

Fire Safety and the National Disability Insurance Scheme

Ian D Bennetts, PhD
Stephen Kip, MEng
Henderikus J Van Ravenstein, EMPA



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Fire Safety and the National Disability Insurance Scheme

ABSTRACT

The National Disability Insurance Scheme is the national program for delivering services and support for people with permanent and significant disability in Australia. In Victoria, the first stage of the scheme began in July 2013, with the majority of the roll-out being achieved by April 2018 and completed by January 2019.

A similar process is being followed in other Australian states and territories. With the National Disability Insurance Scheme, people with disability can choose support and services to meet their individual needs, rather than fit within a one-size-fits-all system.

The services provided (e.g. accommodation) are to provide an adequate level of fire safety and this is to be administered by the National Disability Insurance Agency, which has estimated that by 2019 the National Disability Insurance Scheme will cover about 475,000 participants at a cost of \$22 billion each year [Productivity Commission 2017].

For most residential buildings (dwellings), it is commonly assumed that compliance with the Deemed-to-Satisfy (DtS) provisions of the National Construction Code Series¹, Building Code of Australia Volume One is sufficient to achieve a satisfactory level of performance and safety. However, it needs to be understood that except for access considerations, the DtS provisions have been largely written around non-disabled occupants, this is similar for dwellings in the Building Code of Australia Volume Two.

There has been little consideration of the fire safety of disabled or vulnerable clients. It is for this reason that the Victorian Department of Health and Human Services has developed the Capital Development Guidelines, Series 7 Fire Risk Management 2013 to provide further guidance on fire safety of buildings occupied by vulnerable and disabled clients.

The Guidelines require clients to be profiled with respect to their ability to understand and respond to an alarm and the level of support (if any) required to physically evacuate. Sprinkler protection is required for most but not all residential situations along with a range of other measures.

Given the relatively high cost of retro-fitting sprinkler protection to existing residential buildings, a key issue is to determine under what conditions, if any, it may be appropriate not to require sprinkler protection.

From a consideration of the hazard and risk factors associated with residential buildings and the impact of physical and mental disabilities, two such situations have been identified with respect to the use of Class 1a buildings.

It is already considered reasonable and is permitted under Victorian Department of Health and Human Services, Capital Development Guidelines Series 7 Fire Risk Management, Guideline 7.8 to not require sprinklers where disabled clients can be reasonably considered as having a Type 1 profile, subject to the buildings meeting the fire safety requirements of Guideline 7.8.

¹ The National Construction Code Series 2016© is produced and maintained by the Australian Building Codes Board on behalf of the Australian Government and each State and Territory government

Secondly, it is considered possible that up to two disabled clients could be accommodated in an existing unsprinklered Class 1a building provided the following conditions are met:

- A carer is present whenever the clients are in residence and,
- The total movement time for the carer to reach and assist evacuation of the disabled persons is to be less than 120 seconds, as determined by a trial and,
- All other requirements of Guideline 7.8

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THE NATIONAL DISABILITY INSURANCE SCHEME

Regulatory Framework

The National Disability Insurance Scheme is the new national program for delivering services and support for people with permanent and significant disability in Australia. National Disability Insurance Scheme was trialed in different jurisdictions across Australia, being in New South Wales, Victoria, South Australia and Tasmania.

In Victoria, the first stage of the scheme began on 1 July 2013 in the Barwon area and is being progressively rolled out with the final stage being implemented by January 2019 [National Disability Insurance Scheme Victoria]. The table below lists the transition schedule for the various jurisdictions in Australia.

Source - Productivity Commission *National Disability Insurance Scheme (National Disability Insurance Scheme) Costs, Study Report, Canberra, October 2017- Table 1 - National Disability Insurance Scheme transition arrangements by jurisdiction p11.*

Table 1

	Trial period			Transition to full scheme			Full scheme
	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20
NSW	Hunter area trial			Transition to full scheme (by region)	Full scheme		
		Early Transition in Nepean Blue Mountains area (children aged 0–17 years)					
Vic	Barwon area trial			Transition to full scheme (by region)			Full scheme
Qld				Transition to full scheme from July 2016 (by region). Early Transition from January 2016 in Townsville, Charters Towers and Palm Island			Full scheme
SA	Statewide trial (children aged 0–14 years)			Transition to full scheme (by age and region)		Full scheme	
Tas	Statewide trial (people aged 15–24 years)			Transition to full scheme (by age)			Full scheme
NT		Barkly region trial		Transition to full scheme (by region)			Full scheme
ACT ^a		Territorywide trial		Full scheme			
WA ^b	Perth Hills area trial			Transition to locally administered NDIS			
	MyWay trial						

^a The Bilateral Agreement for the National Disability Insurance Scheme launch between the Australian Government and the ACT Government notes that from 2016-17 the ACT will be in 'transition to full scheme'. This transition has been categorised as 'full scheme' because all residents who meet the eligibility criteria will have access to the scheme. ^b In February 2017, the Australian Government and Western Australian Government signed a Bilateral Agreement for a nationally consistent, but locally administered, National Disability Insurance Scheme.

A bilateral agreement was signed by Prime Minister Malcolm Turnbull and Victorian Premier Daniel Andrews on 16 September 2015 [Bilateral Agreement 2015] for the roll out of the National Disability Insurance Scheme in Victoria. A similar process is being followed in other Australian states and territories. With the National Disability Insurance Scheme, people with disability can choose support and services to meet their individual needs, rather than fit within a one-size-fits-all system.

The National Disability Insurance Scheme is being administered by the National Disability Insurance Agency and this is expected to include approval not only of funding but also the adequacy or otherwise of accommodation. When fully implemented, the cost of the National Disability Insurance Scheme is expected to be around 22 billion dollars per year [Australian Government, 2014], [Productivity Commission 2017].

Approved clients will be provided with funding which can be used for both care (including provisions of a carer) and accommodation. A registered provider is an individual or organisation that delivers a support or a product to a participant of the National Disability Insurance Scheme. Existing or new residential buildings can be provided and operated by registered providers. The National Disability Insurance Agency is currently working with State and Territory governments to develop a national approach to quality and safeguards that will apply to services provided by registered providers [www.ndis.gov.au]. This also applies to residential building construction, including fire safety which is the focus of this paper.

Disabled persons are frequently accommodated in detached houses that are not government owned or funded. In some cases, there may be more than one detached house on an allotment. Residents may be accommodated in one or more dwellings on a site. Such buildings are typically single storey but may also be double storey.

The authors have witnessed one such building where 2 female residents were located on the ground floor of one part of a two-storey building and 5 male residents were located in a functionally separate part of the same building. This part had 4 bedrooms upstairs and one downstairs. The two functional parts were separated by a nominally fire-resistant wall. All persons within this building typically worked during the day and were not within the building between 8am and 4pm. A single carer was present during the time that the building was occupied and slept overnight in one of the parts. It was noted that the group of males had been together for many years and a strong familial relationship existed. It is our understanding that such familial relationships are common, and important for the wellbeing of some disabled residents.

The implementation of the National Disability Insurance Scheme means that funding may be sought by both potential residents and service providers to enable clients to live in existing Class 1a buildings that will often be one or more detached houses on an allotment. It could be reasonably argued that in many of these situations, due to the close relationship between the residents, and between the resident and the carer, a Class 1a classification is still appropriate. Should the use of the building be classified or re-classified as Class 3 (boarding house, guest house, hostel or the like), then this will constitute a change of use and the relevant current National Construction Code Series 2016, Building Code of Australia Volume One² provisions must be implemented. This would include the disabled access requirements, emergency lighting and fire-safety measures as specified in Volume One of the Building Code of Australia.

The question is: what fire safety measures are appropriate for *existing* and/or new Class 1a buildings if they are to be occupied by disabled clients in a residential setting. These measures may differ from the relevant National Construction Code Series 2016, Building Code of Australia requirements which in the case of an existing building, would be imposed

² The National Construction Code Series 2016© is produced and maintained by the Australian Building Codes Board on behalf of the Australian Government and each State and Territory government.

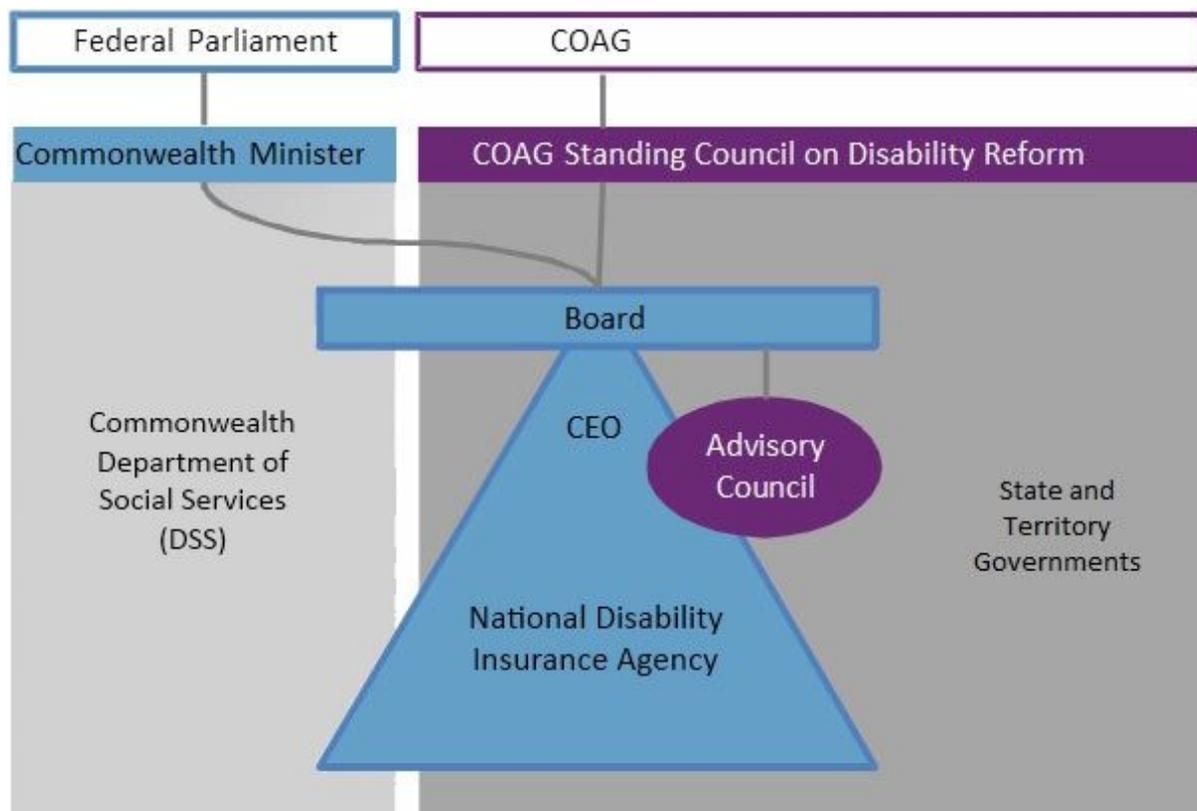
retrospectively if there was a change in use, or significant building work is to be undertaken. Appendix A provides the Building Code of Australia definitions for Class 1a, 1b and 3 buildings.

Aspects of Policy Framework

The governance model for the National Disability Insurance Scheme is outlined in the National Disability Insurance Scheme Act 2013. The scheme is administered by the National Disability Insurance Agency which has been established under Commonwealth legislation, the National Disability Insurance Scheme Act 2013 (National Disability Insurance Scheme Act) and is governed by a Board.

The Commonwealth Minister is responsible for administering the National Disability Insurance Scheme Act, and exercises statutory powers with the agreement of states and territories, including a power to make the National Disability Insurance Scheme Rules and direct the National Disability Insurance Agency [<https://www.ndis.gov.au/about-us/governance/legislation.html>] (See also Table 2).

Table 2



The Federal Government needed to implement a change management strategy by reviewing the previous systems and updating them where required. The main change management strategy that was required was to create a structure that had the authority to enforce public policy requirements, communication tools to assist with negotiations within and external to the Government, and data systems to assist them to monitor and improve compliance.

The full scheme of the roll out of National Disability Insurance Scheme started progressively from July 2016 [www.ndis.gov.au/about-us/our-sites] this, in effect, set the direction and reporting structure that allowed different bodies and Jurisdictions to be involved.

The approved governance structure had to be consistent with the agreements made between the States, Territories and Federal Government about the appropriate control of complex portfolios and risks; so as to provide a sustainable and robust approach in achieving the aims of the scheme. This paper will focus only on fire safety and regulatory compliance, but set in the framework of good policy development and implementation.

Where the market cannot self-regulate or provide adequate services, sound government practices suggest the need to introduce a legal framework by setting minimum standards without restricting technological advancements [Hughes, 2012]. In this regard, fire safety compliance needs to be a major strategic and business priority for all levels of Government and be legally robust.

There is a high demand for good policy advisors and strong leadership in public sector organisations and its performance is linked to how leader's practice. Public sector organisations with strong leadership capacity also exhibit increased adaptability, innovation, effectiveness and efficiency compared to their counterparts with weaker leadership capacity [Andrews & Boyne, 2010].

Good policy framework development aims to positively implement changes in public policy such that the desired outcomes are achieved in a cost-effective manner. Evaluating and benchmarking through the use of appropriate indicators is a process that can be used for improving policies through the systematic use of available experience but also to increase the transparency, accountability and participation in the decision-making process.

To truly understand the underlying driving force for change, it must be understood, that various Acts and Regulations place the accountability and responsibility for building compliance with the owner of the building and in some cases on the service provider. The owner and service providers must abide by all legislation and requirements of the Act and Regulations which are called up under the Act.

It is in this context that the National Disability Insurance Scheme and the fire safety provisions and compliance must be set within a strong and effective policy framework

Fire Risk Management

A Victorian experience that provided motivation for change occurred in 1996 when nine men living at Kew Residential Services (KRS) lost their lives in a fire. This facility was owned and managed by the Victorian Department of Health and Human Services Victoria. At the Inquest, which followed, the Coroner (Inquest Kew Residential Services) criticised the government for paying insufficient attention to the risks of people living in Victorian Department of Health and Human Services Victoria facilities who were unable to safely and independently evacuate in an emergency.

Among a range of issues, the Inquest highlighted the fact that, that fire safety standards in existing buildings may not comply with the Building Code of Australia³, may inadequately deal with client needs and use of buildings, and may be serviced by inadequately skilled building practitioners.

³ The National Construction Code Series 2016© Building Code of Australia is produced and maintained by the Australian Building Codes Board on behalf of the Australian Government and each State and Territory government.

The Coroner, Graeme Johnstone (Inquest Kew Residential Services) in the *Kew Residential Services Coronial Inquest*⁴, in his conclusion stated the following: -

'Fire safety systems must be considered as a total package of risk management, equipment, maintenance, training and fire and evacuation drills. ...Where disabled or immobile persons are concerned, the importance of the total package cannot be underestimated....Modern, fast response residential sprinkler systems designed to reduce fire spread are essential.'

However, it is recognised by the Courts that options available to the Government to address inadequacies in the context of duty of care are limited by resources, requiring difficult policy decisions and discretionary judgments [Crimmins, 1999].

In response to these Court considerations and the Coroner's recommendations, the Victorian Department of Health and Human Services developed a Fire Risk Management Strategy. The Strategy recognises the Coroner's recommendation that Fire Safety Systems for a building need to be considered as 'a total package of risk management, equipment, maintenance, training and fire and evacuation drills' [State Coroner's Report, 199, pg. 311].

The Fire Risk Management Strategy is implemented in Victoria by means of a set of Guidelines. This applies to managing the fire risk in shared accommodation buildings that are operated or funded with the assistance of government funding, noting that some government intervention is desirable in a market driven industry: -

'Government economic action stems from market failure – the inability of an unregulated market economy to achieve an efficient and equitable allocation of resources' [McTaggart et al, 1996]

The Guidelines were extensively reviewed in 2013, with the involvement of Industry bodies, organisations, legal and government program areas which was endorsed by the Secretary of the Victorian Department of Health and Human Services, Director of Housing and the Chief Officers of the Metropolitan Fire and Emergency Services Board (MFB) and Country Fire Authority (CFA) in August 2013. This reflected a modest stirring of interest in the protection of fundamental right of safety (in relation to fire risk) for the most vulnerable people in society, including people with disabilities in the care of organisations.

Government is sometimes required to intervene to offset distortions in service provisions caused by external diseconomies and economies [Mansfield, 1982, p.487]. Effective fire risk management relies on a complex interaction between human factors, building compliance and effective operation of passive and active systems to detect, warn and where appropriate to suppress fire, in addition to having an audit and upgrade program.

It is shown that specific technical knowledge of the subject matter is important, however equally important is the analytical and negotiation skills, as well good communication skills and ongoing learning is required for any policy to be accepted and implemented.

With the introduction of any new policy, change is inevitable; however, the most important aspect is the duty of care a person owes to another person.

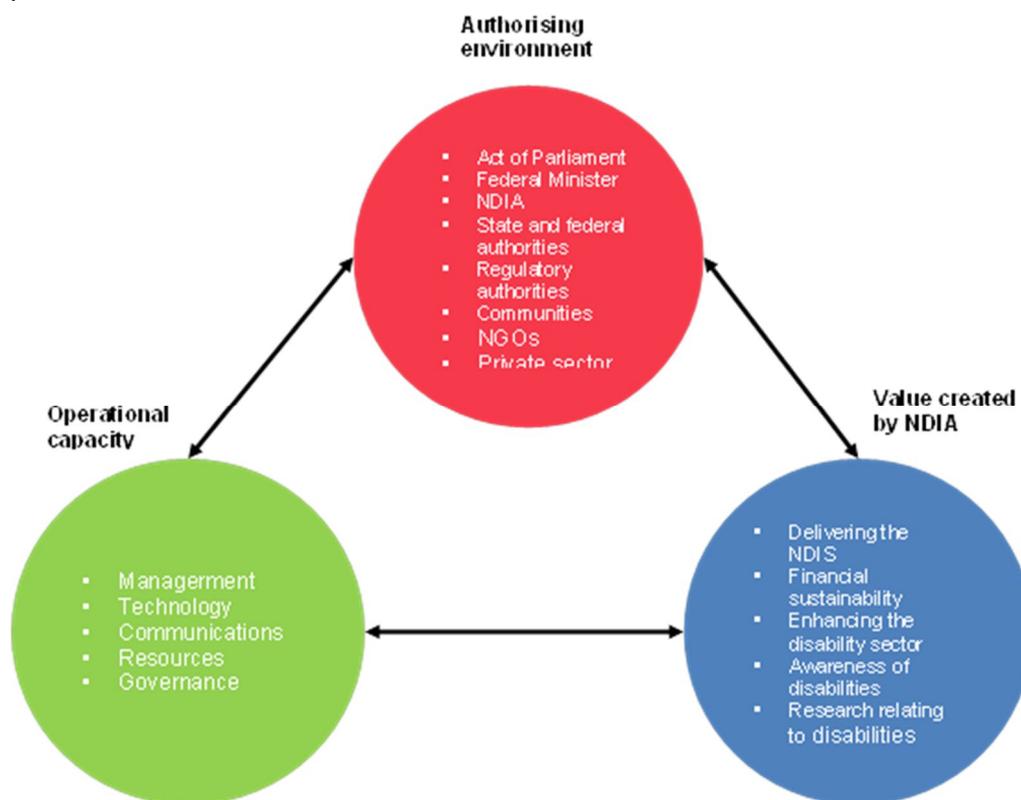
⁴ State Coroners Report (1997), Comments and recommendation into the fire and nine deaths at Kew Residential Services on 8 April 1996 - item 9.15, page 311

Theoretical rationale for the strategy

As the National Disability Insurance Agency is a public sector body, the strategy for the National Disability Insurance Scheme has been influenced by two theoretical frameworks: - The Strategic Triangle and the concept of Public Value.

The strategic triangle enables public sector managers to assess the current situation and also to '...help structure thinking about what ought to be the case...' (Alford, 2008). In order to determine and implement an effective strategy for the National Disability Insurance Agency it is imperative that there is an alignment between the three main principles of the Triangle i.e. the value that will be created, the authorising environment taking into consideration the recognition of the levels of power including political influence and finally the operating capabilities of the organisation.

Below is an analysis of how the Strategic Triangle applies to National Disability Insurance Agency/National Disability Insurance Scheme, which has informed much of the strategy's development.



Public Value 'becomes the value created by Government through services, laws, regulations and other actions...' [Alford, 2008]. This concept takes into consideration 'the total benefits derived from government action [Alford 2008], in this case the value or benefit that National Disability Insurance Scheme will provide to the citizenry of Australia. The public value that National Disability Insurance Scheme will deliver (as outlined in the above diagram) is linked to its objectives and achieved through the implementation of its strategy.

Duty of Care

The objective of the National Disability Insurance Scheme is to pay for support that is reasonable and necessary. This support is related to a person's disability and what is required

for them to live an ordinary life and achieve their goals [<https://www.ndis.gov.au/about-us/what-ndis.html>]. It should follow that any support offered will involve a level of duty of care.

Where an organisation has control of vulnerable persons with a disability in accommodation which is either staffed or with a carer, a duty of care arises by reason of the relationship of dependency. Where a duty of care arises, then the party that owes that duty must meet the appropriate standard of care.

The standard is one of reasonable care, calculated objectively according to what a reasonable person would do in the particular circumstances, taking into account: the magnitude of the risk and the degree of probability of its occurrence [Wyong, 1980].

A Service provider only owes a duty of care if it should reasonably have foreseen that its conduct could cause the injury [Donoghue v. Stevenson (1932)]. One such potential risk is fire within the building. Clearly, a person could suffer injury or death as a result of a fire in a building. Other potential risks may include those associated with the premises as a workplace for carers who are subject to separate duty of care requirements under the Occupational Health and Safety Act.

Where a matter for which a public authority has any direct or indirect control, a duty of care to exercise whatever 'control' it can to avert the perceived danger could exist [Brodie v Singleton Shire Council (2001)]; Gaudron, McHugh and Gummow JJ stated: -

"..on occasions, the powers vested by statute in a public authority may give it such a significant and special measure of control over the safety of the person or property of citizens as to impose upon the authority a duty of care ... that may oblige the particular authority to exercise those powers [i.e. their statutory powers] to avert a danger to safety or to bring the danger to the knowledge of citizens otherwise at hazard from the danger. In this regard the factor of control is of fundamental importance..."

The goal of any public authority is to meet, as a minimum, the standard of fire safety applicable to the wider community and to meet additional standards where appropriate to meet the particular risks from the attributes of a particular client or client group. The public authority should therefore recognise that the risk to life from fire can be significantly greater where bed-based accommodation is provided in a building or where clients need assistance to evacuate a building.

A non-delegable duty of care is a personal duty to ensure that reasonable care is taken to avoid the relevant injury by the person on whom the duty is imposed [Kondis, 1984]. The duty is described as non-delegable because responsibility for discharging the duty cannot be delegated to another person. This can arise in certain special relationships.

The essential features of these relationships are control and responsibility on the one side (service provider) and special dependence or vulnerability on the other (client). If an organisation's duty is to ensure that reasonable care is taken in caring for the individuals in order to avoid injury and if a client were injured through the services providers' negligence, the organisation providing advice could be liable.

The Capital Development Guidelines Series 7 Fire Risk Management

For most residential buildings, it is commonly assumed that compliance with the Deemed-to-Satisfy (DtS) provisions of the National Construction Code Series, Building Code of Australia is sufficient to achieve a satisfactory level of performance and health, safety and amenity. However, it needs to be understood that except for access considerations, the DtS provisions for Class 1 buildings have been largely written around occupants who do not have a significant permanent disability. There has been little consideration of the fire safety of disabled, aged or other vulnerable clients in these buildings.

This is one of the reasons that the Victorian Department of Health and Human Services has developed the Capital Development Guidelines Series 7 Fire Risk Management [DHHS, 2013] to provide further guidance on the fire safety of buildings occupied by disabled and vulnerable clients. The Guidelines require clients to be profiled with respect to their ability to understand and respond to an alarm and the level of support (if any) required to physically evacuate. These profiles are given below:

- **Type 1 (Ambulant)** – A client who is able to understand and respond to an alarm and able to independently evacuate without staff present in the building
- **Type 2 (Ambulant)** – A client, who is able to understand and respond to an alarm, can evacuate with staff intervention or can evacuate independently with a delay. For example, staff implement the evacuation plan including verbal instructions, coordination, supervision and limited physical assistance such as hand or arm holding.
- **Type 3 (Ambulant)** – A client who is not able to understand and respond to an alarm but can evacuate with staff intervention. For example, staff implement the evacuation plan including providing verbal instructions, coordination, supervision and limited physical assistance such as hand or arm holding.
- **Type 4 (Ambulant)** – A client who is able to understand and respond to an alarm but may not be able to evacuate independently or, will take extra time to evacuate independently. They will require verbal instructions and substantial physical assistance from staff to evacuate. For example, removal from bed and placement in a wheelchair or stretcher.
- **Type 5 (Non-ambulant)** – A client who is not able to understand and respond to an alarm and not able to evacuate without physical assistance. The client will require verbal instructions and substantial physical assistance from staff to evacuate. For example, removal from bed and placement in a wheelchair or stretcher.
- **Type 6 (Non-ambulant)** – A client who cannot be evacuated (i.e. on life support or similar)

Currently, residential buildings which are owned, operated or funded by the Victorian Department of Health and Human Services and Director of Housing must be designed in accordance with Capital Development Guidelines Series 7 Fire Risk Management 2013, Guidelines 7.3, 7.4, 7.5, 7.7, 7.8 and 7.9, as appropriate. Key aspects of each of these are now described.

Guideline 7.3 is for Building Code of Australia Class 3 Secure Facilities (relevant to persons who have an intellectual disability who have or may harm other people). The SOUs are each of the bedrooms, offices, seclusion areas and recreation areas.

If sleeping accommodation is provided – all rooms are to be sprinklered with *institutional* fast-response sprinklers. Doors are to be openable from the inside by a downwards action (escape into a secure area (egress freedom level 1); automatic unlock on fire alarm or by persons (egress freedom level 2) and there must be two exits from each compartment or smoke compartment etc.

Guideline 7.4 is for Building Code of Australia Class 3 Supported Community Based Housing. The Sole Occupancy Unit is the entire building. Client profiles range from Type 2 (ambulant and able to respond to alarm) to Type 5 (not ambulant and not able to respond to alarm) and Staff Type 3 (24-hour sleepover staff). In this case, *at least one person* will require assistance with evacuation (c.f. Guideline 7.7) and a maximum of 8 persons are permitted to be accommodated. These buildings are required to be sprinklered with concealed heads in all residential parts of the building

Guideline 7.5 applies to Building Code of Australia Class 3, Class 9a or Class 9c Congregate Care buildings (the SOU is each client bedroom) where at least 8 clients are present such that:

- Staff who provide care, support and supervision are present at all times that clients are present (Type 3 client –sleepover), and
- At least 10% require significant assistance due to physical or intellectual disability, or
- Client who do not have a disability but require support.

These buildings are required to be sprinkler protected, including use of concealed sprinkler heads. Sprinkler heads are residential or fast response. If more than 20 clients, then an addressable smoke detection system is to be provided. Audible alarms are to be activated by activation of a sprinkler head.

Guideline 7.7 is for Building Code of Australia Class 3 Community-based Housing relates to building with *up to 8 Clients*, one of whom *only* would require assistance to evacuate and where a member of staff (24 hours) is present. These buildings are to be sprinkler protected with each house considered to be an SOU.

Guideline 7.8 is for Building Code of Australia Class 1a single dwellings, for Type 1 clients (ambulant) and where there are no staff present (Staff 1). Sprinklers are not required.

Guideline 7.9 is for multistorey Building Code of Australia Class 2 residential (the clients are typically the general public, but potentially including some with a disability). Buildings of 3 storeys or less are not required to be sprinkler protected. Each apartment is a sole-occupancy unit (SOU), as defined in the Building Code of Australia Volume One.

The key issues

The National Disability Insurance Agency has estimated that by 2019 the National Disability Insurance Scheme will cover 475,000 participants at a cost of \$22 billion each year.

The roll-out of the National Disability Insurance Scheme means that buildings previously constructed as dwellings for Class 1a usage (hereafter referenced as Class 1a buildings) will be proposed for accommodation as part of National Disability Insurance Scheme funded plans

for disabled persons eligible for funding under the scheme. Putting aside the question of whether the use of these buildings can remain as Class 1a dwellings, as opposed to Class 3, if these buildings were assessed under the Guidelines, sprinkler protection would need to be provided for buildings having at least one resident with a profile of Type 2 or greater.

Many of these buildings would need to be retrofitted with sprinklers but the associated cost is substantial – it being much more economical to fit sprinkler protection to a new building rather than an existing one. Furthermore, financial resources are limited and there are many competing demands, for example some buildings will be leased and owners may not wish to have sprinklers installed in their building, due to increased long-term maintenance costs and other factors. It is noted that the costs associated with a change of use from an existing Building Code of Australia Class 1a to Building Code of Australia Class 1b may be very substantial, irrespective of the Building Code of Australia DtS fire-safety requirements.

Given that life-threatening fire is known to be a relatively rare event, there is a tension between having an appropriate level of fire safety in existing buildings and sufficient funding to achieve the intended purpose of the National Disability Insurance Scheme – an increase in the wellbeing of disabled persons. This is a key issue.

The purpose of this paper is to consider under what conditions sprinkler protection may not be required in Class 1a or Class 1b or Class 3 to be occupied by disabled persons. It seeks to address this question through a consideration of the following: -

- Residential fire tests and the impact of smoke detection and sprinkler protection on life safety.
- Factors associated with fire fatalities in residential situations, as obtained from coronial records
- Fire statistics in relation to persons with a mental or physical disability
- Literature on the physical and behavioural responses of disabled persons when seeking to evacuate

Based on a consideration of the above, the *dominant* risk factors for disabled persons in a fire situation are derived.

TECHNICAL CONSIDERATIONS

Residential fire tests

BRE (2005) presents the results of a large number of tests involving residential buildings fitted with sprinklers with real furniture. Eight tests were undertaken in a two-storey dwelling with a living area (kitchen and lounge) downstairs and bedrooms upstairs (Figure 1). The two levels were connected by an open stairway with the door of the bedroom above being 50% open.

The door to the lounge room was a standard (non-fire-resistant) door that was closed for some tests and open for others. An approximate layout of the building is shown in Figure 2 and the typical fuel is shown in Figure 3. Tests were done in the lower level lounge room with and without residential sprinklers, with all fires being initiated in the same way – a candle fire next to a TV set.

When the lounge door was open, smoke was able to spill up the stairs and into the rooms on the upper floor including the bedroom with a half-open door. For all tests, measurements

were taken of oxygen (O₂), carbon dioxide (CO₂) and carbon monoxide (CO), as well as optical density and air temperatures at various locations.



Figure 1 BRE house used for first set of tests

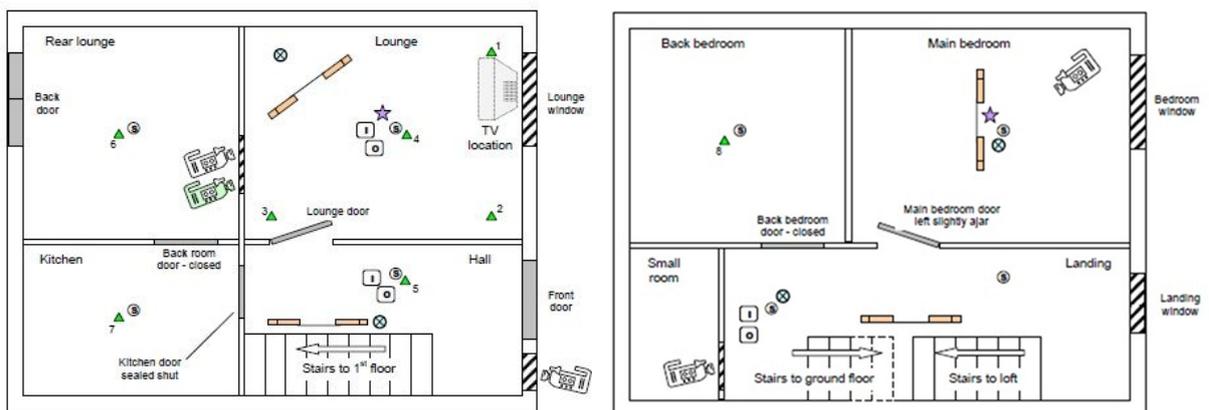


Figure 2 Plans for Ground and Level 1 of Test Building

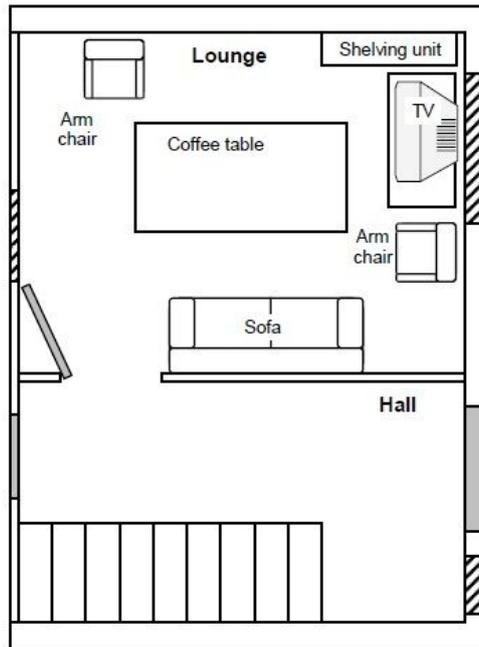


Figure 3 Layout of furniture within lounge

Purser's criteria for incapacitation and death [Purser, 2002] were used to determine whether incapacitation or death was likely in the various spaces.

The results for the unsprinklered tests are given in Table 2. In all tests, untenable conditions were achieved. It was also found that if the lounge door was *open* then conditions within the lounge, lobby outside of the room and upper bedroom ultimately led to conditions leading to incapacitation. However, if the door to the lounge (room of fire origin) was closed, untenable conditions were not achieved in other spaces throughout the building, but only in the lounge being the room of fire origin.

In the case of the sprinklered tests, the times are given in Table 3. Incapacitation only occurred when the lounge door was *closed* but even so it will be noted that the time to incapacitation was longer than for the unsprinklered tests. Incapacitation did not occur elsewhere in the building even when the door to the lounge was left *open*.

Table 2 Ranges of times in room of fire origin (unsprinklered)

Item	Times (secs)
Smoke alarm activation	260, 270, 200
Sprinkler Time Activation	Nil
Visibility Poor @ 1.6m height	400, 360, 450
Incapacitation	920, 1000, 810

Table 3 Ranges of times in room of fire origin (sprinklered)

Item	Times (secs)
Smoke alarm activation	180, 250, 180, 155
Sprinkler Activation	430, 365, 425, 415
Visibility Poor @ 1.6m height	325, 250, 310, 260
Incapacitation	-, 1250, -, 1520

Twenty-nine fire tests were conducted to consider the behaviour of residential sprinklers and the effect on conditions *within* the room of fire origin. Most of the tests were conducted in 4 m x 4 m rooms with a door connecting the room to an adjacent enclosure (see Figure 4).

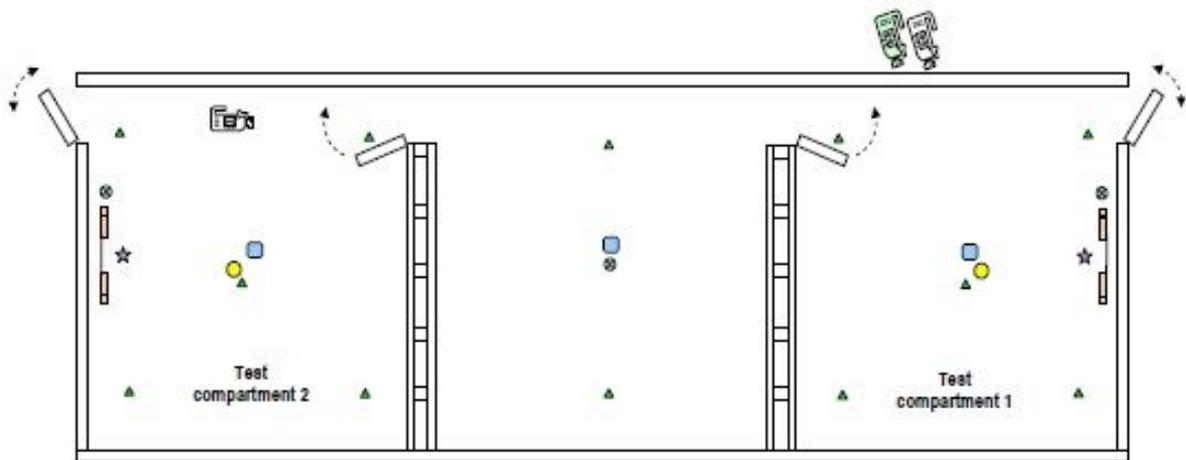


Figure 4 Test set-up used for multiple fire tests

Once again measurements were taken of gas concentrations, temperatures and optical density. Variables in the testing included the furniture and the method and location of ignition. The furniture set-ups included a simulated lounge, bedroom and kitchen. Most of these tests were contrived to cause some sprinkler shielding.

The lounge room fires were conducted by undertaking multiple tests on a nominally identical set-up but starting the fire in different ways and different locations. Fires were started by initiating a TV fire (multiple TV fires), a sofa fire (sofa fires) or a table fire (table fires). The bedroom fire was initiated by setting fire to a pillow on top of the bed. The kitchen fire consisted of a pan with burning oil. For all tests, the external doors to the test rig (Figure 4) were closed whereas the interior doors were either both open or both closed.

The test results are given in Table 4 for most of the tests and show significant variability for nominally identical situations. The smoke alarms were of the ionisation type (the results of which are reported in Table 4) although in some tests optical (photo-electric) smoke alarms were also included. The latter always activated more slowly than the ionisation detectors, presumably because there was flaming ignition and no extended smouldering phase. In two tests, the fire was insufficient to activate the sprinkler system.

In the case of the unsprinklered tests, untenable conditions (incapacitation) always eventually occurred within the room of fire origin. This was only true in the case of the sprinklered fires when the fire was a shielded fire (Table fire) or when the sprinklers did not activate (fire too small) – but in that case, there was a significant time before untenable conditions were achieved.

If the fire was not shielded, it was extinguished by the action of the sprinklers. The table fires, which consisted of material burning below a table, resulted in incapacitation within 200 seconds (unsprinklered) and 360 seconds (sprinklered fire). The time intervals between the ionisation alarm activating and the time at which incapacitation would have occurred in the room of fire origin for the unsprinklered fires were 608, 1073, 1150, 1030, 834, 880, 365 and 167 seconds.

Conditions outside the room of fire origin for the door-open cases were always tenable for the sprinklered situations, but not necessarily so for the door-open unsprinklered fires. If the door to the room of fire origin was closed, then conditions were tenable in the adjacent room spaces. These findings confirm the earlier findings from the previous testing.

The above tests illustrate the value of sprinklers in maintaining tenable conditions away from the SOU of fire origin irrespective of whether the door to the room of fire origin is closed or open. The greater the number of occupants within a residential building, the greater will be the time available for evacuation especially if one of more of these occupants has to be assisted.

Therefore, the sprinkler protection of Community Based Housing (Guideline 7.4 and Guideline 7.7) with higher numbers of clients is important since tenable conditions need to be maintained for longer periods given the time that could be required for evacuation of clients. Considering both unsprinklered and relevant sprinklered situations, the mean times *between* detector activation and poor visibility at a height of 1.6m in the room of fire origin were 180 seconds (door closed) and 213 seconds (door open) and the corresponding standard deviations were 123 and 125 seconds, respectively.

Table 4. Summary of times

Type of Test	Item	No sprinklers		Sprinklers	
		Door open	Door closed	Door open	Door closed
		Times (secs)			
Lounge (TV)	Smoke alarm activation	227	378	197	305
	Sprinkler activation	N/A	N/A	500	1391
	Visibility poor @ 1.6m	474	734	350	414
	Incapacitation	835	1451	No	1224
Lounge (Sofa)	Smoke alarm activation	285	240	24	35
	Sprinkler activation	N/A	N/A	DNO	866
	Visibility Poor @ 1.6m	741	578	295	133
	Incapacitation	1435	1270	No	1297
Lounge (bed)	Smoke alarm activation	70	59	132	87
	Sprinkler activation	N/A	N/A	303	156
	Visibility poor @ 1.6m	159	144	295	133
	Incapacitation	764	938	No	No
Lounge (table)	Smoke alarm activation	37	34	62	34
	Sprinkler activation	N/A	N/A	156	180
	Visibility poor @ 1.6m	152	132	219	115
	Incapacitation	402	201	413	356

This means that there is likely to be only a short length of time between detector activation and loss of visibility in the room of fire origin and a high level of uncertainty. Subtracted from the above time period must be the time that it takes the occupant (or the person designated to assist with evacuations) to respond to a smoke alarm.

The above research also illustrates the importance of closing doors to the room of fire origin once the occupant has evacuated.

United States of America - Fire statistics

The Federal Emergency Management Agency (FEMA) reports on residential building fires [2008, 2011a 2011b] provide some information that is relevant to residential fires in the USA [FEMA, 2008] but also with respect to fires where a physical [FEMA, 2011b] or mental [FEMA, 2011a] disability *contributed* to ignition of the fire.

The rate of fatalities in residential buildings in the United States of America (USA) is around 8 deaths per 1000 fires reported to the fire brigade, based on the statistics provided in FEMA (2008). FEMA (2011b) considers fires where a mental disability contributed to ignition. Typically, there are about 1700 of such fires per year in the United States with a fatality rate per 1000 fires of 40 (5 times higher than general population). FEMA (2011a) considers fires where a physical disability contributed to ignition. There are about 700 such cases per year and the associated fatality rate is 190 per 1000 fires (24 times higher than general population).

The data presented in references [FEMA, 2011a, 2011b] does not consider fires in buildings generally occupied by disabled residents, but where a physical or mental disability contributed to ignition. There is also no indication in the reports of the extent and type of disability, or of whether there was a 'carer' present at the time of the fire. There is too little data to enable such differentiation.

Figures 5 and 6 summarise the causes and heat sources, respectively, for both mental disability (MD) and physical disability (PD) data.

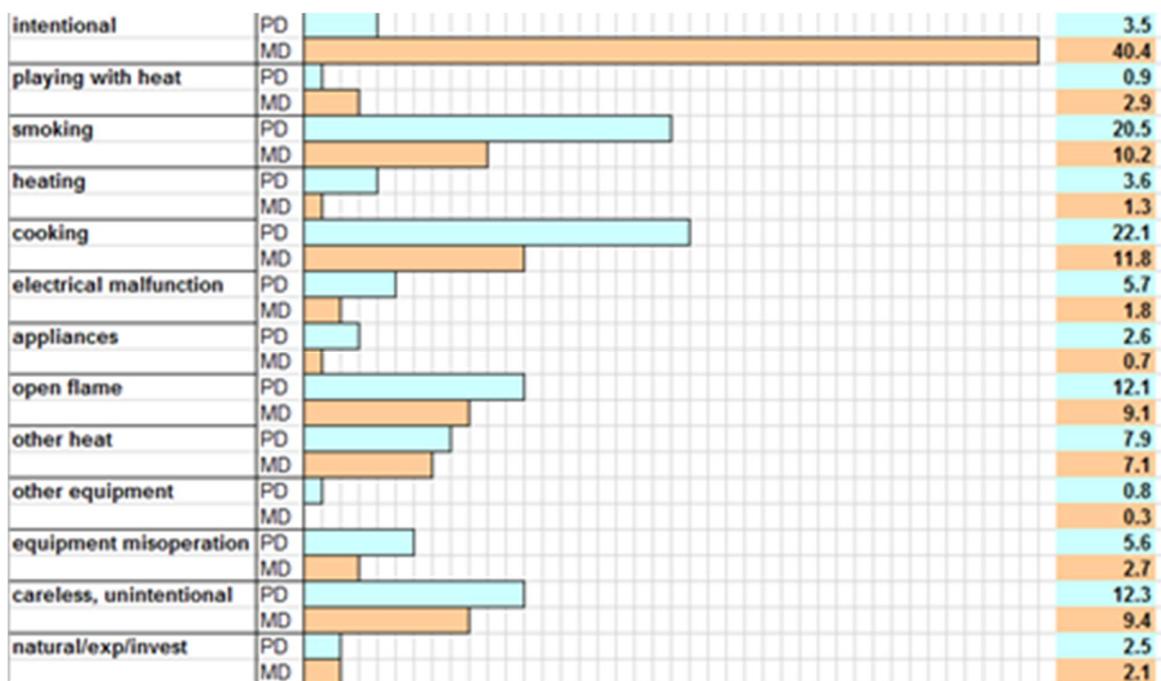


Figure 5 Causes of Fires (% of known cause)

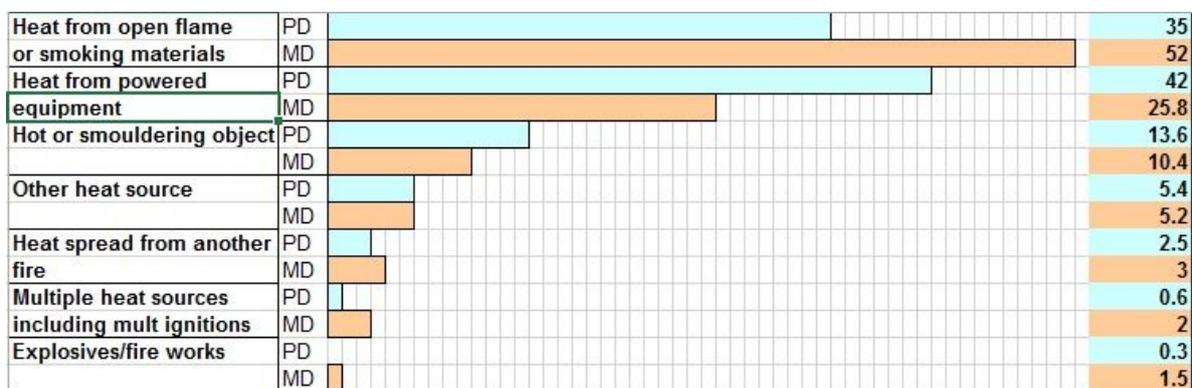


Figure 6 Heat sources associated with fires (% of known source)

Some significant differences in the data presented in Figures 5 and 6 may be noted. In the case of the PD fires, only a low percentage of these were deliberate (3.5%) compared with 40% for fires for which mental disability was a factor in ignition. The category “Heat from Open Flames or Smoking Materials” includes cigarettes, lighters, candles and other open flames and is greater for MD incidents than for PD situations – although smoking was a significantly greater factor for the PD incidents. Conversely “Heat from Powered Equipment” (includes portable heaters and other equipment generating heat) is more significant for PD than MD incidents. A much greater proportion of fires involve cooking for the PD incidents compared with the MD incidents.

Smoke alarms were in 57% of buildings (PD incidents) and 48% buildings (MD incidents), respectively. No details of the detection and alarm systems (type, interconnection, etc.) are available.

The death rate per 1000 fires for fires where physical disability contributed to ignition was almost 5 times higher than for fires where mental disability was a factor in ignition. When physical disability was a factor in ignition, 38% of fires were in kitchens, 24% in bedrooms and 14% in common lounge areas with other areas making up the residual. This compares to 26% in kitchens, 26% in bedrooms and 10% in common areas for fires where mental disability was a factor in ignition. However, there is insufficient data to correlate fatalities and location of fire.

In both MD and PD incidents, 64% of fires were recorded as being limited to the room of fire origin.

Dwellings with persons with a physical disability

The above statistics suggests that the following is important for buildings housing residents with physical disabilities:

- As a general rule, persons with a physical disability appear to be at greater risk than those with a mental disability and may require a greater level of assistance in evacuating. However, it is possible that there may have been a higher level of supervision for persons with mental disabilities than where there was a physical disability.
- Incidents involving cooking and use of portable heating (too close to combustibles?) appear to be key factors in terms of fire ignitions.
- Smoking is also a key factor.

Dwellings with persons with a mental disability

The above statistics suggests that the following is important for buildings housing residents having a mental disability:

- Deliberately started fires are likely to be a significant factor for residential accommodation housing persons with a mental disability – particularly the use of cigarette lighters and the like.
- Important to note is that for persons with a disability in either (a) or (b) category the rate of fire deaths is significantly higher than the rate for the general population.

Other research

There is a wide range of disabilities experienced by persons occupying Victorian Department of Health and Human Services facilities including dwellings. Research into human behaviour of fire has mostly concentrated on the behaviour of the general population, although there has been some consideration of persons with ambulatory disabilities [Kuligowski, 2009] and associated times for evacuation movement. There appears to be a general lack of research into the behaviour of disabled persons in fire.

A paper by Xiong, Bruck and Ball (2005) provides a consideration of risk factors in residential accommodation as determined from an assessment of fires where at least one person died and fires where there were no deaths. Much of the data considered was obtained from coronial records and from detailed interviews with survivors. Some of the tentative findings from this research are summarised below:

- Persons living *alone* were more vulnerable than those living with others
- Persons who are older (>70) were more at risk, all other factors being equal
- The consumption of psychotropic and sedative drugs (PSD) and alcohol (>0.05%) are significant risk factors. Of the fatalities, 44% had PSD in their bloodstream and 56% had a high blood alcohol concentration (BAC) with most being > 0.10%. Other research has demonstrated that BAC of > 0.05% greatly reduces a person's ability to respond to a fire alarm
- Persons who survived residential fires in which there were no fatalities were more likely to have had working smoke alarms, but were also more likely to have been awakened by fire cues other than the alarm, compared with fire situations where there was a fatality
- Survivors in situations where there was a fatality are more likely to be have been awakened by a smoke alarm than the other fire cues
- Fatal fires were most likely to occur in the lounge or the bedroom
- Most fatalities occurred in the room of fire origin
- Cigarette and smoking-related materials were the leading ignition factor of fatal fires with heating units being the most commonly involved appliance.
- The likelihood of a fatality increased with a diagnosed mental illness (about 48% of fatalities had some mental illness reported in their history) or with a pre-existing physical or mental disability.

It is noted that most of the above findings are also applicable to buildings that are accommodated by the general public including those covered by Guideline 7.8 (Single Dwellings) for which sprinkler protection is not required. Many of the above risk factors are associated with life-style choices and apart from known fire-lighting behaviour, cannot be determined or excluded by screening processes, as far as able-bodied residents in general Class 1a or Class 3 buildings are concerned.

Summary of key hazard and risk factors – disabled residents

Section 2.2 considered US statistics for fires in residential buildings where disabled residents were involved in some way in the fire ignition event. It was noted that the resulting fatality rate was **substantially higher** than for normal residential construction.

The key hazard and risk factors obtained from a consideration of the material presented in Sections 2.2 and 2.3 are now summarised with a focus on disabled residents.

Key hazards with respect to fire ignitions

- Cigarettes
- Deliberate fire lighting behaviour (particularly in the case of particular forms of mental disability)
- Portable heaters
- Cooking, although this appears to be rarely associated with fatalities

Key risk factors

Key risk factors in terms of survival of a fire are:

- Physical disability – which may interfere with ability to evacuate in a timely manner (hearing or sight impairment or mobility limitation). This appears to be a dominant factor.
- Mental disability – this may impair cognitive ability and ability to evacuate
- Use of drugs and alcohol – reduces ability to hear alarm and respond
- Smoking and falling asleep

CONSIDERATION OF CLASS 1 BUILDINGS - DISABLED ACCOMMODATION

As noted in Section 1.6, in the State of Victoria, Guideline 7.7 Community-Based Housing is the guideline document that relates to housing where up to 8 persons can be accommodated and where all except one person can evacuate independently (up to 7 Type 1 clients) if the building or clients are funded by the State Government. Sprinkler protection is required for these buildings.

On the other hand, as discussed in Section 1.6, sprinkler protection is not required for Single Houses (Capital Development Guidelines Series 7 Fire Risk Management 2013, Guideline 7.8) occupied by only Type 1 clients. At this point it is noted that high-functioning mentally disabled persons could be assessed as Type 1 occupants subject to adequate screening and assessment.

Such screening would need to assess a client's ability to respond to an alarm and evacuate in a timely manner and a lack of history of fire lighting tendencies and a general absence of risk factors including smoking, PSD and alcohol consumption. The presence of a 24-hour Carer should not necessarily imply that clients are not Type 1 clients. In situations where disabled clients can be considered as having a Type 1 profile, the following measures (as required by Guideline 7.8) would need to be implemented retrospectively:

- Interconnected smoke alarms are provided in each bedroom, corridor, living area. If a client has a hearing impairment, an additional appropriate warning device such as a strobe will be provided.
- Heat detectors within kitchens can be provided.
- At least two exits from dwelling must be provided, except for a single person accommodation Unit, in which case, one exit is acceptable.
- Portable unit heaters are not to be permitted to be used.
- Any accommodation Unit is to incorporate essentially non-combustible interior linings
- All doors to bedrooms are to be openable from the inside by a downwards action. Where restricted access to rooms is necessary, room doors shall be unlocked automatically in the event of a doors and openable fire alarm.
- Smoking is not permitted within the building.

However, many disabled clients will have Types 2-5 profiles thus requiring assistance with evacuation. Sprinkler protection is required for Community-Based Housing (Guideline 7.7) in recognition of the generally greater risk associated with a physical or mental disability and given that a disabled person resident in one of these buildings may exhibit a Type 4 or 5 profile and that it may take considerable time for a Carer to facilitate evacuation of that person.

As illustrated in Section 2.1, sprinkler protection limits the loss of tenability outside the room of fire origin and this is likely to be important in situations where evacuation could take considerable time.

One of the key issues with determining whether sprinkler protection is required in a residential building with disabled clients (with a profile of Type 2 or greater) is whether it is possible for a carer to successfully complete assisted evacuation prior to the onset of untenable conditions. The time to untenable conditions is difficult to predict and is very much a function of the fire growth characteristics.

The total time for evacuation is a function of the time that it takes for a fire alarm to awaken both the carer and the clients, and the time it takes for clients to be mobilised and assisted to safety. Clearly, the greater the number of disabled clients who require assistance, the longer any assisted evacuation will take. Early fire detection is critically important as is an effective alarm system to warn both carer and the clients.

Based on the above considerations, it is considered possible that *up to two* disabled clients with a profile of Type 2 or greater could be accommodated in an existing unsprinklered Class 1 building provided the following conditions are met:

- A carer is present whenever the clients are in residence (“at night time”).
- The total movement time for the carer to assist evacuation of the disabled persons is proposed to be assessed by a practical trial and to be no greater than 120 seconds. Conduct of such a practical trial will provide an indication of any evacuation difficulties with respect to potential client movement.

This proposed period of time is less than the *mean* values summarised in Section 2.1 in relation to the time periods between alarm activation in the room of fire origin and the time at which visibility at a height of 1.6m is lost. However, allowance must also be

made for the time to respond to an alarm which is unlikely to be less than 60 seconds. On the other hand, tenable conditions may persist in the room of fire origin for some time. The nominated time period of 120 seconds applies to the time taken for a carer to move from their room, prepare and evacuate the first client and return to prepare and assist the second client to evacuate. This time is *additional* to any time taken to respond to an alarm.

- Compliance with the nominated time period of 120 seconds may not always result in a conservative outcome in the event of a real fire incident.
- Interconnected mains-powered smoke alarms are provided in each bedroom, corridor and living area. If a client has a hearing impairment, an additional appropriate warning device such as a strobe will be provided.
- Heat detectors are provided within kitchens and bathrooms.
- At least two exits from the dwelling must be provided, except for a single person accommodation Unit, in which case, one exit is acceptable.
- Portable unit heaters are not to be permitted to be used.
- Any accommodation Unit is to incorporate essentially non-combustible interior linings.
- All doors to bedrooms are to be openable from the inside by a downwards action. Where restricted access to rooms is necessary, room doors shall be unlocked automatically in the event of a doors and openable fire alarm.
- Smoking is not to be permitted within the building and designated smoking areas to be at least 3m from the building.

Except for the first two requirements, the other design requirements are specified in Guideline 7.7.

Interconnected smoke detectors (which are now required for all new Class 1 residential construction) provide a greater benefit when there is more than one person in a dwelling; since if one person does not hear the alarm, another person may respond and wake others. Furthermore, the increase in alarm volume across the whole dwelling associated with locating the alarms in bedrooms and other areas, and having them interlinked, results in an increase in the likelihood of being awakened.

CONCLUSION

The roll-out of the National Disability Insurance Scheme (National Disability Insurance Scheme) means that funding will be sought by both potential residents and service providers to enable accommodation in existing Class 1a buildings that will often be one or more detached houses on an allotment. Irrespective of whether such accommodation is considered to constitute a change in use to a Building Code of Australia Class 1b or Class 3 building, it is necessary to consider what fire safety measures are appropriate for such situations and which should be provided retrospectively before any such accommodation is approved.

Ultimately approval will be via the National Disability Insurance Agency (National Disability Insurance Agency). However, the purpose of this paper is to explore fire safety options for such buildings and inform the evolution of that approval process.

Accommodation that is funded by the Victorian Government is currently required to meet the requirements of the Victorian Department of Health and Human Services Capital Development Guidelines Series 7 Fire Risk Management 2013, which require sprinkler protection for many residential situations. These overall requirements are considered to provide an appropriate background for a consideration of fire safety measures for accommodation that is funded by the National Disability Insurance Scheme. These requirements and their basis are considered along with relevant research which is used to identify the key hazard and risk factors associated with residential accommodation generally and that involving disabled persons, specifically.

Given the relatively high cost of retro-fitting sprinkler protection to an existing building, a key issue is to determine under what conditions it may be appropriate not to require sprinkler protection for National Disability Insurance Scheme funded situations. This is considered as being possible in two situations.

The National Construction Code Series, Building Code of Australia⁵ and Regulations set the minimum fire safety and regulatory requirements that apply to a broad range of buildings to reduce the risk of loss of life, property damage and injuries. Under this, the Building Code of Australia does not adequately address or adequately reflect the specific needs, profile and risk behaviours of individual National Disability Insurance Scheme clients.

Therefore, compliance with the National Construction Code Series, Building Code of Australia and the Regulations may not be sufficient evidence of a provider's compliance with health and safety standards and legal duty of care obligations.

Therefore, designers must understand and recognise that buildings used for National Disability Insurance Scheme clients must be designed and managed from a risk informed approach to fire safety engineering. This applies to both the design of the building and its subsequent operation, management and life cycle costings for maintenance.

Finally, a service provider owes a duty of care if it should reasonably have foreseen that its conduct could cause the injury [Donoghue v. Stevenson (1932)]. One such potential risk is fire within the building, housing residents under National Disability Insurance Scheme.

Clearly, a person could suffer injury or death as a result of a fire in a building. Other potential risks may include those associated with the premises as a workplace for carers who are subject to separate duty of care requirements under the relevant jurisdictions "Occupational Health and Safety" Act.

⁵ The National Construction Code Series 2016© Building Code of Australia is produced and maintained by the Australian Building Codes Board on behalf of the Australian Government and each State and Territory government.

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APPENDIX A – NATIONAL CONSTRUCTION CODE SERIES BUILDING CODE OF AUSTRALIA

Definitions of Class 1a, Class 1b and Class 3

Class 1: one or more buildings which in association constitute—

- (a) **Class 1a** — a single dwelling being—
 - (i) a detached house; or
 - (ii) one of a group of two or more attached dwellings, each being a building, separated by a *fire-resisting* wall, including a row house, terrace house, town house or villa unit; or
- (b) **Class 1b** —
 - (i) a boarding house, guest house, hostel or the like—
 - (A) with a total area of all floors not exceeding 300 m² measured over the enclosing walls of the Class 1b; and
 - (B) in which not more than 12 persons would ordinarily be resident; or
 - (ii) 4 or more single dwellings located on one allotment and used for short-term holiday accommodation,

which are not located above or below another dwelling or another Class of building other than a *private garage*.

Class 2: a building containing 2 or more *sole-occupancy units* each being a separate dwelling.

Class 3: a residential building, other than a building of Class 1 or 2, which is a common place of long term or transient living for a number of unrelated persons, including—

- (a) a boarding house, guest house, hostel, lodging house or backpackers accommodation; or
- (b) a residential part of a hotel or motel; or
- (c) a residential part of a *school*; or
- (d) accommodation for the aged, children or people with disabilities; or
- (e) a residential part of a *health-care building* which accommodates members of staff; or
- (f) a residential part of a *detention centre*.