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International collaboration
Development of the International Fire Engineering Guidelines

Beth Tubbs
International Codes Council, 244 Brookway Drive, Northbridge, MA 01534, USA.

Russ Thomas, Igor Oleszkiewicz
Institute for Research in Construction, National Research Council of Canada, Ottawa, Ontario, K1A 0R6, Canada.

Alan Moule
Building Industry Authority, PO Box 11846, Wellington, New Zealand.

Brian Ashe, Matthew Patterson
Australian Building Codes Board, GPO Box 9839, Canberra ACT 2601, Australia.

ABSTRACT

This paper examines the identified need and the process used in the development of the International Fire Engineering Guidelines. It also explains the importance of the proposed document structure to facilitate the application of the guideline in a variety of jurisdictions around the world. The objective of the paper is to highlight the importance of collaboration (both nationally and internationally) in the development of such guidelines.

INTRODUCTION

Since the 1990s, in order to free designers as much as possible from arbitrary restrictions, many building regulatory systems have been progressively changed to become "performance-based". Under this system, the Codes set objectives as clearly as possible and then usually proceed to declare that (for example):

- The building must comply with the objectives or the performance requirements of the Building Code.
- If the building complies with the 'deemed-to-satisfy' provisions (that effectively equate with the old prescriptive requirements), the building is deemed to comply with the objectives or the performance requirements and hence is acceptable.
- If the designer does not wish to follow the 'deemed-to-satisfy' provisions, then it is open to the designer to show by some other means that the proposed 'alternative solution' has met the objectives or performance requirements. Fire engineering is frequently used to develop and support such alternative solutions.

Even in countries were performance based codes have not been fully embraced, many fire engineers are undertaking performance design through a clause in the prescriptive building codes that allows design equivalent to the prescriptive provisions.

Objectives are often expressed in a 'community aspiration' style that cannot be quantified. Performance requirements are normally more specific than objectives, but are rarely expressed in terms that can be readily quantified. Where an objective or performance requirement is expressed in non-quantifiable terms, the question of whether it has, or has not been achieved, is inevitably a question for engineering judgement to resolve. This is even more the case when working through the equivalency process where little guidance on intent is provided.

Thus, fire engineering largely consists of analysis that is intended to:

- Inform the fire engineer and to help in the formation of engineering judgement.
- Help justify that engineering judgement to other people.

Fire engineering currently involves more engineering judgement than traditional engineering disciplines due to the lack of generally accepted guidelines.

WHY DEVELOP THE INTERNATIONAL FIRE ENGINEERING GUIDELINES (IFEG)?

In November 2001 the Australian Building Codes Board (ABCB) published the Fire Safety Engineering Guidelines [1]. This guideline was primarily developed for use in Australia. Through the relationships developed within the Inter-jurisdictional Regulatory Collaboration Committee (IRCC), the ABCB together with the Canadian Codes Centre of the National Research Council of Canada (NRC), the United States International Codes Council (ICC) and the Building Industry Authority, New Zealand (BIA), have decided to undertake a collaborative project. This project involves the revision of the Fire Safety Engineering Guidelines into an International Guideline for use within Australia, Canada, United States of America (USA) and New Zealand.

The objective of the project is establishing a set of Fire Engineering Guidelines that meet the joint needs of the NRC, ICC, BIA and ABCB. These guidelines will reference both nationally and internationally available standards, guides and associated documents. The guidelines will also consider the use of both imperial and SI units. Essentially this document will provide the opportunity to share resources across borders.

The International Fire Engineering Guidelines (IFEG) will be divided into 4 parts:

Part 0	Introduction (for each jurisdiction it describes fire engineering, the profession fire safety engineering, and the link with their regulatory system).
Part 1	Process (describes the process by which fire engineering is undertaken).
Part 2	Methodologies (describes a selection of appropriate methodologies that may be used in undertaking the fire engineering process).
Part 3	Data (provides a selection of data that may be used in applying the methodologies of Part 2 or other chosen methodologies.)

The IFEG will be published in December 2004.

EVOLUTION OF IFEG

The development of the International Fire Engineering Guidelines, builds on a number of earlier advances in documenting the process of fire engineering for alternative building solutions.

In May 1989, the Australian Government established a Building Regulations Review Taskforce (BRRT) to review Australia's building regulations and standards. As a result of the review the BRRT commissioned the principal participants from the Warren Centre Project to *codify the concepts of an alternative approach to building fire safety* [2]. By 1991, a draft National Building Fire Safety Systems Code (NBFSSC) had been produced. The draft NBFSSC was *based on a risk assessment methodology and introduced the concepts of fire engineering sub-systems and time-line analysis for performance evaluation* [2].

In 1994 the Fire Code Reform Centre (FCRC) was established with a mission of advancing the technological basis for the use of fire safety engineering in Australia, to assist the building regulatory reform program being undertaken by the Australian Building Codes Board (ABCB). In 1996 the FCRC released the Fire Engineering Guidelines (FEG) [3] which identified a methodology for the design and assessment of fire safety in buildings. This facilitated the application of the performance based Building Code of Australia 1996 (BCA) [4].

The development of the FEG was based on the NBFSSC and other key documents such as:

- Fire Safety and Engineering, Project Report and Technical Papers, The Warren Centre, The University of Sydney, (1989) [4]
- British Standard Code of Practice for the Application of Fire Safety Engineering Principles to Fire Safety in Buildings, UK (1994) [6]
- Fire Engineering Design Guide, University of Canterbury, New Zealand, (1994) [7]
- Documents from ISO/TC92/SC4 on performance based fire engineering design

The FEG recognised that many integrated factors including a buildings construction and layout, means of egress, occupancy factors, smoke management, detection, alarm and fire suppression, contribute to the achievement of the BCA objectives. It achieved this by detailing various sub-systems that need to be assessed by providing guidance on quantifiable design criteria that could be used in a fire safety engineering design. For example, the FEG specified general life safety criteria for occupant tenability limits.

In 1997 the FCRC commissioned a revision of the FEG. The revision moved away from the approach used in the FEG and concentrated on the process and procedures to be used. As part of the revision, the document was broken up into 4 distinct parts. Part 0 provided background information and guidance that was integral to the use of the Guideline. Part 1 described the process by which fire safety engineering is typically undertaken. Part 2 contained a selection of methodologies that may be used in undertaking the fire safety engineering process whilst part 3 provided data that may be used in applying the methodologies from part 2 or other chosen methodologies.

The revised version of the FEG was known as the Fire Safety Engineering Guidelines (FSEG). The overall result of the production of the FSEG was a more user friendly document that contained a much clearer outline of how a fire safety engineering design is to be carried out, assessed and documented.

The following table provides a single comparison between the FEG and the FSEG.

SINGLE COMPARISON BETWEEN FEG - (1ST ED) AND FSEG - (2ND ED) APPROACHES

FEG Approach	**FSEG Approach**
	Step 1 - Define Process
Refer to Chapter 8, Fire Initiation and Development to determine: 1. How to consider fire initiation in an FSE context and the quantification of various factors for design fires such as, heat release rate, toxic species yield, smoke yield and time to key events. 2. How to consider fire prevention measures 3. Guidance on various calculations related to design fires	Refer to process in Part 1, Chapter 1.4 for guidance on how to consider fire initiation in an FSE context and the quantification of various factors for design fires such as, heat release rate, toxic species yield, smoke yield and time to key events. Also outlines how to consider fire prevention measures.
	Step 2 - Determine Methodologies
	Refer to methodologies in Part 2, Chapter 2.4 for guidance on various calculations related to design fires
	Step 3 - Source Data
	Refer to data in Part 3 for sources of relevant information for use in design

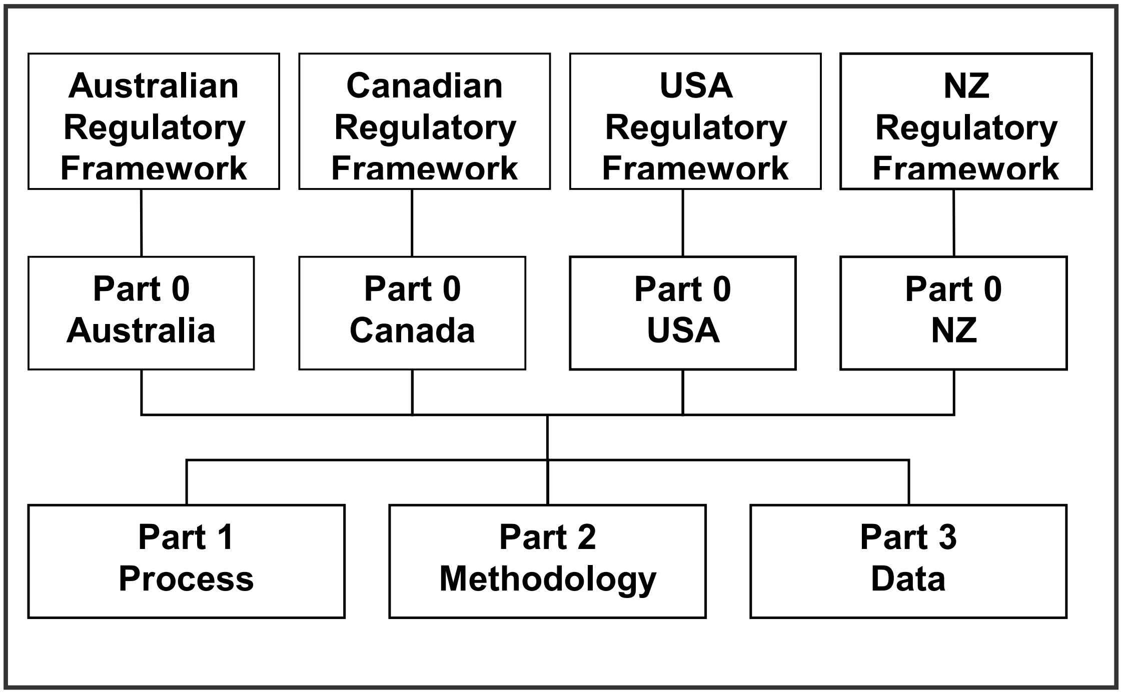
The production of the IFEG is a revision of the FSEG. In the development of the IFEG, a number of changes have been made, to make the IFEG suitable for use in Australia, Canada, USA and New Zealand. These changes are as follows:

- The terminology of Fire Safety Engineer / Engineering changed to Fire Engineer / Engineering, which is the terminology accepted internationally.
- Dual units and conversion factors adopted in order to facilitate the international use of the document.
- Part 3 – Data, reorganised to avoid minimise repetition. Additional international data has been inserted.
- Commentary boxes which related to Australian examples have been replaced with international examples to improve the compatibility of the document with overseas practice.
- Additional methodologies have been incorporated into Parts 2 and 3.
- Additional international references have been inserted.
- The titles of the sub-systems (SS) has been modified to the following to improve understanding:
    - SS-A- Fire initiation, development and control
    - SS-B- Smoke development, spread and control
    - SS-C- Fire spread, impact and control
    - SS-D- Fire detection, warning and suppression
    - SS-E- Occupant evacuation and control
    - SS-F- Fire services intervention

IFEG STRUCTURE

The IFEG is broken up into 4 distinct parts. The following diagram illustrates how the IFEG will be structured. Each Part is explained in further detail below.

Figure 1: IFEG Structure



Part 0 - Introduction

The primary purpose of Part 0 is to provide the link between fire engineering and the regulatory regime in the particular jurisdiction, so that the document is suitable for use within Australia, Canada, USA and New Zealand. Therefore, each country has developed a Part 0 which provides the link between the relevant regulatory regime and the fire science and engineering.

Part 0 of the IFEG is intended to provide insight into the issues that go beyond the actual engineering and provide a perspective on the role of fire engineering within the regulatory and non-regulatory community for a particular country. This portion of the guideline is intended to link engineering practice with the legal and regulatory system of a jurisdiction. More specifically, it is intended to make known that science and engineering is only one aspect of fire safety engineering and that there are other elements that need to be accounted for.

As an example, the Australian version of Part 0 contains information on the following:

- Introduction to the Guidelines – Information on the evolution of the document, differences between this document and the FSEG, scope of the document and limitations.

- The Australian Regulatory System – This section outlines the Australian building regulatory framework, provides an overview to the performance-based BCA and outlines the building approval process including the roles of the building approval authority and the fire engineer.
- Fire Engineering – Outlines the process and benefits of fire engineering. Reinforces that the design of a building to achieve an appropriate level of fire safety is only one element of the process of ensuring that fire safety is achieved for the life of the building. Highlights that fire engineering can play a role in other stages such as commissioning, maintenance, future alterations, etc.
- Fire Engineers – This section describes the competencies that a fire engineer in Australia should possess. It also covers requirements regarding accreditation of fire engineers
- Definitions and abbreviations applicable to the IFEG.
- Useful information sources.

Part 1 – Process

Part 1 outlines the process by which fire safety engineering is typically undertaken. It recommends at the start of each project, that the fire engineer should prepare a Fire Engineering Brief (FEB). A FEB is a documented process that defines the scope of work for the fire engineering analysis and its purpose is to set down the basis, as agreed by all relevant interested parties, on which the fire safety analysis will be undertaken.

The FEB should define the agreed fire safety objectives for the project and identify the relevant Objective / Performance Requirements that need to be satisfied. In order to define the appropriate objectives for the project, it is useful to first identify the goals of each interested party. The objectives of different interested parties may be different or even conflicting and a compromise is needed. In achieving a compromise, the mandatory objectives / requirements must be given due consideration.

In objective / performance-based building codes, each objective is commonly accompanied by performance requirements that amplify the intent of the objective and are typically more specific. Objectives and performance requirements should be presented as definitively as possible and, ideally, numerically; but this is generally not the case. Performance requirements often include non-quantifiable phrases like 'to the degree necessary' and 'appropriate to' that make it inevitable that engineering judgement will frequently be required in assessing whether or not a performance requirement has been met.

Therefore, an FSEB is an important step as it defines the scope of the fire engineering analysis and sets down the basis, as agreed by the relevant parties, on which the fire safety analysis will be undertaken. The FEB will address some or all of the areas from the following (non exhaustive) list.

- Scope of project, ie. contractual context, regulatory framework, schedule etc.
- Relevant stakeholders, ie. client, fire engineer, designer, fire service etc.
- Building characteristics, ie. occupancy, location, size, structure, hazards etc.
- Occupant characteristics, ie. distribution, state, attributes, familiarity etc.
- Objectives, ie. protect occupants, property, facilitate fire service activities etc.

- Hazards, ie. general layout, activities conducted, ignition and fuel sources.
- Preventative and protective measures, ie. maintenance, detection, suppression etc.
- Trial designs for evaluation – develop trial designs to be used in the evaluation.
- Non-compliance issues and specific objectives – determine where the trial designs do not comply with the prescriptive building requirements and what are the specific objectives that the trial design is trying to determine
- Approach and method of analysis – select approaches and method of analysis to be used to determine whether the trial design meets the acceptance criteria ie. comparative or absolute, qualitative or quantitative etc.
- Acceptance criteria, factors of safety
- Fire scenarios, parameters for design fires
- Parameters for design occupants groups
- Standards of construction, commissioning, management and maintenance.

Part 1 also gives guidance on the process for analysis, collating and evaluating results and drawing of conclusions. It also provides advice on the fire engineering report format and contents.

Part 2 – Methodologies

Part 2 describes a selection of methodologies that may be used in undertaking the fire engineering process. It does not preclude the use of other methodologies that may be chosen by the fire engineer and that are acceptable to regulatory and building approval authorities. The methodologies in the document cover

- Acceptance criteria for analysis
- Identification and definition of fire scenarios, including the use of event tree analysis.
- Use of deterministic and probabilistic approaches
- Fire initiation, development and control
- Smoke development, spread and control
- Fire spread, impact and control
- Fire detection, warning and suppression
- Occupant evacuation and control
- Fire services intervention

Part 3 - Data

Part 3 provides a selection of data that can be used when applying the methodologies listed in Part 2 or other chosen methodologies. Similarly to Part 2, it does not preclude the use of other data that might be chosen by fire engineer and that are acceptable to regulatory and building approval authorities. Caution will need to be applied when using this data as it could become irrelevant due to:

- New methodologies, technologies and materials
- Varying regulatory differences
- Cultural differences
- Constructions practices

The data includes the following:

- Probability of fire starts for various buildings
- Properties for materials and products
- Fire load densities for a range of building occupancies
- Effectiveness of fire alarm and suppression systems

The data is not specifically linked to the subsystems since data may have various areas of applicability.

PROCESS OF DEVELOPMENT

Considering the large number of stakeholders involved in this project, the process of development was crucial. The overall development was overseen by an international steering committee consisting of representatives from the collaborating countries. The steering committee met on a monthly basis. Parts 1, 2 and 3 were developed through a consultancy undertaken by an international fire safety engineering consortium. The collaborators jointly funded the consultancy.

Part 0 provides the link between the regulatory regime and the fire science/engineering. Therefore, each collaborator developed a Part 0 which would be suitable for use in their particular country. When developing their own Part 0, each collaborator was able to observe how the other collaborators were developing their Part 0, which proved to be beneficial. Each Collaborator has had a steering committee or some level of consultancy overseeing the development of their Part 0.

Editors have been appointed to review various chapters/sections. These editors are:

Chapter/Section	Editor	Organisation
General	Peter Johnson	Arup
Fire Initiation Development and Control	Jim Mehaffey	Forintek
Smoke Development, Spread and Control	Jim Klote	John H. Klote. Inc. Fire and Smoke Consulting
Fire Spread, Impact and Control	Colleen Wade	Building Research Association New Zealand
Fire Detection, Warning and Suppression	George Hadjisophocleous	Carleton University, Ottawa.
Occupant Evacuation and Control	Jim Shields	University of Ulster
Fire Services Intervention	Paula Beever	New Zealand Fire Service
Data	Vytenis Baubrauskas	Fire Science and Technology Inc.

Each editor will be responsible for reviewing and editing one or more sections of the guidelines document. The editor of a section is also requested to review the data in Part 3 that is associated with the elements of the guide that they are responsible for.

INTERNATIONAL COLLABORATION

Funding for guideline development is limited, like most development, it is beyond the means of any sole agency. For this reason there needs to be a collaborative approach to the development of Fire Engineering Guidelines that involves both national and international agencies. This collaborative approach has allowed the resources for the development of the IFEG, to be shared amongst the collaborators. The 'pool' of knowledge that the various collaborators have and can also draw upon, has been used to create a more robust, internationally recognised Guideline.

Fire science and engineering is the same in all countries/jurisdictions. The difference occurs in the regulatory frameworks and public policy in the different countries/jurisdictions. Therefore to develop a guideline that was suitable of use in various jurisdictions it was necessary to de-couple the document and develop a country/jurisdiction specific Part 0 which provided the link. This approach has and will permit effective and efficient collaboration in the development of methodologies and data sets. This approach permits the document to be relevant to other jurisdictions.

The project has acted as a catalyst for future developments between the collaborators.

DELIVERY OF THE DOCUMENT

The IFEG will be produced in hard copy, CD-ROM along with a web-based version. The hard copy version will be loose leaf so that pages can be replaced as the document is continually developed. It's proposed the web-based version will be produced in XML which would allow units to be displayed as either imperial or SI. It would also allow the Guideline to show only information that is relevant to the particular country where the Guideline is being used.

CONTINUED DEVELOPMENT

It is proposed that once the IFEG is published in December 2004, an Editorial Board would be established. The Board would call for papers to be referenced in the IFEG. The Board would consider the appropriateness of the submitted papers and determine if they should be referenced. For the web-based version of the IFEG, the accepted papers would be updated immediately. For hard copy and CD-ROM, the accepted papers would be updated at each amendment.

The ABCB, NRC, ICC and BIA encourage relevant authorities representing other countries/jurisdictions to consider the use of the IFEG in their country/jurisdiction. The collaborators would be pleased to discuss this proposition further with interested parties and provide assistance where necessary to ensure that the IFEG is suitable for use, outside of Australia, Canada, USA and New Zealand.

CONCLUSION

The discipline of fire safety science and engineering is the same in all countries. However, there are differences in the manner that fire engineering is used between countries/jurisdictions. These differences are due to the differing regulatory frameworks and public policy ideals.

Collaboration between the ABCB, NRC, ICC and BIA has enabled the IFEG to be produced so that it is suitable for use in Australia, Canada, USA and New Zealand. This has been achieved by each collaborator developing a separate Part 0 which contains the information relevant to the regulatory framework in the particular country. Whilst Parts 1, 2 and 3 which contain information on the process, methodologies and data for fire safety engineering, remains unchanged.

Collaboration has allowed resources to be pooled so the amount of resources provided by each collaborator was only a percentage of what would have been required, if the IFSEG was developed by a single body.

The project has acted as a catalyst for future developments. It is likely that the collaborators will be working together in the near future on other projects that are of mutual interest.

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