Evolution of New Zealand's Performance Based Building Code

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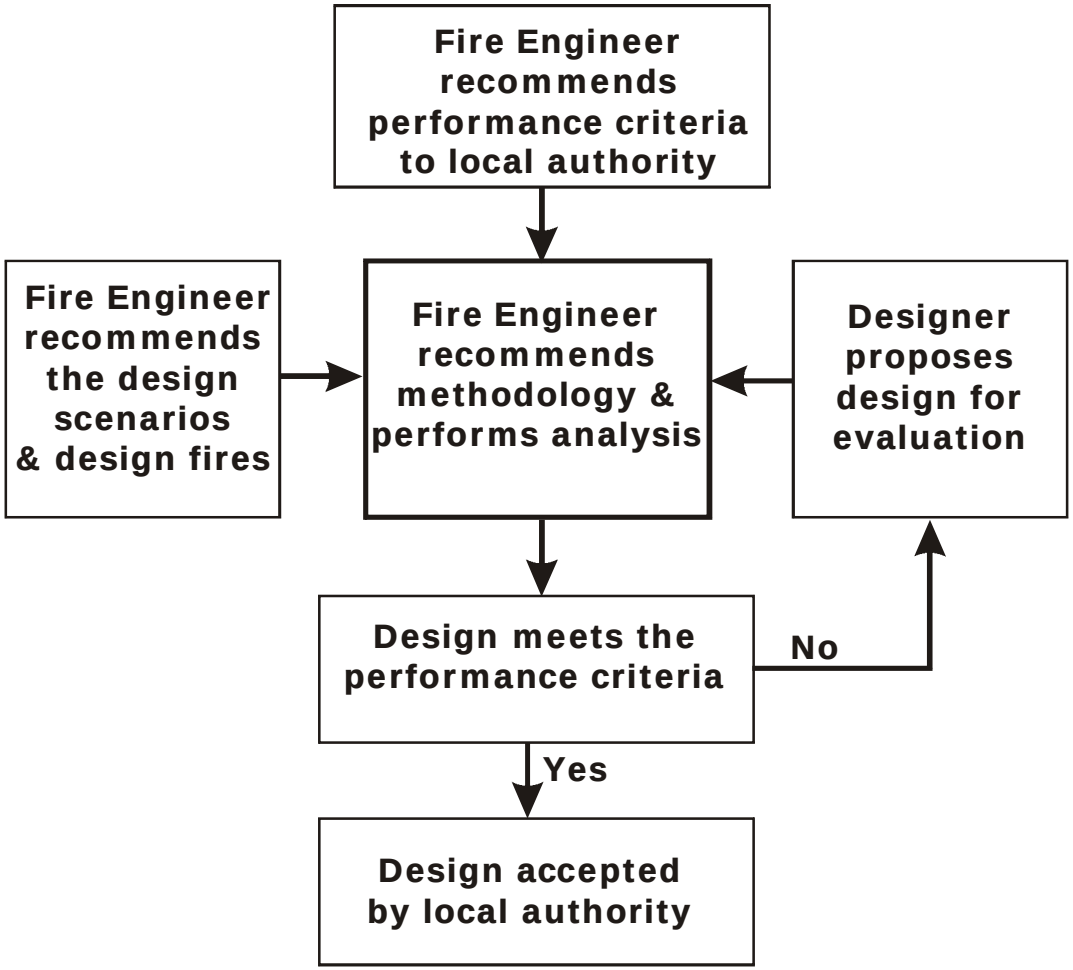
Comprehensive review of the New Zealand Building Code

- Motivated by perceived weakness in the building code quite separate from the fire clauses
- Involves a complete review of the structure and content of the Building Code to match the requirements of the Building Act 2004.
- Consultation with Brian Meacham and other international experts

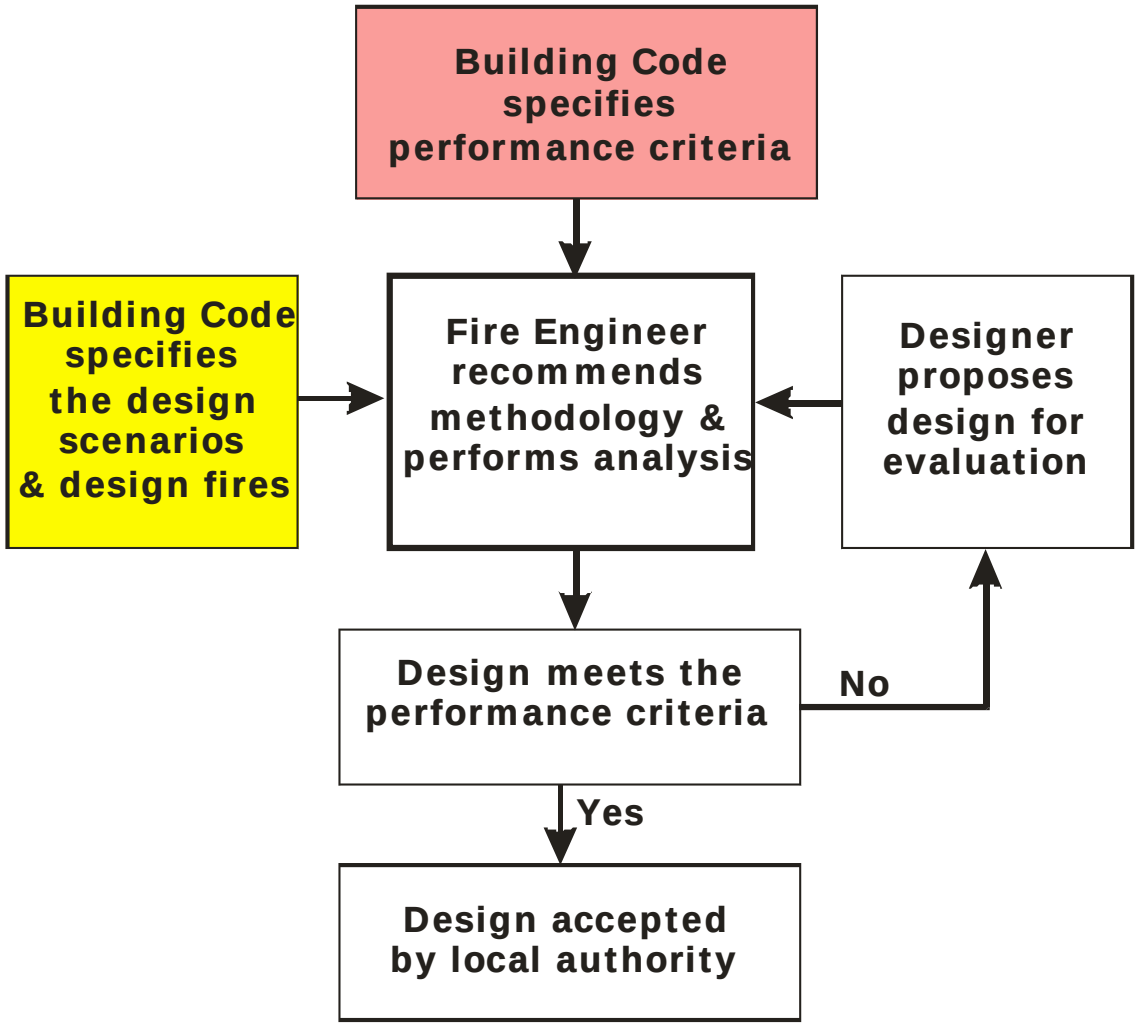
Existing Performance Based Design Process



Problems with existing system

- Local authorities reluctant to challenge recommended design fires and performance criteria designers
- Pool of potential peer reviewers is too small to be independent
- Lack of transparency in the deemed to satisfy documents.
- Inconsistent level of safety in buildings due to different design criteria.

Review of Fire Safety Clauses



- Advantages to new system
  - Local authorities have specific criteria to evaluate designs against.
  - More consistent and transparent performance criteria.
  - More consistent expectation for building design.
  - More transparent compliance documents?

Design Fire Scenarios

- Chose to adapt NFPA 5000 scenarios due to comprehensive nature of the scenarios.
- Other approaches explored to develop design fire scenarios included using event tree analysis as suggested in ISO16733 *Selection of Design Fires Scenarios and Design Fires* .
  - Group not convinced work required to carry out such analysis would result in substantially different set of scenarios.
  - Group did not believe there was sufficient reliable data to carry out event tree analysis in all occupancies
  - Timeline for completion of the project did not allow the event tree analysis

Design Scenarios

1. Occupancy specific fire scenarios
2. Fire blocks a primary means of escape
3. Fire that starts in normally unoccupied room
4. Fire that starts in a concealed space
5. Smouldering fire in sleeping area
6. Fire exposing neighbouring property
7. Fire external to the building exposing façade
8. Fire involving surface linings

Scenario #1

Description: Fire intended to represent a credible worse case scenario that will challenge the fire protection features of the building.

Performance Objective:

Maintain tenable conditions on escape routes until the occupants have evacuated.

Firefighters reasonable expectations.

Design Event:

Design fires will be characterised as t^2 growth, peak HRR and FLED. Yields will be specified for: CO and soot.

Design fires to represent 'free-burning' fires.

Expected Methodology:

Calculate fire environment in the escape routes which will be evaluated using tenability criteria

Scenario #1 – Preliminary Table

Use of Space	Fire Growth Rate (°) (kW/s^2)	FLED (MJ/m^2)	Peak HRR (kW/m^2)	Species Production	References
Crowd Activities					
Auditoriums	Fast	400	100[1]	2	
Backstage areas	Fast	400		2	
Baggage handling	Fast	800		1	
Bars	Fast	400		1	
Cafeteria	Fast	400		2	
Chapel Fixed seating	Fast	400		2	
Airport check-in areas	Fast	800*		1	
Childcare (Non Sleeping)	Fast	400	250[2]	1	
School Classrooms	Fast	400	290[3]	2	
Computer labs	Fast	400	290[3]	2	
Computer rooms (Low occupant load)	Fast	400	290[3]	2	

Fire Scenario #2

Description: Fire located within or near the primary escape route or exitway that prevents occupants from leaving the building by that route.

Performance Objective:

Provide a viable escape route from the building for occupants in the event of fire

Design Event:

Use fire characteristics from scenario 1

Expected Methodology:

Provide alternative escape routes that are tenable

Defend in place?

Fire Scenario #3

Description: A fire that starts in a normally unoccupied room that can potentially endanger a large number of occupants in another room

Performance Objective:

Maintain tenable conditions on escape routes until the occupants have evacuated.

Design Event:

Use fire characteristics from scenario 1

Expected Methodology:

Fire separations or suppression to confine fire to room of origin

Automatic detection to provide early warning

Tenability analysis of escape routes if fire spreads into the occupied space

Fire Scenario #4

Description: A fire that starts in a concealed space that can potentially endanger a large number of occupants in another room

Performance Objective:

Maintain tenable conditions on escape routes until the occupants have evacuated.

Design Event:

Currently unable to identify a suitable quantitative description of the design event, traditional solutions would apply – i.e. containment, detection or suppression.

Expected Methodology:

Fire separations or suppression to confine fire to concealed space

Automatic detection to provide early warning

Tenability analysis with fire spreading into the occupied space

Fire Scenario #5

Description: Smouldering fire in close proximity to a sleeping area

Performance Objective:

Maintain tenable conditions on escape routes until the occupants have evacuated.

Design Event:

Refer scenario 1 tables for fire characteristics for a smouldering fire

Expected Methodology:

Provide automatic smoke detection

Fire Scenario #6

Description: Limit fire exposure to neighbouring property

Performance Objective:

Prevent fire spread to other property for a time sufficient for fire service personnel to arrive on-site and establish fire suppression operations.

Design Event:

Use fire characteristics from scenario 1.

Methodology:

C/AS1 tabulated data

Heat transfer calculations

Fire Scenario #7

Description: Fire source external to the building exposing façade materials and leading to significant façade damage and vertical fire spread.

Performance Objective:

Prevent fire spread to “other property” (at upper levels in same building) and to maintain tenable conditions on escape routes until the occupants have evacuated

Design Event:

Radiant flux of x kW/m² for y min.

Methodology:

Large-scale fire tests (eg NFPA 285, ISO13785)

Small-scale testing (ISO 5660 or AS/NZS 3837)

Use non-combustible materials.

Fire Scenario #8

Description: Fire involving surface linings/finishes

Performance Objective:

Surface lining materials and finishes, when exposed to a moderate fire source, shall not generate excessive amounts of heat and smoke.

Design Event: Corner fire of output 100 kW for 10 minutes followed by 300 kW for 10 minutes (under test conditions of ISO 9705) located in:

- protected means of escape (safe/protected paths)
- open paths

Methodology: ISO 9705 room corner fire

ISO 5660 cone calorimeter test at 50 kW/ m^2

Use non-combustible materials

Validated flame spread models could possibly be used for some materials.

Occupant Response

- Building category (occupant alertness and familiarity):
  - Alarm system (both detection and warning)
  - Building complexity (wayfinding)
  - Management characteristics (trained staff, practised procedures, etc)

Tenability Criteria for Life Safety

- Simple Criteria
  - minimum clear layer height of 2.5 m
  - maximum upper layer temperature of 200°C

- Detailed Criteria PD 7974-6
  - Fractional Effective Dose (FED) for Narcotic Gases
  - Fractional Effective Dose (FED) for Radiant and Convective Heat
  - Visibility

Tenability Criteria – FED Narcotic Gases

- Fractional Effective Dose for Narcotic Gases
  - Accounts for cumulative effects of CO, CO_2, & O_2 depletion effects on respiration rate.
  - **FED ≤ 0.3** → suitable for most general occupancies
  - FED's may be determined at a height of **2.0 m**

Tenability Criteria – FED Thermal

- Fractional Effective Dose for Radiant and Convective Heat
  - Accounts for cumulative exposure to skin to radiant heat (2nd degree burns) and to convective heat from air.
  - **FED ≤ 0.3** → suitable for most general occupancies.
  - FED's may be determined at a height of **2.0 m**

Tenability Criteria - Visibility

- Visibility not less than 5 m, for rooms/spaces ≤ 100 m²
- Visibility not less than 10 m, for rooms/spaces > 100 m² (or distance to nearest exit, if < 10 m)
- Visibility may be determined at a height of **2.0 m**
- Calculation Methods: can be determined based on predicted smoke/soot concentration in the gas layer.
- Has proved to be problematic when comparing model results for currently compliant buildings

On Going Assessment

- 11 case study buildings have been chosen representing a range of typical C/AS1 compliant buildings (residential, commercial, storage and public)
- Tested for life safety, against the proposed tenability criteria, for the eight design fire scenarios using the fire loads described for the appropriate use.
- The aim of the work is to ensure the proposed framework generates the same level of performance as the existing compliance document.
- For this to be true the case buildings should pass the design fire scenarios, but not wildly exceed them.

Other Items Under Consideration

- System Reliability
- Tall buildings – why high levels of fire protection: have we missed something?
- Heritage/cultural buildings and collections - property protection?
- Role of New Zealand (and other) standards in performance-based design – can designers change the standard?
- Fire following earthquake – is this a design case?
- Reasonable expectations of firefighters
- How to progress structural collapse
- Probability risk analysis