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

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BACKGROUND

Based on a number of recent fires in high rise buildings clad with combustible wall insulation systems, global enforcement authorities are revisiting their existing building inventories to assess potential risks. There are a number of risk factors which may impact the level of risk and the consequent priority for inspection and/or remediation. Authorities are seeking a means to make assessments and decisions based on them, using a risk informed methodology.

In August, NFPA initiated a project to develop a risk assessment tool to assist the enforcement community in assessing the risks of their building inventory as it relates to highrise and intermediate height residential and commercial buildings with combustible exterior wall assemblies. We engaged Arup, a global fire engineering firm, to develop the methodology behind the tool; they have also compiled information on candidate mitigation strategies as a resource to complement the tool and validated it against a global portfolio of highrise buildings. An electronic tool based on the methodology has been developed and is freely available, along with a detailed presentation of the risk assessment methodology, through NFPA.

Outline of the Risk Assessment Methodology

A risk informed methodology involves: the identification of key variables (e.g., component materials, connection systems, installation techniques and geometries, occupancy type, age of application, proximity to other structures, external factors such as weather, building fire protection systems, etc.); characterization of those variables in terms of risk or mitigation potential; and incorporation of them into an engineering based risk model whose output will be a means for authorities to prioritize mitigation. Because there is limited test data or statistics to further inform a quantitative approach to risk ranking or scoring, a qualitative assessment is utilized and consists of two levels: an initial screen and a further evaluation based on more detailed building information. A third and final step in assessing building risk is a detailed engineering risk assessment; this is not part of the scope of this method. This approach recognizes the challenges facing the regulatory authorities including the variability in these systems as field installed, the lack of data/information on specific installations, and the orientation of the tool to users who may not have the full engineering capability to make these initial assessments. Within this general framework, the methodology explores the factors associated with two separate dimensions of risk: those associated with the façade itself (for example insulation type) and other building characteristics (for example the presence of sprinklers and other fire protection features).

In general, the FRA tool is intended to be used AHJ's to assess a portfolio of buildings across a town or city where there is a concern that the exterior facade systems are built-up from combustible materials. The FRA tool is intended to provide a framework to aid the AHJ to prioritize buildings in their jurisdiction and to conduct initial fire risk assessments of each building, assessing the highest priority buildings first. A range of possible mitigation measures are suggested to help the AHJ and building owner to begin reducing the fire risk where necessary. The tool can be used to measure the success of the mitigation by revisiting the risk assessment.

Figure 1 illustrates the methodology for the FRA tool. The two-tier process was adopted to help the user refine the inspection need when confronted with large building portfolios:

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- Tier 1 – Desktop study of a portfolio of buildings to establish a priority ranking for further assessment. This could be by a building owner, facilities manager or the AHJ. A small number of questions with clearly pre-defined answers are posed of the users for the Tier 1 assessment to inform the ranking of buildings that then require further detailed assessments.

- Tier 2 – A FRA evaluation by the AHJ, prioritized by the ranking in Tier 1, involving on-site inspections, review of as built information and maintenance records, sampling and laboratory testing of unknown façade materials.

In some instances the Tier 2 assessment will highlight the need for a more detailed risk assessment by a qualified engineering team of façade and fire engineers. This could be because of the complexity of the building, complexity of the façade patterns (combustible cladding/insulation is randomly arranged or non-uniform across the building), difficulties in identifying the façade systems/materials or because the owners objectives are wider reaching than life safety only e.g. business continuity or upgrading the façade system to achieve better aesthetics, acoustics, thermal performance etc. This more detailed FRA would be Tier 3 of this methodology and is outside the scope of this method.
Tier 1 and 2 are further sub-divided into two parallel processes, "A" and "B", which focus on: A) facade fire hazards and ignition sources, and B) internal fire safety provisions, respectively. The two parallel processes have been introduced for the following reasons:

- If the building does not have a combustible façade system then no further assessment is required using this tool. This may be established at Tier 1A or if it is unknown or in doubt at this early stage it may be determined in Tier 2A.

- It allows the AHJ to identify deficiencies interior to the building which should be rectified regardless of the situation with the façade system e.g. if the fire pumps are OFF or the fire alarm panel has multiple faults etc. These changes can be identified through the "B" processes at each Tier.

- Separating the two subjects provides more visibility of the results to the enforcer/AHJ and simplifies the tool as the "B" process should be familiar to most AHJs.

The tool is limited to three occupancy types:

- Sleeping risk and all out evacuation strategy (which may occur in phases);

- Sleeping risk and stay put evacuation strategy; and

- No sleeping risk, i.e. Office/retail premises and all out evacuation strategy (which may occur in phases)

An "all-out" evacuation can only be assumed if there is the ability to sound the alarm throughout all areas of the building using an "all-out" or "all-call" button at the main fire alarm panel. As most high rise buildings adopt a phased evacuation strategy, an all-out alarm would usually be activated manually by the fire department or building management.
A stay put (defend in place) evacuation strategy assumes that building occupants not affected by a fire directly in their apartment, remain in their apartment. Only the apartment affected by a fire/smoke would be in alarm and only these occupants would be expected to evacuate. If fire/smoke spreads then other alarm bases would be expected to automatically activate but may be no ability to simultaneously raise the alarm in all areas of the building.
Questions with clearly pre-defined answers are posed of the users in both the Tier 1 and Tier 2 assessments. Tier 1 includes a small number of questions that could be answered though a questionnaire by a Facilities Management team to initially screen a large number of buildings.
In Tier 2, additional questions are posed of the users. These questions are more detailed in nature and require additional input. It is envisaged that Tier 2 is completed by a more experienced user (code official, authority having jurisdiction, certifier, building control) however specialist expertise in facade design or construction is not required.
The purpose of Tier 2 is to confirm or amend the priority risk ranking assigned to the building in Tier 1 due to a greater understanding of each variable and to identify areas for mitigation to reduce the risk ranking to an agreed acceptable level. Mitigation measures can be tested by using the tool to check the impact of the proposed mitigation measures on the risk ranking. Additional detailed assessment (Tier 3) beyond the scope of this tool, conducted by a team of qualified fire and façade engineers may be required to provide a more tailored approach for an individual building.

Candidate Mitigation Strategies

This tool is intended to assess the fire risk associated with combustible façade systems that have, for whatever reason, been installed on high-rise buildings. Where there are deficiencies in pre-existing fire safety provisions such as sprinklers, fire alarm or passive fire protection that were required by the original design or applicable code, then these should be rectified as a matter of course.

The mitigation options that will reduce the risk rankings assigned by this tool can be classified as follows: management solutions; repair and regular testing/maintenance of existing fire safety provisions; installation of additional fire safety provisions (active or passive); and facade system remediation.

Management solutions:

- Management procedures to eliminate occupancy of terraces or prohibit BBQs and other similar ignition risks from balconies.
- Management procedures to eliminate fire load near the base of the building – for example parking, trash containers, etc.
- Remove or de-energise lighting systems to reduce ignition risks.

Inspection, Testing and Maintenance:

- Repair of a faulty fire pump and initiation of a code compliant testing/maintenance regime for the sprinkler system
- Initiation of a code compliant testing /maintenance regime for any of the passive or active systems in the building

Installation of addition fire safety provisions:

- Upgrade of a fire alarm system to permit an "all-out" evacuation strategy – i.e. the fire alarm will sound simultaneously through the building and not just in the apartment of fire origin
- Addition of sprinklers to balconies

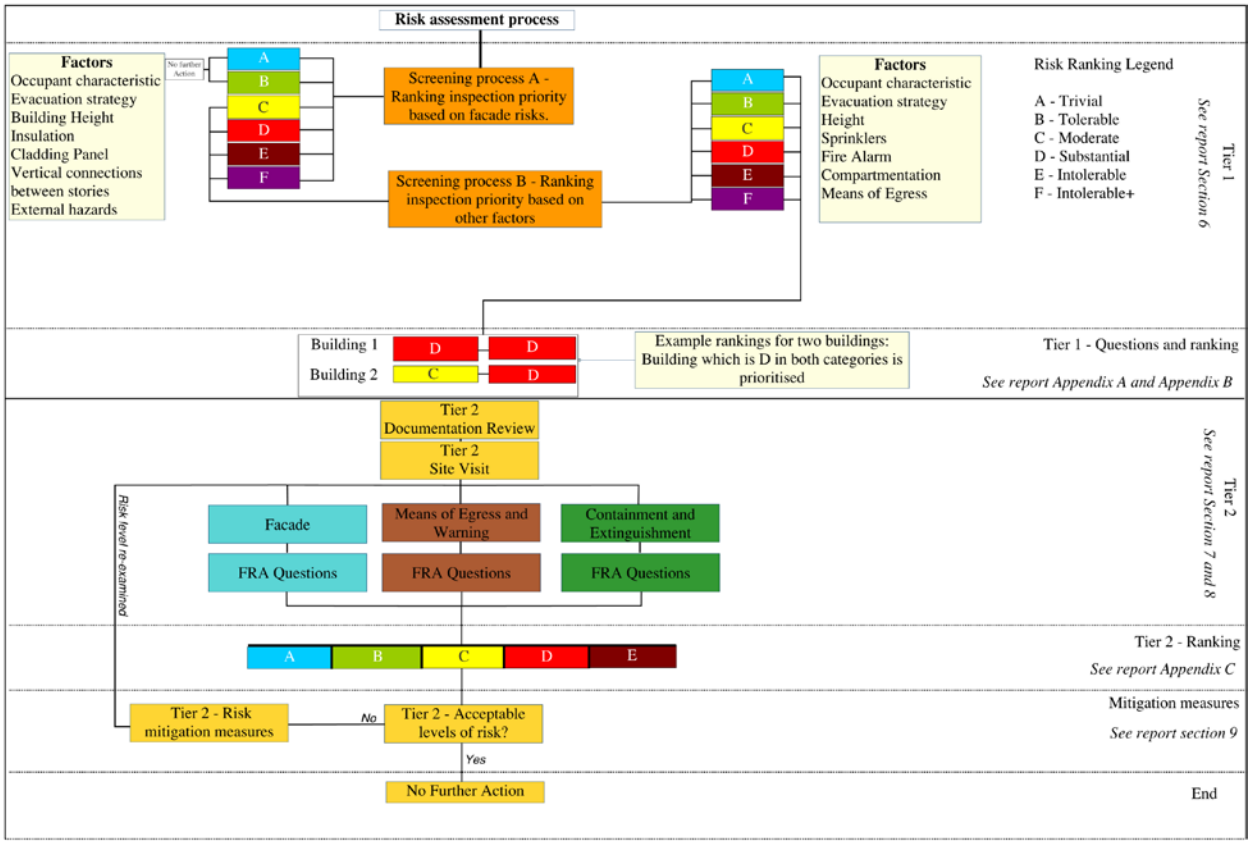
Façade System Remediation:

- Replacement or removal of vertical connections in the façade system
- Removal of combustible façade cladding/insulation near the base of the building
- Removal of combustible façade cladding/insulation in the vicinity of ignition sources
- Replacement of the combustible cladding and/or insulation system in its entirety.

SUMMARY

This paper has provided an overview of a new risk assessment tool designed to assist the enforcement community in assessing the risks of their building inventory as it relates to highrise and intermediate height residential and commercial buildings with combustible exterior wall assemblies.

Figure 1


Risk assessment process
Factors
Occupant characteristic
Evacuation strategy
Building Height
Insulation
Cladding Panel
Vertical connections between stories
External hazards
No further Action
A
B
C
D
E
F
Screening process A - Ranking inspection priority based on facade risks.
Screening process B - Ranking inspection priority based on other factors
A
B
C
D
E
F
Factors
Occupant characteristic
Evacuation strategy
Height
Sprinklers
Fire Alarm
Compartmentation
Means of Egress
Risk Ranking Legend
A - Trivial
B - Tolerable
C - Moderate
D - Substantial
E - Intolerable
F - Intolerable+
Tier 1
See report Section 6
Building 1
D
D
Building 2
C
D
Example rankings for two buildings: Building which is D in both categories is prioritised
Tier 1 - Questions and ranking
See report Appendix A and Appendix B
Tier 2 Documentation Review
Tier 2 Site Visit
Risk level re-examined
Facade
Means of Egress and Warning
Containment and Extinguishment
FRA Questions
FRA Questions
FRA Questions
Tier 2
See report Section 7 and 8
A
B
C
D
E
Tier 2 - Ranking
See report Appendix C
Tier 2 - Risk mitigation measures
No
Tier 2 - Acceptable levels of risk?
Yes
Mitigation measures
See report section 9
No Further Action
End