International Symposium Disaster Reduction on Coasts
Scientific-Sustainable-Holistic-Accessible
14 – 16 November 2005 Monash University, Melbourne, Australia

DESIGN GUIDELINES FOR AUSTRALIAN PUBLIC CYCLONE SHELTERS

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ABSTRACT: This paper outlines guidelines for the design of Australian public cyclone shelters which are occupied during a tropical cyclone. Accommodation of people from potential storm tide inundation areas presents the greatest need for shelter during a tropical cyclone.

In 2002 Emergency Management Australia commissioned the Queensland Government, Department of Public Works to prepare national guidelines on performance criteria for public cyclone shelters. The guidelines provide a method of assessment to ensure the shelter is "fit-for-purpose". They address the temporary use of a building, or a portion of a building, with basic amenities to provide safe shelter for a large number of people during a tropical cyclone.

Design criteria include: the location of the shelter with regard to storm tide heights, flood levels, and other man-made or natural hazards; building structure and external fabric; human factors encompassing both comfort and life safety issues; and fire safety.

This paper presents criteria for the design of public cyclone shelters. These criteria provide the basis for development of national guidelines and form a standard by which Government and Disaster Managers can determine the provision of an appropriate level of safety to address their duty of care to the community.

1. INTRODUCTION

Public cyclone shelters are buildings which may be located in the path of a tropical cyclone, that provide shelter for people during the cyclone.

The greatest need for cyclone shelters arises from people evacuated from areas of a community which may be inundated by the sea due to a tidal surge. People who do not have suitable accommodation to resist wind loads and wind borne debris also require shelter. These people may include travelers, caravan park residents etc. Evacuation inland out of the influence of the cyclone is preferred, but may not be possible for some communities due to: lack of transport; traffic congestion due to road system capacity, traffic accidents and breakdowns; or impassible roads due to flooding or landslides. People may shelter within the community with friends in residences located above the storm tide or in public cyclone shelters, where they are available.

The Design Guidelines for Australian Public Cyclone Shelters [1] are based upon a review of the criteria developed by the Department of Public Works, with reference to state, national and international practices, standards and legislation. The guidelines have incorporated requirements identified by stakeholders in Western Australia, Northern Territory and Queensland and are intended to present a consensus on the proposed criteria for the design of public cyclone shelters in Australia.

2. BACKGROUND

In 1998 the Queensland Government Department of Public Works initiated an assessment program out of concern that people housed in buildings nominated by local authorities as shelters might be placed at risk during a cyclone, due to potential flooding of the shelter or structural inadequacy of the building and building fabric. It is proposed that the provision of shelter buildings can be achieved by the temporary use of a building or part of a building constructed for its primary purpose, such as theatres, carparks, sports halls, assembly buildings etc.

The program assessed 384 buildings nominated by local authorities in Queensland's cyclonic region, as buildings which were suitable or could be made suitable as public cyclone shelters. About one third of the buildings nominated were assessed after a preliminary inspection as not suitable. Most of the remaining buildings were assessed as requiring upgrade works. Local authorities were advised [2,3] of the findings of the investigations.

Based upon the preliminary inspection reports a number of buildings were selected from the 1998 shelter building program for further investigation. The buildings were selected based upon the preliminary assessment, shelter area and a cost indicator of the ratio of shutter area to shelter area. Detailed inspections were undertaken on a total of 71 buildings in the Cairns, Mackay, Mareeba and Townsville disaster districts

No building was assessed as suitable without upgrade works. Investigation of upgrade works revealed conflicts between the requirements of the Building Code of Australia [4] and that of a public cyclone shelter when factors such as, but not limited to, amenities, lighting and ventilation were considered.

The requirements of the Building Code of Australia (BCA) for a building where people may assemble (Class 9b) such as theatres, schools, churches, sporting venues etc are not necessarily appropriate for a building used as a shelter during a tropical cyclone, particularly when loss of power supply occurs and failure of emergency generators is possible.

Discussions with a number of the authorities around Australia indicated that there was a lack of consistency in the performance requirements of the public cyclone shelters within Australia and in some cases the standards adopted were below that required by the BCA.

The Building Code of Australia classifies buildings according to their usage, and most State Building Legislation considers an occupation other than in accordance with the design classification to be an offence. However, under special circumstances, relevant State Legislation (e.g. Queensland State Counter Disaster Organization Act [5] and the Queensland Standard Building Regulation – Regulation 96 [6]) provide a legislative framework so that a building can be used for a purpose other than that for which it is classified, provided the building is 'fit-for- purpose'.

This led Emergency Management Australia to commission the Queensland Government's, Department of Public Works to prepare national guidelines on performance criteria for public cyclone shelters.

The guidelines provide a method of assessment to ensure the shelter is 'fit-for-purpose'. They address the temporary use of a building, or a portion of a building, with basic amenities to provide safe shelter for a large number of people during a tropical cyclone. Guidelines relating to the strength of the shelter building are consistent with, and additional to, the Building Code of Australia requirements for designated emergency shelters.

Emergency Management Australia has proposed the guidelines to the Australian Building Codes Board for adoption as a referenced document to the Building Code of Australia.

The most relevant international references identified are by the United States Federal Emergency Management Agency (FEMA) relating to design and construction guidance for shelters [7,8]. The documents address private and community shelters that will provide protection during tornado and hurricane events. However, the documents were not developed with reference to Australian design and construction standards.

The following section contains a brief outline and discussion of the Australian guidelines.

3. GUIDELINES

The guidelines primarily address the safety of people in the shelter.

The shelter is not intended for the purpose of storage of property. It is intended that people enter the shelter with minimal personal effects.

The guidelines for design of public cyclone shelters are categorised in the following sections as:

- Shelter Location – Factors affecting the location of the shelter including storm tide heights, river or creek flood levels, access and the location of existing significant hazards.
- Structure – Loads that the building structure and external fabric, including windows and doors, are to resist during the cyclone are defined.
- Human Factors – Human factors encompassing both comfort and life safety issues including floor area per occupant, duration of occupation, lighting, ventilation, communications, amenities and emergency provisions along with safe movement and access, emergency power, waterproofing and weatherproofing.
- Other Factors - Fire safety issues including fire detection and emergency warning and lightning protection.

3.1 Shelter Location

The shelter shall be located so that: access to the shelter is maintained; the shelter is not inundated by storm tide or flooded by river or creek flow; the shelter is not at risk from landslip or other significant hazard

3.1.1 Access
The shelter is to be located so that access to the shelter is maintained prior to, during and after the cyclonic event.

3.1.2 Storm tide
The shelter floor level is to be above the 10,000 year return period storm tide height [9,10], including allowances for wave setup and wave runup. Buildings, which have the lower levels inundated, but upper levels above the design storm tide height are considered not suitable, unless there is an access route to the building that is above design storm tide height and the building and foundations are assessed as structurally adequate to resist the wind and water loads.

3.1.3 Flood
The shelter floor level is to be at least 300mm above the 100 year return period river or creek flood or, where no estimate is available; the design flood level is to be the maximum known flood level. The backwater effect on flood levels due to the design storm tide is to be considered in determining the design river or creek flood heights. Where the hydrology of the area is such that flooding with high water velocities may occur concurrently with the cyclonic winds the criteria defined for storm tide is to apply to floods. Stormwater drainage is be provided in the form of piped systems, overland flow or levies to ensure that the floor level of a shelter located below ground level is substantially dry during the design rainfall intensity (100 year return period). Provisions are to be made to ensure that the water level does not exceed 1m depth within the shelter should the piped system become blocked or levies overtopped or breached by a 1 in 2,000 year event.

3.1.4 Land slip
The shelter is not to be at risk from landslip. Where a local authority considers a site to have a potential for landslip the site is to be assessed by a geotechnical engineer. The risk of failure is to be not less than 1 in 2,000.

3.1.5 Hazards
The shelter is not to be located near significant hazards such as: hazardous materials (e.g. fuel or chemical storage), physical hazards (e.g. other building or heavy falling debris), high voltage overhead power lines etc. The safe separation distance between the hazard and the shelter is to be assessed for each shelter and is dependent upon the nature and magnitude of the hazard

3.2 Structure

The guidelines relating to the strength of the shelter building are consistent with and additional to the Building Code of Australia requirements for designated emergency shelters in the cyclonic regions of Australia

3.2.1 Wind loads

While designated emergency shelters are constructed to resist a more severe cyclone than normal buildings within the community, it is possible that a cyclone with even greater severity could occur and may result in failure of the shelter building.

In accordance with the BCA the shelters are not designed for Category 5 cyclones, except in an area of north-western Western Australia between latitudes 20 and 25 degrees. Here the shelters are designed for gust wind speeds up to 356 km/hr.

The Guide to the BCA [11] indicates that "designated emergency shelters" are to be in terms of the BCA Importance Level 4. The BCA defines the annual probability of exceedance for cyclonic wind loads for the shelter to be 1:2000. The Australian wind actions code AS/NZS1170.2 [12] defines the design ultimate gust wind speed for a return period of 1 in 2000 in the tropical cyclone region of Queensland, Northern Territory and Western Australia (region C) as 77m/s (277 km/hr) and in the severe tropical cyclone region of Western Australia (region D) as 99m/s (356 km/hr). By comparison the cyclone severity index defines: Category 4 cyclone as having a central pressure 920-944 hPa and gust wind speeds of 225-280 km/hr with a significant potential for damage; Category 5 cyclone as having a central pressure of less than 920 hPa and gust wind speeds greater than 280 km/hr, with an extreme potential for damage. There is no defined upper limit on the gust wind speed of a Category 5 cyclone.

The guidelines require public cyclone shelters to be designed for a minimum gust ultimate wind speed of 280 km/hr (77.8 m/s) in the tropical cyclone region (region C) which is consistent with the upper limit of a category 4 cyclone and for a minimum gust wind speed of 356 km/hr (99 m/s) in the severe tropical cyclone region (region D – i.e. within 50km of the Western Australian coastline between latitudes 20 to 25 degrees).

3.2.2 Debris loads

AS/NZS1170.2 defines a wind borne debris load in a clause relating to determination of a potential dominant opening on a windward wall. The debris criteria contained in the code is independent of the regional design wind speed. Criteria has been developed [13,14,15,16] for shelter buildings to be located in Region C and are more severe than the code. The criteria are less severe than the FEMA and the Darwin Area Reconstruction criteria [17]. A more severe criterion than developed should be adopted for shelters located in Region D.

The external fabric (debris screens, cladding, windows and doors) of public cyclone shelters in the Australian cyclone region C are to be at least capable of resisting wind debris defined as five spherical steel balls of 2 grams mass {8mm diameter} impacting at 30 m/s (108 km/hr) and a 100mm x 50mm piece of timber of 4 kg impacting at 20m/s (72 km/hr).

A test specification incorporated in the guide requires building products (wall sheeting, debris screens, doors etc) to be subjected to both debris loads followed by cyclic wind loads associated with leeward negative pressures.

The guidelines require the shelter to be located away from taller structures defined by a plane that is 1 vertical to 1 (minimum) horizontal unless the shelter structure and external fabric are capable of resisting the dynamic load associated with the heaviest building material identified as potential falling debris from the taller structure.

3.2.3 Earthquake loads

The occurrence of earthquakes and cyclones are not correlated. It is proposed that the shelter design earthquake load be based upon the buildings normal function.

3.2.4 Permanent and imposed loads

The structure is to be capable of supporting permanent and imposed loads as defined by AS/NZS 1170.1 [18] for a building used for public assembly.

3.3 Human Factors

This section of the guidelines encompass both comfort and life safety issues.

3.3.1 Area per occupant

The concept of shelter density is that the density be similar to the seating capacity of a movie theatre. It is not intended to allow for people to sleep in a supine position. The guidelines define the maximum density as a minimum area of $1m^2$ per person. This is consistent with the Building Code of Australia, which nominates $1m^2$ per person as an appropriate density for uses involving public assembly and gathering (e.g. restaurants, theatres, churches, school multi-purpose halls and spectator stands). Some disabled people may require greater area. In comparison FEMA recommends a minimum of 5 ft^2 ($0.45m^2$) per person for tornado shelters and 10 ft^2 ($0.9m^2$) for hurricane shelters.

3.3.2 Occupancy duration

The occupancy duration is dependent upon the duration of the cyclone event. The guidelines define two periods of occupancy. These periods are the total occupancy period and the lock-down period. The design total occupancy period is 36hrs and includes: a period prior to the wind reaching an average speed of 70km/hr, the period of lock-down of the shelter when the winds are greater, and a period after the winds have abated but prior to people departing the shelter. The design lock-down period when windows and doors are closed to provide protection from winds greater than an average speed of 70km/hr is a maximum of 18hrs.

The occupancy periods are based upon people entering the shelter prior to the wind speed impeding walking. The Beaufort Scale identifies that a Force 8 wind speed with an average wind speed of 62 to 74km/hr impedes walking. Cyclone category 1 corresponds to a Beaufort Force 8 & 9 wind speed. The Bureau of Meteorology has advised that during a tropical cyclone (category 4) the period of time during which wind speeds are greater than 70 km/hr at any one location varies, but suggests that the period would not typically extend beyond 15hrs. Logistically, it is preferable if people enter and leave the shelter during daylight. The period between nightfall and sunrise during the cyclone season varies from about 10hrs to 13hrs depending on location.

The guidelines provide caution against premature lock-down of the shelter where mechanical ventilation systems are not operating. A caution against prematurely opening-up the shelter is also included, as the eye of the cyclone may pass over the shelter. At this time the winds will drop dramatically (well below 70km/hr) and can also rise very quickly as the eye passes over.

3.3.3 Lighting

Lighting within the shelter is necessary to calm shelter occupants during the cyclone and to permit safe movement within the shelter. The minimum desirable level is consistent with AS1680.2 recommendations for indoor car park lighting. Torch lights and batteries would be used should electrical supply fail and the duration of the failure exceed the life of the emergency lighting system.

The guidelines state that the minimum desirable lighting level is 40 lux with supplementary task lighting to provide 400 lux in areas for first aid treatment, tea rooms and for recreation areas where occupants may want to read or write. Emergency lighting must be installed in accordance with the BCA for a class 9b building. External lighting is required at the shelter entry. The provision of torchlights and batteries should be included in the shelter management plan.

3.3.4 Safe movement and access

It is expected that the normal use of the building will have addressed normal safe access and movement issues for such a large number of people. In addition to these normal use matters, it is possible that during the cyclonic event the floors may be wet and the slip resistance of floor surfaces may be affected by moisture. In addition the shelter will include a relatively large number of people in an unfamiliar space.

The guidelines require safe movement and access provisions including handrails, balustrades and barriers, human impact on glazing and signage to comply with the BCA requirements for the normal usage of the building. In shelters where it is probable that the floors may be wet during the cyclonic event, then either the floor coverings shall be slip resistant when wet, or strategies are developed as part of the shelter operations plan to maintain dry floor surfaces during the shelter occupancy period.

3.3.5 Access for people with disabilities

The Disability Discrimination Act and the Anti-Discrimination Act require non-discriminatory access to all buildings. Current Building Regulations include prescriptive requirements to ensure access for people with mobility or sensory impairments. These requirements may affect the access-way to the shelter and provision of amenities. The normal use of the building will require portions of the building to be accessible. It is possible that not all of the building would be required to be, or will be, accessible. It is also possible that those portions that are accessible for normal use may not be the most suitable portions for functioning as a cyclone shelter.

The guidelines require that access for people with disabilities to the shelter areas be assessed for compliance with current building regulations. If a complying accessible path of travel to the shelter area is not available, management arrangements are to be developed as part of the shelter operations plan to ensure that persons resorting to the facility are escorted or assisted to the shelter area. An accessible path of travel must be provided between the shelter area and any amenities, either existing within the building, or provided as temporary measures during the shelter occupancy.

3.3.6 Ventilation

The need for enclosure of the shelter to provide protection from wind and wind borne debris and the desire to waterproof the shelter tend to be contrary to the provision of ventilation.

The current deemed to comply requirements contained in AS 1668.2 [19] do not provide design criteria for emergency situations and are in excess of criteria previously deemed acceptable. Ventilation performance criteria based upon minimum CO_2 levels, maximum air movement velocities, odour control and acceptable temperature rise suitable for people of varying ages in a mostly at rest, although stressed state, are suggested as being more appropriate for the design of the shelter ventilation system during lock-down or emergency conditions when wind velocities are high.

External wind pressures associated with cyclonic winds can render mechanical ventilation equipment ineffectual during the cyclonic event. Mains power supply is likely to fail during the event and be unavailable for a period after the event. Hence a ventilation system based upon natural ventilation during the lock-down period of the shelter is the preferred ventilation system.

The guidelines require sufficient ventilation so that the shelter complies with the performance requirement of the Building Code of Australia, which requires the shelter to be ventilated with outside air to maintain air quality.

The ventilation system is to ensure that people of varying ages including children, the aged and handicapped are safely accommodated in the shelter.

The preferred ventilation design concept is that the shelter be conventionally (mechanical &/or natural) ventilated when the wind speed is less than the “lock-down” condition and naturally ventilated when wind speeds are above that condition. The natural ventilation system is to be specifically designed and fitted with dampers with manual override to enable adjustment of the level of ventilation during the event.

The system is to be protected from damage by debris and the design is to consider the potential for blockage of the inlet to the ventilation system by debris. Natural ventilation openings are to be located to maximize cross flow ventilation, particularly for large shelters.

Design criteria regarding maximum carbon dioxide (CO_2) levels, maximum temperature rise and minimum fresh air levels are defined in the guidelines. The criteria are based upon the assumption that no smoking, cooking or heating are permitted in the shelter.

If the volume of internal space per person is low (less than $6m^3$ per person) the fresh air quantity is to be specifically selected in order to meet the design criteria. The potential that people occupying the shelter may be in wet clothes and that water may be entering the shelter during the event should be a consideration in the design of the natural ventilation system.

Ventilation rates are to be restored to the Building Code of Australia deemed to comply provisions after the lock-down period. Management of the ventilation system, including restrictions on smoking, cooking and heating, is to be documented in the shelter operations plan. The plan is to address the evacuation of the shelter after “lock-down” (i.e. “opening-up”) should natural ventilation not be adequate at wind speeds below the design “lock-down” speed and mechanical ventilation is not available due to damage or loss of power supply.

Underground car park shelters require special attention, as these enclosures tend to be much larger in area and capable of housing higher volumes of people and are often mechanically ventilated with little natural ventilation.

3.3.7 Amenities

Amenities are to be provided in the shelter. At least 1 toilet is to be provided for every 40 people in the shelter. This is consistent with the provision of amenities on aircraft.

The amenities may be existing and/or temporary facilities and are to include facilities for people with disabilities.

Where temporary facilities are provided, consideration is to be given to: adequate screening for privacy purposes; separate facilities for males and females; hand washing; disposal of sanitary napkins; provisions for disable persons.

3.3.8 Communications

Consideration is to be given to provision of communication systems within the shelter and external to the shelter. A battery powered hand held megaphone and a battery-powered radio receiver or television are considered the minimum provisions for internal and external communications. It is desirable that an effective communication system is provided between the shelter and the designated disaster coordination centre.

3.3.9 Emergency power

It is desirable for shelters designed to accommodate large numbers of people to be provided with emergency generators. The guidelines require provision to be made in all shelters for an external generator inlet socket, connected to a manual change over switch on the shelter switchboard, to allow for connection of an emergency generator. Where the generators are external to the shelter the generators and fuel tanks are to be protected from the effects of wind, rain and wind borne debris. The generator exhaust is to be located away from shelter air intakes so that exhaust fumes do not enter the shelter ventilation system. Fuel tanks are to be located and fuel shut-off systems installed so that the shelter is not at risk from a fire associated with the generator fuel storage. Where the generator is to be located within the shelter, ventilation, noise and fire safety issues are to be addressed. Provision of battery-powered torchlights is a minimum requirement.

3.3.10 Emergency Provisions

Provision of essential sustenance items including drinking water and food are to be part of the shelter operations plan. Preference should be given to light snacks and drinks which do not require any significant level of preparation or cooking inside the shelter. Community evacuation plans should incorporate a desire for those seeking shelter to bring items of food (snacks), particularly those who have special diets or needs. Provision of first aid medical supplies shall also be included in the plan.

3.3.11 Waterproofing and weatherproofing

The Building Code of Australia currently expects a building used for assembly purposes to be both waterproof and weatherproof. This expectation would apply to the normal use of the building. Cyclonic winds may cause water penetration into the building, particularly gymnasium style buildings which often have high-level ventilation louvres or openings.

The guidelines require the consequences of water penetration into the shelter, due to cyclonic winds, to be considered, particularly in relation to: safe movement and access as wet floors may present a potential hazard; and to ventilation and thermal comfort conditions as wet clothes for a prolonged period may cause discomfort and health issues. Attention should be paid to matters of safety such as ensuring that floors, particularly principal traffic areas, are provided with non-slip flooring material such as non-slip matting and/or that procedures are documented in the shelter operations plan to ensure frequent and routine removal of water through methods such as using brooms, mops, squeegees etc.

3.4 Other Factors

3.4.1 Fire detection and emergency warning

The building would not normally include sleeping accommodation but while it is occupied as a cyclone shelter it may be inhabited by occupants who are asleep or in unfamiliar surroundings. Early fire warning is required so that the shelter occupants have time to take preventative action.

A real contingency that must be planned for is the loss of electrical power during a cyclonic event. In such cases many of the fire detection, warning and suppression devices provided for the normal use of a building will be rendered ineffective. Some systems will have battery powered back-up, however this is usually only for a limited period and it is likely that failure of electrical supply during a cyclonic event will exceed the capacity of such battery back-up.

It is unlikely that the Fire Brigade could provide assistance during the shelter lock-down period. It is also possible that mains water pressure may not be available.

The guidelines require the shelter to comply with the automatic fire detection and warning requirements of the Building Code of Australia for its normal use. The shelter operations plan is to provide for suitable management of fire risk on the basis that there is no electrical power supply, mains water supply may not be available, and that the fire brigade could not provide assistance, during the shelter lock down period. The plan is to include: Limiting fire ignition through the prohibition of smoking and other naked flames (such as candles, gas lights etc); Eliminating fuel sources by prohibiting gas cylinders in the shelter, removal of cars, vehicles and stored fuel from the shelter prior to occupation; Constant surveillance by persons appointed as shelter supervisors; Advice to shelter occupants of the limitation of sources of ignition, combustibles, surveillance techniques, and a warning system to be employed in case of an emergency; Provision of one tri-class (2A: 20B: (E) minimum) fire extinguisher for each specific risk location, for each shelter management personnel, and for each 1,000 shelter occupants; Provision of two 9-litre water extinguishers at each Fire Hose Reel location. Fire extinguishers are to be tested in accordance with the shelter maintenance plan.

3.4.2 Lightening protection

The shelter may have to provide protection from severe electrical storms and must be provided with adequate lightning protection. Consequently, the guidelines require lightning protection to be provided to protect the shelter structure and to also provide protection from lightning induced surges in power and telecommunications cables entering the shelter.

3.5 Shelter Management

Management issues such as the number of shelter spaces required within a community, and the acquisition and activation of buildings are not considered in the guidelines. The authority for activation of any designated shelter building and its management, including development and updating of shelter operations and maintenance plans, would be as delegated by the respective Local, Disaster District or State Government Disaster Coordination Committee.

This section of the guidelines addresses shelter operations, maintenance and signage issues, which relate to the previous sections.

3.5.1 Shelter operations plan

A shelter operations plan should include clauses regarding: aim; objectives; authority of the plan; management committee; activation of plan; financial aspects; concept of operations; roles and responsibilities; staffing; blankets; sanitation; fire detection; first aid facility; registration; counselling; sustenance; shelter preparation; communications; pets.

The plan should address training of personnel to manage the shelter. A register of trained personnel, contact details and availability is to be compiled/updated annually, prior to the commencement of the cyclone season. A copy of the register is to be provided to the Disaster District Coordinator.

The plan should maintain a register of the location of any items needed for the operation and management of the shelter accommodation and necessary contact details. This register should be reviewed annually for completeness and modified accordingly.

The shelter operations plan is to address the shelter management process including: manning levels and expertise; provision of food and drinking water; provision of basic medical supplies; provision of amenities; management including registration of people entering, accommodated within and leaving the shelter; strategies for redirection of people to alternative accommodation should the shelter reach capacity; provision and management of communications within and external to the shelter; management of public safety issues (e.g. limiting combustibles, fire detection, ventilation, safe walking areas); and enforcement of the operations plan.

It is recommended that the plan is tested by a training exercise.

No special allowance has been made in the performance criteria for accommodation of pets. The guidelines are a minimum standard that primarily addresses the safety of people. Accommodation of pets within the shelter may reduce the number of people able to be accommodated and has implications regarding ventilation and sanitation. While some pets may be reasonably accommodated within the shelter others should not be accommodated as they could affect the health and safety of people. Alternative accommodation could be identified for pets, where such a need is identified.

The potential occupation period is extensive and the shelter operations plan is to consider the needs of people. People in the shelter should be able to move around and involve themselves in different activities: e.g. reading, talking and resting etc. The shelter operation plan should ensure this opportunity is available to all persons resorting to the shelter, including those with a disability. This may require additional consideration in respect of persons with disabilities including: having mobility aids available for those persons who have been evacuated to the shelter without their own personal mobility aids, or making arrangements with search and rescue personnel effecting evacuations to ensure mobility aids for persons with disabilities are evacuated with the person; providing additional lighting in certain areas for persons with sight impairments (e.g. primary circulation routes and amenities areas).

3.6.2 Shelter maintenance plan

The shelter maintenance plan should include: scheduled regular maintenance works in accordance with the buildings approved maintenance plan; a scheduled maintenance inspection prior to each cyclone season and immediately prior to an impending event; a check list of the emergency supplies which are permanently located within the shelter; an updated list of sources of provisions not permanently located within the shelter; a list of items to be inspected/checked (e.g. emergency generators, doors, locks, signage, drainage, debris screens, lighting etc); and person(s) responsible for the inspection.

The guidelines require the annual inspection to include a fitness-for purpose assessment of the shelter. This would include assessment of changed circumstances including any modifications that may have occurred to the shelter or the surrounding area. Where the changes are detrimental to the shelter, action is to be taken to ensure the shelter is fit for purpose prior to the commencement of the cyclone season.

The plan is to ensure that the building is maintained in an appropriate condition to ensure the shelter is fit-for-purpose.

3.6.3 Signage

The location of the shelter, limitations within the shelter, maximum occupancy of the shelter and emergency exits are to be clearly signed. It is suggested that a sign be erected near the entry to the shelter that states condition of entry.

4. FUTURE INIATIAVES

A scoping study for the provision of public cyclone shelters in Queensland is currently being undertaken. The study is a joint funding initiative of the Natural Disaster Mitigation Program (NDMP). The study consists of three phases. Phase 1 is a desktop review of the buildings nominated in the 1998/99 program; Phase 2 is an investigation of the cost of upgrading existing buildings to meet the shelter building criteria, compared with the cost of incorporating shelter requirements into proposed building projects; Phase 3 is to develop a strategy for the provision of public cyclone shelters in Queensland.

Further, there is a need to liaise with industry to develop building products to meet the shelter building requirements. Several products have been developed to meet the shelter building flying debris criteria for the external fabric of the shelter. Lysaght have constructed a test facility to undertake flying debris tests to the shelter building standard; Lysaght have developed the Stormguard debris screen to protect shelter windows from flying debris; GJ James has undertaken tests of a debris resistant glass system; Crimsafe are developing a stainless steel mesh debris screen; Ingersoll-Rank has identified door hardware. Various building products including wall sheeting materials, doors and hardware need to be tested to determine acceptability with shelter building standards.

In addition, the potential need within communities located in the cyclone region of Australia for public cyclone shelters should be identified. It is envisaged that the need is a function of the size of the community, extent of

storm tide inundation; the standard of building construction within the community and the ability to evacuate the community out of the path of the cyclone.

5. CONCLUSIONS

This paper has presented an outline of the guidelines for the design of public cyclone shelters, which are occupied during a tropical cyclone. It provides the background to the development of national guidelines which form a standard by which Government and Disaster Managers can determine the provision of an appropriate level of safety to address their duty of care to the community.

6. ACKNOWLEDGEMENT

The "Design Guidelines for Australian Public Cyclone Shelters" document was developed by the Queensland Government, Department of Public Works. The project was a joint funding initiative of the Queensland Government and Emergency Management Australia (EMA). Stakeholders in Western Australia, Northern Territory and Queensland provided valuable contributions to the development of the guidelines.

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