

Fabric Structures and the new Building Codes

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On 1st July 1992 the Building Regulations 1992 came into force. There was a six month transitional provision until 1st January 1993 when applications could be made for either a building permit or a building consent. From 1st January only building consents could be applied for for new structures.

The documents that control construction are Regulations B1 Structure, B2 Durability, C2 Means of Escape, C3 Spread of fire, C4 Structural Stability during fire, D1 Access, F6 Lighting for emergency, F7 Warning systems and F8 Signs. They are known as the Approved Documents.

Since the topics we are dealing with are Fabric Structures, I will only comment on these requirements from the territorial authorities' point of view.

1. Temporary structures, such as marquees if under 30 square metres in plan area, are not subject to a building consent if they are to remain in place for less than one month. All marquees that exceed this size are required to obtain a building consent regardless of the time that they are going to be on the site.
2. Free standing structures, regardless of size, are subject to a building consent and must show the location of adjoining buildings.
3. Totally enclosed structures are also subject to a building consent with the additional requirement of indicating the means of escape being shown.
4. The cladding life is covered under the legislation, B2 Durability, and being the exterior covering of a building or structure would be expected to have a minimum life of 15 years. The owners of the building or structure may obviously expect a much longer guarantee from the manufacturer/installer of the fabric, but this is all that the Approved Document asks for. Needless to say, Regulation E2 External Moisture also requires the fabric to be waterproof.
5. Fire Codes - The fire code requirements are covered in the approved documents - C2 Means of Escape, C3 Spread of Fire, and C4 Stability during Fire.

Regulation C2 Means of Escape will be based on the area of the structure and the purpose to which the structure will be put, so this will in turn control the number of person who can be within the building at any one time so the width and number of exitways will always depend on the number of occupants. The minimum number of exitways will always be two and the Regulation states that each exitway will be capable of allowing all the occupants to escape if one of the exitways is not available. Tables 1 & 2 give the methods of establishing the widths of the exitway and the number of exits required and are reproduced here.

1.0 SCOPE

1.0.1 This acceptable solution deals with the physical characteristics of *escape routes* such as size, location and degree of protection.

1.0.2 Acceptable solutions for types of construction, fire resistance ratings and fire safety precautions, are provided in C3/AS1. Relevant tables are included in the Annex to the Fire Safety Documents attached to Approved Document C4.

2.0 ESCAPE ROUTES

2.1 General principles

2.1.1 An *escape route* (see Figure 1) shall provide adequate protection to any occupant escaping to a *safe place* from a *fire* within a *building*.

2.1.2 Components of an *escape route* in ascending order of protection are the *open path*, *protected path*, *safe path* and *final exit*. Depending on the total *travel distance*, one or more of these components are necessary. Except for the special case (see Paragraph 4.3) allowing an *exitway* to lead to an *open path*, an *escape route* shall not pass from a higher to lower level of protection in the direction of escape.

2.1.3 Provided the allowable lengths of *open paths* and *protected paths* are not exceeded, an *escape route* may comprise only an *open path* (or *open path* and *protected path*) and *final exit*.

2.1.4 *Escape routes* shall comply with NZBC D1, and in addition shall comply with the specific requirements of this acceptable solution for size and *fire* precautions.

2.2 Number of escape routes

2.2.1 Except where Paragraph 5.0 allows the

use of single *escape routes*, every *occupied space* in a *building* shall be served by two or more *escape routes*. (See Figure 2).

2.2.2 Table 1 gives the minimum number of *escape routes* needed for a given *occupant load*.

Table 1: Number of escape routes from a floor level
Paragraphs 2.2.2, 6.1.1 and 6.2.1

Occupant load on the floor being considered (Note 1)	Minimum number of escape routes
Purpose groups SC, SD	
Up to 50 (bedspaces)	2
Over 50	2 plus (Note 2)
Purpose groups SA, SR	
Up to 100 bedspaces	2
Over 100	2 plus (Note 3)
Purpose groups CS, CL, CO, CM, WL, WM, WD, IA, ID,	
Up to 500	2 (Note 4)
Up to 1000	3
Up to 2000	4
Up to 4000	5
Up to 7000	6
Up to 16000	8
Over 16000	8 plus (Note 5)

NOTES:

1. Guidance on determining occupant load is given in Appendix A. Special conditions applying to crowd and sleeping purpose groups are contained in Paragraph 6.0.
2. Plus 1 for every 100 bedspaces, or part thereof over 50.
3. Plus 1 for every 100 bedspaces, or part thereof over 100.
4. Special cases allowing single escape routes are given in Paragraph 5.0.
5. Plus 1 for every 5000, or part thereof increase in occupant load, above 16000.

Figure 1: **Escape routes**
Paragraph 2.1.1

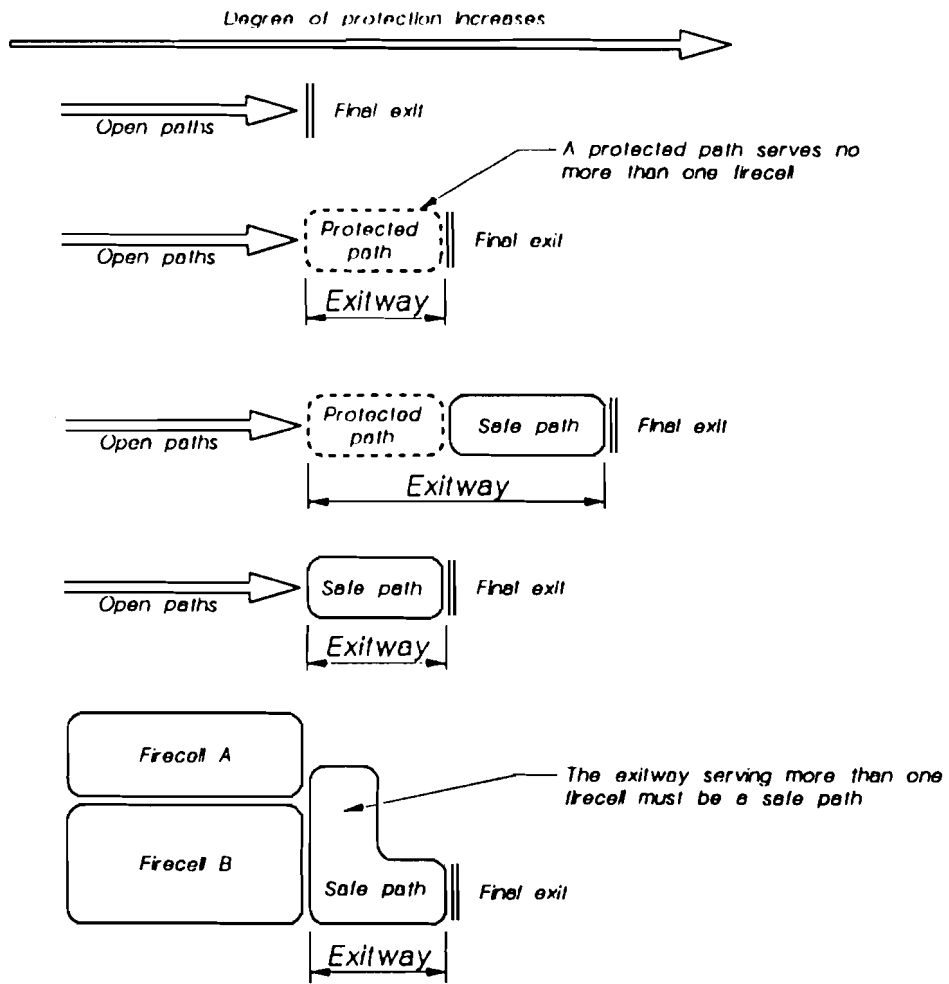


Figure 2: **Minimum number of escape routes**
Paragraph 2.2.1

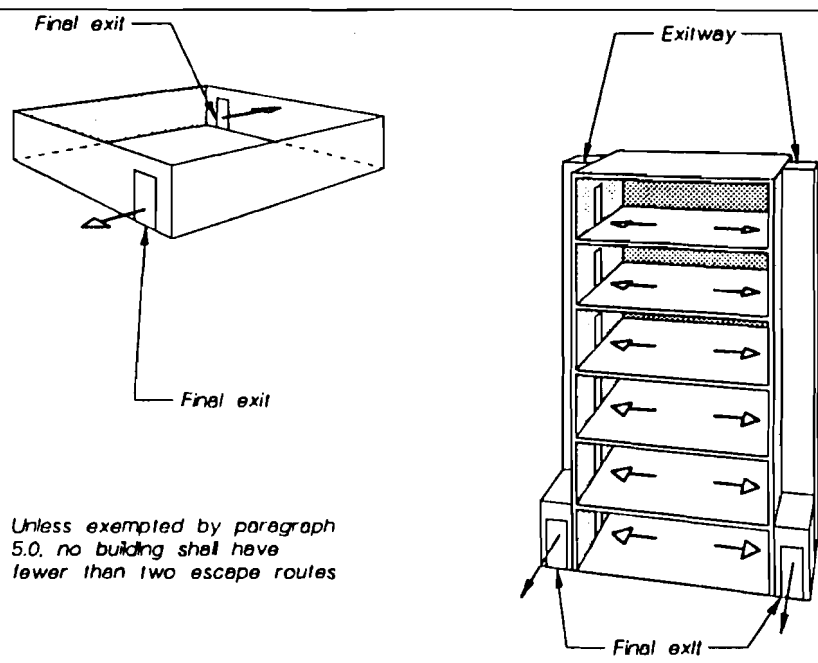


Table 2: Width of escape routes Paragraph 2.3.2			
	Purpose groups		
	CS, CL, CM, SA SR, WL, WM, WD, IA, ID	SC, SD	CO
Based on activity	Minimum width (mm)		
Horizontal travel	850 (Notes 1,2,3,6)	1200 (Notes 4,5)	1000 (Note 6)
Vertical travel (Notes 8 and 9)	1000 (Note 2)	1500 (Note 5)	1200 (Note 6)
Based on occupant load (Note 7)	Minimum width per person (mm)		
Horizontal travel	7	8	2
Vertical travel (Notes 8 and 9)	9	10	3
Column 1	2	3	4

NOTES:

- Where a single escape route is allowed by Paragraph 5.0, the width of the escape route within the exitway shall be no less than 1000 mm.
- Where the occupant load is less than 20, widths of escape routes may be reduced to 700 mm for horizontal travel, and 850 mm for vertical travel.
- For gangways between fixed storage in other than in public areas, width may be reduced to 530 mm.
- For passageways and corridors used for the movement of beds unless sprinklered, width shall be increased to 2400 mm.
- These widths apply only to escape routes from sleeping areas. Escape routes serving only occupants in support activities, may have the width appropriate to those purpose groups.
- For areas of fixed seating, escape routes shall comply with the requirements of Paragraphs 3.3.4 and 3.3.5 for aisles and width between rows.
- The width calculated on occupant load determines any extra width required, but in no case shall the width be less than that based on activity in this table.
- For limitations on width of the escape route in stairways and where the building height exceeds 34 m, see Paragraphs 2.3.3 and 2.3.4.
- Ramps with a slope of not more than 1:8 may be regarded as horizontal travel.

- Regulation C3 Spread of Fire - Each structure is called a fire cell as opposed to a fire compartment under the previous fire code. Maximum areas of fire cells are show in Acceptable Solution C3/AS1 Table 1. It should be noted that if you are going to erect a fabric structure on the roof of a building that it can be treated as a single storey building but the means of escape must comply. The area of single storey buildings is unrestricted as shown in the table which I have reproduced for your information.

Table 1: Firecell floor areas and security ratings (S) for buildings close to a relevant boundary

Paragraphs 3.2 to 3.8.1

Distance to the relevant boundary (Note 2) (m)	Building height	Fire hazard category (From Table A1 Appendix A)								Row
		1		2		3		4		
		Max floor area (m ²)	Min S (Notes 3&4)	Max floor area (m ²)	Min S (Notes 3&4)	Max floor area (m ²)	Min S (Notes 3&4)	Specific fire engineering design is required		
<3	Single floor	No limit	30	No limit	30	No limit	60			1
<3	Two and three floors	5000	30 (Note 6)	4000	60 (Note 6)	3000	90 (Note 6)			2
<4	>7 m and not >25 m	4000	30 (Note 6)	3000	60 (Note 6)	2000	90 (Note 6)			3
<7	>25 m	3000	60 (Notes 6,7)	2000	90 (Notes 6,7)	1500	120 (Notes 6,7)			4
Column 1	2	3	4	5	6	7	8	9		

NOTES:

1. Where sprinklered, S ratings may be reduced and the area may be unlimited, in accordance with Paragraph 3.8.
2. Also applies to a notional boundary where adjacent building contains purpose groups SC, SD, SA and SR.
3. Insulation ratings shall apply to walls less than 1.0 m from a relevant boundary or 2.0 m from an external safe path (see Paragraph 3.5 for appropriate values).
4. Where higher fire resistance ratings are required for stability or integrity from Table B1 of Appendix B, they shall replace the values given by this Table and the associated clauses.
5. The S ratings for a single floor may be used for the top floor of a building with two or more floors, and may be halved when the roof venting provisions of Paragraph 3.3.2(d) are satisfied.
6. Refer to the requirements specified in Paragraph 3.7 relating to ventilation conditions.
7. Where all of the following apply, the S rating for primary elements not resisting compression gravity loading, nor forming part of the lateral force-resisting system of the building, may be reduced by 30 minutes:
 - i) The area of vertical openings or windows provided in the external walls of the firecell is not less than 20 % of the floor area; and
 - ii) The vertical openings or windows are distributed generally in a uniform manner around all external walls of the firecell; and
 - iii) The weighted mean height of openings complies with Paragraph 3.7.5(a), and
 - iv) The floor area is no greater than 1200 m².

Comment:

The lateral force-resisting system required to be considered is only that necessary to maintain stability of the building in fire. The full lateral force-resisting system required to resist design load combinations including earthquake, wind or other design lateral forces may not be required for this purpose. Refer to NZS 4203.

The other section of Regulation C3 that does affect fabric structures is Table 4 which gives the requirements for surface finishes and suspended flexible fabrics to inhibit fire spread of unsprinklered buildings. Table 4 is reproduced here for your information.

Table 4: Requirements for surface finishes and suspended flexible fabrics, to inhibit fire spread in unsprinklered buildings Paragraphs 7.1.1(f) 8.1.2, 8.1.5, 8.3.1, 8.4.1 and 8.4.2			
Building elements	Purpose group or location	Requirements	Row
Walls, ceilings	Purpose groups SR & SH	Nil requirement	1
	Minimum requirement for all spaces in all purpose groups except within household units in purpose groups SR & SH.	SFI not > 9 or where the SFI is > 5 but not >9 then SDI not >8	2
	Exitways in all purpose groups. Sleeping areas in purpose groups SC & SD.	SFI = 0 SDI not > 3	3
	All spaces, excluding exitways, in purpose groups CS & CL. (See Note 1). Purpose group CM where the occupant load is between 50 and 1000. Sleeping areas in purpose groups SA.	SFI not > 2 SDI not > 5	4
	Passageways, corridors and stairways not being part of an exitway.	SFI not > 7 SDI not > 5	5
Suspended flexible fabrics	Exitways in purpose groups, SC, SD SA, SR and CO. All spaces in purpose groups CS & CL. All spaces in purpose group CM where occupant load is between 50 and 1000. Underlay to exterior cladding when exposed to interior spaces in purpose groups WM, WD, CO, CS and CL	FI not > 12	10
Membrane structures	Purpose groups CS and CL	Pass the standard test for flammability of membrane structures	
Column 1	2	3	
KEY: SFI = spread of flame index SDI = smoke developed index FI = flammability index			
NOTES: 1. For purpose groups CS and CL the minimum requirement for occupied spaces need not apply where the occupant load is less than 250, the floor level is served by two or more exitways or final exits (separated by no less than the firecell width), and the difference in floor level between firecell and final exit is no greater than 600 mm. When these requirements are met in classroom spaces in education buildings, the surface finish requirements of Row 4 may be reduced to SFI not > 7 and SDI not > 5.			

Column 1 deals with the building elements, Column 2 with the purpose group or location, Column 3 with the code requirements so when dealing with the walls of a building you may be required by the Territorial Authority to meet the requirements of Row 3 if exitways are created within the structure that lead to a safe place. Normally Row 4 deals with purpose groups CS(crowds small) and CL (crowds large) or CM (exhibition halls/trade fairs) with a Spread of Flame Index not greater than 2 and a Smoke Developed Index not greater than 5, but see note 1.

With free standing structures (mainframe structures) in purpose groups CS and CL the only requirement is to pass the standard test for flammability of mainframe structures. This is NFPA 701 Fire Tests for Flame-Resistant Textiles and Films 1989 Edition. This test would have to be carried out by a Telarc Laboratory, BRANZ, or an equivalent overseas authority. Paragraph 8.3, of Acceptable Solution C3/AS1, Suspended flexible fabrics not only applies to curtains, drapes and similar ornamental fabrics that hang vertically, but also to flexible canopies which may be at or near the horizontal. Paragraph 8.3.2 Membrane Structures, such as tents or marquees used in purpose groups CS and CL, must pass the standard test for flammability for membrane structures.

Paragraph 8.3.3 Air-supported structures calls for additional requirements, such as fully framed exitways, two air blowers, each with the capacity to support the structure. Air blowers shall be interlocked electrically so that if one fails, the other automatically starts, and in purpose group CL shall have a dedicated independent power supply.

The individual purpose groups in the Approved Documents all have special requirements and this is a brief summary of those purpose groups, the designation of the abbreviations in Tabela 1 and 2 and some examples of the purpose groups and ancillary purpose groups are :-

- | | | |
|----|---|---|
| CS | = | Assembly groups in small crowds of up to 100 people - cinemas, art galleries, churches, clubs, court rooms, dance halls, lecture halls, museums, commercial swimming pools, eating places, taverns. |
| CL | = | Assembly groups exceeding 100 people - cinemas, schools, colleges, universities, libraries (up to 2.4m storage), nightclubs, restaurants, theatres, television studios (with live audiences). |
| CO | = | Open grand stands, roofed but unenclosed grandstands, fixed seating (uncovered) for viewing open air activities, sport fixtures. |
| CM | = | Spaces for displaying or selling retail goods or merchandise - exhibition halls, supermarkets, large retail shops and showrooms. |
| IE | = | Exitways on escape routes - protected path and safe path. |
| IA | = | Spaces for intermittent occupation or support activities of a low fire hazard category such as garages, carports, corridors, kitchens and laundries, lift shafts, locker rooms, linen rooms, toilets and amenities. |
| ID | = | Spaces for intermittent occupation or support activities with a medium fire hazard such as maintenance workshops, service rooms incorporating machinery using solid-fuel, gas or petroleum as an energy source. |

Table A2: Occupant densities
Paragraph A3.3

Activity on any floor or firecell	Occupant density (Users per m ²)
Crowd activities	
Standing space	2.6
Bar standing areas	2.0
Stadia and grandstands	1.8
Space with fixed seating	as number of seats (see Note 1)
Space with loose seating	1.3
Areas without seating or aisles	1.0
Exhibition areas, trade fairs	0.7
Concourses, lobbies, and foyers	1.0
Bar sitting areas	1.0
Dance floors	1.7
Stages for theatrical performances	1.3
Spaces with loose seating and tables	0.9
Restaurants, dining rooms	0.9
Dining, beverage and cafeteria spaces	0.8
Indoor games areas/bowling alleys, etc.	0.1
Classrooms	0.5
Reading or writing rooms and lounges	0.5
Teaching laboratories	0.2
Vocational training rooms in schools	0.1
Gymnasias	1.7
Supermarkets, bazaar shops	0.5
Sales floor, ground and basement	0.4
Sales floor, upper floors	0.2
Showrooms	0.2
Sleeping activities	
Bunkrooms	as number of bedspaces (see Note 1)
Bedrooms	
Dormitories, hostels	
Detention quarters	
Wards containing more than two beds	
Working business and storage activities	
Reception areas	0.1
Interview rooms	0.2
Personal service facilities	0.2
Offices and staffrooms	0.1
Computer rooms	0.04
Workrooms, workshops	0.2
Manufacturing and process areas, staff rooms	0.1
Kitchens	0.1
Commercial laboratories, laundries	0.1
Warehouse storage	0.03
Heavy industry	0.03
Aircraft hangars	0.02
Bulk storage	0.01
Parking buildings, garages	0.02
Factory space in which layout and normal use of fixed equipment or plant determines the number of persons using it in working hours	as approved (see Note 2)

These are the purpose groups usually associated with fabric structures.

Table A1: Purpose groups Paragraph A2.1			
Purpose group	Description of intended use of the building space	Some examples	Fire hazard category
CROWD ACTIVITIES			
CS	Occupied spaces with occupant load up to 100.	Cinemas when classed as CS, art galleries, auditoria, bowling alleys, churches, clubs (non-residential), community halls, court rooms, dance halls, day care centres, gymnasia, lecture halls, museums, eating places (excluding kitchens), taverns, enclosed grandstands, indoor swimming pools.	
CL	Occupied spaces with occupant load exceeding 100.	Cinemas when classed as CL, schools, colleges and tertiary institutions libraries (up to 2.4 m high book storage), nightclubs, restaurants and eating places with cooking facilities, (non-residential) theatre stages, opera houses, television studios (with audience).	1
			2
		Libraries (over 2.4 m high book storage).	3
CO	Spaces for viewing open air activities (does not include spaces below a grandstand).	Open grandstands, roofed but unenclosed grandstand, uncovered fixed seating.	1
CM	Spaces for displaying, or selling retail goods, wares or merchandise.	Exhibition halls, retail shops.	2
		Super markets or other stores with bulk storage/display over 3 m high.	4
SLEEPING ACTIVITIES			
SC	Spaces in which principal users because of age, mental or physical limitations require special care or treatment.	Hospitals, care institutions for the aged, children, people with disabilities.	1
SD	Spaces in which principal users are restrained or liberties are restricted.	Care institutions, for the aged or children, with physical restraint or detention. Hospital with physical restraint, detention quarters in a police station, prison.	1
SA	Spaces providing transient accommodation, or where limited assistance or care is provided for principal users.	Motels, hotels, hostels, boarding houses, clubs, (residential), boarding schools, dormitories, community care institutions.	1
SR	Multi-unit residential dwellings.	Multi-unit dwellings or flats, apartments.	1
SH	Detached dwellings where people live as a single household or family.	Detached dwellings, houses, or household units.	1

Waivers - As the new Building Codes emphasis is on life safety this is reflected in the Fire Safety Tables in the Appendix to the C2, C3 and C4 Approved Documents as shown in Table B1/1 Fire Safety Precautions purpose groups Crowds Large (CL).

Table B1/1: Fire safety precautions						Purpose group CS & CL	
Occupant load or highest floor level	Full floors			Intermediate floors			
	Firecell rating and alarm type	Alternative firecell rating and alarm type	Other protection required	Firecell rating and alarm type	Alternative firecell rating and alarm type	Other protection required	
Single floor building							
Occupant load							
up to 50	F0						
51 to 100	F0 1		16ad*				
101 to 250	F0 2		16ad				
251 to 500	F0 3		16ad				
501 to 1000	F0 5		16d				
1001 to 2000	F0 6		16d				
over 2000	F0 7		16d				
Two floor building							
Total occupant load on both levels							
Max occupant load on level 2							
up to 50	up to 30	F15 1	F0 6		F15 2		
51 to 100	31 to 60	F30 2	F15 6		F30 3	F15 6	10
101 to 250	61 to 125	F30 3	F15 6	9,14,16ad	F30 5	F15 6	10,14,16ad
251 to 500	126 to 250	F60 4	F30 6	9,14,16ad	F60 6	F30 7	11,14,16d
501 to 1000	251 to 500	F60 5	F30 6	9,14,16d	F60 7		11,14,16d
over 1000	over 500	F60 6	F30 7	9,14,16d	F60 7		11,14,16d
Three floor building							
Total occupant load for 3 levels							
Max occupant load on level 2 or 3							
up to 50	up to 20	F30 1	F15 4		F30 3	F15 6	
51 to 100	21 to 40	F30 2	F15 6	14,16ad	F30 3	F15 6	10,14,16d
101 to 250	41 to 75	F60 4	F15 6	9,14,16d	F60 5	F30 6	10,14,16d
251 to 500	76 to 150	F60 5	F30 6	9,14,16d	F60 6	F30 7	11,14,16d
501 to 1000	151 to 300	F60 6	F30 7	9,14,16d	F60 7		11,14,16d
over 1000	over 300	F60 7		9,14,16d	F60 7		11,14,16d
Building of more than 3 floors							
Highest floor level containing the purpose group							
7 m not > 16 m		F30 4		14,16d	F60 4		11,14,16d
16 m not > 25 m		F60 5	F30 6	9,14,16d	F60 5		8,11,14,15,16d,18
25 m not > 34 m		F60 6	F30 7	9,12,13,14,15,16d,18	F60 6		8,11,13,14,15,16d,18
34 m not > 46 m		F60 6		9,12,13,14,15,16d,18	F60 7		8,11,13,14,15,16d,18,19
46 m not > 58 m		F60 7		9,12,13,14,15,16d,18	F60 7		8,11,13,14,15,16d,18,19
58 m and greater		F60 7		9,12,13,14,15,16d,18,19	F60 7		8,11,13,14,15,16d,18,19
Column	1	2	3	4	5	6	7

In column 1 for single floor buildings once the occupancy load exceeds 1000 a sprinkler system is required and in a two floor building once the occupant load exceeds 500 on the upper floor a sprinkler system is required. Therefore all buildings of a temporary nature will probably require a waiver from this requirement. The first thing therefore to ascertain is, will the occupant load exceed the number of persons listed in the Tables and if so who do you have to approach in the Territorial Authority to discuss the granting of a waiver.

In the CM purpose group in Table B1/2 for single and two floor buildings the requirements are the same.

Applicants should also be aware of any particular features of the site on which they wish to erect the structure. Most Territorial Authorities should be able to advise you of the wind zone in the area, the presence of any services on, over or under the site. The owners of the site should be able to advise you of the location of underground power lines, water mains, sewers foul or stormwater, the location of stand-pipe connections or other not obvious features. The presence of fill on the site should be made known to the Engineer/Designer of the structure to take care of any additional requirements that the Territorial Authority may ask for.

It is normal to supply everything pertaining to the application in duplicate. The Territorial Authority will keep one copy and issue the other to the applicant as the building consent. The building consent application form supplied indicates the kind of information that shall be lodged with it. The Territorial Authority also want to know what kind of emergency fire fighting equipment is being supplied, exit signage, power supply, toilet facilities and the proposed number of people that are expected to use the facility. Access to and facilities for disabled persons must be attended to. The only authority that can waive the requirements of the Disabled Person Community Welfare Act is the Building Industry Authority, and to obtain a determination from them comes at a minimum fee of \$500.00 and also takes about a month to obtain.