Fire Engineering Design Approaches

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John Noone BSc (Hons) CEng MIEI
Associate - Arup Gulf Ltd
john.noone@arup.com

John Noone – Speaker Bio

John is an Associate Fire Safety Engineer in Arup's Dubai Office. A Chartered Fire Safety Engineer he hold a BSc Hons in Fire Safety Engineering.

John has gained a wide range of experience in fire engineering in Middle East, Africa, UK, Ireland, Russia and across Continental Europe .

He specialises in fire safety design, on-site implementation and handover of transportation, residential, commercial, industrial and assembly buildings.

John is a visiting lecturer at Trinity College Dublin on the fundamentals of fire safety science and fire dynamics.

Learning Objectives & Overview

- **Goals and Objectives**
  - How to define fire engineering goals and objectives?
  - Examples of fire engineering goals and objectives
  - Are alternative approaches available?
  - How to demonstrate an acceptable level of safety?
- **Example of Alternative approaches to allow for design flexibility**
  - Structural Fire Analysis
  - Extended travel distances
  - Atrium design
- **Example of Tools available to achieve alternative approaches.**
  - Structural assessment tools
  - Use of Computational Fluid Dynamics (CFD)
  - Use of evacuation modelling software

Commitment to Best Practice

UAE Fire Code (V: Clause 1)

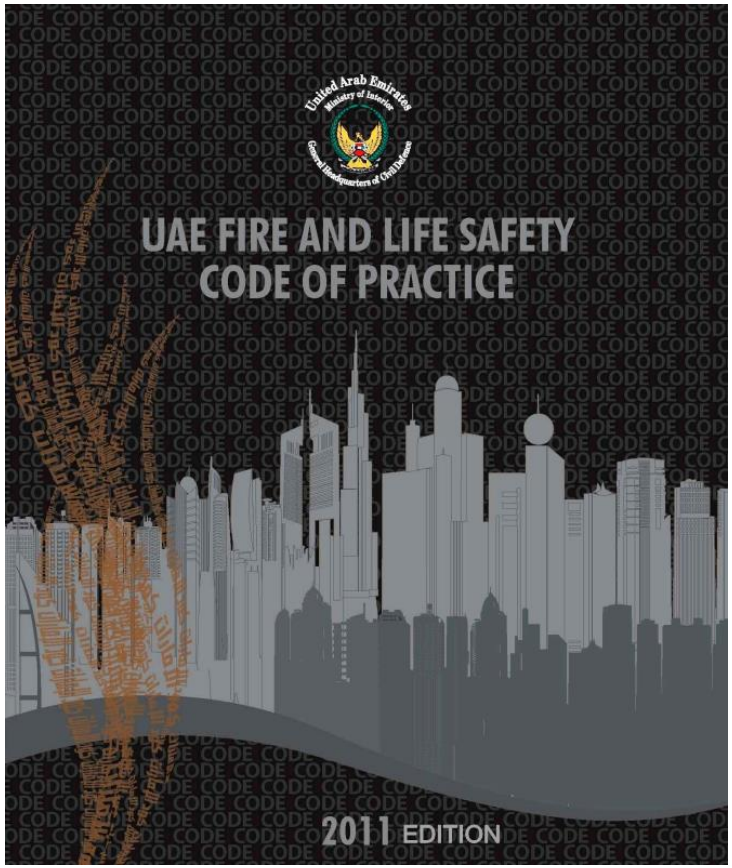
Commitment to Best Practice

- Compliance with Relevant Code
- Compliance with Relevant act and Regulations
- High Level of Quality of Work
- Environmental Management and Sustainability
- Occupational Health and Safety

UAE Fire Code (Chapter 10: clause 27)

Fire Engineering analysis should include:

- Fire Dynamics
- Fire Size and Location
- Materials likely to be burning
- Fire and Plume Geometry
- Tenability



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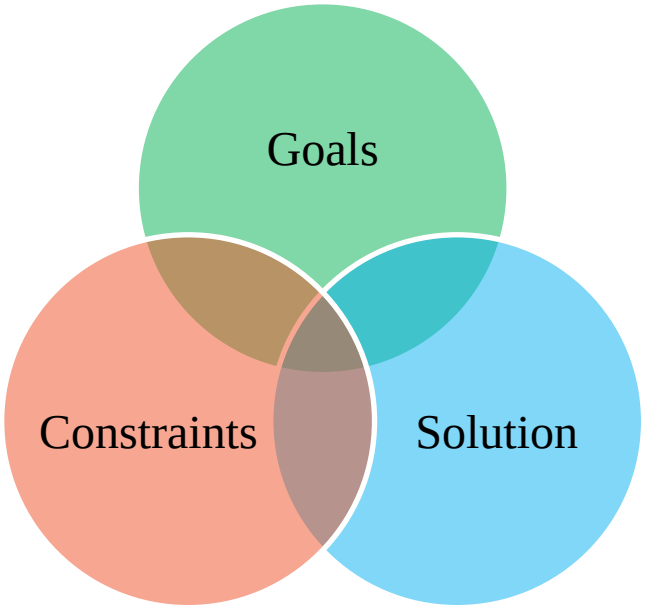
Goals and Objectives



Goal	Social	Economic	Environmental
People	Health and safety	Value for Safety	
Quality of Asset	Quality of space	Cost and value of asset	Construction impact
Quality of Operation	Functionality of space	Operational costs	Operational impact
Protection of Asset	Continuity of asset	Property Protection	Prevention of fire damage to the environment
Protection of Operation	Continuity of function	Business Continuity	

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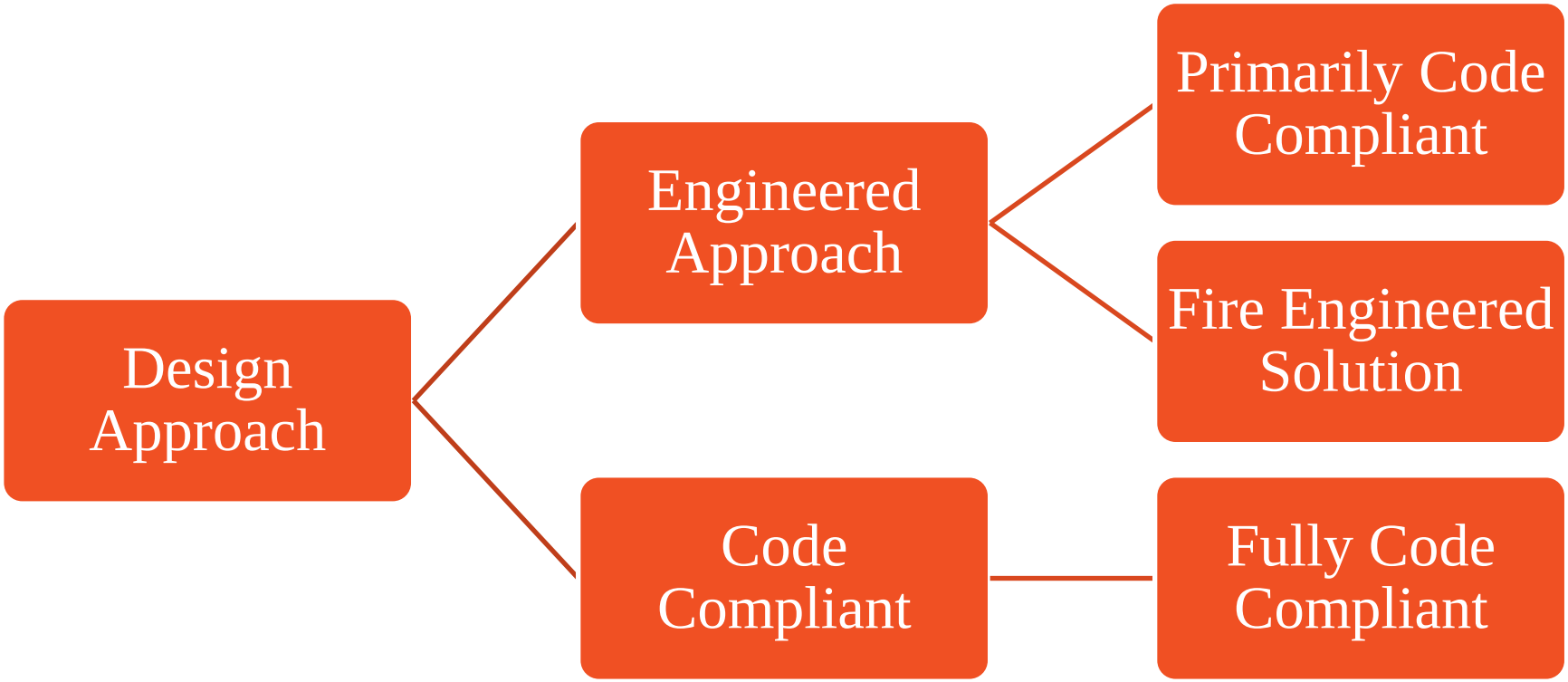
Establish Framework & Benchmarks for Design

- **Framework – Define Fire Engineering Brief**
  - IFEG
  - SFPE
  - BS 7974
- **Enhancing / Optimising Fire Safety – Key Points**
  - Operational and business continuity
  - Quality and functionality of space
  - Enhancing Fire Safety
  - Prescriptive solution may not be possible

Goals and Objectives



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Goals and Objectives

Buildings benefiting from an alternative approach include:

- Airports (Extended Evacuation Time, Business Continuity)
- Public Buildings (Management may wish to remain during fire)
- Heritage buildings (Protection of valuable Assets)
- Train stations (Business Continuity)
- Tunnels (Asset Protection, Business Continuity, Life Safety)
- Power Stations (Societal acceptability)

Concept of Equivalency (NFPA 5000)

NFPA 5000:1.5 Equivalency.

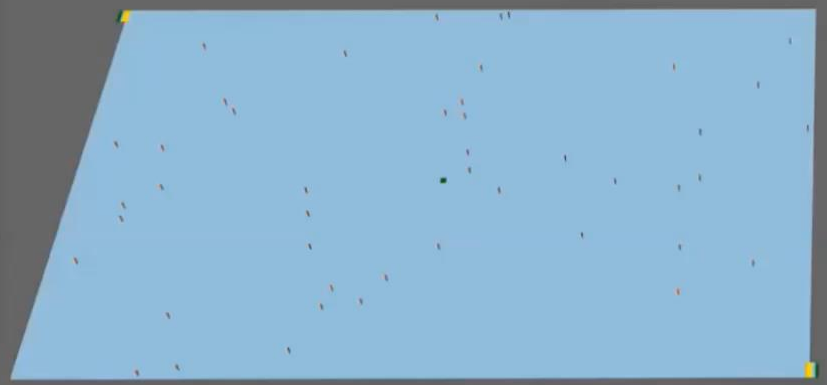
1.5.1 General. Nothing in this Code shall prohibit methods of construction, materials, and designs not specifically prescribed in this Code where equivalent alternatives are approved by the authority having jurisdiction (AHJ).

1.5.2 Approval of Alternatives. Alternative systems, methods, or devices approved as equivalent by the authority having jurisdiction shall be recognized as being in compliance with this Code.

Concept of Equivalency

Code Compliant Scenario

Room: 130m x 80m = 10,400m²
10,400m² @ 9.3m²/pers = 1,120 ppl
Exit capacity = 1,120 x 5mm = 5.6m
Total travel distance = 76m



Non Code Compliant Scenario

Room: 130m x 80m = 10,400m²
10,400m² @ 9.3m²/pers = 1,120 ppl
Exit capacity = 1,120 x 5mm = 5.6m
Total travel distance = 135m

Alternative Approaches

Structural Fire Engineering Analysis

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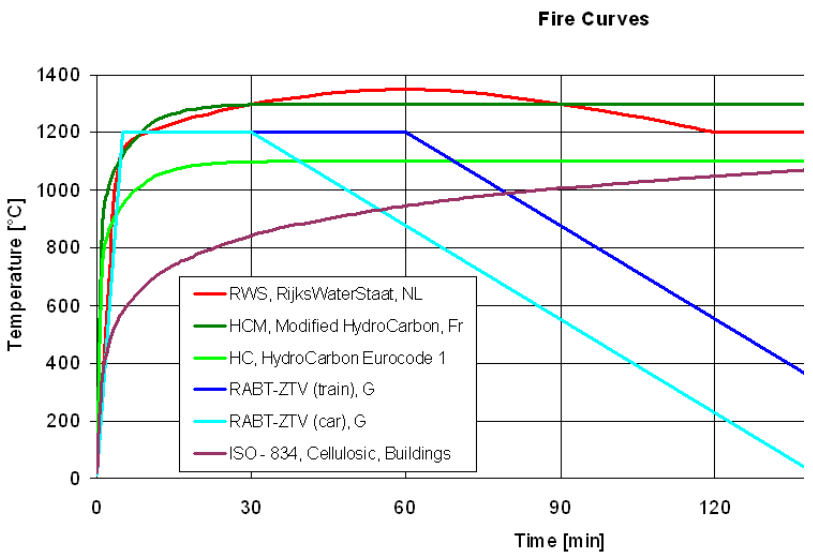
Structural Fire Resistance

Bored Tunnel Example



Temperature Time Fire Curve

Increased Protection

- Fibres to mitigate Spalling
- Consider Temperature-Time Curves
- Increased Fire Resistance may be required

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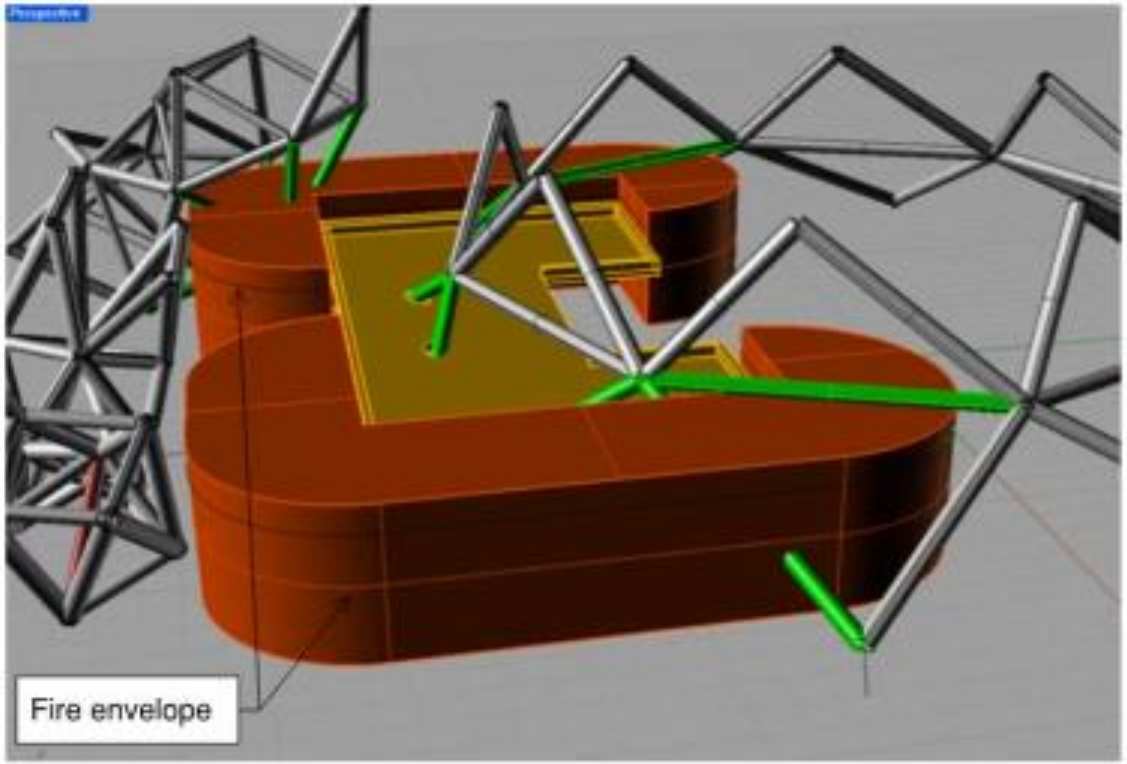
Structural Fire Resistance

Fire Protection to the Structure?

- Common approach in large single storey spaces.
- Common in Airports

Structural Fire Resistance



- Fire load assessment and flame envelope undertaken to determine which members might be affected by a fire.
- Robustness checks done in concert with the ambient structural design team to determine robustness of space frame system.

Alternative Approaches

Evacuation Modelling

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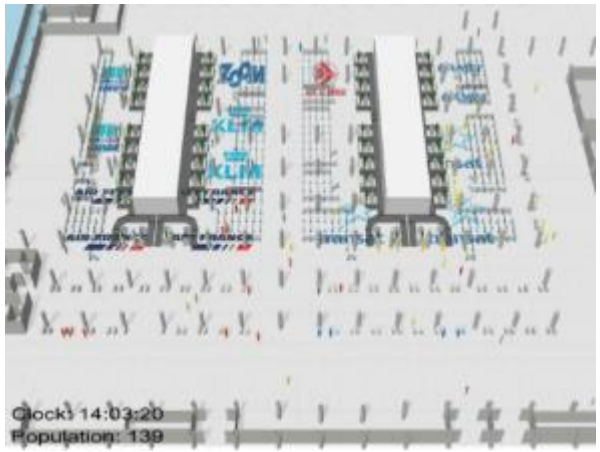
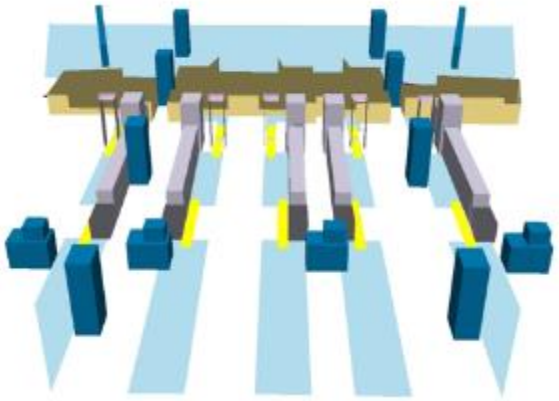
Evacuation Modelling Potential

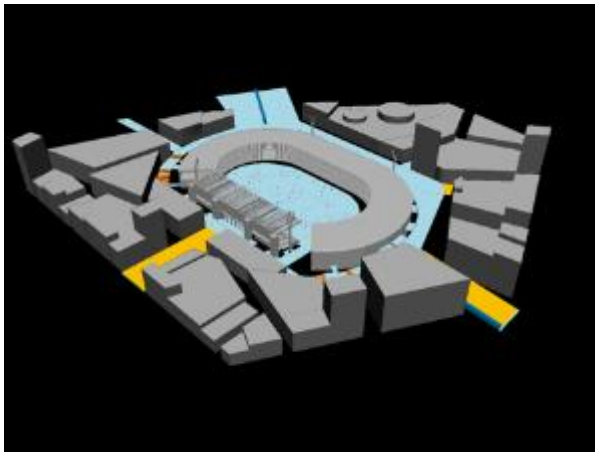
Transport facilities



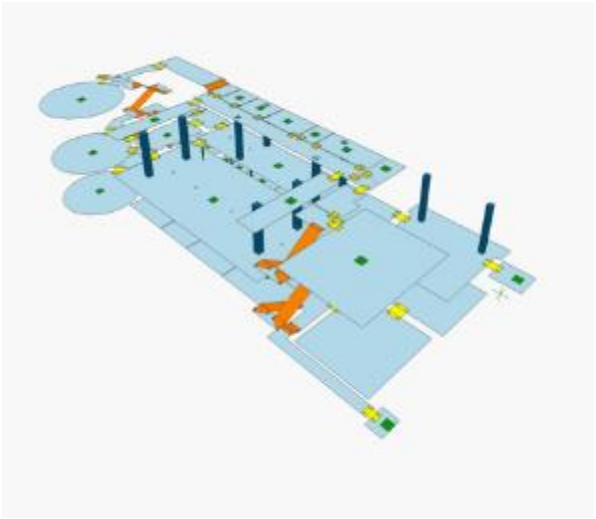
Process modelling



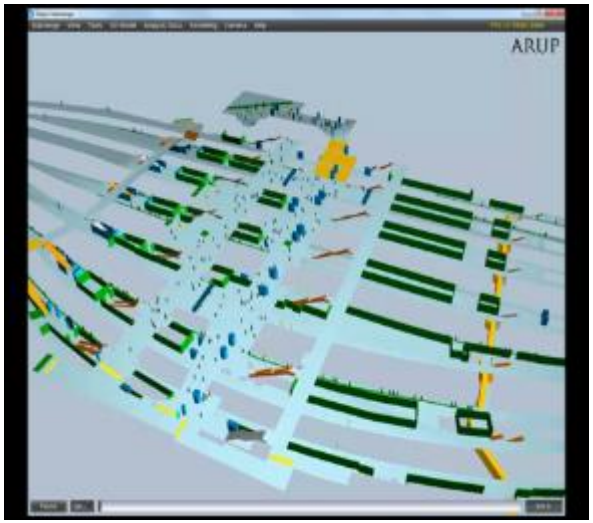
Crowd management



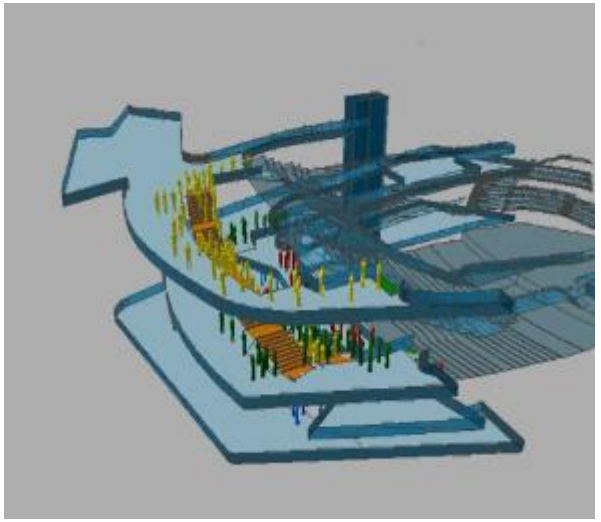
Existing buildings



Live construction environments



Stadia and venues



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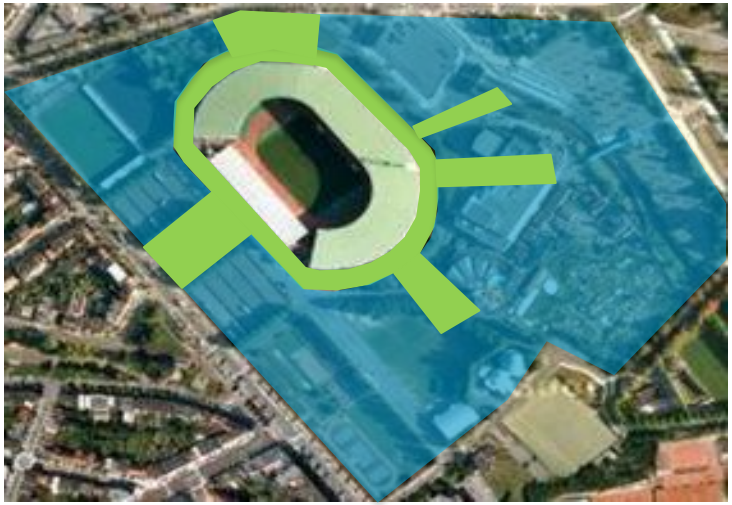
Summary of Applications (Fire)

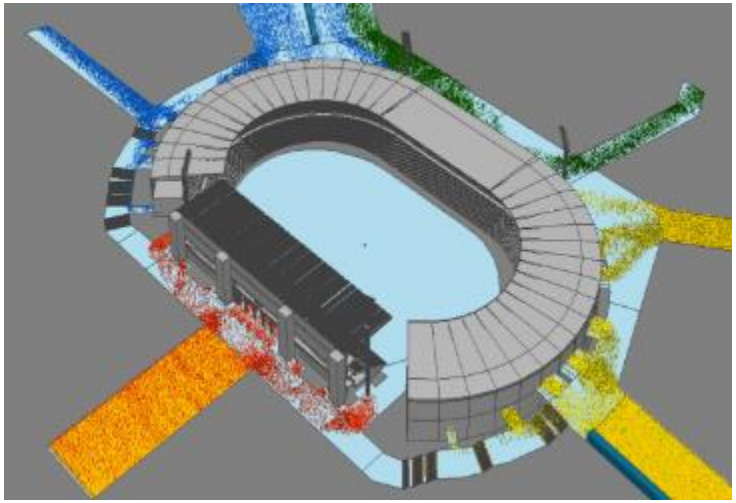
- Large exhibition spaces – Indoor/outdoor events
- Airports
- Construction phasing
- Phased Evacuation/Progressive horizontal Evacuation
- Masterplanning
- Transport facilities – Rail/Underground
- Sports Stadia
- Duplicate Services – Ped Planning, Security etc

European Stadium – Our approach

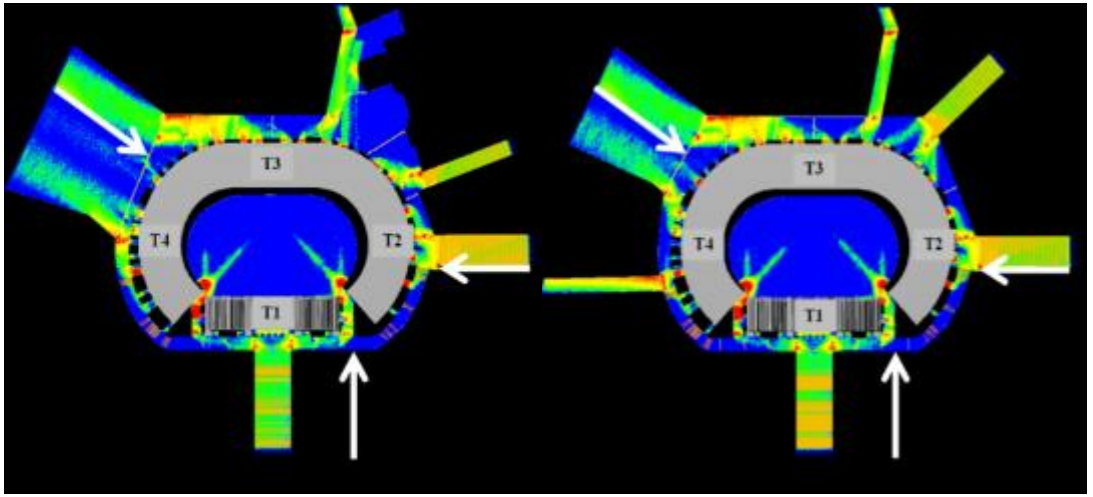


Proposed master plan with constrained space

Modelling approach simulated 80,000 persons for a concert mode



MassMotion model visual



Crowd density maps for different phases

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Alternative Approaches

CFD Modelling

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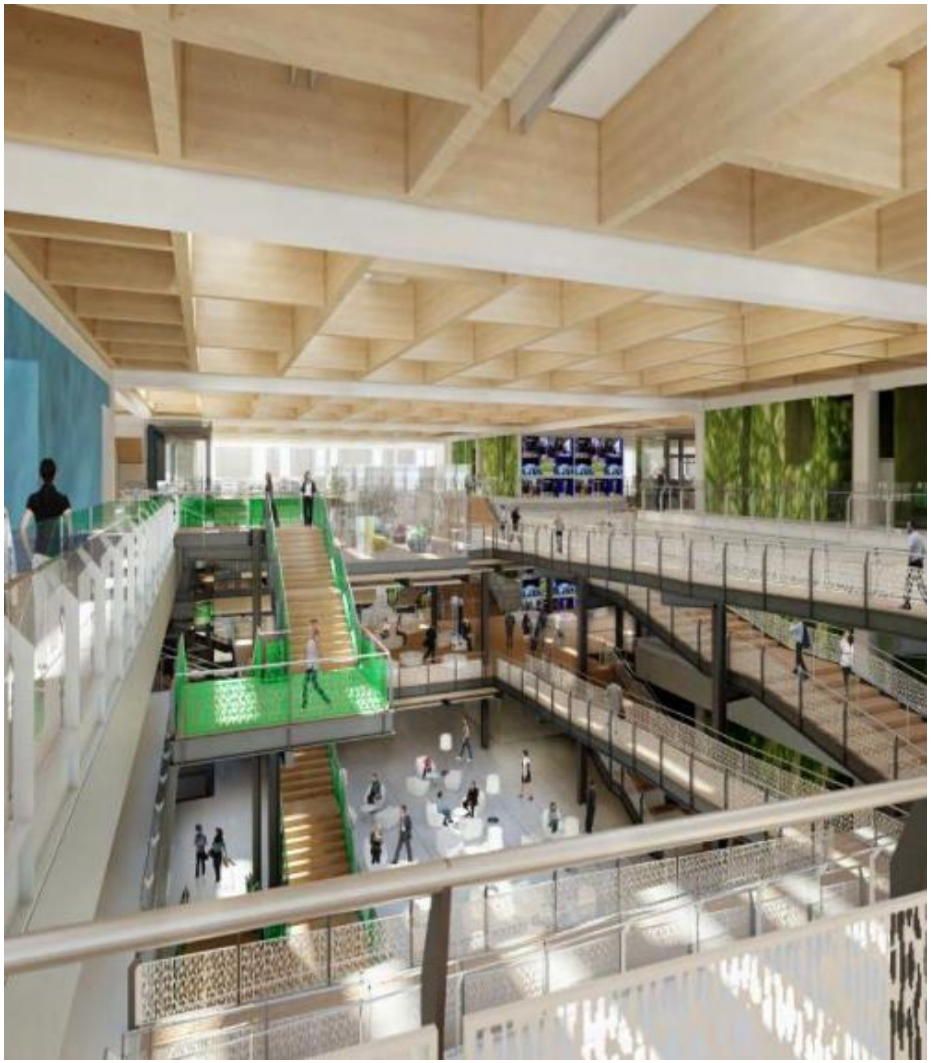
CFD Modelling

- UAE Fire Code Recognises the use of CFD modelling for specific smoke control purposes.

- CFD modelling can be used for other aspects:
  - Assessment of conditions for evacuation
  - Assessment of thermal conditions in the fire compartment
  - Fire investigations
  - Research (NIST, BRE)

Open planning

- Fire Engineering can help enable Architectural visions towards open plan design
- It is a common Architectural desire to avoid heavy doors and partitions as reasonably feasible.



Alternative Approaches

Fire Load Limitations

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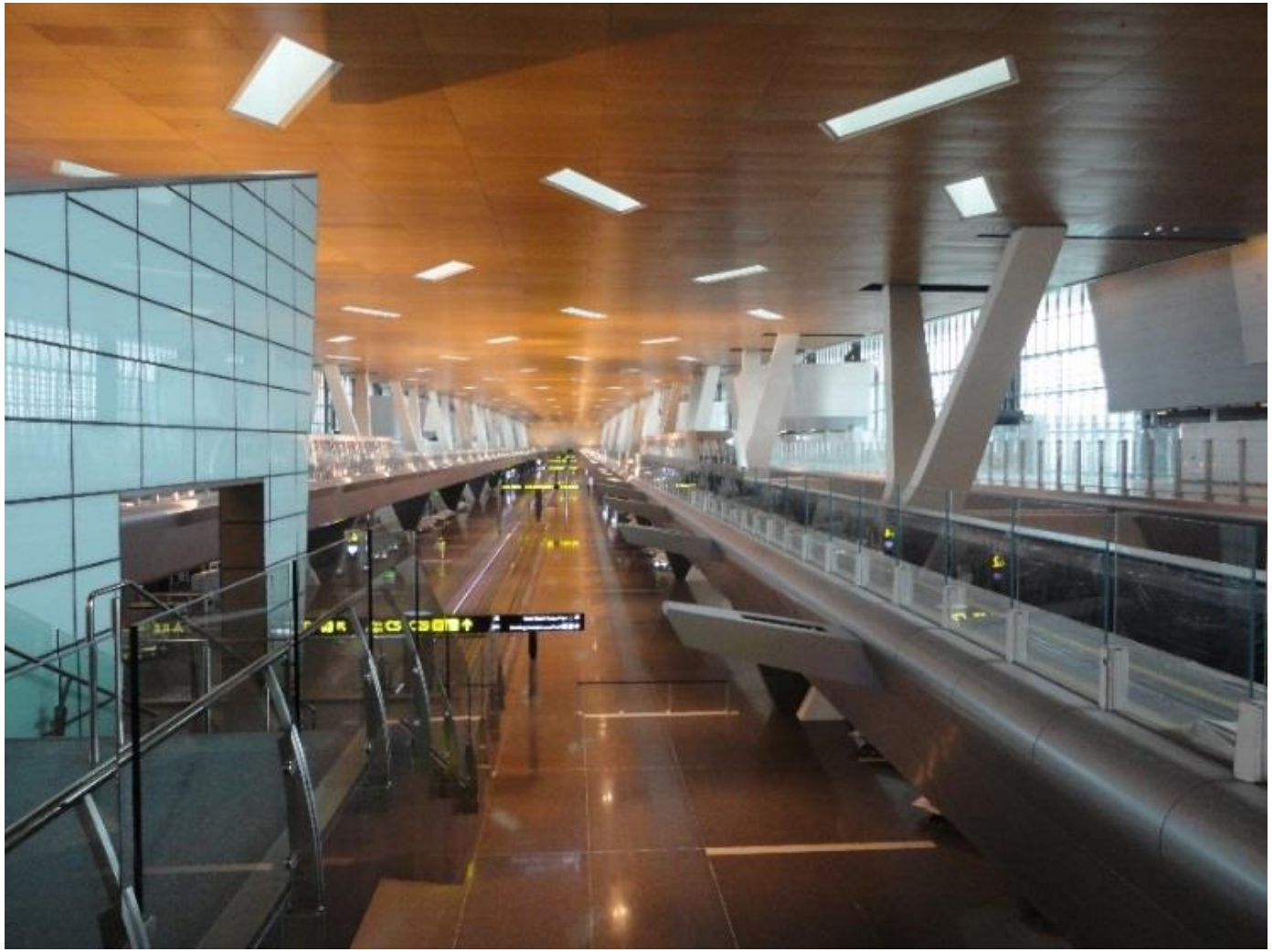
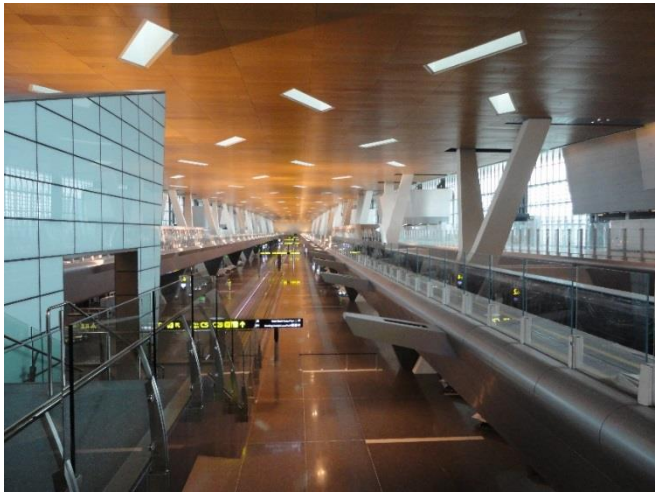
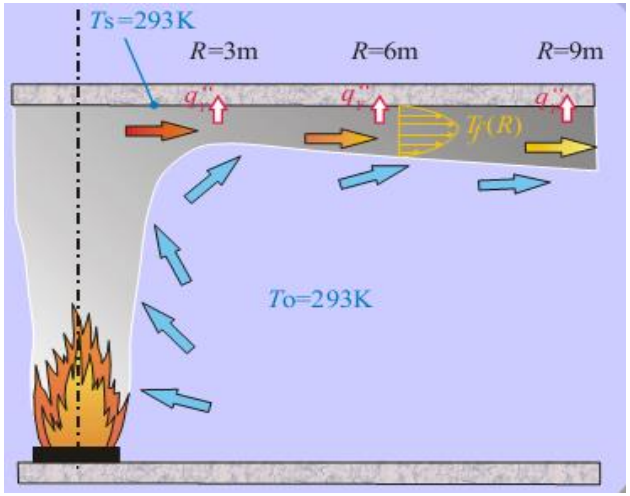
Fuel Load limitations – Example space



Activation of Sprinklers





	Ceiling Height							
	5m	10m	15m	20m	25m	30m	40m	50m
Estimated Minimum Size of fire needed to activate sprinkler (under steady state conditions)[1]	0.75MW	2.1MW	4.2MW	8.5MW	15MW	>20MW	>20MW	>20MW
Estimated time of sprinkler activation[2]	4.8mins	7.5mins	10.3mins	14.6mins	19.2mins	>20mins	>20mins	>20mins
Estimated fire size at time of sprinkler activation[2]	1MW	2.4MW	4.5MW	9MW	15.4MW	>20MW	>20MW	>20MW

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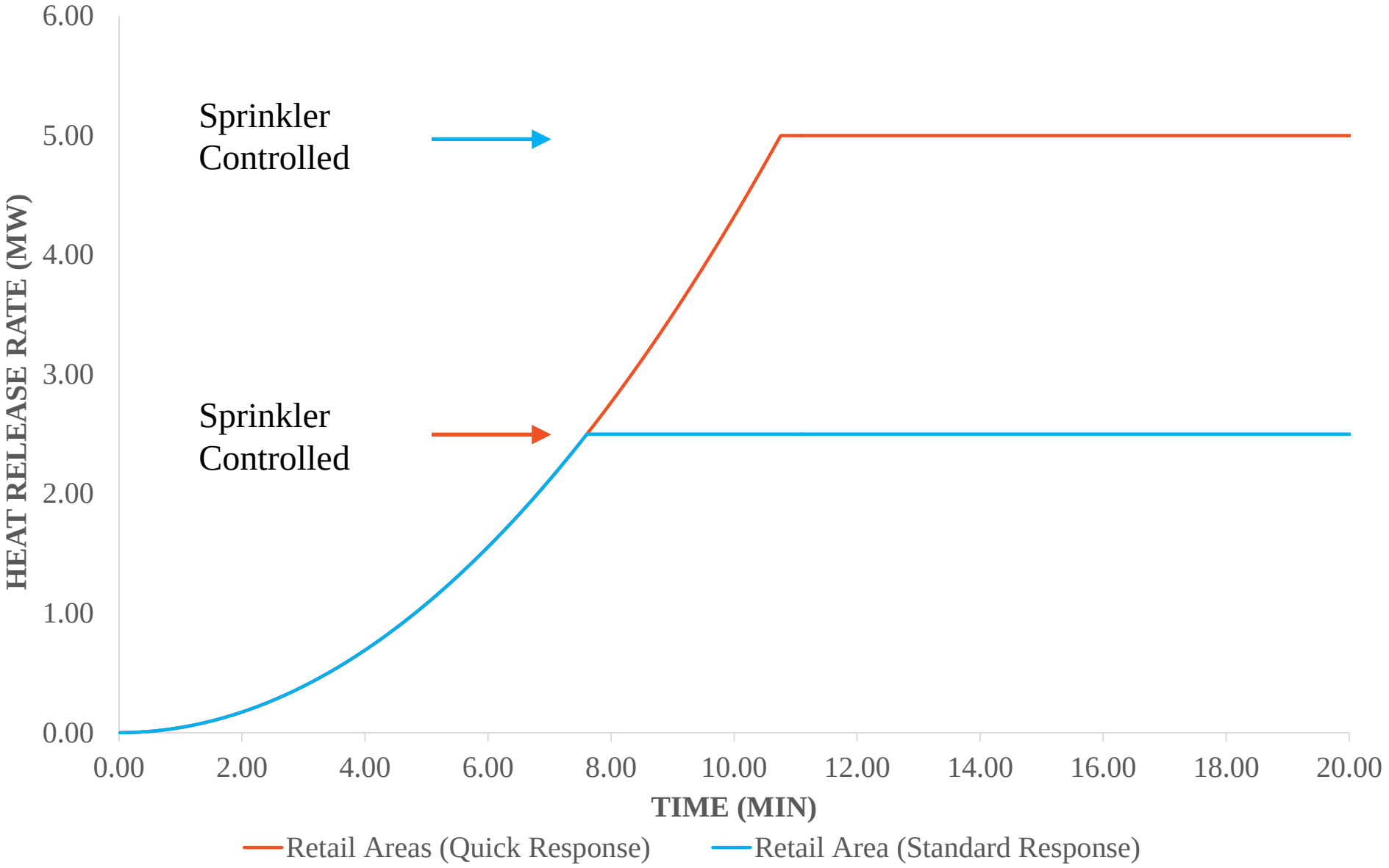
Sprinkler Controlled Fire



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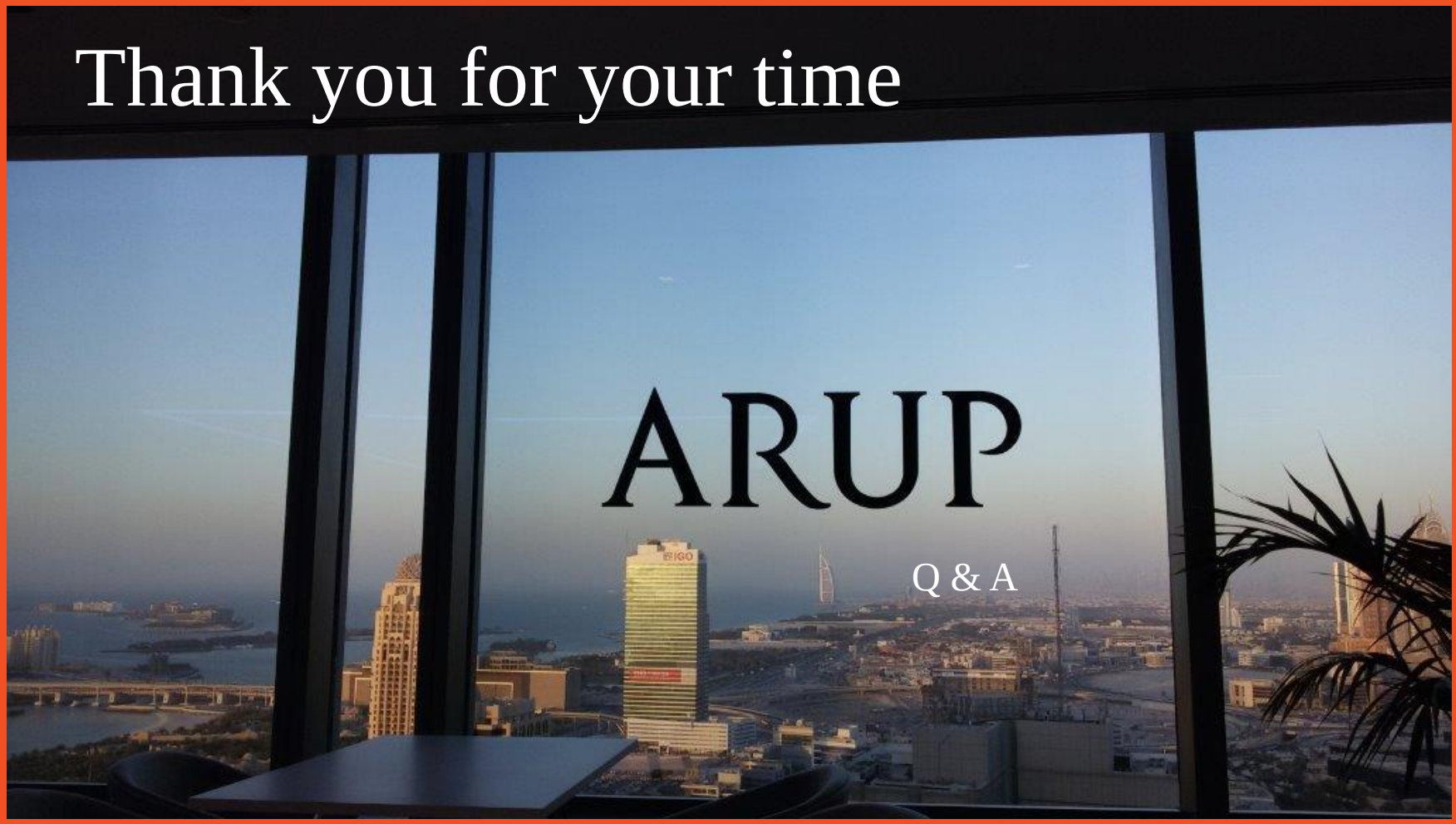
Concluding Remarks

- **Clearly Define Goals and Objectives**
- **Apply Fire Engineering Framework to Design to meet Goals and Objectives**
- **Example of Tools available to achieve alternative approaches and demonstrate appropriate Level of safety.**
  - Structural assessment tools
  - Use of Computational Fluid Dynamics (CFD)
  - Use of evacuation modelling software

Thank you for your time



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