Meacham Associates

Feasibility of a Centralized Hub for Verification of Complex Fire Engineered Solutions in Scotland

Scottish Government
Riaghaltas na h-Alba
gov.scot

May 2018

Report prepared by:

Brian Meacham, PhD, PE, CEng, FIFireE, FSFPE
Managing Director, Meacham Associates, Shrewsbury, MA USA

The opinions expressed in this report are those of the author.

Report commissioned by:
Building Standards Division
Local Government and Communities Directorate
Denholm House
Almondvale Business Park
Livingston
EH54 6GA

Tel: 0300 244 4000
e-mail: buildingstandards@gov.scot
web: https://www.gov.scot/policies/building-standards/-standards

This report is published electronically to limit the use of paper, but photocopies will be provided on request to Building Standards Division.

Acronyms/ Abbreviations

ASCE	American Society of Civil Engineers
ASET	Available Safe Egress Time
BCA	Building and Construction Authority
BCBs	Building Control Bodies
BS	British Standards
BSL	British Standards Institution
C/VM2	New Zealand Building Codes
CEng	Chartered Engineer
CFD	Computational Fluid Dynamics
CIBSE	Chartered Institution of Building Service Engineers
CIC	Construction Industry Council
CICAIR Limited	Construction Industry Council Approved Inspectors Registers Limited
CLT	Cross Laminated Timber
DRU	Design Review Unit
FE	Fire Engineering
FEA Software	Finite Element Analysis Software
FEB	Fire Engineering Brief
FEDB	Fire Safety Engineering Design Brief
FEG	Fire Engineering Guidelines
FER	Fire Safety Engineering Report
FRR	Fire Resistance Rating
FSE	Fire Safety Engineer
FSL	Fire Service Law
HRR	Heat Release Rate
IBC	International Building Code
ICC	International Codes Council
IEng	Incorporated Engineer
IFE	The Institution of Fire Engineers
IPENZ	Institution of Professional Engineers, New Zealand
ISO	International Organisation for Standardization
ITP	Inspection and Test Plan
LABC	Local Authority Building Control
LABSS	Local Authority Building Standard Scotland
LAVs	Local Authority Verifiers
LBO	Landesbauordnung
M & E plans	Mechanical and Electrical plans
MBC	Model Building Code
MBIE	Ministry of Business, Innovation and Employment, New Zealand
MBIE	Ministry of Business, Employment and Innovation
MIFireE	Member – Institution of Fire Engineers
MLIT Notifications	Ministry of Land, Infrastructure, Transport & Tourism, Japan
MW	Megawatt
NSW	New South Wales

NZFS	New Zealand Fire Service
PE	Professional Engineer
QP	Qualified Person
RI	Registered Inspector
RSET	Required Safe Egress Time
SBC	State Building Code
SCDF	Singapore Civil Defence Force
SFPE	Society of Fire Protection Engineers
SFRS	Scottish Fire and Rescue Service
TBB	Technische Baubestimmungen
TBR	Technical Building Regulations
TH	Technical Handbooks
US	United States

Contents

1 Executive Summary

1.1 The objective of this project was to conduct research and provide an independent opinion on the need, appropriateness, potential structure and potential operations of a central hub for assisting in the verification of complex fire engineered designs.

1.2 In conducting the research, the structure of verification (review / approval) approaches used in various countries for fire engineered designs, in particular performance-based designs and / or designs for complex or high-risk buildings, were investigated and assessed.

1.3 In addition, a broad cross-section of stakeholder groups in Scotland were consulted, including representatives from academia (fire engineering), architecture, architectural technology, Scottish Government Building Standards Division, the development community, the fire engineering community, the insurance industry, Local Authority Verifiers via Local Authority Building Standard Scotland (LABSS) and the Scottish Fire and Rescue Service (Fire Engineering Group).

1.4 It is the opinion of the author that the verification system in Scotland largely operates well, and that the fundamental issue is lack of resources. A central hub for review is recommended as the means to provide needed resources in the short term.

1.5 Considering the various options explored as part of this research, and considering the feedback from stakeholders on the concept of a central 'hub' for review of fire engineered designs, it is the opinion of the author that for Scotland, a system that contains aspects of maintaining the current Scottish Government appointed verification authority, Local Authority Verifiers (LAV), would seem to fit best the verification needs and resource constraints within Scotland.

1.6 It is the opinion of the author that the most feasible construct for such a hub would be an entity managed by LABSS, with a fulltime 'gatekeeper' (coordinator) to make initial decisions on whether a design should be reviewed by the hub, and supported by a panel of four additional persons, with access to a range of subject matter experts.

1.7 It is recommended that the Scottish Government consult with stakeholders on the formation of a hub as outlined in this report.

1.8 It is recommended that the Scottish Government initiate an effort to develop a system of 'risk categories' for buildings in Scotland, so as to provide consistency in understanding and application amongst all stakeholders, including the public. Ultimately, any approach to defining 'high risk' buildings in Scotland should begin with a discussion on defining and characterizing risk, and then moving on to categorizing or quantifying risk, as befits the selected model. Consideration of existing classification(s) of risk in the Scottish system would be a likely basis of such an effort (e.g., looking to ‘places of special risk’ and buildings that ‘pose a particular risk’ as discussed in the Technical Handbooks). See also previous reports which discuss risk (Meacham, 2016; 2017; 2018).

1.9 It is recommended that the Scottish Government initiate a project to develop guidelines on defining, recognizing and understanding complexity in buildings as related to fire engineering designs. Complexity in the built environment has many facets, and it is difficult to define it simply. It is deemed better to describe what makes the system complex, provide questions to explore relative to complexity, and to train actors to understand and address complexity as part of design and reporting.

1.10 It is recommended that as part of the hub, and as part of addressing ‘high-risk’ and ‘complex’ buildings, and as part of addressing the current situation with respect to qualifications and competency across the sector, that the Scottish Government consider development of a ‘fire engineering verification method’ to assist engineers and verifiers with ‘simple’ deviations from the Technical Handbooks (see Meacham 2017 and Annex F of this report).

2 Introduction

2.1 INTRODUCTION

2.1.1 The outcome from the project Research to Support the Improvement of the Design Verification of Fire Engineered Solutions as Part of the Scottish Building Regulatory System (Meacham, 2016) identified several shortcomings and opportunities related to the development and to the verification of fire engineered solutions. A key finding was that the lack of qualified fire engineers, across key stakeholder groups, was a limiting factor.

2.1.2 As a means to help address this limiting factor, it was suggested that consideration be given to the establishment of a ‘central’ resource for peer review, or at least guidance on how to select peer reviewers (including qualifications, experience, conflict of interest issues, etc.).

2.1.3 A subsequent research project, Competency Criteria for Local Authority Verifiers (LAVs) when Checking Fire Engineered Solutions for Compliance with Building Standards (Meacham, 2017), likewise recommended the establishment of some type of ‘central’ peer-review panel or committee. This is because a specific fire engineered design, by definition, is addressing issues or buildings deemed outside the scope of Section 2: Fire of the Technical Handbooks and requires persons competent in fire engineering designs to verify, as well as undertake, such designs.

2.2 BACKGROUND

2.2.1 In the aftermath of the Grenfell Tower fire in London, Building Standards Division (BSD) has embarked on a review of certain aspects of the Building Standards (Fire Safety) in Scotland. As part of this work, a Scottish Review Panel has been established with the remit to consider the Building Standards for fire and Section 2: Fire of the Technical Handbooks, in light of any evidence emerging from the Grenfell Tower fire. BSD have also formed an international sub-group to review the work of the Scottish Review Panel and to provide critical challenge as well as feedback to the Review.

2.2.2 To date there have been two meetings of the Scottish Review Panel. One of the consensus outcomes from the first meeting was that the process for the verification of fire engineering solutions, which do not follow the Technical Handbooks, needs to be reviewed to ensure they are sufficiently robust. As part of the second meeting, the value of a centralized fire engineering “hub” or “clearing house” to assist in verification was discussed.

2.2.3 It was suggested that members for this centralized fire engineering “hub” or “clearing house” could be drawn from statutory bodies or alternatively be privately contracted fire engineers. The role of the Scottish Fire and Rescue Service (SFRS) in such verification was discussed. It was acknowledged that with their consultation role there might be the possibility of a perceived conflict of interest. This would need to be addressed.

2.2.4 Previous research and current discussions within the Review Panel on Building Standards (Fire Safety) in Scotland have identified the need to explore the potential benefits, and potential structure and operation of, a ‘centralized’ review hub for complex fire engineered designs.

2.3 PROJECT OBJECTIVES

2.3.1 The objective of this project is to conduct research and provide an independent opinion on the need, appropriateness, potential structure and potential operations of a central hub for assisting in the verification of complex fire engineered designs.

2.3.2 As part of this effort, input is sought from a wide range of stakeholder groups on the following topics:

- The role of a central review hub in relation to responsibilities and authority of LAVs, SFRS and BSD with respect to fire engineered designs
- The form (or forms) of the hub that may be suitable for Scotland, given the regulatory system and the resources and expertise within the system
- The number and representative make-up (e.g., practicing fire engineer, LAVs, SFRS fire engineer, academic, etc.) of persons that might be appropriate for serving in a review capacity as part of the hub
- The qualifications and experience of the persons who might serve as part of review panels for the hub
- The limits and conditions of service as part of the hub, including potential conflicts of interest (private and governmental)
- The triggers for determining when a project could or should be sent to the hub for verification (e.g., complex and ‘high-risk’ buildings, significant variations from Section 2: Fire, Technical Handbooks, etc.), what documentation would be required, from whom, and within what time constraints
- The time limits around the activities of the hub in relation to a specific project (i.e., timelines for undertaking review and reporting back), and
- How such a hub might be funded (i.e., different mechanisms)

2.3.3 Research into how other jurisdictions is conducted as well.

2.4 KEY STAKEHOLDER GROUPS

2.4.1 To obtain a robust perspective from the community, a number of key stakeholder groups have been consulted, including:

- Academia (fire engineering)
- Architects and Architectural Technologists
- Building Standards Division
- Developers
- Insurance industry
- Fire engineers (via IFE Scotland Branch and others)

- Local Authority Verifiers (via Local Authority Building Standards Scotland (LABSS))
- Scottish Fire and Rescue Services (Fire Engineering group)

2.4.2 Consultations included in-person meetings, conducted the week of 19-23 March 2018, as well as written submittal from various persons.

2.5 KEY CONSIDERATIONS

2.5.1 In completing this research, the following issues were considered:

- Past research in Scotland on this topic
- Review Panel views on this topic
- How “complex” and “high-risk” buildings might be defined, and the qualifications and experience recommended for undertaking and verifying fire engineered solutions for such, in the Scottish context

3 Fire Verification Approaches

3.1 INTRODUCTION

3.1.1 The focus of this research is on exploring the potential for a centralized hub for verification of complex fire engineered designs in Scotland. As a starting point, a brief discussion of various approaches used in different countries for verifying complex fire engineered designs is presented.

3.1.2 Some of the discussion below is drawn from the report, Competency Criteria for Local Authority Verifiers (LAVs) when Checking Fire Engineered Solutions for Compliance with Building Standards (Meacham, 2017), and more details can be found there.

3.1.3 As noted in the 2017 report, the challenges currently being faced in Scotland with respect to undertaking and verifying fire engineering designs are not indifferent to those being faced in other countries. Issues of minimum competency / qualifications of fire engineers and verifiers, level of consistency in analysis and design being undertaken and delivered, and process(es) for review and approval, have been implemented and/or are being explored.

3.2 INTERNAL REVIEW / SELF-CERTIFICATION

3.2.1 In many countries, fire engineering firms follow ISO 9001 type quality management programmes, which include internal peer reviews of and approval of engineering work by qualified persons. The scope and depth varies by firm and country.

3.2.2 In some countries, however, the fire engineer can essentially 'self-certify' that their design complies with regulatory requirements. This is relatively common for structural engineering, including within Scotland, but also in some US states, for example. However, such self-certification is not common for fire engineering.

3.2.3 One notable difference is in many Nordic countries, in which the engineer (including fire) is largely responsible for certifying compliance with the regulation, and there is often little in terms of detailed regulatory review.

3.2.3.1 In Sweden, for example, responsibility for compliance with the regulations is targeted at the person (entity) which is paying for the construction of a building, and it is this person (entity) who has the obligation for compliance. There are typically contractual arrangements between this entity and others, including fire engineers, as appropriate. Works which requires a building permit may not begin until the local authority (Building Committee) has given starting clearance. In order to obtain starting clearance, the developer must be able to show that the works fulfil the requirements stipulated in the Planning and Building Act and associated regulations. For the Building Committee to make such a decision, the developer must submit a proposal for an inspection and a test plan (ITP), along with the required technical documentation. The Building Committee affirms the ITP in the starting clearance. In cases where the builder lacks the competence within their organization to demonstrate compliance with the building code, or does not engage an organization with this competence before the construction works starts, the Building Committee can demand that the builder engage a professional with a special certification related to competency in building regulation requirements – a SAK3 certificate – to conduct one or several specified controls, as specified in the ITP. These controls are often to check if the building is being built in compliance with the building code, such as if the escape routes are wide enough.

3.2.3.2 The situation is similar in Norway. However, in this case, contractors (firms) must be pre-approved through a quality management system to be able to undertake designs, with three levels of qualification possible (Stenstad, 2014; Meijer and Visscher, 2017). This system has not been without problems, especially in the case of fire design, as a clear arbiter of opposing views is not clear, particularly when the fire service disagrees with the designer.

3.2.4 It should be noted that verification of fire engineered designs in the Nordic countries has received attention in recent years. In response to the desires to have a clearer, more uniform, and more transparent system, the Nordic Standards Association has drafted guidelines for review and control of fire engineered designs: prINSTA/TS 952, Fire Safety Engineering — Review and Control in the Building Process, which was out for public comment at the time of this work.

Observations

3.2.5 It is the opinion of the author that use of an internal, ISO 9001 quality management approach, for internal review and approval of fire engineered designs is a positive and beneficial review mechanism. However, such systems cannot be expected to be independent, nor can they necessarily be expected to detect and address potential shortcomings. The major concern is that within a firm, there is often a common culture or approach to design, which all employees adopt. As such, designs do not necessarily receive the benefit of ‘a different perspective’ and associated challenges to the design that this might bring for example, if the firm uses a 3 MW fire as the design fire as a matter of course, who internally would challenge that?. An external, independent perspective, can be very beneficial and often can be critical.

3.2.6 It is the opinion of the author that the profession of fire engineering (fire safety engineering / fire protection engineering) is not sufficiently mature, or even sufficiently well defined, to warrant the ability for an individual to ‘self-certify’ fire engineered designs at this time.

3.2.6.1 While many fire engineering guides, codes of practice and standards exist, none are as robust as those which exist within structural engineering, for example. Furthermore, the range of expertise that may be needed within a comprehensive fire engineering design (e.g., expertise in combustion / fire dynamics, structural response to fire, human behaviour and response to fire, fire safety systems performance, etc., and the expertise in the associated analytical and computational tools) is beyond most, if not all, fire engineers, especially for complex buildings.

3.2.6.2 In addition, there is not an internationally agreed set of core competencies and knowledge areas that define the profession (or components that make up the profession), nor is there a broadly accepted qualification (or set of qualifications / certifications), that adequately define the area.

3.2.6.3 In the nearer term, it may be conceivable to establish a qualification system where firms can be approved to ‘self-certify’ if they can demonstrate appropriate qualifications, expertise and competencies in all related areas, there are clear and widely agreed measures for such qualifications, expertise and competencies, a suitably robust internal ISO 9001 quality management approach is in place, and a suitable external audit system and confidential reporting system is in place.

3.3 PRIVATE CERTIFICATION

England

3.3.1 In England, checking that building regulations are being complied with is undertaken by building control bodies (BCBs), which are either a local authority building control service (LABC) or a private sector approved inspector building control service.

3.3.2 Approved inspectors are companies or individuals authorised under the Building Act 1984 to carry out building control work in England and Wales. The Secretary of State has designated CICAIR Limited (a wholly owned subsidiary of the Construction Industry Council (CIC)) as the body responsible for deciding all applications for approved inspector status in England (https://www.planningportal.co.uk/info/200137/how_to_get_approval/77/where_to_get_approval/3, accessed 10 April 2018).

3.3.3 In addition, competent person self-certification schemes (aka competent person schemes) were introduced by the government in 2002 to allow individuals and enterprises to self-certify that their work complies with the building regulations as an alternative to submitting a building notice or using an approved inspector (https://www.planningportal.co.uk/info/200137/how_to_get_approval/77/where_to_get_approval/4).

3.3.4 While the schemes have been in place for several years, not all view the privatisation of building control as being particularly beneficial to the aims of safe buildings. As an example of the concerns being voiced, the following is an excerpt from the Royal Academy of Engineering response to the independent review on building regulations and fire safety in England chaired by Dame Judith Hackitt (RAE, 2017).

3.3.4.1 "The move in recent years to greater privatisation of building control and extensive use of private approved inspectors, appointed by clients rather than by local authority building control, generates significant conflicts of interest in the system. Private approved inspectors are contracted by building owners or contractors from whom they will often seek repeat business in competition with others, including local authority building control. This arrangement is not conducive to independent rigorous building control or assessment of regulatory compliance."

3.3.4.2 "The increase in privatisation of building control has also led to a decrease in capacity and technical expertise within local authorities, who are also not subject to formal qualification and training requirements unlike approved inspectors. This decrease in capacity has knock-on effects on the system. Firstly, approved inspectors have limited authority for regulatory enforcement, relying on referral to local authorities when needed. The decrease in capacity in local authorities means there can be a lack of capacity within building control to interpret and act on these referrals, which is problematic. Local authorities cannot recover costs for such enforcement actions which may be a further barrier to effective control. Secondly, as outlined above, the capacity for local authorities to identify and to feedback trends and changes in practice in the sector is also diminished, meaning regulations do not keep pace with changes in industry."

3.3.4.3 "There has also been decline in the presence of resident engineers and clerks of works on site. This is often due to clients being persuaded that the services of such inspectors are costly and unnecessary, without sufficient understanding of the role of these services in reducing risk."

3.3.5 While it is understood that having options in the market can be very beneficial, and that many projects have been completed with adequate regulatory control from the combination of LABC, approved inspectors, and competent person schemes, concerns associated with potential conflicts, capacity in the market, and ongoing quality control are all issues that should be taken into consideration in Scotland as well.

Australia

3.3.6 Australia has had the option of private certifiers or government building control since the late 1990s. Regulation of certification is addressed on a State and Territory level, so there is variability across the country. The relative effectiveness of private certification is in part a function of the clarity in legislation in each State and Territory, from qualifications of individuals to roles and responsibilities of private certifiers and local councils.

3.3.7 There have been concerns about private certification for several years, with concern in some States and Territories greater than others. The situation in New South Wales (NSW), for example, has been the focus of studies and reviews going back at least ten years.

3.3.8 A 2013 report by Mr. George Maltabarow, Building Certification and Regulation – Serving a New Planning System for NSW, looked at the planning system with a particular aim of proposing improvements to building regulation and certification (see http://bpb.nsw.gov.au/sites/default/files/public/Archive/Maltabarow-building-certification-report-May2013.pdf, last accessed 8 April 2018).

3.3.9 Of interest to the Scottish situation in particular, Maltabarow (2013) looking at the situation with respect to fire safety. Excerpts from the report are presented below:

3.3.9.1 "Extending formal compliance arrangements and accreditation in specialist areas raises a number of issues relating to scope, purpose and administration. A critical building system appropriately identified as involving complex and high risk technical issues is fire safety, where expert opinion is required in the assessment of alternative fire safety solutions before a construction certificate may be issued. This is an area where the industry is itself concerned about a number of current weaknesses, including:

- Around half of all complex building approvals involve at least some elements of engineered solutions (as opposed to "deemed to satisfy" designs which accord with BCA standards).

- The current NSW arrangements are for self certification by installers. In effect, the building owner (or developer) decides who is competent to certify design and installation.

- There is no occupational accreditation for "Fire Engineering" and licencing requirements administered by Fair Trading relating to "specialist work" under the Home Building Act are said to be ambiguous and at best contain gaps.

- There are a number of specialist areas involved including sprinklers; hydrants; mechanical air handling; structural design; and detection. It is unlikely that any professional would be competent in more than one to two of these areas.

- While there is some stability with larger installation and design providers, at the smaller end of the scale there is significant turnover (as with other parts of the construction industry).

3.3.9.2 Accordingly, a number of issues arise. Who should be accredited for compliance certification purposes? The installation and design company, or individual practitioners, or both? Which specific areas of competence should be targeted? Should accreditation be undertaken by the Government (via the Building Professionals Board?) or by the industry?

3.3.9.3 These issues no doubt apply to other specialist areas, but fire protection is perhaps the most critical and serves to illustrate the complexity of specialist certification and accreditation."

3.3.10 These are many of the same issues that Scotland is grappling with, and which should be considered as part of any decision on structure of the 'hub' for review of fire engineered designs.

3.3.11 Following the Maltabarow (2013) review, a more comprehensive review of the Building Professionals Act 2005 was undertaken in 2015 by Michael Lambert (available for download from http://bpb.nsw.gov.au/sites/default/files/public/Attachment%20A%20-%20Final%20Report.pdf, last accessed 12 April 2018).

3.3.12 In his report, Independent Review of the Building Professionals Act 2005, the stated purpose of the review was "to assess the effectiveness of the Building Professionals Act 2005 (BP Act) and the broader issue of the effectiveness of the building regulation and certification system that applies in NSW and to make recommendations to improve the operation of the Act and of the overall regulatory system". The review was broad-ranging, including consideration of the building certification system. The following reflect some findings in this regard:

3.3.12.1 "There is a significant level of concern by industry and the community about the current state of play with building regulation and certification..."

3.3.12.2 "There is a lack of clarity about the role and responsibility of certifiers and of the appropriate relation between councils, as consent authorities, and certifiers. This needs to be addressed by the clear documentation of the role, functions and activities required of certifiers in the form of a practice guide to which certifiers are held to account as well as an agreed protocol governing the relation between certifiers and councils."

3.3.12.3 “An important issue with respect to the certification system is the conflict between the accountability of certifiers for acting in the public interest and their commercial drivers for commercial success, including maintaining good relations with builders and owners/developers. While consideration was given to alternatives to private certification, it was concluded that the majority of certifiers are seeking to do the right thing in the right way and it is better to improve the accountability and transparency of the certification process and develop a culture of professionalism.”

3.3.12.4 “A major deficiency in the current building regulation and certification system is the approach to the regulation of the design, installation, commissioning and maintenance of fire safety systems and the handling of waterproofing which both need urgent reform.”

3.3.13 Additional discussion on the situation in Australia can be found in the report Competency Criteria for Local Authority Verifiers (LAVs) when Checking Fire Engineered Solutions for Compliance with Building Standards (Meacham, 2017).

Observations

3.3.14 While private certification is a viable option to assist in providing a range of options for building control, the effectiveness of such a system is, like any, related to the requirements of the system and its actors under pertinent legislation, the relationship to the balance of the construction sector, and the level of resources available.

3.3.15 Much like the situation of self-certification, a successful private certification system needs to be robust, well-considered, with the linkages to governing legislation clearly defined, the responsibilities, accountability and ethical expectations of participants clearly defined, vetted and audited, and supported by appropriate educational and training resources, guidelines governing work to be performed and how it is to be carried out, and appropriate checks and balances built into the system.

3.3.16 It is the opinion of the author that private certification of fire engineered designs may not be the best option for Scotland at this time, given shortcomings around qualifications of persons, qualifications systems, and the like, as outlined for ‘self-certification above.

3.4 USE OF PEER REVIEW

3.4.1 Many countries around the world make use of peer-review for specific parts or types of design, as deemed appropriate. This can occur within regulatory systems that are largely government focused (e.g., the USA and Scotland), where a choice of private certification or government certification is available (e.g., New Zealand), and even in some countries which permit self-certification (e.g., Sweden).

3.4.2 The situation in New Zealand was discussed in the 2017 report Competency Criteria for Local Authority Verifiers (LAVs) when Checking Fire Engineered Solutions for Compliance with Building Standards (Meacham, 2017) and is not reprinted in detail here. However, some of the concerns with peer-review for fire in New Zealand are pertinent to this research and are excerpted, with modification, and presented below.

New Zealand

3.4.3 There is widespread use of peer review in New Zealand. Various concerns have been raised due in part to engineering being unregulated, that the size of the market is limited market, and there is an overall lack of control of the peer review process.

3.4.4 With respect to regulation of the practice of engineering, there is none in New Zealand. In addition, there is no restriction on the use of the title engineer. Feedback from the sector,[1] including engineers, BCAs and the fire service, suggests that the practice of allowing anyone to call themselves an 'engineer' and practice engineering is having a detrimental impact. Feedback suggests that bad actors are negatively influencing the peer-review process, that they are consuming significant time of the BCAs, and that they can be working for BCAs and other enforcers, as well as in practice.

3.4.5 The current approach is largely voluntary registration via the Institution of Professional Engineers New Zealand (IPENZ), where the fire engineering qualifications are managed by the New Zealand Chapter of the Society of Fire Protection Engineers. This system generally works well for those professionals who hold the relevant qualifications and abide by the requirements. However, since this is not required, this leaves space for un- or under-qualified persons from practicing as fire engineers.

3.4.6 There is also a requirement within some BCAs of having lists of fire engineers as reported via Producer Statements. However, this is also largely a self-reporting system, and feedback suggests that this too does not seem to be working.

3.4.7 Much like the situation in Scotland, it is suggested that minimum competency criteria to define the practice of fire engineering needs to be established. Qualifications should be based on demonstration of competency, along with practical experience, obtained under the mentorship of a qualified engineer.

3.4.8 The concerns regarding the peer-review system are highly related to the competency and qualification issue, since unqualified persons are able to practice by law (or as a result of the lack of regulations which say otherwise). For a peer review system to work as intended, the system must be based on persons with appropriate qualifications. In addition, there must be an adequate number of qualified engineers in the market so as to maintain appropriate separation between design and review, so as to minimise the potential for 'overly friendly' relationship form, in which the designer and reviewer are in the position of changing roles from project to project.

3.4.9 In addition to peer review, there is also review by the fire service, but the nature of the review has changed with time. The previous Design Review Unit (DRU) reviewed designs in great detail. Many issues were found (Wade, 2009). The current requirements are for the fire service to be consulted. This is causing some concern.

---

[1] Feedback was obtained via interviews with stakeholders in New Zealand conducted by Meacham Associates in 2016, as well as through a survey conducted by Brian Meacham in early 2017 as to the situation with performance-based codes and fire safety design around the world. More complete presentation of the outcomes of these efforts is forthcoming.

3.4.9.1 Section 47 of the Building Act 2004 allows the New Zealand Fire Service Commission to provide advice in a memorandum to the BCA with respect to provision of means of escape for fire and in respect of the needs of persons authorised by law to enter the building to undertake firefighting and rescue operations. To perform this role, the New Zealand Fire Service (NZFS) established a unit called the Design Review Unit (DRU) that began conducting reviews of fire engineering designs in late April 2005.

3.4.9.2 An audit was conducted of 25 fire engineering reports and associated building consent documentation submitted to the DRU by various BCAs in New Zealand along with the associated DRU memorandum prepared in response (Wade 2009). Two findings of interest were that: the International Fire Engineering Guidelines have not gained significant uptake amongst the New Zealand fire engineering fraternity, with only one of the reports reviewed including a Fire Engineering Brief; and, in approximately 40% of cases, the investigation conducted in support of a fire "alternative solution" design was not considered to be satisfactory or the analysis was not sufficiently rigorous.

3.4.10 While the DRU was shown to be effective by this audit, subsequent regulatory change meant that the NZFS only needs to be consulted, which typically occurs at the FEB stage (when conducted), so such detailed reviews are no longer routinely conducted by the NZFS. In addition, there is inconsistency related to when the NZFS consultation is requested and how the reviews are undertaken. This is similar to challenges in Scotland, where the role of the fire service in the review process is not well defined or nationally consistent. It is suggested that this should be addressed as part of the overall consideration of the situation with verifier qualifications and competency and possible approaches for review based on complexity of the design and associated analyses.

USA

3.4.11 In the USA, the building regulatory system remains largely prescriptive. However, it is permitted to undertake 'alternative designs' (engineered / performance-based design), often assessed in terms of 'equivalency' to the intent of the prescriptive provisions. These 'alternative designs' can pertain to all areas of the codes including structural and fire engineering. The level in which these designs are reviewed and how they are approved varies significantly.

3.4.12 In general, within small jurisdictions, there remains some apprehension when approving such designs, in part due to lack of clear guidance, expertise and education. These smaller jurisdictions typically do not have the staffing and either will reject the design, look to a third-party reviewer, or simply depend upon the qualifications of the designers. In larger and more significantly funded and staffed building departments, however, there is often one or more engineers on staff, which may include structural, mechanical, and fire engineers, which enables the department to conduct in-house design reviews. This is the case for most large city building departments (e.g., New York City, Chicago, Los Angeles, San Francisco, Boston, etc.). Even so, these departments often enhance this by requiring a peer review on the design.

3.4.13 Depending on the legal situation in a state, infrastructure and comfort level with performance designs, the approvals process will vary widely. For instance, Clark County Nevada and the City of Las Vegas are very accustomed to unique designs and have a specific protocol and procedure for review of such designs. By contrast, smaller jurisdictions that have not been exposed to performance design will typically not have procedures in place to address the review of such designs.

3.4.14 In the Commonwealth (State) of Massachusetts, there is a legislated process for performance designs, including a requirement for engagement of a qualified peer reviewer. Chapter 9 of the Massachusetts State Building Code includes the following requirements for performance-based fire design submittals and reviews:

3.4.14.1 "Any fire protection system or portion thereof not required by this code shall be permitted to be installed for partial or complete protection provided that such system meets the requirements of this code.

> Where alternative fire protection designs, which vary from any prescriptive requirements of this Chapter, are to be utilized, the owner shall engage an independent registered design professional, to review said alternative design. The scope of the review shall include, but not be limited to:
>
> Design assumptions, methodologies, and resulting proposed system designs, to determine whether or not:
>
> - the proposed fire protection systems and any other systems which are affected by the alternative design, are consistent with the general objectives and prescriptive provisions of this Chapter;
>
> - they all conform to accepted engineering practice.
>
> Preparation of a written report to the building official as to the appropriateness of the proposed design specifically listing any variances from the prescriptive provisions of this Chapter and describing, in detail, the design provisions used to achieve compliance.
>
> If the reviewing engineer concurs with the proposed design, the owner shall make application for a variance, to the State Building Code Appeals Board as provided in section 113.0. In addition to all supporting information and materials, the reviewing engineering's report required per this exception shall be included in the application for variance. A building permit shall not be issued until the variance, if required, has been granted, or unless the building permit is issued in part per section 107.3.3."

3.4.15 In the Commonwealth of Massachusetts building regulatory approval scheme, the local building code official cannot approve an engineered fire safety design. By law, all 'alternative fire protection designs' (engineered fire safety designs) require a peer-review as outlined above, and must then be presented to the State Building Code Appeals Board for final approval. In some ways this is like the 'Multi-Actor Review and Approval' processes discussed below; however, it is limited solely to engineered designs and not 'code-compliant' designs (i.e., Technical Handbook compliant designs, in the Scottish context).

Observations

3.4.16 Peer review can be an effective mechanism to assist in the review and approval (verification) of fire engineered designs. However, much like with the discussion on self-certification and private certification, there is a significant reliance on the qualifications, experience, and ethics of the reviewer, which can often be functions of the regulatory environment within which the reviews are undertaken. If well-regulated, the process seems to run smoothly (e.g., Massachusetts). If many components are unregulated (e.g., New Zealand), there can be significant concerns.

3.4.17 It is the opinion of the author that an adequately regulated and managed peer-review system can be beneficial to Scotland. Peer-review is used currently, and largely seems to work adequately. Improvements can arguably be made if issues associated with qualifications, competency and conflict of interest (ethics) are addressed, and a more systematic approach to when required and how used, are addressed.

3.5 MULTI-ACTOR REVIEW AND APPROVAL

3.5.1 Some jurisdictions include numerous regulatory checks and balances with respect to verification (review and approval) of fire engineered (and other) designs. Two highlighted here are Germany and Singapore.

Germany

3.5.2 The professions "Engineer" and "Consulting Civil Engineer" are regulated in Germany. This means that the pursuit of these professions is linked under government regulations to the possession of certain qualifications. In Germany, the occupational title of “consulting engineer” is a requirement for working as a ‘test engineer’ or as a recognised expert. In order to earn the right to hold such an occupational title, engineers need to demonstrate an additional three years of occupational experience following completion of a degree in engineering and also need to have completed certain advanced training courses (from https://www.anerkennung-in-deutschland.de/html/en/engineer.php, accessed on 9 April 2018).

3.5.3 The combination of regulation, design by experts, review by experts, and review and approval by local jurisdiction is complex. A rather comprehensive overview is provided in the White Paper, German Fire Safety - Rules and Regulations, by Kaiser (2015). A free download is available at https://www.feuertrutz.com/white-paper-german-fire-safety/150/50448/ (last accessed 9 April 2018). The following is excerpted from this White Paper with modifications.

3.5.4 Legislative powers for the building regulations law lies within the sovereignty of the sixteen federal states within Germany. Access to the sixteen different building regulations law stipulations can be found on the website of the Construction Ministers’ Conference – a conference of the ministers responsible for city planning, building and housing and the senators of the states, commonly referred to as “ARGEBAU” for short (see www.is-argebau.de).

3.5.5 The ARGEBAU publishes a model building code (MBC), which can be adopted by state and local municipality. The respective building codes – also called state building codes (SBC) [Landesbauordnung (LBO)] – can be also accessed electronically at the ARGEBAU website.

3.5.6 The MBC and special construction regulations provide largely qualitative requirements and protection objectives (i.e., functional standards). The responsible ‘supreme’ building supervisory authorities of the states (i.e., state officials) establish additional regulations that provide guidance for meeting the building regulations law. These technical building regulations (TBR) [Technische Baubestimmungen (TBB)] include a great number of technical rules for the planning, design and construction, and therefore including fire prevention.

3.5.7 Those involved in the construction can be divided into two categories: parties mandated by and operating under public law, and parties operating under private sector laws governing actors in the building construction process.

3.5.7.1 Those acting under public law include checking authorities' which undertake responsibilities of public administration as publicly approved persons. This includes expert inspectors/engineers for fire prevention and expert inspector for engineered safety systems and facilities.

3.5.7.1.1 Expert inspectors/engineers for fire prevention must be appointed by publicly appointed bodies, which varies by federal state and can be, for example, the chamber of architects or engineers, or the chamber of trade and commerce, of the respective federal state. Generally, the expert inspectors/engineers for fire prevention must have a university degree as well as other specific professional experience (mostly at least five years) and prove their knowledge. The names of expert inspectors/engineers for fire prevention are included on special lists indicating them as such.

3.5.7.1.2 Expert inspectors for engineered safety systems and facilities also act under official orders – mostly under private law governing commissioning by the building owner or operator – and must also have a verifiable public license. Generally, the expert inspectors/engineers for safety systems must have a university degree as well as other specific professional experience (mostly at least five years) and must prove their knowledge via the responsible engineer chambers. Their certification must be recognized by the respective state building authorities and is published.

3.5.7.2 Those acting under private law include building clients, architects, specialised planners (including fire protection), contractors and building operators. This includes the private fire prevention experts (Brandschutz Sachverständiger). The private fire prevention experts must generally also have a university degree (e.g., architecture, civil engineering or fire prevention), specific sufficient professional experience (usually at least five years) and special qualification evidence. This must be verified by the respective publicly approved bodies, such as chambers of architects, engineers, building or trade and commerce in special oral and written exams. Just like the *expert* inspectors/engineers for fire prevention, the state approved private fire prevention experts are then included into the special lists.

3.5.8 At the start of a project, the private fire prevention experts (Brandschutz Sachverständiger) develops a fire safety concept. This is required for most buildings over 7 m in height, as well as special buildings.

3.5.9 Applications for construction projects will be examined for fire protection on behalf of the local community (or the building client) – depending on the respective federal state – by officially acting expert inspectors/engineers for fire prevention. During the execution of construction work, the expert inspectors/engineers for fire prevention will check at their own discretion the examined building applications and will attest to their implementation to the local authorities.

3.5.10 As part of project works, there is a need to engage an expert inspector for engineered safety systems and facilities. For the commissioning of specified buildings (mostly special constructions), expert inspectors for safety systems and facilities check the operational safety and efficacy of safety systems stipulated by building regulations law in their respective speciality. These include fire alarm, alerting, automatic fire extinguishing, safety power supply, smoke extraction and forced ventilation systems for firefighter lifts and/or safety stairwells. They test the function of the respective systems for the owners (or operators) who are required to pass these reports onto the local building supervisory authorities. Beyond that, they carry out the repeat tests for these systems required by law, generally every three years.

3.5.11 The overall structure of the German system is shown in Figure 3.1 below.

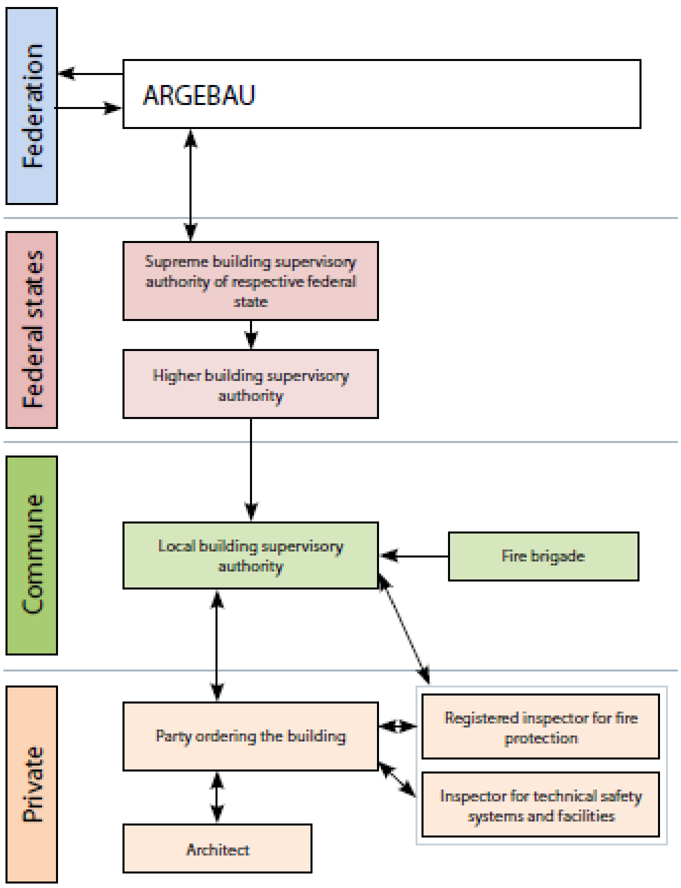

Figure 3.1 Regulatory Hierarchy and Relationships in Germany

Singapore

3.5.12 Singapore is a highly regulated country, and building and fire safety design is no exception. The situation is similar in some respects to Japan, in particular, the split of responsibilities between the Building Code, which is administered by the Building and Construction Authority (BCA), and the Fire Code, which is administered by the Singapore Civil Defence Force (SCDF). Much like in Japan, the Building Code addresses issues of fire resistance, smoke control and egress, and the Fire Code addresses issue of detection, notification, suppression and fire department access.

3.5.13 With respect to performance-based design for fire, the SCDF has implemented a very specific approval process. The key stakeholders involved in the performance-based plan submission process include:

- Building Owner/Developer
- Qualified Persons (Architectural/ M&E/ Civil & Structural)
- Fire Safety Engineer (FSE)
- Peer Reviewer (PR)
- Registered Inspector (RI)
- Singapore Civil Defence Force (SCDF)

3.5.13.1 The plan submission process involving performance-based solutions is as follows:

3.5.13.1.1 **Engaging Fire Safety Engineer (FSE)**

3.5.13.1.1.1 The building owner is required to engage an FSE for the preparation of performance-based solutions as part of the plan submission to SCDF. It is also to be noted that for fire safety engineering design involving structural solution, the owner needs to engage a FSE who is also a Professional Engineer (PE) in the civil/structural engineering discipline. If the FSE is not a PE (civil/structural), the owner will need to engage a PE (civil/structural) to work together with the FSE.

3.5.13.1.2 **Preparing Fire Safety Engineering Design Brief (FEDB)**

3.5.13.1.2.1 The FSE is required to produce a preliminary report - Fire Safety Engineering Design Brief (FEDB) to be submitted to SCDF for in-principle agreement. The FEDB details the proposed fire safety engineering approach, methodology, and software tools etc. The FSE may consult SCDF on his FEDB proposal prior to its submission.

3.5.13.1.3 **Assessment of FEDB by SCDF**

3.5.13.1.3.1 The FEDB will be assessed by SCDF. Upon the in-principle agreement of the FEDB, the FSE can proceed to prepare the following documents: (a) Revised FEDB, if conditional agreement is given (b) Fire Safety Engineering Report (FER) (c) Building Operations and Maintenance Manual (O&M). In the event that the FEDB is rejected, the FSE will have to go through the process of consultation and re-submission of the FEDB for SCDF's consideration and agreement.

3.5.13.1.4 **Engaging Peer Reviewer**

3.5.13.1.4.1 After the preparation of the above documents by the FSE, the owner is required to engage a Peer Reviewer to assess the above documents and ensure that the performance-based solution is incorporated in the Building and M&E plans. The Peer Reviewer shall produce a report of his assessment in a Peer Reviewer's report.

3.5.13.1.5 **Plans Submission by Qualified Person (QP)**

3.5.13.1.5.1 The Project QP is responsible for collating all the above documents for plans submission to SCDF. Plans containing the performance-based solution shall be endorsed by both the QP and the FSE. QPs who are also qualified FSEs may endorse in the capacity of both the QP and the FSE.

3.5.13.1.6 **Audit Checks by SCDF**

3.5.13.1.6.1 The submitted plans and documents may be selected by SCDF for subsequent audit checks.

3.5.13.1.7 **Engaging Registered Inspector (RI)**

3.5.13.1.7.1 Upon completion of the fire safety works, the owner is required to engage a Registered Inspector who is an FSE to inspect the performance-based aspects of the fire safety works.

3.5.13.1.8 **Declaration and Endorsement**

3.5.13.2 The flowchart in figure 3.2 below illustrates the process for performance-based plan submission and review. Note: Under the Fire Safety Act, performance-based solutions are also known as 'alternative solutions'.

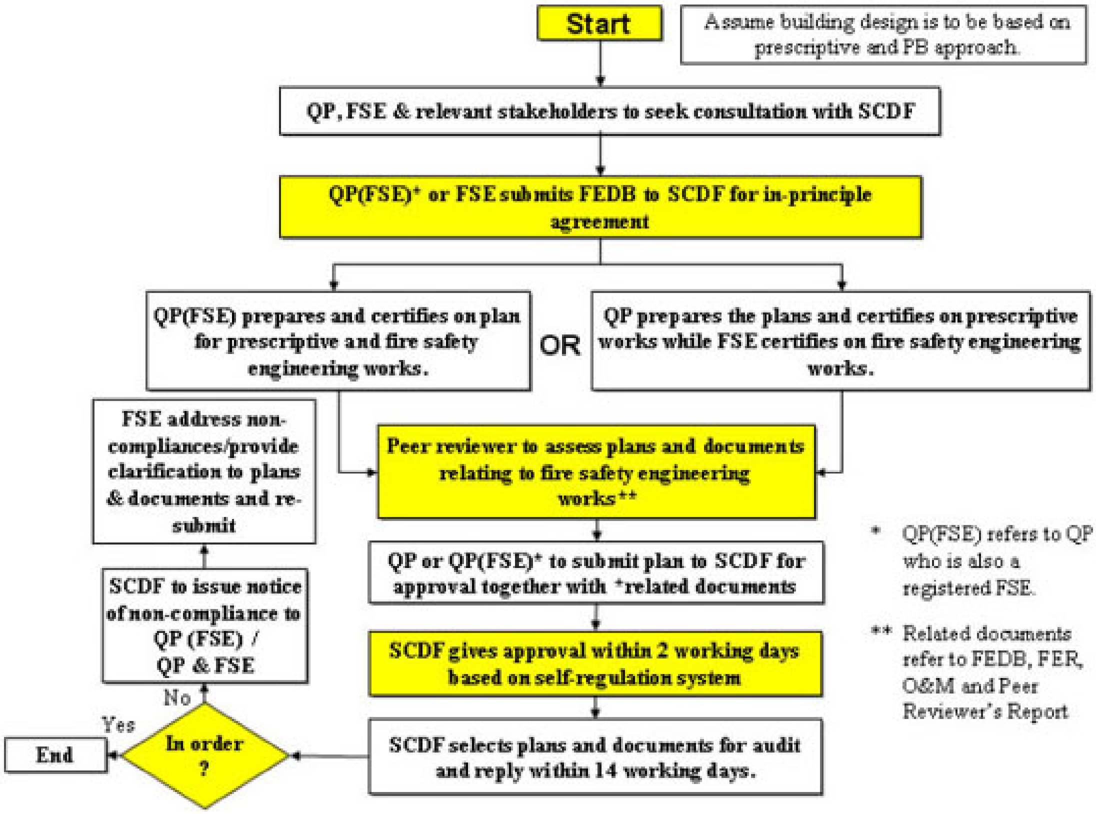

Figure 3.2 – SCDF Flowchart for performance-based plan submission

Observations

3.5.14 Multi-actor review and approval (verification) can lead to a high-degree of confidence, given the numbers of checks and balances in the system. However, such systems can be extremely resource-intensive, costly and time consuming, and there needs to be significant capacity within the government and private sector.

3.5.15 Given the resource limitations around fire engineers in Scotland, and limited resources for LAVs and the Scottish Fire and Rescue Service, it does not seem practicable to move towards such a system at this time, at least in the breadth of actors involved in Germany or the layers of requirements of Singapore. However, aspects of the multi-actor approach are helpful and should be considered.

3.6 MULTIPLE VERIFICATION ROUTES - JAPAN

3.6.1 The building regulatory system in Japan is complex, particularly for fire safety, since building fire safety designs must comply with two laws: the Building Standard Law (BSL), which addresses fire resistance, smoke control and egress, and the Fire Service Law (FSL), which address suppression, detection, notification systems, and fire service access.

3.6.2 Both the BSL and the FSL are performance-based. However, there are different routes to compliance. In addition, there are three routes for compliance, depending on whether strict compliance with specific provisions (Route A), compliance with ordinary verification methods (prescribed performance, Route B), or designed using advanced verification (calculation) methods (engineered / performance-based design, Route C). Furthermore, there are both governmental and private sector building confirmation and inspection bodies (verifiers), which can be used for Route A or B; however, for Route C designs, the design must be submitted for approval by a minister-appointed designated performance evaluation body.

3.6.3 The basic building verification process is illustrated below.

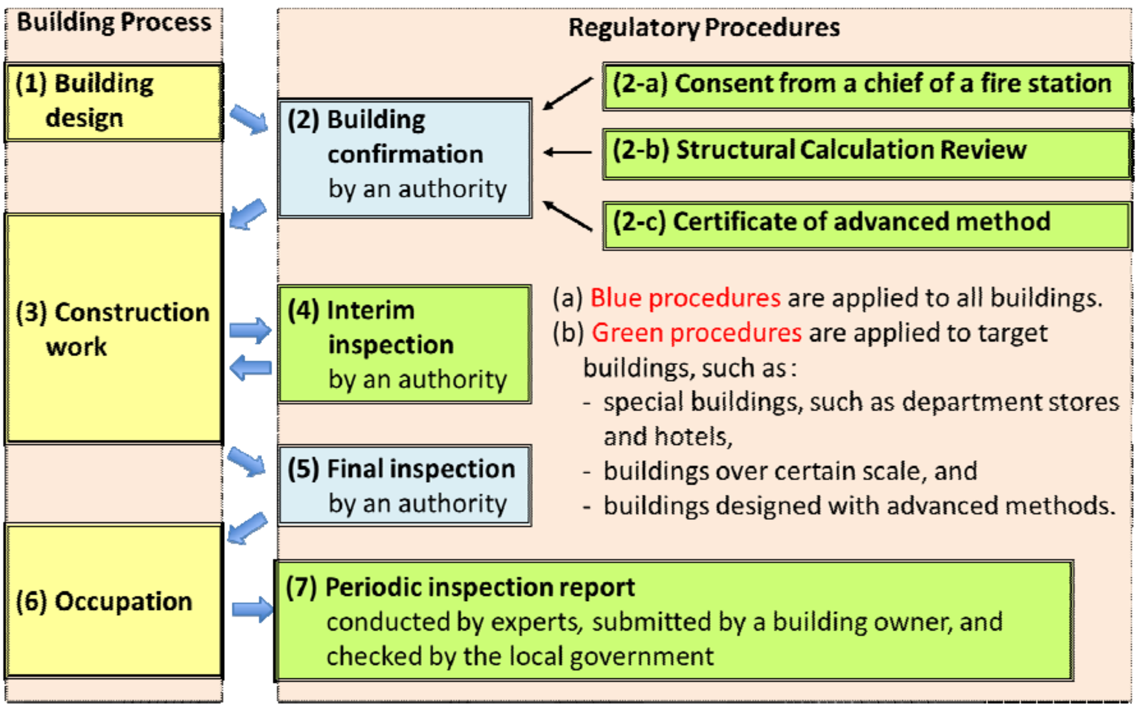

Figure 3.3 – Basic Building Verification Process in Japan

3.6.4 Building confirmation (verification) and on-site inspection can be undertaken by one of two types of authorities, as in the figure above: qualified Building Officials working for local government (Designated Administrative Body), or private sector Designated Confirmation and Inspection Bodies. In the case of the latter, the work is undertaken by Conformity Inspectors who have passed a qualifying examination of Qualified Building Regulation Conformity Inspectors. A certificate of compliance issued by a Designated Confirmation and Inspection Body is the same as that issued by a qualified Building Official under the local government. In recent years, most building confirmations are undertaken by Designated Confirmation and Inspection Bodies.

3.6.5 With respect verification of performance-based fire designs (and fire engineered designs, as would be the terminology used in Scotland), the process is illustrated in Figure 5.2 below. As noted above, compliance with the specific (prescriptive) provisions and with the ordinary verification methods (as might be considered C/VM2 in New Zealand) can be approved by a Building Official working for government or by a Designated Confirmation and Inspection Body. However, for an advanced verification method approach (fire engineered design in Scotland, i.e., BS7974 type), evaluation is required by a Designated Performance Evaluation Body.

3.6.6 Details of the Ordinary Verification Methods are stipulated in the Enforcement Order and in the MLIT Notifications. On the other hand, details of the Advanced Verification Methods are not issued by the Government. Designated Performance Evaluation Bodies evaluate the design/solution of a building, using a manual approved by the Minister, then the applicant sends the evaluation body decision, along with drawings, to the Minister to request approval.

3.6.7 At present there are 27 Designated Performance Evaluation Bodies. For review of fire engineered designs, these bodies engage the most senior researchers and academics in fire in Japan. These specialists tend to be quite conservative, and the benchmark is typically the methods of the ordinary verification methods (i.e., algebraic equations, two-zone fire effects models, etc.). In fact, it has been reported that it is very difficult to get a design approved which uses CFD analysis, given the difficulty in demonstrating verification and validation of CFD codes.

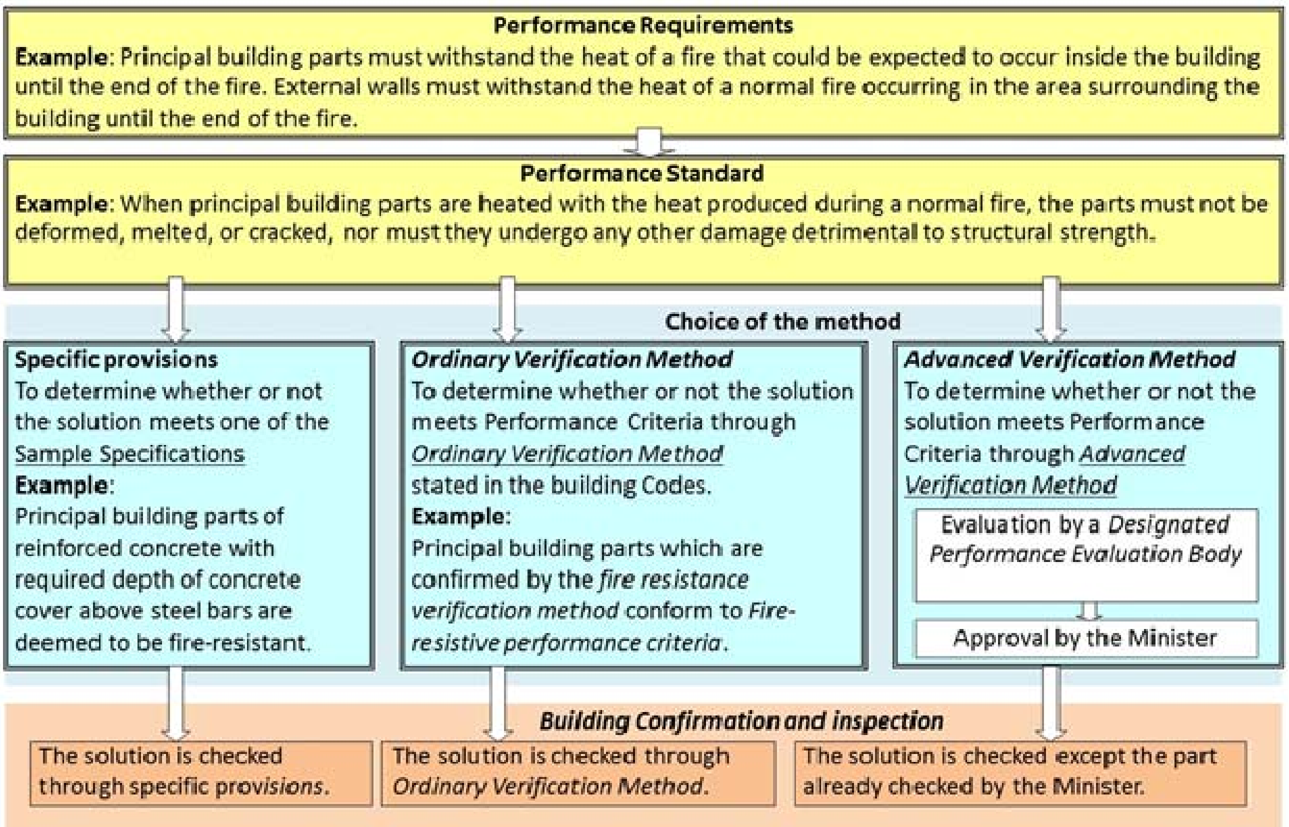

Figure 3.4 – Review Process for Performance-Based Designs in Japan

Observations

3.6.8 A multiple verification approach, based on level / complexity of design, can provide for a system that can effectively allocate resources where needed, and utilise a range of actors with a diversity of expertise, competencies and qualifications. By having three distinct approaches to compliance, i.e., prescriptive, 'prescribed performance', and full performance (fire engineered) designs, resource can be allocated where needed based on the number of designs undertaken within each level.

3.6.9 It is the opinion of the author that such an approach could be beneficial for Scotland, in that a majority of designs are 'prescriptive' (Technical Handbook compliant), with the next greatest number 'minor' deviations, and the smallest number the 'full' fire engineered designs. Such a system would be helped by introduction of a 'fire verification method' as well, although that is not required.

3.7 GOVERNMENT OPINION / DETERMINATION / VIEW / APPEAL

3.7.1 Most countries / jurisdictions have mechanisms for challenging building regulatory decisions, both outside of and within the judicial system. The first step is typically within the building regulatory system, either at a local, regional or national level, depending on the country and issue. This section focuses on this level and not challenges or appeals brought before the judiciary.

Scotland

3.7.2 The building regulatory system in Scotland is national. As such, challenges to decisions are primarily at the Ministerial level. In Scotland there are two Ministerial level processes when compliance is in doubt or the applicability of a portion of a regulation is in doubt: Ministerial Views and Relaxations. The following is excerpted from the Scottish Building Standards Procedural Handbook, 3rd Edition (2015).

3.7.3 **Ministerial Views**

3.7.3.1 To assist verifiers and applicants for warrant in cases where there is doubt on whether proposals satisfy the regulations or whether continuing requirements need to be imposed as conditions of the warrant, Scottish Ministers may give a view on the matter. Verifiers must have regard to any view given when determining the application. It should be noted that a formal view will not be given on matters certified by an approved certifier of design.

3.7.3.2 Either the applicant for warrant or the verifier may choose to request a view. However, a view is only given if, in the words of the Act, the BSD (on behalf of Scottish Ministers) 'think fit'. It will be regarded as unusual to give a view if only one party seeks to approach the BSD. The intention is not to act as an unofficial appeal mechanism but to assist where there is genuine doubt as to the extent to which a proposal meets the regulations.

3.7.3.3 The BSD does not normally consult on their view as it is intended to be a fast response service.

3.7.4 **Relaxations**

3.7.4.1 For any particular building, a person may apply to Scottish Ministers for a direction to either relax or dispense with a provision of the building regulations. The building regulations designate certain provisions that may not be relaxed, although there is currently no designation in relation to the building standards themselves.

3.7.4.2 Where Scottish Ministers consider it unreasonable that the provision should apply to that building they may issue a direction. The direction may set conditions and a date for expiry. Any direction may also be revoked or varied by a further direction. There is no requirement to consult before issuing a direction in relation to a particular building but the fire service will normally be consulted for any question related to fire matters. If the application for relaxation relates to an existing warrant application and particularly where a warrant has been granted, the verifier will also normally be consulted.

3.7.4.3 There are differences between relaxations under the 2003 Act and those previously given under the 1959 Act. The new form of expanded functional regulation gives more opportunity for flexibility and most cases can be decided by verifiers by interpretation of the requirements in schedule 5 of the building regulations. A relaxation or dispensation is for cases where a requirement is clearly, in whole or in part, unreasonable for a particular building. There is an appeal mechanism, as applicants may challenge a decision of the BSD, in relation to relaxations, in the sheriff court.

3.7.5 There is also the opportunity to appeal to the Sheriff's Court on the following matters:

- where Scottish Ministers refuse an application to relax or dispense with a provision of the building regulations
- where a verifier refuses to grant or amend the terms of a warrant, including deemed refusals resulting when the verifier has not made a decision within the specified time limits
- where a verifier refuses to extend the life of a limited-life building, including deemed refusals resulting when the verifier has not made a decision within the specified time limits
- where a verifier rejects a completion certificate, including deemed rejections resulting when the verifier has not made a decision within the specified time limits
- where a verifier imposes continuing requirements
- where a verifier refuses to discharge or vary a continuing requirement
- where a local authority serves a notice (regarding building regulations compliance, continuing requirement enforcement, building warrant enforcement, defective or dangerous buildings).

New Zealand

3.7.6 New Zealand has a national building regulatory system. As such, challenges to building regulatory decisions are at the Ministerial level. The following is excerpted from the website of the Ministry of Business, Employment and Innovation (MBIE), under which the Building Standard sit (https://www.building.govt.nz/resolving-problems/resolution-options/determinations/).

3.7.6.1 A determination is a legally binding ruling made by the Ministry of Business, Innovation and Employment (MBIE) about matters of doubt or dispute to do with building work. They are not for civil disputes or disputes about workmanship. Most determinations are applied for by building owners, but councils and other people can sometimes apply.

3.7.6.2 Determinations can look at whether a building or building work complies with the Building Code. They can be about building work that is planned, partly done or complete. When you can't agree with a council's decision about building work, a determination can help you solve the problem. They are sometimes for when a council has failed to act or refused to make a decision.

3.7.6.3 You may have already asked MBIE for an opinion or advice about the same question. A determination is different because MBIE takes a detailed look at the specific matter and makes a legally binding decision. The law that covers determinations is set out in the Building Act 2004 (sections 176-190).

3.7.6.4 MBIE can make a determination about whether a building or building work complies with the Building Code or a council's decision on a set of specified items (see https://www.building.govt.nz/resolving-problems/resolution-options/determinations/ for the list).

3.7.6.5 Someone might want a determination when: a council refuses to issue a building consent for a proposed building; a building owner has been refused a code compliance certificate for a building that appears to be completed and the owner believes is compliant; building work on a neighbouring property is affecting the stability of adjacent land; or, a building owner disagrees with the contents of a notice to fix.

3.7.6.6 The determination can: make a decision on whether building work complies with the Building Code, and/or confirm, reverse or modify an earlier decision made by the council. For example, a determination may say the council was correct in not issuing a building consent.

3.7.6.7 A determination can also make waivers or modifications to the Building Code. For example, a determination may modify the time period for which the building must be durable make conditions that the council may itself grant or impose. For example, a determination may require the council to issue a building consent with certain conditions.

3.7.6.8 If any party is not satisfied with the determination, they can take the matter to court. The courts can decide whether the decision reached in the determination is correct. This is called an appeal. The courts can also decide whether determination-making process was correct and fair. This is called a judicial review. You need to wait until MBIE have issued the determination before you can ask for an appeal or judicial review.

USA (New York City)

3.7.7 The power for implementing and administering building regulators in the USA rests with the States, which may in turn give that power to regional (i.e., county) government or local government. As such, challenges to building regulatory decisions may be at the state, county or municipal level, as well as at the local level.

3.7.8 In New York City (NYC), for example, there is a two-stage process for appealing a decision on compliance with the construction codes (which include building code (regulation)): determination process and appeals.

3.7.8.1 Determination requests may be submitted to the Department of Buildings for (a) a possible future objection for an application not yet filed, and (b) appeal of an affirmation of objection after second plan review (https://www1.nyc.gov/site/buildings/business/determinations.page).

3.7.8.1.1 The determination request will be reviewed by the appropriate borough office. The request will either be accepted, denied, or require the applicant to meet with the Department for further review.

3.7.8.1.2 When the borough office denies a determination request, the applicant may submit an appeal to the Department's Technical Affairs Unit (requires payment of $2,500 appeal fees).

3.7.8.1.3 When the Department denies an appeal, applicants may make any subsequent appeals to the Boards of Standards and Appeals.

3.7.8.2 The New York City Board of Standards and Appeals is an integral part of the City's system for regulation of land use, development and construction. The Board is empowered by the City Charter to interpret the meaning or applicability of the Zoning Resolution, Building and Fire Codes, Multiple Dwelling Law, and Labor Law. This power includes the ability to vary in certain instances the provisions of these regulations (http://www1.nyc.gov/site/bsa/about/about.page).

3.7.8.2.1 The majority of the Board's activity involves reviewing and deciding applications for variances and special permits, as empowered by the Zoning Resolution, and applications for appeals from property owners whose proposals have been denied by the City's Departments of Buildings, Fire or Business Services. The Board also reviews and decides applications from the Departments of Buildings and Fire to modify or revoke certificates of occupancy.

3.7.8.2.2 The Board can only act upon specific applications brought by landowners or interested parties who have received prior determinations from one of the enforcement agencies noted above. The Board cannot offer opinions or interpretations generally and it cannot grant a variance or a special permit to any property owner who has not first sought a proper permit or approval from an enforcement agency. Further, in reaching its determinations, the Board is limited to specific findings and remedies as set forth in state and local laws, codes, and the Zoning Resolution, including, where required by law, an assessment of the proposals' environmental impacts.

3.7.8.2.3 The Board, pursuant to the 1991 City Charter, contains five full-time, Mayoral-appointed commissioners. By law, the Board must comprise one planner, one registered architect, and one professional engineer. No more than two commissioners may reside in any one borough.

Observations

3.7.9 It is the opinion of the author that Scotland should retain the Ministerial Views process, and the Ministerial Relaxation process, as currently exists. The ability to have an appeals mechanism, prior to entering the judiciary system, provides more opportunity for identifying and resolving issues within the sector. Such an option widely exists, and there seems to be no reason to move away from it in Scotland.

4 High Risk and Complex Buildings

4.1 INTRODUCTION

Risk

4.1.1 Risk means different things to different people. There are numerous definitions and interpretations of risk. Risk can be qualitative or quantitative. From an engineering perspective, risk is often represented as a function of the likelihood (probability) that a particular consequence (unwanted outcome) will occur. When using 'risk' in a guidance document, it is imperative that its use, interpretation and application are clear. Unfortunately, this is not the case with the Technical Handbooks.

4.1.2 The term 'risk' is used in a widely varying manner throughout the Technical Handbooks, in particular non-domestic, with differences between regulated areas (e.g., Structure and Fire), and within a single area (e.g., Fire). For example:

4.1.2.1 Section 1: Structure has four building 'risk groups': 1, 2A, 2B and 3, which relate to occupancy level, use, the number of storeys and floor areas.

4.1.2.2 In Section 2: Fire Introduction, the term 'risk' is used 22 times. Some examples include:

- "… where people may be asleep or where there is a particularly high risk."
- "Occupants in buildings do not normally perceive themselves to be at risk from fire and are not usually aware of the speed that fire can spread."
- "Protected routes of escape - throughout the document there are references to protected routes of escape these include: …places of special fire risk, …"
- "Certain types of buildings pose particular risks and require particular solutions. Additional guidance for three specific building types are grouped in three annexes; residential care buildings in annex 2.A; hospitals in annex 2.B and enclosed shopping centres in annex 2.C."
- "Persons with obligations under Part 3 of the Fire (Scotland) Act 2005, as amended are required to carry out a fire safety risk assessment which may require additional fire safety precautions to reduce the risk to life in case of fire."
- "Construction products are expressed as non-combustible low, medium, high or very high risk and explained in annex 2.E."

4.1.2.3 In these examples there is, among others, reference to 'particularly high risk,' 'special fire risk,' 'particular risks,' 'risk to life in case of fire' and 'low, medium, high or very high risk' – each of which has very different meanings.

4.1.2.3.1 The reference to 'particularly high risk' implies life safety risk to occupants due to activity or vulnerability, such as sleeping.

4.1.2.3.2 The 'particular risks' refer to specific building types: residential care buildings, hospitals and enclosed shopping centres. This could be related to activity or vulnerability, but also to total number of occupants.

4.1.2.3.3 The 'particular risks' might also be the 'places of special fire risk' but that is unclear, since industrial or similar occupancies might present higher risk of fire occurrence, or higher risk of losses due to fire, but not necessarily higher risk to life from fire. In Section 2.1.8 of the Technical Handbook, paint spraying is the only 'place of special fire risk' noted; however, in the definitions, Appendix A, other 'risks' are listed.

4.1.3 This widely ranging use of the term 'risk', within the Technical Handbook guidance, can create challenges in interpreting, applying and the guidance for verification purposes.

4.1.4 As a general observation, it would be extremely helpful from a usability perspective, to develop and implement a common approach to the use of risk, risk classifications, risk levels, and the like, throughout the Technical Handbook. While outside of the scope of this research project, this warrants future attention.

4.1.5 In discussion below, suggestions are provided for how to characterise risk (focused on fire) and how a more uniform approach to classification for fire risk might be represented.

Complexity

4.1.6 Complexity, too, can vary in meaning and by perspective. By one definition, complexity is "the state or quality of being intricate or complicated," where 'complicated' is defined as "consisting of many interconnecting parts or elements" (https://en.oxforddictionaries.com/definition/complexity).

4.1.7 While arguably all buildings consist of many interconnecting parts and elements, and are therefore complex, many approaches to reducing complexity have developed over time, including standardised approaches to space utilisation (e.g., 'standard' office configurations), building components and systems (e.g., door sizes, structural systems, etc.), and construction.

4.1.8 As with the term 'risk' discussed above, the terms 'complex' and 'complexity' are used throughout the Technical Handbooks. With respect to fire, the most common applications seem to be as related to the following:

- Complexity of the building design, in part driven by the use, for example shopping centres, transportation hubs, multi-use buildings, and the like.
- Complexity of the fire engineering design, including use of multiple types of fire mitigation systems and strategies.
- Complexity as associated with the understanding and prediction of human behaviour in fire.
- Complexity of the analyses and tools of analysis.

4.1.9 These uses of the terms complex and complexity are explored in more detail below.

4.2 CHARACTERISING 'HIGH RISK' BUILDINGS WITH RESPECT TO FIRE

4.2.1 There has been much published in the literature regarding characterising risks in and of buildings from a wide range of hazards, including by the author, with a particular focus on fire (e.g., Meacham, 2004; 2007, 2010; Meacham and van Straalen, 2017). The term 'higher risk residential buildings' was recently introduced in the report by Dame Judith Hackitt (2018).

4.2.2 While a Scotland-specific risk characterisation process is ultimately needed, it is suggested that to begin with consideration of fundamental components that have been identified in previous efforts: hazard factors, risk factors and importance factors be undertaken.

4.2.2.1 Hazard factors are developed in response to such questions for example, what is posing the risk, what is the nature of the harm, where is the hazard experience, where and how do hazards overlap? Given such considerations, a set of hazard factors for buildings can be developed, such as:

- The nature of the hazard
- Whether the hazard is likely to originate internal or external to the structure, and
- How the hazard may impact the occupants, the structure, and/or the contents.

4.2.2.2 Risk factors are developed in response to such questions as who is exposed, which groups are exposed (i.e., all of the population, sensitive populations, etc.), what characteristics present the risk, what qualities of the hazard might affect judgments about the risk? Given such considerations, a set of risk factors for buildings can be developed, such as:

- The number of persons normally occupying, visiting, employed in, or otherwise using the building, structure, or portion of the building or structure.
- The length of time the building is normally occupied by people.
- Whether people normally sleep in the building.
- Whether the building occupants and other users are expected to be familiar with the building layout and means of egress.
- Whether a significant percentage of the building occupants are, or are expected to be, members of vulnerable population groups.
- Whether the building occupants and other users have familial or dependent relationships.

4.2.2.3 Importance factors relate to the real or perceived importance of a building to a community, i.e., what are key reasons as to why a community may deem a building, or class of buildings, to be important to community welfare perspective. Key importance factors include:

- The service the building provides (e.g., a safety function, such as a police or fire station, or a hospital)
- The service the building provides in an emergency (e.g., an emergency shelter, hospital, communications facility, or power generating station)
- The building's social importance (e.g., a historic structure, a church or meeting place), or
- The hazard(s) or risk(s) the building poses to the community, not just its occupants (e.g., chemical manufacturing facilities or nuclear power generating facilities).

4.2.2.4 By taking such an approach, one can develop 'risk groups' that define the major considerations by which buildings in a jurisdiction might be considered. This in turn can lead to more uniform 'risk mitigation' requirements (or recommendations / guidance) to be applied across the building stock. An example of using 'risk groups' is shown in Table 4.1, which is excerpted from the International Building Code (IBC) in the USA, as based on the structural design code, ASCE 7.

4.2.2.5 This same fundamental structure is incorporated into the International Code Council's ICC Performance Code for Buildings and Facilities (ICC Performance Code) as well, although the ICC Performance Code is not widely adopted in the US.

4.2.3 There are other approaches used in various countries as well. In some cases, specific Occupancy Groups (Use Groups, Building Classes, etc.), such as Assembly, Business, Hazardous, Healthcare, Industrial, Institutional, Mercantile, Residential, etc. These approaches typically include implicit characterization of risk, but not explicit (e.g., 'healthcare' occupancies might have more fire protection measures, since the occupants are viewed as more at risk / vulnerable). However, this approach can lead to numerous sub-categories, as well as special consideration and/or exceptions.

4.2.3.1 For example, in the International Building Code (IBC) in the US, there are 8 major Use and Occupancy classifications, some with as many as 5 sub-categories, and an additional set of special detailed requirements for 24 specific uses. In such a system, it can be quite difficult to assure that the understanding of implicit levels of risk / safety are fully understood.

4.2.3.2 However, the two approaches need not be mutually exclusive. It is possible to map the specific use classifications in the IBC to the Risk Groups in the IBC, if so desired, although this is arguably a redundant step.

4.2.4 A more quantified risk approach is being considered in some countries, such as Australia and the Netherlands.

4.2.4.1 In Australia, the approach being explored is built around quantifying the individual and societal risk to life from all sources, quantifying the individual and societal risk to life from hazards that impact buildings (i.e., for which mitigation via building regulation / building design are intended to address), and establishing benchmark levels of tolerable risk that a building design should meet.

4.2.4.2 In the Netherlands, the approach being explored considers the probability of life loss in a building, given a hazard event or system failure (e.g., structural system failure). The approach is modelled on the risk-informed approach in the Eurocodes for Structure.

4.2.4.3 In both cases, there is a significant reliance on the data used for benchmarking and the methods used for analysis.

Table 4.1 Example of Risk Group Approach (IBC, 2012)

Risk Category	Nature of Occupancy
I	Buildings and other structures that represent a low hazard to human life in the event of failure, including but not limited to: • Agricultural facilities. • Certain temporary facilities. • Minor storage facilities.
II	Buildings and other structures except those listed in Risk Categories I, III and IV
III	Buildings and other structures that represent a substantial hazard to human life in the event of failure, including but not limited to: • Buildings and other structures whose primary occupancy is public assembly with an occupant load greater than 300. • Buildings and other structures containing elementary school, secondary school or day care facilities with an occupant load greater than 250. • Buildings and other structures containing adult education facilities, such as colleges and universities, with an occupant load greater than 500. • Group I-2 occupancies with an occupant load of 50 or more resident care recipients but not having surgery or emergency treatment facilities. • Group I-3 occupancies. • Any other occupancy with an occupant load greater than 5,000[a]. • Power-generating stations, water treatment facilities for potable water, waste water treatment facilities and other public utility facilities not included in Risk Category IV. • Buildings and other structures not included in Risk Category IV containing quantities of toxic or explosive materials that: Exceed maximum allowable quantities per control area as given in Table 307.1(1) or 307.1(2) or per outdoor control area in accordance with the International Fire Code; and Are sufficient to pose a threat to the public if released[b].
IV	Buildings and other structures designated as essential facilities, including but not limited to: • Group I-2 occupancies having surgery or emergency treatment facilities. • Fire, rescue, ambulance and police stations and emergency vehicle garages. • Designated earthquake, hurricane or other emergency shelters. • Designated emergency preparedness, communications and operations centers and other facilities required for emergency response. • Power-generating stations and other public utility facilities required as emergency backup facilities for Risk Category IV structures. • Buildings and other structures containing quantities of highly toxic materials that: Exceed maximum allowable quantities per control area as given in Table 307.1(2) or per outdoor control area in accordance with the International Fire Code; and Are sufficient to pose a threat to the public if released[b]. • Aviation control towers, air traffic control centers and emergency aircraft hangars. • Buildings and other structures having critical national defense functions. • Water storage facilities and pump structures required to maintain water pressure for fire suppression.

a. For purposes of occupant load calculation, occupancies required by Table 1004.1.2 to use gross floor area calculations shall be permitted to use net floor areas to determine the total occupant load.
b. Where approved by the building official, the classification of buildings and other structures as Risk Category III or IV based on their quantities of toxic, highly toxic or explosive materials is permitted to be reduced to Risk Category II,

provided it can be demonstrated by a hazard assessment in accordance with Section 1.5.3 of ASCE 7 that a release of the toxic, highly toxic or explosive materials is not sufficient to pose a threat to the public.

4.2.5 A similar approach to that described above in the ICC is also used within the Eurocodes for Structure, but in this case, the approach is reflected as consequence classes.

4.2.5.1 The following table presents the definitions of the three consequence classes from the Eurocodes (EN 1990, Table B1).

Table 4.2 Eurocode Consequence Classes (EN 1990, Table B1)

Consequence Class	Descriptions	Examples
CC3	**High** consequence for loss of human life, or economic, social or environmental consequences very great	Grandstands, bridges, public buildings where consequences of failure are high (e.g., concert hall)
CC2	**Medium** consequence for loss of human life, or economic, social or environmental consequences considerable	Residential and office buildings, public buildings where consequences of failure are medium (e.g., office building)
CC1	**Low** consequence for loss of human life, or economic, social or environmental consequences small or negligible	Agricultural buildings where people do not normally enter (e.g., for storage), greenhouses

4.2.5.2 It is observed that the most significant differences between the ICC and Eurocode approach are that the ICC approach breaks down the specific 'risk factors' in more detail (e.g., number of people at risk), while the Eurocode approach focuses more on generalised consequences (e.g., consequence is high). A combination of approaches might be worth considering.

4.2.6 As Australia explores a more quantified approach to risk as a basis of building performance, it has been suggested that an approach that identifies specific risk factors of concern be considered. The following reflects some thinking in this regard.

4.2.6.1 As outlined above, an independent review of the NSW Building Professionals Act 2005 was recently undertaken and the findings were published in a 2015 report (http://bpb.nsw.gov.au/sites/default/files/public/Attachment%20A%20-%20Final%20Report.pdf, last accessed 12 April 2018). This review identified many issues which have parallels to the Scottish situation. The following is excerpted from the report (underline and highlight added by the author):

4.2.6.1.1 In the section on proposed fire safety reforms, the following is noted (pp240-241):

“The key to reform in this area is to ensure that properly qualified and experienced persons are accredited to design, install, commission and maintain fire safety systems with particular attention given to alternative fire safety systems. This will need to be supported by a risk based review process to evaluate complex or significant fire safety systems at the design stage. This will need to draw on suitable independent parties which could include the following:

- Independent review by an accredited fire safety engineer or a company involved in fire safety engineering

- Independent Peer Review Panel which would be a group of accredited certifiers including a fire engineer and an accredited person with fire-fighting experience

Criteria will need to be developed for the circumstances that would trigger an independent review and for when each of the three review mechanisms would be employed. The Society of Fire Engineers has provisionally suggested that fire safety engineering relating to the following circumstances should be considered for an independent review:

- Large infrastructure projects

- Buildings over 25 m in effective height

- Assembly buildings containing more than 1000 occupants

- Buildings containing an atrium which connects more than three stories

- Buildings where the main structure is of exposed steel or timber in lieu of a designated fire resistance level

4.2.6.1.2 It is observed that the suggested criteria are interesting in that they represent the type of criteria that could be considered in Scotland as triggering the need for review by a Chartered Fire Engineer, or even, as suggested for NSW, by an independent review panel.

4.2.7 Ultimately, any approach to defining ‘high risk’ building in Scotland should begin with a discussion on defining and characterizing risk, and then moving on to categorizing or quantifying risk, as befits the selected model.

4.2.8 Consideration of existing classification(s) of risk in the Scottish system would be a likely basis of such an effort (e.g., looking to ‘places of special risk’ and buildings that ‘pose a particular risk’ as discussed in the Technical Handbooks).

4.3 CHARACTERISING COMPLEXITY FOR FIRE SAFETY DESIGN

4.3.1 Raman suggests that in modern buildings, complexity comes from four primary sources (available for download from http://src.holcimfoundation.org/dnl/32e9279c-84dd-4f2e-9547-db6d983bf3f9/F10_BlueWorkshop_Paper_RahmanMahadev.pdf, last accessed 12 April 2018):

- Sophisticated building components

- Sophisticated systems
- Multi-disciplinary integration
- The desire for endless novelty in the built form

4.3.2 Raman suggests that "buildings like this represent, perhaps, no more than 10% of all the building activity that takes place at any given time, but they create much of the excitement in architectural circles. They also offer the greatest challenges in terms of managing complexity and risk."

4.3.3 It is suggested that this taxonomy represents a good starting point, particularly for new construction. There are also considerations associated with the complexity of tools and methods used for analysis and design of systems and performance.

- The sophistication of methods of analysis (in particular, computational tools, such as computational fluid dynamics (CFD), finite element (FE) software, and computational evacuation software.
- The integration (or not) of the various software tools in adequately assessing the holistic performance of a building and its systems.

4.3.4 Added to this might be issues associated with existing construction, including the following:

- Integration of new construction into existing built environment (in particular within dense urban environments)
- Sophisticated ownership or tenancy issues associated with the integration of new construction into existing, including boundaries, pedestrian flows between spaces, and user responsibilities (e.g., systems / space maintenance)

4.3.5 There are also attributes of the design and procurement processes that introduce complexity into the building design and verification process.

- Systems in which there is a not single, clearly defined 'responsible' entity for the design, which assures that the building and its systems are appropriately integrated and implemented in the final operational building.
- Systems in which there is no requirement by designers / engineers to assure that the 'as-built' building and its systems meet the design strategies and associated requirements.
- Systems in which there are few requirements for inspections, testing and commissioning of systems, and other such measures to control quality during construction.
- Systems in which ongoing maintenance and proper operation of the building and its systems are not routinely audited for compliance with the design strategy.

4.3.6 In considering the complexity of systems (including buildings, which are complex systems of systems), and the associated reliability of the systems in delivering the expected performance when needed, the extent of interrelationships and dependencies is important.

4.3.7 In looking at risk associated with complex systems, Perrow (1984) pointed out that complex, tightly coupled systems have more risk of failure than loosely coupled systems. This is largely because of the high level of reliance that each component in the system will delivers its expected function when needed, and if one component fails, the whole of the system is more likely to fail. Unfortunately, attempts to improve safety and reliability through more effective regulation introduces further complexity, intensifying non-linearity and increasing risks, although different than the initial risk challenge (Burns and Machado, 2010).

4.3.8 Arguably, building regulatory systems are themselves complex, socio-technical systems (Meacham and van Straalen, 2017). In order to manage complexity in the system, a number of factors are important to have, including:

- A well-defined building regulatory system, including the interconnections between actors, institutions and technologies.
- A well-defined set of verifiable building performance expectations.
- Education, training, and associated resources to facilitate the required levels of qualifications and competencies of the actors to deliver on design, regulatory, operational and related needs.
- An appropriate set of design, regulatory, and operational data, tools and methods to facilitate delivery of the expected building performance.

4.3.9 These concepts align well with those of Schalcher, who suggests that in order to manage complexity in planning, design and construction, the following maxims apply (available for download at https://src.lafargeholcim-foundation.org/dnl/901ed18a-96ca-4904-a23c-c2620281c611/F10_BlueWorkshop_Paper_SchalcherHansRudolf.pdf, last accessed 16 April 2018):

- Consider a building as a strongly interrelated element of a preceding, extremely complex, human and natural system.
- Plan and design not only for the initially defined use but also for unexpected transformations.
- Foster diversity of use, layout, materials and technologies.
- Apply the principle of integration instead of deconstruction and segregation.
- Achieve economy of means and reduce metabolism by multiplicity and multifunctionality (i.e., one item fulfils more than one purpose).

4.3.10 If we consider the process of planning, designing and executing a building we should be prepared to:

- Take decisions on the basis of fuzzy, i.e., incomplete and uncertain, information.
- Involve internal and external stakeholders at an early stage.
- Manage projects through leadership, team work and forward coupling.

4.3.11 Each of the above seem sets of perspectives is pertinent to the issue of dealing with complexity of buildings / fire engineered designs in buildings in Scotland.

5 Summary of Stakeholder Perspectives

5.1 INTRODUCTION

5.1.1 This section reflects a brief summary of the views of key stakeholder groups. Due to time and resource constraints, the views provided herein reflect a relatively small sample of the community. However, efforts were made to obtain and reflect a reasonable representation of views. The summary views below reflect comments provided during stakeholder meetings held the week of 19 March 2018 at BSD offices in Livingston, along feedback provided by individuals outside of the stakeholder meetings. A more extensive listing of stakeholder comments can be found in Annex B.

5.1.2 Some stakeholder groups were larger and more diverse than others, and therefore reflected a broader set of views. To try and keep the below summary brief, not all views are included. Please consult the more extensive listing of stakeholder comments in Annex B for a more complete representation of views provided.

5.1.3 It should be noted that while reasonable attempts were made to accurately capture and summarize comments, it is possible that inadvertent errors based on misinterpretation were made by the author in the process of taking notes, transcribing notes, and summarizing comments. The author apologizes for any such errors, and welcomes feedback aimed at increasing the accuracy of the summarised comments (here and in Annex B).

5.1.4 To help guide discussions with stakeholders, a set of questions was developed and circulated to the groups in advance of stakeholder meetings. The questions and brief summary of the main stakeholder comments are presented in Section 5.3 below.

5.1 GENERAL OBSERVATIONS FROM STAKEHOLDER DISCUSSIONS

5.1.1 Before presenting and discussing the stakeholder responses to the prepared questions, it is important to provide the following general observations from discussions with the various stakeholder groups.

5.1.1.1 First, the stakeholders that participated in discussions and/or provided written comments were actively engaged and genuinely interested in providing their views to help address the challenges that exist with undertaking and verifying fire engineered designs in Scotland. All groups noted that Scotland is a small country, resources are limited, and there are times when assistance with respect to fire engineered designs would be welcome.

5.1.1.2 Second, the stakeholders that participated in discussions and/or provided written comments largely agreed that the existing system in Scotland works quite well, for a large majority of projects, even with the resource constraints. They largely agreed that should the hub go forward, it be an integral part of the system and not tangential to it, and should not displace key systems of checks and balances that currently exist.

5.1.1.3 Third, there was broad recognition of the difficult challenges that local authority verifiers face given the level of resources available. Not only with respect to fire engineering, but in many cases, in simply addressing the needs of the market, particularly in busy periods of construction. Many held the view that if the local authority verifiers were adequately resourced, the need for the hub would be significantly less.

5.2 STAKEHOLDER QUESTIONS & SUMMARY RESPONSES

5.2.1 Do you see value in the idea of a central review hub to assist in the verification of fire engineered designs for complex and high-risk buildings (to be further defined)? If so, why, and if not, why not?

Academics	Broadly, yes. At this stage in the development of fire engineering, there is not enough self-discipline in the market or resources for LAVs, so a hub could be helpful, especially in high-risk and complex buildings. A hub can foster better communication and become a tool for better understanding educational needs to help all actors in the system. In the long term, moving to self-certification would seem a good target.
Architects & Architectural Technologists	Broadly, yes. The market is 'atomized,' characterised by a large number of very small firms, and resources are not enough to go around. A hub could help facilitate sharing of knowledge and information, and provide a coordinated and holistic review of fire engineered designs of buildings.
Building Standards Division	Uncertain. The function and structure of the hub is unknown, so difficult to assess. The real needs of the LAVs is also unknown. Perhaps a bigger issue is focusing on qualification and competence within the fire engineering sector.
Developers and Owners	Broadly, yes. The concept is appealing if it can help reduce time for approvals. It would also be appealing in helping to provide consistency in approval throughout a project and across the country.
Fire Engineers	Broadly, yes. A hub could be helpful in developing consistency in verification, and in demonstrating that safe buildings are being designed and constructed. Given the shortage of fire engineers in Scotland, few go to LAVs, so the verification capabilities can vary widely. It can be a reasonable short-term step along the way toward developing a certification scheme for fire engineering, which seems a reasonable long-term goal.
Insurers	Broadly, yes. Given the resource limitations in Scotland, a hub could be beneficial as technology changes and specific expertise is needed in the verification process. It could also help deliver consistency across the country in approvals, and in interpretations of 'sustainability' with respect to fire.
Local Authority Verifiers	For complex and 'one-off' projects, a hub could be beneficial, as long as it does not interfere with the existing verification process. Many projects seem too small to warrant review by a hub, so

	building up LAV capacity would be of great benefit.
Scottish Fire & Rescue Service	Broadly, yes. The SFRS Fire Engineering Group largely serves in this capacity now, helping LAVs that are under-resourced, as well as providing the statutory consultation. Any such hub would have to be properly resourced with clear processes and procedures.

5.2.2 Please provide your views on the role of a central review hub in relation to responsibilities and authority of local authority verifiers, Scottish Fire and Rescue Services (SFRS), and BSD with respect to fire engineered designs.

Academics	The decision-making structure needs to be clear. In practice some LAVs use the SFPE FEG more as a 'hub' than as statutory consultees. Need to be clear whether hub gives advice or decision. Critical issue is acceptance criteria: is the TH the benchmark?
Architects & Architectural Technologists	Hub would be a resource for assisting LAVs in review of complex designs.
Building Standards Division	The roles of the LAV, SFRS, BSD and the hub need to be very clear. The LAV is the decision-maker. The SFRS have a statutory consultee role and should not be decision-maker. The hub should not be run by BSD – there is a Views process that needs to be maintained, and the hub should not muddy the waters. Perceived and real conflicts of interest must be identified and addressed.
Developers and Owners	Keeping the function within the building warrant process seems best – keep it simple. There just needs to be clear understanding of when something goes to the hub, what it will cost, and what the timelines are. If everything goes to the hub that could slow things down. Timely decisions by LAVs should be expected based on feedback from the hub.
Fire Engineers	There were differing views as to whether the decision-making should remain with the LAVs, with most in agreement that is how it should remain. However, roles and relationship between hub, LAVs, and SFRS need to be very clear. If projects go to the hub, and then still need to go to a Views process, it just gets more costly. Fundamental issue is resourcing. If LAVs had proper resources, there would be no need for a hub. The primary role of the central hub will be to act as technical advisors to local authority building control, the SFRS and the BSD.
Insurers	A hub might help foster better communication between parties involved, and help stakeholders better understand the decision-making process.
Local Authority Verifiers	The hub should serve a supportive role to LAVs with the approval of building warrants still lying with the local authority. It would have to fit within the verification process, and rationalised with the view process. The hub would have to have a clear remit and purpose.

	Guidance around different levels of engineering and associated verification could be helpful.
Scottish Fire & Rescue Service	The SFRS FEG has beneficial knowledge, expertise and experience, and should see all fire engineered designs, regardless of whether another form of hub is developed or not.

5.2.3 Please provide your views on the form (or forms) of the hub that may be suitable for Scotland, given the regulatory system and the resources and expertise within the system.

Academics	The extent of the 'problem' is unknown, so it is difficult to make a judgement on how the hub might be structured and resourced. How, and how often, the hub is used, would influence resource needs. The 'integration' role is missing: the hub could help. If it goes forward, period review / audit is needed. Short-term solution.
Architects & Architectural Technologists	The hub would need expertise that has appropriate 'T' shape – depth of fire engineering knowledge but breadth of understanding of how it fits into and integrates with the overall design. Complexity is difficult to define, but following RIBA type approach can help to make sure critical issues are addressed.
Building Standards Division	Comments on the form ranged from under BSD to supported by the LAVs (LABSS). Fees would have to be such so as not to be a deterrent from use. Liability would have to be clarified for any participants, including entity overseeing the hub. Perceived and real conflicts of interest must be identified and addressed. Regardless of form, there would be need for appropriate quality assurance processes, performance monitoring, audits and the like.
Developers and Owners	No particular views.
Fire Engineers	Views differed on whether the hub should be something where all fire engineered designs go into – this gets to consistency, competency, and related issues, but is resource intensive. Wide range of views. Some think the hub should be operated / administrated by full time staff with the resource to meet service conditions required by industry. Others think there should be a pool of people who are rotated to minimise bias.
Insurers	It seems like the hub should be independent, with dotted line reporting to the BSD. The hub would be in support of verifiers, but it seems like it can also help the market.
Local Authority Verifiers	It was noted that LABSS have qualified people to help out a local authority when needed as internal resource. It would be helpful to have a filter process to screen what can be done 'internally' and what warrants going to the hub. Two forms: permanent panel, which invited expertise as needed, or panel formed as needed.

Scottish Fire & Rescue Service	The SFRS FEG can provide the services as understood to be needed, but need statutory authority and should be paid for the service. Capabilities, skills, etc. can be expanded if deemed necessary. All fire engineering designs should be submitted, and should have all necessary documentation. Feedback is given to the LAV, who ultimately makes a decision.

5.2.4 Please provide your views on the number and representative make-up (e.g., practicing fire engineer, local authority verifier, SFRS fire engineer, academic, etc.) of persons that might be appropriate for serving in a review capacity as part of the hub.

Academics	Membership should come from BSD, LAVs / LABSS, the FE community, and SFRS, and if a suitable role exists, academia, government representative (Minister, not BSD), someone with procurement expertise, and someone with building regulatory expertise from outside of Scotland (e.g., England, Wales, Ireland).
Architects & Architectural Technologists	There needs to be a coordinator who understands fire performance as part of overall building performance, with the competence to identify issues that may exist and allocate the appropriate expertise to sort the issues. A wide range of expertise would be needed, including architectural, architectural technology, fire, fire service, verifier and more, depending on specific project. Need to have holistic, integrated perspective.
Building Standards Division	Make-up of the hub should include LAV, SFRS, and FEs. Role of BSD not clear with respect to the Views process. Would be good to be involved, but cannot be in conflict with statutory role. Perceived / potential conflicts of interest with BSD and SFRS need to be sorted.
Developers and Owners	Input from fire engineers, architects, and the SFRS important. Need to have good practical knowledge as well as specific fire engineering knowledge. Academics could be helpful for review of complex models and such. Someone from BSD would be desirable.
Fire Engineers	A qualified person to screen submittals and decide whether to send to the hub is needed. Views differed as to whether this and other members of the hub should be permanent / semi-permanent (substantially dedicated) or rotated in and out. Key attributes are expertise and relevance experience, which should be current. The hub needs to largely consist of fire engineers or verifiers who specialise in fire engineering. Range of views on numbers needed.
Insurers	Need a mix of expertise. No one person knows everything. Need to have expertise in fire engineering, the tools used, how the building comes together.
Local Authority Verifiers	Range of views. The number of people that sit on the hub would have to be relatively small so that a decision could be reached. It was discussed that the assistance offered within LABSS could

	essentially serve as the 'gatekeeper' role, helping local authorities make decisions on what can be addressed internally, providing LABSS resource where needed, and facilitating additional review by experts where deemed appropriate. Role of BSD and SFRS need to be clear and not conflict with statutory responsibilities.
Scottish Fire & Rescue Service	A key concern is the independence of a hub. Having a broad range of people to draw from does not guarantee independence if they are still working in the market (including academics, architects, fire engineers). The SFRS FEG is independent.

5.2.5 Please provide your views on the qualifications and experience of the persons who might serve as part of review panels for the hub.

Academics	An important issue for the hub will be determining who sets the competency level for hub members, and how that is determined (i.e., not just what competencies hub members should have, but who makes judgment and appointments). It seems as if a starting point is Chartered status in the disciplines that are deemed necessary.
Architects & Architectural Technologists	The IFE have a set of subjects for which competency is required. The issue is a combination of depth, exposure and time (i.e., what time is required to reach what depth of understanding across which areas).
Building Standards Division	With respect to qualifications, one size does not fit all. May need IEng and CEng and equivalent, as per project needs.
Developers and Owners	Not specifically discussed.
Fire Engineers	Wide range of views. Generally, anyone working in the hub should have highest qualification, e.g., Chartership. Expertise and experience crucial. The 'gatekeeper' needs to have the right knowledge, expertise and experience to know when to send something to the hub. The hub will fail if technical decisions are not made by competent persons using appropriate engineering knowledge and methodology.
Insurers	Not specifically discussed beyond needed appropriate expertise.
Local Authority Verifiers	Verifiers have a range of expertise across the breadth of building design, which includes fire engineering in some authorities. The Section 34 letter caused significant concern, as it was open to interpretation. Needs to be clarified. All people should be a member of appropriate professional body.
Scottish Fire & Rescue Service	Reviewers need to be adequately qualified and competent. It is not clear that requiring IEng or CEng (in fire engineering) necessarily accomplishes this. It might be too early to require such without

	having a better understanding of what such qualifications actually means. The SFRS Fire Engineer Group (FEG) has fire engineering expertise and computational modelling expertise to review fire engineered designs, and has the added benefit of operational experience.

5.2.6 Please provide your views on the limits and conditions of service as part of the hub, including potential conflicts of interest (private and governmental).

Academics	Anyone (actively) involved in fire engineering work should not be in the hub.
Architects & Architectural Technologists	Not discussed.
Building Standards Division	Not discussed.
Developers and Owners	Not specifically discussed.
Fire Engineers	Range of views. For the fire engineering community to have confidence in the hub, the process has to be transparent and the appointment of members to the review clear to all. There should be no 'conflict of interest' as the 'target' for all is a fire safe building. Assuming that it is not practicable to avoid any commercial or industrial people in a hub then each of the professional people in the hub need to declare any potential conflicts. A fire engineer serving the hub should not be able to review a fire engineering report prepared by their firm. Therefore, the hub's fire engineer should not be a practicing fire engineer employed by a private firm.
Insurers	Not discussed.
Local Authority Verifiers	Limits of service not discussed – depends on form and where housed. BSD and LAVs impartial – practicing engineers need to manage conflict, SFRS status unknown in terms of statutory role.
Scottish Fire & Rescue Service	There is concern that there are resource limitations if one prohibits practising professionals from participating, so as to avoid conflict of interest.

5.2.7 Please provide your views on the triggers for determining when a project could or should be sent to the hub for verification (e.g., complex and 'high-risk' buildings, significant variations from Section 2: Fire, Technical Handbooks, …), what documentation would be required, from whom, and within what time constraints.

Academics	A trigger for sending a fire engineered design to the hub should be any design for which the LAV does not believe that they are competent to assess. The intersection of energy efficiency and fire, and compliance with sustainability and safety Standards are topical.
Architects & Architectural Technologists	Triggers difficult to define, since all buildings different, level of expertise diffuse, and complexity a function of the particular building.
Building Standards Division	Potential triggers for review could be something like risk classes (as in Eurocodes for structures), with focus on consequence if failure occurs. 'High-risk' and 'complex' designs may be drivers, but terms need to be defined.
Developers and Owners	Different risk classifications for buildings was noted as one potential trigger. Complexity is a more difficult baseline to describe. Complexity comes in many forms, and not just new build. In many cases, complexity arises out of multi-tenancy (and even multi-owner) issues, working new or renovation of existing buildings in and around existing spaces owned or managed by others, and trying to get all the pieces to fit together. The space itself may be 'simply' retail, but the integration of the building / space into existing can be extremely complex. Even something as 'simple' as alarm and evacuation zones can be a challenge.
Fire Engineers	Range of views. Difficult to understand why a hub would only be used for complex and high risk buildings: does this mean that incompetent fire design will not result in death or injury in less complex buildings? All fire engineering solutions, should be subject to hub verification. Any fire engineered solution that is out with the expertise of the LAV. Triggers might be: very tall; complex space uses and complex geometry; those that house dangerous activities; significant variation(s) to the guidance in Section 2; 'extreme' designs (floating buildings); extensive application of fire engineering; and use and application of computer aided fire safety design.
Insurers	Complexity is a trigger, but difficult to define. High risk might be people sleeping, new technologies (e.g., CLT), high-rise, area of building, multi-tenancy, shopping centres.
Local Authority Verifiers	The main trigger would have to be variation or alternative from Section 2 in the Technical Handbook. There is difficulty in defining what is complex. The view process has been used for single stairs, external wall systems, and similar, but these are not necessarily complex. There is already a two-stage process: the verifier needs help or does not. If help is needed, they can go out and get it within LABSS or third-party review.
Scottish Fire & Rescue Service	One part of the challenge with the existing process is that some verifiers only accept fire strategies at the end, when work is nearly complete, instead of in the beginning, when most beneficial. There is concern that the SFRS FEG only sees part of a design in some

	cases, and not the full documentation. It can be difficult to assess the suitability of a design component out of context with the entire design approach. In addition, some documentation, even for components, is incomplete. There is no statement of assumptions, limitations, bounding conditions, or similar rationale.

5.2.8 Please provide your views on the time limits around the activities of the hub in relation to a specific project (i.e., time for undertaking review and reporting back).

Academics	Response time depends on the project, but should be reasonably quick (e.g., 2-4 weeks).
Architects & Architectural Technologists	Difficult to determine at this point, but three months is better than three years.
Building Standards Division	The timeliness of response is difficult to address in advance, as it depends on project scope, complexity, etc. In any case, it should be relatively fast, as that is one challenge in the existing system.
Developers and Owners	Time to approval is always difficult, but for small projects, the order of 2 weeks seems appropriate, and perhaps 6 weeks for a larger project. Having a process that provides consistency from start to finish will help a great deal.
Fire Engineers	Wide range of views. At one end, timescales should be similar to currently provided under the BSD's 'Views' process. At the other end, the construction programme for the building(s) will influence time needed: the construction process could be very long, more than 10 years, with discrete multiple phases. This would need to be informed by our collective experience of typical projects, but could be in the order of: 2 to 4 weeks for small projects with limited fire engineering; 4 to 6 weeks for projects with more fire engineering; and longer times could be expected for major projects.
Insurers	Not discussed.
Local Authority Verifiers	Any hub which is set up would delay the processes if this is referred after the warrant is submitted. If submitted at an early stage this may reduce the period to grant the warrant as most of the issues should or could be addressed during the review by the hub. This would encourage architects and fire engineers to discuss at an early stage projects which deviate from the guidance.
Scottish Fire & Rescue Service	Not specifically discussed, but it was noted that a better understanding of perceived problems with the current process is needed. Quantification of delays in the verification process would be helpful.

5.2.9 Please provide your views on how such a hub might be funded (i.e., different mechanisms).

Academics	Government seems appropriate.
Architects & Architectural Technologists	Funding should come from all (i.e., all participate to the benefit of all).
Building Standards Division	As a resource for LAVs, funding the hub could come from levies, fees, etc., but it is recognised that there can be problems with assuring funds collected as part of building control get appropriated to building control within local government.
Developers and Owners	There would be no problem paying additional fee for the centralized review if the fee is allocated to the verification process and the time required for a decision is significantly reduced.
Fire Engineers	Wide range of views. Could have several layers: (a) Scottish Government – for permanent staff; (b) LAV to self-fund contribution of own staff seconded part-time on a project specific basis; (c) project budget – for contributions from client design team; (d) all project budgets + LAVs + SFRS + Local Authorities – for general funding for the part-time members of Hubs; and (e) maybe from ‘the industry’ through a national levy.
Insurers	Not sure about funding. This is a government issue to answer. Insurers have their own research and review and approval process, so not sure they would support a hub.
Local Authority Verifiers	Funding could come from government, but could also be from fees paid by LAVs which use the hub (as collected from fees from those submitting complex designs for review). A concern was voiced that if any 3rd party contributes it could be considered a bribe.
Scottish Fire & Rescue Services	Not specifically discussed.

5.2.10 Please provide any additional feedback or information, which you think should be addressed, as related to the potential formation of a central review hub to assist in the verification of fire engineered designs for complex and high-risk buildings.

Academics	There is a capacity issue. All fire engineering grads go to consulting firms, not to LAV or SFRS, and many out of country. Not that much interest by students, as they do not see fire engineering in many universities, so do not see it as an option. ‘Engineer’ not being a protected term is problematic, especially in fire engineering, since the discipline is so broad. Fire engineers are not engaged throughout the entire process – often stop at strategy.

Architects & Architectural Technologists	Every building should have a fire strategy, but all do not. Some buildings seem to be 'over designed' for fire. Perhaps others are in the opposite direction. Without a strategy, it is difficult to know what is being targeted, and what impact future changes might have. Overall, level of fire engineering knowledge seems to have decreased a bit, at least in architecture / architectural technology, with very little being taught is associated university programmes.
Building Standards Division	Not specifically discussed.
Developers and Owners	The existing process is sound, the relations are good, the problem seems largely to be resourcing and time to a decision – anything new that is added should be focused on reducing time to a decision and not adding time and complexity to the process.
Fire Engineers	Wide range of comments. The persons responsible for setting up the hub (assumed to be BSD), need to develop a plan of what they want to see and have a round table discussion with all interested parties (e.g., local authorities, the fire service and fire engineers). There are benefits of a hub in the short term but concerns to its effect over the medium to long term, to such an extend it will not alter the situation where there is a lack of competence and expertise throughout the industry. Fire engineer should be involved from 'cradle to grave' for any assurance that systems / features installed and function as intended; however, not the procurement system in Scotland. The BSD with their many years of knowledge in the area of Certification and the setting up of such schemes, should assist the Fire Engineering community.
Insurers	The hub should help the process and not add time or problems.
Local Authority Verifiers	Various views. There are numerous problems within the regulatory and fire engineering community in relation to number and competency of qualified staff. It should however be noted that the number of fire engineering solutions that are submitted is not large within Scotland and many projects which provide an engineering report do not require one. The hub appears to be trying to address the issues with the lack of qualified staff within the local authorities and none of the issues within the fire engineering community as a whole. While the idea of certification (self-certification) for fire engineering, such as with structural engineering, is interesting, there have not been any fire engineered designs through the verification process without changes, and it would seem unwise to push too fast at this point – the market is just not ready.
Scottish Fire & Rescue Service	While the SFRS FEG provides feedback to LAVs, they often do not get any information in return, so the SFRS does not know what final solutions were implemented. There are concerns that the procurement process isn't working as it should, since fire engineers not involved in beginning of projects, which can sometimes lead to

	issues at the end.

5.3 SUMMARY OBSERVATIONS

5.3.1 Based on discussions with stakeholders, the following observations are made:

Areas of General Agreement / Consensus

5.3.1.1 There is general agreement across all groups that the current verification system works rather well a large majority of the time, and that if some type of centralized review hub is formed, that is enhances and does not negatively impact the current system.

5.3.1.2 There is general agreement across all groups that the primary issue being faced with respect to verification of fire engineered designs is one of resources: numbers of fire engineers, numbers of verifiers, available time, and necessary funding.

5.3.1.3 There is general agreement across all groups that given the shortage of fire engineers in practice and working for LAVs that a hub could be helpful in developing consistency in verification and in demonstrating that safe buildings are being designed and constructed, at least until more resources are available.

5.3.1.4 There is general agreement across most groups that a fundamental purpose of the hub is to provide support to the LAVs as part of the existing verification process, including processes for views and relaxations.

5.3.1.5 There is general agreement across most groups that a hub can be a reasonable short-term step along the way toward developing a certification scheme for fire engineering, which seems a reasonable long-term goal (several years away).

5.3.1.6 There is general agreement across most groups that any such hub would benefit from a range of expertise, depending on project specifics, but the particular focus is fire engineering / delivering a fire safe building.

5.3.1.7 There is general agreement across most groups a hub should have a 'gatekeeper' who is sufficiently knowledgeable and experienced to make rather quick determinations as to whether consideration by the hub is warranted.

5.3.1.8 There is general agreement across most groups that conflict of interest must be addresses for all potential parties, whether statutory (e.g., BSD, SFRS) or commercial (e.g., use of persons currently practicing in the market).

5.3.1.9 There is general agreement across all groups that a hub should not result in additional time for approvals, but needs to be structured so as to reduce time.

5.3.1.10 There is general agreement across most groups that a well-functioning hub could be beneficial in facilitating better understanding of issues, communication, education and training needs.

Areas with Diversity of Views

5.3.1.11 There is a diversity of views as to structure, i.e., permanent staff, temporary panel, mix of both. Concerns impacting this are availability of qualified and ‘unconflicted’ (independent) experts, under what legal / operational structure the hub sits, and the exact remit of the hub (e.g., decision, advice, …).

5.3.1.12 There is a diversity of views as to where the hub best sits, e.g., within BSD, LABSS, SFRS, or other.

5.3.1.13 There is a diversity of views as to the appropriateness of BSD and SFRS participation from a legal / statutory perspective, and of practicing fire engineers, from a conflict of interest perspective.

5.3.1.14 There is a diversity of views as to what might trigger a review by the hub, ranging from any fire engineered design, or at least any that deviates from the TH, to only those fitting within a somewhat narrow bound of ‘high-risk’ or ‘complex’ buildings and designs.

5.3.1.15 There is a diversity of views as to the actual scope of the hub; specifically, does the hub provide advice or does the hub make a decision. The majority see the hub as providing advice. However, some question whether this will then make any difference, if the LAV does not have to act on the advice. Action on a decision, whether voluntary or other, will be a major factor in the success of a hub.

5.3.1.16 There is a diversity of views as to funding, from ‘pay for service’, to multi-source funding, to government supported. A concern of ‘private’ funding as potentially being seen as a ‘bribe’ would need to be explored.

6 Discussion Items

6.1 INTRODUCTION

6.1.1 This section summarises issues the might influence the establishment of a hub, and the operation of a hub, should it be formed.

6.1.2 Material in this section draws upon research previously conducted, as well as developed during this project. As such, this section is summary in nature, with reference made to supporting documentation.

6.2 STATE OF FIRE ENGINEERING PRACTICE

6.2.1 The situation with fire engineering in Scotland was explored in 2016 (Meacham, 2016). The principal finding was that some aspects were working well, but some gaps existed. From limited discussions in 2018, it is suggested that the situation has not significantly changed, although progress is being made toward recognised professional qualifications. The following are a few pertinent summary points from the 2016 report.

6.2.1.1 Due to the lack of a prescribed qualifications system, there is a wide range of competency in fire engineering community. This leads to a range in quality in projects, uncertainty in terms of what level of reliance on expertise of fire engineers is appropriate, and how / at what levels reviews should be undertaken. The lack of students undertaking fire engineering degree programs contributes to this situation.

6.2.1.2 There is a lack of consistency and clarity in the application of fire engineering approach(es). While flexibility is a hallmark of a function-based regulatory system, it should be expected that appropriate means / methods of engineering be applied, and where a standard, guide or code of practice is used, it is followed in its entirety to a level appropriate to the project. There are numerous indications that this is not the case in Scotland.

6.2.1.3 There is a wide range in the quality of designs and associated documentation. This is in part a function of the lack of qualifications and consistent application of fire engineering guidance, but it is also an attribute of the building regulatory system, which could state more clearly the expectations of design reports and level of documentation required.

6.2.2 Each of these issues has a fundamental impact on how well the application, and the verification, of fire engineering designs is perceived. With a lack of clarity on qualifications and competency, verifiers are not in a position to simply accept designs, as the case may be if a certification system were in place. With variability in the application of engineering tools and methods, it is difficult to understand which are appropriate, and which may not, and under what conditions. With a lack of documentation, making such judgments on the applicability of designs is difficult. Together, these factors lead to significant uncertainty, variability and delay in the verification of fire engineered designs.

6.3 DIVERSITY IN APPLICATION OF ENGINEERING TOOLS AND METHODS

6.3.1 The diversity in the application of fire engineering tools and methods is a concern that was identified in past research on the situation in Scotland (Meacham, 2016; 2017), as well more broadly (e.g., Beard, 2005; 2005a; Rein et al., 2009; Meacham, 2013).

6.3.1.1 With respect to engineering methods or approaches, challenges include incomplete characterisation of the problem to be solved, incomplete consideration of the fire and life safety issues within the context of the overall building design, incomplete adherence to comprehensive guidance, lack of consideration for sources of uncertainty, variability and unknowns, and incomplete consideration of the operational state of the building as compared to 'ideal' (design) conditions.

6.3.1.2 With respect to engineering tools, particularly computational models, challenges include variability and lack of data, inherent uncertainty within the model / algorithms (i.e., model uncertainty), uncertainty regarding the limits of applicability of the model (i.e., range of validated operation), and variability of the users.

6.3.2 With respect to engineering methods, while it is understood that each fire engineered design is individual, the approach to undertaking the designs do not have to be individual, and in fact should be consistent. This is the reason that codes of practice and guidance documents such as BS 7974, BS 9999, the SFPE Engineering Guide to Performance-Based Fire Protection Design, the International Fire Engineering Guidelines, and ISO 23932 exist. The level of application and extent of data and information provided may vary, but it is unclear why the approach needs to vary.

6.3.3 With respect to application of engineering tools, in particular computational models, guidance exists as well, including the SFPE Engineering Guide, Guidelines for Substantiating a Fire Model for a Given Application (SFPE, 2011).

6.3.3.1 The Guidelines for Substantiating a Fire Model for a Given Application (SFPE, 2011) establishes a methodology with specific steps to review the suitability of a fire model for a specific application including:

- Define the problem of interest
- Select a candidate model
- Verify and validate the model
- Address user effects
- Documentation.

6.3.3.2 The methodology is summarized in the Figure 6.1 below as excerpted from the Engineering Guide.

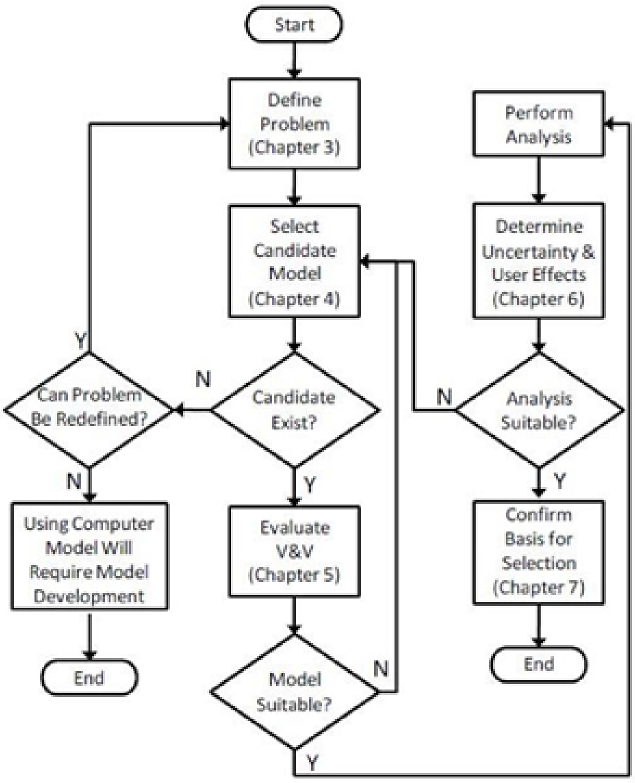

Figure 6.1 Process Diagram for Substantiating Use of a Fire Model

6.3.4 While challenges exist, guidance exists to help address issues in the application of tools and methods.

6.3.4.1 As noted above, the reason that codes of practice and guidance documents such as BS 7974, BS 9999, the SFPE Engineering Guide to Performance-Based Fire Protection Design, the International Fire Engineering Guidelines, and ISO 23932 exist. The level of application and extent of data and information provided may vary, but it is unclear why the approach needs to vary. Better adherence to guidance will improve the situation.

6.3.4.2 To provide even more consistency, especially for ‘simple’ fire engineering designs, one suggestion from 2016 was that the fire engineers might consider development of a Scottish equivalent to the New Zealand C/VM2. There were some comments received in 2018, principally from verifiers, that a move in this direction would still be useful. It is noted that the Australian Building Codes Board (ABCB) has in 2017 developed such a verification method, which has been out for public consultation in early 2018. As in New Zealand, views on the verification method range from strongly for to strongly against. It is likely that changes will result based on the public consultation. At this point in time, there is no decision on the final version of the verification method or its implementation status.

6.3.4.3 Regarding documentation, in addition to guidance in such documents as BS7974, BS9999, etc., there are guidelines available from other countries, which might serve as useful models. One example is the Institution of Professional Engineers New Zealand (IPENZ) Practice Note 22, Guidelines for Documenting Fire Safety Designs (available for download from https://www.building.govt.nz/assets/Uploads/building-code-compliance/c-protection-from-fire/Fire-safety-design-guidelines/pn22-documenting-fire-safety-designs.pdf).

6.3.5 Guidance also exists on review of fire engineered designs. One example is the SFPE / ICC *Code* Official's Guide to Performance-Based Design Review (SFPE and ICC, 2004). There is also a standard in development in the Nordic countries, prINSTA/TS 952, Fire Safety Engineering — Review and Control in the Building Process (Standards Norway, 2018). Consideration should be given to development of a similar type of verification process for Scotland, as this can help increase consistency in fire engineering designs as well as in the verification of such designs.

6.4 QUALIFICATIONS AND COMPETENCY

6.4.1 Challenges with qualifications and competency related to development and verification of fire engineered designs has been broadly addressed in previous studies (BSD, 2015; Meacham, 2016; 2017; 2018). Excerpts from the cited reports can be found in the annexes to this report. Along with resource challenges within LAVs, this is one of the primary motivators for consideration of a central hub for assisting with the verification of fire engineered designs.

6.4.2 Specific to the potential formulation of a centralized hub for review of fire engineered designs, a critical issue will be identifying and utilising personnel who meet or exceed the qualifications, competency, experience, and ethical expectations of the market. As discussed otherwise in this report, personnel should have demonstrated qualifications and competency in their area of expertise, which is broadly recognised and accepted by all stakeholders. These persons should have demonstrable experience with fire engineering in complex buildings. This does not mean exclusively fire engineering experience, but extends to holistic designs, systems integration, verification and related issues associated with such buildings.

6.4.3 Likewise, these persons should understand and be able to work with and address the multifaceted issue of complexity in the design process, such as presented in Section 4:

6.4.3.1 Considerations associated with the complexity of tools and methods used for analysis and design of systems and performance.

- The sophistication of methods of analysis (in particular, computational tools, such as computational fluid dynamics (CFD), finite element (FE) software, and computational evacuation software.
- The integration (or not) of the various software tools in adequately assessing the holistic performance of a building and its systems.

6.4.3.2 Issues associated with existing construction, including the following:

- Integration of new construction into existing built environment (in particular within dense urban environments).
- Sophisticated ownership or tenancy issues associated with the integration of new construction into existing, including boundaries, pedestrian flows between spaces, and user responsibilities (e.g., systems / space maintenance).

6.4.3.3 Attributes of the design and procurement processes that introduce complexity into the building design and verification process.

- Systems in which there is a not a single, clearly defined ‘responsible’ entity for the design, which assures that the building and its systems are appropriately integrated and implemented in the final operational building.
- Systems in which there is no requirement by designers / engineers to assure that the ‘as-built’ building and its systems meet the design strategies and associated requirements.
- Systems in which there are few requirements for inspections, testing and commissioning of systems, and other such measures to control quality during construction.
- Systems in which ongoing maintenance and proper operation of the building and its systems are not routinely audited for compliance with the design strategy.

6.4.3.4 In considering the complexity of systems (including buildings, which are complex ‘systems of systems’), and the associated reliability of the systems in delivering the expected performance when needed, the extent of interrelationships and dependencies is important.

6.5 CLASSIFYING ‘HIGH-RISK’ AND ‘COMPLEX’ BUILDINGS

6.5.1 The issues of ‘high-risk’ and ‘complexity’ are largely addressed in Section 4, including some considerations for classifying such for Scotland. In addition, Annexes D and E provide some exemplar approaches to how risk and complexity can be incorporated into a matrix type approach for the purpose of correlating qualifications and competency requirements to the risk and complexity associated with a building or design.

6.5.2 As is noted elsewhere in the document, with respect to defining ‘high risk’ buildings, it is suggested to consider development of a ‘risk group’ concept for all Scottish buildings, new and existing. Critical factors including such items as hazards associated with the building / building uses, occupant numbers, characteristics and vulnerabilities, and the types of fire protection schemes which may be applicable, given the fire, building and occupant characteristics. It is suggested that the effort can start with consideration of the various risk definitions / characterisations in the Technical Handbooks, and through an analytic-deliberative process, develop risk groups and associated factors for Scotland.

6.5.3 With respect to dealing with ‘complexity’, it is suggested to craft guidelines based on factors outlined in Section 4 (several of which are repeated above), which includes a ‘complexity matrix’ such as presented in Annex E, and illustrating how such a matrix could be a structure for decision-making.

7 Potential Central Hub Options

7.1 INTRODUCTION

7.1.1 This section outlines a set of potential options for the central hub structure, membership and operation, as based on research presented in Section 3, input from stakeholders summarised in Section 5, and related issue presented in other sections.

7.1.2 It is also important to discuss those structures that, in the opinion of the author, are not appropriate for Scotland, given the current situation.

7.2 VIEWS ON POTENTIAL VERIFICATION STRUCTURES FOR SCOTLAND

7.2.1 Section 3 presented and discussed several approaches to verification of fire engineered designs:

- Internal review / self-certification
- Private certification
- Peer review (various levels)
- Multi-actor review and approval (government and private sector)
- Multiple verification routes
- Government opinion / determination / view

7.2.1.1 Given the reasons stated in Section 3, it is the opinion of the author that Scotland is not yet ready for self-certification, although this might be a reasonable long-term target. Lack of fire engineers, competency / qualifications system, and the diversity and complexity of fire engineering compared to other engineering disciplines are among the major concerns.

7.2.1.2 Given the reasons stated in Section 3, it is the opinion of the author that private certification of fire engineered designs may not be the best option for Scotland at this time, given shortcomings around qualifications of persons, qualifications systems, and the like, as outlined for 'self-certification above.

7.2.1.3 It is the opinion of the author that an adequately regulated and managed peer-review system can be beneficial to Scotland. Peer-review is used currently, and largely seems to work adequately. Improvements can arguably be made if issues associated with qualifications, competency and conflict of interest (ethics) are addressed, and a more systematic approach to when required and how used, are addressed. However, it is recommended that this be included as part of a system led by government review and approvals (LAVs) and not independent.

7.2.1.4 Given the resource limitations around fire engineers in Scotland, and limited resources for LAVs and the SFRS, it does not seem practicable to move towards a multi-actor verification system at this time, at least in the breadth of actors involved in Germany or the layers of requirements of Singapore. There does not seem to be a need for the additional layers of review and associated costs: the need is more around supplementing the existing system. However, aspects of the multi-actor approach are helpful and should be considered, including qualifications requirements and the like.

7.2.1.5 It is the opinion of the author that a multiple verification approach, based on level / complexity of design, could be beneficial for Scotland, in that a majority of designs are 'prescriptive' (Technical Handbook compliant), with the next greatest number 'minor' deviations, and the smallest number the 'full' fire engineered designs. By having three distinct approaches to compliance, i.e., prescriptive, 'prescribed performance', and full performance (fire engineered) designs, resource can be allocated where needed based on the number of designs undertaken within each level. Such a system would be helped by introduction of a 'fire verification method' as well, although that is not required.

7.2.1.6 It is the opinion of the author that Scotland should retain the Ministerial Views process, and the Ministerial Relaxation process, as currently exists. The ability to have an appeals mechanism, prior to entering the judiciary system, provides more opportunity for identifying and resolving issues within the sector.

7.2.2 Considering the various options explored as part of this research, and considering the feedback from stakeholders on the concept of a central 'hub' for review of fire engineered designs, it is the opinion of the author that for Scotland, a system that contains aspects of maintaining the current government verification authority (LAV), with peer-review if needed, but largely circumvented by implementation of a 'central review hub' for fire engineered designs (along the lines of the Japanese system), would seem to fit best the verification needs and resource constraints within Scotland.

7.3 OPTIONS FOR POTENTIAL STRUCTURES

7.3.1 Determining that some type of resource for review of fire engineered designs will be helpful for Scotland, and that such a resource needs to fit within the existing Scottish building regulatory and verification system, is the first step. The next step is considering the structure, charge, responsibilities and make-up of such a resource.

7.3.2 Broadly, it is suggested that such a resource be a concentration of required expertise to review, provide comments, and develop a consensus expert opinion on the appropriateness, completeness and adequacy of fire engineered designs in Scotland, as a resource for LAVs which are charged with passing judgment on such designs. Such a 'hub' of expertise could take many forms.

7.3.3 While many forms are possible, it is suggested that based on the existing legislation and situation in Scotland, there are four fundamental constructs which seem most appropriate to consider:

- a new independent body reporting to government
- a new body / entity reporting to local authorities

- the existing SFRS FEG or some variation thereof, or
- an entity of the fire engineering community, perhaps the Institution of Fire Engineers, Scottish Branch, or other.

7.3.4 Each of these constructs could in turn have variations. A key consideration in each option is staffing and access to subject material experts.

7.3.4.1 A clear message emerged from the stakeholder discussions about the value of a 'gatekeeper' to vet designs as submitted and to make decisions (or help make decisions) as to whether they warrant review by the hub or not. While views diverged with regards to whether all designs should go to the hub or not, the need of a qualified 'gatekeeper' seems essential, and having someone allocated to this fulltime, at the start, would provide flexibility and confidence. As such, it is the opinion of the author that all options include a fulltime 'gatekeeper' (coordinator).

7.3.4.1.1 To be successful, it is suggested that the gatekeeper would need to be a rather senior expert, well-respected by all key stakeholder groups, who possesses considerable depth and breadth of knowledge of both fire engineering and of the verification process. Arguably, the fire engineering knowledge and experience is more pertinent given that verification of fire engineering design is the primary purpose of having a hub. However, knowledge of how fire engineering fits within the building design as a whole is critical as well, since the fire design cannot be divorced from the holistic performance of a building. As such, the gatekeeper would need to be able to make a judgement on what subject matter experts are needed, in addition to fire engineering.

7.3.4.2 Another staffing question is whether the hub has a sitting panel of experts, which serve for perhaps a 2- or 3-year term, or if there is simply a pool of panellists, from which a panel is formed when review by the hub is needed. In some respects, this cannot be fully answered without knowing how many designs will go to the hub, and what the logistics would be if panels had to be formed rather often. There is also the question as to whether the panellists would be 'staff' or contractors.

7.3.4.2.1 For stability and consistency, it is the opinion of the author that there should be a 'standing' panel, with each member serving a 2- or 3-year term (with re-appointment possible).

7.3.4.2.2 If the number of fire engineered designs warranted it, the panellists could be full time employed by the hub. However, it does not seem as if this would be the case in Scotland, except perhaps if all fire engineered designs (including any deviation from the Technical Handbooks), were sent to the hub for review.

7.3.4.2.3 In either of the above options, any real or perceived conflicts of interest, non-disclosure requirements, and the like would have to be carefully managed for any panellist (which would arguably be less of an issue if fulltime staff).

7.3.4.3 When considering the viability of a fire engineered design in the context of the holistic performance of a building, many types of expertise may be needed to review aspects of the design or comment on interactions with other systems. In addition, for comprehensive fire engineered designs that utilise computational analysis tools, specific expertise for review may be needed. Use of innovative materials and systems might trigger the need to additional expertise as well.

7.3.4.3.1 While the hub needs access to a broad range of expertise, it is not necessary to have the subject material experts as fulltime members of the hub. Rather, the necessary expertise should be identified to the extent possible in advance and appropriate persons contracted to provide expert services if and when needed.

7.3.4.3.2 As with the concern with panellists above, any real or perceived conflicts of interest, non-disclosure requirements, and the like would have to be carefully managed for any subject material expert.

7.3.5 Given the above considerations, a set of potential options under the four fundamental constructs of the hub is presented below.

Option A – Independent body, full-time staff, contract experts, reporting to government

7.3.5.1 The primary attraction of this construct would be the formation of an independent body, which does not currently exist, that would report directly to government. To maintain the current Ministerial Views process, the reporting would most likely be direct to Scottish Ministers outside of the Building Standards Division (BSD) and the local authority verifiers (LAVs).

7.3.5.1.1 In this variation, there would be a fulltime gatekeeper (coordinator) and panel members (suggest maximum of four, in addition to the gatekeeper), and a reliance upon a collection of subject matter experts who would be called upon when needed.

7.3.5.1.2 It is assumed that this construct would necessitate changes to legislation. The costs of more than five staff (including administrative support) would be rather high, especially if there is not fulltime work (i.e., not a full load of projects to review).

7.3.5.1.3 While this option is worth considering, it is not clear that a new body, outside of the current system, is necessary. Stakeholders largely report that the system as is works generally well, with challenges in a somewhat small percentage of cases. It is also not clear if the anticipated workload would be proportional to the cost.

Option B – Independent body, one full-time staff, rotating panellists, contract experts, reporting to government

7.3.5.2 This option is similar to Option A, except that instead of fulltime expert staff (panellists), the panellists are contracted on a rotating basis (2- or 3-year terms), with a limited expectation of workload (perhaps 2-4 days per month). It is difficult to determine exactly what the workload would be at this point, but the estimated number of projects that might need hub review is assumed to be relatively small.

7.3.5.2.1 As with the above, while this option is worth considering, it is not clear that a new body, outside of the current system, is necessary. Stakeholders largely report that the system as is works generally well, with challenges in a somewhat small percentage of cases.

Option C – Construct of LABSS, full-time staff, contract experts

7.3.5.3 The primary attraction of this construct would be keeping the hub within the existing verification process, operating as an extension of the LAVs.

7.3.5.3.1 In this variation, there would be a fulltime gatekeeper (coordinator) and panel members (suggest maximum of four, in addition to the gatekeeper), and a reliance upon a collection of subject matter experts who would be called upon when needed.

7.3.5.3.2 For this option to work, there would need to be agreement by LABSS and the LAVs that the hub is staffed with a range of experts, as discussed above, and is not fully staffed by LAV personnel.

7.3.5.3.3 It is assumed that this construct would not necessitate changes to legislation. The costs of more than five staff (including administrative support), however, would be rather high, especially if there is not fulltime work (i.e., not a full load of projects to review).

7.3.5.3.4 This option is worth considering. Stakeholders largely report that the system as is works generally well, with challenges in a somewhat small percentage of cases. However, it is not clear that the anticipated workload would be proportional to the cost of a large number of fulltime staff.

Option D – Construct of LABSS, one full-time staff, rotating panellists, contract experts

7.3.5.4 This option is similar to Option C, except that instead of fulltime expert staff (panellists), the panellists are contracted on a rotating basis (2- or 3-year terms), with a limited expectation of workload (perhaps 2-4 days per month). It is difficult to determine exactly what the workload would be at this point, but the estimated number of projects that might need hub review is assumed to be relatively small.

7.3.5.4.1 For this option to work, there would need to be agreement by LABSS and the LAVs that the hub is staffed with a range of experts, as discussed above, and is not fully staffed by LAV personnel.

7.3.5.4.2 As with the above, while this option is worth considering. Stakeholders largely report that the system as is works generally well, with challenges in a somewhat small percentage of cases. This option is more cost-effective that Option C.

Option E – Construct of SFRS, full-time staff

7.3.5.5 The primary attraction of this option is that, in some respects, the hub already exists.

7.3.5.5.1 However, challenges exist in the legal structuring, given the existing statutory consultee role of the SFRS in the verification process. In addition, it is not clear that there would be a possibility to inject outside experts into the SFRS FEG. At present, all members come from the fire service, with fire engineering knowledge and expertise, but not necessarily verifier or other expertise, as has been noted as being important. Whether the SFRS could contract subject matter experts is also unknown.

7.3.5.5.2 This option needs to be explored in much greater detail relative to the issues noted above.

Option F – Construct of FE community, full-time staff, contract experts

7.3.5.6 The primary attraction of this construct would be coordination of the hub within the discipline around which the expertise is needed: fire engineering.

7.3.5.6.1 In principle, this option would be quite similar to Option C above, in that there would be a fulltime gatekeeper (coordinator) and panel members (suggest maximum of four, in addition to the gatekeeper), and a reliance upon a collection of subject matter experts who would be called upon when needed. The difference being this option managed within the fire engineering community.

7.3.5.6.2 For this option to work, there would need to be agreement by the fire engineering community that the hub be staffed with a range of experts, as discussed above, and is not fully staffed by fire engineers. Importantly, there would need to be a mechanism within the fire engineering community to facilitate this, such as perhaps the Institution of Fire Engineers Scottish Branch.

7.3.5.6.3 It is assumed that this construct would not necessitate changes to legislation. The costs of more than five staff (including administrative support), however, would be rather high, especially if there is not fulltime work (i.e., not a full load of projects to review).

7.3.5.6.4 While there are some appealing aspects to this option, it is not clear that a hub for supporting the review of fire engineering should be a construct of the fire engineering community. While there is no doubt that suitable controls can be put in place, the ‘fox guarding the chicken house’ perception would be difficult to overcome.

Option G – Construct of FE community, one full-time staff, rotating panellists, contract experts

7.3.5.7 This option is similar to Option F, except that instead of fulltime expert staff (panellists), the panellists are contracted on a rotating basis (2- or 3-year terms), with a limited expectation of workload (perhaps 2-4 days per month). It is difficult to determine exactly what the workload would be at this point, but the estimated number of projects that might need hub review is assumed to be relatively small.

7.3.5.7.1 Much like with Option F, while there are some appealing aspects to this option, and the costs of this option would be less than Option F, it is not clear that a hub for supporting the review of fire engineering should be a construct of the fire engineering community.

7.3.6 At the present time, it is suggested that Option D seems the most attractive in terms of minimal impact on the existing system, relative ease to establish, and minimal costs. There would need to be discussion with LABSS and the LAVs, as well as with the rest of the sector, on exactly how it would be structured, how it would be staffed, and how it would operate, given the other actors and processes involve in the verification system.

7.3.7 To be successful, all stakeholders would need to buy into the hub concept and agree to use it as per final operating agreement. In particular, success will depend on LAVs agreeing to use the hub in a consistent manner across all local authorities. If this does not occur, the benefit of increasing consistency may not be achieved.

7.4 VIEWS ON POTENTIAL SCOPE OF THE HUB

7.4.1 Discussions with stakeholders clearly identified that one of the major challenges being faced is a lack of resources for LAVs, not just in fire engineering, although fire engineering seems to raise the most significant challenges. It was broadly felt that if LAVs were adequately resourced there would be no need for a hub. As understood, 'adequate resources' means fire engineers as well as other staff, time, etc. to fulfil the necessary obligations. Since the fire engineering work is not equally distributed in the country, i.e., not all LAVs will see a large number of fire engineered designs, placing a fire engineer in each LAV would be costly and unnecessary for many LAVs. Thus, it was widely agreed that a fundamental purpose of a hub is to provide LAVs with a resource to be used in the review and verification of fire engineered designs, at least those involving 'high-risk' buildings, 'complex' buildings, and 'complex' designs, but also in some cases deviations from the Technical Handbook, as related to the capacity of the LAV to address.

7.4.2 As a resource to the LAVs, a key question is whether the hub (a) makes a decision on verification of design, or (b) provides input to the LAV, who takes the decision. Based on feedback from stakeholder groups, and considering whether there is sufficient cause and benefit to remove decision-making from the LAVs, it is the opinion of the author that the hub should provide input to the LAVs, and that the LAVs retain decision-making authority as currently exists.

7.4.3 In addition, as noted above, it is the opinion of the author that Scotland should retain the Ministerial Views process, and the Ministerial Relaxation process, as currently exists. The ability to have an appeals mechanism, prior to entering the judiciary system, provides more opportunity for identifying and resolving issues within the sector.

7.4.4 However, there remain issues on what the specific scope of the hub would be, what would trigger review by the hub, and what the expectations of the LAVs would be with regard to advice from the hub.

Scope

7.4.4.1 The basic scope of the hub is to provide an expert review of any fire engineered design submitted to it, in the context of the overall building design and expected operation, to determine if:

7.4.4.1.1 The fire engineered design adequately considers and addresses the building systems and features with which it interacts with regard to compliance with the relevant fire safety Standards, without negatively impacting any other Standards which are applicable to the building design, or without such other Standards impacting on the level of fire safety delivered. While this may seem obvious, issues of energy performance and fire, sustainability and fire, and structure and fire are areas in which potentially 'competing objectives' might exist, for which an holistic assessment is needed. In specific occupancies such as hospitals, there may also be issues of ventilation system and alarm system 'competition' for such things as 'containment' zones (for airborne health hazards) and smoke control, 'containment' zones (for airborne hazards) and fire compartments, and nurse alarm and fire alarm, among others. The zoning issue may also be a concern in multi-tenant / multi-occupancy buildings, whether new or existing. These types of complexity need holistic treatment.

7.4.4.1.2 The fire engineered design has adequately characterised and assessed the fire scenarios, design basis fires and conditions of concern given the use of the building, the expected fuel loads, compartment configurations, paths of available egress, the associated vulnerabilities / life safety parameters of occupants, and related issues in meeting the life safety Standard; and, as deemed appropriate, the sustainability of the building against fire threats in meeting the sustainability Standard. This is needed regardless of whether a ‘comparative’ approach, first-principles approach, or probabilistic approach is taken.

7.4.4.1.3 The fire engineered design has been adequately undertaken, from a technical perspective, including use of appropriately justified data, statistics, analytical methods, and computational methods, with appropriate consideration of sources of uncertainty and variability across all aspects (i.e., data, methods, post-occupancy conditions, etc.). This is needed regardless of whether a ‘comparative’ approach, first-principles approach, or probabilistic approach is taken.

7.4.4.1.4 Where a ‘comparative’ approach has been taken, the fire engineered design has been adequately justified the ‘base case’ for comparison.

7.4.4.1.5 Where new or innovative materials, components and systems are used, that performance (test) data are appropriate, and/or analytical approach taken to demonstrate fitness for purpose of the materials, components and systems are adequately justified.

Triggers

7.4.4.2 Triggers for review by the hub are difficult to precisely quantify at this time, as discussed above. However, there should be a few fundamental tenets:

7.4.4.2.1 Any fire engineered design for which the responsible person within the LAV believes the scope of the design is outside of the area of expertise of the person or persons within the LAV charged with verifying the design.

7.4.4.2.2 Any fire engineered design for a building deemed to be of ‘high-risk’, such as in Risk Category 3 or 4, as described in Section 4. Note: a decision is needed on whether Scotland wants to move in this direction (i.e., risk categories), and if so, work is needed within Scotland to identify specific risk parameters that are necessary so as to allocate specific building uses / occupancies and/or specific building features (e.g., height) to the associate risk category.

7.4.4.2.3 Buildings, and building designs, for which the complexity as described in Section 4 is such that the LAV requests assistance in review. This could be the complexity of building (e.g., mixed occupancy with multiple property owners, etc.), complexity of systems (e.g., complex smoke and heat venting, or complex façade system of double-skin design and louvres for control of airflow, etc.), or sophistication of tools of analysis (e.g., CFD software, FEA software, evacuation software, etc).

7.4.4.2.4 Buildings, and building designs, for which innovative materials, components, or systems, or innovative methods of construction, are used and the LAV requests assistance in review. This could include new façade materials and systems, new CLT systems, and more.

7.4.4.2.5 In addition, it is suggested that there should be a pathway by which a fire engineer, or a building developer / owner, can request review by the hub. The decision should be made along with the LAV, but there should not be barriers to requesting a review if the building owner / developer or their fire engineer requests such.

Expectations of LAVs Once Given a Hub Opinion

7.4.4.3 With respect to expectations of the LAVs with regard to advice from the hub, it is suggested that the LAVs consider the opinion of the hub as having at least the weight of a Ministerial View. While not a View, any opinion should be the considered recommendation of well-respected leaders of a cross-section of building-related disciplines, including fire engineering. If the hub is set up and resourced appropriately, there should be no technical reason by which to overturn the opinion of the hub. While there may be non-technical reasons that a LAV may not accept a hub opinion, it would be expected that the hub opinion would accompany any subsequent submittal for a Ministerial View or other legal challenge.

7.5 NUMBER / QUALIFICATIONS / SERVICE OF PANEL MEMBERS

7.5.1 Assuming a decision to pursue the Option D approach for a central review hub, it has been suggested that there would be a fulltime gatekeeper (coordinator) and a set of part-time (contract) panel members, and reliance upon a collection of subject matter experts who would be called upon when needed.

7.5.1.1 It has been suggested that, in addition to the gatekeeper (coordinator) that the primary hub members include four additional panel members. This should be deliberated as part of the formation of a hub, if it goes forward. However, four is suggested as providing a suitable representation of most likely needed expertise, while keeping the numbers small to facilitate decision-making. The base number may change depending on exactly how the SFRS FEG would interface with the hub. At present, the suggested disciplines are as follows:

- Gatekeeper (coordinator), who has appropriate knowledge, expertise and experience with fire engineering, verification, building regulations, and if possible, building design
- Verifier (fire experience, as well as more broadly)
- Fire Engineer (design experience)
- Architect / Architectural Technologist
- SFRS FEG member

7.5.1.2 It is suggested that each member commit to a term of 2- or 3-years (with reappointment possible), with a time commitment of at least 2-4 days per month. The actual need, however, will not really be known until a hub is developed and the scope and operation are fully agreed. Ideally, a pool of at least 15 persons, three-each who meet the requirements of the five positions, can be identified. From this pool, members will be appointed to serve terms, rotating out after completion of their service. If there is agreement on the five positions, it is suggested that the relevant organisations, LABSS, SFRS FEG, the fire engineers, and the architects and architectural technologists, nominate members, and the leaders of the organisations (or their designees) select the panellists. Note: It could be that appointments should come from government. If that is so decided, nominations could be sent to BSD, who could sit on the panel. The main issue is that this be a group that meets requirements, can be expected to work well together, and as a group, will have the respect of the community.

7.5.1.3 An extensive range of subject matter expertise may be needed over the lifetime of the hub. This includes acousticians, architects, architectural technologies, CFD experts, electrical engineers, evacuation software experts, finite element analysis (FEA) experts, health and safety experts, mechanical engineers, physiologists, psychologists, structural engineers, toxicologists, fire scientists, fire test experts, and more. External (outside of Scotland) experts in fire engineering, building control, and related disciplines may be valuable as well. A list of expertise should be compiled, and as above, a set of experts identified, who are able and willing to commit time to serve as needed. Service in this case might be agreement to serve in the pool of experts for a 2- or 3-year term (with reappointment possible), with expectations of 2-4 days per project, and perhaps only 2-3 projects per year. This is very difficult to gauge, however, so flexibility is needed.

7.5.2 With respect to qualifications of panel members, that will necessarily vary by discipline. However, all members should hold a university degree (honours, ideally with post-graduate credentials, as appropriate) and the highest level of qualification appropriate to their discipline (e.g., chartership or similar). Each member of the hub should be well-respected both within their discipline as well as across disciplines as well, to the extent possible. They should have extensive experience in their area of practice and expertise, suggested as at least 10 years, but perhaps as much as 15 or 20 years, and have demonstrable experience in the design or review of complex fire engineered designs and/or buildings which involved fire engineering solutions.

7.5.3 Active panellists should not currently be involved in fire engineering and design. While this will significantly limit the pool, independence from current design work and corporate affiliation seems necessary to achieve buy in from all sectors. If the hub had sufficient work to warrant secondment, that perhaps might be an option, if appropriately controlled. Of course, if the pool is too small, certain experts may have to be drawn from industry, and clear means of avoidance of conflict of interest, nondisclosure, and the like would need to be drawn up.

7.5.4 Panellists and experts serving in the hub would most likely seek some protection from liability for the opinions that they offer. An appropriate liability scheme would therefore be needed. It may be that the liability component will influence the structure and operation of the hub and its members.

7.6 TIME AND COST CONSIDERATIONS

7.6.1 A central review hub only makes sense if properly resourced to be able to respond when needed and conclude its work within a reasonably short period of time. Otherwise, the delays might result in more problems than if the hub does not exist.

7.6.2 Ultimately, decisions on funding will be developed within Scotland by the relevant stakeholders. However, it seems a multi-layer funding model could work, including:

7.6.2.1 Government, which might provide seed funding, perhaps physical office space and equipment, computer equipment and software resources, and perhaps administrative support.

7.6.2.2 Local authorities, which could perhaps use levies on the warrant process, perhaps specifically for designs designated to go to the hub, to support hub panellists. This could work if the local authorities assure such funds go only to support the hub.

7.6.2.3 Developers and owners could pay a specific fee, especially if they request directly that the hub carry out the review for their project. Since the LAV ultimately makes the decision on acceptability, there should not be a 'bribe' concern.

7.6.3 The costs to operate the hub will greatly depend on agreed structure. Assuming for now that the Option D approach as discussed above is adopted, requirements would include:

- One fulltime, expert as gatekeeper / coordinator of the hub
- Administrative support
- Funds for four panellists, nominally 24-48 days per year, plus expenses
- Physical meeting space and computers (perhaps)
- Funds for subject matter experts, perhaps 2-4 days per project (assuming perhaps 2-4 projects per year needing specific expertise)

7.6.4 It is suggested that the gatekeeper (coordinator) should be able to make a determination on whether a design should be reviewed by the hub within 2 business days. Assuming the hub panellists meet monthly, small projects might be completed within one month from submittal, and larger projects within 2-3 months, depending on complexity.

7.6.4.1 Should frequency of meetings reduce, time scales might reduce as well. However, it should not be expected that any project be reviewed in less than 2 weeks.

7.6.4.2 In some cases, projects will have many phases over months (or years), so response time would be as per above based on phase.

7.7 TERM OF HUB, AUDITS AND REVIEWS

7.7.1 Most stakeholders do not see that a hub is needed indefinitely. There are opportunities to increase the fire engineering knowledge within LAVs, and ultimately, the fire engineering community would like to move to a certification system approach, where qualified firms (persons) can certify designs (some, if not all). However, the time needed to reach a certification system could be a decade or more.

7.7.2 To help get to that point, it is suggested to think in terms of the hub operating on an initial term of five years, with the possibility of extension, if needed, in five-year increments. This is similar to how the Australian Building Codes Board (ABCB) is formulated, via an inter-governmental agreement (http://www.abcb.gov.au/ABCB/The-Board, last accessed on 22 April 2018). An agreement similar in form to this might be suitable for the hub as well.

7.7.3 To assess how the hub is performing, relative to its charge, it is suggested that annual audits be conducted, looking at such factors as number of designs reviewed, acceptance by LAVs, customer satisfaction, and the like. A detailed review might be conducted every 2 years, and the 4th-year review would include consideration of the continuation of the hub for an additional five years.

7.7.4 Details of the scopes of audits / reviews would need to be developed as part of the formation of the hub. It is expected that the system might mirror that used currently for assessment of the LAVs.

8 Conclusions and Recommendations

8.1 SUMMARY

8.1.1 This project explored the need, appropriateness, potential structure and potential operations of a central hub for assisting in the verification of complex fire engineered designs. As part of this effort, input was obtained from a wide range of stakeholder groups on the following topics:

- The role of a central review hub in relation to responsibilities and authority of LAVs, SFRS and BSD with respect to fire engineered designs
- The form (or forms) of the hub that may be suitable for Scotland, given the regulatory system and the resources and expertise within the system
- The number and representative make-up (e.g., practicing fire engineer, LAVs, SFRS fire engineer, academic, etc.) of persons that might be appropriate for serving in a review capacity as part of the hub
- The qualifications and experience of the persons who might serve as part of review panels for the hub
- The limits and conditions of service as part of the hub, including potential conflicts of interest (private and governmental)
- The triggers for determining when a project could or should be sent to the hub for verification (e.g., complex and 'high-risk' buildings, significant variations from Section 2: Fire, Technical Handbooks, etc.), what documentation would be required, from whom, and within what time constraints
- The time limits around the activities of the hub in relation to a specific project (i.e., timelines for undertaking review and reporting back), and
- How such a hub might be funded (i.e., different mechanisms).

8.1.2 Research into how other jurisdictions undertake verification (review and approval) was conducted as well, and included private certification, peer review, multi-actor approval process, and multi-pathway review processes.

8.2 CONCLUSIONS

8.2.1 It is the opinion of the author that the verification system in Scotland largely operates well, and that the fundamental issue is lack of resources. A central hub for review is recommended as the means to provide needed resources in the short term.

8.2.2 It is the opinion of the author that Scotland is not yet ready for self-certification, although this might be a reasonable long-term target.

8.2.3 It is the opinion of the author that private certification of fire engineered designs may not be the best option for Scotland at this time.

8.2.4 It is the opinion of the author that given the resource limitations around fire engineers in Scotland, and limited resources for LAVs and the SFRS, it does not seem practicable to move towards a multi-actor verification system at this time, at least in the breadth of actors involved in other countries.

8.2.5 It is the opinion of the author that an adequately regulated and managed peer-review system can be beneficial to Scotland.

8.2.6 It is the opinion of the author that a multiple verification approach, based on level / complexity of design, could be beneficial for Scotland, in that a majority of designs are 'prescriptive' (Technical Handbook compliant), with the next greatest number 'minor' deviations, and the smallest number the 'full' fire engineered designs.

8.2.7 It is the opinion of the author that Scotland should retain the Ministerial Views process, and the Ministerial Relaxation process, as currently exists. The ability to have an appeals mechanism, prior to entering the judiciary system, provides more opportunity for identifying and resolving issues within the sector.

8.2.8 Considering the various options explored as part of this research, and considering the feedback from stakeholders on the concept of a central 'hub' for review of fire engineered designs, it is the opinion of the author that for Scotland, a system that contains aspects of maintaining the current government verification authority (LAV), with peer-review if needed (but largely circumvented by implementation of a 'central review hub' for fire engineered designs, along the lines of the Japanese system), would seem to fit best the verification needs and resource constraints within Scotland.

8.2.9 It is the opinion of the author that the most feasible construct for such a hub would be an entity managed by LABSS, with a fulltime 'gatekeeper' (coordinator) to make initial decisions on whether a design should be reviewed by the hub, and supported by a panel of four additional persons, with access to a range of subject matter experts. The gatekeeper and panellists would be as follows. The base number may change depending on exactly how the SFRS FEG would interface with the hub. At present, the suggested disciplines are as follows:

- Gatekeeper (coordinator), who has appropriate knowledge, expertise and experience with fire engineering, verification, building regulations, and if possible, building design
- Verifier (fire experience, as well as more broadly)
- Fire Engineer (design experience)
- Architect / Architectural Technologist
- SFRS FEG member

8.2.9.1 The primary attraction of this construct would be keeping the hub within the existing verification process, operating as an extension of the LAVs.

8.2.9.1.1 In this construct, there would be a fulltime gatekeeper (coordinator) and four panel members, contracted on a rotating basis (2- or 3-year terms), with a limited expectation of workload (perhaps 2-4 days per month). There is also a need for a large pool of subject matter experts who would be called upon when needed.

8.2.9.1.2 For this option to work, there would need to be agreement by LABSS and the LAVs that the hub is staffed with a range of experts, as discussed above, and is not fully staffed by LAV personnel.

8.2.9.1.3 It is assumed that this construct would not necessitate changes to legislation. The costs of one fulltime staff (not including administrative support), using 'as needed' contracts for panellists and subjective material experts, should be relatively cost-effective.

8.2.10 With regard to decision-making, it is the opinion of the author that the hub should provide input to the LAVs, and that the LAVs retain decision-making authority as currently exists.

8.2.11 It is the opinion of the author that Scotland should retain the Ministerial Views process, and the Ministerial Relaxation process, as currently exists. The ability to have an appeals mechanism, prior to entering the judiciary system, provides more opportunity for identifying and resolving issues within the sector.

8.2.12 The basic scope of the hub is to provide an expert review of any fire engineered design submitted to it, in the context of the overall building design and expected operation, to determine if:

- The fire engineered design adequately considers and addresses the building systems and features with which it interacts with regard to compliance with the relevant fire safety Standards, without negatively impacting any other Standards which are applicable to the building design, or without such other Standards impacting on the level of fire safety delivered.

- The fire engineered design has adequately characterised and assessed the fire scenarios, design basis fires and conditions of concern given the use of the building, the expected fuel loads, compartment configurations, paths of available egress, the associated vulnerabilities / life safety parameters of occupants, and related issues in meeting the life safety Standard; and, as deemed appropriate, the sustainability of the building against fire threats in meeting the sustainability Standard.

- The fire engineered design has been adequately undertaken, from a technical perspective, including use of appropriately justified data, statistics, analytical methods, and computational methods, with appropriate consideration of sources of uncertainty and variability across all aspects (i.e., data, methods, post-occupancy conditions, etc.).

- Where a 'comparative' approach has been taken, the fire engineered design has been adequately justified the 'base case' for comparison.

- Where new or innovative materials, components and systems are used, that performance (test) data are appropriate, and/or analytical approach taken to demonstrate fitness for purpose of the materials, components and systems are adequately justified.

8.2.13 Triggers for review by the hub are difficult to precisely quantify at this time, as discussed above. However, there should be a few fundamental tenets:

- Any fire engineered design for which the responsible person within the LAV believes the scope of the design is outside of the area of expertise of the person or persons within the LAV charged with verifying the design.

- Any fire engineered design for a building deemed to be of 'high-risk', such as in Risk Category 3 or 4, as described in Section 4. Note: a decision is needed on whether Scotland wants to move in this direction (i.e., risk categories), and if so, work is needed within Scotland to identify specific risk parameters that are necessary so as to allocate specific building uses / occupancies and/or specific building features (e.g., height) to the associate risk category.

- Buildings, and building designs, for which the complexity as described in Section 4 is such that the LAV requests assistance in review. This could be the complexity of building (e.g., mixed occupancy with multiple property owners, etc.), complexity of systems (e.g., complex smoke and heat venting, or complex façade system of double-skin design and louvres for control of airflow, etc.), or sophistication of tools of analysis (e.g., CFD software, FEA software, evacuation software, etc).

- Buildings, and building designs, for which innovative materials, components, or systems, or innovative methods of construction, are used and the LAV requests assistance in review. This could include new façade materials and systems, new CLT systems, and more.

- In addition, it is suggested that there should be a pathway by which a fire engineer, or a building developer / owner, can request review by the hub. The decision should be made along with the LAV, but there should not be barriers to requesting a review if the building owner / developer or their fire engineer requests such.

8.2.14 It is the opinion of the author that the LAVs consider the opinion of the hub as having at least the weight of a Ministerial View. While not a View, any opinion should be the considered recommendation of well-respected leaders of a cross-section of building-related disciplines, including fire engineering. If the hub is set up and resourced appropriately, there should be no technical reason by which to overturn the opinion of the hub.

8.2.15 Ultimately, decisions on funding will be developed within Scotland by the relevant stakeholders. However, it seems a multi-layer funding model could work, including:

- Government, which might provide seed funding, perhaps physical office space and equipment, computer equipment and software resources, and perhaps administrative support.

- Local authorities, which could perhaps use levies on the warrant process, perhaps specifically for designs designated to go to the hub, to support hub panellists. This could work if the local authorities assure such funds go only to support the hub.

- Developers and owners could pay a specific fee, especially if they request directly that the hub carry out the review for their project. Since the LAV ultimately makes the decision on acceptability, there should not be a 'bribe' concern.

8.2.16 The costs to operate the hub will greatly depend on agreed structure. Assuming for now that the approach as discussed above is adopted, requirements would include:

- One fulltime, expert as gatekeeper / coordinator of the hub
- Administrative support
- Funds for four panellists, nominally 24-48 days per year, plus expenses
- Physical meeting space and computers (perhaps)
- Funds for subject matter experts, perhaps 2-4 days per project (assuming perhaps 2-4 projects per year needing specific expertise)

8.2.17 It is suggested that the gatekeeper (coordinator) should be able to make a determination on whether a design should be reviewed by the hub within 2 business days. Assuming the hub panellists meet monthly, small projects might be completed within one month from submittal, and larger projects within 2-3 months, depending on complexity.

- Should frequency of meetings reduce, time scales might reduce as well. However, it should not be expected that any project be reviewed in less than 2 weeks.
- In some cases, projects will have many phases over months (or years), so response time would be as per above based on phase.

8.2.18 It is the opinion of the author that the hub be established for an initial term of five years, with the possibility of extension, if needed, in five-year increments.

8.2.19 To assess how the hub is performing, relative to its charge, it is suggested that annual audits be conducted, looking at such factors as number of designs reviewed, acceptance by LAVs, customer satisfaction, and the like. A detailed review might be conducted every 2 years, and the 4th-year review would include consideration of the continuation of the hub for an additional five years.

8.3 RECOMMENDATIONS

8.3.1 It is recommended that the Scottish government consult with stakeholders on the formation of a hub as outlined in this report.

8.3.2 It is recommended that the Scottish government initiate an effort to develop a system of 'risk categories' for buildings in Scotland, so as to provide consistency in understanding and application amongst all stakeholders, including the public. Ultimately, any approach to defining 'high risk' buildings in Scotland should begin with a discussion on defining and characterizing risk, and then moving on to categorizing or quantifying risk, as befits the selected model. Consideration of existing classification(s) of risk in the Scottish system would be a likely basis of such an effort (e.g., looking to 'places of special risk' and buildings that 'pose a particular risk' as discussed in the Technical Handbooks).

8.3.3 It is recommended that the Scottish Government initiate a project to develop guidelines on defining, recognizing and understanding complexity in buildings as related to fire engineering designs. Complexity in the built environment has many facets, and it is difficult to define it simply. It is deemed better to describe what makes the system complex, provide questions to explore relative to complexity, and to train actors to understand and address complexity as part of design and reporting.

8.3.4 It is recommended that as part of the hub, and as part of addressing 'high-risk' and 'complex' buildings, and as part of addressing the current situation with respect to qualifications and competency across the sector, that the Scottish Government consider development of a 'fire engineering verification method' to assist engineers and verifiers with 'simple' deviations from the Technical Handbooks.

9 References

ABCB (2018). NCC 2019 – Fire Safety Verification Method, draft for public consultation, ABCB, Canberra, ACT, Australia (available for download at http://www.abcb.gov.au/Resources/Publications/NCC-2019-Public-Comment-Draft/Fire-Safety-Verification-Method-proposed-for-NCC-2019, last accessed 11 March 2018).

ABCB (2018a). NCC 2019 – Fire Safety Verification Method, Calibration Study Summary, ABCB, Canberra, ACT, Australia (available for download at http://www.abcb.gov.au/Resources/Publications/NCC-2019-Public-Comment-Draft/Fire-safety-Verification-Method-calibration-study-summary, last accessed 11 March 2018).

Alvarez, A., Meacham, B.J., Dembsey, N.A. and Thomas, J.R. (2014). "A Framework for Risk-Informed Performance-Based Fire Protection Design for the Built Environment," Fire Technology, DOI 10.1007/s10694-013-0366-1, Vol. 50, pp161-181, 2014.

Beard, A.N. (2005). "Requirements for acceptable model use," Fire Safety Journal, 40, pp477-484.

Beard, A.N. (2005a). "Problems with Using Models for Fire Safety," Chapter 14, The Handbook of Tunnel Fire Safety, Beard, A. and Carvel, R. Eds., Thomas, Telford, London, UK, ISBN 0-7277-3168-8.

Burns, T.R. and Machado, N. (2010). "Technology, Complexity and Risk: A social systems perspective on the discourses and regulation of the hazards of socio-technical systems," SOCIOLOGIA, PROBLEMAS E PRÁTICAS, No. 62, pp. 97-131.

Hackitt, Dame Judith (2018). Building a Safer Future - Independent Review of Building Regulations and Fire Safety: Final Report, ISBN 978-1-5286-0293-8, (available at https://www.gov.uk/government/publications/independent-review-of-building-regulations-and-fire-safety-interim-report, last accessed 24 May 2018).

Maltabarow, G. (2015). Building Certification and Regulation – Serving a New Planning System for NSW, (http://bpb.nsw.gov.au/sites/default/files/public/Archive/Maltabarow-building-certification-report-May2013.pdf, last accessed 8 April 2018).

MBIE (2017). C/VM2 Verification Method: Framework for Fire Safety Design, MBIE, Wellington, NZ (available for download at https://www.building.govt.nz/building-code-compliance/c-protection-from-fire/c-clauses-c1-c6/#jumpto-acceptable-solutions-and-verification-methods, last accessed on 11 March 2018).

Meacham, B.J. (2004). "Understanding Risk: Quantification, Perception and Characterization," Journal of Fire Protection Engineering, Vol. 14, No. 3, pp.199-228.

Meacham, B.J. (2007). "Using Risk as a Basis for Establishing Tolerable Performance: An Approach for Building Regulation," Workshop on Risk Acceptance and Risk Communication, Stanford University, Stanford, CA, 26-27 March 2007.

Meacham, B.J. (2010). “A Risk-Informed Performance-Based Approach to Building Regulation,” Journal of Risk Research, Vol.13, Issue 7, 2010.

Meacham, B.J. (2016). Research to Support the Improvement of the Design Verification of Fire Engineered Solutions as Part of the Scottish Building Regulatory System, Report prepared for the Scottish Government, Building Standards Division, June 2016 (download available at http://www.gov.scot/Topics/Built-Environment/Building/Building-standards/publications/pubresearch/researchfire, last accessed 11 March 2018).

Meacham, B.J. (2017). Competency Criteria for Local Authority Verifiers when Checking Fire Engineered Solutions for Compliance with Building Standards, Report prepared for the Scottish Government, Building Standards Division, March 2017 (download available at http://www.gov.scot/Topics/Built-Environment/Building/Building-standards/publications/pubresearch/researchfire, last accessed 11 March 2018).

Meacham, B.J. (2018). Research on Regulatory Appropriateness of Currently Cited Reaction to Fire Tests in Technical Handbook – Section 2: Fire – Standards *2.4 – 2.7*, Meacham Associates, March 2018.

Meacham, B.J. and van Straalen, IJ.J., (2017). “A Socio-Technical System Framework for Risk-Informed Performance-Based Building Regulation,” Building Research & Information, DOI 10.1080/09613218.2017.1299525, published on line 30 March 2017.

Park, H., Meacham, B.J., Dembsey, N.A., and Goulthorpe, M. (2014). “Enhancing Communication with Architects: A Key Player in Building Fire Safety,” Fire Technology, DOI: 10.1007/s10694-013-0365-2, Vol. 50, No. 2, pp183-203, 2014.

Park, H., Meacham, B.J., Dembsey, N.A., and Goulthorpe, M. (2015). “Conceptual Models for Holistic Building Fire Safety Performance Analysis,” Fire Technology, DOI:10.1007/s10694-013-0374-1, Volume 51, Issue 1, pp 173–193, 2015.

Park, H., Meacham, B.J., Dembsey, N.A. and Goulthorpe, M. (2015a). “Improved incorporation of fire safety performance into building design process,” Building Research and Information, DOI:10.1080/09613218.2014.913452, published on-line 16 May 2014, print January 2015.

Perrow, C. (1999, 1984). Normal Accidents.Living with High-Risk Technologies, 2nd ed., Princeton, NJ, Princeton University Press, New York, Basic Books.

Rein, G., Torero, J.L, Jahn, W., Stern-Gottfried, J., Ryder, N.L., Desanghere, S., Lázaro, M., Mowrer, F., Coles, A., Joyeux, D., Alvear, D., Capote, J.A., Jowsey, A., Abecassis-Empis, C. and Reszka, P. (2009). “Round-robin study of a priori modelling predictions of the Dalmarnock Fire Test One,” Fire Safety Journa*l*, Volume 44, Issue 4, May 2009, Pages 590-602.

Schalcher, H.R., Complexity in Construction, available for download at https://src.lafargeholcim-foundation.org/dnl/901ed18a-96ca-4904-a23c-c2620281c611/F10_BlueWorkshop_Paper_SchalcherHansRudolf.pdf, last accessed 16 April 2018.

Technical Handbook 2017: Non-Domestic, Scottish Government, Building Standards Division, 31 May 2016 (downloaded from https://beta.gov.scot/publications/building-standards-technical-handbook-2017-non-domestic/ on 24 February 2018).

Technical Handbook 2017: Domestic, Scottish Government, Building Standards Division, 28 June 2017 (downloaded from https://beta.gov.scot/publications/building-standards-technical-handbook-2017-domestic/ on 24 February 2018).

Wade, C.A. (2009). Technical Audit of New Zealand Fire Service Design Review Unit, QStar Solutions Report QST1013-R01, QStar Solutions Limited, Porirua, NZ.

Van Hees, P. (2016). “The Urgent Need for System Thinking in Fire Safety – The Only Way Forward for Testing, Engineering and Education,” 14th Interflam Conference, Interscience Communications Ltd, London, 2016.

10 Bibliography

Prior Workshops and Reports – Fire Safety Engineering in Scotland

BSD (2015). Verifying Fire Engineered Solutions as part of a Building Regulatory System, BSD – IRCC Workshop, Edinburgh, Scotland, June 2015.

Meacham, B.J. (2016). Research to Support the Improvement of the Design Verification of Fire Engineered Solutions as Part of the Scottish Building Regulatory System, Report prepared for the Scottish Government, Building Standards Division, June 2016 (download available at http://www.gov.scot/Topics/Built-Environment/Building/Building-standards/publications/pubresearch/researchfire, last accessed 11 March 2018).

Meacham, B.J. (2017). Competency Criteria for Local Authority Verifiers when Checking Fire Engineered Solutions for Compliance with Building Standards, Report prepared for the Scottish Government, Building Standards Division, March 2017 (download available at http://www.gov.scot/Topics/Built-Environment/Building/Building-standards/publications/pubresearch/researchfire, last accessed 11 March 2018).

Scottish Regulations and Guidance

Technical Handbook 2017: Non-Domestic, Scottish Government, Building Standards Division, 31 May 2016 (downloaded from https://beta.gov.scot/publications/building-standards-technical-handbook-2017-non-domestic/ on 24 February 2018).

Technical Handbook 2017: Domestic, Scottish Government, Building Standards Division, 28 June 2017 (downloaded from https://beta.gov.scot/publications/building-standards-technical-handbook-2017-domestic/ on 24 February 2018).

Fire Verification Methods

ABCB (2018). NCC 2019 – Fire Safety Verification Method, draft for public consultation, ABCB, Canberra, ACT, Australia (available for download at http://www.abcb.gov.au/Resources/Publications/NCC-2019-Public-Comment-Draft/Fire-Safety-Verification-Method-proposed-for-NCC-2019, last accessed 11 March 2018).

ABCB (2018a). *NCC 2019* – Fire Safety Verification Method, Calibration Study Summary, ABCB, Canberra, ACT, Australia (available for download at http://www.abcb.gov.au/Resources/Publications/NCC-2019-Public-Comment-Draft/Fire-safety-Verification-Method-calibration-study-summary.

MBIE (2017). C/VM2 Verification Method: Framework for Fire Safety Design, MBIE, Wellington, NZ (available for download at https://www.building.govt.nz/building-code-compliance/c-protection-from-fire/c-clauses-c1-c6/#jumpto-acceptable-solutions-and-verification-methods, last accessed on 11 March 2018).

11 Annex A: Three-Routes for Fire Safety Design Compliance in Japan

11.1 Overview

11.1.1 The building regulatory system in Japan is complex, particularly for fire safety, since building fire safety designs must comply with two laws: the Building Standard Law (BSL), which addresses fire resistance, smoke control and egress, and the Fire Service Law (FSL), which address suppression, detection, notification systems, and fire service access.

11.1.2 Both the BSL and the FSL are performance-based. However, there are different routes to compliance. In addition, there are three routes for compliance, depending on whether strict compliance with specific provisions (Route A), compliance with ordinary verification methods (prescribed performance, Route B), or designed using advanced verification (calculation) methods (engineered / performance-based design, Route C). Furthermore, there both governmental and private sector building confirmation and inspection bodies (verifiers), which can be used for Route A or B; however, for Route C designs, the design must be submitted for approval by a minister-appointed designated performance evaluation body. The basic building verification process is illustrated in Figure 11.1 below.

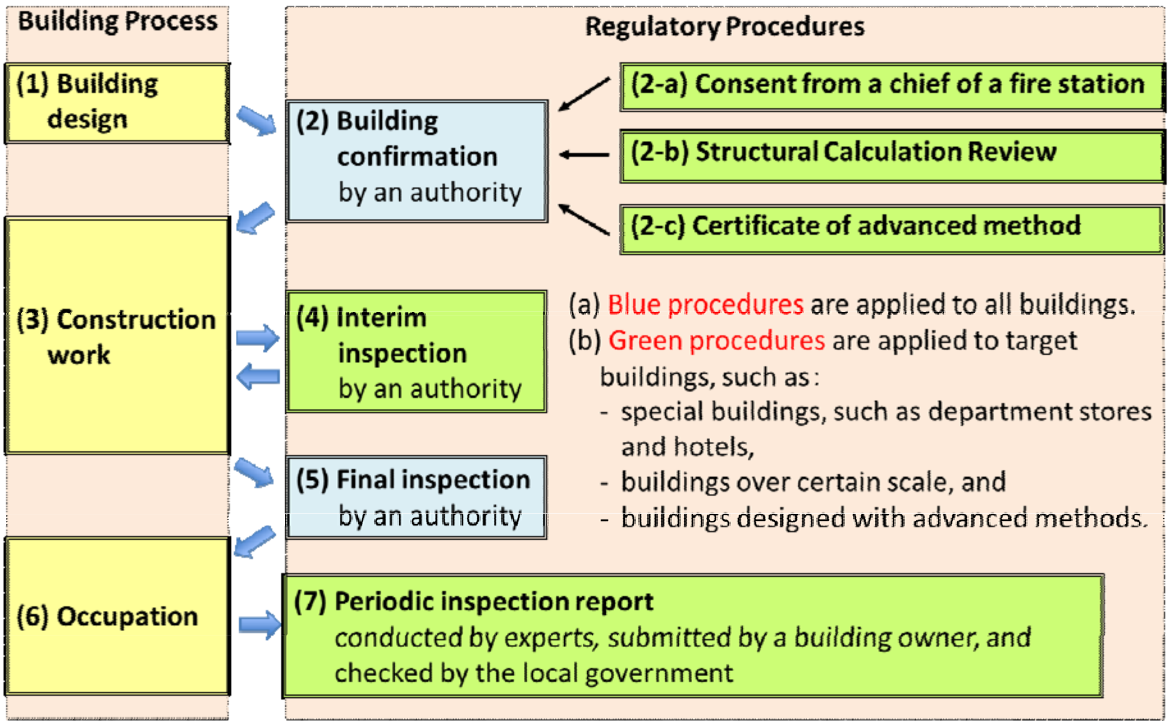

Figure 11.1 – Basic Building Verification Process in Japan

11.1.3 Building confirmation (verification) and on-site inspection can be undertaken by one of two types of authorities, as in the figure above: qualified Building Officials working for local government (Designated Administrative Body), or private sector Designated Confirmation and Inspection Bodies. In the case of the latter, the work is undertaken by Conformity Inspectors who have passed a qualifying examination of Qualified Building Regulation Conformity Inspectors. A certificate of compliance issued by a Designated Confirmation and Inspection Body is the same as that issued by a qualified Building Official under the local government. In recent years, most building confirmations are undertaken by Designated Confirmation and Inspection Bodies.

11.1.4 With respect verification of performance-based fire designs (and fire engineered designs, as would be the terminology used in Scotland), the process is illustrated in Figure 11.2 below. As noted above, compliance with the specific (prescriptive) provisions and with the ordinary verification methods (as might be considered C/VM2 in New Zealand) can be approved by a Building Official working for government or by a Designated Confirmation and Inspection Body. However, for an advanced verification method approach (fire engineered design in Scotland, i.e., BS7974 type), evaluation is required by a Designated Performance Evaluation Body.

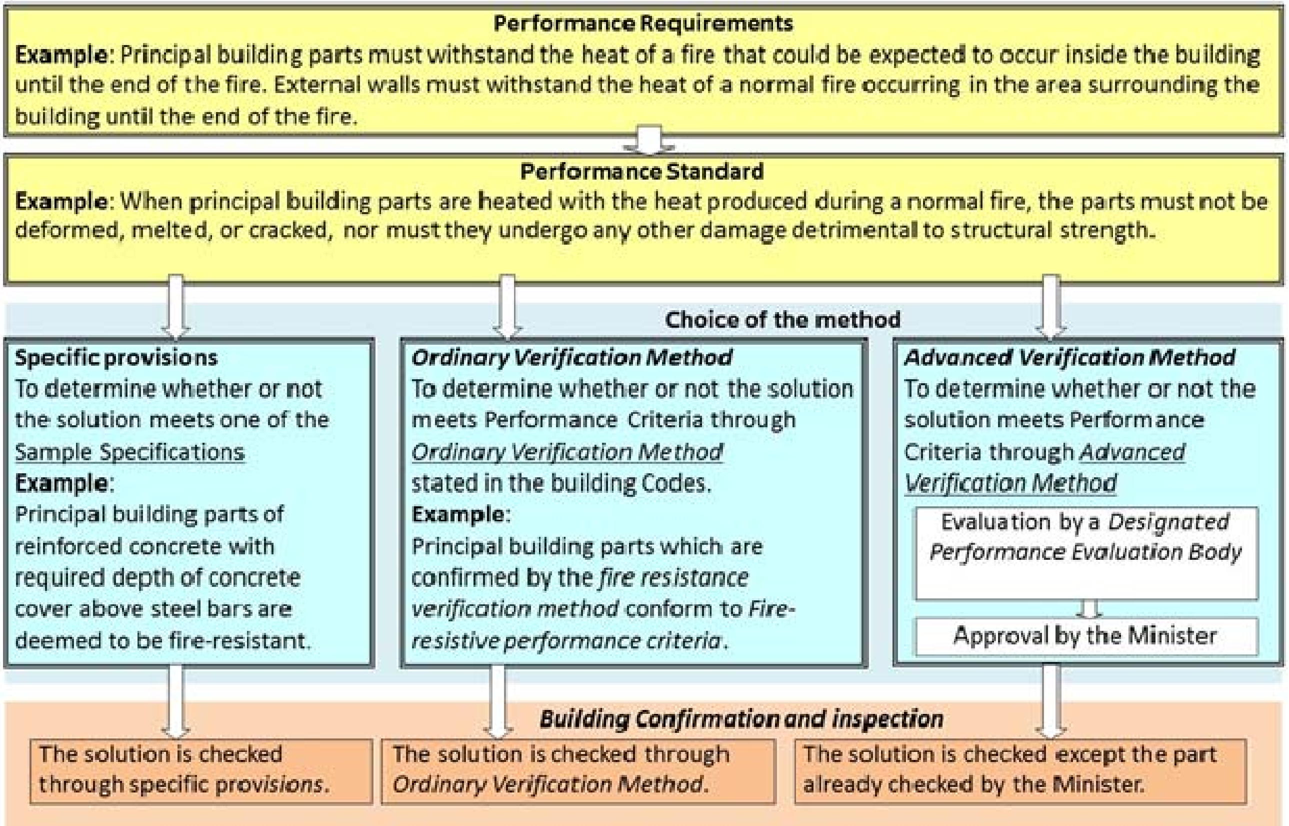

Figure 11.2 – Review Process for Performance-Based Designs in Japan

11.1.5 Details of the Ordinary Verification Methods are stipulated in the Enforcement Order and in the MLIT Notifications. On the other hand, details of the Advanced Verification Methods are not issued by the Government. Designated Performance Evaluation Bodies evaluate the design/solution of a building, using a manual approved by the Minister, then the applicant sends the evaluation body decision, along with drawings, to the Minister to request approval.

11.1.6 As of 2017, there are 27 Designated Performance Evaluation Bodies. For review of fire engineered designs, these bodies engage the most senior researchers and academics in fire in Japan. These specialists tend to be quite conservative, and the benchmark is typically the methods of the ordinary verification methods (i.e., algebraic equations, two-zone fire effects models, etc.). In fact, it has been reported that it is very difficult to get a design approved which uses CFD analysis, given the difficulty in demonstrating verification and validation of CFD codes.

11.1.7 In part, some of this conservatism is a function of the Aneha Scandal in the early 2000s.[2] This was an unfortunate situation in which a Kenchikushi (architect-engineer) engaged in fraudulent structural design calculations, which ultimately were not caught until several hundred buildings had been constructed and occupied. Several of these buildings subsequently had to be demolished because they were so unsafe.

11.1.8 As a result of the Aneha Scandal, the government instituted new requirements for review of structural designs, including the review of software used for structural calculations. A representation of the review process is shown in Figure 11.3 below. As a result of the new review procedures, very few advanced structural designs have been undertaken, since very few computational programs have been verified. In principle, there is one software package which has been verified against the Ordinary Verification Method calculations. In many respects, this situation is mirrored on the fire engineering area.

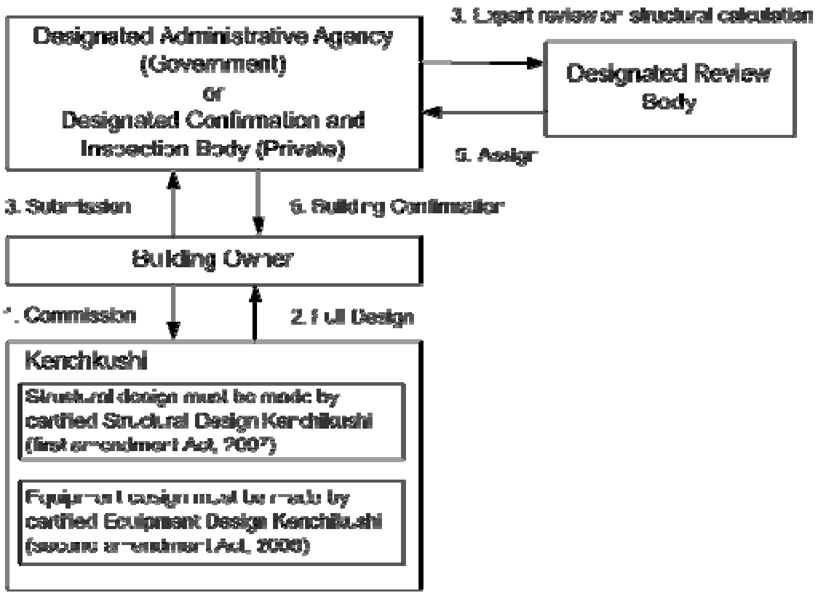

Figure 11.3 – Overview of Review System for Structural Design

11.1.9 A key aspect to the building design system in Japan is the qualification and licensing of Kenchikushi under the Kenchikushi Law. Kenchikushi are essentially architect-engineers, who are licensed to design buildings and to conduct construction administration. The qualifications of Kenchikushi are classified into three types: 1st Class Kenchikushi, 2nd Class Kenchikushi, and Mokuzo (wooden structures) Kenchikushi. In principle, a person who has the necessary educational background and job experience of architecture (university degree) and has passed the official examination can be registered. The Kenchikushi Law stipulates the use, structure, height, etc. of buildings for which only Kenchikushi may design and conduct construction administration. This is illustrated in Figure 11.4 below.

[2] Gojo, W. (2011). "The Aneha scandal: building fraud in Japan," Proceedings of the Institution of Civil Engineers – Forensic Engineering, Vol. 164, Issue 4, pp.179-187.

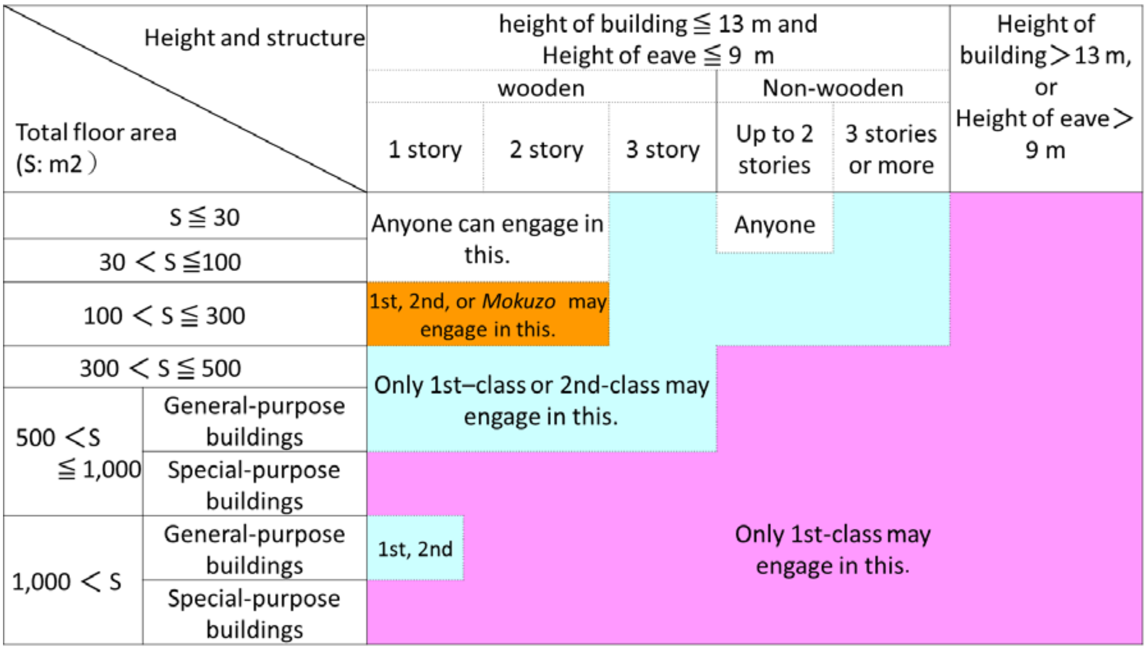

Figure 11.4 – Size and Type of Building Permitted by Kenchikushi Class

11.1.10 The purpose for presenting such an extensive discussion on Japan (albeit still only a brief overview of the system) is that the qualifications and competencies of designers and reviewers is quite high (university degrees and registration), and yet there are increasing levels of review required with the complexity of analysis which is undertaken.

11.1.11 In summary, review of fire safety designs in Japan is based on the design approach: compliance with prescriptive (Route A), compliance with ‘prescribed performance’ (ordinary verification) designs (Route B), both of which may be by building officials or designated private bodies, and requirement for expert panel for advanced analysis (Route C). It is also worth noting that this level of verification is also used for structural design, and in fact, one could say a higher level of verification is required around the verification of calculation software. The combination of size and complexity of building design for which different categories of designers (Kenchikushi) can undertake, and the triggers for level of review required, and by persons with what expertise, are attributes which could be considered in Scotland.

12 Annex B: Stakeholder Comments

12.1 Academia

Is there value in the concept of a centralized review hub?

12.1.1 There is a sense that moving to a certification system, as with structural engineering, would be appropriate in the long run. However, there are a lot of questions around how competency would be determined, what ongoing continuing professional development (CPD) requirements there might be, how project work audits would be conducted, and who would administer such a scheme. For now, some type of review is needed.

12.1.2 Liability associated with a fire engineering certification scheme could also be a challenging issue. At present, perception is that LAV carries liability for ‘approving’ design. Fire engineers would have this under certification scheme.

12.1.3 A central review hub (hub) could be helpful, as there is a lack of awareness of self-limits for some practicing in the fire engineering area. There does not seem to be a ‘code of conduct’ by which engineers practice only in their area of competency. Since fire engineering is not a mature and well-defined discipline, and engineering is not a protected term (profession) in Scotland, there is considerable variability. The ethical standards do not seem to be at the same level as other engineering disciplines.

12.1.4 It could be of value since the market is small, there is a limited number of fire engineers, and the level of expertise is variable. With small numbers, it difficult for LAVs to find and hire fire engineers. Lower salaries than the private sector does not help. The situation can be exacerbated when fire engineers come in from England and elsewhere who are unfamiliar with the Scottish building regulatory system and assume the same practices as elsewhere.

12.1.5 There is value for assisting in a wide range or project types, not just ‘complex’ or ‘high-risk’ (which are undefined), since in some LAVs there is a lack of personnel with fire engineering knowledge, which can make it difficult to decide if something is a ‘minor’ deviation or a ‘significant’ change.

12.1.6 A value of the hub concept is that the creation of a stakeholder review group enhances communication and understanding between groups, which should be a good thing for Scotland.

How would you view the Role of the Hub in Relation to the Existing System?

12.1.7 In practice it seems as if some LAVs are using the SFRS in a review capacity, not just as a statutory consultee, which creates complications, since the LAV is the decision-maker, and desires of the fire service may in some cases differ from the requirements identified by the Building Standards.

12.1.8 An issue that would need to be addressed is who makes the decision on what goes to the 'hub' and what is dealt with locally.

12.1.9 The elephant in the room is design / acceptance criteria. At present compliance based on comparison to TH. It is assumed TH based on societal risk tolerance, but not specified. Standard of care not clearly defined. No way to determine if uniform level of fire safety is being delivered.

12.1.10 The decision-making structure needs to be clear. Who ultimately makes the decision? Does the hub make a decision or give advice? If advice, is that enough? Ultimately the client will decide if they like the answer: if they do not, what are their options?

12.1.11 Liability is a question under hub as well – who has liability, and for what?

12.1.12 Scotland should be open to looking at other countries, e.g., Norway, Japan, etc., to see how they have arranged things. Various models, tools, approaches may be useful.

Do you have views on a form which may be suitable?

12.1.13 The extent of the 'problem' is unknown, so it is difficult to make a judgement on how the hub might be structured and resourced. How, and how often, the hub is used, would influence resource needs. It might be helpful to have someone look at the fire engineering designs that have been approved over some period of time to better define the situation.

12.1.14 In Scotland the procurement process dictates the diversity of disciplines required and associated responsibilities. In the past, the architect was responsible for delivering an integrated design. This cannot be expected anymore. The construction manager increasing plays this role, and they may not understand how the strategies are intended to fit together.

12.1.15 The concept of a 'three-prong' verification approach was tabled and feedback was that it could be a useful concept to explore.

12.1.16 If the hub goes forward, there should be some built in review / audit process to periodically assess what is done, how it is working, what changes might be needed, and ultimately whether it delivers value.

What make-up of membership is appropriate?

12.1.17 Membership should come from BSD, LAVs / LABSS, the fire engineering community, and SFRS, and if a suitable role exists, academia, government representative (Minister, not BSD), someone with procurement expertise, and someone with fire engineering / building regulatory expertise from outside of Scotland (e.g., England, Wales, Ireland).

12.1.18 As a statutory consultee, the SFRS should not be part of the hub, since that might create a conflict. If part of the hub, legislation might need to be changed. The SFRS should remain involved in some manner, given their expertise and experience.

What qualifications and experience is appropriate for members?

12.1.19 An important issue for the hub will be determining who sets the competency level for hub members, and how that is determined (i.e., not just what competencies hub members should have, but who makes judgment and appointments). It seems as if a starting point is Chartered status in the disciplines that are deemed necessary.

What limits on member service might be applicable?

12.1.20 Anyone (actively) involved in fire engineering work should not be in the hub.

What attributes of a design would trigger review via the hub?

12.1.21 This is a difficult issue. As noted previously, ‘complex’ and ‘high-risk’ are undefined, and since some LAs lack personnel with fire engineering knowledge, it can make it difficult to decide if something is a ‘minor’ deviation or a ‘significant’ change.

12.1.22 A trigger for sending a fire engineered design to the hub should be any design for which the LAV does not believe that they are competent to assess. It is assumed most will have some level of competency, but it varies based on size of authority, types of projects they see, and the like. A major issue seems to be ‘deviations’ from the TH. Having guidance around this might be helpful.

12.1.23 The intersection of energy efficiency and fire safety seems to be one of the biggest issues at the moment (e.g., Grenfell Tower). How to comply with Standards for sustainability and safety open to interpretation.

What order of magnitude of response time is appropriate?

12.1.24 Response time depends on the project, but should be reasonably quick (e.g., 2-4 weeks).

How do you think the hub should be funded?

12.1.25 Government seems appropriate.

What other issues are important to consider?

12.1.26 There is a capacity issue. All fire engineering grads go to consulting firms, not to LAV or SFRS, and many out of country. Not that much interest by students, as they do not see fire engineering in many universities, so do not see it as an option. Could be more interest post-Grenfell, but still a long-term issue.

12.1.27 The issue of ‘engineer’ not being a protected term was raised again in this regard as being problematic, especially in fire engineering, since the discipline is so broad.

12.1.28 Another challenge for fire engineers is that they are not engaged throughout the entire process. Many just develop ‘strategy’ and do not develop detailed designs, check that the constructed building complies with design, or provide guidance for building in use. This should be considered (required) as part of a certification scheme.

12.2 ARCHITECTS AND TECHNOLOGISTS

Is there value in the concept of a centralized review hub?

12.2.1 The concept seems fine. Having an integrated perspective is important. Coordination of performance in performance-based design is essential.

12.2.2 The current situation is that some 90% of design firms are less than 10 people, with fire engineering similar, and LAVs with limited fire engineering resources. A centralized review hub could help in this environment. Ultimately, a certification scheme for fire would seem appropriate, but the market does not seem to be there.

12.2.3 The approach to projects / procurement changed in 2005. Before then, the architect had significant responsibility and oversight. With change of regulation, client has responsibility. As such, the architect is more in an advisory role now, and it is up to the client what they want to do. It is difficult to push people in a particular direction – one can only encourage.

12.2.4 Development of the hub has the benefit of sharing of knowledge and experience for the benefit of all.

How would you view the Role of the Hub in Relation to the Existing System?

12.2.5 Hub would be a resource for assisting in review of complex designs.

Do you have views on a form which may be suitable?

12.2.6 The hub would need expertise that has appropriate 'T' shape – depth of fire engineering knowledge but breadth of understanding of how it fits into and integrates with the overall design. Complexity is difficult to define, but following RIBA type approach can help to make sure critical issues are addressed.

12.2.7 The RIBA Plan of Work approach (2013) provides a good model that could be followed to identify what pieces of fire engineering strategy and design need to be submitted at what point in the project to get everyone on board and to check that the design components all work together.

What make-up of membership is appropriate?

12.2.8 If the hub goes forward, there needs to be a coordinator who understands fire performance as part of overall building performance, with the competence to identify issues that may exist and allocate the appropriate expertise to sort the issues.

12.2.9 A wide range of expertise would be needed in the hub. Industry is in an 'atomised' state – need breadth of expertise including architectural, architectural technology, fire, fire service, verifier and more, depending on specific project. Need to have holistic, integrated perspective.

12.2.10 With respect to SFRS, they have a statutory consultee role, so that needs to be considered.

What qualifications and experience is appropriate for members?

12.2.11 The IFE have a set of subjects for which competency is required. The issue is a combination of depth, exposure and time (i.e., what time is required to reach what depth of understanding across which areas). Some work was done on this in the past – perhaps time to revisit it.

What limits on member service might be applicable?

12.2.12 Not discussed.

What attributes of a design would trigger review via the hub?

12.2.13 Triggers difficult to define, since all buildings different, level of expertise diffuse, and complexity a function of the particular building.

What order of magnitude of response time is appropriate?

12.2.14 Difficult to determine at this point, but three months is better than three years.

How do you think the hub should be funded?

12.2.15 Funding should come from all (i.e., all participate to the benefit of all).

What other issues are important to consider?

12.2.16 Every building should have a fire strategy, but all do not. Some buildings seem to be 'over designed' for fire. Perhaps others are in the opposite direction. Without a strategy, it is difficult to know what is being targeted, and what impact future changes might have. For example, if design based on certain systems working as intended, and inspection and maintenance not being kept up, what will be the outcome if a fire occurs?

12.2.17 Overall, level of fire engineering knowledge seems to have decreased a bit, at least in architecture / architectural technology, with very little being taught is associated university programs. With limited number of engineers, and limited resource in LAVs, the situation can be problematic.

12.2.18 Knowledge and know-how have diminished over time. Knowing what you know, and knowing what you don't know, are important boundaries. Thinking you know, but not really knowing or understanding, is problematic. With an increasing focus on more narrow fields of study / understanding, the broader knowledge of how the pieces all fit together is diminishing. This is a big educational need.

12.2.19 To change from existing approach(es), the industry needs to see value. The development of robust details reflects an approach where the value is seen in many ways. The structural certification is similar. For fire, there would need to be clear processes, competencies, accountability and need.

12.3 BUILDING STANDARDS DIVISION

Is there value in the concept of a centralized review hub?

12.3.1 The concept of a hub in general seems like a good thing; however, what the hub would do is not well-defined, so difficult to assess value. Questions exist around whether it would be used for all fire engineered designs, or only 'complex' and 'high-risk' buildings and designs, what are resourcing needs, and how is competency of LAVs helped.

12.3.2 The need is not well-known, since there are some local authorities with fire engineering competency within the staff, and not all other authorities have the need for fire engineering competency on staff, at least on a regular basis. Perhaps a bigger issue is that some fire engineers lack appropriate self-awareness of limits, and have too much of a 'can do' attitude, in that if it has anything to do with fire, I can do it (even if not properly qualified or competent). The combination is problematic, and it is acknowledged that there have been issues, so the hub could provide value.

How would you view the Role of the Hub in Relation to the Existing System?

12.3.3 The question is what do the LAVs need now (in the short term)? There is an expectation that the LAV should be able to determine whether 'minor' deviations are fine and when they are outside of their competency. If the focus is on 'complex' and 'high-risk' buildings and designs, that may be the highest value. However, the issue of when and how to make determination needs to be sorted. (The 'three-prong' verification idea was introduced and there was support for the concept.)

12.3.4 The roles of the LAV, SFRS, BSD and the hub need to be very clear. The LAV is the decision-maker. The SFRS have a statutory consultee role and should not be decision-maker. The hub should not be run by BSD – there is a Views process that needs to be maintained, and the hub should not muddy the waters. Perceived and real conflicts of interest must be identified and addressed.

Do you have views on a form which may be suitable?

12.3.5 Comments on the form ranged from under BSD to supported by the LAVs (LABSS). Fees would have to be such so as not to be a deterrent from use. Liability would have to be clarified for any participants, including entity overseeing the hub. Perceived and real conflicts of interest must be identified and addressed.

12.3.6 Regardless of form, there would be need for appropriate quality assurance processes, performance monitoring, audits and the like.

12.3.7 A significant issue that impacts the form of the hub is the role it performs – would the hub be undertaking a decision or providing advice? If making a decision, how does that legally fit, and what are liabilities? If providing advice, how is that different from a View, which the LAV must have regard to but does not have to follow?

12.3.8 Scope of reviews should be well-defined. Focus should be on technical issues, i.e., are the data, tools and methods used appropriate to the problem, and applied appropriately, and was the breadth of issues considered / assessed appropriate (i.e., from an holistic perspective, did the fire engineered analysis adequately address all fire safety impacts of the building as associated with the requested change).

12.3.9 Liability is a big issue in the post-Grenfell environment, at least for engineers in England.

What make-up of membership is appropriate?

12.3.10 Make-up of the hub should include LAV, SFRS, and FE representation. Role of BSD not clear with respect to the Views process. Would be good to be involved, but cannot be in conflict with statutory role.

12.3.11 The roles of the LAV, SFRS, BSD and the hub need to be very clear. The LAV is the decision-maker. The SFRS have a statutory consultee role and should not be decision-maker. The hub should not be run by BSD – there is a Views process that needs to be maintained, and the hub should not muddy the waters. Perceived and real conflicts of interest must be identified and addressed.

What qualifications and experience is appropriate for members?

12.3.12 With respect to qualifications, one size does not fit all. May need IEng and CEng and equivalent, as per project needs.

12.3.13 Perceived and potential conflicts of interest with BSD and SFRS need to be sorted.

What limits on member service might be applicable?

12.3.14 No discussion.

What attributes of a design would trigger review via the hub?

12.3.15 Potential triggers for review could be something like risk classes (as in Eurocodes for structures), with focus on consequence if failure occurs. ‘High-risk’ and ‘complex’ designs may be drivers, but terms need to be defined.

12.3.16 The question of whether designs can be ordered to go to the hub should be addressed, or if only voluntary. If not used, what is the benefit?

What order of magnitude of response time is appropriate?

12.3.17 The timeliness of response is difficult to address in advance, as it depends on project scope, complexity, etc. In any case, it should be relatively fast, as that is one challenge in the existing system.

How do you think the hub should be funded?

12.3.18 As a resource for LAVs, funding the hub could come from levies, fees, etc., but it is recognised that there can be problems with assuring funds collected as part of building control get appropriated to building control within local government.

What other issues are important to consider?

12.3.19 No particular discussion.

12.4 DEVELOPERS AND OWNERS

Is there value in the concept of a centralized review hub?

12.4.1 The idea of a centralized review hub is appealing especially if it can help to reduce the significant time required for approvals. Almost all projects have deviations from the TH, often involving stairs, lifts, exits and more, with a range of complexity. The time for approval from the warrant application has been as long as 18 months, with a recent project taking 9 months. The challenge is on the resource side of the LAVs, with perhaps not enough staff. The fire engineering usually goes well, but the lengthy delay for verification has implications for the project.

12.4.2 Experience with the verification process is varied. Because LAVs are resource limited, it can take months to get an answer. The 'simple' designs (TH compliant or 'minor' deviation) are usually addressed in reasonable time with no concerns. It seems like complex design go into the queue and stay a long time.

12.4.3 From a project management perspective, any fire engineered design sits high on the risk register, driven largely by the unknown and lengthy time for review. The hub could potentially help with this.

12.4.4 A challenge with fire engineering design in Scotland is that many fire engineering practices are small, do not have a broad range of experience and expertise, and in some cases do not know the Scottish system very well. This creates challenges when it comes time for approval, as well as during the design phases. New technologies (e.g., electric vehicle charging plates, driverless cars) create problems for designers and verifiers. A high level of knowledge and competence is needed.

12.4.5 In concept the hub could be helpful in delivering consistency. Knowing who you will be working with, and how decisions are made, are significant to the success of a project. With limited and distributed fire engineering resources, this could be good.

How would you view the Role of the Hub in Relation to the Existing System?

12.4.6 Keeping the function within the building warrant process seems best – keep it simple. There just needs to be clear understanding of when something goes to the hub, what it will cost, and what the timelines are. If everything goes to the hub that could slow things down. Timely decisions by LAVs should be expected based on feedback from the hub.

12.4.7 Overall, the existing process is sound, the relations are good, the problem seems largely to be resourcing and time to a decision.

12.4.8 Time for review and approval is important. Sometimes process takes a long time, with delays at LAV, SFRS feedback, etc. When LAV has time for pre-warrant discussions, that helps a lot. If the hub can help with this, it would be good.

Do you have views on a form which may be suitable?

12.4.9 No particular views.

What make-up of membership is appropriate?

12.4.10 Input from fire engineers, architects, and the SFRS important. Need to have good practical knowledge as well as specific fire engineering knowledge. Academics could be helpful for review of complex models and such. Someone from BSD would be desirable.

What qualifications and experience is appropriate for members?

12.4.11 Not specifically discussed.

What limits on member service might be applicable?

12.4.12 Not specifically discussed.

What attributes of a design would trigger review via the hub?

12.4.13 Complexity comes in many forms, and not just new build. In many cases, complexity arises out of multi-tenancy (and even multi-owner) issues, working new or renovation of existing buildings in and around existing spaces owned or managed by others, and trying to get all the pieces to fit together. The space itself may be ‘simply’ retail, but the integration of the building / space into existing can be extremely complex. Even something as ‘simple’ as alarm and evacuation zones can be a challenge.

12.4.14 Consideration of the process for structural certification might provide some insight on triggers for what type of project would go to the hub. There are many steps in the structural certification process, but it seems to help move things along.

12.4.15 Different risk classifications for buildings was noted as one potential trigger. Complexity is a more difficult baseline to describe.

12.4.16 The ‘three-prong’ concept for verification was raised. There was general support. The concern is with the middle level – the decision on what the LAV can handle and when it goes to the hub. This needs to be clear. A two-level approach might be cleaner.

What order of magnitude of response time is appropriate?

12.4.17 This may vary based on complexity of project, but should be weeks not months, as is sometimes the case now.

12.4.18 Time to approval is always difficult, but for small projects, the order of 2 weeks seems appropriate, and perhaps 6 weeks for a larger project. Having a process that provides consistency from start to finish will help a great deal.

How do you think the hub should be funded?

12.4.19 There would be no problem paying additional fee for the centralized review if the fee is allocated to the verification process and the time required for a decision is significantly reduced.

What other issues are important to consider?

12.4.20 As noted above, the existing process is sound, the relations are good, the problem seems largely to be resourcing and time to a decision – anything new that is added should be focused on reducing time to a decision and not adding time and complexity to the process.

12.5 FIRE ENGINEERS

Is there value in the concept of a centralized review hub?

12.5.1 At the end of the day, the motivation is better, safer, buildings. There are some perceptions in the market that there are concerns with some buildings approved under the existing system. A hub could help.

12.5.2 In 2005, the Scottish government brought in a 'performance-based' system, but did not provide adequate resources to support such a system, particularly from the verification side. The fire area is particularly under-resourced. A benefit of the hub approach is it helps in this regard.

12.5.3 Something needs to change. LAVs do not evaluate fire engineered designs in the same way, and it is not clear why that needs to be. More consistency in the market is better for everyone.

12.5.4 There is a clear shortage of fire engineers in Scotland, with LAVs being significantly under-resourced in this area. These lead to issues of fire engineering competency in LAVs – not because they do not want the expertise – they cannot find or afford it.

12.5.5 Such a hub would be of a high value for the verification of designs for projects acknowledged to be outside the normal scope of an LAV. Clearly, the continuing value would be dependent on the supply of proposals for 'complex' buildings and the continuing lack of fire engineering expertise in the LAV's generally. The Hub may generate a level of consistency of appraisal that has been lacking for several years. it should be noted that before the LAV's were given the authority to assess submissions for acceptability a central unit for all Relaxations (from the statutory minimum standards) did exist and did operate successfully. The unit served all local authorities in Scotland.

12.5.6 A hub could have value as a short to medium term solution due to the limited numbers of appropriately trained fire engineers in Scotland, it is prudent to make best use of the available resources. It is not a long term solution, as there has to be clear lines of responsibility for the fire engineering of buildings. The hub would need to make sure all users of the system were aware of its role and the function of its members so that it was not seen as a continuation of the present system of reviewing fire engineering designs.

12.5.7 The hub would have benefit in the short term, while the wider industry is forming/taking a professional approach-such as registration. The hub will not result in the required structural changes needed, manifesting in qualified competent engineers who can be trusted in the context of the building regulations. However, the hub could help as a temporary measure to improve service, but unfortunately without wider industry controls (on who can practice), the benefits of the hub will be mainly limited.

12.5.8 A centralized hub will allow for a much more consistent approach throughout the industry. It is recognised that fire engineering is subjective and what is one person's 'safe' might have another slightly nervous. However, a centralized pool will aid this as reviewers will be able to discuss the matter and come to an agreement (i.e., approve or reject). This will also help increase the level of understanding of fire engineering as a centralized group (we believe) would have a more specific knowledge base, this increasing the industry standards.

12.5.9 A centralized hub will provide more consistency with the way fire engineering solutions are processed compared with the current system where various firms are appointed to act as third-party checkers for local authorities. At present the time it takes for some local authorities to appoint a third party checking consultant can lead to very long overall times for the fire engineering reports to be processed and approved. This can cause significant problems for many projects, which typically run on tight programmes. As numerous firms are currently appointed to act as third-party checkers for local authority building standards, there are a wide range of views and approaches that are taken to deal with fire engineering solutions. This can lead to inconsistency with feedback and with suggested technical approaches. This inconsistency and the long approvals times can lead to uncertainty with fire engineers and clients. We have had feedback from some clients that because of this uncertainty, they no longer wish to pursue a fire engineering approaches and would rather design to meet standard code approaches even though it results in a less efficient design. That is a concern that could be addressed by a centralized hub, assuming the speed that they process fire engineering applications is better than the current system, and the approaches and technical feedback is consistent. The more consistent approach will not only help clients, but it will also help less experienced, or less competent, fire engineers to improve their technical approaches.

12.5.10 A downside of current situation is built-in conservatism – ability of the market to innovate is limited. A concern with the hub is unintended consequences – not just for building but the sector.

12.5.11 If the hub goes forward, it needs to provide good value, and who pays needs to be clearly defined.

How would you view the Role of the Hub in Relation to the Existing System?

12.5.12 There were differing views as to whether the decision-making should remain with the LAVs, with most in agreement that is how it should remain. However, roles and relationship between hub, LAVs, and SFRS need to be very clear. If projects go to the hub, and then still need to go to a Views process, just gets more costly. In the end, just meet the Technical Handbook.

12.5.13 The hub formation needs to be central and have agreed mix of people. Need to minimize tensions between groups and foster collaborative relationship. Need to remember that ultimately the hub is to benefit the end user – the market – roles, responsibilities, decisions and process all need to be clear.

12.5.14 Fundamental issue is resourcing. If LAVs had proper resources, there would be no need for a hub. Under the current situation, wide range of approaches to deal with gap, from a very few having internal resource, to 3rd party, to hesitancy to approve fire engineered designs.

12.5.15 There is some concern of friction between LAVs and the SFRS. However, the LAVs have the verification authority – SFRS provides input as a statutory consultee.

12.5.16 The legislation for standards of building direct the LAV to be the most important authority. Therefore, the relationships need not be demonstratively different to the current situation. That is that the SFRS act as consultants to the LAV, on request, and the BSD are contacted for advice on the interpretation and application of the published guidance. If further advice is needed on specific issues the LAV is able to buy-in the necessary expertise. This expertise may be available from a range of 'experts' and the LAV may need advice on the selection of an adviser/consultant. The hub may have contact with experts in fire safety engineering and the LAV would be advised to make contact with the Hub for assistance.

12.5.17 The continuing use of performance-based designs, has put additional strain on the resources of regulators. The system has been introduced without sufficiently trained personnel being in place to undertake or review it. The formation of a central review panel will allow Local Authorities still to have the control to grant building warrants in their geographical area and have confidence that a fire engineered solution put forward is appropriate. The SFRS currently are supporting many Local Authorities in fire engineering by reviewing submitted designs on behalf of the Local Authority. This is outwith their current role and is a potential conflict of interest with their role under the Procedure Regulations, a review panel would still allow the SFRS to contribute to the review of a proposal but allow them to focus on the fire fighting and rescue aspects. BSD's role should be to facilitate the process by ensuring relevant qualified personnel are involved in the process to enable a rigorous review to take place. As the guardians of the building standards system they can then disseminate the findings allowing a consistency of procedures to develop. The output from any review would need to be treated appropriately by local authorities and not just be ignored. The Local Authority Verifiers must have regard to any decision given when determining the building warrant application. The review panel would also recheck (send back) to Local Authorities applications that should be within their capability.

12.5.18 The local authorities, fire service and BSD would be technical advisors to the hub as their primary role unless they are appointed as a technical reviewer (on the condition they are qualified), specifically on matters relating to firefighting, procedural issues, and building regulations.

12.5.19 A centralized hub should have specific specialist knowledge and be afforded the funds for training in this fee, if this is not provided it is difficult to see how exactly things will change (without training the same problem exists, it just has a new face). It would be our view that the hub would be a centralized approving body for fire engineering, not your typical approving authority. Having actual fire engineers in this position, removes the need for the Fire Service to be treated as third party reviewers and, therefore, allows SFRS to resume a consultation role. BSD may be the home of the hub or the hub would need to be totally independent from BSD. BSD would provide a great base for the hub and could be completely independent from the local authorities, this also provides the hub with direct access to BSD's background knowledge to the Technical Handbooks guidance. What needs to be defined in the approval authority of the hub (i.e., can the hub be an approving body or is the hub a third-party reviewer which recognises and agrees with the fire engineering solution without also having the final say on approvals.

12.5.20 The primary role of the central hub will be to act as technical advisors to local authority building control, the SFRS and the BSD.

Do you have views on a form which may be suitable?

12.5.21 Regardless of final structure, the hub must be adequately resource to deliver on the intent, or it will not address the challenges currently faced. There needs to be a clear process. All LAVs, fire engineers, SFRS, etc., need to buy in and follow the process. The process needs to be transparent. Basic documents like a process flowchart would be helpful.

12.5.22 With respect to service in the hub, a qualified person to screen submittals and decide whether to send to the hub is needed. Views differed as to whether this and other members of the hub should be permanent / semi-permanent (substantially dedicated) or rotated in and out. Key attributes are expertise and relevance of experience, which should be current.

12.5.23 Scotland is small. One might ask why there needs to be 32 local authorities. It could be that a central hub for all verification functions would be an efficient option.

12.5.24 The hub means different things to different people, as it is currently undefined. It could be one location, or perhaps focused on the largest authorities (Glasgow and Edinburgh), with different expertise or functions in each, or other.

12.5.25 The hub should be something where all fire engineered designs go into – this gets to consistency, competency, and related issues. There should be a clear review process and the verification decisions need to be clear.

12.5.26 The hub should be somewhat removed from individual LAVs, until they have needed resources. It would seem that LABSS could form / support a hub. SFRS has a big role. BSD is conflicted out because of the Views process.

12.5.27 There are many actors and linkages. At the centre will be the coordinator. The coordinator would be capable of deciding on the members of the team that would make up a specific hub. Decisions about the need for a traffic engineer or a structural engineer or a smoke control designer or a fire safety engineer would be made by the coordinator. Each 'expert' would be represented by a segment. The level of expertise of each individual would then be represented by the circumferential bands. Any one of the people in the hub could be a technical person from an LAV, a private consultant, or a government official.

12.5.28 The hub should be administered by BSD. Who on receipt of a referral would determine its suitability and notify the applicants accordingly. If a referral is accepted, BSD would appoint appropriate persons to review the project depending on its nature, (complexity of calculations CFD etc.) They would keep under review a 'pool' of suitable experts that they can call upon. The fire engineering personnel would be rotated to prevent the appearance of bias. The Institution of Fire Engineers (IFE), Scottish Branch, could be contacted by BSD for assistance in identifying suitably qualified and experienced personnel when the fire engineered design or building is sufficiently unique, for example tall CLT buildings.

12.5.29 The hub should operated / administrated by full time staff with the resource to meet service conditions required by industry, the unit must be responsible for service and be sanctioned if not fulfilling its obligations, otherwise there will be no change from the service provided to date from local authorities. The unit should not be thought of as an add on to building control or the fire service, but an independent professional organisation able to operate without prejudice from the wider industry.

12.5.30 A hub would either need to operate as a body which reviews fire engineering solutions and has its own employees with specific training, or the hub acts as a pot of third party reviewer from consultancies and each consultancy has to undertake a certain amount of reviews (per number of CEng staff operating in Scotland). Either way there are cost implications involved that would result in an increased fee for local authorities or fire engineers (i.e., a hub-subscription fee).

12.5.31 The hub should be group of individuals with experience in both fire engineering design and verification, ideally from a range of backgrounds. This group should have the expertise to deal with any fire engineering solution proposed and have the tools and the resources to process them quickly. The individuals within the group should not change on a regular basis and they should aim to provide a consistent approach to dealing with the applications, both technically and procedurally. To avoid a conflict of interest, the fire engineer should not be a practicing fire engineer employed by a private firm.

What make-up of membership is appropriate?

12.5.32 With respect to service in the hub, a qualified person to screen submittals and decide whether to send to the hub is needed. Views differed as to whether this and other members of the hub should be permanent / semi-permanent (substantially dedicated) or rotated in and out. Key attributes are expertise and relevant experience, which should be current.

12.5.33 A hub would need to be flexible in many ways. It has to have expertise and competency in many areas, including fire. It needs to have a coordinator to decide what it is about a design characterizes it as needing to be reviewed by the hub personnel. There needs to be access to a wide range of expertise and skills, from CFD analysis of a specific issue to how that fits holistically with the building design and operation.

12.5.34 The role of BSD is unclear – some suggest BSD should facilitate the process, much like when the Government reviewed all such submittals in the past – while others are concerned that going through BSD will introduce delays, not to mention the potential conflict with the Views process. There was a view that, as it is now, all submittals should go to the LAV, who then decides whether to send it along to the hub, which would help reduce delays.

12.5.35 Assuming that support staff are available then one ‘expert’ in each of the necessary sectors could be sufficient in number. Note that there could be several hubs in operation at one time. A pool of expertise would be sensible from which to populate an appropriate hub. It is suggested that 20 people from all appropriate backgrounds could be selected initially. This number to be added to or subtracted from as the system develops. Some training on analysis and assessment may be necessary for the coordinators – probably the only full time paid post.

12.5.36 The hub would need to include representatives of the Local Authority the SFRS, BSD and fire engineers. The numbers of each would be as follows: 2 appropriately qualified building standards personnel, 1 from the authority in whose geographical area the works are proposed and 1 member from another Local Authority; A member of the SFRS fire engineering unit and if desired an attendee from the geographical area where the works are proposed; 3 fire engineers, 1 whose fire engineered solution is being discussed and 2 fire engineers from a ‘pool’ of suitably qualified fire engineers, (BSD would need to run and maintain such a list, which would need to be publicly available); The list of fire engineers would include consultants, academics SFRS and building standards personnel, with experience in specific areas; BSD would be able to support the meeting with the resources that they required, but it would be expected it would include the technical author for fire and administrative support.

12.5.37 It is hard to say, but would need to be specific to the requirements of specific projects. A variety of technical staff may be needed for a project – both a fire safety engineer and structural fire engineer may be required for projects, and on other projects none. It is important that the competent engineers and technical advisors are held professionally responsible for their work, unlike the present system where the approval authorities take no responsibility for their actions. Without this, the system will fail and be seen effectively as trial by committee - something that cannot be accepted by a professional body. This could be mitigated by the adoption of a professional registration system.

12.5.38 The hub needs to consist of fire engineers or verifiers who specialise in fire engineering. It cannot be made of a pool of people without fire engineering training otherwise it will be ineffective. The exact number of representatives is difficult to nail down, it will depend on the complexity of each project and the number of projects to be reviewed.

12.5.39 A Fire Engineer, a local authority verifier, and a SFRS fire engineer would be an ideal mix. But again consistency is key if we are to see an improvement over the current system.

12.5.40 If people are rotated through the hub, conflict of interest needs to be carefully addressed. Likewise, statutory conflicts, such as with BSD (Views) and SFRS need to be taken into consideration. Legislation would have to be looked at if changes in responsibilities considered.

What qualifications and experience is appropriate for members?

12.5.41 Anyone working in the hub should have highest qualification, e.g., Chartership, Expertise and experience crucial. The ‘gatekeeper’ needs to have the right knowledge, expertise and experience to know when to send something to the hub.

Someone with broad knowledge of how a building works is needed too. A process like the RIBA process might be helpful in looking at designs more holistically.

12.5.42 The verifier does not necessarily have to be a CEng or IEng in fire, as they have broader responsibilities for verifying across several disciplines. However, verification of fire engineered designs must be undertaken by those with appropriate qualifications and competency in fire engineering, especially for designs that deviate from the Technical Handbooks.

12.5.43 If people are rotated through the hub, conflict of interest needs to be carefully addressed. Likewise, statutory conflicts, such as with BSD (Views) and SFRS need to be taken into consideration. Legislation would have to be looked at if changes in responsibilities considered.

12.5.44 All participants need to have at least a first class honours degree in a relevant discipline AND be qualified professionally to Chartered status. To have had at least 5 years' experience in a responsible role(s) in an aspect(s) of fire safety engineering.

12.5.45 All attendees should be members of an appropriate professional organisation. Fire engineers should be Chartered Fire Engineers, while local authority and SFRS attendees should have at least a degree in fire engineering. All should have appropriate training, knowledge and expertise to be aware of the hazards and risks involved and be part of an engineering registration program. If the role of the representative from BSD is to facilitate the process, publish the outcome and ensure the regulatory procedures are complied with, then there is no need for them to have a specific fire engineered qualification. All professionals present must be able to demonstrate that they have met their CPD requirements in a relevant area.

12.5.46 If the purpose of the hub is to review fire engineering, the hub must be staffed by competent and qualified fire engineers. It is irrelevant whether the engineer is a consultant or from the approval authorities as long as they meet the qualification/competency criteria, work in a transparent and professional manner and take responsibility for their actions. The hub will fail if technical decisions are not made by competent persons using appropriate engineering knowledge and methodology, further there must be a mechanism to enforce professional practices on the hub, i.e., a regular audit process undertaking by peers, similar to that provided to structures, gas, electric. This would fit into registration for all fire engineers (designers or approval authorities).

12.5.47 It will entirely depend on the fire engineered solution. Qualifications of IEng and CEng for standard reviewers is recommended.

12.5.48 A chartered fire engineer or a fire engineer with at least 10 years' relevant experience in Scotland could be considered suitably qualified. The local authority verifier and SFRS representative should either be chartered or have at least a BEng in fire engineering, or suitable experience dealing with complex fire engineering solutions.

What limits on member service might be applicable?

12.5.49 The employment of 'building professionals' who will populate the hub(s) could be very flexible as permanent staff would result in fixed views and limited knowledge for application to a complex challenge. Although a totally flexible workforce would not be a good idea as the task for the coordinator to gather a suitable group could be difficult and very time consuming – a situation that should be avoided. Maybe a 'skeleton' group should be employed for one or two groups (hubs) but the majority of the staff would be part-time people. The part-time staff need to regard service on a hub as more important than other work. There should be no 'conflict' of interest as the 'target' for all is a fire safe building. Assuming that it is not practicable to avoid any commercial or industrial people in a hub then each of the professional people in the hub need to declare any potential conflicts.

12.5.50 For the fire engineering community to have confidence in the hub, the process has to be transparent and the appointment of members to the review clear to all. As regulators are independent from design pressures there would not be the same concern as to who attends. The reality however, is that there are very few local authority and SFRS personnel with fire engineering qualifications and experience. This will result in certain individuals being called upon to attend the hub more regularly than the other members. LABSS and others should use this process as a learning exercise and send along representatives from other authorities to watch learn and understand.

12.5.51 A registration process for all involved would be an effective tool for mitigating/avoiding a conflict of interest between different parties and upholding professional standards.

12.5.52 As stated above, the hub needs to be for fire engineering and employ fire engineers. If the role of the hub is expanded to include a centralized approving authority role (i.e., similar to the current role of local authority verifiers), the required level of knowledge to review a fire engineering solution will be missing. We accept the concerns raised that a private firm would be looking out for business opportunities, however, in our experience in England, the higher level of fire engineering knowledge is found in approved inspectors as they spend more money training staff than a governmental approving body, who frequently face cut backs.

12.5.53 A fire engineer serving the hub should not be able to review a fire engineering report prepared by their firm. Therefore, the hub's fire engineer should not be a practicing fire engineer employed by a private firm.

What attributes of a design would trigger review via the hub?

12.5.54 The trigger(s) that cause a submission to a LAV to be 'called in' by the hub might be: very tall; complex space uses and complex geometry; those that house dangerous activities; significant variation(s) to the guidance in Section 2; 'extreme' designs (floating buildings); extensive application of fire engineering; and use and application of computer aided fire safety design.

12.5.55 Buildings of national significance, hospitals and tall buildings should all go through the hub. In addition any fire engineered solution that is outwith the expertise of the Local Authority Verifier. For example CFD modelling, calculations, FED, or where the regulators or fire engineers knowledge and competence is in question or it is believed that there is inappropriate use of the design codes etc.

12.5.56 It is difficult to understand why a hub would only be used for complex and high risk buildings: does this mean that incompetent fire design will not result in death or injury in less complex buildings? The uncertainty associated with fire design is not just bounded by the size and complexity of the building, therefore there is little confidence in the ability of a non-competent/qualified designer or verifier being able to undertake fire engineering in any building irrespective of complexity. My understanding of structural, gas, electrical is that professional competence is required to all buildings irrespective of size, given fire is a critical safety system why should it be treated any differently. Therefore all projects which deviate from the Technical Handbook (guidance) should be sent for review, the complicity and size is irrelevant in the context of incompetent design and verification. I think a verifier or indeed the Scottish minister responsible would be hard pushed to defend their action of not using competent review on the basis of it being a small and non-complex building, if it materialized the design was sub-standard, bad design and verification is independent of size and complexity and is a function of incompetency, which is related to a underregulated industry that does not support competence.

12.5.57 As a minimum information should be passed to the hub as soon as a local authority recognises that they do not have the specific knowledge in house. This should also be recognised by the project fire engineer to help smooth out the approval process. Documentation required, the fire strategy from the local authority as soon as possible (i.e., once they recognise they do not have the knowledge in house).

12.5.58 I think all deviations from standard code guidance, i.e., all fire engineering solutions, should be subject to hub verification. That way, there will be no confusion or time needed to agree on a category of the fire engineering solution as complex or simple, high risk or low risk, and the process will be simplified.

What order of magnitude of response time is appropriate?

12.5.59 This is a difficult aspect of the Hub activity. Least time: 2 weeks. The construction programme for the building(s) will influence time needed. The construction process could be very long, more than 10 years, with discrete multiple phases. The time constraint can only be assessed from the initial analysis of the submission. Time for any particular project cannot be predicted with any certainty as there will be some dependence to cooperation of people and bodies outside the immediate Hub.

12.5.60 The timescales should be similar to currently provided under the BSD's 'Views' process. On receipt of a request for a project to be assessed by the hub BSD, should issue a response within 48 hours, stating whether the BSD consider it an appropriate referral. The timing will depend on the nature and complexity of the fire engineering proposal and whether sufficient information has been submitted to allow it to be reviewed. BSD would then notify the applicant of the proposed timescale, who would need to accept it before the process could begin.

12.5.61 Extremely difficult question as all projects and circumstances differ, but 2-4 weeks would be within norms.

12.5.62 Two weeks to review a fire engineering solution and provide response. However, this may need to be tweaked depending on the number of fire engineering solutions received per day and the level of complexity.

12.5.63 This should ideally be based on the industries requirements for design and construction programmes. Larger projects typically have longer programmes that allow more time for building warrant and fire strategies to be approved. This would need to be informed by our collective experience of typical projects, but could be in the order of: 2 to 4 weeks for small projects with limited fire engineering; 4 to 6 weeks for projects with more fire engineering; and longer times could be expected for major projects.

12.5.64 There was agreement that pre-warrant discussions are helpful, and most LAVs happy to have such – when time permits. Getting discussion on issues early, and agreeing path forward, is a major issue. Waiting until the end almost always causes problems. How will the hub help this?

12.5.65 Response time is difficult to specify. A key issue is having a qualified person making the initial determination, and having whatever review resources needed to be readily available.

12.5.66 Documentation and time constraints include: (i) the same documentation as submitted to LAV; (ii) assuming that the following is not available in the submission to the LAV: test results (where a request can be justified) for materials, components and systems; (iii) design calculations; (iv) maintenance regimes for fire safety critical elements (advisory OR under the Fire (Scotland) Act); (v) advice on replacement of systems that are safety critical (advisory OR under the Fire (Scotland) Act); (vi) type of construction contract;(vii) construction programme) and (viii) arrangements to observe and assess changes during construction.

How do you think the hub should be funded?

12.5.67 There are several layers: (a) Scottish Government – for permanent staff; (b) LAV to self-fund contribution of own staff seconded part-time on a project specific basis; (c) project budget – for contributions from client design team; (d) all project budgets + LAVs + SFRS + Local Authorities – for general funding for the part-time members of Hubs; and (e) maybe from 'the industry' through a national levy!

12.5.68 The Scottish Government recently reviewed the fees for Local Authority Verifiers. Included in the implementation of the review was that some of the additional income would go towards funding the role of BSD. This was to allow BSD to undertake research, talks and other works to support Local Authorities and improve the Verification process in Scotland. As it is not envisaged that there will be a large number of projects going through the hub, it would be reasonable to expect BSD to fund the running of the hub out of the additional monies they now receive from Local Authority Verifier.

12.5.69 Government or local authority or combination. One way of reducing costs to the country would be the adoption of a registration scheme that would improve the application standards reducing the energy required for the individual reviews, as well as speeding up the warrant process, this would give clients and the public confidence that they were getting safe and effective buildings. Given the commercial competition between Scotland and the other countries in the UK, any tools that give Scotland a commercial advantage need to be implemented.

12.5.70 Local authority approval fees increase (if governmental), fire engineering fees increased (agreed rate throughout the industry) if a pool of engineers, private body approved inspector role specific to fire engineering.

12.5.71 Government, local authorities, possibly building warrant fees.

What other issues are important to consider?

12.5.72 Fire engineer should be involved from 'cradle to grave' for any assurance that systems / features installed and function as intended. Not the procurement system in Scotland. It was noted that the SFPE performance-based design approach calls for an Operations and Maintenance Manual (OMM) to be developed, and that NFPA 3 and 4 provide helpful resources for testing and commissioning of integrated performance of fire protection systems.

12.5.73 CPD programmes: Such programmes for any or all of the construction professions. Could be on general topics within fire safety or on parts of fire engineering by request. At present (2018) there seems to be no provision. Attendance could be required as part of the review process!

12.5.74 As the majority of projects are designed before a building warrant is submitted the review panel would need to be able to consider fire engineered solutions prior to building warrant submission. I think the trigger of complex and high risk may be misleading, while the outbreak of fire in such buildings may have catastrophic outcomes all live should have the same value, and even some of the simplest buildings with the smallest segments of fire engineering could contain the highest risk for improper engineering. The responsibility of design should clearly rest with the fire engineer, and BSD should encourage the continued development of the profession along the lines of other engineering professions such as structural engineers. A clear matrix should be developed identifying the different risk types and the level of checking that should be undertaken.

12.5.75 The BSD with their many years of knowledge in the area of Certification and the setting up of such schemes, should assist the Fire engineering community. They will be able to help the fire community see the benefits of such a scheme, such as: The confidence given to local authorities by the undertaking of independent third party monitoring; Robust procedures for membership; Recognises that experienced and qualified professionals can accept responsibility for their design; Recognition that members carry professional indemnity insurance; Recognition that members are covered by a robust complaints procedure.

12.5.76 The persons responsible for setting up the hub (assumed to be BSD), need to develop a plan of what they want to see and have a round table discussion with all interested parties (e.g., local authorities, the fire service and fire engineers).

12.5.77 I can understand the benefits of a hub in the short term but have concerns to its effect over the medium to long term, to such an extend it will not alter the situation where there is a lack of competence and expertise throughout the industry. Fundamentally the "hub" is a small iteration of the present system, being centralized to ideally generate a greater degree of professionalism and application of technical review, however this does not change the fundamental issue, that there's no industry controls on who can practice fire engineering, which effectively means technical and professional competence is not a requirement to design and verify buildings for fire.

12.5.78 Fire is a safety critical system, however unlike Structures, Gas, Electric there's no controls on who can practice, which in light of recent events I would imagine the Scottish Ministers and the public would be shocked and amazed that Scotland does not have ANY qualification/competence controls that the other safety critical systems named have adopted.

12.5.79 Furthermore unless the industry puts a focus on providing an industry staffed by highly competent and skilled professionals, away from the current focus on formulating the regulatory system for approvals by simple applied guidance, we will not optimise buildings for the advantage of Scotland, but will continue to produce buildings that are thrown together with little thought for holistic and principle safety, I have provided a Quote from the Cullen Report (Piper Alpha) which highlights the problem of relying on guidance which adheres well to a low skill/qualification baseline found in industry: "many regulations are unduly restrictive in that they are of a type that impose solutions rather than objectives and are out of date in relation to technological advances. There is a danger that compliance takes precedence over wider safety considerations".

12.5.80 Fundamentally the hub will allow the present situation to fester which will not increase competence within the industry with a continuation of all associated endemic negative effects, without the individual engineers accepting responsibility for their competence and not hiding behind approval authorities (competent or not), the industry will not improve to a standard where safe, efficient and effective designs are the norm.

12.6 INSURANCE INDUSTRY

Is there value in the concept of a centralized review hub?

12.6.1 There is a lot of inconsistency, in design and approval, in Scotland and across the UK. A hub could help in that regard in Scotland.

12.6.2 As technology changes, associated knowledge and expertise is required. This is not just for building-related technology, but the fire engineering analysis tools. The hub could help concentrate the needed expertise.

12.6.3 The hub could perhaps provide clarity in interpretation of the Standards, such as whether sustainability is applicable to fire safety design of buildings (i.e., a building that burns down is arguably not sustainable).

How would you view the Role of the Hub in Relation to the Existing System?

12.6.4 A hub might help foster better communication between parties involved, and help stakeholders better understand the decision-making process.

Do you have views on a form which may be suitable?

12.6.5 It seems like the hub should be independent, with dotted line reporting to the BSD. The hub would be in support of verifiers, but it seems like it can also help the market.

What make-up of membership is appropriate?

12.6.6 Need a mix of expertise. No one person knows everything. Need to have expertise in fire engineering, the tools used, how the building comes together.

What qualifications and experience is appropriate for members?

12.6.7 Not specifically discussed beyond needed appropriate expertise.

What limits on member service might be applicable?

12.6.8 Not discussed.

What attributes of a design would trigger review via the hub?

12.6.9 Complexity is a trigger, but difficult to define. High risk might be people sleeping, new technologies (e.g., CLT), high-rise, area of building, multi-tenancy, shopping centres.

12.6.10 Reviews need to happen at all levels, including occupancy. The draft Nordic standard on building control was noted as a potential document to consider.

What order of magnitude of response time is appropriate?

12.6.11 Not discussed.

How do you think the hub should be funded?

12.6.12 Not sure about funding. This is a government issue to answer. Insurers have their own research and review and approval process, so not sure they would support a hub.

What other issues are important to consider?

12.6.13 The hub should help the process and not add time or problems.

12.7 LOCAL AUTHORITY VERIFIERS (LAVS)

Is there value in the concept of a centralized review hub?

12.7.1 From experience, many of the fire engineered projects are too small to warrant review from something like a hub, and given the experience and support within the authorities (via LABSS), there are many cases where a hub would not be needed.

12.7.2 Some type of centralized hub could provide some benefits. It could be a resource for LAVs when needed. It could also be used for unique, one-off designs, which are completely engineered or deviate significantly from the TH. However, it is expected that the total number of such designs would be rather small.

12.7.3 It was noted that the idea of a hub has merit, particularly for complex projects, as long as it fits within the verification process, does not undermine verifiers, is not abused by being used for even minor deviations, and can take advantage of review assistance as already exists within LABSS.

12.7.4 There is value in the idea of a central hub for complex fire engineering solutions e.g., Level 3 in the recent letter issued by BSD. However, this should be a short-term solution until local authorities have the appropriate number of qualified staff to deal with the demand.

How would you view the Role of the Hub in Relation to the Existing System?

12.7.5 If it goes forward, the central hub should serve a supportive role to local authority verifiers with, the approval of building warrants still lying with the local authority. Unless the legislation changes the hub would technically have no authority unless the BSD used the system such as granting of relaxations / views process. The use of SFRS for 3rd party reviews for fire should not be permitted. The hub structure should be set up and SFRS should be a consultee or sit within the hub. The BSD would facilitate any process within the hub and ensure that a proper and rigorous review would take place. They would also have to check qualifications of each party that sit on the hub.

12.7.6 If a hub were to be formed, it would have to fit within the verification process, and rationalised with the view process. The hub would have to have a clear remit and purpose.

12.7.7 Guidance around different levels of engineering and associated verification could be helpful. It was stated that some designs use comparative analysis, but that the baseline for comparison is not always appropriate. It was noted that similar input has been obtained in other countries, such as Sweden. It was noted that the Nordic standards committee has a draft document for review of fire engineered designs, which at the time of the meeting was out for public consultation.

12.7.8 The idea of a 'verification method' such as C/VM2 in New Zealand was raised as being something that could be of significant value for designs which are more than simply minor issues (e.g., extending travel distance by 1m) but not a fully performance-based design. It was noted that the Australian Building Codes Board (ABCB) has developed a fire verification method now for Australia as well, which at the time of the meeting was out for public consultation.

Do you have views on a form which may be suitable?

12.7.9 A question was asked about the 3-route verification process in Japan, which was explained (Note: see discussion in Annex A).

12.7.10 It was noted that LABSS have qualified people to help out a local authority when needed as internal resource. The 3rd party review option is also available. A hub could perhaps replace the need for the 3rd party review.

12.7.11 It would be helpful to have a filter process to screen what can be done 'internally' and what warrants going to the hub.

12.7.12 There are two forms which the hub could take: (1) There is a permanent review panel which invites people with the relevant expertise to comment on a design and the panel makes the decision based on the outcomes of the review. (2) A panel is formed each time from a pool of people with the required expertise. The people would have to be rotated in order to prevent any bias within the various stake holders. There is also a sensitivity of commercial information regarding designs which maybe an issue particular for fire engineering companies.

What make-up of membership is appropriate?

12.7.13 The number of people that sit on the hub would have to be relatively small so that a decision could be reached.

12.7.14 It was noted that verifiers have a broader remit and understanding of a project beyond just fire, and that such an holistic approach is needed for proper verification.

12.7.15 It was discussed that the assistance offered within LABSS could essentially serve as the ‘gatekeeper’ role, helping local authorities make decisions on what can be addressed internally, providing LABSS resource where needed, and facilitating additional review by experts where deemed appropriate.

12.7.16 It is proposed that the number of verifiers would have to be at least two: one from the local authority and one with the appropriate fire engineering qualification. If SFRS is involved, the same would be required from SFRS. There might need to be two also from fire engineering community. To maintain an even balance, perhaps a member of the fire section from BSD.

12.7.17 The SFRS needs to remain involved as they play a significant role. The role should stay as a statutory consultee, and not verge into any approval function, as verification is the role of the LAV.

12.7.18 BSD should not be involved, or at least should not do anything to impact the views system and responsibilities.

12.7.19 A range of subject material experts may need to be available to the hub, at the highest level, if certain expertise is needed as part of review. However, it is not anticipated that this would be needed often.

12.7.20 The BSD would have to administer the hub and if a design required to be referred they would inform all parties and select relevant qualified people for the review. The hub would have to consider having the people for the relevant backgrounds such as fire engineers, local authorities, SFRS and possibly academics that are specialist in a particular field.

What qualifications and experience is appropriate for members?

12.7.21 Verifiers have a range of expertise across the breadth of building design, which includes fire engineering in some authorities. Fire engineering is in demand the most, so most authorities have some experience in the area. Those authorities with experience have graciously shared their knowledge and experience with others, and have served as resources for review when an authority lacks the necessary knowledge and experience.

12.7.22 All people should be a member of a professional body. Fire engineers should be chartered, while local authority and SFRS should be at least degree level with relevant experience in dealing with fire engineering solutions in the short term. Local authorities and SFRS should also be trying to attain CEng or IEng qualifications. Similarly, the BSD should have suitability qualified members to sit on the panel.

12.7.23 The Section 34 letter caused significant concern, as it was open to interpretation. It is not clear that IEng or CEng in Fire Engineering is needed, or exactly how it will help, since verifiers need knowledge across the broad spectrum of areas regulated by the building standards. Some staff have experience and competency, but not the post-nominal letters. This is just a process issue.

12.7.24 The Section 34 letter has resulted in some LAVs sending all fire engineered design for additional review, even for deviations they handled in the past. In part driven by interpretation of the Section 34 letter to require this, in other cases caused consideration as to whether decision should be made based on competency in fire engineering. The Section 34 letter has negatively impacted confidence in some cases.

12.7.25 Discussion around background of Section 34 letter noted that the underpinning research was tabled as a starting point, not an end point, and that it was understood that work was required on delineating the levels of complexity / analysis that might trigger different levels of competencies / qualification as part of the verification process.

12.7.26 It has been observed that since the Section 34 letter some designs have been submitted, purporting to have followed BS7974 or other fire engineering guidance, of which that level was not used in the past or necessarily warranted. This adds unneeded complexity and cost to the verification process. Qualifications should be appropriate to the work undertaken.

What limits on member service might be applicable?

12.7.27 The BSD should be impartial, providing the decision taken are not political and are based on the technical aspects of the report. Similarly the local authorities are impartial when making decisions on designs within their geographical area. There is potential conflict when companies are reviewing other companies' reports and there may also be a commercial sensitivity regarding some design information particular if it is unique.

12.7.28 Ultimately under the legislation, the local authority makes the decision to accept a design (unless the BSD grant some form of relaxation). Depending how the hub is set up and administered (if set up and administered by BSD and reviews are issued as part of the relaxation process) then the local authorities is bound by that decision.

12.7.29 The input from the hub is there expertise and to evaluate the fire engineering design. It would be up to the BSD to issue the acceptance of the design based on the report by the hub and any other consideration which they feel may be required (e.g., continuing requirement).

What attributes of a design would trigger review via the hub?

12.7.30 From experience, many of the fire engineered projects are too small to warrant review from something like a hub, and given the experience and support within the authorities (via LABSS), there are many cases where a hub would not be needed.

12.7.31 There is difficulty in defining what is complex. The view process has been used for single stairs, external wall systems, and similar, but these are not necessarily complex. There is already a two-stage process: the verifier needs help or does not. If help is needed, they can go out and get it within LABSS or third-party review.

12.7.32 The difficult in addressing complexity was further explored, with issues such as predicting movement through some amount of smoke without consideration of toxicity, reliance on safety management practices of owner (which may change over time), and mix-and-match of different engineering approaches without necessarily demonstrating their compatibility.

12.7.33 They are a number of considerations, because a building is large or of national significance does not mean it has to go through the hub (after all they are numerous design guides such as those for hospitals) because it may still comply with the guidance. The guidance clearly states that an alternative solution can be provided but must still meet the functional standard.

12.7.34 The main trigger would have to be variation or alternative from Section 2 in the Technical Handbook (although with recent events the Technical Handbooks will be reviewed) as the legislation sets this out.

12.7.35 The only issue is when this trigger is activated to send this to the hub. If the BSD Section 34 letter is still current, that would mean any deviation from Section 2 would be sent to them which is not practical to manage. The IEng level on the letter would cover 95% if not all the fire engineering solutions submitted currently. Some local authorities can deal with this level of application because they have qualified staff and a level of experience in dealing with fire engineering solutions. Therefore Level 3 (on Section 34 letter) should be sent to the hub.

What order of magnitude of response time is appropriate?

12.7.36 Any hub which is set up would delay the processes if this is referred after the warrant is submitted. If submitted at an early stage this may reduce the period to grant the warrant as most of the issues should or could be addressed during the review by the hub. This would encourage architects and fire engineers to discuss at an early stage projects which deviate from the guidance.

12.7.37 The hub which would or could be made up from people that have a normal day job, therefore timelines could be an issue for people on the hub and responding to key performance objectives set by Scottish Government.

12.7.38 If a design is referred then the BSD could give an initial response to whether the design should be reviewed by the hub, then the timeline would depend on length of time to set up the review board, complexity of the application etc.

How do you think the hub should be funded?

12.7.39 Funding could come from government, but could also be from fees paid by LAVs which use the hub (as collected from fees from those submitting complex designs for review).

12.7.40 The funding should be by Scottish government. This would maintain the impartiality of the review and more importantly the decision. If any 3rd party contributes to the hub it could be considered a bribe.

What other issues are important to consider?

12.7.41 While the idea of certification (self-certification) for fire engineering, such as with structural engineering, is interesting, there have not been any fire engineered designs through the verification process without changes, and it would seem unwise to push too fast at this point – the market is just not ready.

12.7.42 There are numerous problems within the regulatory and fire engineering community in relation to number and competency of qualified staff. It should however be noted that the number of fire engineering solution that are submitted is not large within Scotland and many projects which provide an engineering report do not require one. The hub appears to be trying to address the issues with the lack of qualified staff within the local authorities and none of the issues within the fire engineering community as a whole. The hub if set up correctly should be used more as a short term aid for local authorities rather than a long term solution.

12.7.43 The focus of a review of a fire engineering report by different parties will vary depending on their role e.g., the fire brigade looks at it mainly from a fire fighting and rescue point of view, the local authority from the deviation within the guidance and fire engineers mainly in how far they will be allowed to deviate from the guidance and what they are required to provide for that deviation.

12.7.44 If the hub is organized by the BSD they will review any report to see if it is required to be reviewed by the hub group. The BSD should establish clear guidelines on what the criteria will be for this and if they decide not to have it reviewed what will be the process, do they review it their self, or do they refer the local authority that submitted the report to another local authority that has expertise in a particular area.

12.7.45 There is also a role for LABSS here to pull its resources and expertise gained over the years to aid authorities, which do not have any qualified staff.

12.7.46 The problem changes if the BSD are saying that local authorities have no competent staff to carry out a review of a fire engineering solutions in which case any deviation should be reviewed by them. (but if you go by the requirements of the section 34 letter they do not have the qualified staff either).

12.7.47 The definition of high risk or complex building would have to be clarified as people's perception would vary greatly.

12.8 SCOTTISH FIRE AND RESCUE SERVICES (SFRS)

Is there value in the concept of a centralized review hub?

12.8.1 The verification system in Scotland is not broken. However, LAVs have a lack of resources, and use the SFRS, 3rd party verifiers and peer reviewers to help. Ultimately, verifier has decision-making role. If better resourced, they could do better.

12.8.2 The concept of a central review hub has merit, given LAV resource limitations: in many ways, the SFRS FEG serves in that capacity now, as an unpaid consultee. However, it would seem to be better to have fire engineering resource within LAV as compared to have a hub.

12.8.3 If any formalized hub is brought forward, it would need to be efficient. Processes and procedures need to be in place, decision-making clear, and outcomes understood. At this point, it is difficult to know what might go to the hub. Overall, process would work better if verifiers were properly resourced.

How would you view the Role of the Hub in Relation to the Existing System?

12.8.4 The SFRS FEG has beneficial knowledge, expertise and experience, and should see all fire engineered designs, regardless of whether other form of hub is developed or not.

Do you have views on a form which may be suitable?

12.8.5 The SFRS FEG can provide the services as understood to be needed, but need statutory authority and should be paid for the service. Capabilities, skills, etc. can be expanded if deemed necessary. All fire engineering designs should be submitted, and should have all necessary documentation. Feedback is given to the LAV, who ultimately makes a decision.

What make-up of membership is appropriate?

12.8.6 A key concern is the independence of any proposed hub. Having a broad range of people to draw from does not guarantee independence, if they are still working in the market (including academics, architects, fire engineers). The SFRS FEG is independent.

What qualifications and experience is appropriate for members?

12.8.7 Reviewers need to be adequately qualified and competent. It is not clear that requiring IEng or CEng (in fire engineering) necessarily accomplishes this. It might be too early to require such without having a better understanding of what such qualifications actually means.

12.8.8 The SFRS Fire Engineer Group (FEG) has fire engineering expertise and computational modelling expertise to review fire engineered designs, and has the added benefit of operational experience.

What limits on member service might be applicable?

12.8.9 There is concern that there are resource limitations if one prohibits practising professionals from participating, so as to avoid conflict of interest.

What attributes of a design would trigger review via the hub?

12.8.10 One part of the challenge with the existing process is that some verifiers only accept fire strategies at the end, when work is nearly complete, instead of in the beginning, when most beneficial.

12.8.11 There is concern that the SFRS FEG only sees part of a design in some cases, and not the full documentation. It can be difficult to assess the suitability of a design component out of context with the entire design approach. In addition, some documentation, even for components, is incomplete. There is no statement of assumptions, limitations, bounding conditions, or similar rationale.

What order of magnitude of response time is appropriate?

12.8.12 Not specifically discussed, but it was noted that a better understanding of perceived problems with the current process is needed. Quantification of delays in the verification process would be helpful.

How do you think the hub should be funded?

12.8.13 Not specifically discussed.

What other issues are important to consider?

12.8.14 While the SFRS FEG provides feedback to LAVs, they often do not get any information in return, so the SFRS does not know what final solutions were implemented. There are concerns that the procurement process isn't working as it should, since fire engineers not involved in beginning of projects, which can sometimes lead to issues at the end.

13 Annex D: Three-Route Verification Concept for Scotland

13.1 B.1 INTRODUCTION[3]

13.1.1 The building regulatory system in Scotland is function-based. It is comprised in part of a set of functional Building Standards, which are supported by guidance provided in a set of the Technical Handbooks. The Technical Handbooks offer a range of prescriptive and performance-based approaches that, when followed in full, should be accepted by the verifier as indicating that the building regulations have been complied with. In addition, it is also acceptable to use alternative methods of compliance, provided they fully satisfy the regulations.

13.1.2 The responsibility for demonstrating that the regulations have been complied with – that the Building Standards have been met – rests with the Relevant Person, typically the building owner or developer. The owner may engage architects, engineers or others to develop compliant designs. For building structural design there is a Certification scheme, where a registry of Approved Certifiers is maintained, and certification is done by an Approved Certifier, without the need for regulatory review. This is in part supported by government recognition of qualifications for structural engineering. There is no similar system for fire engineering, as there is no qualification system and associated government recognition thereof. As such, designs are subject to verification by Local Authority Verifiers (LAVs), often with input from Scottish Fire and Rescue Services (SFRS) and sometimes from peer-reviews.

13.1.3 This approach sometimes creates challenges, in that there is not a clear way in which to identify 'qualified' fire engineers, some LAVs lack on-staff fire engineering expertise, there is a regulatory separation with respect to SFRS, and there is no particular system for peer-review. (See reports from Meacham (2016, 2017) for more discussion).

13.1.4 To help address the challenges and provide a system that is more robust, uniform in decision-making, and equitable, various suggestions have been tabled. These include: simplifying the Technical Handbook provisions to be simpler to use, especially for common buildings / building types, developing fire safety engineering verification methods for more complex building types and uses, and creating a centralized hub for review and verification of the most complex buildings, in particular those involving fire safety engineering approaches. It has been suggested that a system that employs all three of these approaches would be of value (e.g., see Meacham, 2016; 2017; Review Panel on Building Standards (Fire Safety) in Scotland - UK Review Panel Agreed Notes (January 2018 meeting) and International Sub-Panel Agreed Notes (February 2018 meeting)).

---

[3] This section is excerpted from the report, Meacham, B.J. (2018). Research on Regulatory Appropriateness of Currently Cited Reaction to Fire Tests in Technical Handbook – Section 2: Fire – Standards 2.4 – 2.7, Meacham Associates, March 2018. The concept can be expanded beyond Standards 2.4 – 2.7, but is limited to these Standards for the purpose of example.

13.1.5 The following provides some preliminary concepts for how such a three-level verification approach might work, focusing on compliance with Standards 2.4 – 2.7 as a starting point. The approach largely follows the three-level approach outlined by Meacham (2017) as part of his report on competency criteria for verifiers of fire safety designs. For discussion purposes, the same basic levels are used, labelled here as: Level 1: Technical Handbook Compliance (Simple and Conservative), Level 2: Deviations or Alternatives (Verification Methods / Tests), and Level 3: Analyses (Fire Safety Engineering).

13.1.6 It should be noted that this type of three-level approach is already in place in other countries, notably Japan. In brief, the Japanese has three compliance routes: Route A, compliance with prescriptive deemed-to-comply provisions; Route B, simplified performance-based analysis, based on codified criteria and verification methods for egress, smoke filling, and structural fire performance; and Route C, full fire safety engineered designs, requiring approval by the Minister (approved expert panels). Additional discussion on the Japanese system is provided in Annex C.

13.2 Level 1 – Technical Handbook Compliance (Simple and Conservative)

13.2.1 In brief, the 'simple and conservative' approach is intended primarily for simple buildings with straightforward solutions, where no additional engineering analysis is needed. However, not every building is the same, and variability in design and solutions exist. Since life safety is a paramount concern, the simple approach should have some conservatism built in to account for variability in design and materials.

13.2.2 With respect to Standards 2.4 – 2.7, the primary focus is on inhibiting the development and spread of fire and smoke, and the building components of concern are cavities, internal linings, (fire) spread to neighbouring buildings, and (fire) spread on external walls.

13.2.3 A simple and conservative approach would be to require that all materials used as part of cavity enclosures, internal linings, and external walls, including fasteners, joint seals, and the like, must be non-combustible. This might also be extended to allowing limited use of combustible materials, if encased (enclosed) with non-combustible materials, and integrated into the building in such a way as to limit void spaces that could facilitate the spread of flame and smoke.

13.2.4 Such an approach would work well for many, but not all buildings. It may not be practicable or desirable for some, and/or it may be deemed excessively costly for others. In such cases, the other two verification routes are available.

13.3 Level 2: Deviations or Alternatives (Verification Methods / Tests)

13.3.1 For more complex buildings, or building uses in which the level of performance (safety) needs to be higher, due to increased life safety risk (e.g., due to occupant numbers, characteristics, vulnerabilities), increased hazards, firefighting challenges, or sustainability and resiliency objectives, there is often a need for some engineering analysis, or additional (and sometimes more comprehensive) testing to be conducted.

13.3.2 In many cases, the extent and/or complexity of engineering analysis and/or additional testing is not great, as there may only be a few deviations from the 'simple and conservative' solution. In a 'traditional' sense, these types of designs are often referred to as ‘variances’ or ‘deviations’. Deviations can often be addressed using ‘simplified engineering methods’, such as algebraic smoke filling equations, or hydraulic modelling of people movement, especially when conservative assumptions are included, appropriate safety margins are applied, and so forth. However, as the complexity and/or extent of deviation from the simple solution increases, the complexity of the engineering analysis and/or testing requirements increases. As complexity increases, cost and/or conservatism is likely to as well.

13.3.3 There are at least two distinct levels for this type of solution: single variable (or perhaps two at maximum), and multiple variable.

13.3.4 A single variable type of design problem, for example, might be a request for an extended travel distance, with all other fire safety requirements as per the ‘simple and conservative’ solutions, and ‘simple’ engineering analysis of people movement, with an appropriate margin of safety, is used in developing a solution.

13.3.5 From a material (component, system) perspective, a single variable type of problem might be consideration to use an ‘unapproved’ material (i.e., not subjected to the required standardised fire test method(s)) as an internal surface lining material. In such a case, an alternative fire test method may be proposed, and if deemed appropriate, used.

13.3.6 A multiple variable design problem might be a building in which there is a desire to reduce the total required number of exits (or width of required exit), based on installation of a smoke and heat venting system to maintain a smoke-free path of travel, and a more sophisticated fire (smoke) detection system and alarm system, to alert occupants sooner, activate the smoke venting, and/or other functions. This requires consideration of the scenarios, fire, design criteria, reliability of systems, and much more.

13.3.7 From a material (component, system) perspective, a multiple variable type of problem might be consideration to use an external insulated wall system, that includes unapproved’ material (in this case, perhaps combustible or limited combustible), as part of the wall system. In such a case, an alternative fire test method may be proposed, and if deemed appropriate, used (e.g., BS 8418, or ISO 13782 Part 2, or…).

13.3.8 One approach taken for a multiple variable type of ‘design’ problem in New Zealand was the development and implementation of a Compliance/Verification Method (C/VM2) for fire engineering analysis (MBIE, 2017). The NZ C/VM2 lays out specific fire scenarios, design fires, pre-movement assumptions, fire modelling assumptions, and more, and is intended to be applied for ‘typical’ performance-based design buildings; that is, buildings where several ‘variations’ from deemed-to-satisfy solutions (i.e., simple and conservative) are requested, and a uniform approach to fire engineering analysis is desired. There is some built in conservatism and limitations on applicability.

13.3.9 An approach for the multiple variable type of problem for a material (component, system), which is already cited in the Technical Handbook (non-domestic), Part 2: Fire for use in assessing fire performance of external walls is as in the example above – use of BR135 and BS 8414 as an ‘alternative’ approach to the guidance in 2.7.1.

13.3.10 "Alternative guidance - BR 135, 'Fire Performance of external thermal insulation for walls of multi-storey buildings' and BS 8414: Part 1: 2002 or BS 8414: Part 2: 2005 have been updated to include the most up-to-date research into fire spread on external wall cladding. The guidance provided in these publications may be used as an alternative to non-combustible or low risk classifications (as described in clauses 2.7.1 and 2.7.2) and for materials exposed in a cavity, as described in clause 2.4.6.

13.3.11 Clearly there is a wide range of potential 'variances' that fit this category: many that might have simple solutions and some that may have rather complex solutions. One way to manage this is to only permit designs, analyses, tests which are demonstrated to comply with broadly agreed methods which are appropriate to the regulatory purpose. Full implementation of such an approach would take time to carefully identify, vet and agree appropriate methods.

13.3.12 With respect to fire performance of external walls, however, it would seem appropriate that subjecting an external insulated wall system to one of the recognised standardised reaction-to-fire test methods for external insulated wall systems / external cladding systems would be appropriate, i.e., BR135 and BS 8414 or ISO 13782 Part 2 (and/or NFPA 285 and others, if deemed appropriate).

13.3.13 In the case of any verification approach associated with this level of verification, it is assumed that guidance would be developed as to what, when, where and how the analysis method, test method, or other verification method may be applied, including the documentation that is to be provided as part of demonstrating performance, and that guidance for verification and acceptance of any such designs, by Local authority Verifiers, is developed, implemented and available for use.

13.4 Level 3: Analyses (Fire Safety Engineering)

13.4.1 There will be times when 'simplified' verification approaches are not suitable, given the complexity of a building, complexity of a fire safety design, variability in materials used, cost of compliance with 'simple' verification methods, and more. In many of these cases, a full 'first principles' fire safety engineering analysis and design approach may be warranted, as described by guidance such as BS 7974, the IFEG, or similar.

13.4.2 While the details would need to be worked out, this level of verification would encompass any designs that substantially follow a 'first principles' fire safety engineering analysis and design approach, such as described by guidance in BS 7974 or the like. Such designs would be limited to those engineers with appropriate education, qualifications and credentials (to be determined and agreed), and would be subject to verification by those with appropriate education, qualifications and credentials (to be determined and agreed), or via a recognised central verification body, as has been tabled in previous discussions (e.g., see Meacham, 2016; 2017; Review Panel on Building Standards (Fire Safety) in Scotland - UK Review Panel Agreed Notes (January 2018 meeting) and International Sub-Panel Agreed Notes (February 2018 meeting)).

13.4.3 It would be anticipated that such analyses are applicable across a broad range of problems, including multiple variable design, material, component, system or assembly problems, which either fall outside of the scope of the 'Verification Methods / Test' level of verification, or which propose an alternative to such.

13.4.4 For example, considering again the fire performance of external insulated wall / cladding systems, and that the proposed verification scheme is adopted, the ‘simple and conservative’ approach would require that only non-combustible materials are used (with perhaps limited exceptions). The ‘verification methods / tests’ approach, however, would allow for those external insulated wall / cladding systems, that have successfully passed BR 135 and BS 8414 (or alternative, if permitted), to be accepted. Since such tests can be expensive, one might propose to take a ‘fire safety engineering’ approach. In such an approach, it might be deemed appropriate to test materials using small- or intermediate-scale apparatus and test methods, and combined with appropriate engineering analysis (e.g., flame spread modelling), present a credible design option.

13.4.5 Solutions using a fire safety engineering approach would be subject to a high level of adherence to guidance (e.g., BS 7974), including identification and treatment of uncertainty, clear definition of boundary conditions and limits of analysis and design, proper application of test results and computation models, and the like.

14 Annex E: Qualifications, Competency and Verification Level

14.1 INTRODUCTION[4]

14.1.1 There has been discussion in Scotland for some years now on issues related to qualifications and competency of engineers and verifiers with respect to fire safety engineered designs, especially for complex buildings and innovative materials, systems and approaches (e.g., see BSD, 2015; Meacham 2016; 2017).

14.1.2 In considering the regulatory appropriateness of standardised reaction-to-fire tests, as cited in the Technical Handbook – Section 2: Fire (non-domestic and domestic), particularly if a three-level verification approach is adopted, qualifications and competency, as associated with each route, is important.

14.1.3 Development of a qualifications and competency framework is outside of the scope of this project. However, it is suggested that the approach outlined in the 2017 research report, Competency Criteria for Local Authority Verifiers when Checking Fire Engineered Solutions for Compliance with Building Standards (Meacham, 2017), is valid and consistent with the three-level approach discussed in this report. The discussion below focuses on issues associated with the three-level approach with respect to Standards 2.4 – 2.7.

14.2 LEVEL 1 – Technical Handbook Compliance (Simple and Conservative)

14.2.1 As defined in Meacham (2017), if a design is developed in compliance with all aspects of Section 2: Fire of the Technical Handbooks (Level 1 Analysis), no fire engineering qualifications beyond what is currently expected of verifiers is needed.

14.2.2 With respect to Standards 2.4 – 2.7, specifically if recommendations such as modifying the Technical Handbook – Section 2: Fire, to be 'simple and conservative,' meaning use non-combustible materials (to a large extent, with few exceptions) in cavities, cavity barriers, internal linings, and external (insulated) wall / cladding systems, the above level of qualifications is appropriate. Since the solutions are conservative, and no fire engineering analysis is involved, no fire engineering qualification is particularly needed as part of the verification process. (See Meacham, 2017, for details).

14.3 Level 2: Deviations or Alternatives (Verification Methods / Tests

14.3.1 If a design involves 'minor' deviations from Section 2: Fire of the Technical Handbooks, or in the case that Scotland moves to develop a 'prescribed performance' approach for verification of fire engineered designs, much like the C/VM2

[4] This section is excerpted from the report, Meacham, B.J. (2018). Research on Regulatory Appropriateness of Currently Cited Reaction to Fire Tests in Technical Handbook – Section 2: Fire – Standards 2.4 – 2.7, Meacham Associates, March 2018. The concept can be expanded beyond Standards 2.4 – 2.7, but is limited to these Standards for the purpose of example.

framework in New Zealand, then it is suggested that a IEng MIFireE qualification and level of expertise is likely appropriate, depending on how the verification method is structured (see Meacham, 2017 for details).

14.3.2 This level of qualification is suggested, since with either a single variable type design or multiple variable type design (see 6.3.3 above), some knowledge of fire engineering principles will be helpful in guiding adequately informed decisions.

14.3.3 This is particularly desirable if Scotland chooses to develop a Verification Method for fire designs, such as New Zealand's C/VM2 (MBIE, 2017) or the proposed Australian Fire Safety Verification Method (ABCB, 2018; 2018a), especially if the approach would specify input parameters, including those to be used in modelling, and would assume some knowledge of proper use of the models. Such a Verification Method would be considered a Level 2 Analysis.

14.3.4 Specific to Standards 2.4 – 2.7, the flexibility that would be permitted as part of deviations based on limited engineering analysis (through application of a Verification Method or other) or use of 'alternative' standardised reaction-to-fire test methods is such that some knowledge of fire physics and chemistry would be helpful (for example, in determining suitability of 'alternative' standardised reaction-to-fire test methods to a particular building application).

14.4 Level 3: Analyses (Fire Safety Engineering)

14.4.1 Owing to the complexity and potential risk associated with Level 3 fire engineering analyses and designs, it should be that the qualifications and expertise required for anyone undertaking a Level 3 fire engineered design, or verifying such a design – whether employed as a local authority verifier or as an independent third party reviewer working on behalf of the verifier – should meet the requirements of CEng, MIFireE (see Meacham, 2017, for more discussion). This is fundamental, since any engineering solution can make use of any engineering tool or method, and the verifier / verifying body needs to be in a position to competently verify appropriate application of the tools and methods in the development of the engineered solution.

14.4.2 An example of a fire engineered design relative to Standards 2.4 – 2.7 might be an approach which aims to combine outcomes from 'screening' tests, such as ISO 5660 (Cone Calorimeter Test Method), ISO 9705 (Room Corner Test Method), ISO 13823 (Single Burning Item Test Method), or ISO 13782 Part 1, and combined with demonstrably robust fire development and flame spread models, to demonstrate acceptable fire performance of an external insulated wall system. Such approaches can be complex and require care. Various examples of related analysis are available in the literature (e.g., see Janssens et al., 2003; Meunders et al., 2012; Elini et al., 2013; van Hees, 2016).

14.4.3 Alternatively, or additionally, the establishment of some type of 'central' peer-review panel or committee could be extremely beneficial for such designs. As outlined by Meacham (2017), the intent would be to have a panel which reflects the sector – not just fire engineers, but verifiers, the regulator, fire service, insurance and potentially industry and public representation – who are outside of the specific design of a complex building or application of advanced fire safety engineering approach, who can competently and independently verify compliance of the fire engineered solution with the intent of the Building Standards.

14.4.4 Such a body can be helpful because a specific design, by definition, is addressing issues or buildings deemed outside of the Section 2: Fire of the Technical Handbooks, or of a C/VM2 type verification method, and therefore must consider the broader scope of the Building Standards and compliance with it. By including the verifier (LAV), regulator (BSD) and fire service (SFRS), it should eliminate the need for additional review. By including insurance, it should reduce concerns from that sector as well. There is a separate research project underway to explore this in more detail.

References

ABCB (2018). NCC 2019 – Fire Safety Verification Method, draft for public consultation, ABCB, Canberra, ACT, Australia (available for download at http://www.abcb.gov.au/Resources/Publications/NCC-2019-Public-Comment-Draft/Fire-Safety-Verification-Method-proposed-for-NCC-2019, last accessed 11 March 2018).

ABCB (2018a). NCC 2019 – Fire Safety Verification Method, Calibration Study Summary, ABCB, Canberra, ACT, Australia (available for download at http://www.abcb.gov.au/Resources/Publications/NCC-2019-Public-Comment-Draft/Fire-safety-Verification-Method-calibration-study-summary, last accessed 11 March 2018).

Eleni K. Asimakopoulou, Dionysios I. Kolaitis and Maria A. Founti (2013). "Comparative assessment of CFD Tools and the Eurocode Methodology in describing Externally Venting Flames," 1st International Seminar for Fire Safety of Façades, Paris (France), published in MATEC Web of Conferences, 9 (2013) 03003 DOI: https://doi.org/10.1051/matecconf/20130903003.

Janssens, ML., Kimble, J., Murphy, D. (2003). "Computer Tools to Determine Material Properties for Fire Growth Modelling from Cone Calorimeter Data," Proceedings of Fire and Materials 2003 Conference, San Francisco, USA, pp. 377-387. Lawson, R. (2009). A History of Fire Testing, NIST Technical Note 1628, NIST, Gaithersburg, MD, USA, pp41.

MBIE (2017). C/VM2 Verification Method: Framework for Fire Safety Design, MBIE, Wellington, NZ (available for download at https://www.building.govt.nz/building-code-compliance/c-protection-from-fire/c-clauses-c1-c6/#jumpto-acceptable-solutions-and-verification-methods, last accessed on 11 March 2018).

Meunders, A., Trettin, C., Wittbecker, F. (2012). "The capability of FDS to model flames and plumes emerging from compartment openings", Proceedings of the 2012 International Congress of Fire Computer Modelling, 457–470, Santander, Spain.

Van Hees, P. (2016). "The Urgent Need for System Thinking in Fire Safety – The Only Way Forward for Testing, Engineering and Education," 14th Interflam Conference, Interscience Communications Ltd, London, 2016.

15 Annex F: Verifier Qualifications and Competence Framework (Fire)

15.1 E.1 INTRODUCTION

15.1.1 The following is excerpted with minor modification from Meacham (2017) given its relevancy to qualifications and competencies for design and verification.

15.2 E.2 Verifier Qualifications

15.2.1 It is suggested that the level of qualification and expertise required to attain a CEng in fire engineering should not be required of all verifiers, as this is outside of the scope of their primary responsibilities. Rather, it is suggested that the qualifications be connected to the type and level of fire engineering analyses being verified.

15.2.2 If a design is developed in compliance with all aspects of Section 2: Fire of the Technical Handbooks (Level 1 Analysis), no fire engineering qualifications beyond what is currently expected of verifiers is needed.

15.2.3 If a design involves 'minor' deviations from Section 2: Fire of the Technical Handbooks, or in the case that Scotland moves to develop a 'prescribed performance' approach for verification of fire engineered designs, much like the C/VM2 framework in New Zealand, then it is suggested that a IEng, MIFireE qualification and level of expertise is likely appropriate (see Section 4), depending on how the verification method is structured. If like New Zealand's C/VM2, for example, which specifies values to be used for all input parameters, including those to be used in modelling, the level of fire engineering expertise can be less. This would be considered a Level 2 Analysis.

15.2.4 Finally, owing to the complexity and potential risk associated with Level 3 fire engineered designs, it should be required that the qualifications and expertise required for anyone verifying a Level 3 fire engineered design – whether employed as a local authority verifier or as an independent third party reviewer working on behalf of the verifier – should meet the requirements of CEng, MIFireE. This is fundamental, since any engineer solution can make use of any engineering tool or method, and the verifier needs to be in a position to competently verify appropriate application of the tools and methods in the development of the engineered solution. The level of qualifications is summarized in table E.1 below.

Table F.1. Verifier Qualifications based on Fire Engineering Design Level

Verifier / 3rd Party IFE EC Qualification	**Level 1** Technical Handbook Compliance	**Level 2** 'Minor' Deviation, 'Limited' Fire Engineered Design, C/VM2 Verification	**Level 3** 'Complex' / BS7974 / IFEG Fire Engineered Design
None			
IEng			

CEng			

15.3 E.3 Complexity Matrix

15.3.1 Should a tiered system of qualifications be adopted, such as suggested above, a more substantial set of conditions which bound / describe 'minor' deviation and 'complex' or fire engineered design are needed, beyond what currently exist in the Simplified Approach to Alternative Fire Safety Strategies.

15.3.2 It is suggested that the quantification of 'minor' deviations and the qualification and competency for designers and verifiers will ultimately need to be decided by Scottish government in consultation with practitioners. The following are suggested starting points only. It is expected that considerable consultation will be needed to develop agreed criteria should this approach be adopted.

Table F.2 Factors Triggering Level of Qualification for Design and Verification

Fire Engineering Scope	**Level 2 Deviations or Alternatives**	**Level 3 Analyses**
General Applicability[5]	• 1-2 family domestic • Lodging less than 100 persons and less than 25 m in height • Office buildings less than X m^2 in floor area per level and 25 m in height and occupant load of 100 • Shops less than X m^2 in floor area per level, and 25 m in height and occupant load of 100 • Restaurants with less than 100 person capacity • Simple analyses using algebraic equations and correlations, as presented in credible standards and guidelines, such as smoke filling following CIBSE guidelines • Analyses using simple	• Any building over 25 m in height • Any building with population greater than 1000 or limits as given for Level 2 analyses • Any building with atrium open to 3 floors or more • Any building of exposed CLT framing • Any lodging more than 100 persons capacity or more than 25 m in height • Stores greater than X m^2 in floor area per level • Office buildings greater than X m^2 in floor area per level • Hospitals with more than 50 overnight care beds and more than 2 operating suites

[5] Technical Handbook Compliance: The guidance clauses to the building standards set out the aims followed by guidance to help satisfy the standard. The intent is that a limited number of inconsequential variances from the guidance in Section 2: Fire can be verified by the building standards surveyor without additional Fire Engineering training.

	hydraulic modelling of occupant evacuation • Analyses using C/VM2 approach or equivalent • Qualitative analysis and comparison against design criteria	• Analyses using 2-zone fire effects models • Analyses using CFD models • Structural fire engineering analyses using FE models • Any ASET versus RSET analysis using computational models • Any probabilistic analyses
Fuel / Fire Characteristics Strategies and/or Analyses	• Use of more fire resistive interior finishes than minimum requirements • Use of lower HRR products • Use of more ignition resistant materials • Reduction of ignition hazards • Limitations on total fuel load	• Any proposed use of materials which do not comply with standard fire tests, or which have not been tested using such methods • Interior finish materials based on room corner test or equivalent • Use of 'fuel control' as part of safety management plans (e.g., limit fuel to 1MW fire) • Analyses based on development and assessment of design fire curves • Analyses using 2-zone fire effects models • Analyses using CFD models
Occupant Notification Strategies and/or Analyses	• Use of additional early detection devices beyond minimum requirements • Use of additional notification appliances and systems above minimum requirements (e.g., voice alarms, visible notification appliances, etc.)	• Calculations which estimate fire detection response as trigger of notification system • Calculations of audibility and intelligibility based on specific devices, locations, interior finishes, etc. • Analyses which assume particular occupant recognition and response, given specific notification characteristics (e.g., sound power level, type of signal), as based on research or literature
Egress Strategies and/or Analyses	• Small deviations on fixed parameters, such as exit width, dead end length,	• Any deviation on fixed parameters, such as exit width, dead end length,

	maximum travel distance to an exit, where deviation is generally less than 10% and number of persons exposed is equal or less than as listed above	maximum travel distance to an exit, where deviation is generally greater than 10% • Any reduction in exit capacity, number or location of exits as compared with Technical Handbook • Any proposed use of lifts for occupant self-evacuation • Any phased evacuation strategies • Any ASET versus RSET analysis using computational models
Compartmentation / Structural Fire Resilience Strategies and/or Analyses	• Use of more fire resistive construction than is otherwise required • Use of more fire protective covering (e.g., spray applied fire protection material, more concrete cover, etc.) or thermal barriers (e.g., gypsum board) than is otherwise required • Use of alternative structural materials and systems, which have passed standard fire tests, under specific configurations (e.g., CLT with gypsum cover, which has passed applicable fire resistance tests)	• Any strategy which proposes to use fire resistance ratings of structural components which are lower than otherwise required • Any strategy which proposes structural fire engineering to determine fire performance of structural system • Structural fire engineering analyses using FE models
Smoke Control Strategies and/or Analyses	• Simple smoke filling / development analyses using algebraic equations and correlations, as presented in credible standards and guidelines, such as smoke filling following CIBSE guidelines • Smoke control, exhaust or pressurization strategies which follow in all aspects approaches as defined by recognized standards or guidelines (e.g., CIBSE	• Any smoke filling and control strategies using 2-zone fire effects models, CFD models, or system models (such as CONTAM)

	guidelines)	
Suppression Strategies and/or Analyses	• Use of fire suppression systems, where not otherwise required, without reducing other fire requirements, where there is no question of negative interaction of systems (e.g., sprinklers and natural smoke venting) • Use of special suppression systems which meet recognized standards	• Proposed use of suppression system to reduce other fire safety feature (e.g., extended travel distance, reduced FRR of structure, etc.) • Proposed change of suppression system parameters (e.g., type of head, flow rate, design density, etc.) based on hazard analysis
Fire Brigade Intervention		• Any strategy which aims to quantify and include fire brigade response

15.4 E.4 Expert Peer Review Panel

15.4.1 Another approach which may be helpful is the establishment of some type of 'central' peer-review panel or committee. The intent would be to have a panel which reflects the sector – not just fire engineers, but verifiers, the regulator, fire service, and potentially industry and public representation. This is needed because a specific design, by definition, is addressing issues or buildings deemed outside of the Section 2: Fire of the Technical Handbooks, or of a C/VM2 type verification method, and therefore must consider the broader scope of the Building Standards and compliance with it. By including the verifier, regulator (BSD) and fire service (SFRS), it should eliminate the need for additional review.

15.4.2 How such a panel is set up, who sits on the panel, what their qualifications are, what their scope is, when and how often they are used, how one controls conflict of interest, how they get compensated, and related issues need to be addressed. Considerations might include:

15.4.2.1 Whether the panellists are paid, and if so, how much and by whom (flow of funds).

15.4.2.2 Establishment of an appropriate number of panel participants (large enough to be representative: small enough to function efficiently). Probably a target of 3-5 would be reasonable. There could be a larger pool, from which panellists are drawn, as outlined below.

15.4.2.3 Decision on the range of interests which should be represented (e.g., all sectors of the fire industry, only engineers, …). This could depend on the nature of the project.

15.4.2.4 Decision on how members are selected. It is suggested that 'the owner' might identify minimum qualifications (see above), put out a call for members to serve, and establish a pool of candidates from which a panel can be formed as needed (the pool might have 20-30 people, but specific panels only 3-5 people). Formation of a panel could be in different ways: establish a panel, and have it sit for a period of time, or form a panel only when needed for a specific interpretation, or take a hybrid approach. The hybrid approach may be most flexible, say sitting a core panel of 3 persons to serve a period (year?), and draw from the pool if specific expertise / perspective, beyond the core group, is needed on a specific interpretation question. Ultimately, the format would have to fit with time and resource constraints. Issues of confidentiality and disclosure of proprietary information would need to be addressed. Having some international expertise / experience could be helpful.

15.4.2.5 Establishment of term(s) of service. This would lay out period of time someone is in the pool (maybe 3 years?), how long they can serve on a panel (maybe 1 year?), how many times they can be reappointed to the pool or a panel, reasons / process for dismissal, and so forth.

15.4.3 While the peer-review panel / committee approach could be more involved to establish and to manage, as compared with keeping the Level 3 design verification process decentralized, the panel approach could carry more weight with verifiers and be viewed as being fairer and more balanced (i.e., not a single person's view).

Scottish Government
Riaghaltas na h-Alba
gov.scot

This publication is available at **www.gov.scot**

Any enquiries regarding this publication should be sent to us at
The Scottish Government
St Andrew's House
Edinburgh
EH1 3DG

ISBN: 978-1-78781-665-7 (web only)

Published by The Scottish Government, March 2019

Produced for The Scottish Government by APS Group Scotland, 21 Tennant Street, Edinburgh EH6 5NA
PPDAS555870 (03/19)