

INTRODUCING A PROTOCOL FOR AN INTEGRATED FIRE SAFETY EVALUATION PROCEDURE FOR HISTORIC BUILDINGS

A.G. Copping

Department of Architecture and Civil Engineering, University of Bath, UK

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ABSTRACT

This paper outlines the framework of a protocol for an integrated life and property fire safety assessment procedure for historic buildings in the UK. Traditionally, such procedures have been developed for a single objective of fire safety and not as an integrated assessment. This assessment structure enables the assessor to produce an assessment that will satisfy the requirements of the UK Fire Precautions (workplace) Regulations 1997 amended 1999 for life safety as well as providing custodians of historic property with their own assessment of the vulnerability of the fabric and content to fire.

The procedure described, uses a 'points scheme' method of assessment. Contributions to fire safety are evaluated under 18 different component sections. The degree to which each component is present is determined from information collected in an observational survey. Weightings are established to indicate the importance of each component both for life and property protection. Fire safety levels for life safety and property protection are calculated by the scalar product of the component weightings and grades. Norms for life and property protection are created against which the levels of fire safety are adjudicated. For the assessment of property fire protection account is also taken of the historic value of the building.

This tool is simple in its operation and provides a cost-effective means of fire safety evaluation that is sufficient in validity and utility. It is argued in the paper that as the model is highly portable it could be readily adapted for use in assessing levels of fire safety amongst the huge portfolio of historic buildings in China.

1. INTRODUCTION

There are four recognised objectives for fire safety. These are:

- life safety;
- the protection of the contents of a building;
- the protection of the building fabric; and
- the minimisation of the threat to the environment [1].

In the UK, the principle concern of legislation is life safety, while property protection is largely controlled by the insurance industry. For historic buildings, it may be argued that both life and property protection carry equal importance. Nations around the world have lost and continue to lose considerable qualities of unique historic fabric. Unlike modern buildings, such losses cannot be replaced by insurance payouts. They are essentially irreplaceable national artefacts which are lost forever. In addition to the fire incidents that make national headlines, such as Windsor Castle and Hampton Court Palace in the UK or the Turin Cathedral fire in Italy, fires in historic buildings are commonplace. However, it is very hard to determine the true exact of heritage loss as fire data is selected only on factors that relate to fire cause

and origin and not by historic significance or building age [2].

It is advocated that in order to effectively address the 'dual important' multiple objectives of life and property protection that fire safety strategies need to be developed for historic buildings which balances both the risk to life and property in an integrated holistic package. The protocol described in this paper presents a model which enables an integrated assessment of life safety and property protection to be conducted, which may in turn provide decision-makers with definable data from which fire safety strategies can be composed.

2. THE PROTOCOL

2.1 Fire Safety Evaluation – Options and Methods

A wide range of fire safety evaluation techniques may be used to assess fire safety levels in buildings. These include statistical or probabilistic approaches, hazard analyses using event trees, stochastic computer simulation models and fire risk ranking method [3] otherwise known as a 'points scheme'

approach. This latter method has been chosen for this model.

Essentially a 'points scheme' is a process which enables the judgement on the adequacy of fire safety to be undertaken. Qualitative descriptions of events, techniques and processes are given numerical values assigned by a group of experts in a particular part or combination of parts of fire safety. The output can be summarised in terms of acceptable or not acceptable based on the total number of points scored compared to a stated benchmark. The benchmark enables the assessor to make a decision on the adequacy of fire safety for the whole building or an area of it.

The first forms of 'points schemes' for fire risk evaluation were those developed by insurance companies for calculating insurance tariffs, an example being the Fire Offices Committee (FOC) Tariff System [4]. During the 1960's the chemical industry produced 'points schemes' in the form of the Dow and ICI Schemes for chemical plants [5]. 'Points schemes' were first used for assessing fire risk in specific building types in the 1970's, although the use of applying a 'wise men' approach has been used for many years. The Building Industry National Council (BINC) Means of Escape from Fire evaluation conducted in 1935 is one such example [6].

Various 'points scheme' type models have been applied to historic buildings. These include models by English Heritage [7,8], Mohammed [9], Shields et al. [10], and Watts and Kaplan [11].

The 'points scheme' assessment technique was considered to be particularly suitable for conducting assessments of fire safety in historic buildings for the following reasons:

- The inherent flexibility of this approach makes it useful in the appraisal and upgrading proposals in existing buildings.
- It overcomes the problems of inadequate data, and the integration of qualitative attributes.
- The framework of the technique ensures the results are equable, and that assessments can be both repeatable and reproducible.
- As the values assigned to the components of fire safety are processed arithmetically, the results can be compared with some norm that represents acceptable safety.
- Such an assessment offers an immediate appraisal acceptability and a method for the rapid identification of deficiencies.
- Combined with a knowledge of unit costs for the improvement of components, and of the practicability of improvements, the assessment method is an effective tool in the provision of cost-effective fire safety.
- The output from 'points schemes' can be a very powerful tool in influencing non-technical decision makers about the importance of fire safety and conforming with fire safety guidance.
- The 'points scheme' approach is a cost-effective means of assessment.

2.2 Description of the Integrated Evaluation Approach

The assessment of fire safety is conducted by an expert, knowledgeable in historic building construction and fire safety. Each building assessment takes approximately five hours to complete and consists of an observational and desk-top survey. The assessment is designed to act as an initial evaluation only. Features of the building, which are highlighted as being a high risk receive a more in-depth follow-up evaluation.

The assessment follows the sequence shown in the flow diagram in Fig. 1. The assessor assesses 18 measurable components which are considered to contribute to fire safety in historic buildings. For each component a worksheet is used to guide the assessor to an accurate assessment of the safety contribution of each component for life safety and property protection. Aid-memoirs are presented for each component which helps the assessor consider all the necessary sub-components before making the assessment. Each component is scored between 0 and 5.

The assessed levels of fire safety for life safety and property protection are set against norms which are considered to be the base-line acceptable levels. The norm for life safety is comprised from the prescriptive legislation, the scope and guidance of which for the UK, is detailed in the Fire Safety: An Employer's Guide [12]. For property protection, a best practice document is derived from guidance notes on fire safety in historic buildings. An example of one such guidance document is Heritage Under Fire [13]. For those assessments that score above the norms (or a pre-agreed acceptable level which exceeds the norms) the procedure is complete. The assessment is recorded and conducted again at an agreed date or sooner if a change to the environment occurs. For those scores which fall below the norm level, the procedure requires a review of fire safety deficiencies to take place. This will involve reviewing the performance of the fire safety system. Suitable fire safety upgrades should be sought giving due consideration to both life safety and property protection objectives. After the fire safety

upgrades are complete, another assessment takes place against the norms. If a score continues to fall below the acceptable norm level, the cycle is repeated and another review of fire safety deficiencies is undertaken and further upgrades are carried out until an acceptable level of fire safety is reached.

The scoring system adopted by the integrated evaluation system is illustrated in Table 1. As can

be seen, the 18 components are listed down the left-hand column and for each component, a percentage fire safety contribution for both of the fire safety objectives is provided. The individual percentage contributions (A & C) are multiplied by the grade scores (B & D) and totalled to produce fire safety measures (FMS) for property protection and life safety.

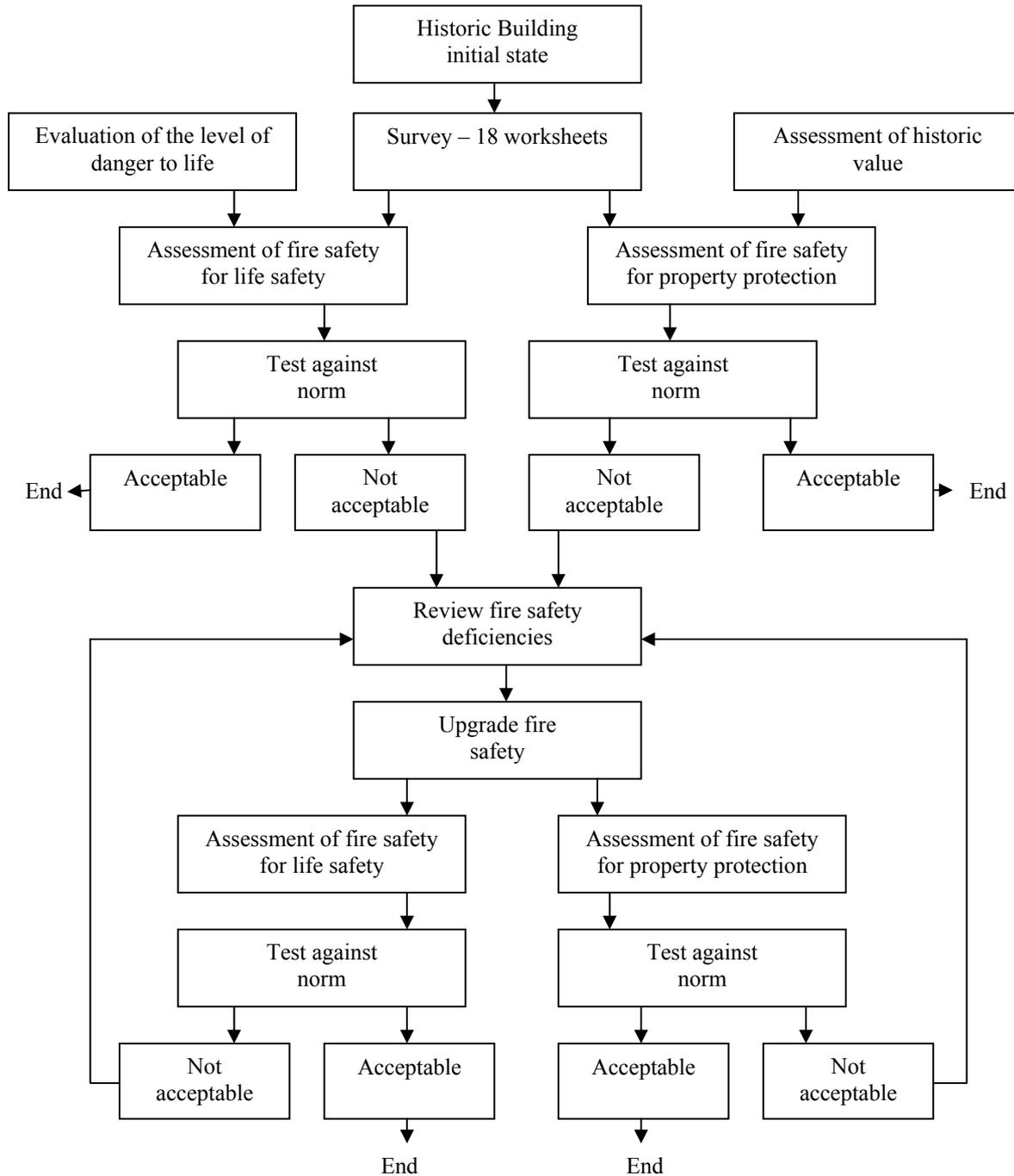


Fig. 1: Integrated fire safety evaluation protocol

Table 1: Sample evaluation summary table

<i>Fire safety measure (FSM)</i>	Property protection			Life safety		
	Components of fire safety	% con. (A) ⁱ	Grade (B)	Total (A x B)	% con. (C) ⁱⁱ	Grade (D)
Access and escape routes	2			12		
Building services	6			5		
Building structure	4			6		
Detection and communication	6			5		
Emergency lighting	2			5		
Furniture and furnishings	5			6		
Fittings and fixtures	5			6		
Housekeeping	7			7		
Interior finishes	4			5		
Manual fire fighting equipment	7			3		
Management systems	13			12		
Passive protection	5			7		
Retrieval training and practice	4			0		
Spatial configuration	1			5		
Security	4			2		
Smoke control	5			7		
Suppression systems	8			3		
The fire brigade	12			4		
	FMS-p			FMS-l		
	<i>Fire vulnerability rating (FVR)</i>			<i>Building life risk rating (BLRR)</i>		
	Statutory listing			Population		
	Average attendance			Familiarity		
	Largest max enclosure			Location		
Overall fire safety ratings	(OFSR-p)			(OFSR-l)		

ⁱ Established by a Delphi group

ⁱⁱ Estimate taken by the author

The FMS scores are then factored with, in the case of the property protection objective, a fire vulnerability rating (FVR) and for the life safety objective, a building life risk rating (BLRR) to produce overall fire safety ratings (OFSR_{p&l}).

The fire vulnerability rating (FVR) is a measure of the impact of the loss of the property and the potential extent of the loss from fire. Three variables are used in this calculation: the statutory listing of the building, the average attendance at the building and the size of the largest enclosure taken as a percentage of the overall floor space of the building.

The building life risk rating (BLRR) is a measure of the level of life risk in the building. It attempts to model (in a very crude fashion) some human characteristics of the population. This calculation considers the population of the building, the mobility of individuals, the population's level of familiarity with building layouts and the location of individuals in the building.

A detailed account of the development of the protocol and the testing of the property protection element can be read in *The Development of a Fire Safety Evaluation System for the Property Protection of Parish Churches* [14].

3. POTENTIAL APPLICATIONS

In the drive for the creation of integrated holistic fire safety strategies, the parallel assessments of life safety and property protection are considered critical. For historic buildings where life and property protection carry equally high importance, the often delicate process of integrating life and property protection measures makes this need even more desirable.

This evaluation procedure combines both elements of horizontal cross-meshing and vertical segregation (The concept is illustrated in Fig. 2). This enables the impacts of fire safety deficiencies on both life safety and property protection to be jointly considered and fire safety upgrades sought which satisfy both objectives. In addition, the cross-meshing elements of the procedure ensures

the assessment is efficient and cost-effective when compared again undertaking two separate evaluations.

The integrated fire safety evaluation procedure has been developed and is being tested on individual historic buildings in the UK. The tool ultimately has the capacity to aid decision-makers in developing fire strategies at both an individual building level and in a multiple-building context, (This may be specific historic buildings types – for example, churches or castles or historic building portfolios owned by one organisation or individual) where the assessment outcomes may be used to rank properties to aid decision-makers in allocating resources. It is in this latter context that the

application of this procedure is seen as having particular appeal and application in Hong Kong and may be other regions of China where the collections of historic buildings are vast. In Hong Kong, similar style ‘points scheme’ have been developed for karaoke establishments [15] and existing tall buildings [16] but not for historic buildings. A recent survey by the Antiquities and Monuments Office in Hong Kong [17] revealed that out of 502 pre-world war II buildings which have been identified as having historical value, only 77 buildings are listed as protected monuments. This protocol, for example, could be readily used to evaluation fire safety levels in the 77 identified protected properties and to provide prioritisation lists in respect to fire safety upgrading.

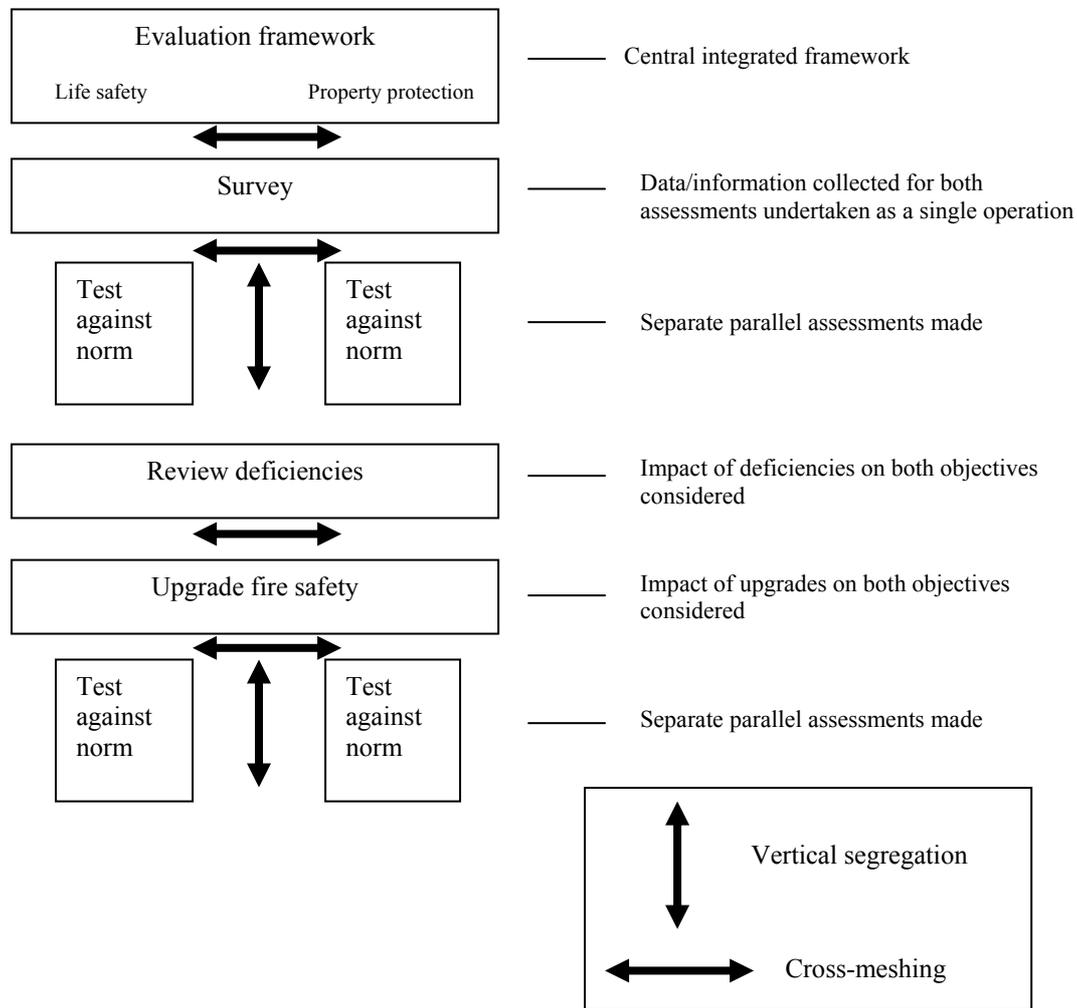


Fig. 2: Horizontal cross-meshing within the integrated evaluation procedure

4. SUMMARY

This paper has presented an outline of an integrated fire safety evaluation procedure for historic buildings. The protocol offers employers working in historic buildings and custodians of historic properties a single assessment procedure from which two outcomes are produced: a fire safety assessment for life safety which will satisfy the requirement of the UK Fire Precautions (workplace) Regulations 1997 amended 1999 and an independent assessment of the vulnerability of the property to fire.

While quantitative approaches to assessments of fire safety remains expensive and data of sufficient quality is not available, systematic 'points scheme' approaches offer reliable, effective and cost-efficient options both for single building and for multiple-building assessments.

Fire engineered solutions and performance-based fire safety engineering can only be successfully undertaken if reliable assessments of both existing life safety and property protection levels can be established. The integrated nature of this evaluation procedure enables a holistic view to be taken when deriving fire safety strategies.

While the tool has been developed and tested in the UK, it is considered that it is readily suitable for application in China particularly in conducting first stage evaluations of large historic building estates or portfolios.

The author would be interested in hearing from anyone who has experience of assessing fire safety in historic buildings in China or has an interest in testing this evaluation procedure in China. He can be contacted at the University of Bath, UK, e-mail: a.g.a.copping@bath.ac.uk

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