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Report

On the Fire Safety Verification Method

Revision: 001, date 22/01/2020

Prepared by

Society of Fire Safety VM working Group on behalf of the
Society of Fire Safety (Lead by Marianne Foley)

Engineers Australia

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SFS Fire Safety Verification Method Investigation

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Executive Summary

Six teams of fire safety engineers from a variety of companies and locations across Australia have tested the Fire Safety Verification Method in NCC 2019, using six different typical case studies (performance-based designs that are typical of projects being undertaken currently). They followed the methodology in the FSVM and associated Handbook to identify the benefits and disbenefits of this approach.

All teams saw benefit in the framework for selection of the fire scenarios with which to test a performance-based design and are of the opinion that this brings additional rigour and transparency to our work. All teams are of the view that this framework/thought process can be used in current practice with or without the application of the FSVM itself.

No other benefits were identified in the use of the FSVM and it is clear that use of the FSVM will lead to significantly more work required to deliver the same performance-based solutions on a project, with no additional technical rigour over current reasonable practice. The adoption of the FSVM also leads to additional work for the rest of the design team as a reference building needs to be designed and analysed and there is no clarity on where the design burden for that should sit.

Some common performance solutions done currently could not be done with the FSVM, with its strict comparison to a deemed to satisfy (DtS) reference building with no deviation in footprint, proximity to the boundary, use, population, height, etc. being advised by the Handbook. This has an adverse impact on the outcomes for building design and consequent productivity. As such, selection/design of a reference building is problematic and the FSVM really is only practicable where a very similar reference building can be identified. Any more complex projects or deviations from the prescriptive provisions should be approached using more fundamental or absolute approaches to demonstrate performance.

The need to engage with the fire brigades for every project using the FSVM is impractical as the role of the fire brigades is called up under state legislation rather than the building code. It also increases the time burden on the brigades, who are known to already be under resource constraints in some states.

The conclusion of this work is the recommendation to the SFS membership that fire safety engineers adopt the approach to selection of fire scenarios as proposed by the FSVM in their current practice.

However, more generally the FSVM (and Handbook) are not recommended for use in the majority of performance-based designs.

Authorship

This document has been produced on behalf of Engineers Australia's Society of Fire Safety by a working group lead by Marianne Foley (Arup) and subsequently approved by the SFS for issue.

All working group members contributed to the development of this proposal on a pro bono basis and are thanked for their time and effort in contributing to this work.

The working group for this project included the following members, who are thanked for donating their time:

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Introduction

The 2019 version of the National Construction Code (NCC) includes a Fire Safety Verification Method that is due for adoption in May 2020. It is one of the ways in which a performance-based fire engineering design may be tested or assessed.

There has been much debate about the implications of the FSVM, whether it is a verification method at all, and the appropriateness of its fundamental premise; that of comparison to a deemed to satisfy reference building with the implied assumption that a deemed to satisfy design actually does meet the performance requirements, as opposed to being 'deemed' to meet them without evidence.

On the flip side, the FSVM is understood to be aimed at both increasing the use of performance-based fire engineering in order to access productivity benefits for the Australian economy, and to

give greater consistency in quality and outcomes from performance-based fire engineering. There have certainly been cases where the quality of fire engineering done is not what society should be able to expect from a profession, and the FSVM may assist with this.

In order to neutrally assess the FSVM, the concerns and opportunities were put to one side and a team of volunteer fire engineers across many firms, members of the Society of Fire Safety, was put together to trial the use of the FSVM across six case studies. The methodology and findings are described below, with the detailed commentary from each of the teams provided in the appendix for the sake of transparency.

Methodology

Volunteers were requested from the Society of Fire Safety to undertake the project. They were then briefed on the project and requested to provide suggestions for case studies to use, drawn from common building designs and performance solutions that they each see in their work. These suggested case studies were then reviewed and consolidated to form the six case studies that formed the project. Volunteers to work on the different case studies as both engineers and reviewers were then sought from the group.

The Teams

The teams that were formed came from a variety of fire engineering firms nationally. Each case study had different fire engineers i.e. nobody was on more than one case study, and most teams had fire engineers from different companies working on it. The intent was to bring broad experience and views to the process. There was a separate peer reviewer for each case study, drawn from a different company. The AAC were approached to provide a certifier to assist with each case study, although this did not materialise.

The working teams had no involvement with the development of the FSVM or associated Handbook, or any involvement with the prior iteration of the FSVM in order to avoid bias. One or two were familiar with the New Zealand Verification Method (known as CVM2). One person with prior involvement in testing the previous iteration of the FSVM played a coordination role only.

The Chair of the projects was independent of any previous SFS work on the FSVM or NCC more broadly.

The Brief

The brief for the project, as given to the teams was to undertake a review of the proposed fire safety verification method with the aim of reaching one of three recommendations to the membership of SFS (i.e. the fire safety profession):

- The FSVM (and Handbook) are recommended for use in most performance-based designs (noting that the NCC does state that it will not be the most appropriate approach in all cases); or

- The FSVM (and Handbook) are not recommended for use in any/the majority of performance-based designs; or

- The FSVM and Handbook are recommended for use in certain cases, with certain limitations/considerations.

The Case Studies

Many examples of 'typical' projects were provided from the member firms, and 5 building designs were selected. One was broken into two projects; a podium level retail and the high rise above it, giving 6 different case studies with a variety of performance solutions. The designs were considered to be generally simple, with most designs having a number of 'non-compliances' with the deemed to satisfy solutions within the design solution. The working group intentionally avoided designs that could be considered as controversial or cutting edge, purely in the interest of focusing on assessment of the FSVM, rather the focus was on selecting 'typical' non compliances which occur more commonly.

Case studies were chosen to try and represent as many different building classifications/uses as practical, however it should be noted that some building classifications were not tested by this study.

The case studies were:

1. New two storey apartment block

With the following performance solution:

- Extended dead-end travel distance from an apartment door to a single exit stair.

Case study 1 was intended to represent a very common and simple case, having a single non-compliance, as this was expected to be a good case to test the amount of work required to apply the FSVM to a 'bread-and-butter' type project.

2. Commercial office building with podium retail. Split into Case Study 2a: Office and Case Study 2b: Retail Podium

The performance solutions for Case Study 2a were:

- FRL of office reduced to 90/90/90 in lieu of 120/120/120.
- Three-storey interconnection via a non-required, non-fire isolated stair between levels 10-12.
- Egress width reduction from the tower (2 x 1m stairs with 220 persons per floor).
- Increased single direction travel distance and overall distance to an exit on the commercial floors.
- Note that the three-storey interconnection and the egress width shortfalls were considered for separate levels.

The performance solutions for Case Study 2b were:

- Reduction of FRL to retail areas.
- A number of ground floor retail tenancies have only a single exit, in a high-rise building.
- The ground and first floor retail areas are not provided with a zone smoke control system, required as the building is over 25m in height.
- The class 6 retail mall is served by a rationalised smoke control system in lieu of a system designed to EP2.2.

Case study 2 building was considered to represent a typical large-scale mixed-use development that could be used to test the amount of work involved in applying the FSVM to a large project. Note the project was so large that the assessment work was split (Case Study 2a and Case Study 2b) and completed by two teams from the working group - however in a real scenario, such a building would be expected to have a single fire engineering firm working on it to complete the Fire Engineering Assessment.

3. New residential high rise building with basement car parking and some office use at ground floor

The performance solutions were:

- Protection of operable windows in the residential units less than 3m from the boundary.
- Extended travel distances to an exit.
- Extended travel distances to a point of choice, to an exit, and between exits in the car park.
- Discharge of a fire isolated stair into the residential entry foyer.
- No separation of rising and descending fire stairs.

Case Study 3 was chosen to represent a more complex residential building (as compared to the simple residential building in Case study 1).

4. Industrial building (warehouse): 'Large isolated building'

This building was located closer to the boundary than permitted for perimeter access for a large isolated building, under the deemed to satisfy provisions.

- The performance solutions were:
- Perimeter vehicular access on 3 sides only of a large isolated building.
- Extended travel distance to a point of choice, an exit and between exits.
- An additional length of hose required for hydrant coverage.

Case Study 4 has been considered as being very typical for Class 7b and Class 8 buildings.

5. Aged care building, four storeys

The performance solutions were:

- Increased smoke compartment size.

- Protection of openings between compartments.
- Direction of door swings.

Case study 5 was included to assess an occupancy type that includes 'vulnerable occupants'.

The Process

Following the selection of the project teams, each team reviewed the FSVM and Handbook with their case study in mind and designed the solution building and a DtS reference building. The solution building and reference buildings were submitted to the peer reviewer, then forwarded to the project coordination team for final review and questions. The development of the reference building was in strict accordance with the FSVM and Handbook, although noting that some aspects required engineering judgement to be used and the peer reviewer was consulted for consensus on such decisions.

The next stage was for the teams to identify the fire scenarios that would be relevant for their project, and the same process was repeated. The Performance-Based Design Briefs were then documented and reviewed. This was followed by testing and analysis. The full performance-based design reports were not documented, as the aim of the project was not to see how good the fire engineers were at detailed analysis and documentation; rather to see how they would use the FSVM and what advice they could then give to others using it or considering its use. Throughout the project there were regular check-ins in the form of teleconferences in order to share questions where there was found to be a lack of clarity in the FSVM, or where there was debate in interpretation.

The projects used the FSVM as per the NCC, and the supporting Handbook, as this is potentially anticipated to form the benchmark or working guide to the use of the FSVM by the stakeholders and approval authorities.

The design teams worked as far as determining how they would assess a performance solution and determining if it could be done using the FSVM. In some cases, this involved detailed analysis, in others the answer was obvious without doing detailed calculations. All were asked specific questions close to the end of their projects on their experience and observations; these are given below. These were expanded from the original brief, to give richer data.

- What were the benefits of using the FSVM over current practice?
- What, if any, were the key issues found with the FSVM and Handbook?
- What were the lessons learnt in using the FSVM and Handbook?
- What was the time, and hence fee, impact of using the FSVM over current practice?
- Does the use of the FSVM limit the viability of certain reasonable designs that are currently being done?
- Could the use of the FSVM lead to unsafe designs?
- Where would the FSVM be appropriate for use?
- Will the FSVM lead to more performance-based design, based on your experience?
- Any other feedback, insights or recommendations for change'?

Summary of Findings

The details of the findings and reflections from each of the project teams are shown in Section 4, for the purposes of transparency. There were common themes and findings, and these are summarised below.

General observations

Whilst it is understood that the FSVM is only one way of doing performance based design, the comments below are largely based on assuming that the FSVM is mandated on a project i.e. that is it being used, as there is the potential for it to become the default request of approval authorities and stakeholders, in the same way that it is often assumed by them now that the DtS provisions are 'right' and every deviation is a lessor standard and needs to be justified with an increased degree of rigour.

It was not clear to most of the teams what value the FSVM could be to the profession, or to the industry more broadly, and the intent of providing the FSVM was not clear. Some thought that it would potentially allow less competent practitioners, or even automation, for fire engineering, whereas others thought that it increased the need for experience and competence as the reference building, selection of data, and increased analysis all required greater skills. The use of a FSVM was considered to be no substitute for competence, and concern was expressed that the 'paint by numbers' approach in the FSVM could reduce the overall competence of the profession over time.

Some thought the FSVM would only be appropriate for simple cases where the reference building was very similar to the subject building, but then the additional workload required in using the FSVM was not seen as adding any benefit. Others thought it would only be used on complex buildings because simpler solutions could not justify the additional fees, but complex buildings are much harder to align to a reference building and hence a first principles performance approach is much more suitable for a complex building.

The comparison to untested DtS design solutions, with the assumption that DtS 'represents societal expectations for safety', was considered by all as fundamentally flawed. All the limitations of the DtS provisions remain embedded in the NCC and the use of the FSVM. This was not considered to be best practice performance-based design.

Pros

There was broad support for the framework for selection of design scenarios, helping to ensure that designers are checking their designs with a wide range of test scenarios. There was concern that this could drive an unnecessary amount of non-productive documentation to justify why scenarios were not relevant and certainly a large part of fire engineering time today is spent on extremely detailed reporting which adds little value, and is nowhere near as productive as designing, analysing, reviewing and site checking. There needs to be common sense applied to the requirements for reporting selection of fire scenarios.

There were not too many cases that the teams could think of where proper use of the FSVM could lead to less safe buildings than the DtS, albeit the DtS was often considered not to meet the performance requirements if tested currently, hence a comparative assessment is mostly only going to lead to an equivalent standard of fire safety. There were cases where the use of the FSVM was considered to lead to less safe designs than a competent fire engineer would develop using first principles performance-based design.

One team did see a positive that use of the FSVM allowed a number of non-compliances with the DtS provisions to be assessed together as a performance solution, as compared to current practice that generally has each and every non-compliance documented separately. It is noted that this is not driven particularly by the current NCC but has arisen as practice from the approach of a BCA assessment being used to identify non compliances then fire engineers needing to 'account' for each one of these to approval authorities. This could easily be changed in practice without the use of the FSVM and a more rational approach to documentation would increase productivity of the industry now.

Cons

All teams saw issues with the selection of the reference building. The methodology implied in the Handbook is that a DtS building is designed and then variations are done to that to create a subject building design. This is not how building design is done in reality, however, there is almost never a DtS compliant building as a starting point. This means that there is always additional and largely redundant work needing to be done to create a reference building. There was no clarity on who would do that; is it the fire engineer but then for all but simple building variations a greater range of skills is needed to create a building design? For anything other than simple variations, creating a reference building requires additional design work by the architect, potentially certifier, fire engineer and in some cases the engineering team. This results in reduced productivity/higher fees for no value by more members of the design team than just the fire engineers.

The strict requirement to not alter location, size, population, openings and generally building geometry between a subject building and a DtS building was seen as unnecessarily restrictive and often problematic. Amending physical building features is a part of designing a building, and to not have this option in the 'toolkit' as building designers was considered unnecessarily restrictive. It essentially means that a comparative assessment can only be done with very similar buildings, and hence the FSVM is overly limited in its applicability. In some cases, the enforced reference building forced the designer to consider the wrong issues, with potential improvements in safety not showing a benefit in the comparison hence would be unlikely to be incorporated into a project.

Furthermore, despite the level of detail within the FSVM and the Handbook, there were still many questions that were raised during the process of developing reference design buildings. For example, although the volume of the reference design is required (by the Handbook) to be the same as the subject building, is the ceiling height within space required to be the same also, or can that be considered as a design enhancement feature of the subject building?

As it currently stands, the FSVM and handbook are not considered to provide sufficient framework or guidance to guarantee consistency in the DtS compliant reference design that is developed for

each project and as such would fail to achieve the consistency in levels of fire safety that it is assumed the FSVM aims to attain.

One fundamental issue with the FSVM and the comparative based analysis that it is based on is that it allows for results showing a negative margin of safety to be deemed adequate. The working group has been able to foresee instances where the results of assessment of a DtS reference design against the FSVM results in a negative margin of safety (or people trapped within the building). In such cases, the analysis of the subject building also permits a negative margin of safety and the Performance Requirements are considered to be satisfied providing that the negative margin of safety is of a magnitude less than the DtS result. Whilst it is recognised that the FSVM analysis is a framework for yielding results for comparison purposes only and does not represent reality, there is a risk that application of the FSVM may result in designs that would not satisfy the Performance Requirements when assessed using traditional first principles Fire Engineering approach (i.e. without comparison to the DtS).

All thought the use of the FSVM would significantly increase the workload and hence fees, required for a project, by approximately 200-300%. This could mean a reduction in the extent of performance-based fire engineering/number of performance solutions, and fewer projects having performance-based engineering. This could also lead to less competent engineers entering the industry to attempt to capitalize on the financial opportunity without having the appropriate expertise.

The FSVM requires stakeholder consultation with the fire brigades for all use of the FSVM, yet this is controlled by state legislation not the NCC. The additional work required in the use of the FSVM by the fire engineers plus the requirement to engage with the fire brigades for every project will result in additional work by the fire brigades. Are they resourced to do this?

All saw discrepancies between the NCC and the Handbook, with generally the FSVM as articulated in the NCC being more manageable than the Handbook, although not in every case.

The FSVM drives a higher benchmark in some cases than equivalence to the DtS, as some design scenarios require demonstration of both equivalence to the DtS reference design and absolute demonstration of a secondary acceptance criteria. This could potentially lead to additional cost and/or reduced use of performance solutions e.g. has not been shown to be policy neutral.

Some common performance solutions that are considered by most as being reasonable and safe, such as a single exit from ground floor retail in a high rise building or increased density in an office tenancy, can no longer be done if the FSVM becomes the default, resulting in loss of the productivity gains that Performance Solutions can currently deliver in such cases.

Potential implications if FSVM becomes the norm

If the FSVM were to replace the current methodology for Performance-Based Fire Engineering, either due to AHJ's or other stakeholders enforcing its use, or by other means, the working group has inferred the following potential impacts on the wider Fire Engineering industry and profession.

There would be an increase in workload for Fire Engineers and Certifiers on each project where Performance Solutions apply. This might be good news for our industry if clients are willing to bear additional fees associated with that additional amount of work. However, the increased cost of implementing a Performance Solution on a project may result in it being not cost effective to apply Fire Engineering to address small number of DtS deviations. These designs would return to DtS and the productivity gains associated with Performance-Based Design are lost. Performance-Based Fire Engineering would become reserved for the larger or more complex projects where it is economically viable to use the FSVM. Even in the case of clients being willing to bear the costs, there is already a shortage of competent and well-educated fire engineers and this would likely exacerbate that issue resulting in more work being completed by less competent engineers.

Furthermore, Performance Solutions that most considered as 'standard type solutions' may not be feasible under FSVM and this would also represent a step backwards in terms of productivity gains.

Junior Fire Engineers may not learn how to think critically, they would just learn how to follow the process and best apply the FSVM. Furthermore, there would be a reduced number of small projects for them to 'cut their teeth on' (due to the reasons discussed above). It would result in all Fire Engineers becoming better code consultants, undoubtedly a good thing for Fire Engineers, but perhaps not for certifiers. It is considered that the scenarios covered by the FSVM represent a reasonably wide range of scenarios that should be addressed by a robust Fire Engineering assessment, however, when these scenarios are served on a platter, Fire Engineers are not practiced in thinking beyond the standard roadmap and considering the fringe cases, which are the cases that often drive the design most. This may have flow on implications for the overall competence of the fire engineering industry - lowering the bar for what is required to be a fire engineer. The FSVM may also accelerate the trajectory towards automation of Fire Engineering without critical analysis of soft impacts on building safety such as occupant characteristics, operational strategies, and long-term flexibility/building life cycles.

Recommendations

SFS sees benefit in the use of the range of fire scenarios given in the FSVM (and possibly additional ones) as a rigorous approach to testing that a design is robust and has no single points of failure. Huge amounts of documentation are not needed to do this, rather a quick checklist to identify the relevant scenarios to test each design/performance solution or set of performance solutions would more often than not be adequate. It is recommended that fire safety engineers incorporate that into their current practice by considering some of these in a hazard analysis process.

However, as the FSVM seems to offer no benefits above current reasonable fire engineering practice, increases time and workload for a project for both the design team and the fire brigades, potentially reduces productivity from both the amount of design work and the designs that are created, SFS does not recommend its members to adopt it in their work. It is not considered to represent best practice nor an appropriate direction for the profession.

It is recognised that despite the views of SFS, members may be required to use the FSVM on certain projects by the AHJ or other stakeholders. In this case, SFS recommends that the Fire Engineering documentation be peer reviewed by a suitably qualified Fire Engineer and that any analysis undertaken does not allow for the margin of safety in the subject building to be less than 0.

A separate short guide is to be developed by the SFS to assist fire safety engineers, certifiers and design teams in the appropriate use of the FSVM. For further information, the responses to key questions in relation to the usage of the FSVM have been provided for each Case Study.

Detailed Reporting from Each Group

Case Study 1: residential

Residential building below 25 m, single stair. Extended travel distance of 8m to an exit in lieu of 6m.

Benefits of the FSVM

For a simplified case such as the one under consideration, the broad considerations within the FSVM within the NCC and the Handbook are largely not applicable as a short analysis comparing the available egress times of both solutions is the appropriate and most efficient method. Simple scenarios such as this could benefit from a reduced VM process as the considerations within the method itself are valid.

Key issues with the FSVM and Handbook

- The primary issue lies with the Handbook requirement that all geometry is unchanged between the reference building and the design building. This leads to a comparison between a 2-stair building and a single stair building which the single stair building does not compare favourably, precluding the solution.
- When comparing the design building to a single stair DtS solution with a 6 m travel distance, then a performance solution can be found by enhancing the protection of the corridor (e.g. smoke seals on SOU doors, increased detection within SOUs).
- Forcing the comparative approach meant that the greatest fire hazard, a fire in a SOU, was not considered explicitly so a good solution, that of improving the warning to help wake people quicker, would not be considered as it doesn't help the comparison.
- Given that the two key performance requirements that are impacted and must be analysed are DP4 and EP2.2. The Verification method requires consideration for scenarios BE, UT, CS, SF, IS, FI, CF and RC. Most of which are redundant in this scenario (e.g. Fire brigade intervention (FI) will have the same outcome for both scenarios unless the DtS building is fundamentally different in geometry (i.e. has another stair). This leads to an extensive amount of engineering effort being required for not much gain in safety or improved design as the analysis in practice will simplify to 'this is the same as DtS therefore no further consideration is needed'. Whether or not the scenario is a valid one from an absolute perspective does not come into the process.

Lessons learnt in using the FSVM

None in this case.

Time/fee impact of using FSVM

Approximately three times the time/fee greater than not using the FSVM. This would be expected to reduce somewhat as templates are developed for regular use, however it was considered to always require a significant additional work and hence fees.

Does use of the FSVM limit viability of certain designs?

The FSVM itself does not but use of the Handbook will. An extended travel distance in a single stair building under 25m is considered to no longer be viable.

Could the FSVM lead to unsafe designs?

Not for this test case.

Other feedback, insights or recommendations for change?

The principle of the VM is a valid one and the considerations within both the FSVM and the handbook are also valid. However, it cannot substitute for competent practitioners, in fact it requires a level of competency which places more onus, not less, on its user. If the VM is made the de-facto method of comparison to DtS measures it is likely that Fire engineers will become experts at manipulating it to extremes (having efficiency and safety implications). Design efforts are likely to focus on direct comparison to DtS measures some of which may not be the best or most safe solutions for the cases under consideration. This is likely to lead to less, not more, building fire strategy thinking in the industry which in turn is not anticipated to lead to safer outcomes as the remit as a fire engineer will not be to think about the safest outcome but the best way the design can fit into the FSVM.

Where would the FSVM be appropriate for use?

The FSVM as drafted within the NCC (but not the Handbook) should be appropriate for the scenario we were tasked with.

Will the FSVM lead to more performance-based design?

The use of the FSVM is likely to lead to less performance-based design as the cost/time involved in using the VM and the restrictiveness of the handbook are likely to drive design teams towards DtS solutions or very close to DtS solutions.

Case Study 2a: office

Benefits of the FSVM

The FSVM is a quantity tool to allow alternative method to demonstrate compliance with the Performance Requirement and it could be used to drive design consistency for the fire life safety design. However, there are limitation of using FSVM as a form of alternative method to demonstrate compliance with the Performance Requirement. In theory, a handbook accompanying the FSVM could be a very useful tool, however the inconsistencies between the two documents would need to be ironed out prior to its implementation.

Key issues with the FSVM and Handbook

- In the event where partial or whole upgrading works to the development, the application of FSVM might not be extensive to review the impact of the entire fire safety strategy. It might be reviewed as an isolation to the affected work and subject to the designer and peer reviewer's judgement.
- The Handbook specifically requires a reference building to be designed. The FSVM only appears to require this when doing fire modelling, as per Section 1.5. This led to confusion in determining a methodology.
- FSVM includes in the design scenarios options for 'typical methods of assessment'. This could be confusing and misleading to building surveyors or others in industry who expect that these are the only suitable methods of assessment.
- FSVM states that design scenarios ***must*** be assessed. Handbook offers the alternative that a justification can be provided as to if a design scenario which isn't considered relevant can be set aside. Again, the inconsistency is confusing.
- The requirement that occupancy numbers need to be the same for the reference and subject building essentially renders any design for increased occupancy redundant, and no design can take advantage of a subject building having a low number of occupants for the exit width provided. For example, a common design is for a small office plate building (and hence low occupant numbers) to have three floors connected in lieu of two, where the occupant numbers over three floors are less than the exit width capacity (say 2 fire stairs, 400 people in DtS permitted over 2 floors; the same 400 people could be spread over 3 floors but this comparison is not permitted by the FSVM and Handbook).
- Handbook: The NCC does not have any specific requirements generally for the types of rooms considered by The UT fire: storage rooms, cleaning rooms and service corridors. This means that equivalency with DtS can be proved in most instances, rendering the intent almost redundant. There is a risk that individuals could 'game the VM'.
- Consideration is to be given to assisted evacuation, however with the required outcome having to achieve equivalency with DtS, and no requirement for DtS to consider evacuation, DtS is actually less safe than a performance solution which would consider assisted evacuation.
- Intent and outcome are different for UT fire scenario i.e. FSVM requires equivalency with DtS, and Handbook requires less than or equal to reference building
- For the CS fire scenario, there is a direct conflict between the Handbook and FSVM. The latter requires both comparison to DtS and that fire spread will not endanger occupants in other rooms. This is potentially a higher bar than the DtS. The Handbook only requires comparison to the DtS reference building. No consideration is given to smoke spread.

Lessons learnt in using the FSVM

- The FSVM does not include a definition, or reference to, a reference building. Should the intent be that comparison against a reference building is required, as per Handbook, this should be included in the FSVM.
- Handbook requires a proper definition of reference building in order for a fair and consistent comparison to the proposed building design.
- The use of FSVM will require early engagement of the Fire Safety Engineer in the concept design stage to work through the design aspect for fire life safety required.
- The Structural Engineer will be required to be upskilled to perform the required FSVM's UT and SS design scenarios.

- FSVM will impact on the higher cost for Fire Engineering consultancy fee due to additional works and time spent required.

Time/fee impact of using FSVM

The Handbook approach takes a fair bit of time to set up the reference building in terms of building layout, egress strategy and other fire life safety requirement.

In terms of fire modelling, the Handbook approach requires modelling and simulations for both proposed and reference buildings and it will take up to at least twice the computing time for required design scenario.

Does use of the FSVM limit viability of certain designs?

The FSVM approach will also discourage the innovative building design with application of fire engineering due to the confined rules and regulation. It will not allow a unique building design to be properly define a relevant reference building. Therefore, it will discourage the use of FSVM.

The FSVM approach tends to encourage the building design to incorporate the active and passive fire safety systems for safer design (e.g. fire detection system, sprinkler system, fire compartmentation, etc)

Could the FSVM lead to unsafe designs?

In UT, consideration is to be given to assisted evacuation, however with the required outcome having to achieve equivalency with DtS, and no requirement for DtS to consider evacuation, DtS is actually less safe than a performance solution which would consider assisted evacuation.

The FSVM mentioned ‘typical method or solution’, which could lead to unsafe designs. It will further discourage the of design a holistic fire strategy for the proposed building.

Other feedback, insights or recommendations for change?

SFS could consider preparing a technical guidance for the use of FSVM and ABCB to consider to also reference SFS’s technical guidance as another official guidance document.

ABCB should consider the accreditation of Fire Safety Engineer in order to allow qualified Fire Safety Engineer to address the Performance Solution via FSVM.

Where would the FSVM be appropriate for use?

Nowhere.

Will the FSVM lead to more performance-based design?

The use of the FSVM will possibly reduce the amount of fire engineering design based on first principle or engineering judgement.

It appears that the Handbook is attempting to introduce additional performance requirements to the NCC rather than simply providing a robust Verification Method. Where additional requirements are included above achieving equivalency the DtS provisions, these are not necessarily inappropriate, but are more onerous than both the DtS provisions and performance requirements of the NCC.

Should the verification method be required on a project, it is likely that a DtS design would be preference to any fire engineering or application of the verification method. Which is not the best outcomes for projects because, as evidenced by the additional measures nominated in the handbook and FSVM, DtS is not always the safest.

Case Study 2b: retail

Two-storey retail shopping centre within a podium.

Benefits of the FSVM

Key issues with the FSVM and Handbook

- Reference Building cannot be achieved as outlined in Handbook, having same footprint, occupant numbers, fire load, internal layout, ceiling height etc., as the Performance Solution.
- It is easier to develop a Reference Building and convert the design to apply to a Performance Solution. However, most fire safety engineers will need to reverse design (or work backwards) to develop a hypothetical design for a Reference Building, which cannot be done.

  For example, it is easier to delete a 2nd stair from the Reference Building and make it 'dead space' or 'non-usable space' in a Performance Solution.

  In real industry application, fire safety engineers are already presented with a building design from an architect having a single stair. By adding a 2nd stair will reduce the floor area, occupant numbers, fire load and internal layout.

- The intent of FSVM is to quantitatively demonstrate that the level of safety is at least equivalent to the Reference Building based on a risk analysis. This cannot be carried out due to the following reasons:

i) Considering that 'variables' are the same for both Performance Solution and Reference Building, the risk assessment is the same. This defeats the purpose of assessing the fire safety concern in a comprehensive approach.

   For example, FSVM requires assessment of structural stability associated with reduced fire rating. Based on risk assessment, risk of structural stability is the same considering all fire safety systems are performing in accordance with the design intent. If failure of systems were considered, then a reduced FRL can never be equivalent to a DtS reference building. So, either FRLs can never be reduced, or they can be zero (or very minimal) if the building is sprinkler protected – the interpretation of this varied across the team. It is therefore more appropriate

that an absolute assessment (like Equivalent Fire Severity) be undertaken to properly assess the reduced fire rating.

ii) Recommended Analysis Method in the FSVM Handbook discusses assessment methods that are absolute approach (i.e. ASET vs RSET), which contradicts the purpose of comparative assessment for FSVM.

iii) The ASET vs. RSET approach is not appropriate for comparative analysis because:

- If ASET>RSET×FoS (factor of safety) for the Performance Solution comparison with DtS is not necessary; and
- If ASET<RSET×FoS for both the Performance Solution and the DtS benchmark yet the ASET/RSET ratio is larger for the Performance Solution, the analysis reveals both designs are not acceptable on performance basis, contradicting the principle of the comparative approach.

- Generally, the Verification Methods does not capture the improvements to life safety that can be demonstrated by absolute assessments. This is due to comparative assessment having same variables for frequency/consequence analysis. For example, enhancement to the active fire system (i.e. type/spacing of sprinkler, spacing of detectors) which cannot be demonstrated from frequency analysis of sprinkler/detection system in general.
- Insufficient data is provided within the Datasheets for risk assessment required in the Handbook. In order to undertake comparative assessments and carry out either 'frequency analysis' or 'consequence analysis', there is no statistical data on ALL active and passive fire safety measures to adopt Verification Method for all Performance Solutions.
- Requirement to consult with the fire service: how can this be managed when legislation does not require it in all States/cases?
- Blocked exit scenario is confusing. Handbook recognises that occupant tenability cannot be met if flame blocks an evacuation route. This contradicts the BE scenario. Then, further explanation of BE discusses a fire grows to block an alternative evacuation route. This means that BE relates to blocking of alternative exit. Clarification is sought on exactly what BE is required.

Lessons learnt in using the FSVM

- Inconsistency between FSVM and Handbook.
- Inadequate data available for comparison of risk in some cases.

Time/fee impact of using FSVM

Use of FSVM would take at least twice as long as need to do everything for the subject building and the reference building. Additional time needed to design the reference building (who does this?).

Does use of the FSVM limit viability of certain designs?

Possibly, depending on interpretation. May not be able to do any reduced FRLs. May not be able to have a single exit at ground level retail of a high rise building, as reference building will have two exits and need to consider a blocked exit scenario (or this may be acceptable by simply saying all systems work – discrepancy in interpretation in the team).

Could the FSVM lead to unsafe designs?

Potentially, particularly as comparison with DtS is always required, and DtS may not be appropriate. Absolute assessments, such as equivalent fire severity, are not encouraged by the FSVM. There is room to interpret scenarios to say, for example, no fire ratings are required where there are sprinklers.

Other feedback, insights or recommendations for change?

Provided in detailed appendix.

Where would the FSVM be appropriate for use?

Society of Fire Safety understands ABCB's intention to improve the consistency of fire engineering assessment when the comparative assessment method is used. However, through hypothetical application of the Fire Safety Verification Method in this case, we have found that the Verification Method and Handbook cannot be adopted without significant amendments.

Will the FSVM lead to more performance-based design?

No, it will likely lead to less due to the additional time needed for each design and there appears to be no benefit to using the FSVM. Engagement with the fire service is always required, which will increase cost and slow down projects, and that will influence developers' decision to use performance-based design.

Case Study 3

Benefits of the FSVM

- FSVM, the handbook and the data sheets are excellent additions to the already existing large repository of documents and literature available for Performance Solution design.
- FSVM and handbook provide good, useful compiled information for Performance Solution design. There is really not much new about this, as most of this information is already available in the open literature and VM has only compiled this information.
- A wide range of design scenarios are listed for consideration. All the scenarios proposed by VM may not be mandatory for analysis and the Fire Engineer should have the choice to analyse only selected relevant scenarios and discard others as not relevant.

Key issues with the FSVM and Handbook

- FSVM and the handbook state right at the outset that these documents are not mandatory but only advisory in nature. VM is just one of many means of demonstrating compliance and may not be suitable in some situations. Therefore, it must be emphasised particularly for AHJ (certifiers, councils) and Fire Brigades that they should not enforce on fire engineers the use of FSVM just because scenarios are prescribed which makes it easy to tick boxes. Fire engineer in consultation with stakeholders should be allowed to use FSVM or other appropriate assessment methods as described in Section A2.2 of BCA 2019.
- Considering all the excitement and controversy FSVM has generated, there is really not much new about it. It is an organised compilation of methods, processes and information,

which practising Fire Engineers have been using all these years. VM is basically a Performance Solution assessment method which requires the building fire safety level to be at least equivalent to that of a reference equivalent DTS building. Thus, effectively VM seems to be very similar to the Assessment Method A2.2(2)(d) of BCA 2019, in comparison with DtS. The only difference is that VM imposes a very large number of scenarios to be analysed, much more than what practising fire engineers have been doing.

- Designing an equivalent DtS building is at the heart of VM. This can be challenging, bordering on near impossible for large complex buildings due to the stringent requirements imposed by VM on designing an equivalent DtS building. This is where VM can fail. Designing an equivalent DtS building is easier on a micro level for a simple building or for a part/single level of a large complex building.
- Occupants with disability and vulnerable must be considered with regards to DtS equivalency process.

Lessons learnt in using the FSVM

Seems to be daunting for first time users, will be okay once you have used it a few times. Too many design scenarios to be analysed, all may not be relevant. Designing a reference DtS building is challenging for complex buildings and may not be possible to meet all the FSVM requirements in this regard.

Time/fee impact of using FSVM

Expect a much longer time for VM design due to a large number of scenarios to be analysed. Substantial increase in Fire Engineer's time to write a report and for the peer reviewer to review the report. You can expect a steep rise in fire engineering fees and peer review fees for VM. Is the industry ready to bear the increased cost, particularly if VM does not necessarily lead to safer buildings?

Does use of the FSVM limit viability of certain designs?

VM might be a burden and an overkill for simple buildings with simple issues.

Could the FSVM lead to unsafe designs?

Cannot, as yet see any examples.

Other feedback, insights or recommendations for change?

- FSVM handbook is mainly qualitative, generic, gives only an outline of fire engineering strategy and does not provide specific detailed information for fire engineering design. It points to references and data sheets for detailed information. FSVM handbook has similarities to IFEG and in fact can be part of a revised IFEG.
- ABCB should state the names of the authors, their professional qualifications/credentials/positions for FSVM and handbook. This is essential to maintain transparency because practising fire engineers would like to know the authors and their background.
- Keep the VM, handbook and datasheets but treat them as additions to the already existing literature to be used by fire engineers for Performance Design. Do not enforce VM, treat it

as an additional methodology to design Performance Solutions. Handbook could be used as part of an amended IFEG.

Where would the FSVM be appropriate for use?

Cannot think of a scenario. It would be overkill for a minor variation and cannot be applied for a complex building as cannot create a sensible reference building.

Will the FSVM lead to more performance-based design?

VM will not lead to more or less Performance solutions. This is determined by BCA analysis of the building which is a step prior to fire engineering design.

Case Study 4: Warehouse 'LIB' close to boundary

Benefits of the FSVM

The FSVM does provide a number of design scenarios that provide a holistic approach to the assessment of the building.

Key issues with the FSVM and Handbook

- The main issue was the importance of the derivation of the reference building and the restraints on the derivation of the reference building from the FSVM Handbook. For this test case, because the reference building has to be the same distance from the boundary, it could not be a large isolated building and therefore needed to have compartmentation in accordance with the DtS provisions. This resulted in the subject building being a LIB with all the associated fire safety systems, which was beneficial in design compared to the reference building for assessment against the design scenarios.
- The subject building, while derived in accordance with the FSVM Handbook, was not fundamentally similar to the design of the reference building. Does compliance with the principals for the derivation for the reference building from the FSVM guarantee that the buildings are similar enough for stakeholder acceptance?

Lessons learnt in using the FSVM

- The initial assessment that was completed as a part of the scope of this working group indicated that the performance of the reference building with respect to the subject building was driven by the requirements for the derivation of the subject building from the FSVM Handbook.
- The FSVM Handbook requirements resulted in a reference building that was developed as a Large Isolated Building and a subject building that was developed with a high degree of fire compartmentation. This resulted is a significant degree of variation between the fire safety systems required for the two buildings, as shown in Section 2.0.
- The additional fire safety systems and the large open area in the subject building provided a benefit to the assessment against the reference building. However, the buildings were determined to be quite different in design.
- An ASET/RSET assessment for the design scenarios would have benefited from the design of the subject building with the sprinkler system to control the fire and the large open space

for smoke filling as occupants egressed from the building. The subject building would have had a larger design fire, as the building was not required to be provided with an automatic fire suppression system and faster smoke filling due to the compartmentation.

Time/fee impact of using FSVM

It is expected that this complete process would require approximately 2-2.5 times the time required for a typical project. This is mainly due to the time cost to develop the reference building, the fire safety strategy for the reference building and then completing the design scenarios for 2 buildings, instead of 1.

It is also assumed that this would require additional time for other stakeholders, such as the architect and BCA consultant.

Does use of the FSVM limit viability of certain designs?

The results from this test case indicated that it would be challenging to address Large Isolated Buildings that are not provided with compliant perimeter vehicular access because the subject building would have to be quite different from the reference building. Unless it was established that compliance with the requirements for the derivation of the reference building guaranteed that the building was similar enough to the subject building (i.e. comparing the two buildings derived in this test case is acceptable).

Could the FSVM lead to unsafe designs?

This design scenario would not consider the impact on egress time for the provision of fire hose reels compared to fire extinguishers.

Other feedback, insights or recommendations for change?

Necessary to establish metrics for when a reference building is similar enough to a subject building.

Where would the FSVM be appropriate for use?

It is shown that it is difficult to apply FSVM to a LIB closet to the boundary than a DtS case due to the requirements of defining DtS reference buildings in the FSVM Handbook.

Will the FSVM lead to more performance-based design?

The FSVM is only one option to provide performance-based design. Therefore, as an industry we can still address design objectives through Performance Solutions using verification methods other than the FSVM.

Case Study 5

Benefits of the FSVM

- Lends itself well to automation.

- Multiple non-compliances can be addressed by assessment of single scenario as compared to traditional approach of addressing non-compliances in isolation.

Key issues with the FSVM and Handbook

- Unnecessarily increases the amount of work needed to adopt a Performance Solution approach.
- FSVM can allow for unsafe designs - e.g. analysis of the CF scenario demonstrates equivalent to Deemed-to-Satisfy but does not satisfy the BCA Performance Requirements.
- Lowers the barriers to entry for fire engineers to be competent. Paint-by-numbers approach trains future engineers (those just joining the industry now) to only follow the VM process rather than think for themselves and determine what is important to consider on each project
- Perpetuates the industry mindset of 'Deemed-to-Satisfy is gospel'. Ideally the industry should be moving towards a full performance approach where the Deemed-to-Satisfy are irrelevant if a Performance Solution is adopted.
- The need to compare to Deemed-to-Satisfy effectively prevents simple/low risk solutions that are commonly accepted under traditional analysis approach (e.g. single exit from Ground Level tenancy in Building > 25 m effective height). There is no scope for an absolute assessment.

Lessons learnt in using the FSVM

Nothing new gained, it is all the same stuff a competent fire engineer would be doing currently - it is just that the VM requires one to do all of it every time, rather than selecting the relevant tools and assessments on each project.

Time/fee impact of using FSVM

- 2.5 x average time spent (since you have to do the Deemed-to-Satisfy analysis as well + add more time to explain why it is not necessary to address certain scenarios in relation to certain issues).
- This will have a significant impact on industry if FSVM becomes the preference of AHJs - it will not be cost effective to do one or two Performance Solutions or small Performance Solutions, so these projects will revert to Deemed-to-Satisfy, limiting the productivity benefits that Performance Based design can provide. Performance Solutions will once again be reserved for only the large/complex projects (as it was 15 years ago).

Does use of the FSVM limit viability of certain designs?

Cannot do:

- Single exit from Ground Level tenancy in Building > 25 m effective height.
- Door swinging against direction of travel.

Could the FSVM lead to unsafe designs?

Designs adopting a Performance Solution in relation to Vertical separation of openings in external walls.

Other feedback, insights or recommendations for change?

- SFS should advocate for peer review of all VM solutions (at least for the first 1-2 years).
- Is the blocked exit (BE) scenario essentially the same as the Robustness Check (RC) for a door?
- Note that a door can be considered as a fire safety system as it will 'provide for safe evacuation' (as per definition).
- Do we need to consider sprinkler failure as part of robustness check?
- Is partial sprinkler failure acceptable?
- Acceptance criteria for RC requires you to demonstrate the 'disproportionate fire spread does not occur' (as well as equivalence to Deemed-to-Satisfy). Yet if you consider sprinkler failure, any building with full height glazing would not be able to satisfy this criterion.
- Robustness should be investigated for all applicable VM scenarios. The way the VM is currently structured some practitioners may only apply the robustness check to the CF scenario.
- FSVM Table 1.2 is poor - I think we should recommend not adopting it directly and only using it as a first pass. Selected scenarios to be chosen by fire engineer and agreed in FEB.
- FSVM Table 1.2 does not list any Scenarios for the DP2 non-compliance. Chose what I believed were appropriate.
- Generally, there seems to be more a of a focus on fire spread than smoke spread, but smoke is probably more dangerous.
- Spent a good chunk of time justifying/documenting why scenarios did not apply to the building or to certain non-compliances. This process should be documented in the FEB.
- Difference between "typical method or Solution" vs "Method". VS is only scenario that uses the terminology "Method", therefore VS requires using CV3, however this only applies to cladding issues.
- SFS recommend use of another method or solution for justification of spandrel type non-compliances.
- CV1 and CV2 are not able to be used for fire spread between different fire compartments (by nature of the definitions of CV1 and CV2 – always between buildings). Therefore, cannot satisfy HS scenario.
- CV1 and CV2/radiant heat calculations are not the typical methodology that would be applied here for non-compliances related to protection of openings in external walls of different fire compartments.
- Single exit from Ground Level tenancies in Buildings >25 m will not be possible, regardless of size/occupant load.
- For the SF scenario, how does one satisfy the "provide a safe sleeping area" acceptance criteria?
- For the SF scenario, although the acceptance criteria say you need to 'demonstrate', I am of the opinion that it is acceptable to simply state "smoke detectors to be provided in accordance with…" and no analysis or demonstration is presented (assuming that is the solution you are adopting).
- SF scenario nominates 'separating elements' as an option to satisfy the scenario, however, the definition only refers to fire resistance and a smoke wall would not be considered a 'separating element'. Yet the scenario talks about smoke spread a lot. In fact, the whole paragraph about separating elements in the 'typical methods' section is a mess.
- VM does not specifically say that SF scenario only applies to particular classifications or even only to sleeping areas. Handbook does clarify.

- In a childcare or prison does one need to consider SF scenario given that those sleeping are being supervised by awake and alert staff.
- One positive found - larger smoke zones in Class 9c become easier to justify the larger the zone is, as long as you are not adding more beds in that larger space.
- There is no data sheet for the time taken to open an exit door (inward swinging vs outward swinging) so I will have to source this data myself = opportunity for low quality data to be used by engineers.
- It is not clear how to use the VM to assess the risk of an inwards swinging door being un-usable due to a crowd forming at the door.
- Subject building has inward swinging smoke door so will always be worse than Deemed-to-Satisfy which has dual swing doors. However, this may result in lower reliability of the smoke doors over the life of the building.
- Presence of inward swinging doors means that you need to do the CF scenario for every smoke zone to assess the impact that the slight delay on egress associated with inwards swinging door might have; small issue massively increases workload.
- In my opinion Fire hydrants need not be considered to fail in Robustness Check, unless you have a Performance Solution related to ring main, isolation valves, relay pumps or the like.
- Does VM address smoke leakage under Deemed-to-Satisfy SOU entry doors in residential buildings?
- Handbook notes that for the HS scenario sprinklers are a typical mitigation measure, however, the HS scenario required one to considered fully developed fires. This is a conflict.
- For reduced FRL assessments, despite Deemed-to-Satisfy providing a greater factor of safety, it should be acceptable to demonstrate that subject building design FRL is adequate to resist burnout (and Deemed-to-Satisfy FRL also resists burnout).

Where would the FSVM be appropriate for use?

Essentially any design that involved rationalised smoke hazard management (shopping centres, atria, warehouses).

Will the FSVM lead to more performance-based design?

Probably the same overall amount of fees for professional fire engineers, however, there will be a shift towards Performance Solutions being reserved for the larger more complex projects, so that will limit the productivity benefits that Performance Based design can provide.

Slightly worse outcomes in terms of building design and functionality, only because required use of the FSVM is likely to limit the use of Performance Solution on smaller projects or for minor deviations.