



Fire Safety Engineering Design in High-rise Building in Hong Kong

6th Tall Building Fire Safety Conference (18 to
19.6.2019)

**Skyscrapers
in
Hong Kong**

**Fire Safety
Engineering
Approach**

Case Study

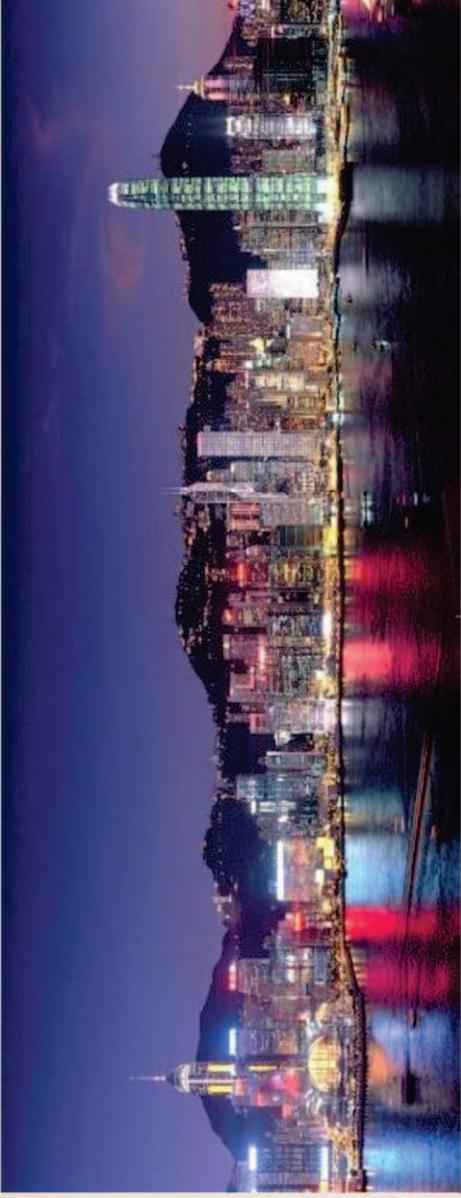
**Fire Safety
Requirements**

Presented by
Ir Wilson W S KWOK
Divisional Officer
Hong Kong Fire Services
Department

Skyscrapers in Hong Kong



A grid of eight informational cards, each containing text, images, and charts related to Hong Kong skyscrapers. The cards are arranged in two rows of four. The top row includes cards on 'Skyscraper Height', 'The Skyscraper Center's Skyscraper List', and 'The Skyscraper Center's Skyscraper List'. The bottom row includes cards on 'The Skyscraper Center's Skyscraper List', 'The Skyscraper Center's Skyscraper List', 'The Skyscraper Center's Skyscraper List', and 'The Skyscraper Center's Skyscraper List'. Each card features a small image of a skyscraper and a bar chart.



- Skyscrapers in Hong Kong
- Fire Safety Requirements (Active & Passive)
- Fire Safety Engineering Approach
- Case Study – ICC (Highest Building in HK)



Population Density

- 7,449,800 persons
- 6,890 persons per km²
(figures at 2018)



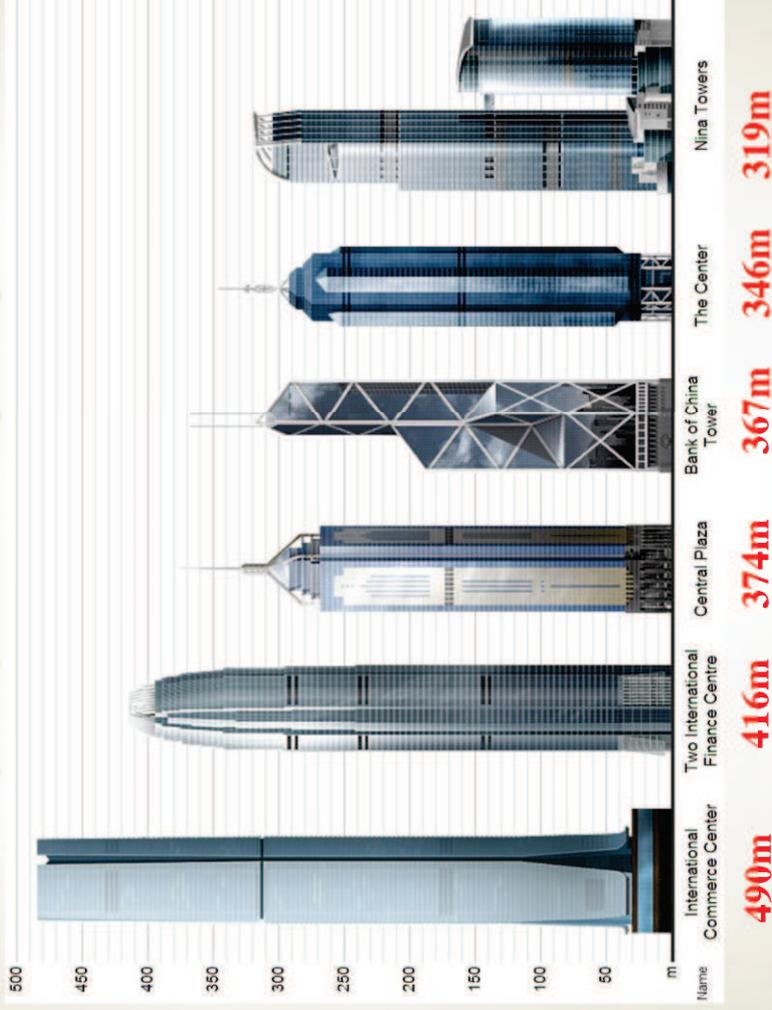
Land Utilization

- Total land area – 1,111km²
- Urban or built-up area – 24.4%





Skyscrapers in Hong Kong





Super high-Rise Residential Buildings in Hong Kong



The Arch
81 Floors
(261m)



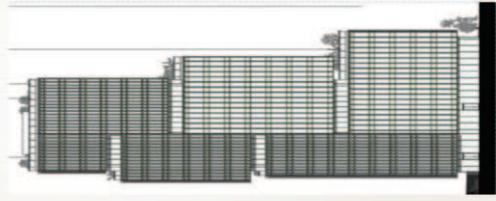
The Harbourside
74 Floors
(270m)



Sorrento
75 Floors
(256m)



High-rise Building



FSI Code

High-rise Building
 $H > 30m$

Super High-rise Building



FSD Circular Letter

Super High-rise Building
 $H > 80m$



Hong Kong

- Exceeds 30m = High-rise building
- Exceeds 80m = Super high-rise building

Other Countries (e.g. USA)

- Exceeds 23m = High-rise building (NFPA101)

China

- Exceeds 24m = High-rise building (GB 16-87)
- Exceeds 100m = Super high-rise building (GB 50045)





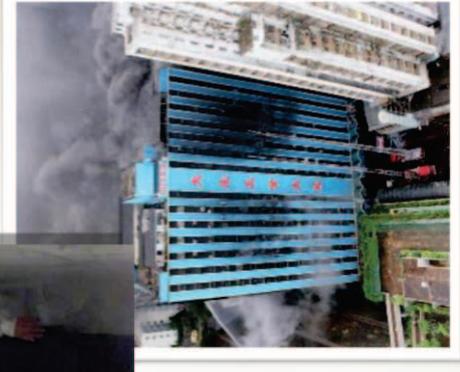
Risks in High-rise building

- A large number of occupants / visitors
- Unfamiliar with the Mean of Escape
- Complicated layout
- Long travel distance



Risks for firefighting

- High fire load
- Rapid vertical fire spread
- Difficult communication among firemen
- Delivery of fire fighting and rescue equipment





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Active & Passive Requirements





Code of Practice

Buildings Department (BD)

Fire Services Department (FSD)



MoA Code



FS Code 2011



FSI Code 2012



MoE Code



FRC Code



FSD Circular Letters



Passive Fire Safety Provisions

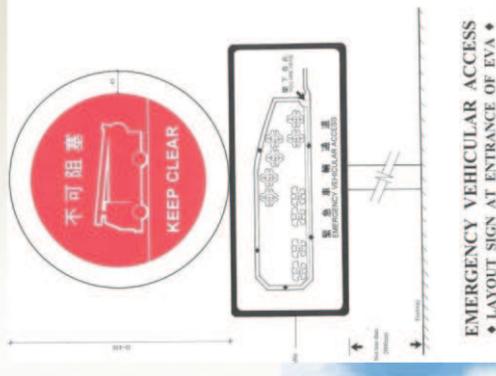
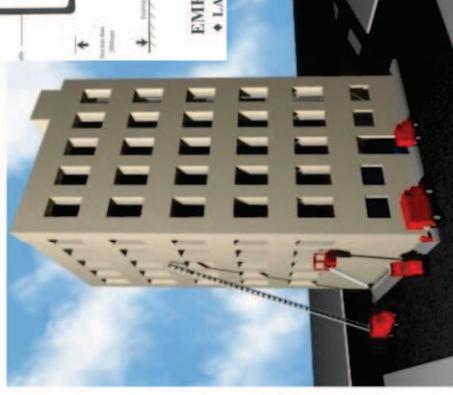
Means of Access (MoA)

Emergency Vehicular Access (EVA)

EVA should be provided for every building

General Requirements:

1. Width > 7.3 m
2. Hard-paved
3. Clear headroom > 4.5m
4. Gradient < 1:10
5. Gross weight > 30 tonnes
6. Turning circle > 26m
7. Turning space at all dead end
8. Serving major façade > 25%



EMERGENCY VEHICULAR ACCESS
◆ LAYOUT SIGN AT ENTRANCE OF EVA ◆



Passive Fire Safety Provisions

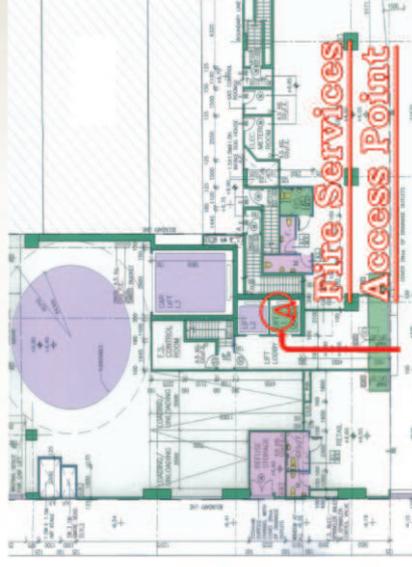
Means of Access (MoA)



Fire Service Access Point (FSAP)

Requirements:

1. Distance < 18m
2. Width > 1.5m
3. Clear headroom > 2m
4. Required FRR protection
5. Required notice to be displayed



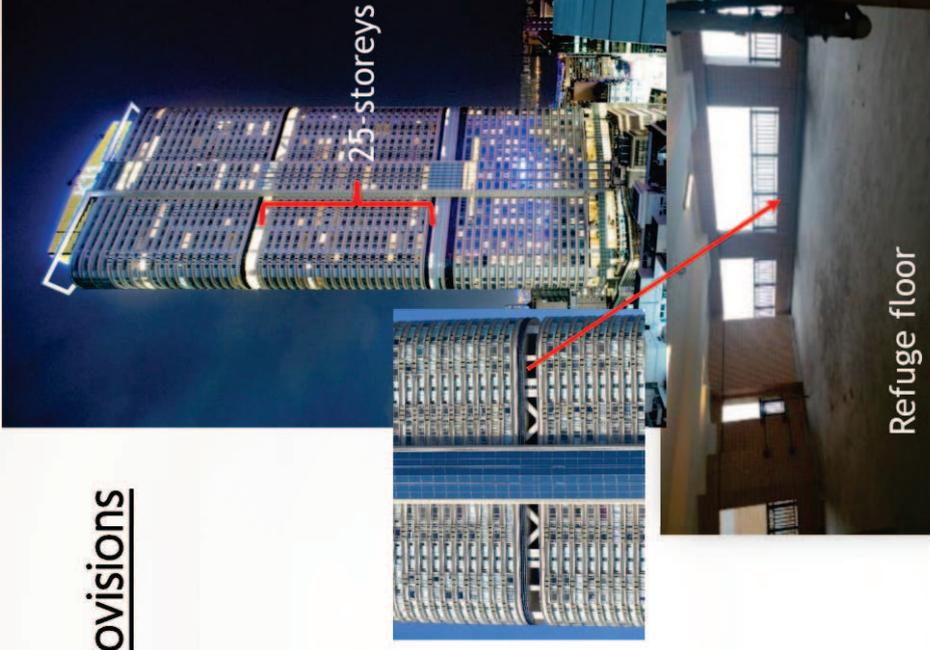


Passive Fire Safety Provisions

Means of Escape (MoE)

Refuge Floors

- Buildings exceeding 25-storeys in height, with max. 25-storeys per segment
- Area for refuge > 50% of the floor area
- No other occupancies
- Served by fireman's lift
- Two opposite sides open-sided → cross ventilation
- External drencher system with independent water supply to protect external wall opening
- Discontinuation of staircases





Active Fire Safety Provisions

FSI requirements are formulated in accordance with the Code of Practice for Minimum Fire Service Installations and Equipment.



Active Fire Safety Provisions

Fire Service Installations (FSIs) Requirement

- With due reference to the intended use, occupancy, height and size of the building.
- classified buildings into 45 groups.
- Common classifications include:
 - Commercial use
 - Composite
 - Domestic
 - Special risks
 - Hotel
 - Industrial
 - Institutional





Active Fire Safety Provisions

F.S. Installations and Equipment	Building Types							
	Commercial Building		Domestic Building		Hotel		Industrial Building	
	Low-rise	High-rise	Low-rise	High-rise	Low-rise	High-rise	Low-rise	High-rise
a. Audio/visual advisory system*	Y	Y			Y	Y	Y	Y
b. Automatic actuating devices	Y	Y			Y	Y	Y	Y
c. Automatic fixed installation other than water	Y	Y			Y	Y	Y	Y
d. Emergency generator	Y	Y		Y	Y	Y	Y	Y
e. Emergency lighting	Y	Y		Y	Y	Y	Y	Y
f. Exit sign	Y	Y		Y	Y	Y	Y	Y
g. Fire alarm system	Y	Y	Y	Y	Y	Y	Y	Y
h. Fire control centre	Y	Y			Y	Y	Y	Y
i. Fire detection system	Y	Y			Y	Y	Y	Y
j. Fire hydrant/hose reel system	Y	Y	Y	Y	Y	Y	Y	Y
k. Fireman's lift	Y	Y		Y	Y	Y	Y	Y
l. Firefighting and rescue stairway								Y
m. Fireman's lift or firefighting and rescue stairway							Y	Y
n. Portable hand-operated approved appliance	Y	Y	Y	Y	Y	Y	Y	Y
o. Pressurization of staircase*		Y			Y	Y	Y	Y
p. Sprinkler system	Y	Y			Y	Y	Y	Y
q. Static or dynamic smoke extraction system*	Y	Y			Y	Y	Y	Y
r. Ventilation/air conditioning control system	Y	Y			Y	Y	Y	Y



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Fire Safety Engineering Approach





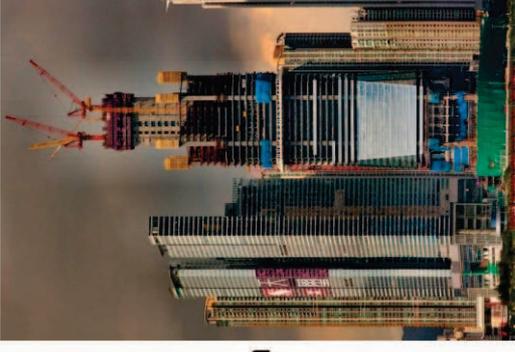
Fire Engineering Approach

A flexible alternative:-

- **impracticable** to comply with prescriptive provisions
- **special or large** and complex buildings

Aims

- **Equivalent or enhanced** fire safety achieved through full compliance with the prescriptive provisions
- Deemed-to-Comply Provisions





Fire Engineering Approach

1.3 Discretionary powers of the Director of Fire Services

Compliance with the prescriptive provisions in this Code may be regarded as a reliable way to satisfy the requirements for fire service installations or equipment. However, the Director of Fire Services may, in the case of any particular building, vary any of the requirements of the Code (whether by requiring the provision of any fire service installations or equipment not indicated in the Code either in addition to or in substitution for any fire service installations or equipment so indicated or by relaxing any of the requirements in the Code or otherwise) where, in his opinion, such a variation is required in order to ensure the provision of all such fire service installations and equipment, as, having regard to the purpose for which the building is intended to be put, comprise the minimum fire service installations and equipment necessary for that building/premises, or as the case may be, where such a variation is not inconsistent with the provision for the building of all such fire service installations and equipment as aforesaid.

For buildings of special designs or hazards which necessitate special considerations, the Director of Fire Services may accept, on a case by case basis, fire engineering approach as an alternative to the prescriptive provisions provided that the fire engineering approach shall not provide a level of safety inferior to that provided by prescriptive requirements. Methodology for application of the fire engineering approach should outline a structured fire engineering principle(s) to the assessment of total building fire safety effectiveness and to the achievement of pre-identified design objective(s) having taken into consideration of the objectives of fire service installations and equipment for the protection of life and property of the occupants within the premises and the firefighting personnel in the event of emergency.



FSI Code



Fire Engineering Approach

Adopted when:

Genuine difficulty in code compliance

Difficulties

- Building size
- Usage
- Complexity
- Location



Re-issued under new categorization in August 2009 as Practice Note for Authorized Persons, Registered Structural Engineers and Registered Geotechnical Engineers

APP-87

Practice Note for Authorized Persons and Registered Structural Engineers

204

Buildings Department

Guide to Fire Engineering Approach

This practice note provides guidance on fire engineering approach for the design of new buildings or alteration and addition works in existing buildings to meet the fire safety objectives and performance requirements of Building (Construction) Regulation 90, Building (Planning) Regulations 41, 41A, 41B & 41C and as an alternative to the prescriptive requirements set out in the three Codes of Practice for Means of Escape, Means of Access for Firefighting and Rescue and Fire Resisting Construction, covering fire safety in buildings.

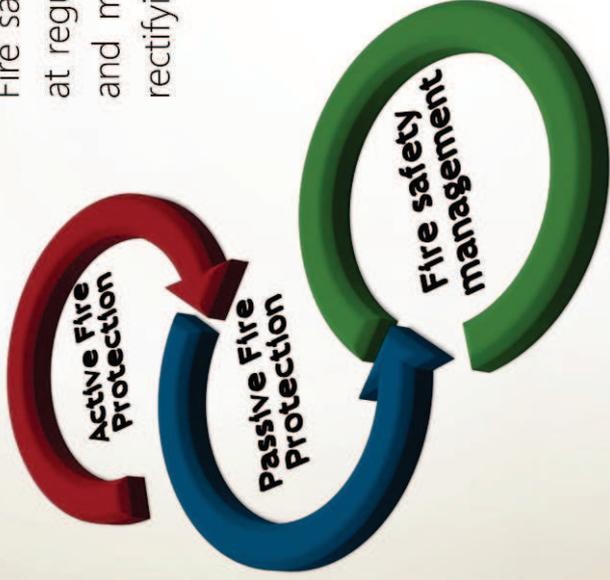
Objectives

2. Fire engineering design offers a flexible alternative where it is impracticable to comply with prescriptive provisions in the Codes, especially when designing for special or large and complex buildings or alteration and addition works in existing buildings. The aim is to provide for an overall level of safety that is equivalent to that which would result if fire safety was achieved through full compliance with the prescriptive provisions of the relevant codes of practice. The acceptability of fire engineering approach is recognised in paragraph 3 of the Codes. Fire engineering design provides a framework for practitioners to demonstrate that the performance requirements of legislation are met, or in some cases bettered, even though some of the design solutions adopted fall outside or short of the prescriptive provisions in the Codes when additional fire safety measures are proposed to compensate for the deviation or shortfall.
3. To achieve this objective it is important to understand the performance requirements and the prescriptive provisions that are required as a minimum to comply with the legislation. If the design being considered is not substantially different from the prescriptive provisions or can be readily accommodated by adopting conservative assumptions, it may simply be a case of demonstrating like-for-like substitution or "equivalence" with prescriptive provisions and fire safety objectives without having to embark on a full fire safety strategy. However, practical test may be required where necessary to demonstrate the equivalence by practitioners.



Fire Engineering Approach

Fire safety management should be carried out at regular intervals through routine inspections and maintenance of fire safety provisions for rectifying any identified irregularities.



FS Code 2011 - Part F



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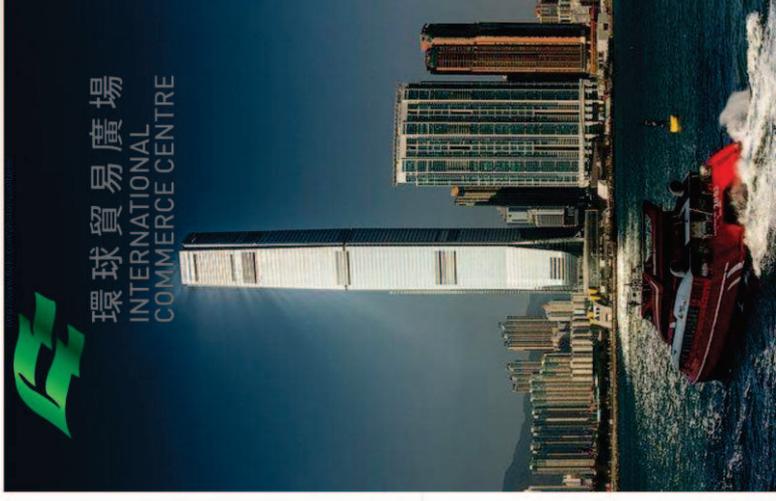
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Case Study

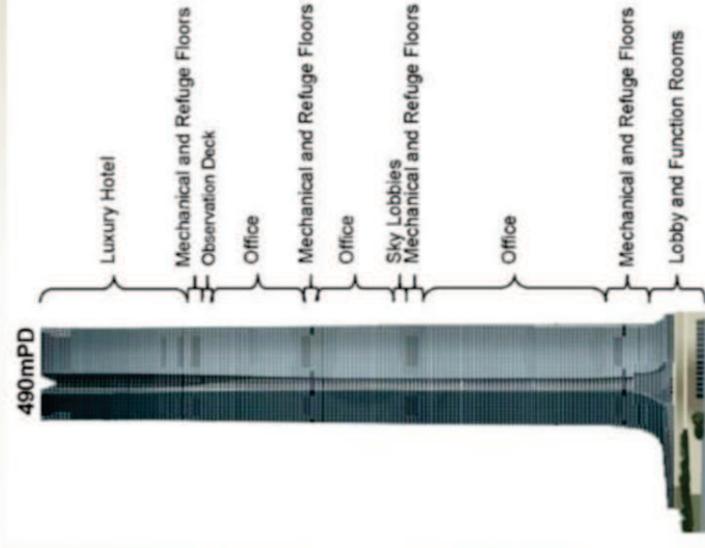
International Commerce Centre
(ICC)





International Commerce Centre (ICC)

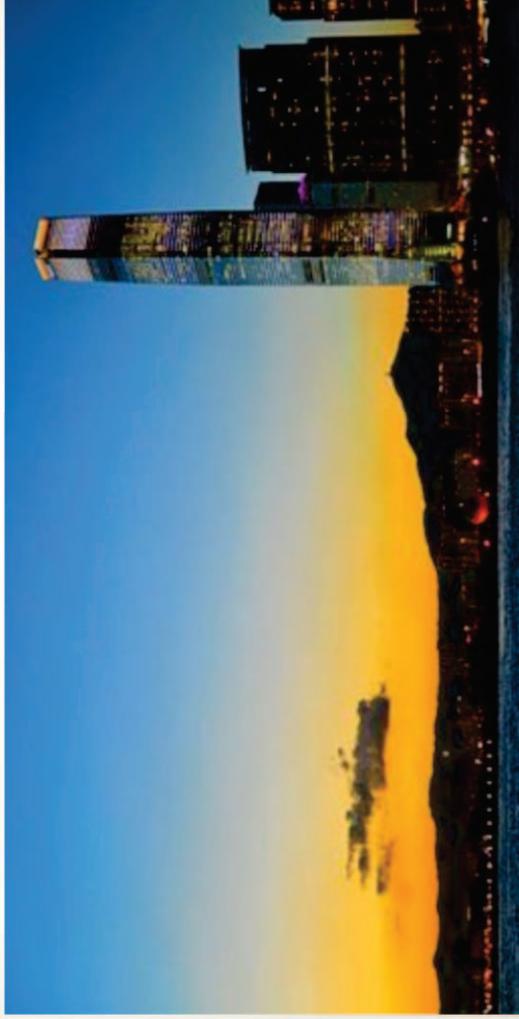
- Height – 490m
- 118 Floors with 4-level Basement
- Mixed uses (hotel with restaurants, observation deck, offices, entrance lobby, car parks)
- Linking to retail complex
- Over 10,000 persons in capacity
- Large Atrium - "Dragon Tail"
(Where Fire Safety Engineering Design is needed)





Fire Safety Issues

1. Huge Atrium of "Dragon Tail"
2. Extended travel distance on office floor
3. Mass Evacuation
4. Communication difficulties for fire-fighters





“Dragon Tail”

Huge atrium - 63,000m³ (Max of 28,000m³ under CoP)



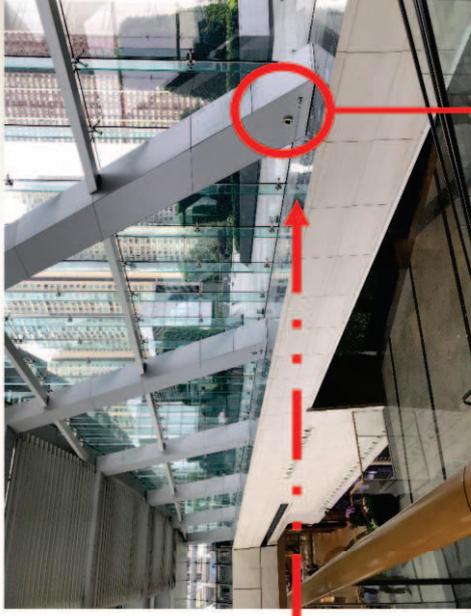


Huge Atrium

Beam Detectors in Dragon Tail
(Reduce Detection / Alarm time for huge atrium)



Transmitter

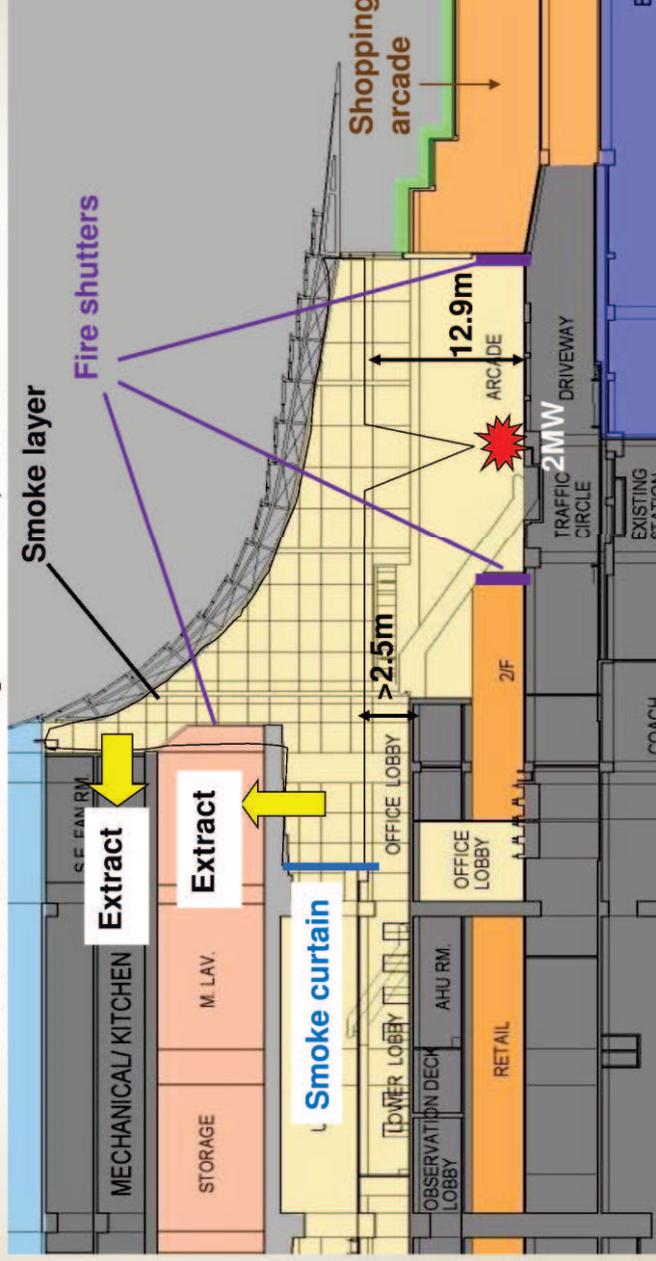


Receiver



Huge Atrium

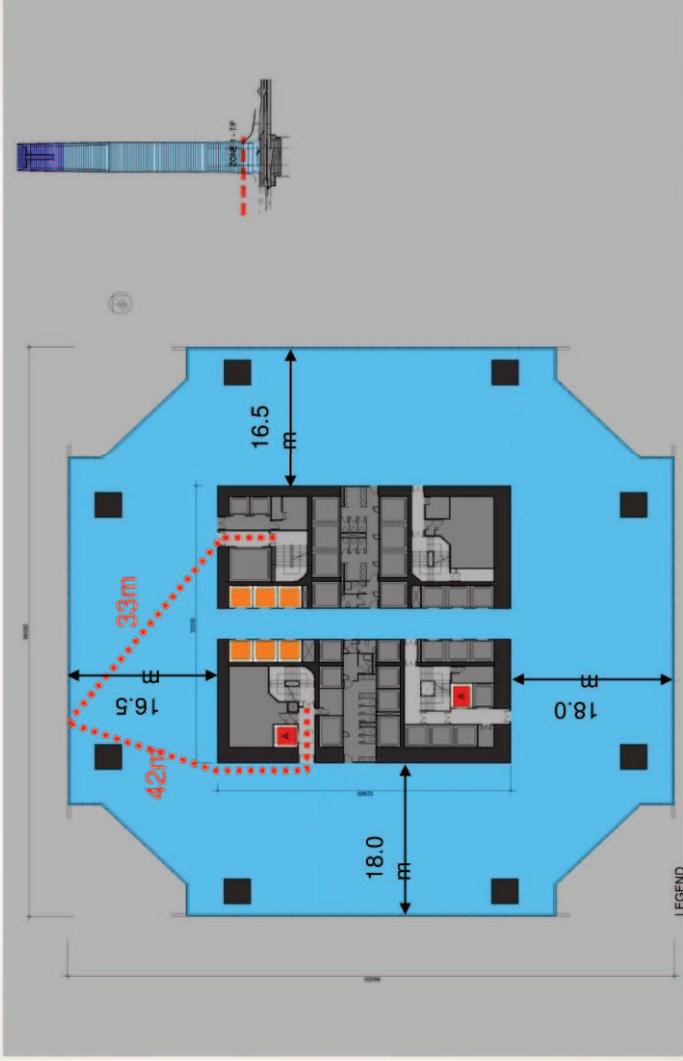
- Fire shutters
- Smoke curtains
- Smoke-clear height of 2.5m
- Smoke extraction at "Dragon Tail" top corner





Extended travel distance on office floors

(Max. distance of 42m which is 12m more than CoP compliant design)



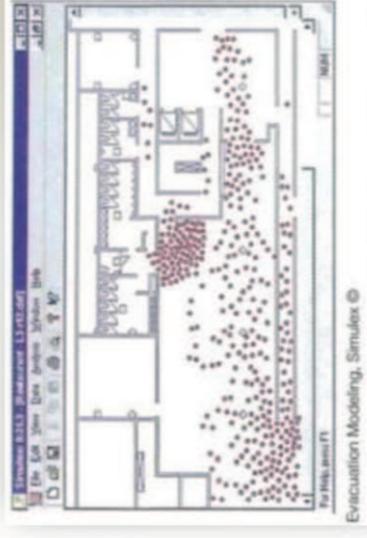
Travel distance 42m
(Code requirement 30m)



Extended travel distance on office floors

Reduce RSET :

- Smoke detection system
- Air aspiration detection system
- Pre-recorded alert message via public address system

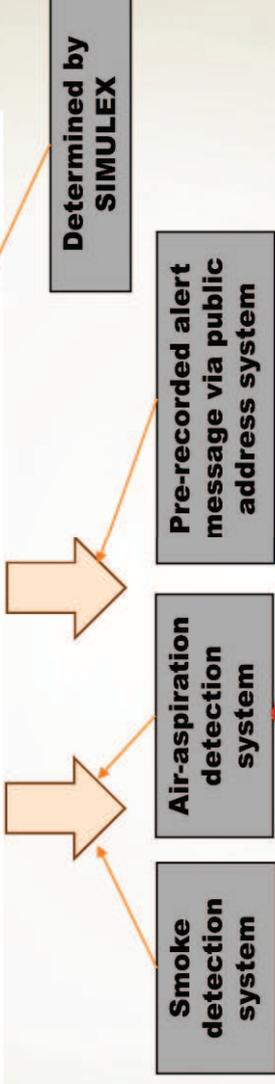


$$\mathbf{RSET} = \Delta t_{\text{det}} + \Delta t_{\text{alarm}} + (\Delta t_{\text{pre}} + \Delta t_{\text{trav}})$$



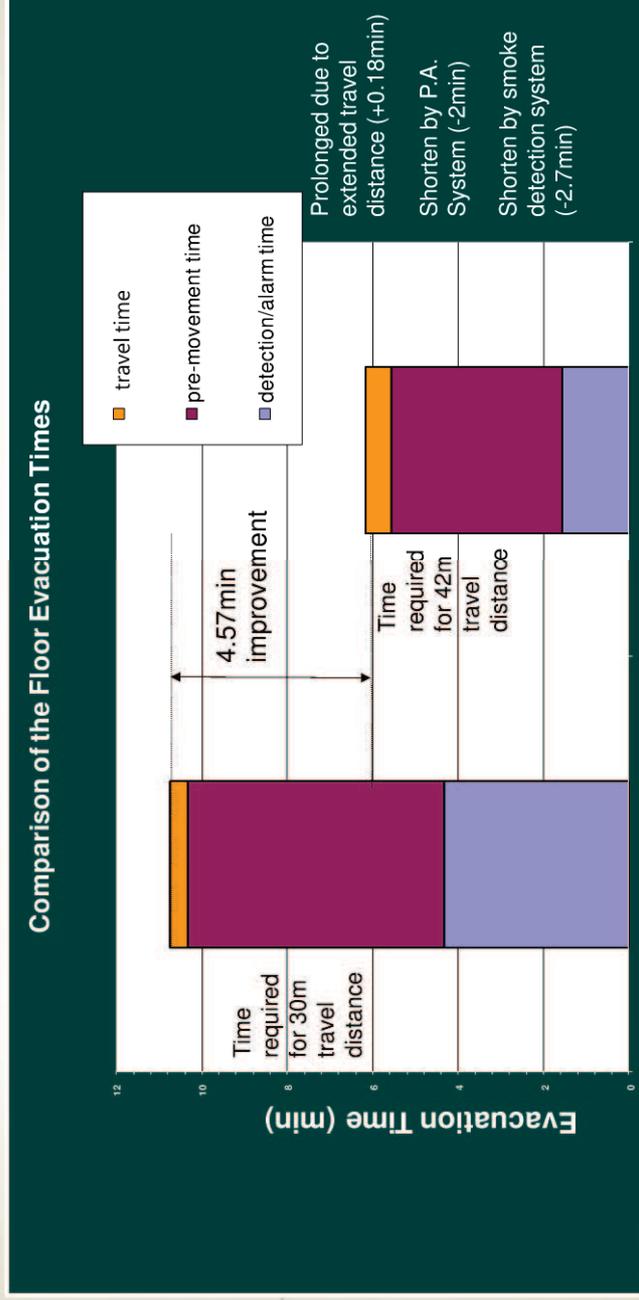
Extended travel distance on office floors

$$RSET = \Delta t_{det} + \Delta t_{alarm} + (\Delta t_{pre} + \Delta t_{trav})$$





Extended travel distance on office floors





**Evacuation for huge capacity of
more than 10,000 persons**



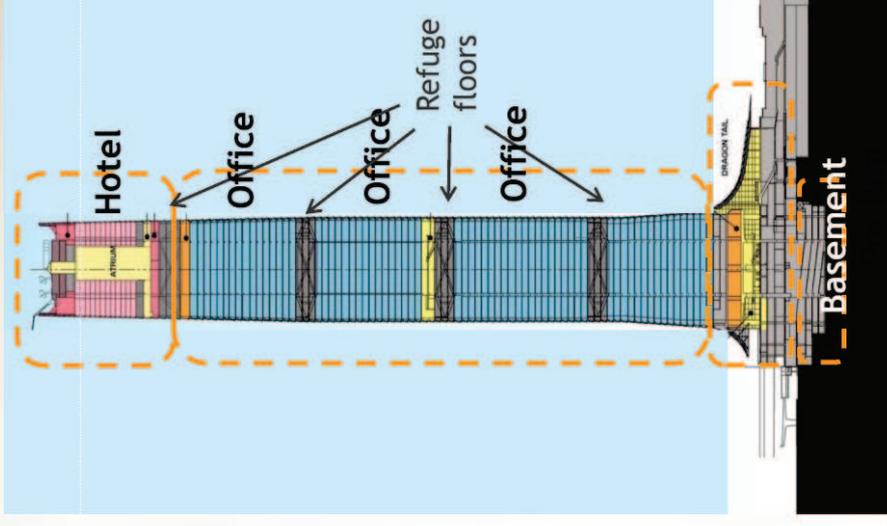


Evacuation Strategy

4 evacuation zones
(Hotel, Office, Podium and Basement)

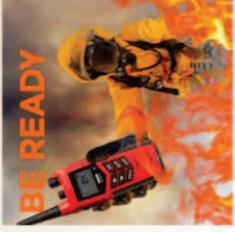
Evacuation of office floors

- 4-floor concept (fire floor +1 floor below + 2 floors above)
- Evacuation message in activated floors; alert message in other floors
- Subsequent evacuation on 4-floor basis in the same zone
- If necessary, other zones are evacuated





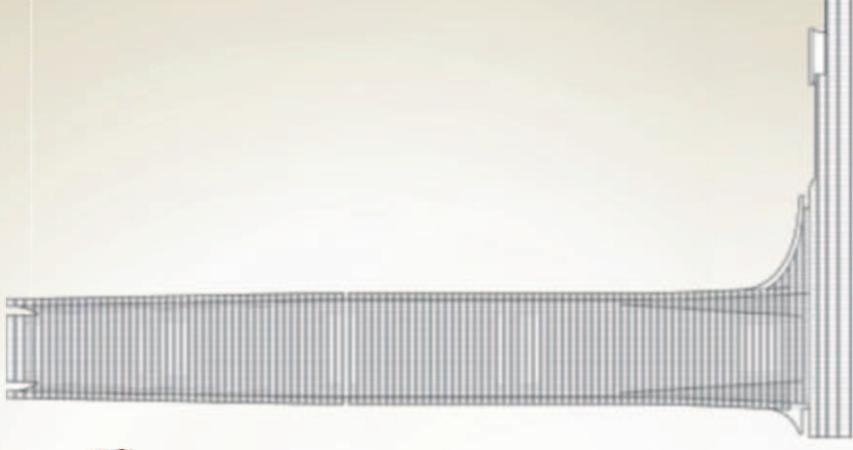
Communication difficulties (Long-distance)





Communication difficulties (Long-distance)

Emergency Intercom on office floors





Fire Safety Management Plans

Managing and Maintaining the Fire Safety Provisions

- Maintenance Plan
- Training Plan
- Fire Action Plan





Fire Protection Measures during Construction Stage (FSD Circular Letter 8/2008)





Fire Protection Measures during Construction Stage > 30m

Provide

- Provision of a closed circuit type water relaying system
- Temporary fire hydrant system; or
- Fire pump (Electrical and Portable)





Fire Protection Measures during Construction Stage > 80m

Provide

- Provision of a closed circuit type water relaying system
- Fixed riser;
- Fixed fire pump or portable pump; and
- Control Panel



Thank you





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