FIRE SAFETY ENGINEERING AND THE ROLE OF THE INSURER

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INTRODUCTION

The Institution of Fire Engineers defines fire safety engineering as

> *the application of scientific and engineering principles, rules [Codes], and expert judgement, based on an understanding of the phenomena and effects of fire and of the reaction and behaviour of people to fire, to protect people, property and the environment from the destructive effects of fire.* (Chitty, 2003).

A more succinct definition is

> *the use of engineering principles for the achievement of fire safety*. (British Standards Institution, 2001, 2003).

As an engineering discipline, fire safety engineering is relatively young, and it has been accepted as an alternative means of meeting the functional requirements of the UK Building Regulations (Great Britain, 1985a) since the publication of the 1985 edition of Approved Document B (Great Britain, 1985b).

Research suggests (Wilkinson, Glockling et al. 2010) that fire safety engineering design methods have facilitated architectural design freedoms and supported creative construction allowing the UK, and more specifically London, to continue to develop its reputation as a city of world-class importance. However, it has also become evident that since fire safety engineering has become more accepted, significant concerns have been raised regarding many various elements of the design process including the involvement of the insurer and the ability to champion objectives other than life safety. Furthermore, fire safety engineering almost inevitably leads to a reduction of both active and passive fire protection installed in buildings, which can significantly impact on insurance. This paper investigates the role played by commercial property insurers in the building design process.

METHODOLOGY

This research resulting in this paper involved two stages. Firstly, an extensive literature review was conducted to understand the background to the topic as well as the present day issues. Secondly, in order to fully understand current practice relating to the involvement of the insurance industry within the fire safety engineering design process, a case study investigation was undertaken. The investigation involved a combination of face-to-face meetings and site visits where the individuals were observed undertaking their professional role. The following people were involved in the case study investigation;

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Job title	Employer	Stakeholder group	Role
Property Risk Manager	Major UK commercial insurance company	Insurer	Senior managerial role overseeing surveyors and influencing company commercial property underwriting strategy.
Risk and Insurance Manager	Property portfolio with 33 high-rise office buildings.	End-user client	Senior role responsible for insurance procurement, risk transfer and risk management.
Risk Surveyor and Sprinkler Risk Surveyor	Major UK commercial insurance company	Insurer	Field-based team assessing the acceptability of properties in relation to the insurer's requirements.
Associate	Major fire safety engineering consultant	Practitioner	Experienced practicing fire engineer.

Table 1. Case study investigation participants

This investigation involved a small but high quality cohort, united by their relationship with fire safety engineering of an iconic property portfolio, which represents an interpretive epistemology employing inductive research methods as discussed by Fellows and Liu (2008). It followed a less structured methodology in order to gain richer and deeper information, with the interviewees commenting on their personal experiences. Such commentaries are acceptable as scientific data, as asserted by Brown and Sime (Brenner (Ed.) 1981).

RESULTS

Insurance and Reinsurance

Insurance is one method that businesses can reduce the financial impact of a risk occurring. Whilst holding an insurance policy does not remove a risk, it provides some security should the worst happen (Dickson, 1997). In simple terms, the concept of insurance works as follows. The *insurer*, a business that provides insurance, agrees to take on a risk on behalf of the *insured.* It does this by providing the insured with a *policy*, an insurance contract. Within the policy, the insurer states what risks it has agreed to insure against and what it will pay the insured if the risk happens. The insurer receives a fee from the insured, known as an insurance *premium*. To be included in an insurance policy, a risk must be capable of being measured in monetary terms. It must also be something that is not certain to happen, and the insured must have a direct interest in any loss (Lloyd's of London, 2008a).

Actuarial risk theory is concerned with the application of probabilistic techniques and models to the risk process involved in the operation of an insurance business. The risk arises due to the fact that an insurance company agrees to meet the claims of its policy holders to compensate their losses due to the occurrence of events they insure. The insurer would face ruin during a period if the total claim amount to be paid by the insurer during that period exceeded its assets, consisting of free reserves (capital) and total premiums received (Ramachandran, 1998).

Insurers manage the risks they take on through the process of reinsurance. Reinsurance is an extension of the concept of insurance, in that it passes on part of the risk for which the original insurer is liable. Reinsurance contracts are similar to insurance policies, with the insured being the direct insurer, or the *reinsured.* A contract of reinsurance is between the insurer and the reinsurer only. There is no direct link between the original insured and any reinsurer (Lloyd's of London, 2008b). Reinsurance allows insurers to protect against large claims, such as catastrophic events like earthquakes, as well as increasing the capacity of the direct insurer. There are two basic methods of reinsurance:

1. **Facultative Reinsurance**- specific reinsurance covering a single risk. The reinsurer is reinsuring one insured on a specific policy. Each facultative risk is submitted by the insurer to the reinsurer.
2. **Treaty Reinsurance**- a method of reinsurance requiring the insurer and the reinsurer to formulate and execute a reinsurance contract. The reinsurer then covers all the insurance policies coming within the scope of that contract.

Fire insurance

Fire insurance provides financial compensation for damage due to and consequent on a fire to the owners or occupiers of the premises where this occurred. The compensation is normally for direct material damage (MD) by the fire itself, by heat or smoke from the fire and by water and other agents used to control and extinguish the fire. In addition, business interruption (BI) insurance provides financial compensation for such consequences as loss of orders due to late delivery, loss of key facilities and cost of reorganisation. The extent of these consequential losses may exceed the direct losses (Institution of Fire Engineers, 1989).

Fire insurance in Europe has two roots. In northern Europe, the rise of co-operatives and guilds during the Middle Ages generated the need for mutual protection, and the duties of co-operatives included providing mutual assistance in the event of fire. The idea of sharing the economic consequences of fires across a risk community of property owners was first developed in Denmark (Galey, Kuhn, 2009). The Mediterranean provides the commercial roots for marine insurance which also branched out into property insurance on land, and thus into fire insurance. As early as the 14th century, marine insurance contracts were arranged in exchange for payment in Italian seaports. This is confirmed by the oldest known insurance document- the Genoa policy drawn up in 1347 (Gruss, 1982).

In the UK, the first insurance companies offering cover for property damage and financial losses were set up as a result of the Great Fire of London in 1666. The fire swept rapidly through medieval wooden houses and raged for five days, destroying more than 13000 homes (Read, 1993). By the end of the 17th century, three companies were engaged in providing fire insurance. These London based companies conducted business through a network of local agents, insuring virtually all types of buildings from residential properties to industrial sites. These early insurers set up their own fire brigades to protect the properties they insured (Galey, Kuhn 2009).

Today, fire insurance is provided by insurance companies and by *Lloyd's* underwriters, known as a leading market for specialist insurance. Insurance may be placed directly with a company, or through an intermediary, usually an insurance broker. When a new insurance policy is proposed to an insurer, a fire surveyor will normally visit the premises to be insured to evaluate potential risk from fire and to advise the insured on fire prevention and protection. The fire surveyor prepares a report for consideration by the insurer's underwriter. The underwriter decides on the acceptability of the insurance and the premium to be charged according to the conditions described by the fire surveyor (Institution of Fire Engineers, 1989). This process is described in greater detail below.

Underwriting

Insurance underwriters evaluate the risk and exposures of potential clients, decide how much coverage the client should receive and how much they should pay for it. Underwriting involves measuring risk exposure and determining the premium that needs to be charged to insure that risk. Essentially, underwriting is the process of issuing insurance policies. The acceptance or rejection of risk is based on a prescribed capacity concept and is normally performed in accordance with organisational guidelines (Galey, Kuhn 2009). Fire underwriters perform a task which Galey (2009) describes as difficult, extensive and important, especially in industrial and large-risk business. He identifies the following individual responsibilities;

1. Gathering background information at the enquiry stage, with site survey from a specialist risk engineer, if appropriate;
2. Scrutinising insurance application;
3. Checking *objective* risk features such as type of operation, type of construction, separation, fire protection measures, exposure to natural perils, etc;
4. Understanding the *subjective* risk aspects, such as claims history, reputation, etc;
5. Checking the technical insurance conditions, sums insured, limits, deductibles, warranties, exclusions, etc;
6. Basic accept or reject decision;
7. Determining the costing for the insurance policy, in order to maintain a *self-supporting* risk portfolio, i.e. aggregate premiums exceed claims expenditure and costs in that year.

Two loadings are generally imposed on the risk premium when calculating the total premium payable by the insured. The first is known as a *safety loading* and the second is an *administrative loading* to cover the insurer's operating costs which include profits, taxes and administrative expenses. The premium rate should also be adjusted for any self-insurance (deductible) agreed between the insurer and the insured. When a deductible is introduced in an insurance contract, the insured is expected to take greater interest in adopting loss prevention and reduction measures. With adequate fire protection, particularly sprinklers, the insured can take the risk of accepting a large deductible which will minimise the total cost of insurance and protection. In order to promote this concept, it is necessary for the insurance company to establish statistically sound rebates on insurance premiums for different levels of deductibles, taking sufficient account of the reduction in loss due to a fire protection measure (Ramachandran, 1998).

It is customary to use estimates of expected loss under different conditions in data for estimating premiums. Some definitions of loss expectancy are listed in table 1 (Rasbash, Ramachandran et al. 2004). The association of the loss with the failure of items of fire safety defence allows quantification of the probabilities of the loss occurring.

Term	Definition
Maximum possible loss	Financial loss that would occur under catastrophic or extremely unfavourable conditions (failure of two or more protection systems, active and passive)
Maximum probable loss	Maximum financial loss under normal conditions, for example one protective system failing.
Estimated maximum loss	Usually expressed as percentage of value of building under consideration; see full definition below.
Normal loss expectancy	Financial loss under average operating conditions- all protective systems operational.

Table 2. Loss expectancy definitions. Adapted from Rasbash, et al (2004)

Estimated Maximum Loss (EML) is the loss expectancy definition commonly used in the UK. The London Insurance and Reinsurance Market Association define EML as

> *an estimate of the monetary loss which could be sustained by insurers on a single risk as a result of a single fire or explosion considered by the underwriter to be within the realms of probability* (Rigby-Smith, 1995).

During the case study investigation interviews, it was confirmed that underwriters are interested in five key issues when writing insurance policies;

1. EML- the calculated worst case scenario,
2. The materials the building is constructed from,
3. The attitude of the insured to risk improvement, and housekeeping,
4. Hazards to which the building is subjected, including external exposures such as deliberate fire setting,
5. Protection measures included within the building.

It is also understood that the geographical proximity of other properties being insured by the company is considered so as to limit their exposure within a defined area. However, it is the EML calculation is the most important factor for the underwriter. Within the firm investigated, surveyors will comment on EMLs as part of the survey and provide a percentage EML for buildings, contents, and business interruption where requested by underwriters. However, the final decision on the percentage EMLs to use to calculate exposures rests with the underwriter, although the underwriters must assess the EML on the information provided by the Risk Adviser. Where in the opinion of the underwriter, the EML is significantly different than that suggested by the Risk Adviser; the underwriter would discuss their rationale with the surveyor for agreement. It was suggested that the fundamental reasons for calculating the EML of a risk are:

- To ensure that the firm underwrite to their maximum capacity, which would not necessarily be the case if acceptance was based purely on the sum insured.
- To avoid over-exposure, i.e. writing above the firm's acceptance level.

Surveyors often express EML as a percentage. An increase in sum insured will generally not alter the percentage unless there is a significant change in the risk. However, a simplified list of factors to be taken into consideration when assessing EML, as defined by the Insurance Institute of London (Rigby-Smith, 1995), now part of the Chartered Insurance Institute is as follows;

- Size, height and shape of area potentially exposed to a single fire or explosion.
- Construction of roof, walls and floors.

- Presence of combustible linings to walls, roofs, ceilings and partitions.
- Nature, distribution and combustibility of contents (fire load).
- Use of hazardous processes and substances and their degree of separation.
- Susceptibility of contents to damage by smoke, heat and water.
- Risk of explosion from any source.
- Hazards arising from gases or corrosive materials.
- Concentrations of values within a small area.
- Standards of management and housekeeping.

Similarly, the Insurance Institute of London (Rigby-Smith, 1995) defines factors which should NOT be taken into account when assessing an EML;

- Any horizontal separations.
- Fire resisting doors.
- The absence of any normal source of ignition.
- The existence or installation of fire detection, prevention or extinguishment arrangements including sprinklers and the adequacy or otherwise of Fire Brigade facilities.

Insurance EML is also of importance to reinsurers. Whilst reinsurers do not impose any underwriting or risk acceptance standards on their insurer clients, they do like to understand the insurer's approach in general terms, such as EML philosophy, and they periodically visit the insurer to gain a better understanding of the risk management undertaken with the insureds.

Risk management

Within the framework of loss prevention, insurers and reinsurers have long been analysing the quality of the risks they insure, and options for improving the quality of the portfolio. Loss prevention has a direct impact on the prices, terms and conditions in the sense of risk-adequate rating and is the basis for profitable business (Schadenspiegel, 2007). In order to assess and control the likelihood and magnitude of these risks, insurers have their own technical standards giving requirements for constructional measures, fire protection equipment and methods of work (Bickerdike Allen Partners, 1996). These standards are often used as benchmarks against which a building and its contents can be assessed. During his interview, the insurance Property Risk Manager revealed that his firm undertake between 35000 and 40000 surveys each year at properties they insure. By discussing the role of the Risk Adviser, it is apparent that insurers have a big commitment to active risk management and loss prevention activities in order to maintain and improve their portfolio of risks.

However, insurance is a profit-generating business and is affected by economic considerations. In a soft insurance market there is much competition between insurance companies for premium income in order to invest the capital profitably on the stock market. This desire for premiums can override the need for stringent risk control, an attitude which in time must result in bad loss experience. This in turn leads to an increased emphasis on loss prevention and risk improvement and then the market hardens, i.e. insurance is more difficult to obtain unless insurers requirements are met, when the stock market is depressed (Bickerdike Allen Partners, 1996). In addition, an insurer may accept bad risks as part of a Broker-presented portfolio.

Fire safety engineering design process

A framework for a fire engineered approach to building design is described in BS7974-0 (British Standards Institution, 2001) and illustrated in figure 1, below. Clause 4.1 of that Code divides the framework into three stages;

1. Qualitative design review (QDR) where the scope and the objectives of the fire safety design are defined, and where performance criteria are established and acceptance criteria set;
2. Quantitative analysis, where engineering methods are used to evaluate potential solutions; and
3. Assessment against criteria, where the results of the quantitative analysis are compared against the acceptance criteria.

It is suggested in BS7974-0 that the QDR team on a major project *might* include a representative of the approvals body and/or the insurer. However, the insurance industry sees this as an important stage in the building design phase and suggests that, wherever practicable, the insurer *must* be invited to join the QDR team (Fire Protection Association, 2008).

The objectives for the fire safety design are discussed and described in the QDR process. Objectives of fire safe building design are defined as life safety, property protection and continuity of operations (Cote, 2004). Life safety objectives are those mandated in the UK Building Regulations (Great Britain, 2006) and are often achieved by providing systems for early warning of fire, extinguishment of a fire and proper egress for prompt exiting from the building. Property protection is not a mandated objective, but is of concern to insurers. It can be achieved by installing fire extinguishing systems, by providing compartmentation features to confine or limit fire spread within a building, and by constructing the building of materials that resist fire development. Similarly, continuity of operations objectives are not mandated, but of interest to insurers. It considers the specific and unique functions of the building and its contents and is best accomplished through the installation of automatic fire extinguishing systems and by ensuring duplication of the 'unique' function, either within the building under consideration, or elsewhere. Within the BS7974-0 framework, support is given to the consideration of property protection and continuity of operations objectives. Clauses 6.3.1 and 6.3.3 state that;

> *The fire safety objectives that might typically be addressed in a fire safety engineering study [include] loss control…It might be desirable to take measures to reduce the potential for large financial losses…Consideration may be given to minimise damage to the structure and fabric of the building, the building contents, the ongoing business viability, the corporate image.* (British Standards Institution, 2001)

Therefore, to meet the requirements of the insurance industry, the fire safety objectives of the QDR *must* include property and business protection matters, to the extent determined by the agreed acceptance criteria.

The insurer's role

Although the process described in the preceding section describes how a recognised and well used fire engineering design process allows for insurer involvement, the reality may be very different. Recent research suggests that insurers do not play an active role in the fire engineering process, and when they do, their poor levels of knowledge and understanding precludes any meaningful interaction (Wilkinson, Glockling et al. 2010). The interview with the insurance Property Risk Manager confirmed that his firm do not often get involved in the building design process, citing less than 10 percent of their property risk portfolio having had insurer input at design stage. Although he believes there is a good understanding of fire engineering, and its potential implications to the insurance industry, he explained that there could be numerous reasons why insurers do not appear to get involved. As approximately 90 percent of his firm's commercial property insurance comes to them via brokers. It could be that the broker hinders good communication between the insurer and the client's design team.

Further research suggests another reason for poor insurer engagement. It is not the case that insurers don't want to get involved in the fire engineering design process but, more often than not, they are not invited to do so, or are only invited to get involved at a very late stage, merely to 'rubber-stamp' the design decisions (Barrett, 2010).

Although there is some reluctance from the fire engineering design community, there is also evidence that some designers are keen for more insurer involvement. One responsible fire engineer says that they consult with insurers on the majority of their projects (Barrett, 2010).

The insurance company Property Risk Manager was able to list some examples where his firm had contributed in the building design process, and even influenced significant changes in terms of installed fire safety measures. However, these 'successes' are often limited to very prescriptive type messages, such as 'put in sprinklers', a point echoed by recent research (Wilkinson, Glockling et al. 2010).

The interview with the insured's Risk and Insurance Manager described how the insurer was recently invited to participate in a QDR process as part of the design of a transport interchange within their site. The fire safety engineering consultants invited the client and the insurer to discuss the development of a fire strategy for the station design. The insurer was able to convince the client and the fire safety engineers that the addition of fire sprinklers within voids over false ceilings within the retail areas of the station would be a prudent investment, based on the insurers experience of fire related losses. This anecdotal example illustrated good practice where a responsible fire safety engineer had involved an experienced insurer and the result was the inclusion of additional fire suppression features. However, it also illustrated the limitations of insurer involvement as the discussion simply concentrated on the prescriptive solution, rather than discussing any performance-based objectives. The insurer is also aware that if they try to impose their requirements too forcefully, the end-user client, or their Broker, may seek an alternative insurance provider.

The interview with the insurance company's Risk Adviser and Sprinkler Risk Adviser revealed that when invited to survey fire engineered buildings, insurance risk surveyors are aware of the physical differences when compared to code compliant properties. They described how they give more consideration to potential fire inception hazards, the distribution of fire load and the potential for fire spread, especially when novel construction materials or design features are encountered. However, this approach is reactive, i.e. surveying the constructed building, rather than active, i.e. being an influential part of the design process.

It is clear that even with the best intentions, whether the insurer is involved in the design process or not, the current approach is not effective and the robustness of the fire engineering design suffers.

Despite a small number of minor examples, it is clear that the insurer does not play a suitably active role in the building design process, nor do they command sufficient influence. This is due to a number of reasons, including;

- Commercial property insurers are often not identified at the conceptual design stage and are therefore not able to participate.
- If a contract works insurer is appointed, their priorities are quite different with their focus is concentrated on the construction process, rather than the occupied building.
- Insurance brokers acting as the intermediary between insurer and insured can mean that any opportunities to be involved with design are missed;
- In a soft market, insurers are less inclined to insist on costly fire protection measures when they are competing for income premium against other insurers, and are therefore less likely to want to participate in the design process, or fearful of losing the client;
- Fire engineering designers are often reluctant to invite insurers into the QDR process for fear of the project incurring costly fire protection features in addition to the mandated life safety requirements.

CONCLUSIONS

This paper involved two research elements, a literature review to understand the concept of insurance, and a case study investigation to discover the involvement and motivations of insurers in the building design and construction process.

It has become apparent that, at least within the largest insurance companies, there is an understanding of the differences between prescriptive, ‘code-compliant’ buildings and performance-based, ‘fire engineered’ buildings. There is an acknowledgement that processes within insurance underwriting for fire engineered buildings should take account of these differences in risk, and examples have been cited.

However, despite a small number of minor examples, it is clear that the insurer does not play a suitably active role in the building design process. This is due to a number of reasons.

Insurers display a big commitment to risk management of the properties they have a financial interest in, but appear to lack the skills, and sometimes the will or authority, to commit the same effort when properties are being designed.

Fire engineering is a technique which supports innovative architectural design, vital to sustaining modern Britain. However, the probable inevitable outcome is that more buildings will suffer greater material damage and business interruption without early insurer involvement in the design process. It would be naive to assume this will not have an impact on insuring such buildings.

FURTHER WORK

This paper is part of a wider project that is being conducted as an Engineering Doctorate research topic funded by the Engineering and Physical Sciences Research Council (EPSRC), administered by the Centre for Innovative and Collaborative Engineering (CICE) at Loughborough University and sponsored by the Fire Protection Association (FPA).

Further projects and papers will focus on;

- Fire safety engineering as a tool for business and property protection. To review current practices for ensuring and to develop better methodologies for ensuring business and property protection objectives are met in the fire engineering design process.
- Insuring fire safety engineered buildings. To understand the methods used to calculate EML values for traditionally designed and constructed buildings; to establish methods for commercial property insurers to quantify financial exposure when insuring buildings subject to fire safety engineering design and ongoing maintenance requirements; and to formulate insurance premium calculation tools for fire safety engineered buildings.
- Fire safety engineering: Proposals for change. To propose changes to fire safety engineering methods, codes and regulation; to change the way insurers and post-loss investigators consider and challenge fire safety engineering proposals, buildings and subsequent fires; and to improve engagement between the design community and the commercial property insurance industry.

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