# Fire Safety Engineering

## Comparison of FSE Guidance Documents and Assessment Criteria

Commissioned Research Report for the Australian Building Codes Board – Fire Safety Engineering Series

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# 1. Executive Summary

This report describes a review of four guidance documents for fire safety engineering to determine their suitability for use in Australia; namely CIBSE Guide E, ISO23932- 1:2018, BS7974 (2019), and the SFPE engineering guide to performance-based fire engineering. The review was undertaken on instruction from the Australian Building Codes Board (ABCB). The intention with the report was to identify one preferred document that could be recommended by ABCB for adoption for use in Australia.

The methodology followed in the review was based on a comparison of each of these four documents against series of Assessment Criteria identified by the project team and agreed upon with representatives of the ABCB. These 30 criteria were grouped under the headings of “Scope, structure and application”, “Overall process and major components”, “Methods of evaluation”, “Variability and uncertainty”, “Documentation”, “Adoptability” and “Other”.

For each of the criteria it has been identified whether these were fully, partially, largely or not achieved by the individual documents. In summary, none of the documents achieve all of the criteria. However, BS7974 achieves more of them than any of the other documents. ISO23932 and the SFPE guide perform to very similar levels, and CIBSE Guide E achieves the fewest of the criteria.

Despite the fact that there are three criteria that BS7974 does not achieve, it is concluded that this appears to be the most appropriate for adoption in Australia if one single document is to be chosen. The possibility of allowing practising fire safety engineers the flexibility to adopt the most appropriate document on a case by case basis is also briefly discussed.

# 2. Scope and Structure




*Fire and emergency response crews at a site in Rozelle, NSW*

## 2.1 SCOPE

**THE SCOPE FOR THIS CONSULTANCY AS SET OUT BY ABCB WAS AS FOLLOWS:**

Given that there is existing fire engineering guidance available from international organisations and that the regulation/ code explanations within the IFEG are contemporary, "the ABCB intends to undertake a review of four existing engineering guidance documents to determine their suitability for use in Australia". In addition, "a preferred document for use in Australia will be sought." As a result, the ABCB commissioned a consortium led by the Warren Centre to review four international fire engineering guidance documents to determine their suitability for use in Australia. The documents that were included in this review were:

1. CIBSE Guide E, Fire Engineering, Chartered Institute of Building Services Engineers, UK (May 2010).
2. Relevant fire safety engineering standards produced by ISO/TC 92/SC 4 – ISO23932-1:2018, Fire safety engineering — General principles — Part 1: General.
3. Fire safety engineering in buildings – Code of Practice, BS7974 (2019).
4. Engineering guide to performance-based fire protection analysis and design of buildings, SFPE, Bethesda, MD. USA (2000).

> ... [I]t is likely that none of the four guidance documents may be compatible with all the concepts and terminology of the NCC in terms of the "fire safety engineering process."

These are hereinafter referred to as CIBSE Guide E, ISO23932, BS7974 and the SFPE guide respectively.

These four documents were evaluated in this report against Assessment Criteria that were developed by the project consortium and presented to and agreed with representatives of the ABCB at a meeting held on the 20th April 2019. By means of undertaking this evaluation, the suitability of each document was assessed for use in Australia and a preferred document was recommended. It was also discussed if there is a possibility of allowing all four documents to be used in Australia.

In addition to the four documents for evaluation, this study was further informed by three documents provided by the ABCB as part of this consultancy, namely:

1) A High-Level Comparison of the International Fire Engineering Guidelines, BS7974 - Application of Fire Safety Engineering Principles to the Design of Buildings, SFPE Engineering Guide to Performance-Based Fire Protection, ISO 13387 - Application of Fire Performance Concepts to Design Objectives (a report prepared by WPI).
   - This report compared three of the documents that are evaluated in this Warren Centre study (ISO23932; BS7974; and the SFPE guide) with the International Fire Engineering Guidelines.
   - In summary, the report concluded that all four approaches were essentially the same, although that BS7974 was more detailed and addressed issues which relate to the use of risk assessment and probabilistic methods in fire safety engineering better than the other documents.
2) Building Codes Committee (BCC) Agenda Item 6 - Process for developing performance solutions, a four-page document stating that:
   - BCC members have agreed in-principle that the process for developing Performance Solutions contained in the IFEG could be referenced in the NCC Governing Requirements
   - To potentially include the process contained within the Guideline document (i.e. based on the IFEG) in the NCC 2022 Governing Requirements. Draft wording has been developed for comment (refer Attachment 6.1).
   - The Guideline document is the four page "Development of Performance Solutions".
3) Proposed draft wording for A.2.2 (4) on Performance Solutions (and requirement to prepare PBDB and consult with stakeholders) as follows:

(4) *Where a Performance Requirement is satisfied by a Performance Solution in order to comply with (1), the process to develop the Performance Solution must incorporate the following steps:*

*(a) Preparation of a performance-based design brief (PBDB).*

*(b) Consultation with stakeholders.*

*(c) Analysis, modelling and testing undertaken.*

*(d) Collation and evaluation of results.*

*(e) Preparation of a final report.*

***Schedule 3***

*Performance-based design brief (PBDB), means the documentation and associated report that defined the scope of work for the performance-based analysis (such as fire engineering analysis) and the technical basis for analysis as agreed by stakeholders.*





The second and third ABCB documents help set the context on where elements of "fire safety engineering process" are located. These include:

- A.2.2 (4)
- IFEG
- FSVM
- ABCB "Development of Performance Solutions" document
- Guide to the BCA

The ABCB provided clarification of this situation at the project's inception meeting. The context for the review work on the guidance documents was therefore:

- A new and complete IFEG will likely not be developed
- The NCC in 2022 could be amended to include this new A.2.2(4) to make it mandatory that if a Performance Solution is developed as part of a building design, then an FEB (PBDB in NCC language) will need to be developed, and there must be consultation with all stakeholders (including the fire services).
- The more detailed process for fire safety engineering associated with Performance Solutions may be an expansion of the ABCB "Development of Performance Solutions" document, or an expanded part of the Guide to the BCA (NCC). For this current research paper, this is referred to as the ABCB process document.

Given all the above, it is likely that none of the four guidance documents may be compatible with all the concepts and terminology of the NCC in terms of the "fire safety engineering process". However, they may be suitable in terms of the methodologies and data that could be incorporated in any analysis to demonstrate compliance with the NCC Performance Requirements.

## 2.2 STRUCTURE

This report has been structured in three main sections.

- The first section, chapter 3, describes the methodology that was used for the evaluation and summarises the criteria against which the documents that were reviewed and assessed.
- The second section, chapters 4 to 7, comprises the individual evaluations of the documents that are assessed. The evaluation of each document is contained in one chapter, with a short summary of the evaluation and then detailed comments in response to each of the criteria.
- Finally, in chapters 8 and 9 the evaluations have been compared, recommendations have been made and conclusions drawn.

## 2.3 LIMITATIONS

This report assesses the four documents referred above treating them as "engineering guidance documents." Some of these documents are originally presented as such (i.e. CIBSE Guide E or the SFPE guide), but the objectives of others are specified either as general principles (i.e. ISO23932) or in the case of BS7974 the opening statements indicate that the document "is intended to provide a framework" for "fire safety design by which an adequately fire safe building can be constructed while allowing for inevitable uncertainties in the development of a fire and the response of the building and occupants to it." The BS7974 document also "sets out a reporting methodology which allows for the design to be readily assessed by approvals bodies." The document is supported by a series of documents that contain guidance and thus are aligned with the objectives of this review.

This review limits the treatment of these documents to their role as "guidance documents" and does not address other roles (for example, principles, frameworks, reporting methodologies, approvals assessment, adequate construction, etc.) that extend the scope of some of these documents beyond their role as guidance.

The information provided in all four documents has different levels of detail and address the different subjects to different levels of complexity. The detail and complexity attempt to be consistent with the intended users. Furthermore, these documents state, to varying degrees, the requirements of competency for users of the documents. This report has identified where issues of competency of intended users are included in the guidance documents but has not set out to address any specific implied or required levels of competency.


*Prof. Peter Shergold launched the Warren Centre's Fire Safety Engineering project in 2018*

# 3. Methodology

[A] rating assigned to each document ...

## 3.1 OVERVIEW

The assessment criteria were structured based on five groups of key assessment criteria and two groups of general assessment criteria. The five key assessment criteria groups were agreed as follows:

- Scope, structure and application
- Overall process and major components
- Methods of valuation
- Variability and uncertainty
- Documentation

Under each of these headings a number of key assessment criteria were identified that the different documents under review needed to fulfil. The assessment criteria were defined in order for the documents to be suitable for use by fire safety engineers as designers in Australia as “guidance documents.” These criteria were identified by the project team and are the key assessment criteria against which the four documents were to be reviewed. They reflect technical aspects that will make these documents valuable if used in Australia. A summary of the evaluation of these four documents against these criteria is given in chapters 4, 5, 6 and 7 respectively along with a detailed evaluation.

In addition to these key assessment criteria, a number of additional assessment criteria were identified. These reflect the perceived ease of adoption of these documents in Australia as well as other criteria that do not fit into the above categories. These are also discussed in subsequent sections and are grouped under the categories of:

- Adoptability
- Other

# 3.2 CRITERIA

**THE INDIVIDUAL CRITERIA, ACCORDING TO THE SEVEN GROUPS LISTED ABOVE ARE FURTHER DESCRIBED BELOW.**

### 3.2.1 SCOPE, STRUCTURE AND APPLICATION

- The guidance document uses building code, regulatory language or terminology that is compatible with the NCC and the proposed ABCB process document
- The definitions used are compatible with NCC, regulatory and ABCB process documents
- The "sub-systems" outlined in the guidance document are the same as the ABCB process document[1]
- The guidance document applies to the design and analysis of both new and existing buildings
- The guidance document applies to design and analysis of Performance Solutions
- The guidance document applies to the design and analysis of a partial DTS / Performance Solution.

### 3.2.2 OVERALL PROCESS AND MAJOR COMPONENTS

Issues of process were addressed only to establish problems of compatibility. The studied documents were intended for a different design process and none of them was intended to be part of a verification scheme. Given that this present report treats these four documents purely as guidelines, then the guidance documents, when used as a voluntary supplement to the design process in an Australian context, allowed the following assessment criteria to be defined:

- The key steps in the design and verification process are compatible with Australian design and analysis practice
- The process of FEB/FER and hazard analysis, fire scenarios, trial design, etc is similar to or compatible with the proposed ABCB process document.

### 3.2.3 METHODS OF EVALUATION

As in the previous section, the treatment as guidance documents allows the following issues of procedural incompatibility to be addressed:

- The flow charts for general analysis to evaluate levels of fire safety are compatible with the ABCB process document
- The flow charts for analysis and evaluation of particular sub-systems, e.g. smoke control, fire performance of structures, etc are consistent with the ABCB process document
- The flow charts for analysis and evaluation of particular sub-systems, e.g. smoke control, fire performance of structures, etc are consistent with current Australian practice
- The defined design methods and analysis methodologies are appropriate to current Australian design practice
- The defined design methods and analysis methodologies are compatible with the ABCB process document
- Where these general and high-level guidance documents refer to other related parts or standards (e.g., as is the case with BS7974 and ISO23932), methods and data are appropriate for Australia
- Risk assessment and probabilistic methods are incorporated or accounted for (looking forward to quantification of NCC Performance Requirements)
- Related sources like the SFPE Fire Protection Handbook are referenced
- Any related sources referenced could be useful in the Australian context.

### 3.2.4 VARIABILITY AND UNCERTAINTY

- Variability and uncertainty are incorporated into the guidance document.
- The detail on variability and uncertainty is directly applicable to Australian design practice
- There are details of safety factors, sensitivity analysis and reliability, and these are consistent with the ABCB process document.

### 3.2.5 DOCUMENTATION

Documentation requirements are an integral part of the design process. Nevertheless, guidelines to best practice can be provided. Such guidelines are not intended to direct the structure or content of the design documentation but instead to provide guidance on accepted approaches to documentation. As such, this section addresses issues of incompatibility, and therefore the following criteria can be introduced:

- Any documentation requirements are compatible with the ABCB process document and Australian regulatory processes.

### 3.2.6 ADOPTABILITY

This section addresses practicalities associated with the ease of adoptability in Australia and the capacity of Australian practice to influence the content of the guideline. It is important to emphasise that each document has a different intended audience and therefore different expectations of competency. This assessment is therefore done on the basis that the audience is the current Australian practitioner, as defined within the current Australian framework of competency.

- The guidance is currently in widespread or limited use in Australia
- The guidance is likely to be easy to use by practitioners in Australia
- The guidance is likely to be accepted by FSEs and others in Australia
- The guidance is internationally recognised and utilised
- Implementation or adoption of the guidance will not add significant cost to the fire safety engineering process[2]
- Australian representation is possible on the committee responsible for update and review of the guidance.

A number of key assessment criteria were identified...

[1] By sub-system, this refers to the methods of analysis and the typical breakdown of fire engineering analysis into six sub-systems that are used in the fire safety engineering design process and which are described either in the guidance documents themselves or in the referenced supporting documentation.

[2] When discussing cost, this means the likely costs associated with the use of the guidance in the design process. This includes the cost of licensing of the document *and associated parts* by engineers, as well as any anticipated additional cost required for the analysis undertaken in the design process, *and the training of fire safety engineers to ensure effective use of the guidance documents in practice.*

### 3.2.7 OTHER

This heading covers those additional criteria that were identified and that do not fall under the headings for the different criteria as outlined above. As with the previous section, it is important to emphasise that each document has a different intended audience and therefore different expectations of competency. This assessment is therefore done on the basis that the audience is the current Australian practitioner, as defined within the current Australian framework of competency. In a similar manner, the assessment of building complexity is only intended to define the generality of the guidance information provided by each document and is not related to any specific framework that defines concepts such as building complexity.

- The guidance document or its related parts including design/analysis methods and data is appropriate for simple and/or complex buildings[3]
- The assumptions and limitations of the guidance document are clear and comprehensible by users
- The level of competency required of users is clear.

*Firefighters about to go through a flaming door*

[3] When referring to simple / complex buildings the intended meaning is related to the anticipated adherence to the guidance and the classifications available in the building regulations. A simple building is likely to only have minor deviation from prescriptive guidance, whereas a more complex problem will require more detailed analysis of many of the components of the building.





# 3.3 EVALUATION

Each of the four documents under review was evaluated against these criteria, with the exception of those criteria listed under adoptability, by the project team. In all four of the evaluations, whether or not the documents met the individual criteria was described based on the following 4-point scale:

- FA – fully achieved
- LA – largely achieved
- PA – partially achieved; or
- NA – not achieved.

The rating assigned to each document against each criterion has been supported in the evaluations by a short comment describing the relevant features of the guidance document which led to the assigned rating.

For those criteria that fall under the adoptability heading, a short survey was carried out at RED Fire Engineers and at ARUP. The questions asked were a reformulation of the first five of the six criteria and were worded in such a way that they elicited a yes / no response referring to each of the documents under review. These responses were then compiled to reflect whether the criteria were achieved or not, and if so to what degree. The questions asked were:

1. Is the guidance currently in widespread or limited use in Australia?
2. Is the guidance likely to be easy to use by practitioners in Australia?
3. Is the guidance likely to be accepted by FSEs and others in Australia?
4. Is the guidance internationally recognised and utilised?
5. Is the implementation or adoption of the guidance likely to add significant cost to the fire safety engineering process?

A short summary of the survey is included in Appendix 1 to this report.

The sixth criteria under adoptability was evaluated in the same way as for the criteria under the other headings.

The results of the evaluations are presented and discussed in chapters 4 to 7. For ease of discussion, these evaluations have been split into the respective headings. Reference in the summary discussion is made in brackets to the individual numbers of the criteria under the relevant headings.

No weighting was applied to the individual criteria.

# 4. Evaluation of BS7974

## 4.1 SUMMARY

### BS7974 FULLY ACHIEVES 16 OF THE CRITERIA, LARGELY ACHIEVES FIVE OF THE CRITERIA, PARTIALLY ACHIEVES SIX OF THE CRITERIA AND DOES NOT ACHIEVE THREE OF THE CRITERIA.

In terms of the scope, structure and application of the document when compared with the ABCB “process document”, it outperforms all of the other three documents that were reviewed by virtue of fully achieving (criteria A4, A5, A6) or largely achieving (A1, A2) five of the six criteria. The only criteria under scope, structure and application that BS7974 does not achieve is that the sub systems outlined in the document are not included in the ABCB process document (criteria A3).

Criteria related to the overall process and major components are fully achieved by BS7974.

Under methods of evaluation, BS7974 fully achieves three of the criteria (criteria C4, C5, C7), largely achieves one (criteria C1), partially achieves four (criteria C2, C3, C6, C8) and fails to achieve one of the criteria (C9).

Those criteria which are partially or largely achieved are generally related to the flow charts for the analysis and evaluation of levels of fire safety or particular sub systems, where these differ from the ABCB “process document” or current Australian practice; or to the referred documents and related sources. In particular, the related sources referenced in terms of the Published Documents that accompany BS7974 have been prepared for a British context. These sections of BS7974 move away from the concept of a guideline, thus it is not surprising that the context plays a more significant role.

Criteria related to variability and uncertainty, as well as documentation, are fully achieved by BS7974.

In general, it is considered that BS7974 can be used in the context of Australian practice as a guidance document. It fully achieves criteria related to ease of use and likely acceptance within Australia by practising fire engineers (criteria F2, F3 and F4). However, as a British standard, while it is difficult to see how Australia might be represented on the relevant committees (criteria 6), the technical content is all extracted from international research and engineering best practice. Thus, Australian research and practices do have an indirect impact on the document. The areas where Australian representation might not be possible are not areas necessarily relevant to a guidance document.

Finally, under additional / other criteria BS7974 achieves to some degree all of these criteria.

# 4.2 EVALUATION

The complete evaluation, including detailed comments, of BS7974 against the criteria identified is presented in Table 1.

**TABLE 1: EVALUATION OF SCOPE, STRUCTURE AND APPLICATION OF BS7974**

| | CRITERIA EVALUATION FOR BS7974 | RATING | COMMENTS |
|---|---|---|---|
| A1 | The guidance document uses building code, regulatory language or terminology that is compatible with the NCC and the proposed ABCB process document | LA | BS7974 is fire safety engineering (FSE) specific, as well as its language, therefore some wording discrepancies are found. However, it is still compatible. Examples of key concepts taken form the ABCB document and section 0 of BS7974 include:<br>• 0.1 Fire safety engineered proposals / design = Performance solutions / proposal<br>• 0.1 Functional objective = Performance requirement<br>• 0.1 Assessment methods = Assessment methods<br>• 0.1 Fire safety design = Performance based design<br>• 0.1 Acceptance criteria = acceptance criteria |
| A2 | The definitions used are compatible with NCC and regulatory and ABCB process documents | LA | Section 3 of BS7974 includes a wide range of FSE specific definitions (e.g. 3.3 ASET), as well as many others related to the proposed design assessment process (e.g. 3.7 Design objective). These slightly differ from the wording used in the process document but not enough to pose an understanding issue for a competent fire safety engineer. Key stakeholders other than fire safety engineers should be able to use both documents given the clear definitions provided. |
| A3 | The “sub-systems” outlined in the guidance document are the same as the ABCB process document | NA | The BS7974 sub-systems (Section 0.2 and associated PD1-6) should be specified as part as the analytical assessment process. This is not explicit in the ABCB process document. |
| A4 | The guidance document applies to the design and analysis of both new and existing buildings | FA | Yes, BS7974 states in Section 1 that: “It is applicable to the design of new buildings and the appraisal of existing buildings”. |
| A5 | The guidance document applies to design and analysis of Performance Solutions | FA | Yes, BS7974 states in Section 0 that it provides a formalised framework to achieve a fire safety design, based on the functional objectives applicable. |
| A6 | The guidance document applies to the design and analysis of a partial DTS / Performance Solution | FA | Yes, BS7974 “provides alternative approaches to existing standards for fire safety and also allows the effect of departures from design codes to be evaluated”. If a partial DTS/Performance Solution is required, this should be defined within the functional objectives to achieve with the design. |
| B1 | The key steps in the design and verification process are compatible with Australian design and analysis practice | FA | Based on the NCC (2019) contents and requirements, as well as the guidelines of the process document, BS7974 seems compatible and does not contradict them. In essence it follows the same principles: check for deviations from the code > propose an alternative solution for the deviation > use calculations / testing / modelling to show the solution works > check against acceptance criteria > adjust if necessary or if not required, move forward with the design. |





**TABLE 1: EVALUATION OF SCOPE, STRUCTURE AND APPLICATION OF BS7974**

| | CRITERIA EVALUATION FOR BS7974 | RATING | COMMENTS |
|---|---|---|---|
| B2 | The process of FEB/FER and hazard analysis, fire scenarios, trial design, etc is similar to or compatible with the proposed ABCB process document | FA | BS7974 establishes three main stages for its application:<br>1. Qualitative design review (QDR): compatible with the PBDB agreed upon with the stakeholders (similar to FEB)<br>2. Quantitative analysis: compatible with the assessment/ modelling/testing step, although with an emphasis on quantitative engineering methods for fire safety and its impacts (similar to FER)<br>3. Assessment against criteria: compatible with the ‘collate and evaluate results’ step (FER)<br>Section 10 defines the requirements for reporting and presentation of results, compatible with the ‘Prepare a final report’ step. |
| C1 | The flow charts for general analysis to evaluate levels of fire safety are compatible with the ABCB process document | LA | The basic fire safety design process (figure 5 of BS7974) follows the process document steps in a general sense, however these steps involve a set of feedback loops in which designs are reviewed both qualitatively and quantitatively and then iterated until a satisfactory solution is found. Furthermore, the QDR, the quantitative assessment and the resulting report review include specific teams of professionals, which are outlined by BS7974; while the process document defines all stakeholders involved, it does not mention the required specific teams for specific tasks.<br>The QDR process (see previous criterion) and its process (figure 6 of the BS7974) exhibit much more detail than the corresponding PBDB step of the process document. Within the QDR the assessment type, method and basis for analysis are defined as in the PBDB step, but in a more structured manner, but also hazards, consequences and fire scenarios are defined, using tools like what-if analysis.<br>The process of figure 5 includes a Business Impact Analysis (BIA) that while optional, can be a key element that differs from the process document steps. Annex B.2.1 states BIA is not required in every project but might apply to some in order to “inform the organisation’s continuity and recovery strategy, identify mission-critical activities, their dependent resources, and the timeframe within which they need to be recovered”.<br>In general the process is compatible, but there are additional complexities involved for the PBDB in case a BIA is used and for the “PBDB” and “analysis, modelling, testing” steps of the process document. These complexities and impact on the assessment process would need to be highlighted. |

## TABLE 1: EVALUATION OF SCOPE, STRUCTURE AND APPLICATION OF BS7974

| | CRITERIA EVALUATION FOR BS7974 | RATING | COMMENTS |
|---|---|---|---|
| C2 | The flow charts for analysis and evaluation of particular sub-systems, e.g. smoke control, fire performance of structures, etc are consistent with the ABCB process document | PA | Not all supporting PD1-7 documents for BS7974 contain flowcharts. PD 2, 4 and 5 contain them at a very high level. However, all these documents have different dates of release and the most recent ones omit this kind of flowchart, as section 0.2.2 indicates that the connection between sub-systems is not obvious and can be highly complex, impacting the assessment process and outcomes (see criteria 4.7.3). This means that there is not a single way in which the analysis should be carried out and the users are meant to define it. |
| C3 | The flow charts for analysis and evaluation of particular sub-systems, e.g. smoke control, fire performance of structures, etc are consistent with current Australian practice | PA | See previous criterion. Note that not all of supporting PD1-7 documents for BS7974 contain flowcharts and that therefore there is not a single way in which the analysis should be carried out; leaving flexibility to the users. |
| C4 | The defined design methods and analysis methodologies are appropriate to current Australian design practice | FA | See next criterion. |
| C5 | The defined design methods and analysis methodologies are compatible with the ABCB process document | FA | Yes, BS7974 includes a wide range of design methods and analysis methodologies from which practitioners can select to perform their assessment. This wide range of options is well known in Australia and has been used in practice. |
| C6 | Where these general and high-level guidance documents refer to other related parts or standards (e.g., BS7974 and ISO), methods and data are appropriate for Australia | PA | BS7974 and the supporting PD1-7 include a wide range of data which has to be used with caution as it may be outdated (several decades) or might not apply to innovative or highly complex systems. See criterion 4.4 in which variability and uncertainty are addressed. In general, users are advised to treat data with caution and to highlight potential sources of uncertainty that might invalidate the assessment (Commentary on section 9.4 and section 9.4.2). |
| C7 | Risk assessment and probabilistic methods are incorporated or accounted for (looking forward to quantification of NCC Performance Requirements) | FA | Yes, BS7974 highlights the requirement of quantitative analysis to verify the achievement of functional requirements. Furthermore, it defines a set of assessment alternatives (deterministic, probabilistic) that help the design team to check for the achievement of said criteria. BS7974 also references PD 7974- 7 which determines the guidelines and requirements for performing a probabilistic risk assessment tool. |
| C8 | Related sources like the SFPE Fire Protection Handbook are referenced | PA | BS7974 references are limited to PD 7974 1-7 and other legal documents. It does not include fire safety engineering dedicated documents; nevertheless, PD 7974 1-7 does reference a large amount of fire safety engineering specific sources including the SFPE handbook. |
| C9 | Any related sources referenced could be useful in the Australian context | NA | Some of the regulatory documents applicable to UK countries would not apply to Australia. As mentioned in the previous criterion, no technical documents are directly referenced by BS7974. |





## TABLE 1: EVALUATION OF SCOPE, STRUCTURE AND APPLICATION OF BS7974

| | CRITERIA EVALUATION FOR BS7974 | RATING | COMMENTS |
|---|---|---|---|
| D1 | Variability and uncertainty are incorporated into the guidance document. | FA | Yes, BS7974 in Section 9 provides an account of the key elements impacting the quality of the assessment. These include uncertainty, sensitivity and simplifications. |
| D2 | variability and uncertainty is directly applicable to Australian design practice | FA | Yes, these details are of general application and not only for the UK context of the BS7974. |
| E1 | Any documentation requirements are compatible with the ABCB process document and Australian regulatory processes | FA | Yes, BS7974 specifies in section 10 the reporting requirements which are compatible with the process document and its “Prepare a final report” step. Furthermore, BS7974 requires a dedicated section in which the competency and experience of the fire safety engineers involved are explicitly presented (section 10.10). |
| F1 | The guidance is currently in widespread or limited use in Australia | LA | The guidance is reasonably well known in Australia and usage is substantial but somewhat limited rather than widespread. |
| F2 | The guidance is likely to be easy to use by practitioners in Australia | FA | Given current NCC, fire safety education and qualifications available as well as the widespread use of performance-based solutions, BS7974 would be easy to use for competent and experienced fire safety engineers. Stakeholders not competent in the field might struggle with the technical details of PD 7974 1-7. |
| F3 | The guidance is likely to be accepted by FSEs and others in Australia | FA | BS7974 is aligned with current teaching contents and international practice, therefore it could potentially be accepted by FSE. Other stakeholders might find resistance to it due to the complexities of the processes it entails, which could translate into the need for guidelines to facilitate transition and to match the guidance outputs with the Australian building approval framework. The view amongst a limited number of practising FSEs is that it is very likely to be accepted by FSEs and others. |
| F4 | The guidance is internationally recognised and utilised | FA | Yes, it is referenced even by IFEG 2005 and other relevant FSE documents such as the SFPE handbook (Chapter 75). |
| F5 | Implementation or adoption of the guidance will not add significant cost to the fire safety engineering process | PA | As previously presented, the fire safety design process could require a complex iteration process as per BS7974. This could indeed add significant costs to the assessment. Although this iterative approach is found within the process document, the details of the BS7974 processes could add additional costs, although FSE practitioners think the overall cost will be fairly small. |
| F6 | Australian representation is possible on the committee responsible for update and review of the guidance | PA | Given it is British document and written by a BSI sub-committee with only UK organisations represented, it is difficult to see how Australia might directly contribute to updating or further development of the document. |
| G1 | The guidance document or its related parts including design/ analysis methods and data is appropriate for simple and/or complex buildings | FA | Yes, BS7974 allows applying its assessment process for both simple and complex buildings. |

**TABLE 1: EVALUATION OF SCOPE, STRUCTURE AND APPLICATION OF BS7974**

| | CRITERIA EVALUATION FOR BS7974 | RATING | COMMENTS |
|---|---|---|---|
| G2 | The assumptions and limitations of the guidance document are clear and comprehensible by users | PA | BS7974 section 0.2.2 refers to the complexities of defining the way in which sub-systems can be connected and how this impacts the assessment process. Although examples are provided, the complexity of these early decisions in the assessment might not be entirely clear for less experienced users, users with no formal fire safety competence or for users whose experience has been narrow and based on the same type of buildings/solutions over their entire career. |
| G3 | The level of competency required of users is clear | LA | Yes, BS7974 states in section 4.1 that “Adequate and relevant competence should be demonstrated”, defining what this implies and providing examples in the form of commentaries. It is important to note that section 4.1 highlights the difference in complexity of the process of dealing with a ‘simple’ or ‘complex’ solution, and actually differentiates the required competencies. Given the possible unknown unknowns and complexities that may lie even in apparently ‘simple’ solutions, as well as the evidence of recent events of poor decision making even by competent professionals, such differentiation should not apply. It is important to highlight this in case BS7974 is selected and then not highly competent people find a loophole to keep producing ‘solutions’. |

BS7974 .... is still compatible....






*Bronwyn Weir addressed the “Rise to Challenge” Fire Safety Engineering forum hosted at University of Sydney in February 2019*

# 5. Evaluation of the SFPE guide

## 5.1 SUMMARY

### THE SFPE ENGINEERING GUIDE TO PERFORMANCE BASED DESIGN PROTECTION AND ANALYSIS OF BUILDINGS FULLY ACHIEVES NINE OF THE CRITERIA, LARGELY ACHIEVES FOUR, PARTIALLY ACHIEVES FIFTEEN AND DOES NOT ACHIEVE TWO.

Under scope, structure and application of the guideline, only two of these criteria are fully achieved (A5, A6), those being that the guidance document applies to the design and analysis of performance solutions and partial performance / DTS solutions. As with BS7974 the SFPE guide does not achieve the criteria that the sub- systems are the same as in the ABCB process document as they are currently absent in the more general ABCB document (A3). Other criteria under scope, structure and application are largely (A1) or partially achieved (A2, A4).

The SFPE guide partially achieved all of the criteria within the category of overall process and major components.

The SFPE guide is the only document of the four which were reviewed that achieves to some degree all of the criteria under the category of methods of evaluation. Two of these are fully achieved (C7, C8), being criteria related to the incorporation of probabilistic methods and the criteria regarding related sources being referenced. The former of these two is fully achieved by all of the documents reviewed.

The SFPE document incorporates variability and uncertainty. However, the details of this are only partially compatible with Australian practice or the ABCB process document (criteria D2 and D3).

Documentation requirements are compatible with the ABCB “process document” and the Australian regulatory environment.

This is the only one of the four documents where it was immediately clear that Australian representation on the committee may be possible (criteria F6). Aside from this, other criteria under adoptability are either fully achieved (F3, F4); or partially achieved (F1, F2, F5).

With regards to other criteria, this is the only one of the documents reviewed where there is no explicit presentation of the assumptions and limitations, therefore assumptions and limitations cannot be established in a manner that is consistent with Australian practice (criteria G2).

# 5.2 EVALUATION

The complete evaluation, including detailed comments, of the SFPE guide against the criteria identified is presented in Table 2.

**TABLE 2: EVALUATION OF THE SFPE GUIDE**

| | CRITERIA EVALUATION FOR SFPE ENGINEERING GUIDE TO PBD PROTECTION ANALYSIS AND DESIGN OF BUILDINGS | RATING | COMMENTS |
|---|---|---|---|
| A1 | The guidance document uses building code, regulatory language or terminology that is compatible with the NCC and the proposed ABCB process document | LA | The SFPE guide is fire safety engineering (FSE) specific, but its language is aligned with the process document. Examples of key concepts taken from the ABCB document and chapter 2 are 'Performance-based design' and 'performance criteria' (same in both documents). |
| A2 | The definitions used are compatible with NCC and regulatory and ABCB process documents | PA | The SFPE guides include a set of definitions which partially differ from the process document such as 'safety factor' and 'verification'. These definitions are key within the SFPE guide and imply an approach in which uncertainty can be dealt with through adjustments in calculations and comparison to computer codes that 'reproduce results or large-scale fire testing'. This is not necessarily consistent with the approach of the process document. |
| A3 | The "sub-systems" outlined in the guidance document are the same as the ABCB process document | NA | The SFPE guide sub-systems (Chapter 9.1.5.2) should be specified as part of the analytical assessment process. This is not explicit in the process document. |


*"Rising to Challenges" forum in February 2019 at University of Sydney*





**TABLE 2: EVALUATION OF THE SFPE GUIDE**

| | CRITERIA EVALUATION FOR SFPE ENGINEERING GUIDE TO PBD PROTECTION ANALYSIS AND DESIGN OF BUILDINGS | RATING | COMMENTS |
|---|---|---|---|
| A4 | The guidance document applies to the design and analysis of both new and existing buildings | PA | The SFPE guides do not specifically state if it applies for existing and new buildings (chapter 1.4), but the design process presented in 3-1 as well as the approach of a holistic 'fire safety design' of figure 3-2 suggests that the document was written with new buildings as the target. However, nothing in the guideline specifies that it cannot be applied to existing ones. |
| A5 | The guidance document applies to design and analysis of Performance Solutions | FA | Yes, the SFPE guide is explicitly written to provide a performance-based solution for fire safety design. This is stated in chapter 1.4.1.b., although the language used is "alternative fire protection options" rather than performance solutions. |
| A6 | The guidance document applies to the design and analysis of a partial DTS / Performance Solution | FA | Yes, both chapters 3.3.2 and 3.3.3 specify the use of the guideline to address prescriptive requirements through alternative solutions and to achieve performance requirements. There is no mention of a partial DTS/ Performance Solution, but it is implicit that these elements are related and that comparison between them can be done as a way to show acceptable performance (chapter 3.4). |
| B1 | The key steps in the design and verification process are compatible with Australian design and analysis practice | PA | Based on the NCC (2019) contents and requirements, as well as the guidelines of the process document, the SFPE guides seem partially applicable. Each of the steps and in particular the process of figure 3-2 are aligned with Australian process, however as a whole, the SFPE guides seem to have a more holistic approach to the fire safety design, not a specific performance requirement approach as in the process document. |
| B2 | The process of FEB/FER and hazard analysis, fire scenarios, trial design, etc is similar to or compatible with the proposed ABCB process document | PA | The SFPE guide includes a very aligned approach to the FEB/FER approach. It begins by defining the scope, goals, stakeholder objectives, performance criteria, design fire scenarios and trial designs, which go to a Fire Protection Engineering Brief (analogous to the FEB). After the evaluation of trial designs and the selection of a final one, a Performance-based design report is produced (analogous to the FER). A key difference in the process is the development of the 'trial designs' within the assessment process. This differs from the approach of the process document in which a proposed solution is put to test through the four steps. |

## TABLE 2: EVALUATION OF THE SFPE GUIDE

| | CRITERIA EVALUATION FOR SFPE ENGINEERING GUIDE TO PBD PROTECTION ANALYSIS AND DESIGN OF BUILDINGS | RATING | COMMENTS |
|---|---|---|---|
| C1 | The flow charts for general analysis to evaluate levels of fire safety are compatible with the ABCB process document | PA | Figure 3-2 of the SFPE guide specifies a performance-based design process that is aligned with the process document. However, the first six steps of the process specify the contents of the Fire Protection Engineering Brief (analogous to the PBDB). This departs from the process document as it specifies the need to begin the assessment by developing the PBDB, while in SFPE this is a document produced to summarise the first steps of the assessment. Furthermore, the SFPE proposed process (Figure 3-2) and also the trial design evaluation flowchart (figure 10-1) include a step in which if all designs fail the performance criteria, the stakeholders' objectives may be adjusted. This deviates from the intention of the process document and introduces a step that could be incompatible with the process document. |
| C2 | The flow charts for analysis and evaluation of particular sub-systems, e.g. smoke control, fire performance of structures, etc are consistent with the ABCB process document | PA | Figure 9-1 establishes the SFPE fire safety concepts tree, which is further developed in figure 9-2, both of which help identify "general approaches and methods for achieving a given design objective". These do not match the sub-systems list (chapter 9.1.5.2), and Figure 9-2 is actually an example. Flowcharts 10-3 to 10-6 provide example methodologies to implement for some (not all) the sub-systems identified. These are just examples, and there is not much guidance on what the recommended path should be or the existing alternatives for analysis. |
| C3 | The flow charts for analysis and evaluation of particular sub-systems, e.g. smoke control, fire performance of structures, etc are consistent with current Australian practice | PA | See criterion above. |

This is the only one of the documents reviewed where there is no explicit presentation of the assumptions and limitations...





## TABLE 2: EVALUATION OF THE SFPE GUIDE

| | CRITERIA EVALUATION FOR SFPE ENGINEERING GUIDE TO PBD PROTECTION ANALYSIS AND DESIGN OF BUILDINGS | RATING | COMMENTS |
|---|---|---|---|
| C4 | The defined design methods and analysis methodologies are appropriate to current Australian design practice | LA | See criterion below. |
| C5 | The defined design methods and analysis methodologies are compatible with the ABCB process document | LA | The SFPE guide does not require specific design methods and analysis methodologies but only refers to useful references and leaves the decision to the competent engineer to select the most adequate ones. With this said, all design methods and analysis methodologies referenced should be well known for competent fire safety engineers and also compatible with the process document, mainly being divided into deterministic and probabilistic approaches with absolute or comparative evaluations. |
| C6 | Where these general and high-level guidance documents refer to other related parts or standards (e.g., BS7974 and ISO), methods and data are appropriate for Australia | PA | Most references found in chapter 9 and 10 for scenarios identification and for trial design evaluation are well known references for competent engineers and part of both FSE literature (SFPE handbook) and internationally known standards (NFPA 550, 92A, 92B). However, it must be noted that the guideline includes mostly American references and a few indexed journal articles, not referencing many well-known international guidelines and resources such as IFEG. Furthermore, the selected readings chapter includes references which are no longer valid like "Fire Engineering Guidelines, Fire Code Reform Centre Limited, Sydney, NSW, Australia, 1996. Fire Safety Engineering in Buildings, DD 240, British Standards Institute, London, 1997. ISO CD13887, Fire Safety Engineering, International Standards Organization, Geneva, 1997". This could be related to the document being published in 2001. |
| C7 | Risk assessment and probabilistic methods are incorporated or accounted for (looking forward to quantification of NCC Performance Requirements) | FA | Yes. Chapter 8.4.1 describes the use of a probabilistic approach to identify fire scenarios. |
| C8 | Related sources like the SFPE Fire Protection Handbook are referenced | FA | The SFPE guide states that it does not contain itself the methods, data and others required for the assessment process, but it does reference the sources where these are available (chapter 1.5) and explicitly states the relevance of the SFPE Fire Protection Handbook. Furthermore, chapter 1.5.3 specifies a set of criteria to determine the appropriateness of information sources to be used in the assessment process. Chapter 1.5.7 specifies that sources presented are not all inclusive. |
| C9 | Any related sources referenced could be useful in the Australian context | PA | See criterion C6 above. |

## TABLE 2: EVALUATION OF THE SFPE GUIDE

| | CRITERIA EVALUATION FOR SFPE ENGINEERING GUIDE TO PBD PROTECTION ANALYSIS AND DESIGN OF BUILDINGS | RATING | COMMENTS |
|---|---|---|---|
| D1 | Variability and uncertainty are incorporated into the guidance document. | FA | Chapter 10.5 describes how to account for variations and unknown effects within the performance-based design. Uncertainty Analysis is described in detail in Annex G. |
| D2 | The detail on variability and uncertainty is directly applicable to Australian design practice | PA | In chapter 1.2.4 when referring to the responsibilities of the engineer, it fails to explicitly state the need to identify, highlight and monitor sources of uncertainty and assumptions within the design process. Furthermore, chapter 10.5 specifies a series of guidelines and recommendations for practitioners to deal with uncertainty and availability. However, it must be noted that some simplifications are found. For example, clause 10.5.4.2 states, “It is possible to simplify an uncertainty analysis by determining which variables contribute the most significantly to the overall uncertainty. If some variables have a low effect on the results of the analysis, the effect of these variables on the uncertainty might be neglected”. In the context of fire dynamics in complex buildings, identifying such variables might involve knowledge gaps and unknown factors to even the best practitioners, which is why these guidelines are not considered directly applicable to the Australian practice. |
| D3 | There are details of safety factors, sensitivity analysis and reliability and these are consistent with the ABCB process document | PA | Chapter 10.5.3.2 specifies the use of safety factors as part of a deterministic analysis, and it is possible to observe that it is treated as a rather procedural element. As experience has shown and literature reports [Claudia Eckert, Ola Isaksson, Safety Margins and Design Margins: A Differentiation between Interconnected Concepts, Procedia CIRP, 2017, Pages 267- 272, https://doi.org/10.1016/j.procir.2017.03.140], safety factors and margins are different, have a potentially significant impact on the safety level and might be embedded both in the requirement and in the design. All of these add a level of complexity which is not explicitly stated by the SFPE guide and might not be obvious for less experienced practitioners. |
| E1 | Any documentation requirements are compatible with the ABCB process document and Australian regulatory processes | FA | Yes, the SFPE guide mainly implies the production of a brief at the beginning of the process and then a final report (see criterion 4.2.2 above). |
| F1 | The guidance is currently in widespread or limited use in Australia | PA | There is a reasonable degree of use of this guidance in Australia, but it could not be called widespread. More people use the SFPE Handbook. |
| F2 | The guidance is likely to be easy to use by practitioners in Australia | PA | The guidance is thought to be reasonably easy to use, although because it includes many different options in terms of tools and methodologies, it may prove more challenging to use for the less competent FSEs (see assumptions and limitations section G2 below). |





## TABLE 2 EVALUATION OF THE SFPE GUIDE

| | CRITERIA EVALUATION FOR SFPE ENGINEERING GUIDE TO PBD PROTECTION ANALYSIS AND DESIGN OF BUILDINGS | RATING | COMMENTS |
|---|---|---|---|
| F3 | The guidance is likely to be accepted by FSEs and others in Australia | FA | There are many practising members of the SFPE in Australia; and the SFPE Handbook and other documents are very well known in Australia. Very likely to be acceptable to FSEs and other stakeholders. |
| F4 | The guidance is internationally recognised and utilised | FA | SFPE documents are very well recognised around the world, including in Australia. |
| F5 | Implementation or adoption of the guidance will not add significant cost to the fire safety engineering process | PA | The views of some FSEs was that the use of this document could add some costs to the undertaking of FSE, mostly because of the processes and options required to be evaluated for any project, and costs of training people in its use who have been used to the IFEG. |
| F6 | Australian representation is possible on the committee responsible for update and review of the guidance | FA | SFPE encourages strong international participation in the development of its standards, guidance and other documents, and Australia has an SFPE Chapter of over 100 FSEs who have an opportunity to be involved in the development processes of their standards and guidelines. |
| G1 | The guidance document or its related parts including design/ analysis methods and data is appropriate for simple and/or complex buildings | PA | The SFPE guide does not address a specific type of building, and it is in fact of a very general character, not specifying any particular method for any particular requirement. The guideline focuses on giving practitioners general guidelines and examples of methods and analysis routes. This makes the applicability of the guidelines to cover most systems but also limits the tools it provides to actually carry out the assessments. |
| G2 | The assumptions and limitations of the guidance document are clear and comprehensible by users | NA | The SFPE guide provides a wide range of design approaches and assessment methodologies and tools, not defining any preferred ones. This allows the scope of the document to be wide but its applicability and limitations to be unknown. The document does not specify a section of limitations and only deals with uncertainty in Chapter 10.5 and Annex G. Such an approach does not highlight the importance of assumptions and uncertainty sources at each step of the process, as specified in the process document in the third step. This makes many of the guidelines of a very general character, which might not be clear for unexperienced professionals or by some of the stakeholders involved. While not explicitly stated, this aspect demonstrates that the SFPE guide makes very strong assumptions of competency. |
| G3 | The level of competency required of users is clear | LA | Chapter 1.2.1 explicitly specifies who the guideline has been written for and the characteristics that make them a qualified professional, including knowledge regarding fire dynamics, hazards, risks, fire prevention, control and suppression and the impact of fire events. It is stated these are the engineers who should be responsible for the performance-based design. However, it does not go into details of the experience and accreditations required by said engineers. |

# 6. Evaluation of ISO23932-1:2018

## 6.1 SUMMARY

**ISO23932 FULLY ACHIEVES 10 OF THE CRITERIA, WHICH IS THE SECOND HIGHEST NUMBER OF ALL OF THE DOCUMENTS REVIEWED. IT ALSO FAILS TO ACHIEVE FOUR, WHICH IS ALSO THE SECOND HIGHEST NUMBER OF ALL OF THE DOCUMENTS REVIEWED. THE STANDARD LARGELY ACHIEVES SEVEN CRITERIA AND PARTIALLY ACHIEVES EIGHT CRITERIA.**

In terms of scope, structure and application, ISO23932 performs arguably better than the SFPE guide. It fully achieves two (A4 and A5) and fails to achieve one of the criteria (A3). However, it largely achieves the other three. This is also significantly better than the CIBSE Guide performs but worse than BS7974. Of those criteria that it fully achieves, these are the application of the guidance to new and existing buildings and to performance solutions. In contrast to both BS7974 and the SFPE guide, ISO23932 only largely applies to partial DTS / performance solutions.

The criteria associated with the overall process and major components are partially achieved (B1) and largely achieved (B2).

In terms of the methods of evaluation, while five criteria are fully achieved (C4, C5, C6, C7, C9) three of these criteria are not achieved by ISO23932 (C2, C3, C8).

Variability and uncertainty are well accounted for in ISO23932, with the only reservation being that the detail is only partially applicable to Australian design practice (criteria D2). Both of the other criteria are fully achieved (D1 and D3).

Under adoptability, this is the only one of the documents reviewed that does not fully achieve any of the criteria. However, all of the other criteria are either partially achieved (F1, F2, F4 and F5) or largely achieved (F3, F6).

Finally, under other criteria, ISO23932 either largely or partially achieves all of them.

# 6.2 EVALUATION

The complete evaluation, including detailed comments, of ISO23932 against the criteria identified is presented in Table 3.

**TABLE 3: EVALUATION OF SCOPE, STRUCTURE AND APPLICATION OF ISO23932-1:2018**

| | CRITERIA EVALUATION FOR ISO23932 | RATING | COMMENTS |
|---|---|---|---|
| A1 | The guidance document uses building code, regulatory language or terminology that is compatible with the NCC and the proposed ABCB process document | LA | ISO23932 begins by stating that PBD is based on requirements associated to “fire safety objectives (FSO), functional requirements (FR) and performance criteria (PC)” which exhibits more detail and levels of requirements as the “Performance Requirements” mentioned by the process document. However, this is largely aligned with current NCC requirements and could be interpreted by competent practitioners. |
| A2 | The definitions used are compatible with NCC and regulatory and ABCB process documents | LA | Yes, although there are many differences in wording, competent practitioners should be able to understand the parallel between definitions contained in the ISO guideline and the process document, taking into account that the latter is of a much more general character. Some examples are:<br>• Performance criterium = acceptance criteria<br>• Functional requirements = performance requirement<br>• Trial fire safety design = proposed solution<br>• Fire safety design plan = PBDB<br>• Final report (same in both)<br>A key difference in definitions is the key role of risk analysis as an evaluation tool in ISO23932. Given the existence of standards such as ISO 31000, this guidance document also has a risk-based approach to evaluate FSE. This is a deviation from the more general “performance requirement” approach of the process document. It might present some difficulties in its implementation for practitioners not familiar with a risk-based approach or those who prefer a different approach. |
| A3 | The “sub-systems” outlined in the guidance document are the same as the ABCB process document | NA | ISO23932 does not explicitly specify the sub-systems but does mention supporting documentation to analyse fire phenomena components: ISO 16734 (fire plumes), ISO 16735 (smoke layers), ISO 16736 (ceiling jet flows), ISO 16737 (vent flows), ISO 24678-6 (flashover), ISO/TR 16738 (behaviour and movement of people). |
| A4 | The guidance document applies to the design and analysis of both new and existing buildings | FA | Yes, ISO23932 explicitly states so in Clause 1, numeral 1. |
| A5 | The guidance document applies to design and analysis of Performance Solutions | FA | Yes, the third step of the ISO process is defining the functional requirements to be achieved (Clause 7). |





**TABLE 3: EVALUATION OF SCOPE, STRUCTURE AND APPLICATION OF ISO23932-1:2018**

| | CRITERIA EVALUATION FOR ISO23932 | RATING | COMMENTS |
|---|---|---|---|
| A6 | The guidance document applies to the design and analysis of a partial DTS / Performance Solution | LA | ISO23932 does not explicitly state this, but from its FSE evaluation process it is possible to understand that partial DTS/performance solutions can be covered. Furthermore, figure 2 of Clause 8.1 specifies that the risk analysis approach can be either absolute or comparative, with the latter referring to the comparison of a solution alternative with DTS. |
| B1 | The key steps in the design and verification process are compatible with Australian design and analysis practice | PA | Yes, although ISO23932 specifies that its process is an iterative one. This approach is well known in Australian practice, but it is usually found in complex systems where safety concerns call for third party reviews and thorough examination of assumptions and uncertainty sources. In contrast, ISO23932 applies this approach to any FSE design. |
| B2 | The process of FEB/FER and hazard analysis, fire scenarios, trial design, etc is similar to or compatible with the proposed ABCB process document | LA | Yes, Figure 1 specifies the FSE process, which is aligned with the FEB/FER approach. Here, the approach extends to the commissioning and operation of the system, including a life-cycle analysis for identifying potential changes in use or anything that might require the fire safety engineering to be reassessed. This extended approach is not contemplated in the process document. |
| C1 | The flow charts for general analysis to evaluate levels of fire safety are compatible with the ABCB process document | LA | Although ISO23932 has an emphasis on its iterative approach, it is largely aligned with the process document and does not deviate significantly from it. However, it does go beyond it and tracks the system after the FSE is approved, and this might constitute an important difference. |
| C2 | The flow charts for analysis and evaluation of particular sub-systems, e.g. smoke control, fire performance of structures, etc are consistent with the ABCB process document | NA | See criterion A3. This ISO document does not specify the sub-systems and references supporting documentation for parts of the fire dynamics which are involved in the FSE evaluation. |
| C3 | The flow charts for analysis and evaluation of particular sub-systems, e.g. smoke control, fire performance of structures, etc are consistent with current Australian practice | NA | See criterion C2 above. |

## TABLE 3: EVALUATION OF SCOPE, STRUCTURE AND APPLICATION OF ISO23932-1:2018

| | CRITERIA EVALUATION FOR ISO23932 | RATING | COMMENTS |
|---|---|---|---|
| C4 | The defined design methods and analysis methodologies are appropriate to current Australian design practice | FA | Yes, see criterion below. |
| C5 | The defined design methods and analysis methodologies are compatible with the ABCB process document | FA | Yes, ISO defines different alternatives for the approach (Figure 2, clause 8.1), which is compatible with the alternatives of the 'analysis, modelling, testing' step in the process document. |
| C6 | Where these general and high-level guidance documents refer to other related parts or standards (e.g., BS7974 and ISO), methods and data are appropriate for Australia | FA | Yes, most references are ISO documents, which are appropriate for Australia and most of which are connected to Standards Australia. |
| C7 | Risk assessment and probabilistic methods are incorporated or accounted for (looking forward to quantification of NCC Performance Requirements) | FA | Yes, given the existence of standards such as ISO 31000, this guidance document also has a risk-based approach to evaluate FSE. This is a deviation from the more general "performance requirement" approach of the process document. It might present some difficulties in its implementation for practitioners not familiar with a risk-based approach or those who prefer a different approach. |
| C8 | Related sources like the SFPE Fire Protection Handbook are referenced | NA | No, all of the references are ISO documents. |
| C9 | Any related sources referenced could be useful in the Australian context | FA | Yes, normative references include ISO 13943, Fire safety — Vocabulary, which is aligned to this guidance document and to Australian context. |
| D1 | Variability and uncertainty are incorporated into the guidance document. | FA | Yes, clause 12.7 deals with engineering judgment and 13.3 with uncertainty. Furthermore, several of the key steps of the document specify the need to identify and highlight the uncertainty sources. |

In terms of scope, structure and application, ISO23932 performs arguably better than the SFPE guide.





TABLE 3: EVALUATION OF SCOPE, STRUCTURE AND APPLICATION OF ISO23932-1:2018

| | CRITERIA EVALUATION FOR ISO23932 | RATING | COMMENTS |
|---|---|---|---|
| D2 | The detail on variability and uncertainty is directly applicable to Australian design practice | PA | Clause 12.7 regarding engineering judgment narrows its use to situations when no data or methods are available, however it might also be applicable and required to using existing data and methods, as they could not be applicable for the system or solution being assessed; this is not clear in the guidance.<br><br>Both clause 10 and 12 referring to the fire safety design plan do not specify the need to identify and communicate the main assumptions and uncertainty sources on which the assessment is built upon. This is a key deviation from the approach of the process document in its third step "collate and evaluate results".<br><br>Clause 13.3 takes a probabilistic approach to uncertainty, listing a set of uncertainty sources and stating that to deal with them "The magnitude of uncertainty associated with each component of the evaluation shall be considered and then combined to establish an overall level of uncertainty". However, this might not always be possible, particularly in systems where there are significant knowledge gaps (new materials, innovative designs).<br>In the end of this section there is a set of key guidelines highlighting the impossibility of quantifying all sources of uncertainty, but it fails to highlight what this implies for the assessment outcomes. |
| D3 | There are details of safety factors, sensitivity analysis and reliability and these are consistent with the ABCB process document | FA | Yes, it specifies both the possibility of using safety factors (multiplicative adjustment) and safety margins (additive adjustments) to compensate for uncertainty. |
| E1 | Any documentation requirements are compatible with the ABCB process document and Australian regulatory processes | FA | As specified in criterion 4.2.2, ISO23932 requires an initial and final report, both of which align with the documentation required by the process document. |
| F1 | The guidance is currently in widespread or limited use in Australia | PA | SA is part of the committee and a member of ISO, which makes this guidance document known in Australia but to a limited cohort and often researchers rather than FSE practitioners. The views of a limited sample of practising FSEs is that usage is very limited. |
| F2 | The guidance is likely to be easy to use by practitioners in Australia | PA | SA is part of the committee and member of ISO, which makes this guidance document known in Australia but in a limited way. A small sample of FSE practitioners think such guidance would be reasonably easy to use, but others differ. |
| F3 | The guidance is likely to be accepted by FSEs and others in Australia | LA | Given these documents have had substantial international input, including from Australia, the guidance is likely to be acceptable to FSEs and others in Australia. |
| F4 | The guidance is internationally recognised and utilised | PA | Yes, this document and those of this series are internationally known and a product of international working teams. But utilisation amongst FSE practitioners is considered low. |

## TABLE 3: EVALUATION OF SCOPE, STRUCTURE AND APPLICATION OF ISO23932-1:2018

| | CRITERIA EVALUATION FOR ISO23932 | RATING | COMMENTS |
|---|---|---|---|
| F5 | Implementation or adoption of the guidance will not add significant cost to the fire safety engineering process | PA | The full suite of ISO fire engineering documents is quite costly to purchase. In addition, there could be costs associated with re-training FSEs in the use of ISO documents for which most FSEs in Australia are not familiar. |
| F6 | Australian representation is possible on the committee responsible for update and review of the guidance | LA | Yes, “Standards Australia is recognised by the Commonwealth Government as the nation’s peak Standards body” in the ISO/TC 92/SC 4 Fire safety engineering in charge of the guidance document, see https://www.iso.org/committee/50552.html?view=participation. Having said that, change comes very slowly in ISO Standards because of the low frequency of meetings and the need to get broad international consensus. |
| G1 | The guidance document or its related parts including design/analysis methods and data is appropriate for simple and/or complex buildings | LA | The ISO document does not stipulate what buildings are in or out of scope. However, it does refer to fire safety as applied to all configurations of the built environment. The document is not intended as a detailed technical design guide but rather gives a good overview of the fire safety process and systems, with reference made to other documents for more detailed information. |
| G2 | The assumptions and limitations of the guidance document are clear and comprehensible by users | PA | Given its high-level approach, the document is clear on what it provides and what is out of its scope. This document does not specify the particular challenges of fire dynamics, and it does fall short in explicitly expressing this in section 12, where the selection of engineering methods limits itself to specify the selection of a ‘fire model’ and an ‘evacuation model’. |
| G3 | The level of competency required of users is clear | PA | In clause 3.3. when defining engineering judgment, it is stated that the relevant professionals should be “qualified by way of education, experience and recognized skills to complement, supplement, accept or reject elements of an engineering analysis”. However, competency in FSE assessment is a key challenge as presented in other guidance documents and as seen in recent legal cases against fire safety consultancies. ISO23932 does not define clearly enough the level of competency required by the professionals involved and does not provide guidance on the members of the teams required to carry out the different steps of the FSE evaluation process. |


*Peter Johnson, Fire Engineer from ARUP and contributing author for the Warren Centre Fire Safety Engineering project will present at the World Engineering Conference in November 2019*

# 7. Evaluation of CIBSE Guide E

## 7.1 SUMMARY

**CIBSE GUIDE E ONLY FULLY ACHIEVES THREE OF THE CRITERIA, WHICH IS THE FEWEST OF ANY OF THE DOCUMENTS REVIEWED. IT FAILS TO ACHIEVE SEVEN, WHICH IS MORE THAN ANY OF THE OTHER DOCUMENTS REVIEWED. IT PARTIALLY ACHIEVES THIRTEEN AND LARGELY ACHIEVES ANOTHER SEVEN.**

One criterion which is not achieved is that the document should be applicable to partial DTS / Performance Solutions (criteria A6). All other criteria are partially achieved.

CIBSE Guide E partially achieves both criteria under overall process and major components.

Considering criteria related with the methods of evaluation, two of these are fully achieved (criteria C7 and C8). Three of these criteria are not achieved (C1, C2, and C3), all associated with the fact that there are no flowcharts provided in CIBSE Guide E, other than some which are referenced from the previous version of the BS7974 standard that was evaluated in this document. All other criteria under methods of evaluation are largely achieved.

Variability and uncertainty are poorly accounted for in CIBSE Guide E. It is acknowledged, partially fulfilling criteria D1; however, there is no further detail, and so criteria D2 and D3 are not considered to be achieved.

In terms of adoptability, the guidance was judged as likely to be easy to use by Australian practitioners (fully achieving criteria F2), whereas all other criteria in this category are either largely (F1, F3, F5) or fully achieved (F4, F6).

Finally, CIBSE Guide E only partially achieves all three of the other criteria identified.

# 7.2 EVALUATION

The complete evaluation, including detailed comments, of CIBSE Guide E against the criteria identified is presented in Table 4.

**TABLE 4: EVALUATION OF CIBSE GUIDE E**

| | CRITERIA EVALUATION FOR CIBSE GUIDE E | RATING | COMMENTS |
|---|---|---|---|
| A1 | The guidance document uses building code, regulatory language or terminology that is compatible with the NCC and the proposed ABCB process document | PA | CIBSE Guide E uses a general language as it encompasses a large extent of codes, standards and fire safety related guidelines. Compatibility is partially achieved as the language in chapter 4 (Performance-based design principles) and 5 (Application of risk assessment to fire engineering designs) significantly differs from the process document. Furthermore, the process document addresses performance solutions, while CIBSE Guide E addresses both performance and prescriptive approaches. CIBSE Guide E addresses a more holistic approach to fire safety strategy for the whole building and aligns with BS7974:2001, while the process document is focused on specific performance solutions. A central element of CIBSE Guide E is the scope definition (Chapter 5.3) in which a clear departure from the process document can be seen. |
| A2 | The definitions used are compatible with NCC and regulatory and ABCB process documents | PA | Definitions provided in chapter 5 are focused on risk assessment, while the process document does not explicitly state the role of risk assessment or the definitions associated. |
| A3 | The “sub-systems” outlined in the guidance document are the same as the ABCB process document | NA | Chapter 5 addresses fire dynamics and decomposes the problem in different elements usually addressed in fire safety engineering analysis. However, these do not directly match the sub-systems of BS7974. Chapters 8 through 15 address a mix of passive and active safety features within a fire safety strategy, without an overarching structure articulating them. This is not explicit in the process document. |

In terms of adoptability, the guidance was judged as likely to be easy to use by Australian practitioners.





**TABLE 4: EVALUATION OF CIBSE GUIDE E**

| | CRITERIA EVALUATION FOR CIBSE GUIDE E | RATING | COMMENTS |
|---|---|---|---|
| A4 | The guidance document applies to the design and analysis of both new and existing buildings | PA | It is not explicitly stated, and in Chapter 5.5.1 it is stated that a limitation for risk assessment in fire safety engineering could be found when: “If it were to be applied to existing premises, the cost of compliance with the guidance would be grossly disproportionate to the fire risk reduction achieved”. |
| A5 | The guidance document applies to design and analysis of Performance Solutions | PA | Although no explicit restriction seems to exist in the document, the general approach of the CIBSE Guide E is holistic and seems to address fire safety for a whole building. |
| A6 | The guidance document applies to the design and analysis of a partial DTS / Performance Solution | NA | No reference to this is found, and as previously stated, the document is of high-level and has a very general approach to FSE. |
| B1 | The key steps in the design and verification process are compatible with Australian design and analysis practice | PA | Since CIBSE Guide E is 9 years old and presents content heavily focused on the UK’s regulatory framework, it is considered that it is only partially applicable to the Australian practice, which has evolved significantly in the last years. |
| B2 | The process of FEB/FER and hazard analysis, fire scenarios, trial design, etc is similar to or compatible with the proposed ABCB process document | PA | Yes, these elements are found within the guideline as per the BS7974:2001 referenced content. However, the CIBSE Guide E itself does not offer a particular approach to be followed. |
| C1 | The flow charts for general analysis to evaluate levels of fire safety are compatible with the ABCB process document | NA | No flowcharts are provided, except a few which are referenced from BS7974:2001. |
| C2 | The flow charts for analysis and evaluation of particular sub-systems, e.g. smoke control, fire performance of structures, etc are consistent with the ABCB process document | NA | See above. |
| C3 | The flow charts for analysis and evaluation of particular sub-systems, e.g. smoke control, fire performance of structures, etc are consistent with current Australian practice | NA | See above. |
| C4 | The defined design methods and analysis methodologies are appropriate to current Australian design practice | LA | CIBSE Guide E does not establish a particular set of methods, and it rather presents a set of useful resources and recommended technical resources which can be easily applied within the Australian context. |

## TABLE 4: EVALUATION OF CIBSE GUIDE E

| | CRITERIA EVALUATION FOR CIBSE GUIDE E | RATING | COMMENTS |
|---|---|---|---|
| C5 | The defined design methods and analysis methodologies are compatible with the ABCB process document | LA | See criteria C4 above. |
| C6 | Where these general and high-level guidance documents refer to other related parts or standards (e.g., BS7974 and ISO), methods and data are appropriate for Australia | LA | Most references are internationally well known documents for FSE community and are used in Australia in educational settings as well as in practice. However, CIBSE Guide E is of a general character and references multiple resources, not choosing a particular approach. This could lead to confusion or additional difficulties if applied directly in Australia. |
| C7 | Risk assessment and probabilistic methods are incorporated or accounted for (looking forward to quantification of NCC Performance Requirements) | FA | Chapter 4.4.3.3 established probabilistic methods as one of the three approaches available to judge the acceptability of a design. |
| C8 | Related sources like the SFPE Fire Protection Handbook are referenced | FA | References to all kind of useful resources are made, including SFPE Handbook, NFPA documents and standards, British standards, research papers amongst others. A detailed reference to cited equations in chapter 6 is presented in Annex 6.A2 in which a large range of useful technical references are provided. |
| C9 | Any related sources referenced could be useful in the Australian context | LA | There are a few direct references to Australian FSE such as the ones listed below, but no updated documents such as the ABCB ones are referenced. Most resources are well known by the FSE community and should be largely applicable to Australia.<br>• AS 4391:1999: Smoke management systems —- Hot smoke test<br>• AS 2118 Automatic fire sprinkler systems Parts 1 to 10<br>• AS 2118.2-95: Automatic fire sprinkler systems Part 2: Wall wetting sprinklers/drenchers |
| D1 | Variability and uncertainty are incorporated into the guidance document. | PA | Chapter 4.3.3.2 acknowledges uncertainty within the design and the need to record it in the fire strategy report. Sensitivity analysis is portrayed as the preferred way to deal with uncertainties (which is not always the ideal way to deal with them or the most suited). No further references or guidance are provided beyond this general mention. |
| D2 | The detail on variability and uncertainty is directly applicable to Australian design practice | NA | Given the limited references and the lack of any technical references or further guidance on uncertainty beyond what Chapter 4.3.3.2 states, CIBSE Guide E does not include enough detail for Australian practice. |
| D3 | There are details of safety factors, sensitivity analysis and reliability and these are consistent with the ABCB process document | NA | See above. |





## TABLE 4: EVALUATION OF CIBSE GUIDE E

| | CRITERIA EVALUATION FOR CIBSE GUIDE E | RATING | COMMENTS |
|---|---|---|---|
| E1 | Any documentation requirements are compatible with the ABCB process document and Australian regulatory processes | NA | Although Chapter 14.4.3 establishes the requirement of providing full documentation to the fire safety manager, the actual FSE procedure during design (Chapter 4 and 5) has no explicit mention of the need to produce documents and in which way to do so except for a 'Fire strategy report' which is mentioned both in Chapters 1.5.2 and 4.3.3.2 without any other reference in which it is fully described. |
| F1 | The guidance is currently in widespread or limited use in Australia | LA | The guidance is used by quite a number of FSE practitioners, and while probably not described as widespread, the usage is substantial, in part because there are a fair number of members of CIBSE in Australia. |
| F2 | The guidance is likely to be easy to use by practitioners in Australia | FA | A small sample of FSE practitioners were all in agreement that CIBSE Guide E is relatively easy to use. |
| F3 | The guidance is likely to be accepted by FSEs and others in Australia | LA | A small sample of FSE practitioners were all in agreement that CIBE Guide E is likely to be accepted by FSEs and others in Australia. |
| F4 | The guidance is internationally recognised and utilised | PA | Most practitioners in the small sample tested thought that Guide E would be internationally recognised, although this would more likely to be the case in the areas of the world with a UK heritage and CIBSE membership. |
| F5 | Implementation or adoption of the guidance will not add significant cost to the fire safety engineering process | LA | No suggestion of significant cost implications except for re-training of some FSEs in its use where not using it currently. |
| F6 | Australian representation is possible on the committee responsible for update and review of the guidance | PA | Although it is stated that CIBSE Guide E could be of international application, Australian participation is not found, and it is unknown to what extent it would be possible, as it is also stated that the document represents the UK perspective. |
| G1 | The guidance document or its related parts including design/ analysis methods and data is appropriate for simple and/or complex buildings | PA | In general, yes, the large range of references presented could be suitable to deal with both simple and complex buildings. This is not explicitly specified in the document, and there is no differentiated treatment of the two types of problems besides stating that some buildings will be easier to deal with through the deemed to satisfy provisions (Chapter 4.1). |
| G2 | The assumptions and limitations of the guidance document are clear and comprehensible by users | PA | Given the general character of the document, there are many assumptions and limitations which are not formulated, as the document does not select a particular approach. The limitations or requirements of particular elements are explicitly stated in some chapters (see example in 6.11.4). |
| G3 | The level of competency required of users is clear | PA | Chapter 4.1 states the expected level of qualification and experience from the personnel in charge of fire safety engineering. However, examples are not provided, and the information specified is not specific enough. This chapter does not make reference to key competency and responsibilities found in other chapters, such as 6.11.4 where clear responsibilities for the engineers are provided regarding the use of complex models such as CFD. |

# 8. Comparison

A summary of which of the criteria the four documents that have been reviewed achieve is provided in Table 5. BS7974 fully achieves 16 of these criteria. ISO23932 fully achieves 10. The SFPE guide and CIBSE Guide E fully achieve nine and three of the criteria respectively.

In terms of criteria not achieved, CIBSE Guide E fails to achieve eight. BS7974 fails to achieve three, the SFPE guide two and the ISO standard four.

**TABLE 5: SUMMARY OF CRITERIA ACHIEVED BY THE FOUR DOCUMENTS REVIEWED**

| | | CRITERIA EVALUATION | BS7974 | SFPE | ISO | CIBSE GUIDE E |
|---|---|---|---|---|---|---|
| *Scope, Structure and Application* | A1 | The guidance document uses building code, regulatory language or terminology that is compatible with the NCC and the proposed ABCB process document | LA | LA | LA | PA |
| *Scope, Structure and Application* | A2 | The definitions used are compatible with NCC and regulatory and ABCB process documents | LA | PA | LA | PA |
| *Scope, Structure and Application* | A3 | The “sub-systems” outlined in the guidance document are the same as the ABCB process document | NA | NA | NA | NA |
| *Scope, Structure and Application* | A4 | The guidance document applies to the design and analysis of both new and existing buildings | FA | PA | FA | PA |
| *Scope, Structure and Application* | A5 | The guidance document applies to design and analysis of Performance Solutions | FA | FA | FA | PA |
| *Scope, Structure and Application* | A6 | The guidance document applies to the design and analysis of a partial DTS / Performance Solution | FA | FA | LA | NA |
| *Overall Process and Major Components* | B1 | The key steps in the design and verification process are compatible with Australian design and analysis practice | FA | PA | PA | PA |
| *Overall Process and Major Components* | B2 | The process of FEB/FER and hazard analysis, fire scenarios, trial design, etc is similar to or compatible with the proposed ABCB process document | FA | PA | LA | PA |

## TABLE 5: SUMMARY OF CRITERIA ACHIEVED BY THE FOUR DOCUMENTS REVIEWED

| | | CRITERIA EVALUATION | BS7974 | SFPE | ISO | CIBSE GUIDE E |
|---|---|---|---|---|---|---|
| *Methods of Evaluation* | C1 | The flow charts for general analysis to evaluate levels of fire safety are compatible with the ABCB process document | LA | PA | LA | NA |
| *Methods of Evaluation* | C2 | The flow charts for analysis and evaluation of particular sub-systems, e.g. smoke control, fire performance of structures, etc are consistent with the ABCB process document | PA | PA | NA | NA |
| *Methods of Evaluation* | C3 | The flow charts for analysis and evaluation of particular sub-systems, e.g. smoke control, fire performance of structures, etc are consistent with current Australian practice | PA | PA | NA | NA |
| *Methods of Evaluation* | C4 | The defined design methods and analysis methodologies are appropriate to current Australian design practice | FA | LA | FA | LA |
| *Methods of Evaluation* | C5 | The defined design methods and analysis methodologies are compatible with the ABCB process document | FA | LA | FA | LA |
| *Methods of Evaluation* | C6 | Where these general and high-level guidance documents refer to other related parts or standards (e.g., BS7974 and ISO), methods and data are appropriate for Australia | PA | PA | FA | LA |
| *Methods of Evaluation* | C7 | Risk assessment and probabilistic methods are incorporated or accounted for (looking forward to quantification of NCC Performance Requirements) | FA | FA | FA | FA |
| *Methods of Evaluation* | C8 | Related sources like the SFPE Fire Protection Handbook are referenced | PA | FA | NA | FA |
| *Methods of Evaluation* | C9 | Any related sources referenced could be useful in the Australian context | NA | PA | FA | LA |
| *Variability and Uncertainty* | D1 | Variability and uncertainty are incorporated into the guidance document | FA | FA | FA | PA |
| *Variability and Uncertainty* | D2 | The detail on variability and uncertainty is directly applicable to Australian design practice | FA | PA | PA | NA |





TABLE 5: SUMMARY OF CRITERIA ACHIEVED BY THE FOUR DOCUMENTS REVIEWED

| | | CRITERIA EVALUATION | BS7974 | SFPE | ISO | CIBSE GUIDE E |
|---|---|---|---|---|---|---|
| *Variability and Uncertainty* | D3 | There are details of safety factors, sensitivity analysis and reliability and these are consistent with the ABCB process document | FA | PA | FA | NA |
| *Documentation* | E1 | Any documentation requirements are compatible with the ABCB process document and Australian regulatory processes | FA | FA | FA | NA |
| *Adoptability* | F1 | The guidance is currently in widespread or limited use in Australia | LA | PA | PA | LA |
| *Adoptability* | F2 | The guidance is likely to be easy to use by practitioners in Australia | FA | PA | PA | FA |
| *Adoptability* | F3 | The guidance is likely to be accepted by FSEs and others in Australia | FA | FA | LA | LA |
| *Adoptability* | F4 | The guidance is internationally recognised and utilised | FA | FA | PA | PA |
| *Adoptability* | F5 | Implementation or adoption of the guidance will not add significant cost to the fire safety engineering process | PA | PA | PA | LA |
| *Adoptability* | F6 | Australian representation is possible on the committee responsible for update and review of the guidance | NA | FA | LA | PA |
| *Additional* | G1 | The guidance document or its related parts including design/ analysis methods and data is appropriate for simple and/or complex buildings | FA | PA | LA | PA |
| *Additional* | G2 | The assumptions and limitations of the guidance document are clear and comprehensible by users | PA | NA | PA | PA |
| *Additional* | G3 | The level of competency required of users is clear | LA | LA | PA | PA |

# 9. Conclusions and recommendations

The analysis presented in this report assesses the potential to use CIBSE Guide E, the SFPE guide, BS7974 and ISO23932 as engineering guidance documents within the Australian context. A series of criteria were considered, most of them aligned with the objectives of an engineering guideline. Nevertheless, some criteria had to include issues of compatibility with Australian regulatory structures, design frameworks and standards of competency and practice. While all the criteria are ranked together, without any weighting or considerations of associated to the relative importance of adequacy and non-compatibility, it is essential that these considerations be taken in the context of any formal recommendation.

CIBSE Guide E fully achieves fewer of the criteria than any of the other documents. Also, it fails to achieve more than all of the other documents. On this basis, it can be established with certainty that its use in the Australian context will be more difficult.

BS7974 fully achieves more of the criteria than any of the other documents reviewed. However, those criteria which it does not achieve should be carefully considered before recommending its use in the Australian context. In particular:

1. That the sub-systems outlined in the guidance document are not included in the current ABCB Process document.
2. That it is unclear whether or not Australian representation on the relevant committees will be possible.
3. That the related sources cited may not be useful in the Australian context.

With regard to the first of these criteria, the guidance documents typically break fire safety engineering analysis into six sub-systems that form part of a typical performance-based design brief and subsequent final report as set out in the general ABCB Development of Performance Solutions document (version 2.1). These reports are typically identified as FEB and FER documents in fire safety engineering. The guidance documents typically break the analysis into six sub-systems such as fire development in the room of fire origin, smoke spread beyond the room of fire origin, spread of fire and structural response, etc, although the actual titles of the sub-systems in the different guidance documents vary slightly. While the ABCB Development of Performance Solutions document is general, any fire safety engineering Process Document developed by ABCB for fire safety should include this sub-systems approach to analysis, as has traditionally been the case in the IFEG used widely in Australia and internationally.

With regard to the second of these criteria, if Australian representation on the committee responsible for revision of the adopted guideline is of critical importance, then it is recommended that the ABCB explore the possibility of Australian membership on this committee with the British Standards Institute. Alternatively, if one of these documents were to be adopted for use in Australia, then it is likely that any issues with regards to changes made in subsequent revisions, or minor alterations, could be addressed through the addition of, for example, a national annex that limits or informs the use of different clauses.

With regard to the third of these criteria, the fact that the usefulness of the related sources in the Australian context is not achieved is possibly a more significant issue with BS7974. This should be the subject of greater scrutiny by the ABCB. However, if the document is

adopted as a guidance document, then it is likely that practitioners would be able to refer to locally applicable documents in lieu of the supporting documents published by the BSI.

In summary:

- that the sub-systems are not the same as in the process document is not achieved by any of the documents can be resolved through further development of the process document by ABCB specifically for fire safety engineering;
- that Australian representation on the revision committees may not be possible should not significantly impact their use in Australia; and
- that related sources may not be applicable in the Australian context is also not likely to have an impact on the adoption of the overall guidance.

Of the remaining two documents, the SFPE guide achieves to some degree more of the criteria than any of the other documents. However, the ISO standard fully achieves one more of the criteria than the SFPE guide and largely achieves more.

These conclusions are very similar to the conclusions of the WPI Report comparing the IFEG with BS7974, ISO23932 and the SFPE guide. The WPI Report concluded that all four of these documents were largely similar, although that BS7974 was more technically detailed and addressed issues related to the use of risk assessment and probabilistic methods in fire safety engineering that the others did not. The WPI report did not review CIBSE Guide E. Note that some, but not all, of the categories for this evaluation and analysis overlap with the categories from the

*A Fire Safety Engineer uses a number of technical resources available to them when performing their role*






A series of criteria were considered, most of them aligned with the objectives of an engineering guideline.

WPI Report, and so a similar conclusion is not perhaps surprising.

Based on the above evaluation and the relative performance of the four documents reviewed, the following is concluded:

- If the sub-system compatibility with the ABCB process document is not of critical importance (and that can be developed as ABCB address their own approach to a Process Document); and
- If the representation of the ABCB on the technical committee responsible for BS7974 is either not of critical importance or is possible to achieve; and
- If it can be shown that the related sources are useful in the Australian context, then BS7974 is recommended as the preferred document inclusion as a recommended engineering guideline in Australia.

In case one or more of these conditions is not met, then either the SFPE guide or the ISO standard are the preferred documents. Here it is argued that, although the ISO standard fully achieves one more of the criteria than the SFPE guide, ease of adoptability, in part at least due to the extent of use in current practice in Australia, probably favours the SFPE guide.

If one guidance document, such as BS7974, is favoured and promoted by ABCB, then a potential benefit is a little more consistency in practice with fire safety engineering report reviewers and certifiers seeing more common usage of particular analysis methods and inputs and some terminology. However, this may prove somewhat restrictive for some projects and new methods and inputs if applied too rigidly.

As a potential alternative to the adoption of one single guideline in Australia, a further option would be to encourage all four of these documents to be used as appropriate. If such an alternative would be pursued, then it would be the responsibility of the fire safety engineer to select the relevant document balancing all of:

- the assumptions behind the document;
- their own competency and the competency required for implementation of the guidance;
- any statutory weight given to the document; and
- the needs of specific projects.

This would most likely require input from other stakeholders. In such an instance there is a need to recognise that each of the guidance documents was developed for somewhat different purposes and has its own merits and limitations. To some extent this report serves as a summary of these.

The Warren Centre view is that encouragement by ABCB for fire safety engineers to consider use of all four guidance documents as and when appropriate, fits with the idea of the growing competence and move to full and proper professional practice of fire safety engineers in Australia.

# 10. Appendix



## 10.1 APPENDIX 1: SURVEY ON ADOPTABILITY

As noted, for those criteria that fall under the adoptability heading, a short survey was carried out at RED Fire Engineers and at ARUP. The related questions asked were a reformulation of the first five of the six criteria under adoptability and were worded in such a way that they elicited a yes / no response referring to each of the documents under review. The questions asked were:

1. Is the guidance currently in wide spread or limited use in Australia?
2. Is the guidance likely to be easy to use by practitioners in Australia?
3. Is the guidance likely to be accepted by FSEs and others in Australia?
4. Is the guidance internationally recognised and utilised?
5. Is the implementation or adoption of the guidance likely to add significant cost to the fire safety engineering process?

These responses were then compiled, and the results reviewed to determine if the different criteria were achieved and if so to what extent. The compiled responses are shown in Table 6.

**TABLE 6: COMPILED RESPONSES TO QUESTIONNAIRE REGARDING ADOPTABILITY**

| | CIBSE | | BS7974 | | ISO | | SFPE | |
|---|---|---|---|---|---|---|---|---|
| **QUESTIONS** | YES | NO | YES | NO | YES | NO | YES | NO |
| Is the guidance currently in widespread or limited use in Australia? | 13 | 6 | 13 | 6 | 2 | 14 | 10 | 8 |
| Is the guidance likely to be easy to use by practitioners in Australia? | 14 | 2 | 14 | 5 | 4 | 10 | 11 | 5 |
| Is the guidance likely to be accepted by FSEs and others in Australia? | 15 | 1 | 16 | 2 | 7 | 7 | 13 | 3 |
| Is the guidance internationally recognised and utilised? | 13 | 3 | 12 | 4 | 7 | 6 | 13 | 3 |
| Is the implementation or adoption of the guidance likely to add significant cost to the fire safety engineering process? | 2 | 14 | 4 | 13 | 2 | 13 | 4 | 13 |

In general, surveyed engineers from both companies were in agreement, although responses from ARUP indicated a wider use of CIBSE Guide E; and responses from RED were more positive about the likely acceptance and widespread international use of ISO23932-1:2018.

# 10.2 APPENDIX 2: GLOSSARY AND ACRONYMS

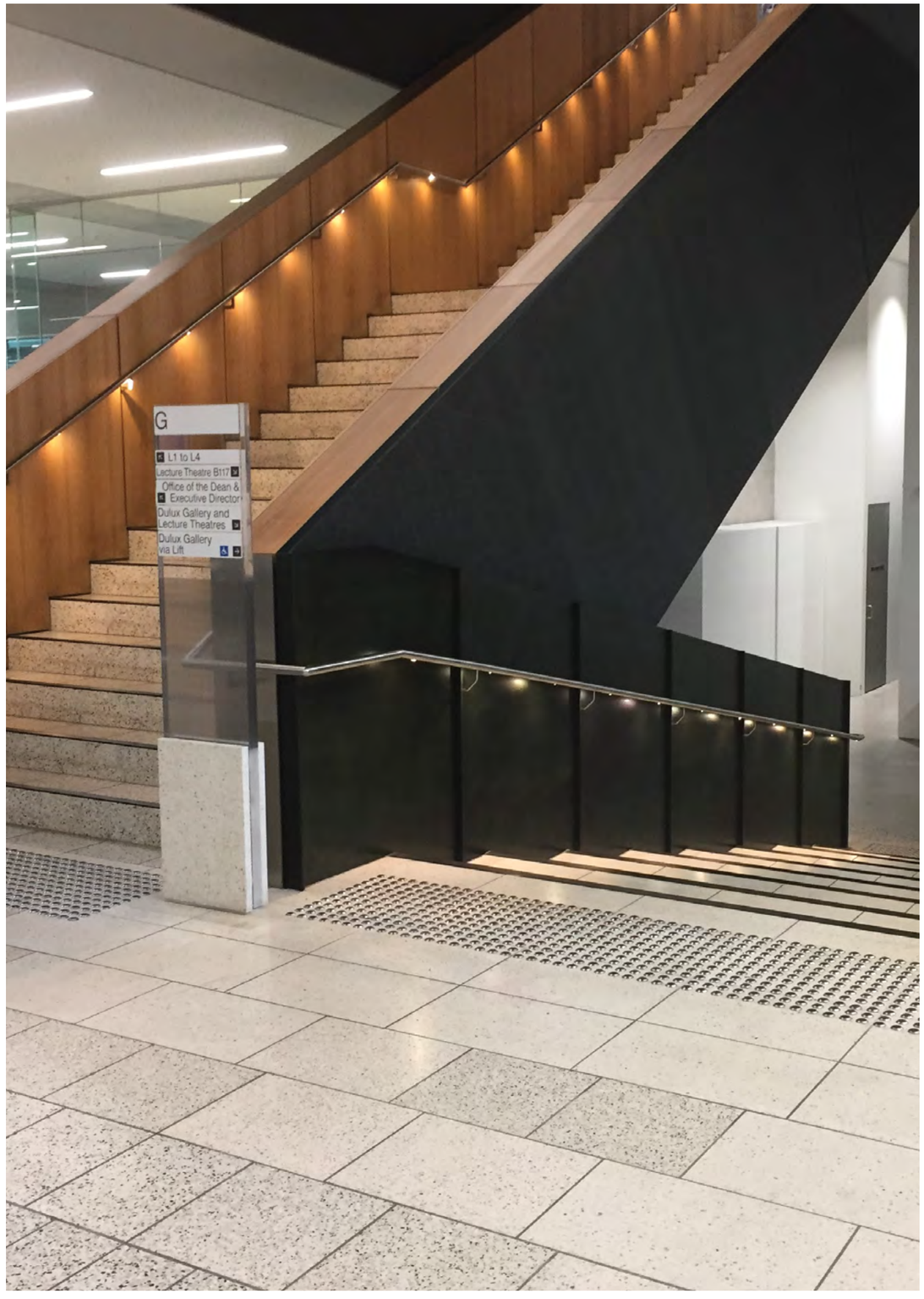
Where definitions are included in the NCC Volume One Building Code of Australia, they are in bold. Other definitions or notes of explanation have been developed in the Warren Centre Fire Safety Engineering Project as a means to use consistent language throughout the Project reports.

| TERM | DEFINITIONS AND NOTES OF EXPLANATION |
|---|---|
| *ABCB* | Australian Building Codes Board – A council of Australian Government (COAG) standards writing body that is responsible for the development of the NCC, comprised of the BCA and PCA. The ABCB is a joint initiative of all three levels of government in Australia. (ABCB) |
| *Assessment Method* | **Means a method that can be used for determining that a Performance Solution or Deemed-to-Satisfy Solution complies with the Performance Requirements.** *(NCC, vol 1, amendment 1)*<br><br>The means by which a building proponent proves that a solution achieves the Performance Requirements. These include:<br>• Evidence to support that the use of a material or product, form of construction or design meets a Performance Requirement or a Deemed-to-Satisfy Provision as described in A2.2<br>• Verification Methods<br>• Expert Judgement<br>• Comparison with the Deemed-to-Satisfy Provisions<br><br>*(NCC, vol 1, amendment 1)* |
| *BS7974* | Refers to "Fire safety engineering in buildings – Code of Practice, BS7974 (2019)". BS stands for British Standards. Also, BSI is the British Standards Institute. |
| *BCA* | Building Code of Australia - Forms volumes one and two of the NCC, which contains technical provisions for the design and construction of buildings and other structures. The BCA addresses structural adequacy, fire resistance, access and egress, services and equipment, energy efficiency and sustainability, and provisions for the health and amenity of occupants. *(NCC, vol 1, amendment 1)* |
| *BIA* | Business Impact Analysis - a systematic process to determine and evaluate the potential effects of an interruption to critical business operations as a result of a disaster, accident or emergency. |
| *Building Solution* | **A solution which complies with the *Performance Requirements* and is a:**<br>• ***Performance Solution***<br>• ***Deemed-to-Satisfy Solution***<br>• ***Combination of both solutions***<br><br>*(NCC, vol 1, amendment 1)*<br><br>This term has been replaced with the terms Deemed-to- Satisfy Solution and Performance Solution. It has been retained as some jurisdictions still refer to this term. *(NCC, Guide, amendment 1)* |





| TERM | DEFINITIONS AND NOTES OF EXPLANATION |
|---|---|
| *CIBSE Guide E* | Refers to the Chartered Institution of Building Services Engineers Guide E, UK, May 2010 |
| *Deemed-to-Satisfy Provisions* | Make up the bulk of the NCC. **Means provisions deemed to satisfy the *Performance Requirements*.** *(NCC, vol 1, amendment 1)* |
| *Deemed-to-Satisfy (DtS) Solution* | **A method of satisfying the *Deemed-to-Satisfy Provisions*.** *(NCC, vol 1, amendment 1)*<br><br>Should be used if any designer, builder or the like, does not want to develop a new means of compliance with the Performance Requirements. *(NCC, Guide, amendment 1)* |
| *Equivalent* | **Equivalent to the level of health, safety and amenity provided by the *Deemed-to-Satisfy Provisions*.** *(NCC, vol 1, amendment 1)* |
| *FEB* | Fire Engineering Brief – A document developed by a fire safety engineer to outline the fire safety strategy and design for the proposed works, and allows stakeholders to provide input into the assessment methods and acceptance criteria that is agreed to be used for the solution. Process is outlined in the IFEG. Same purpose as a PBDB. (Fire and Rescue NSW) |
| *FER* | Fire Engineering Report – details the formulation and analysis of the fire safety design solutions against the fire safety objectives developed in the Fire Engineering Brief process. Contains all required calculations, analysis of test evidence and fire modelling to support the recommendations for the formulated fire safety design solution for the building. |
| *Fire Safety Engineer* | An appropriately qualified and experienced practitioner who, through sound and robust engineer practice, provides services that achieve reductions of risk for life for people in buildings, reduction in property and environmental damage from building fires and the implementation of cost-effective fire safety codes and regulations. |
| *Fire Safety System* | **One or any combination of the methods used in a building to:**<br>**• Warn people of an emergency**<br>**• Provide for safe evacuation**<br>**• Restrict the spread of fire**<br>**• Extinguish a fire**<br>**• and includes both active and passive systems.**<br><br>These systems may be active, passive or any combination of the two.<br><br>**Active Systems**<br>• Sound systems and intercom systems for emergency purposes<br>• Emergency lighting<br>• Exit signs<br>• Sprinkler systems<br>• Fire hydrant systems<br>• Fire hose reel systems<br>• Smoke and heat vents<br>• Mechanical smoke-exhaust systems<br>• Portable fire extinguishers<br><br>**Passive Systems**<br>• Fire-isolated stairways, ramps and passageways<br>• Fire walls<br>Other fire-resisting building elements *(NCC, Guide, amendment 1)* |
| *FSVM* | Fire Safety Verification Method – A voluntary tool under a Performance Solution pathway, providing a documented process in the design of fire safety Performance Solutions and is based on the IFEG. |




*Example of Performance based fire safety engineering stairway in a 5 storey university building*





| TERM | DEFINITIONS AND NOTES OF EXPLANATION |
|---|---|
| *IFEG* | International Fire Engineering Guides – Codes developed and made for Australia, New Zealand, USA and Canada. A reference for anyone involved in the development of performance solutions for fire engineered designs. |
| *ISO23932* | International Organization for Standardization (ISO) – Refers to the relevant fire safety engineering standards produced by ISO/TC 92/SC 4 - ISO23932-1:2018(en); Fire safety engineering — General principles — Part 1: General. |
| *NCC* | National Construction Code – Provides the minimum necessary requirements for health, safety, amenity and sustainability in the design and construction of new buildings throughout Australia. It comprises of the BCA and PCA and is given legal effect by relevant legislation in each state and territory. (ABCB) |
| *NFPA* | National Fire Protection Agency – International NGO based in the United States devoted to eliminating death, injury, property and economic loss due to fire, electrical and related hazards. |
| *PBDB* | Performance-Based Design Brief – the documentation and associated report that defined the scope of work for the performance-based analysis and the technical basis for analysis as agreed by stakeholders. |
| *PCA* | The Plumbing Code of Australia – Volume three of the NCC |
| *Performance Requirement* | **Means a requirement which states the level of performance which a Performance Solution or a Deemed-To-Satisfy Solution must meet**. *(NCC, vol 1, amendment 1)*<br><br>Performance Requirements outline the levels of accomplishment different buildings must attain. There are three options to comply with the Performance Requirements: Deemed-to-Satisfy Solutions, Performance Solutions or a combination of both (*NCC, vol 1, amendment 1)* |
| *Performance Solution (Alternative Solution)* | **Means a method of complying with the Performance Requirements other than by a Deemed-To-Satisfy Solution**. *(NCC, vol 1, amendment 1)*<br><br>A Performance Solution is unique for each individual situation. These solutions are often flexible in achieving the outcomes and encouraging innovative design and technology use.<br><br>It is a route which is not included in a DtS Solution. It complies with the NCC when the Assessment Method demonstrates compliance with the Performance Requirements.<br>If it is demonstrated to be at least equivalent to a DtS Provision, the Performance Solution is deemed to have achieved compliance with the relevant Performance Requirement.<br>(*NCC, vol 1, amendment 1)* |
| *QDR* | Qualitative Design Review – Document compatible with the PBDP agreed upon with the stakeholders (similar to FEB) |
| *SFPE* | Refers to “Engineering guide to performance-based fire protection analysis and design of buildings, Society of Fire Protection Engineers (SFPE), Bethesda, MD. USA (2000)”. |

As a potential alternative to the adoption of one single guideline in Australia, a further option would be to encourage all four of these documents to be used as appropriate. If such an alternative would be pursued, then it would be the responsibility of the fire safety engineer to select the relevant document.

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