Retrofitting Automatic Sprinklers Systems in Queensland Class 9a Age Care Facilities – V1

Fire and Security Consulting Services (FSCS) has, on a number of occasions, been requested to provide advice on retrofitting sprinklers in Queensland Class 9a *Age Care* buildings.

This issue has risen because for a number of years, some Age Care buildings have been Classified by Private Certifiers as Class 9a - being Hospitals and the like, despite Class 9c being (from 2011) the appropriate classification. Note that from inception, Class 9c Age Care buildings were required to be sprinkler protected whilst Class 9a buildings had no such requirement.

In order to normalise the issue of sprinkler protection being required, the Queensland Government under the auspices of The Queensland Development Code (QDC) published (in June2011) *MP 2.3 Fire safety in existing residential care buildings applicable to* Pre 1 June 2007 buildings.

This document required all Age Care buildings to be sprinkler protected, as well as having other fire safety facilities.

The QDC MP 2.3 –requires a sprinkler system to comply with AS2118.4 – *Automatic fire sprinkler systems – Part 4: Residential*, ***1995*** *edition*. Whilst this reference might seem innocuous, AS 2118.4 was superseded by the **2012** edition and adopted under the Building Code of Australia (BCA) in 2014. Note that subsequent to 2011, the NCC is to be properly referenced as the National Construction Code (NCC).

Accordingly a situation existed where sprinklers in Age Care buildings of different eras were required to meet different Standards. In order to rectify that situation, owners of a number of Age Care buildings which were then Class 9a, requested Fire and Security Consulting Services to seek relief from using the referenced QDC MP 2.3 for meeting the 1995 Sprinkler Standard from.

The FSCS brief did not include changes in Classification from 9a to 9c, that being left to the owners to consider as a separate issue.

At that time FSCS made a specific project submission on behalf of one owner to The Office of the Minister for Housing and Public Works seeking permission to use the 2012 edition of AS2118.4. The response was positive subject to an assessment of the differences in the Standard and the impacts thereof.

Accordingly the remainder of this Paper provides details of the differences such that other owners of Class 9a buildings being used for Age Care can make similar submissions for relief.

QDC MP2.3 Sprinkler System Requirements for Automatic Sprinkler Systems

Figure 1 is an extract from QDC MP 2.3 with the referenced Sprinkler Standard.

Referenced Standards

Number	Date	Title
AS 2118.4	1995	Automatic fire sprinkler systems – Part 4: Residential.

Figure 1 – QDC MP 2.3 Referenced Sprinkler Standard

Initially, the differences between the two editions of AS2118.4 are their titles:-

1. The 1995 edition being titled *Automatic fire sprinkler systems – Part 4: Residential*; and
2. The 2012 edition being titled *Automatic fire sprinkler systems – Part 4: Sprinkler protection for accommodation buildings not exceeding four storeys in height*.

Whilst the title might provide some explanation of the scope of each Standard, in this stage it will be useful to examine the intent of each Standard and the type of occupancy the Standard is intended to cover.

The Preface to the 1995 Standard advises the following:-

- The Standard is intended to provide a degree of life safety and property protection for the inhabitants of low rise Class 2, 3 and 9a buildings, excluding hospitals; and
- A sprinkler installation installed in accordance with the Standard is expected to prevent flashover in the room of fire origin; and
- The Committee considered the 1991 NFPA Standard NFPA 13R – *Standard for the Installation of Sprinkler Systems in Residential Occupancies up to Four Stories in Height in preparing this Standard*.

The Foreword to the 2112 Standard advises the following:-

- The Standard provides criteria for automatic fire sprinkler protection in low rise (four storeys or less) Class 2, Class 3 and Class 9c Age Care buildings; and
- The purpose of the Standard is to provide design, installation and acceptance testing (commissioning) for sprinkler systems to aid in the detection and control of fires in accommodation buildings; and
- The sprinkler system is expected to prevent flashover (total involvement) in the room of fire origin and to improve the chance for occupants to escape or be evacuated; and
- The Committee considered the NFPA Standard NFPA 13R – *Standard for the Installation of Sprinkler Systems in Residential Occupancies up to Four Stories in Height in preparing this Standard*.

In addition to referencing a number of other Australian Standards, both 1995 and the 2012 Standards also referenced the (then) BCA and the NCC. This is important because they both require certain building features to be compliant with other Standards that may influence the flammability and / or combustibility of materials of construction. This point is considered further in this comparison.

The Preface to the 2112 Standard provides a summary of the changes made to the 1995 Standard and include the following:-

A. The water supply section has been expanded.
B. A minimum design flow is specified.
C. Design criteria for ancillary areas have been revised.
D. Detailed sprinkler spacing and positioning requirements are included particularly related to obstructions, heat sources and sloped ceilings.
E. Acceptance testing (commissioning) requirements are detailed.

A – Water Supplies

Water supplies for residential; sprinklers systems may be:-

AS2118 4 - 1995	AS2118 4 - 2012
Town Main with or without pump	Town main drinking water supply with or without pump
Recycled water not addressed	Town main recycled water supply with or without pump
	Storage tank with pump
Private Reservoir with pump	Common storage tank with pump serving domestic and sprinkler system
	Pressure tank
	Natural water source such as rivers, lakes and aquifers
No tank details	Comprehensive design details for tanks
No pump details	Comprehensive design details for pumps
No hosereel or hydrant allowance	Allowance for hose reels / hydrants when supplied from same source

The change brings AS2118.4 into line with the base Standard AS2118.1 providing more options for the water supplies. The outcome of the change does not affect the efficacy or reliability of the system.

B – Minimum Design Flow

The minimum design flow is a function of the sprinkler spacing and the flow per sprinkler.

AS2118 4 - 1995 – Fully hydraulically calculated	AS2118 4 - 2112– Fully hydraulically calculated
All sprinklers within a compartment with a minimum of 4.	All sprinklers within a compartment with a minimum of 4.
Sprinkler spacing to be as per the Manufacturer listing.	Sprinkler spacing to be as per the Manufacturer listing. Standard provides maximum and minimum spacing criteria with maximum area coverage of 24m^2. Where Manufacturer spacing is greater than Standard, the spacing in the Standard to be used.
Sprinkler flow to be as per the Manufacturer listing. No minimum flow specified	Minimum flow to be not less than 200l/min
Minimum flow capacity = 30 minutes	Minimum flow capacity = 30 minutes

The change provides for minimum performance data in terms of minimum flow and area coverage. The outcome of the changes is tighter control of the system design and better understanding by Certifiers.

C – Ancillary Areas

AS2118 4 - 1995	AS2118 4 - 2012
1 - Non residential areas specified to be protected with a design density of 5mm/min over a design area of 36m^2. This gives a total flow of 180l/min.	**1** - Ancillary specified non accommodation areas >75m^2 require fast response sprinklers with k factor of 8.0 and minimum flow of 60l/min at the most hydraulically disadvantaged head. This gives a total flow of 240l/min.
2 - List of permitted exceptions provided including dedicated water closets not exceeding 2m^2, other spaces not exceeding 2.5m^2, open porches, balconies, walkways and stairs.	**2** - List of permitted exceptions provided including cupboards and the like not exceeding 3.0m^2, toilets and bathrooms, open external porches, balconies, carports walkways and stairs.
3 - Permitted exceptions for roof spaces and other concealed spaces **not intended for** living or storage spaces or the installation of equipment such as flexible ductwork, heating and refrigeration equipment	**3** – Permitted exceptions in concealed spaces less than 200mm in depth, concealed spaces bounded entirely by non combustible construction **and containing only** lighting and power cables, piping containing non flammable fluids and metal ducting with insulation and flexible connections complying with AS4254 - 1995.

1. The change provides for a greater degree of protection for ancillary areas by specifying minimum flow rates per sprinkler and fast response sprinklers.
2. The 2012 edition makes minor changes to the areas where sprinklers are permitted to be omitted.
3. The 1995 edition required sprinklers in roof spaces containing certain equipment, storage and flexible ducting whilst the 2012 edition provides clearer definitions regarding omission of sprinklers in concealed floor and roof spaces. In the 2012 edition, roof spaces bounded by non combustible construction which contain ducting and associated connections which meet AS4254 may have sprinklers omitted; see the FSCS commentary later in this report.

D – Acceptance Testing

The 2012 edition now includes acceptance testing procedures.

Summary

In summary, the 2012 edition provides for clearer and more comprehensive design and commissioning requirements. The sections on sprinkler omission are clarified with specific explanations of size and content.

Discussion on Standards

The key change between the editions is the omission of sprinklers in roof spaces. This is a significant issue and has implications on the overall costs of a sprinkler system.

When assessing compliance of a building or system within a building, it is important to understand how the NCC references various Australian Standards. Usually when a new Standard is issued, the NCC adopts that Standard at the next issue – usually on May 1st of the following year.

Now with reference to AS2118.4, The 1995 edition required sprinkler protection in ceiling spaces because the designs then underway utilised building wide air conditioning systems that incorporated air handing ducting. Flexible ducting was the material of choice because of cost and ease of installation.

Age care building constructed up to 2012 generally used flexible ducting compliant with the then referenced AS 4254 1995 – including Amendment 1 (1996) and 2 (1999). Note that Amendment 2 referenced AS1530.3 – 1999 – see below.

AS4254 1995 (including Amendments 1 and 2) required that flexible ducting meet certain Australian Standards including AS 1530.3-1999 "*Methods for fire tests on building materials, components and structures - Simultaneous determination of ignitability, flame propagation, heat release and smoke release"*

As a point of interest, it is noted that Australian Standard AS 4254 - 1995 was revised in mid-2012 to become two separate standards, designated AS 4254.1-2012 and AS 4254.2-2012 relating to flexible and rigid ducting respectively and as of May 2013 these two standards were referenced in the NCC as requirements for fire hazard properties.

Consequently proponents desiring to use AS2118.4 2012 need to ascertain whether or not the air handling ductwork in the subject buildings meet the requirements of AS4254 1995 (including Amendments 1 and 2) in force when the building was constructed.

If it can be reasonably demonstrated that at the time of construction the ductwork met the requirements of AS4254 1995, the requirements of AS2118.4 for compliance will be met and sprinklers may be omitted in the roof space.

The further qualification for omission of sprinklers in the roof space is that for non combustible bounding construction. If it can be reasonably demonstrated that the building construction is of non combustible **(Note 1)** walls, steel stud load and load bearing construction with plasterboard wall and ceiling sheeting, it is considered that with steel framing and plasterboard construction (considered as *non combustible* in Part C1.12 of the NCC) within the roof space, the additional qualification for omission of sprinklers is met.

(Note 1) FSCS considers that both internal and external walls should be considered as being part of the roof space bounding construction because in most cases the line of the ceiling is below the top of the both the internal and external walls.

Flexible Ductwork Standards

Readers may be interested in why the 1995 edition of AS2118.4 required sprinklers in roof spaces containing flexible ductwork. Information available to Standards' committees being written and adopted in the years 1994 and 1995 contained conflicting and ambiguous data which raised issues regarding compliance with AS1530.3 and AS1530.4

In 1993, the author of this paper (whilst Director of Eagle Consulting Group – See CV and work history on http://fscs-techtalk.com) was approached by CSR (Bradford Insulation) to comment on polyester materials being used for insulated flexible ductwork in buildings. This was a result of the South Australian Metropolitan Fire Service (SAMFS) who were also conducting their own

investigation into a domestic house fire where it appeared that the same polyester ducting contributed to the rapid spread of fire.

Eagle sponsored tests at CSIRO on behalf of Bradford Insulation to compare polyester (Dacron) and glasswool filled flexible insulating ducts under the *UL181 - Underwriters' Laboratories – USA - Factory-Made Air Ducts and Air Connector t*est regime. Whilst AS1530.3 "*Methods for fire tests on building materials, components and structures - Simultaneous determination of ignitability, flame propagation, heat release and smoke release"* is not a test for combustibility, it is interesting to note that UL181 tests for early fire hazard (the same as AS1530.3) is a more severe test for fire spread.

The ducting manufacturer under investigation (**Note 2**) produced evidence that their flexible ducting had passed AS1530.3 1989. This led me to examine the Standard and witness a CSIRO test. The Standard required a sample of the duct to be cut out, flattened and then mounted vertically in the test apparatus. This apparatus had a gas burner which imposes radiant heat on the sample which after a prescribed period, a pilot flame was applied to the sample. The observed test passed because by that time all the polyester had melted and flowed out of the test leaving no material to burn. With that result, CSIRO had no choice but to pass the material.

One important point however, as with ALL such tests, the Test Laboratory issues 2 Reports, the first being a "short form" indicating pass or fail and the second including observations. This is why all Certifiers should require the full test report to be submitted for consideration.

Subsequently, CSIRO conducted a UL test on the polyester sample together with a sample of CSR "rockwool" ducting.

The results are shown in the attached photographs; Figure 2 is the CSR Rockwool duct showing the inner and outer structure and the rockwool insulation.

Figures 3 shows the UL181 test with the polyester insulated duct on the left and the rockwool insulated duct on the right.

Figure 4 shows the Dacron ducting fully consumed after the pilot flame was removed whilst the rockwool ducting (on the right) did not propagate flame after application of the pilot flame.

Figure 2 - CSR Duct

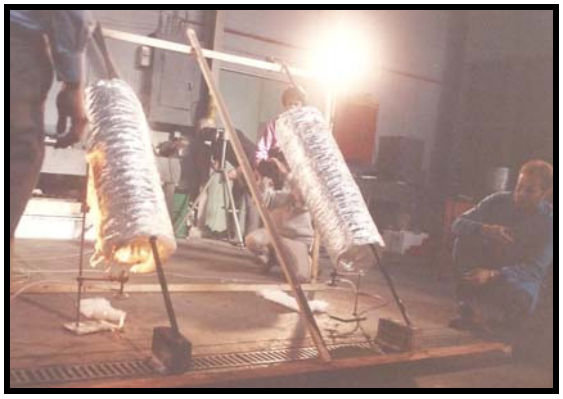

Figure 3 - UL181 Test Start

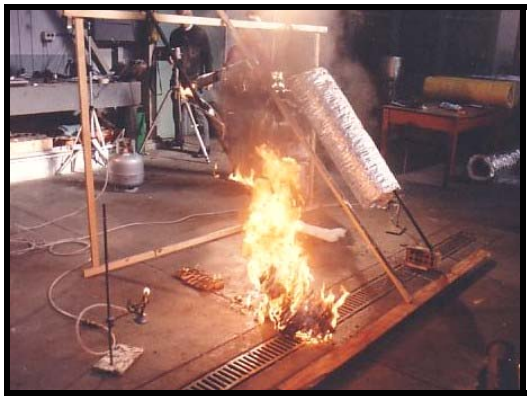

Figure 4 - UL181 Test End

This led to CSIRO advising Standards Australia that AS1530.3 1989 tests on ducting should be considered as flawed.

In 1995, when the AS2118.4 Standard was released, consideration was given to the Flammability and Early Fire Hazard properties of materials in the building. At that time AS 1530.3-1989 "*Methods for fire tests on building materials, components and structures - Simultaneous determination of ignitability, flame propagation, heat release and smoke release"* was the Standard used and as discussed earlier, the NCC required compliance with this Standard for certain materials such as sarking and ducts.

As indicated earlier, the AS2118.4 Standards committee had been made aware of the flawed test process and would have covered the issue by certain requirements to compensate for the issue, thus it is thought that the presence of flexible ducts was considered as requiring sprinkler protection. Note that NFPA13R, the US Standard on residential Sprinklers, had no such issue because the UL tests would have precluded the use of non UL181 approved ducting.

As with all Standards Processes, it was only in 1999 that AS/NZS 1530.3:1999 "*Methods for fire tests on building materials, components and structures - Simultaneous determination of ignitability, flame propagation, heat release and smoke release*" was released.

The revised Standard required three dimensional samples to be tested in the configuration as proposed to be installed and later tests on the same polyester type materials that previously passed, consistently failed. Note that the failure of polyester type materials that failed at that time does not mean that materials of that type in a different configuration would not pass.

This extract is from the Preface to AS/NZS 1530.3:1999:-

The objective of this revision is to specify procedures for laboratories to adopt when mounting specimen materials in the test apparatus. The basic method of test has not been changed.

The mounting procedures are specific for a range of materials being tested. The adoption of these procedures is designed to improve the consistency of the test results.

It is interesting to note that AS4254 test requirements now read as follows which substantiates the 1993 tests and adoption by Standards Australia.

2.8 FLEXIBLE DUCTWORK

2.8.1 Construction

Flexible ductwork shall be constructed in accordance with one of the following methods:

(a) *Metal* The ductwork may comprise either—

(i) corrugated duct, helically wound with lockseam capable of being bent or set by hand without spring back and without deforming the circular section; or

(ii) single or multiple layers of strip formed into corrugations and wound in helical or annular form, without an obvious seam or joint.

Strip thickness shall be not less than 0.127 mm.

(b) *Reinforced fabric* The ductwork may comprise either—

(i) tough, flexible laminate; or

(ii) tough, tear-resistant, airtight material liner and cover incorporating a reinforcing former to retain circular section and permit flexibility with minimal spring back when formed to the required shape.

2.8.2 Compliance with test criteria

All insulated and non-insulated flexible ductwork shall be tested in accordance with UL 181 and the requirements of Table 2.8.2. All tests shall be carried out on 300 mm internal diameter duct. All tests shall be carried out on the duct system, i.e. the assembled final product, as opposed to individual layers. The duct core shall be separately tested in accordance with Clause 2.8.3(d).

Extract from AS4254

Conclusion

In consideration of the above, FSCS concludes that the 2012 edition of AS2118.4 is an equal or better standard then the 1995 edition in terms of the performance of the system.

However it should only be used where, as discussed earlier, that its use should only be permitted where ducting, roof space structure and any other constrains in the 2012 edition can be met.

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Note 2 – Investigated manufacturer identity is confidential.