone, so debris screens should be installed on all windows.
Whirly birds will keep your roof on	Whirly birds can be damaged by wind or debris and allow both wind and water into your roof.
Mopping up rainwater as it comes through doors and windows will prevent damage to floors, walls and ceilings	Water comes through the same windows or doors that would be hit by debris, so you are risking injury if debris breaks a door or window and you are near it at the time. Other rainwater may accumulate above ceilings, behind walls and in other places you are unable to access, which will cause damage anyway.

20 Stockton Bend Cockburn Central WA6164
T: +61 8 9395 9300
E: dfes@dfes.wa.gov.au
ABN: 39 563 851 304
dfes.wa.gov.au/cyclone