COST Action C26
"Urban Habitat Constructions Under Catastrophic Events"
Malta, 23-25 October 2008

Fire Engineering in the UK
A Fire Officer's Perspective

Steve Beckley
Chief Fire Officers Association and
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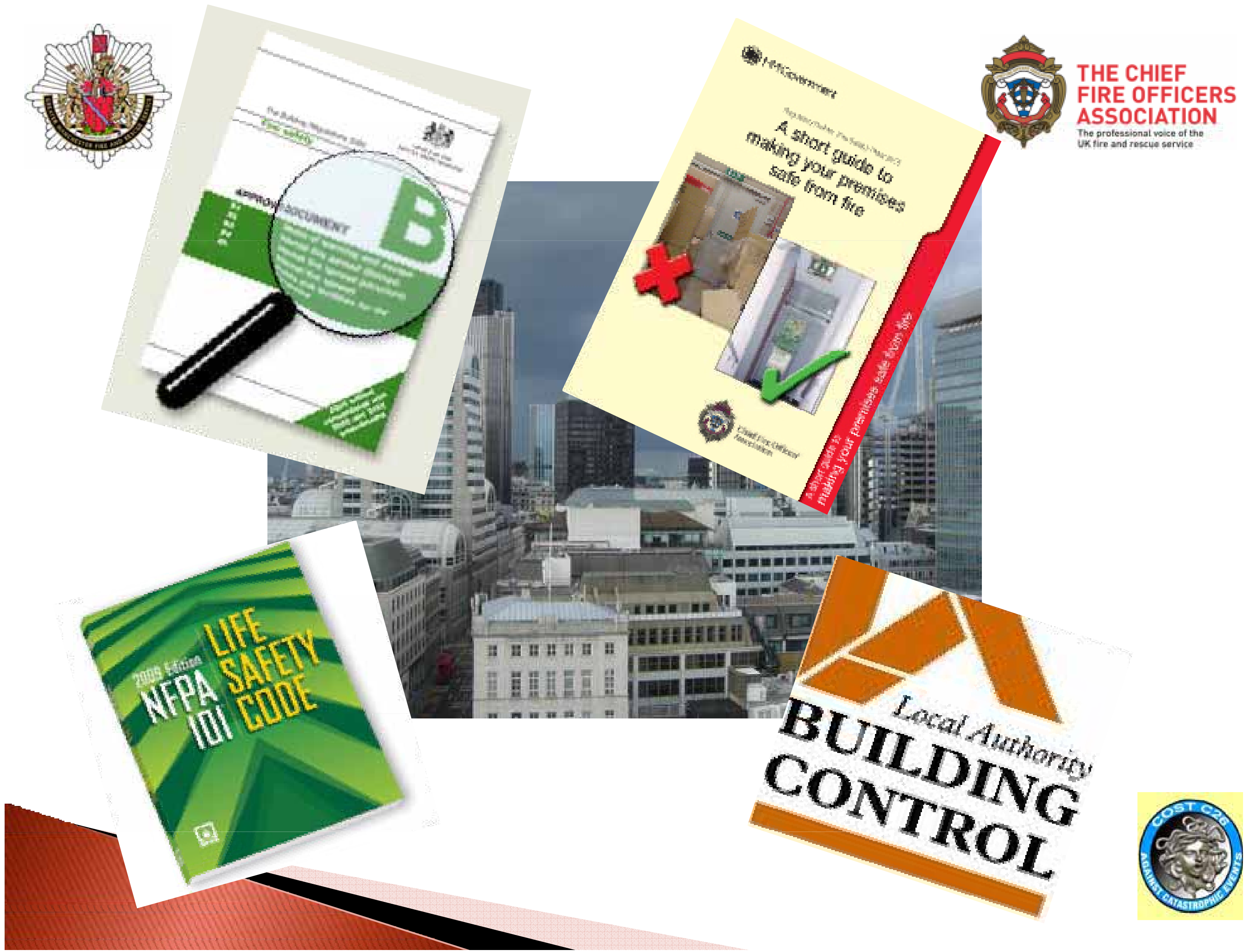
United Kingdom

THE CHIEF FIRE OFFICERS ASSOCIATION
The professional voice of the UK fire and rescue service

On Nov. 18, 1987, a flash fire engulfed an old wooden escalator at the King's Cross underground station. Thirty one people perished in that disaster. Pictures Courtesy of London Fire Brigade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The professional voice of the
UK fire and rescue service
APPROVED DOCUMENT
B
A short guide to
making your premises
safe from fire
2009 Edition
NFPA
101
LIFE
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BUILDING
CONTROL
COST C26
AGAINST CATASTROPHIC EVENTS

The Bad? - Ryugyong Hotel, Pyongyang, North Korea. Built in 1992 and still unoccupied

The Good? The Sanyo Solar Arc, Gifu, Japan

The Ugly? The Barbican Centre, London

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Testing does not always predict how a component will perform in a real fire

Small scale fire tests are important but have their limitations

Large scale fire tests are expensive

Sandwich Panels are in use for all building types but must be correctly specified and installed

The Edge, Salford. Fire spread up the outside of the building in 30 seconds due to flammable cladding

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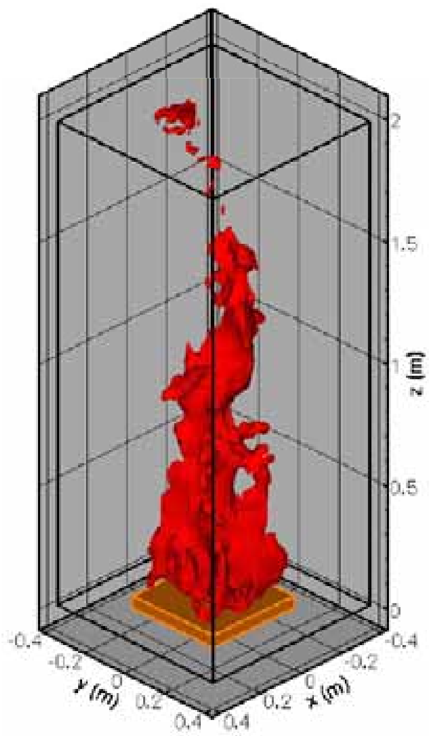
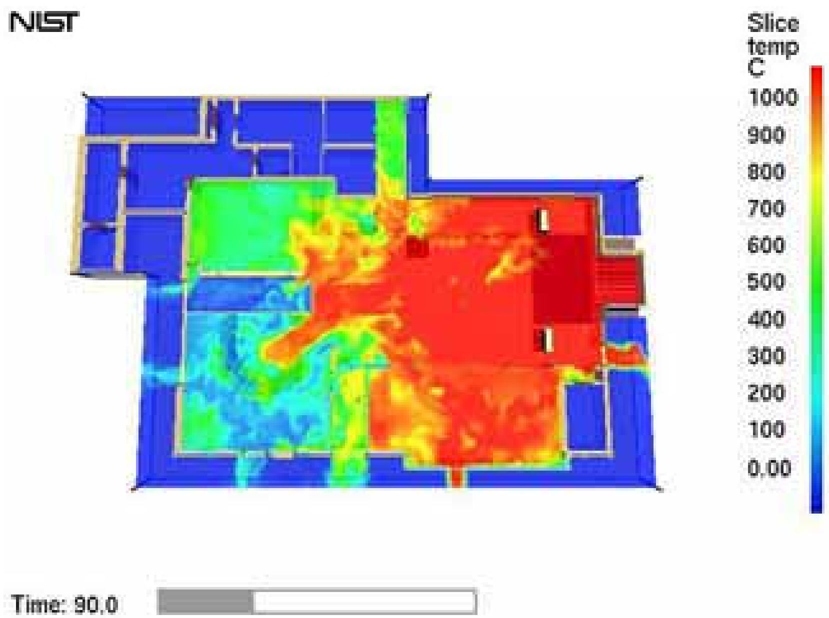


Computer fire modelling can be very useful and cost effective but still has limitations.



The Trafford Centre, Greater Manchester. With smoke control and sprinklers.

A Timber Framed Building. The fire in the wall cavity destroyed the building. Caused by brazing a copper pipe

**Collingdale Fire, London.
Timber Framed Building
under Construction.
Took just a few minutes
to burn to the ground**

The Betham Hilton Tower, Manchester. High rise buildings present challenges for firefighters during construction and when completed and occupied.

Firefighters are trained to spot signs of impending collapse in traditional buildings

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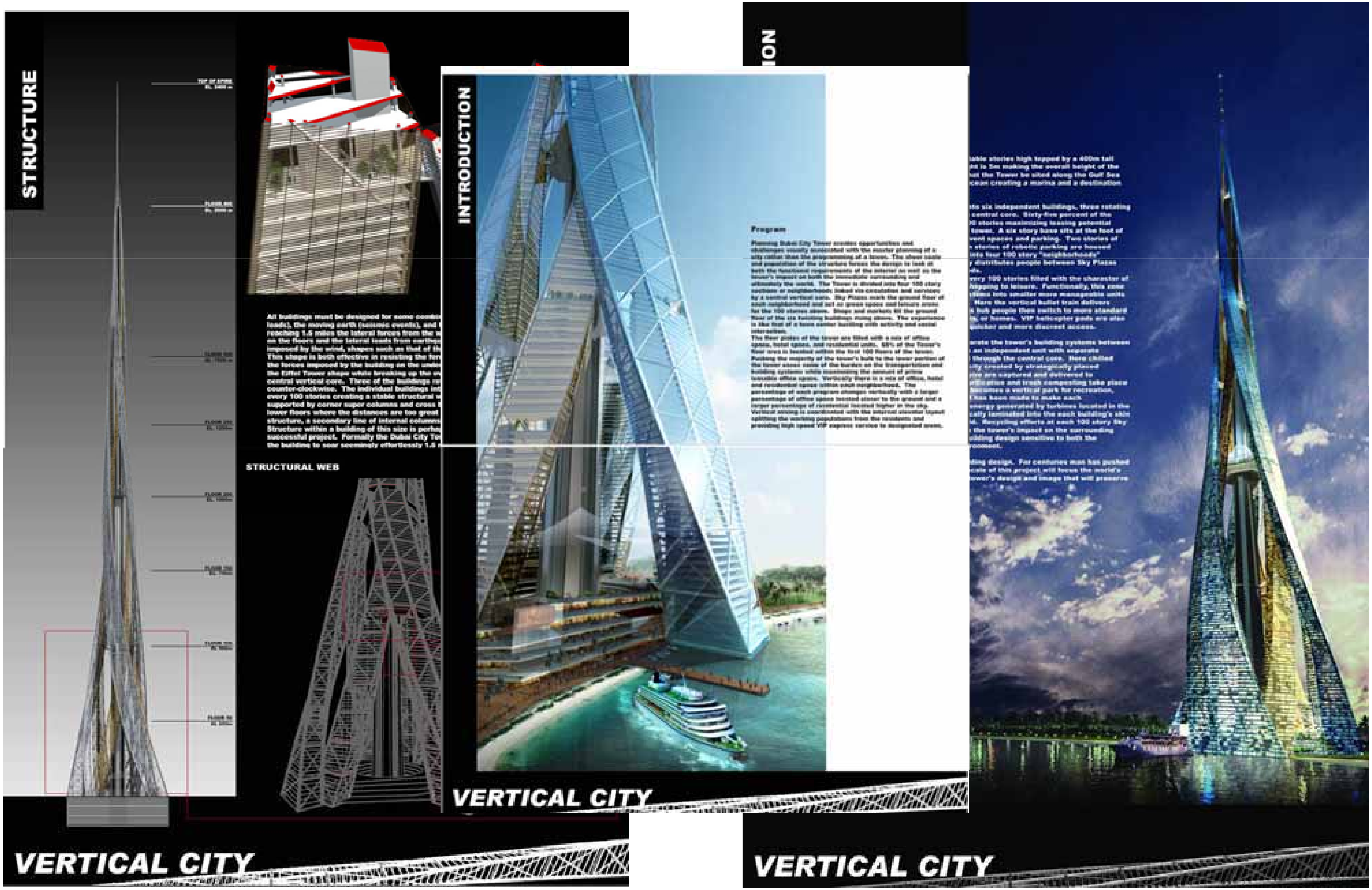
Modern construction methods present dangers to firefighters and signs of impending collapse may not be clearly evident.

COST C26 AGAINST CATASTROPHIC EVENTS



Future Plans for a new Tower in the middle east – 2.4 Kilometres high!

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Thank You

Steve Beckley
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COST Action 26 International Symposium
Urban Habitat Constructions Under Catastrophic Events
24th to 26th October 2008
Department of Building and Civil Engineering
University of Malta

The Application of Fire Engineering in the UK – A Fire Officers Perspective

Assistant Chief Fire Officer Steve Beckley
Chief Fire officers Association and
Greater Manchester fire and Rescue Service

Title Slide: Application of Fire Engineering in the UK

Ladies and gentleman
Many thanks for inviting me here today to speak at the COST Action C26 International Symposium. I am honoured to be asked to speak in front of a gathering of such powerful minds, all working hard to understand how buildings behave when subject to the extraordinary stresses that arise during catastrophic events. Although my main reason for being here is professional, I have always wanted to visit this beautiful island of Malta and therefore your invitation was doubly welcome.

I have been a fire officer in Greater Manchester Fire and Rescue Service for almost 28 years and have witnessed time and time again the devastating effect that fire can have on buildings and human beings. In that time I have seen the number of people killed in fires in the United Kingdom plunge from almost 1,000 when I first joined the fire service to 447 in 2007. Whilst one fire death is one too many the dramatic reduction is, in no small part, due to improvements in the quality of the built environment driven by sound research and development.

In most countries of Europe, the Fire Service are not only responsible for dealing with the effects of fire in buildings but they are also responsible for ensuring that buildings are safe places to live work and visit by enforcing appropriate standards of fire precautions. Quite often our requirements will cost money over and above the minimum requirements for a buildings core function. Also, facilities for assisting firefighters should they be called to fight a fire at the building are often seen as an additional expense with no potential for a return on the investment. Research therefore plays a very important part, not only in convincing all stakeholders of the need for improved safety but also by developing ways of achieving appropriate standards in a cost effective way.

Slide 2 London Underground Fire and another major fire

Fire is an unforgiving phenomenon. If we make small mistakes the consequences can be dramatic and tragic. In spite of the hard work of people like yourselves, I believe we still have much to learn about fire and the impact it can have on buildings and after every major loss of life in a building some new learning emerges in relation to fire behaviour. I also believe that the outcomes of research and testing are often misunderstood and occasionally deliberately misrepresented in an attempt to prove that a fire safety strategy and fire risk assessment for a building is suitable and sufficient.

The risk of fire exists throughout the entire life of a building and should be at the forefront of a designers mind at the conceptual stage, even before the first line is drawn on plans. Quite often the risk of fire is considered too late and this results in conflict between the designer, the developer, the builder, and the enforcers of regulations such as the fire and rescue service. The fire strategy must also be developed in harmony with the ongoing use of the building if it is not to be compromised when occupied.

Slide 3 ADB, Building Regs UK, RRO, and other standards

All countries in the European Union have regulations in place to ensure that buildings are constructed and subsequently maintained and managed to certain standards supported by codes of practice. If architects comply with these standards we can generally be reassured that the building will deliver an acceptable level of safety. Alternatively, designers may adopt other acceptable standards for example NFPA 101. Good design can however be significantly compromised by poor standards of construction or where the wrong construction products are specified. Even where a building is designed and constructed to the highest standards, this can all be undermined by poor management once it is occupied.

In the UK, Codes of Practice supporting building regulations, for example Approved Document B, which deals with fire safety, provide a benchmark for architects and designers who choose to be more innovative, and take the bold option of not following the traditional route of complying with the codes of practice, instead adopting innovative concepts where design and functionality take centre stage resulting in exciting and in the designers eyes at least, aesthetically pleasing buildings.

Slide 4 The good, the Bad and the Ugly buildings.

This is when architects and designers call on fire engineers to develop solutions to ensure that the building, when occupied, is at least as safe as an equivalent but more traditional code compliant building. Fire Engineers will often use complex calculations to predict how building systems, structures and people will behave in fire. Many of these assumptions are based on sound evidence derived from studies of real fires and extensive practical testing. However, I remain concerned that the assumptions made by **some** fire engineers may be flawed and may fail to stand up to close scrutiny. For example, research into human behaviour in fire is relatively limited, and by its very nature, extremely difficult to research in a controlled environment; therefore can we really make accurate assumptions in relation to the speed in which a building can be evacuated when a fire occurs? Predictions in relation to fire size and growth are also difficult to accurately assess. As these two elements form the basis of any fire strategy for the building there is a very high level of responsibility on fire engineers to do their very best to develop a credible solution using data derived from high quality research.

Slide 5 Pictures of Fire Tests – small scale and large

One important area of work for researchers is to consider how fire testing can be used (and abused) to determine the safety of a building. The use of full scale fire testing to determine how buildings behave in fire is extremely important but also very expensive and I believe the EU and European governments must fund such research and make best use of some of our fantastic academic institutions to expand our knowledge. Small scale fire tests are more cost effective and they have their value but must be used with extreme caution when predicting how a building or an element of a building will behave in a real fire.

The testing and certification of construction products is a vital part of the quality assurance systems for safe buildings. Fire Tests conducted on building components, such as fire door sets, columns and beams, establish minimum standards for use in certain situations and also provide useful comparisons between products. They do not however always provide an accurate indication of how the component will behave in a real fire. This is because the environment where the component is installed may differ significantly from the original test environment and an individual component may form just one element of a buildings fire safety system. The interrelationship between components and the quality of installation and ongoing maintenance can be more important than the performance of each individual product. This is particularly the case in complex fire engineered buildings where a number of passive and active components must work together.

Developers must bear in mind that construction products which are deemed to be compliant due to test certification may therefore not be fit for purpose when installed and it is extremely important that the practical use of the building is considered. It is not sufficient to simply consider the overall purpose group, the developers must also consider how, in practice, the building is likely to be used and the fire risks that may be present.

Slide 6 Sandwich panel buildings - fire and no fire.

For example insulated sandwich panels can present significant risks, especially for firefighters if they are not installed correctly or the wrong type of panel is used for a particular application. When specified and fitted correctly, sandwich panels can be a very safe and effective product and are extensively used for external and internal applications, often in food processing warehouses, but also common in many other building types. However, certain sandwich panels present major risks when the building is involved in fire even though the panels, often incorrectly quoted as non combustible, have a Class O surface spread of flame rating. Some types of panel have a flammable core which, when heated give off massive quantities of flammable gases and, if ignited due to exposure of core, will burn rapidly, and at extremely high temperature.

Slide 7 The Edge, Salford

Other similar cladding systems can also present unforeseen risks when involved in fire. At one incident at a residential building in Salford, a City adjoining Manchester, we were faced with a partially occupied high rise building still under construction. The external facia of the building was covered with a cladding system that complied with all applicable standards, however, during construction, a fire occurred outside the building at low level and spread vertically from first floor to roof in 30 seconds. With the combustible lining of the cladding exposed it provided the fuel for the spread of fire and the timber floor of the balconies sustained the burning. Fire then entered the building at five different levels, involving residential apartments and the roof. The building complied with all the necessary regulations and all occupiers and construction workers were able to make their escape but firefighters were then faced with dealing with a very challenging fire. The assumption at design stage was that there was no possibility of ignition on the external face of the building therefore the combustible lining presented no risk! Similar cladding systems are being fitted on many high rise residential buildings with balconies where flammable furniture, small barbeques and other sources of ignition are becoming increasingly common. Developers MUST therefore take into account the use of the building when specifying any construction product.

Slide 8 Computer modelling

I have already mentioned the high cost of large scale fire tests and computer modelling is increasingly being used by fire engineers to predict fire growth and smoke movement in buildings. Early versions of some fire modelling software were developed from calculations derived from heating and ventilation systems but in recent years the technology has moved on considerably and when used by appropriately qualified and experienced people who understand their limitations and can apply the results responsibly, these tools can be very valuable and have proved to be quite accurate when subsequently compared with large scale fire tests and real building fires. However, even computerised fire modelling can be quite expensive, using very powerful computers to run different fire scenarios. Yes, there are some less expensive versions of fire modelling software available which can be useful in limited applications. However, if used inappropriately they can be misleading and when making predictions based on data extrapolated from relatively small scale fire tests, where the input parameters are incorrect or simply where the software is used way beyond its design limitations, there is significant potential for error.

This presents a challenge for the authorities responsible for ensuring innovative buildings are designed and built in accordance with the relevant national standards. Enforcing authorities must confirm the validity of the assumptions made by fire engineers and quite often, in the UK, the Building Control Authority will rely on the Fire Service to comment on fire safety provisions. I am fortunate that some of my officers are qualified fire engineers although there are many fire services in Europe who do not have access to such expertise. It is therefore common for enforcing authorities to seek independent third party validation and these quality control measures have proved to be quite effective, allowing designers to create some absolutely stunning buildings that are also very safe.

Slide 9 Trafford Centre with smoke control, sprinklers and structural fire protection

Traditional design concepts rely heavily on passive fire protection using the structure to separate the fire from the occupiers giving sufficient time for escape. Codes of practice include minimum standards of fire resistance, maximum travel distances and early fire detection and warning as the basis for designing a safe building. It is relatively easy for a fire officer to inspect and audit this type of premise to ensure they remain safe from fire. It is also relatively simple for the occupier to maintain the fire precautions. Buildings with Fire Engineered solutions take a different approach, predicting the most likely fire scenario, considering the fire growth and the smoke movement as well as some predictions of how the occupants will react. As I have already said, these buildings will have a combination of passive and active systems working together to provide a fire safe building. Quite often the inter-relationships between the components of a system will not be understood by the occupier or sometimes for that matter the fire officer attending a fire in the building.

Ongoing management and maintenance of these buildings is therefore more challenging and fire officers must be highly trained not only to deal with fires in such buildings but also in order to carry out inspections and audit the fire risk assessment. The person responsible for the building when it is occupied must therefore be provided with all the relevant information to allow them to maintain the building throughout its life and they must also be competent to understand the fire strategy and be in a position to advise the fire and rescue service in relation to the facilities in the building. Buildings such as the Trafford Centre in Greater Manchester, incorporating shopping malls, restaurants and mixed leisure facilities are now replicated in every major city of the world. The fire engineering for these types of buildings, predominantly using sprinklers and smoke control systems is now so common that it is becoming almost traditional!

Which leads me to the issue of sprinklers! The single most effective way of ensuring that a building and its occupants are safe from fire is to prevent the fire in the first place, but other than in the most sterile of environments, it must be assumed that a fire is likely to occur. The next best option is to control the size of the fire. Some fire engineers attempt to include the fire and rescue service response in their fire strategy but this is not an acceptable approach in the UK. You will not be surprised that I am a strong advocate for automatic fire suppression systems, the most common of which are water sprinklers. I firmly believe that due to their reliability and the many years of data from fire tests and real fires that any designer should start with the assumption that the building will have sprinklers fitted. From this starting point the fire engineer can predict the fire size and likely smoke movement with some accuracy and the design freedoms are then almost endless. By allowing compensating features such as reduced fire resistance, extended travel distances and fewer staircases, the overall cost of a sprinklered building can compare favourably to a building without sprinklers. Sprinklers also significantly simplify the ongoing fire risk assessment of the building throughout its life and make it much safer for firefighters.

So, designers, architects, fire engineers, researchers and enforcing authorities have worked together to ensure that a new building will be safe if there is a fire. So now we move to the next and equally important phase of the building – its actual construction. With innovative building design becoming increasingly common and the development of new building systems to meet the designers aspirations and to cut costs for the developers, the issue of quality control and ongoing maintenance is increasingly important.

Slide 10 Worsley Residential block fire

I will use a relatively simple example of where poor quality control can have devastating implications. A residential block in Worsley near Manchester was built with a timber frame. Timber framed houses are quite common but this method of construction is now being increasingly used in larger buildings. When finished, the building looks no different to a traditional cavity wall building. Due to the potential for fire spread through the cavity affecting the stability of the structure, non combustible linings are installed. In this particular case the lining does not appear to have been installed correctly and fire spread throughout the entire cavity and resulted in a total building loss. Firefighters could not get access to extinguish the fire which is believed to have been started by a plumber brazing a copper pipe from the outside of the building!

Slide 11 Collingdale fire

Timber framed buildings under construction also present major risks for construction workers and challenges for firefighters due to the rapid fire spread and loss of structural stability when involved in fire. Poor management of the site during construction can lead to total building loss in minutes as was the case in the Collingdale fire in London.

Slide 12 High Rise building under construction – Betham tower

Other buildings under construction also present firefighters with major challenges. High rise buildings are provided with firefighting shafts, lifts and wet risers to assist them in fighting a fire at high levels. During construction most of these facilities are inoperable and should a major fire occur it is highly unlikely that firefighters would be able to extinguish it. The fire load during construction can be significant with many buildings using timber shuttering and the fitting out of the areas to be occupied often commences before the firefighting facilities are fully functional. Even where sprinklers are specified they are rarely connected until late in the construction phase.

Slide 13 Large Mill Fire

Traditional construction methods produce buildings that when completed behave in a relatively predictable manner when involved in fire and firefighters have relied on some basic signs of impending collapse to ensure safe systems of work. For example bulging walls, spalling of brickwork, dropped arches, and cracks in brickwork over beams and lintels. However, modern construction products and building systems are now so varied and often hidden from the naked eye or disguised to look like traditional construction that firefighters have increasing difficulty in predicting the behaviour of a building in fire.

Many major building projects make extensive use of reinforced concrete suspended from an inner core, rather than using the external walls to support floor joists.

Slide 14 Betham tower completed

The external facade of the building is then clad with decorative panels such as glazing, quite often fitted from floor to ceiling. The structural stability and fire performance rating of floors in these buildings relies on the quality of the reinforced concrete, usually requiring at least 25 to 30 mm of concrete covering the reinforcing rods. If quality control is poor, the surface covering of the rods may be as little as a couple of millimetres. How would such a component then behave if subjected to temperatures in excess of 800 degrees centigrade? the point at which steel loses half its strength! There are other factors for firefighters to consider. For example, the apartments in the same type of building may be designed as individual fire tight cells to prevent fire spread beyond the apartment and when involved in fire, temperatures may be in the region of 800 to 1,000 degrees Centigrade or more. Firefighters may enter the apartment to extinguish the fire resulting in rapid cooling of the structure, possible failure of the floor to ceiling glazing system exposing the firefighter to hazards at very high level!

I would like to conclude by sharing with you some of the latest concepts being considered by some of the world’s leading designers.

Slide 15 City Tower

Buildings now reaching 2.4 kilometres in height! If buildings like this are being considered we are entering a new phase for fire engineers and firefighters. These concepts become total communities, requiring shops, houses, parks, hospitals, transport infrastructure, fire stations, police stations, the list goes on. People could spend most of their lives in such buildings? Our whole approach to fire safety will need to be revised if we are to meet these challenges and your research is vital to ensuring the highest standards of public safety.

I am not an academic and I do not pretend to understand some of the complexity associated with the research that you deal with in your daily lives. Most of the information you will receive over the next three days will probably be of far more relevance to the objectives of COST Action C26 but I hope that I have given you food for thought with some practical real world examples of where your research adds value to the fire industry.

Slide 16 Thank you

I thank you once again for inviting me to speak and thank you for listening. I wish you success with the remainder of the symposium.
Thank you