



# NFPA EFFECT:

## Fire Risk Assessment Tool

April 18<sup>th</sup> 2018

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# Summary

- Background - Why we need the Fire Risk Assessment (FRA) Tool
- Challenges
- Literature Review
- Methodology
  - *Applicability*
  - *Tiers*
  - *Scoring likelihood and consequences to arrive at risk*
  - *Limitations*
- Online Tool
- Questions



Atlantic City  
2007



Busan  
2010



Roubaix  
2012



Sharjah  
2012



Dubai  
2012



Melbourne  
2014



Marina Torch  
2015, 2017



Ajman One  
2016

## Why we need the FRA tool

- High rise building fires with combustible façade systems are becoming more frequent
- NFPA wanted to provide AHJs with a standardized method of assessment for existing buildings



Grenfell  
2017



Address  
2015

# Project team



Project sponsor

Project management and technical panel

Project Consultant

Peer Reviewers

Technical advisor to Project on fire testing



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# Options?



## 1. Do nothing

More fires, potential fatalities, much larger incident, insurance premiums, investor confidence, image, reputation.



## 2. Prepare for the next incident

Disaster-recovery, emergency response, enforce testing & maintenance/fire drills.



## 3. Upgrade knowingly

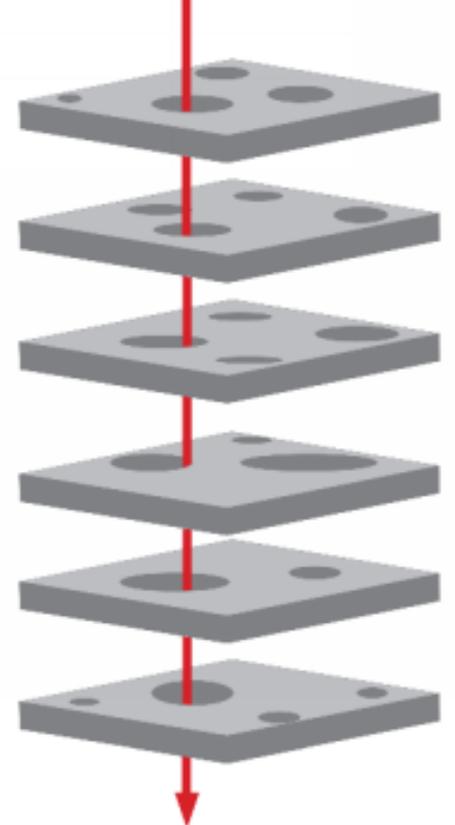
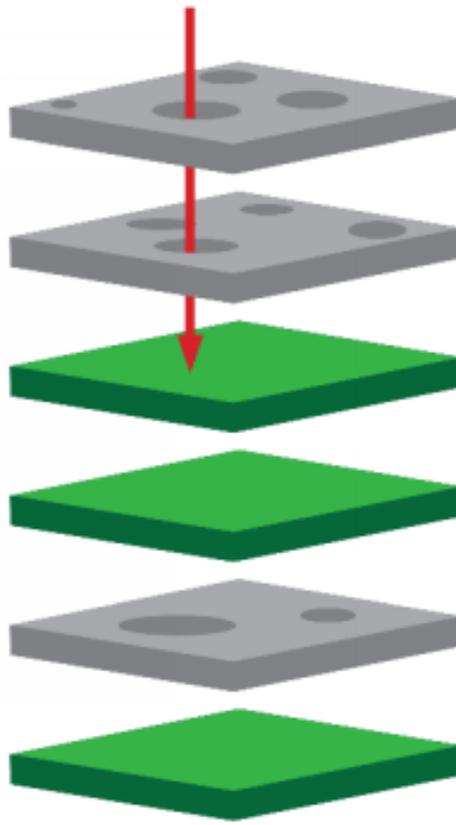
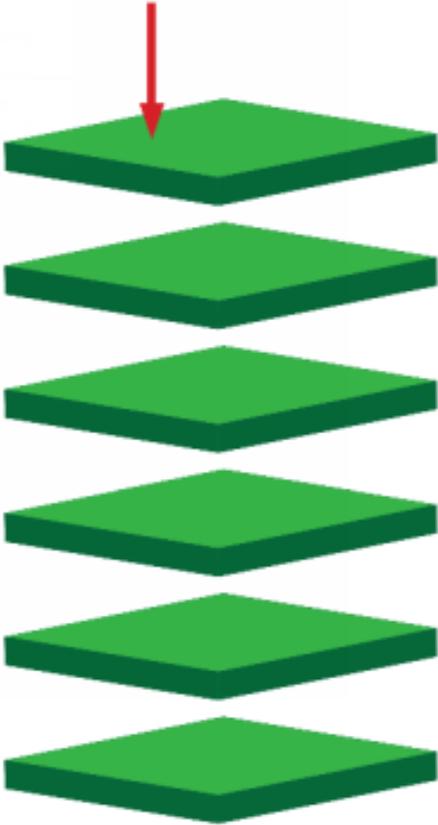
Address safety, economic, political, societal risks in a planned and balanced way.



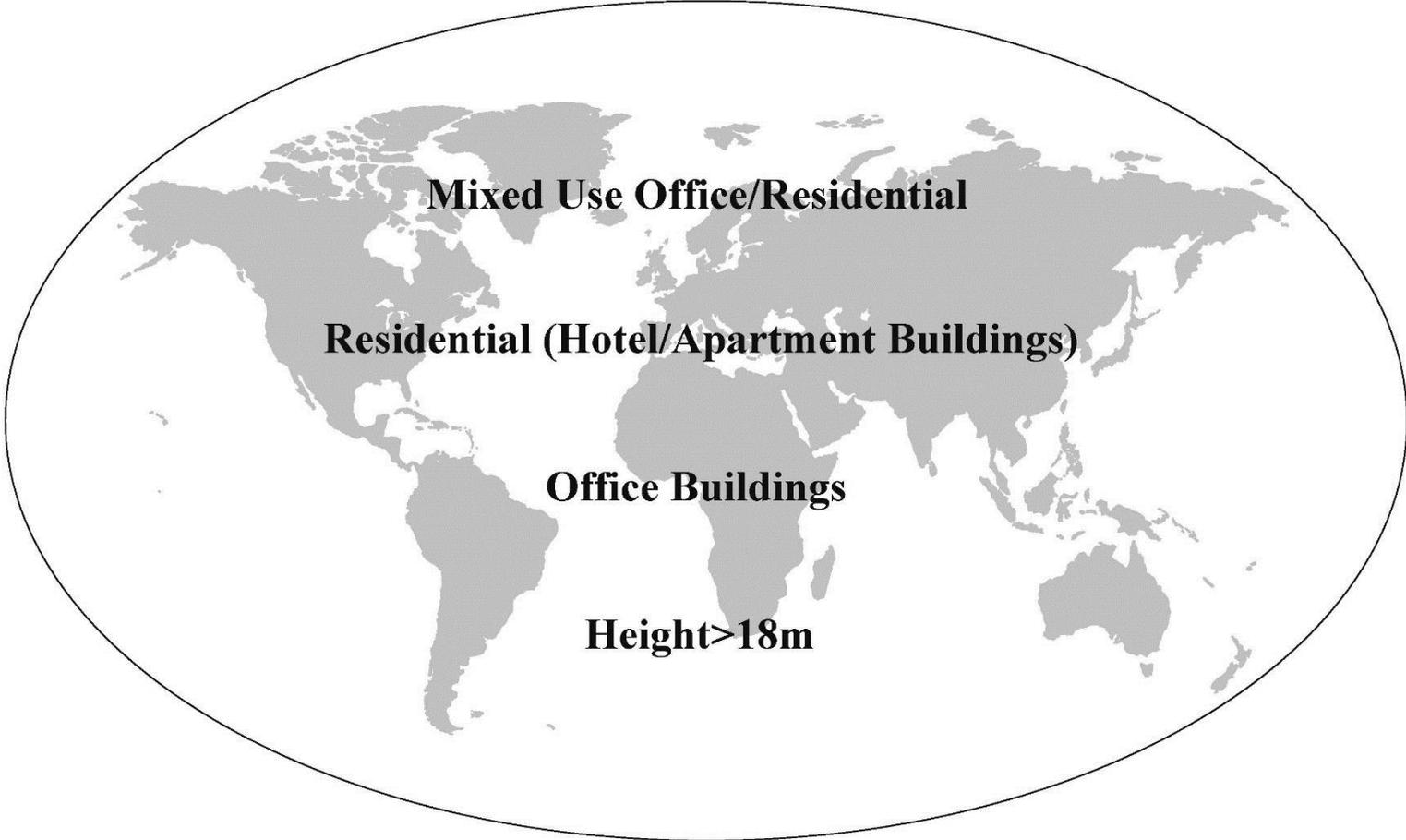
## 4. Full upgrade of all buildings

How? when? where to start?

# Why we need the FRA Tool – Layers of Safety



# Scope of the Project



# Challenges?

- Which primary factors contribute to building risk?
- How do we prioritise which buildings to look at first?
- Range of façade systems and components.
- Which variables to address?
- Availability of as-built information for audits.



# Literature Review



# Risk ranking method

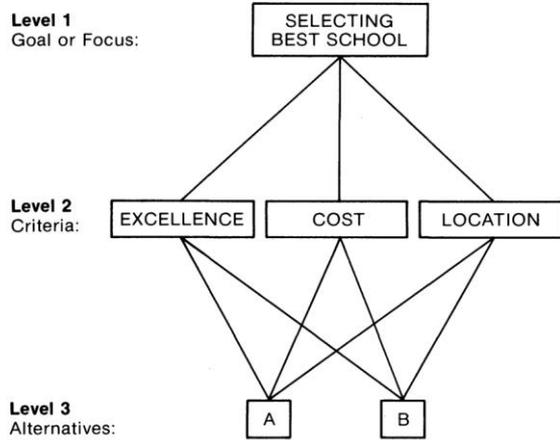
- Quantitative approaches
- Semi-quantitative (e.g. FSES in NFPA 101A)
- Qualitative (e.g. PAS 79)

**The risk assessment tool is qualitative**

	Likelihood of fire hazard		
Potential consequences of fire hazard	Low	Medium	High
Slight harm	Trivial risk	Tolerable risk	Moderate risk
Moderate harm	Tolerable risk	Moderate risk	Substantial risk
Extreme harm	Moderate risk	Substantial risk	Intolerable risk

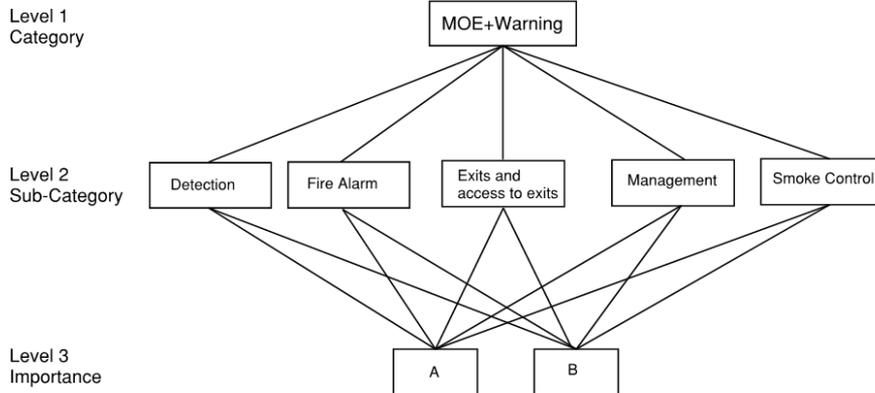
# Relative importance of variables?

## Analytical hierarchy process



Comparison of Categories							
	ARUP	#	JH	#	NFPA	#	Overall
Façade Hazard	36%	20	31%	10	41%	4	35%
Means of Escape and Warning	38%	20	37%	10	32%	4	37%
Containment and Extinguishment	27%	20	33%	10	27%	4	29%

Category: Means of Escape and Warning							
	ARUP	#	JH	#	NFPA	#	Overall
Detection	19%	20	18%	10	17%	4	18%
Fire Alarm	26%	20	22%	10	22%	4	24%
Exit and access to exits	29%	20	30%	10	29%	4	29%
Management	15%	20	15%	10	17%	4	15%
Smoke Control	12%	20	16%	10	15%	4	13%



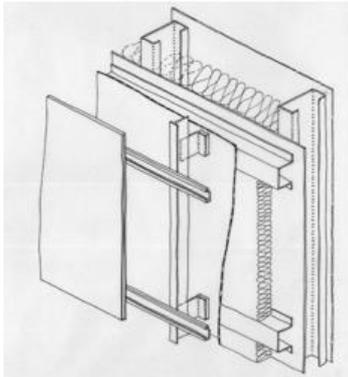
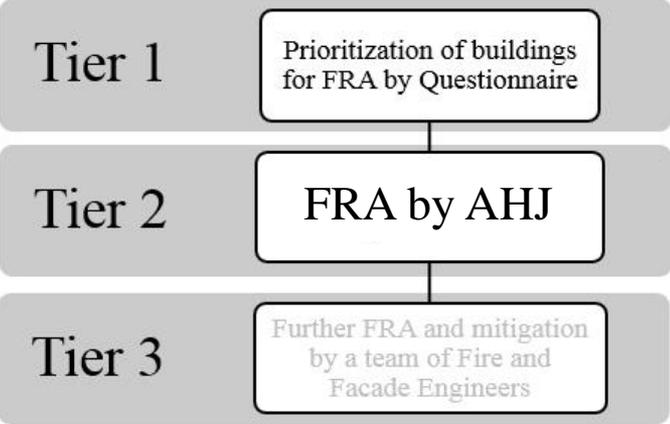
Category: Containment and Extinguishment							
	ARUP	#	JH	#	NFPA	#	Overall
Sprinklers	40%	20	36%	10	31%	4	38%
Fire Service Facilities	21%	20	31%	10	37%	4	26%
Compartmentation	40%	20	33%	10	31%	4	37%

Category: Façade Hazard							
	ARUP	#	JH	#	NFPA	#	Overall
Façade ignition sources	20%	20	17%	10	22%	4	20%
Component materials	30%	20	25%	10	30%	4	29%
Combustible connections	20%	20	22%	10	19%	4	21%
Perimeter fire stop	14%	20	19%	10	14%	4	16%
Cavity barriers	15%	20	17%	10	16%	4	16%

# Methodology



# Scope of Methodology



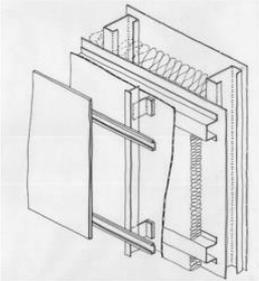
Process A



Process B

# Scope of Methodology

Variables assessed in Tier 1 and 2 in Process A are:



Process A



Process B



Insulation (fuel)



Façade Ignition Sources



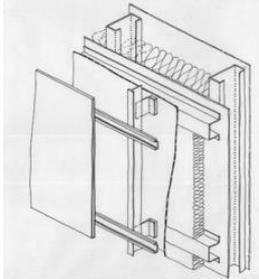
Cladding (fuel)



Vertical Connectivity

# Scope of Methodology

Variables assessed in Tier 1 and 2 in Process B are:



Process A



Process B



# Tier 1

For a town, city or large portfolio of buildings.

A few relatively simple questions are issued by AHJ to facilities managers.

Building	Tier 1 Prioritization		Action
	Process A	Process B	
1	E	C	Tier 2 assessment required as process A prioritization > Tolerable
2	E	B	
3	D	C	
4	D	B	
5	C	D	
7	C	A	
8	C	A	
9	B	B	No action
10	B	D	Fire safety provisions to be assessed using alternate tool
11	A	D	
12	A	C	No action
13	A	B	
.			
etc.			



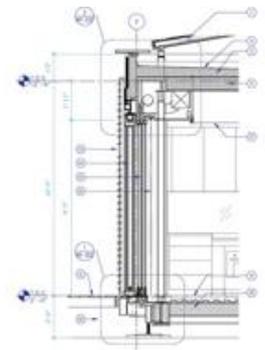
Potential consequences of fire hazard	Likelihood of fire hazard		
	Low	Medium	High
Slight harm	Trivial risk	Tolerable risk	Moderate risk
Moderate harm	Tolerable risk	Moderate risk	Substantial risk
Extreme harm	Moderate risk	Substantial risk	Intolerable risk

# Tier 2

- AHJ then visits each building in order of priority.
- More detailed questions are asked about the façade system, ignition sources and the fire safety systems.
- Each elevation of the building is given a risk ranking to help identify problem areas.

## Step 1

Review as built drawings (if available)



## Step 2

Review as built material submittals (If available)



## Step 3

Visual inspection of façade at the building.



## Step 4

Visual inspection with removal of façade elements.



## Step 5

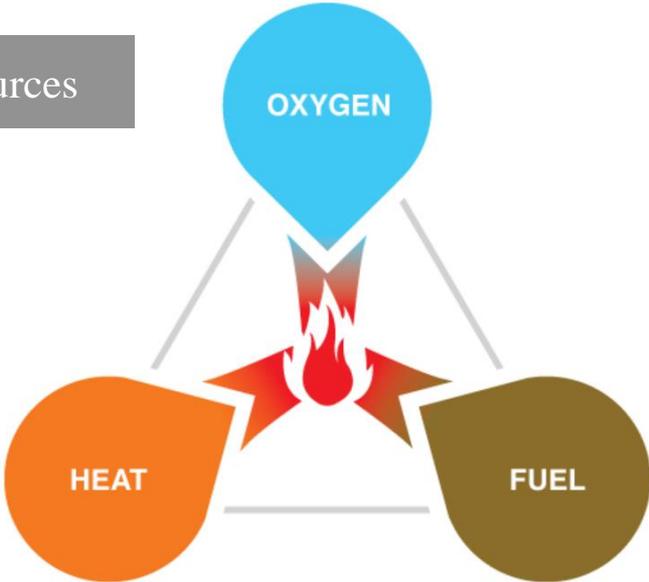
Destructive sampling and laboratory testing of component façade materials (insulation and cladding) if necessary



# Likelihood of a Fire Over Multiple Stories



Ignition sources



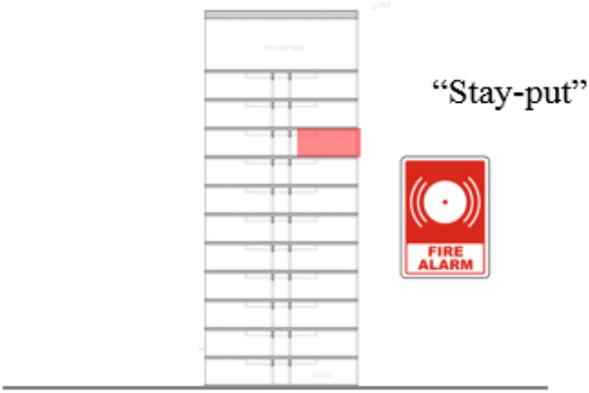
# Likelihood of a Fire Over Multiple Stories

Hazard			Ignition source	Likelihood of a fire over multiple stories (cladding not vertically connected)
Fuel		Cladding		
Insulation	Cladding			
High Medium Low	High Medium Low	High Medium Low	High Medium Low	V. High High Medium Low V. Low
High Medium Low	High Medium Low	High Medium Low	High Medium Low	V. High High Medium Low V. Low
High Medium Low	High Medium Low	High Medium Low	High Medium Low	V. High High Medium Low V. Low
High Medium Low	High Medium Low	High Medium Low	High Medium Low	V. High High Medium Low V. Low
High Medium Low	High Medium Low	High Medium Low	High Medium Low	V. High High Medium Low V. Low
High Medium Low	High Medium Low	High Medium Low	High Medium Low	V. High High Medium Low V. Low
High Medium Low	High Medium Low	High Medium Low	High Medium Low	V. High High Medium Low V. Low
High Medium Low	High Medium Low	High Medium Low	High Medium Low	V. High High Medium Low V. Low
High Medium Low	High Medium Low	High Medium Low	High Medium Low	V. High High Medium Low V. Low
High Medium Low	High Medium Low	High Medium Low	High Medium Low	V. High High Medium Low V. Low
High Medium Low	High Medium Low	High Medium Low	High Medium Low	V. High High Medium Low V. Low
High Medium Low	High Medium Low	High Medium Low	High Medium Low	V. High High Medium Low V. Low
High Medium Low	High Medium Low	High Medium Low	High Medium Low	V. High High Medium Low V. Low
High Medium Low	High Medium Low	High Medium Low	High Medium Low	V. High High Medium Low V. Low



Likelihood of a fire over multiple stories (cladding vertically connected)				
V. High	High	Medium	Low	V. Low
V. High	High	Medium	Low	V. Low
V. High	High	Medium	Low	V. Low
V. High	High	Medium	Low	V. Low
V. High	High	Medium	Low	V. Low
V. High	High	Medium	Low	V. Low
V. High	High	Medium	Low	V. Low
V. High	High	Medium	Low	V. Low
V. High	High	Medium	Low	V. Low
V. High	High	Medium	Low	V. Low
V. High	High	Medium	Low	V. Low
V. High	High	Medium	Low	V. Low
V. High	High	Medium	Low	V. Low
V. High	High	Medium	Low	V. Low
V. High	High	Medium	Low	V. Low

# Consequence of Fire Over Multiple Stories – Height, Occupancy

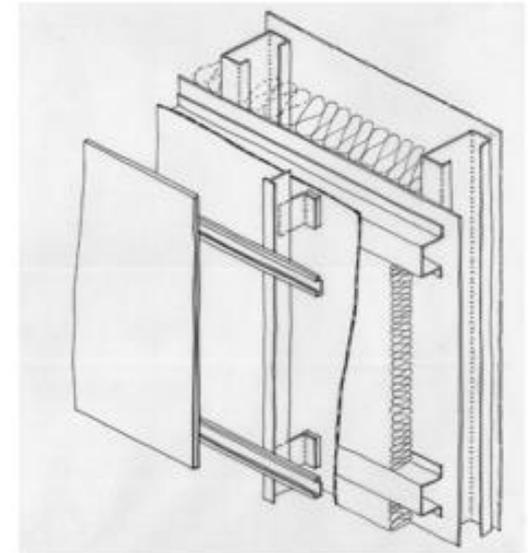


# Likelihood + Consequence = Risk

RISK MATRIX FOR OFFICE - TIER 1A and 2A						
Building Height (m)	Consequence due to Height	Likelihood of a fire on multiple stories				
		Very Low	Low	Medium	High	Very High
<18m	Slight harm	A	A	B	C	C
18-30m	Slight-moderate harm	A	B	B	C	D
30-50m	Moderate harm	A	B	C	D	E
>50m	Moderate-Extreme harm	A	C	D	D	E

RISK MATRIX FOR RESIDENTIAL "ALL-OUT" - TIER 1A and 2A						
Building Height (m)	Consequence due to Height	Likelihood of a fire on multiple stories				
		Very Low	Low	Medium	High	Very High
<18m	Slight-moderate harm	A	B	B	C	D
18-30m	Moderate harm	A	B	C	D	E
30-50m	Moderate-Extreme harm	A	C	D	D	E
>50m	Extreme harm	A	C	D	E	E

RISK MATRIX FOR RESIDENTIAL "STAY-PUT" - TIER 1A and 2A						
Building Height (m)	Consequence due to Height	Likelihood of a fire on multiple stories				
		Very Low	Low	Medium	High	Very High
<18m	Moderate harm	A	B	C	D	D
18-30m	Moderate-Extreme harm	A	C	D	D	E
30-50m	Extreme harm	B	D	D	E	E
>50m	Extreme harm	B	D	E	E	E

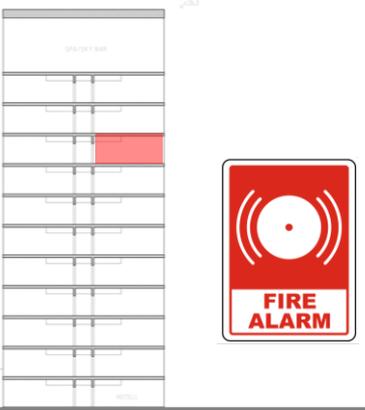


Process A

# Likelihood of Means of Egress and Warning Compromised

“Stay-put”

High



“All-out”

Low



# Likelihood of Means of Egress and Warning Compromised

Means of Escape	Detection and Fire Alarm	Likelihood of means of egress and warning being compromised
High Medium <b>Low</b>	High Medium <b>Low</b>	V. High High Medium Low <b>V. Low</b>
High <b>Medium</b> Low	High Medium <b>Low</b>	V. High High <b>Medium</b> Low V. Low
<b>High</b> Medium Low	High Medium <b>Low</b>	<b>V. High</b> High Medium Low V. Low
High Medium <b>Low</b>	High <b>Medium</b> Low	V. High High <b>Medium</b> Low V. Low
High <b>Medium</b> Low	High <b>Medium</b> Low	V. High <b>High</b> Medium Low V. Low
<b>High</b> Medium Low	High <b>Medium</b> Low	<b>V. High</b> High Medium Low V. Low
High Medium <b>Low</b>	<b>High</b> Medium Low	V. High <b>High</b> Medium Low V. Low
High <b>Medium</b> Low	<b>High</b> Medium Low	<b>V. High</b> High Medium Low V. Low
<b>High</b> Medium Low	<b>High</b> Medium Low	<b>V. High</b> High Medium Low V. Low



Likelihood of means of egress and warning being compromised if compartmentation also poor
V. High High Medium <b>Low</b> V. Low
V. High <b>High</b> Medium Low V. Low
<b>V. High</b> High Medium Low V. Low
V. High <b>High</b> Medium Low V. Low
<b>V. High</b> High Medium Low V. Low
<b>V. High</b> High Medium Low V. Low
<b>V. High</b> High Medium Low V. Low
<b>V. High</b> High Medium Low V. Low
<b>V. High</b> High Medium Low V. Low

# Likelihood + Consequence = Risk

RISK MATRIX FOR OFFICE - TIER 1B and 2B

Building Height (m)	Consequence due to Height	Likelihood of means of egress and warning being compromised				
		Very Low	Low	Medium	High	Very High
<18m	Slight harm	A	A	B	C	E
18-30m	Slight-moderate harm	A	B	C	C	E
30-50m	Moderate harm	A	B	C	D	E
>50m	Moderate-Extreme harm	A	C	D	E	E

RISK MATRIX FOR RESIDENTIAL "ALL-OUT" - TIER 1B and 2B

Building Height (m)	Consequence due to Height	Likelihood of means of egress and warning being compromised				
		Very Low	Low	Medium	High	Very High
<18m	Slight-moderate harm	A	A	B	C	E
18-30m	Moderate harm	A	B	C	D	E
30-50m	Moderate-Extreme harm	A	C	C	D	E
>50m	Extreme harm	A	C	D	E	E

RISK MATRIX FOR RESIDENTIAL "STAY-PUT" - TIER 1B and 2B

Building Height (m)	Consequence due to Height	Likelihood of means of egress and warning being compromised				
		Very Low	Low	Medium	High	Very High
<18m	Moderate harm			C	D	E
18-30m	Moderate-Extreme harm			D	E	E
30-50m	Extreme harm			D	E	E
>50m	Extreme harm			E	E	E



Process B

# Mitigation

**Effectiveness**



- Management solutions;**
- Repair and regular testing/maintenance of existing fire safety provisions;**
- Installation of additional fire safety provisions;**
- Façade system remediation.**



	Likelihood of fire hazard		
Potential consequences of fire hazard	Low	Medium	High
Slight harm	Trivial risk	Tolerable risk	Moderate risk
Moderate harm	Tolerable risk	Moderate risk	Substantial risk
Extreme harm	Moderate risk	Substantial risk	Intolerable risk

# Limitations

EFFECT is for office or residential (apartment/hotel) buildings over 18m high and with a combustible façade problem.

It is only suitable for buildings with a steel or concrete frame (not timber).

EFFECT is not suitable for assessing buildings without combustible facades. Do not use to assess internal fire safety provisions only.

It is for assessment of existing buildings – it is not a design tool.

Some buildings will need Tier 3 assessment (not addressed by EFFECT).

The output is only as reliable as the input by the user.

# Online Tool





## High Rise Buildings with Combustible Exterior Wall Assemblies: Fire Risk Assessment Tool

FINAL REPORT BY:

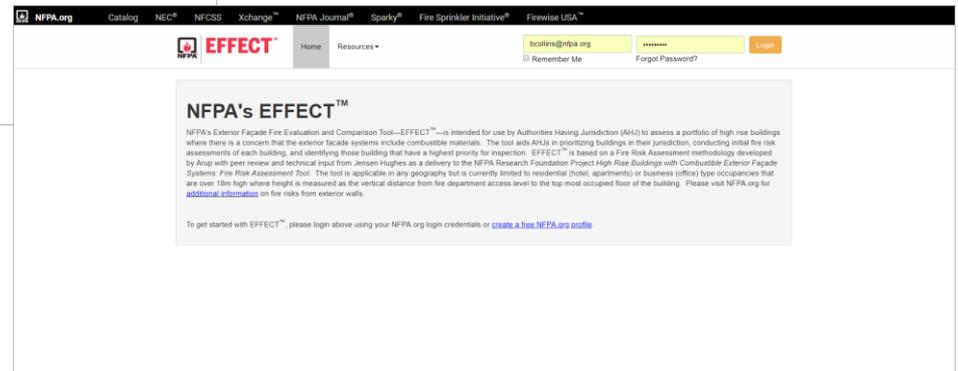
Susan Lamont  
Arup

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January 2018

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Email: [research@nfpa.org](mailto:research@nfpa.org) | Web: [nfpa.org/research](http://nfpa.org/research)

<http://www.nfpa.org/exteriorwalls>





## Add Property

\* Required

Is the structural frame of the building non-combustible (e.g. concrete and/or steel)?

Back

Save & Continue

Webinar building

Is the structural frame of the building non-combustible (e.g. concrete and/or steel)?

Yes

Occupancy Type:

+ Additional Information

Business

Building Height:

+ Additional Information

Very High: > 50 meters

Is there an assembly use (bar, restaurant, pool deck, nightclub) in the building?

+ Additional Information

No

Back

Save & Continue

\* Required

Webinar build

Business

Insulation

1. Is the insu

+ Additional I

Cladding

2. Are the o  
(ACP) etc...?

+ Additional Information

# Question 1

- Methodology
- Building Characteristics
- Tier 1-A**
- Tier 1-B
- Tier 2-A
- Tier 2-B
- Mitigation

## Tier 1A, Q1

**Question 1:**

- Is the insulation provided within the building façade system made of a combustible material, e.g. foam insulation etc. ?

**Commentary:**

- Mineral wool and glass wools are made up of fibers that are scratchy and sharp to the touch. Foam is cellular and smooth.
- Mineral insulation does not pose a fire hazard but any type of foam will burn.
- Answer "yes" if the insulation is a foam.
- Answer "no" if the insulation is mineral or glass wool.
- Answer "no" if there is no insulation.



Tier 1, Process A - Insulation

**Users Guide**

Yes

## External Ignition Sources

3.1. Does the building have balconies within 6 m of the combustible façade system?

+ Additional Information

No

3.2. Does the building have PV panels or external lights fixed to the combustible facade system (or similar)?

+ Additional Information

No

3.3. Are there ignition sources (e.g. vehicles or trash cans or similar at the base of the building) within 6 m of the combustible façade system?

+ Additional Information

Yes

## Internal Ignition Sources

4. Is a sprinkler system provided throughout the building?

+ Additional Information

Yes

4.1. Is the sprinkler system fully operational and reliable, and being tested and maintained regularly?

+ Additional Information

Yes

## Façade Vertical Connectivity

5. In terms of the façade system pattern over the building, is there continuity in the combustible insulation and/or the combustible cladding vertically across more than one story?

+ Additional Information

Yes

Back

Save & Continue



## Webinar building Tier 1B - Egress, Warning, Containment and Extinguishment

\* Required

Webinar building

Business ▾

Very High: > 50 meters ▾

### Fire Alarm

6. Is a fire detection and fire alarm system provided within the building?

[+ Additional Information](#)

Yes ▾

6.1. Is the fire alarm system fully operational and reliable, and tested and maintained regularly?

[+ Additional Information](#)

Yes ▾

## Exits and Access to Exits

7. Do the occupants within the building have more than one escape route available?

+ Additional Information

7.1. Is the escape stair(s) unlocked from the egress side and enclosed in fire rated construction?

+ Additional Information

## Compartmentation

8. Are there any unprotected openings in the walls between apartments, in the walls of vertical shafts or in floors?

+ Additional Information

Back

Save & Continue

## Tier 1A Façade Fire Hazard

Risk Score:

**E**

**Intolerable:** Premises (or relevant area) should not be occupied until the risk is reduced.

Risk Factors:

Insulation:

**High**

Cladding:

**High**

Ignition:

**Medium**

Connectivity:

**High**

## Tier 1B Egress, Warning, Containment and Extinguishment

Risk Score:

**A**

**Trivial:** No action required and no details need to be kept.

Risk Factors:

Fire Alarm:

**Low**

Exits and Access to Exits:

**Low**

Compartmentation:

**Low**

Show 25 entries

Search:

Action	Property	Occupancy Type	Building Height	Tier 1A Façade Fire Hazard	Tier 1B Egress, Warning, Containment
<input type="checkbox"/>	Building 2 Scenario 3	Business	Very High: > 50 meters	E	A
<input type="checkbox"/>	Webinar building	Business	Very High: > 50 meters	E	A
<input type="checkbox"/>	Building 2	Business	Very High: > 50 meters	D	A
<input type="checkbox"/>	Building 2 Scenario 2	Business	Very High: > 50 meters	D	A
<input type="checkbox"/>	Building 2 Scenario 4	Business	Very High: > 50 meters	D	A
<input type="checkbox"/>	Building 3 Scenario 1	Residential (All out)	High: 30-50 meters	D	A
<input type="checkbox"/>	Building 3 Scenario 4	Residential (All out)	High: 30-50 meters	D	A
<input type="checkbox"/>	Building 1 Scenario 1	Business	Very High: > 50 meters	D	A
<input type="checkbox"/>	Building 2 Scenario 5	Business	Very High: > 50 meters	D	A
<input type="checkbox"/>	Building 3 Scenario 3	Residential (All out)	High: 30-50 meters	D	A

Action	Property	Occupancy Type	Tier 1A	Tier 1B	Tier 2A	Tier 2B	Flags
			<b>E</b>			Tier 2B gress, Warning, ontainment	
	Build Scen						
	Build Scen						
	Webi build						
	123						
	ETIC						
	Stay						gs
	Build Scen						
	Build						
	Build Scen						
	Build Scen						
	Build Scen						gs
	Build Scen						
	Building 3 Scenario 3	Residential (All out)	High: 30-50 meters	<b>D</b>	<b>A</b>	<b>A</b>	<b>A</b>
							N/A

### Webinar building - Tier 2B

**Risk Score:**

**A**

**Trivial:** No action required and no details need to be kept.

---

**Risk Factors:**

- Fire Alarm:** Low
- Exits and Access to Exits:** Low
- Compartmentation:** Low

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The leading information and knowledge resource on fire, electrical and related hazards

# Questions?