OCCUPANT WARNING IN HEALTH AND AGED CARE FACILITIES V4

Fire and Security Consulting Services (FSCS) is frequently consulted on the requirements for occupant warning systems in health and aged care buildings. These, under the Building Code of Australia (BCA) are Classes 9a and 9c respectively.

Whilst the BCA and Australian Standards requirements are quite clear, and will be summarised later in this paper, the effectiveness of the required systems are often questioned.

The other issue is that there is a fuzzy line between Class 9a and 9c occupancies. The BCA defines Class 9a as a "health care" building and Class 9c as an "aged care" building. Whilst "aged care" is self evident, a "health care" building can range from a large multi storey hospital to a small rural nursing home which was once a district hospital! Note however that Class 9c was only introduced in BCA 1990 and before that time all aged care buildings were Class 9a.

This is causing much concern as to the proper Classification, and consequently the extent of occupant warning requirements under the BCA.

FSCS believes that the reason that many owners and / or operators resist the Class 9c Classification is that under the BCA, a Class 9c building is required to be sprinkler protected; a not inconsequential cost impost.

A simple analysis of the functionality and staffing requirements of each Class is useful to explore as follows:-

- A Class 9a building is a "health care" building and envisages staffing requirements applicable for the care of occupants who are patients and require short to medium term care and treatment.
- A Class 9c building provides for the care of aged occupants, many of whom are "patients' in a like sense to occupants in a Class 9a building but generally for long term occupancy. The staffing in such buildings is generally far less than in a Class 9a building.

FSCS is in complete agreement with the intent of the BCA fire safety provisions which address the real differences between the Classes by the prescribed mix of passive and active fire safety systems as follows:-

- Class 9a addresses fire safety by fire and smoke compartmentation and reliance on staff to relocate patients from the fire origin compartment to another safe compartment. This requires significant staff and an emergency control organisation adequate for the task.
- Class 9c addresses fire safety by larger fire compartments, smaller smoke compartments and the installation of sprinklers. This requires far less staff to relocate fewer occupants because the sprinkler system will suppress (or at least control) the fire and the smaller smoke compartments allow for quicker relocation.

1 - BCA REQUIREMENTS

Under the BCA , both Classes 9a and 9c require smoke detection systems to be installed in accordance with BCA Table E2.2a and Specification E2.2a as follows:-

- *Clause 2* (c) for Class 9a requires, where the number of beds is 6 or less, a smoke alarm system complying with *Clause 3*, or a smoke detection system complying with *Clause 4*.
- *Clause 2* (d) for Class 9c requires a smoke detection system complying with *Clause 4*.

So far, so good, and at this stage it would seem reasonable to ignore the 6 or less bed Class 9a building which only requires smoke alarms, so bear with me as I proceed through the complexity of the requirements.

The issue of occupant warning arises when a building is required to have a *Clause 4* detection system.

Clause 4 of BCA Specification E2.2a requires, under sub-clause (b) a "building occupant warning system in accordance with *Clause 6*.

Clause 6 of Specification E2.2a requires the occupant warning system to comply with Clause 3.22 of AS1670.1 [1] except:-

6 (d) *in a Class 9a health-care building, in a patient care area, the system-*

(i) must be arranged to provide a warning for occupants; and

(ii) in a ward area, may have its alarm adjusted in volume and content to minimise trauma consistent with the type and condition of the patients.

6 (e) *in a Class 9c aged care building, the system-*

(i) must be arranged to provide a warning for occupants; and

(ii) must notify staff caring for the residents of the building; and

(iii) in areas used by residents, may have its alarm adjusted in volume and content to minimise trauma consistent with the type and condition of residents.

Prior to the 2010 edition of the BCA, the requirements of E4.9 for intercommunication systems were often missed. It is now included within the first sentence of *Clause 6* of Specification E2.2a.

The key word in this clause is *intercommunication*, which adds further complexity to the system requirements.

At this stage it might be opportune to mention that in a recent project, Andrew Gilchrist, Advisor - Building Standards, Sustainable Planning, Building Codes Queensland, Department of Local Government, Planning, Sport and Recreation, has advised that he is of the opinion that bedrooms containing ensuite bathrooms are considered as sole occupancy units. Thus the requirements of Class 3 units may need to be incorporated. Luckily the BCA Clause 3 requirements for occupant warning are less onerous that those in *Clause 4.*

2 – AUSTRALIAN STANDARDS

Now moving on to AS1670.1, it is required to address the requirements in Clause 22 of that Standard, which is reproduced below. Of particular interest are sub-clauses (a), (d) and (e).

3.22 OCCUPANT WARNING

Occupant warning shall be provided to alert all building occupants to a fire alarm situation.

The warning system shall be one of the following:

(a) A sound system for emergency purposes in accordance with AS 1670.4, initiated by the fire detection system. The fire alarm system shall monitor the sound system for fault signals required by AS 1670.4.

(b) Electronic sounders, or amplified sound systems producing the evacuation signal (with or without verbal message). The evacuation signal shall operate simultaneously throughout the building. At all places where warning signals are conveyed to building occupants, the A-weighted sound pressure level during the 'on' phases of the audible emergency evacuation signal, measured with the time-weighting characteristic F (fast) (see AS 1259.1), shall comply with the following:

(i) The requirements of ISO 8201.

(ii) Exceed by a minimum of 10 dB the ambient sound pressure level averaged over a period of 60 s, not be less than 65 dB(A) and not more than 105 dB(A). These values shall be determined in accordance with AS 2659.1.

NOTES:

1 It is recommended that the default evacuation signal complying with ISO 8201 consists of a uniformly increasing frequency during the 0.5 s on phase of the signal. Other signals may be more appropriate for use where the ambient noise will mask the signal.

2 Measurement should be taken in the normal standing positions on the floor of coverage.

(c) Additional visual and tactile signals shall be provided to augment the audible emergency evacuation signal if the averaged A-weighted sound pressure level of the background noise is higher than 95 dB. The temporal pattern described in ISO 8201 shall be imposed on the visual and tactile emergency evacuation signals.

(d) If the audible evacuation signal is intended to arouse sleeping occupants, the minimum A-weighted sound pressure level of the signal shall be 75 dB at the bedhead, with all doors closed.

NOTE: 75 dB(A) may not be adequate to awaken all sleeping occupants.

(e) Where occupants, such as patients in hospital wards, must not be subject to possible stress imposed by loud noises, the sound pressure level and message content shall be arranged to provide warning for the staff and minimize patient trauma.

(f) The sounders shall be connected to a supervised output at the CIE.

Let's now address the three sub-clauses of interest.

- Sub-Clause (a) requires that the sound system shall comply with AS670.4 [2]. Section 4 of that Standard is the relevant section and Clause 4.3.4 is reproduced below:-

> **4.3.4 Output of loudspeakers**
>
> At all places within the evacuation zone within a building where warning signals are conveyed to building occupants, the A-weighted sound pressure level during the 'on' phases of the audible warning signals, measured with the time-weighting characteristic F (Fast) (see AS 1259), shall exceed by a minimum of 10 dB the ambient sound pressure level averaged over a period of 60 s, shall not be less than 65 dB and not more than 105 dB. These values shall be determined in accordance with AS 2659.1.
>
> NOTE: Measurement should be taken in the normal standing positions on the floor of coverage.
>
> If the audible warning signals are intended to arouse sleeping occupants, the minimum A-weighted sound pressure level of the signal shall be 75 dB at the bedhead, with all doors closed.
>
> NOTE: 75 dB(A) may not be adequate to awaken all sleeping occupants.

This is essentially the same as Clause 3.22 (d) of AS1670.1 and reinforces the statement that a sound pressure level of 75dBa is required at the bedhead, and that 75dBa may not waken sleeping occupants.

- Sub-Clause (d) requires a sound pressure level of 75dBa is required at the bedhead, and that 75dBa may not waken sleeping occupants.
- Sub-Clause (e) permits an alternative arrangement so that warning is provided to staff so that certain occupants, such as patients, are not subject to possible stress by an audible warning.

It should be noted that BCA E4.9, also requires intercommunication in certain Class 9a buildings. Reference here is to AS1670.4 Clause 5.3.3 reproduced below.

> **5.3.3 Location**
>
> WIP handsets shall be located in the following areas:
>
> (a) On each floor, as determined by the emergency control organization defined in AS 3745.
>
> (b) At the designated building entry point in accordance with AS 1670.1 (if remote from the intercom panel).
>
> (c) In each zone, if each floor is divided into two or more emergency zones, as determined by the emergency control organization defined in AS 3745.
>
> (d) In each designated emergency lift.
>
> (e) If required by the fire service, in or adjacent to pump rooms, sprinkler valve rooms and hydrant relay booster pump sets.
>
> (f) Adjacent to the FIP (if remote from the intercom panel).
>
> The WIP handset shall be mounted at a height of not less than 1200 mm and not more than 1800 mm above finished floor level.
>
> WIP handsets shall be permanently fixed in position.

The interesting point in this clause which says that WIP handsets shall be located "as determined by the emergency control organisation defined in AS3745 [3]. This will be discussed later in this paper but briefly, what if the emergency control organisation, because of limited staff numbers, determines that Wardens are not required or are inappropriate for the building.

3 – DISCUSSION ON WARNING SIGNALS

Whilst the BCA and Australian Standards are very clear on the sound pressure levels of 75dBa at the bedhead, the critical sentence in each of the requirements is ***"if the audible evacuation signal is intended to arouse sleeping occupants"***.

So, who is really an occupant? FSCS is of the opinion that occupants of both Class 9a and Class 9c buildings have potentially equally diminished physical and acuity capabilities. As an example, a patient in a hospital with a broken pelvis may be alert but not physically capable of self evacuation whereas an occupant in an aged care facility may be physically capable but may suffer from dementia and not be capable of understanding or reacting to evacuation signals.

In fact both the BCA and Australian Standards allow that in a Class 9a ward area, the alarm system may have its alarm adjusted in volume and content to minimise trauma consistent with the type and condition of the patients. So why shouldn't the alarm system in a Class 9c aged care facility have the same concession?

FSCS is of the opinion that in both Class 9a and 9c buildings, the preferred alarm outcome is that it should not be the intent of the alarm system to arouse sleeping occupants, but only to alert staff to both the location and nature of a fire alarm.

To awaken and alert all occupants would certainly result in trauma in both types of occupancy because, whether because of physical or mental capacity, the result would be difficult for staff to cope with.

This also leads to the question of whether alarms should be broadcast throughout the entire building. Appropriate zoning as permitted under AS1670.1 and AS1670.4 will allow staff to concentrate on evacuation of occupants in the fire affected area. The last thing that staff want is another occupant either pushing the nurse call button or wandering around questioning what is going on.

4 – DISCUSSION ON ALARM HEARING AND RECOGNITION

Now in relation to the above, there are a number of discussion points that need to be covered.

The 75dBa Issue

Recalling that AS1670.1 requires 75dBa at the bedhead, I have researched this issue and find that this requirement was based on BS 2750[4] and the various additional research documents [5] that I have viewed all base the minimum requirement on that figure.

Note also that AS1670.1 also states that "*75dB (A) may not be adequate to arouse sleeping occupants".* This is an important statement because it recognises the limitations of any warning system. Later on I will address the issue of automatic warning to aged and infirm occupants (along with children, intoxicated and drug affected persons) which I would consider to be the target of this note in AS1670.1.

Response of Elderly Persons

Further to this issue I have carried out a brief literature survey [5] on the subject of warning sound levels and elderly persons. In summary, my findings are:-

- A significant proportion of persons surveyed in aged residential premises aged over 70 had hearing difficulties in the range of ~30dB reduction in audibility. Hearing aids were unlikely to be activated whilst asleep or resting.
- A significant proportion of persons surveyed in aged residential premises take medication of various types including sleeping drugs. Such medication is not limited to night time.
- Sleep patterns (time of day) were varied with random sleep and wakening times at any period in day or night.
- The sound level itself is not the key issue in awakening any person of any age. The real issue is the frequency of the signal; low frequency signals are more likely to be responded to than high frequency signals at the same sound level. Typical sounders in modern alarm systems are piezo sounders providing high frequency signals and due to the efficiency of their construction requiring only small currents to achieve the required sound level – hence small batteries and cheaper equipment for smoke alarms and more cost effective loop powered sounders in AS1670.1 systems.
- Regardless of occupant age, sound levels and frequency, it appears that the depth of sleep controls the response. During REM (rapid eye movement) sleep patterns, all persons in test programmes were aroused earlier than in deep sleep patterns. The

distribution between ages and gender with relation to periods of REM was random and varied. REM sleep patterns in all age groups are random according to the time of day.

- Tests were carried out using strobe lights of high intensity to stimulate awakening. Tests results varied from 30% to 70% success rate but with no age or gender patterns apparent. Strobe lights however were considered to have the potential to trigger epileptic attacks.
- The most successful test results utilised “bed shakers”. An expensive solution. However not all occupants slept in bed during observed patterns of behaviour. Many aged persons frequently fall asleep in comfortable chairs – significantly it was in these that the deepest sleep periods occurred.
- A significant proportion of persons surveyed in aged residential premises had mobility difficulties and were not capable of self evacuation. In many circumstances they were aware of the requirement to evacuate but suffered severs trauma because they were not capable of a physical response.

CONCLUSION

It is concluded that the occupant evacuation of health and aged care facilities should not be dependant on alarms being provided to all occupants. In fact it should be noted that to rely on such may in fact be detrimental to the safe and efficient evacuation that has to be effected by staff.

It is recognised that in both Class 9a and Class 9c occupancies, there are frequently occupants who are not residents. These will include visitors to the residents, contractors, visiting volunteers and the like. These persons will almost certainly be awake and mobile and should be afforded the opportunity to hear an alarm. However the alarm for them would not be to “arouse sleeping occupants” and the standard 10dBa above ambient should be adequate for the purpose.

With respect to intercommunication with WIPs, the emergency control organisation should take precedence over BCA E4.9, and where there are limited staff, WIPs would be a useless facility.

I trust that this Paper clarifies the issues considered.

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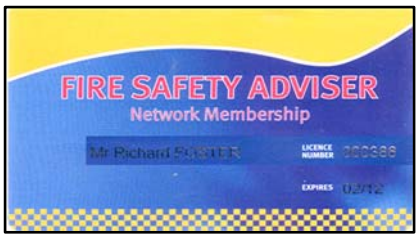

References

[1] Standards Australia 2005, *AS1670.1 – Fire detection, warning, control and intercom systems – System design, installation and commissioning. Part 1: Fire*, Standards Australia International, Sydney NSW Australia

[2] Standards Australia 2004, *AS1670.4 – Fire detection, warning, control and intercom systems – System design, installation and commissioning. Part 4: Sound systems and intercom systems for emergency purposes*, Standards Australia International, Sydney NSW Australia

[3] Standards Australia 2002, *AS3745 – Emergency control organization and procedures for buildings, structures and workplaces*, Standards Australia International, Sydney NSW Australia

[4] BS EN ISO 140-3: 1995 (formerly BS 2750 Part 3)

[5] Various Research Papers including:

- "A Review of Sound Effectiveness of Residential Smoke Alarms" – US Consumer Product Safety Commission.
- "Recognition of Fire Cues During Sleep" – Dorothy Bruck, Victoria University – Melbourne.
- "Optimising Fire Alarm Notification for High Risk Groups" - Dorothy Bruck & Ian Thomas, Victoria University – Melbourne.
- "Waking Effectiveness of Emergency Alerting Devices for the Hearing Able, Hard of Hearing, and Deaf Populations" - Erin Ashley – University of Maryland.
- "Behavioural Response to Fire and Smoke" John Bryan in the SFPE Handbook of Fire Protection Engineering.

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