

Proposed Framework for Performance Based Fire Engineering Design in the Next Generation New Zealand Building Code: Specification of the Design Fire

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Abstract

As part of the proposed framework for the new building code in New Zealand, Fire Safety Engineers will use a set of specified design fires to demonstrate that their performance based design complies with the code. There are currently 9 fire scenarios that the designers must test their design against. These scenarios are described in great detail in a previous presentation. This paper describes the proposed design fires used in most of the 9 design scenarios. Design fires for specific scenarios, i.e., spread to adjacent property or surface spread of flame will be briefly described.

The design fire is intended to represent a credible worse case scenario that will challenge the fire protection features of the building. Although simple in concept this definition is very difficult to interpret when attempting to quantify the design fire especially in low ceiling spaces where occupants are expected to be sleeping. Even in relatively large spaces a fast t^2 fire often proves to challenge a building that is designed in accordance with the compliance documents.

The design fire is characterised using one or more of the following parameters:

- fire growth rate
- fire load energy density
- peak heat release rate
- species production (CO, CO₂, soot)
- heat flux
- time

The fire characteristics for the design fires used for performance based design are summarized in Table 1. The table is based on the use of the building or significant spaces within a building that has multiple uses, for example in a hotel the design fire would be different for the guest rooms, bedrooms, ballrooms, and kitchen. The fire growth rate for the preflashover phase of the fire assumes an αt^2 growth with a peak heat release rate per unit floor area being specified to limit the maximum heat release rate. The species production is also specified based on the expected fuel in the space. Three different species production levels are given: 100% polyurethane or similar plastic material, 50%

polyurethane and 50% wood or 100% wood. For the majority of the spaces, the growth rate has been specified as a “fast t^2 ” fire. This is based on the assumption that in most normally occupied areas of non-storage buildings the most challenging fire would be from upholstered furniture. It is acknowledged that there are other materials and indeed furniture items that burn faster than “fast t^2 ”, however, such rapidly developing fires are felt to be rare events.

The parameters specify only the initial conditions for the fire for both pre- and post-flashover. The specified growth rates are only for the pre-flashover phase of the fire. Because the time to flashover is a function of the room size, ventilation, and thermal properties, it is up to the designer to determine the time of flashover based on their analysis. Once flashover occurs the designer must increase the heat release rate to the post-flashover value. The post-flashover heat release rate is the lower value of the ventilation limit or the maximum heat release rate specified. The designer may also modify the fire behaviour based on the calculated effect of active fire protection systems.

Table 1– Exemplar version for design fire values. Values in this table are considered indicative only.

Use of Space	Fire Growth Rate (α)	Fuel Load Energy Density	Peak HRR	Net Heat of Combustion	Species Production
	(kW/s ²)	(MJ/m ²)	(MW/m ²)	(MJ/kg)	
Crowd Activities					
Auditoriums	Fast	300	100	16.5	2
Bars	Fast	400		20	1
Cafeteria	Fast	400		16.5	2
Childcare (Non Sleeping)	Fast	400	250	20	1
School Classrooms	Fast	400	290	16.5	2
Racquetball Courts	Moderate	400	100	16.5	2
Exhibition/Meeting space ceiling height > 3m	Fast	400	250	16.5	2
Kitchen	Fast	400	290	16.5	2
Sleeping Activities					
Bedrooms	Fast	400	250	20	1
Guest rooms	Fast	400	250	20	1
Hospital patient rooms	Fast	400	250	20	1
Working Business and Storage Activities					
Services					
Dental or Medical Office	Fast	400	290	20	1
Bank Counter	Fast	400	290	20	1
Hairdressing shops	Fast	400	290	20	1
Personal or Professional Service	Fast	800	290	20	1

Species Pre-Flashover Endnotes

- (1) Species 100% Polyurethane $f_{CO}=0.04$ kg/kg, $f_{Soot}=0.20$ kg/kg
- (2) Species 50% Polyurethane 50% Wood $f_{CO} =0.022$ kg/kg, $f_{Soot} =0.11$ kg/kg
- (3) Species 100% Wood $f_{CO}=0.004$ kg/kg, $f_{Soot}=0.015$ kg/kg

Species Post-Flashover Endnotes

CO production is 10 times larger than preflashover value
Soot production is 2 times larger than preflashover values