Halcrow
Capability in fire safety engineering

1 INTRODUCTION

Fire Safety Engineering may be defined as the application of engineering principles within a system (e.g. a building, transportation system etc.) in order to:

- Identify the fire risks involved
- Establish the required safety levels
- Design a compliant solution

Traditionally, fire safety measures within buildings have been based on compliance with a set of prescriptive design guides or codes of practice that have been developed from past experience and often provide a consensus view on what is regarded as an acceptable level of safety. Such solutions, whilst being fairly straightforward to apply, rarely provide cost-effective solutions for more complex or innovative developments, neither can they always be relied upon to provide a totally effective solution.

Many regulations are unduly restrictive in that they are of a type that imposes solutions rather than objectives; in addition they may be out of date in relation to technological advances. There is a danger that compliance takes precedence over wider safety considerations.

Fire Safety Engineering addresses these problems and employs tried-and-tested rational methodologies to determine, objectively, the most suitable solution for any particular design scenario. Fire Safety Engineered solutions do not rely solely on any particular safety system, or set of systems. Rather, the safety systems, management systems, building occupants and the building itself is analysed in order to identify the synergies that arise from treating the system (e.g. building) holistically; that is, as a total organic system rather than simply as a structure.

A total fire safety engineering approach (as described in BS 7974: The Application of Fire Safety Engineering Principles to Fire Safety in Buildings) often divides the problem into a number of sub-systems:

1- Initiation and development of fire within the enclosure of origin
2- Spread of smoke and toxic gases within and beyond the enclosure of origin
3- Fire spread beyond the enclosure of origin and structural response.
4- Detection, activation and suppression.
5- Fire service intervention
6- Human factors
7- Probabilistic risk assessment

Fire Safety Engineering has given architects the freedom to design unusual and complex schemes that would have been difficult to achieve in the past due to the constraints imposed by Building Regulations. Today's fire safety engineers require an in-depth understanding of architects' requirements, coupled with wide ranging experience of cost-effective solutions, to prevent fire and safeguard people and property.

2 THE HALCROW WAY

Halcrow is a leader in developing Fire Safety-Engineered solutions to architecturally bespoke buildings and underground spaces, with experience in solving 'difficult' cases in a cost-effective manner. We do this by thoroughly understanding the intentions of the prescriptions, and by using leading-edge computational tools to carefully check our proposals. These include Computational Fluid Dynamics tools for calculating smoke spread, and Finite Element calculations to model the structural deformations due to fire-induced heating.

2.1 Computational Fluid Dynamics (CFD)

Computational Fluid Dynamics (CFD) is a technique which enables the study of the dynamics of fluid flow. Using CFD, a computational model is built that represents a system or device – for example a building or structure. Then, fluid flow physics is applied to this virtual prototype, and the software outputs a prediction of the fluid dynamics.

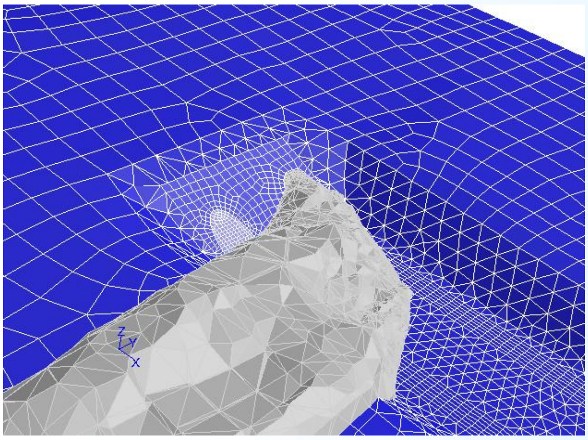
CFD is a sophisticated analysis technique. It not only predicts fluid flow behaviour, but also the transfer of heat and mass (e.g. convection or diffusion), phase changes (such as in freezing or boiling) and chemical reactions (such as combustion). Applications of CFD within Halcrow using the Fluent software package include:

- The modelling of pressure pulses within rail tunnels due to multiple train operation, and the interpretation of aural comfort levels (Strood and Higham Rail Tunnels)

- Modelling of smoke movement due to fire scenarios within buildings (Liverpool South Parkway interchange building)

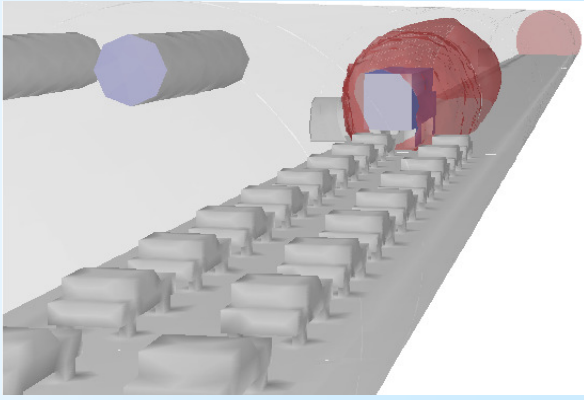
- Prediction of environmental conditions in the vicinity of highway tunnel portals, in order to determine the requirement for an anti-recirculation wall (A303 Stonehenge Tunnel)

- Design of the air and water-based cooling systems for cable tunnels (Abu Dhabi Cable Tunnel)

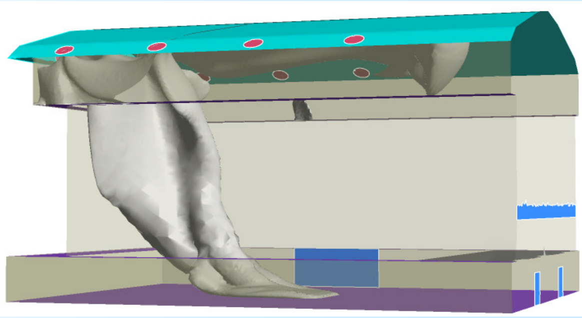


Calculations of vehicular emission traces at the A303 Stonehenge Tunnel portals

Smoke development in a building fire

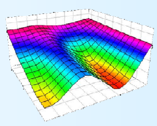


Smoke simulation in the A303 Stonehenge Tunnel



Calculation of smoke movement within Hackney Service First Centre

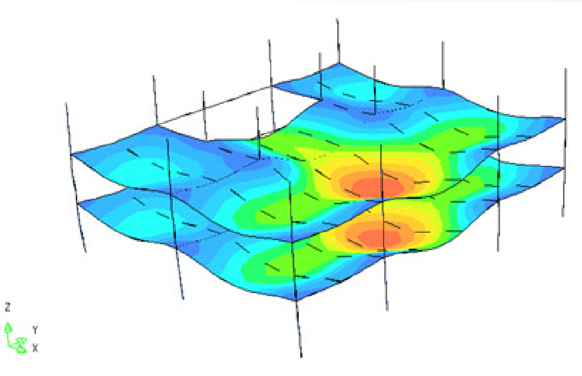
2.2 Structural Fire Safety Engineering



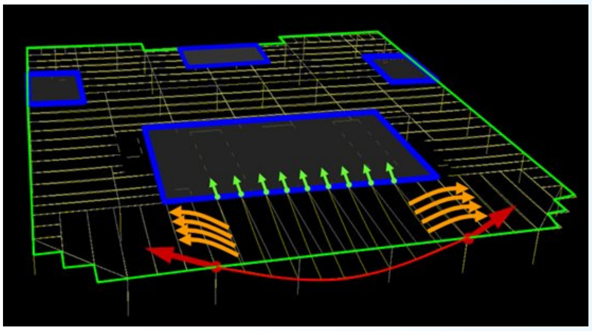
Large-scale fire tests and observations of actual building fires have shown that the fire performance of real buildings can be much better than expected. Recent research has shown that standard fire resistance requirements typically over-specify the fire protection needed. It is clear that there are large reserves of fire resistance in modern steel-framed buildings and that standard fire resistance tests on single unrestrained members do not provide a satisfactory indicator of the performance of such structures.

The tragic events of 11th September 2001 showed that a structural collapse might be caused by a combination of an initial impact followed by a severe fire. However, detailed investigation of the structural behaviour of high-rise buildings subject to such events has facilitated a better understanding of the principal cause of the ultimate structural collapse – and the most effective forms of mitigation.

Halcrow's experts are collaborating with TNO in the development of the DIANA finite element software suite to investigate the thermal response of a structure subjected to a fully developed compartment fire. Individual fire scenarios are studied separately to identify possible failure mechanisms, before examining the most likely combinations. This approach is adopted in order to determine which mechanisms would contribute most and what structural/fire mitigation strategies are likely to be most effective. As the analysis progresses, the cases can be modified to take account of new information and the results of previous analysis.



Response of composite steel structure to fire

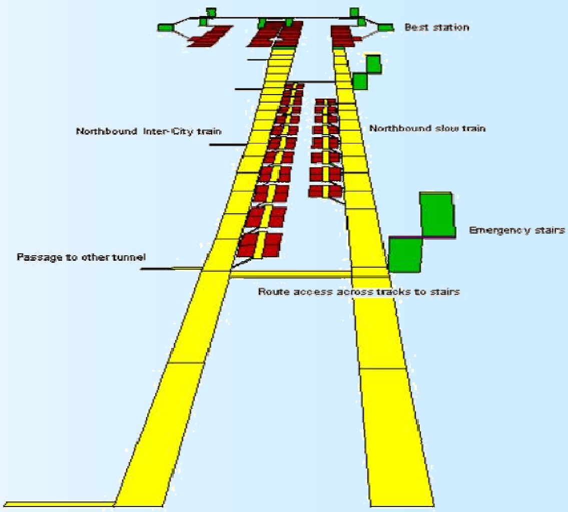


Prediction of structural response to a combined action of both severe fire and local failure as a result of an extreme event

This analysis comprises computational and analytical investigation of the possible failure mechanisms of multi-storey steel frame composite structures subjected to fire as a result of an extreme event. These analyses are carried out using computer models of realistic structures. As most of the computational analysis work focuses on simulating failure events, a range of highly non-linear structural analyses are carried out using established finite element packages. Detailed design advice for construction detailing and structural design can be developed from these failure analyses.

2.3 Evacuation Modelling

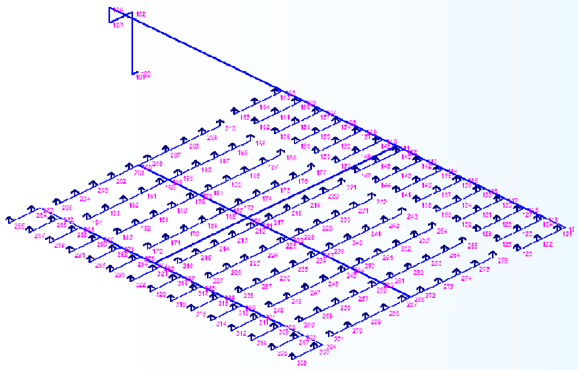
Halcrow has considerable and long standing experience of escape and egress modelling. Since 1993, in the aftermath of the King's Cross fire, Halcrow has developed PEDROUTE on behalf of London Underground Limited for the modelling of passenger movements and the prediction of escape times. These computer simulation techniques have been further developed into the PAXPORT code, to allow sophisticated modelling of passenger and occupant egress. Halcrow's evacuation and CFD modelling engineers are able to work collaboratively in order to provide a holistic and powerful modelling approach.'



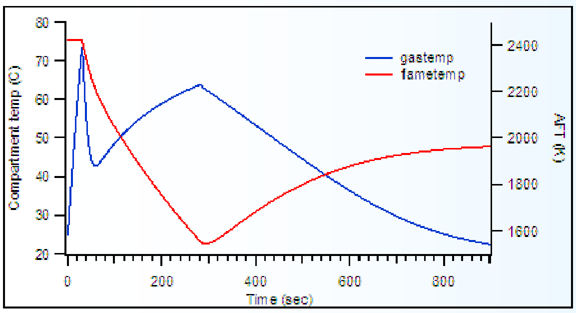
Evacuation modelling – train tunnel egress

2.4 Fire Detection and Suppression

Halcrow's Fire Safety Engineering team has experience in the design, specification and testing of fire detection and suppression systems for a wide range of applications, including: buildings, tunnels, trains and ships. We employ industry-standard sprinkler design software, including Canute's FHC code for hydraulic calculations. Where prescriptive design codes are inadequate or unsuitable for the application in question, we can develop performance-based solutions based on our extensive R&D experience coupled with advanced analytical techniques. We can apply this methodology equally effectively for sprinkler, deluge, water mist and 'clean agent' fire suppression media.



Example of deluge system hydraulic analysis



Transient simulation of water mist fire suppression in a compartment

3 RANGE OF SERVICES

At Halcrow, we enjoy working as part of design teams – it is part of our company ethos. Our successful track record in working closely with architects, developers, M&E designers, quantity surveyors, building control, fire officers and end clients underlines Halcrow's commitment to the fire safety engineering profession. Our services include:

- Risk assessments, both qualitative and quantitative
- Fire safety strategy development, from project conception, through detailed design up to commissioning
- Advice on passive fire protection requirements, in particular for structural steel members
- Smoke ventilation for road, rail and metro tunnels
- Design of fire protection measures in underground stations
- Fire and smoke detection and alarms in buildings
- Design of smoke control measures in conventional and naturally ventilated buildings
- Design of fire suppression systems, including sprinkler design
- Research and development activities in the fields of structural fire safety engineering and tunnel safety

4 MEET OUR TEAM

Peter Woodburn

MA PhD CEng MIMechE

Peter is an Associate with extensive experience across a wide range of areas of fluid mechanics, particularly related to fire dynamics and applications of Computational Fluid Dynamics (CFD). He has undertaken research into CFD simulations of tunnel fires, including both King's Cross and Mont Blanc tunnel fires amongst others. His work is typically directed towards developing optimum ventilation and smoke control strategies within complex buildings and structures.

Patrick Stone

GIFireE

Patrick is a former fire safety officer and has over 28 years experience in Municipal Fire services, performing operational, training and fire safety duties before specialising in fire engineering. He has significant experience in developing and reviewing fire strategies for London Underground refurbishment contracts, and has an appreciation of applied fire engineering and structural fire protection in the built environment.

Mike Deevy

MSc PhD CMath

Mike specialises in the analysis and optimisation of systems involving fluid flow. He has a PhD from UMIST (now the University of Manchester) in turbulence model development for Computational Fluid Dynamics (CFD). Mike worked in the Fluid Dynamics team at the Health and Safety Laboratory (an agency of the HSE) for three years, undertaking projects in a wide variety of areas, using both analytical and computational methods. These projects included gas dispersion following a high pressure release; indoor air problems and thermal comfort; particle transport and deposition; explosions.

Hal David

BEng

Hal is a fire safety engineer with experience in fire detection and ventilation control systems. He recently provided the specification for a CCTV based smoke detection system and automated ventilation response regime for a major UK road tunnel, and has provided fire risk assessments for a major investment bank in the City of London. Hal has experience in maintaining compliance to British Standards relating to fire safety for various commercial, industrial and residential properties.

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Fraser McCourt

BSc

Fraser is a graduate fire safety engineer and has experience in writing fire safety strategies and evacuation calculations for large London Underground projects. This includes specifying compartmentation, detection and suppression measures, and developing evacuation strategies. Fraser also has experience in preparing risk assessments on the risk of fire, and the risk to a project/company due to fire (business risk) for both specific sites and for projects as a whole, and suggesting how these risks could be mitigated.

Chris Morley

BA

Chris is an Associate with over 7 years experience in pedestrian planning. Chris is skilled in the use of Pedroute, Paxport and, latterly, Legion pedestrian modelling software, as well as static analysis techniques. Chris is well versed in the corporate standards and measures of pedestrian experience applicable to station planning and design. He has a deep understanding of the requirements of urban designs in terms of facilitating optimised passenger flows.

5 TRACK RECORD

Commercial and public buildings
- Abbey Stadium in Redditch, a major sporting, leisure and entertainment facility in the UK.
- Qatar Petroleum's new headquarters in Doha, Qatar.
- Shell UK's Central Control Room in Stanlow, UK.
- Ashton under Lyne Market Hall, UK.
- Dubai International City (structural fire analysis).
- Service First Centre, Hackney, UK.
- Shell Shutdown Village, UK.
- Portsmouth Spinnaker Tower (lift fire engineering), UK

Educational Establishments
- Engineering College in Qatar Education City, Doha.
- Business & IT College in Qatar Education City, Doha.
- Qatar Foundation's new headquarters in Doha
- Park Lane College, Leeds, UK.
- Design of smoke control measures (passive ventilation and smoke curtains) for the refurbished Deane Tower (Bolton Institute), UK.

Surface railway stations
- Liverpool South Parkway interchange building, including smoke control in a passively ventilated building.
- Fire safety strategy for the entire Irish Rail network.
- Bromley South Station, UK.
- Selhurst Train Depot, UK.

Underground rail stations and tunnels
- Crossrail – eastern branch, UK.
- Review of fire safety strategy for Heathrow Express extension to Terminal 5
- Docklands Light Railway – extension to Woolwich Arsenal, UK.
- Highbury and Islington station – step-free access project, UK.
- New MetroRail, Perth, Australia.
- RailCorp Station Fire Survey, Sydney, Australia.
- Gautrain Rapid Rail Link, South Africa.
- Edinburgh Airport Rail Link, UK.
- Young Dong Railroad Relocation Project, Korea.
- Highbury and Islington Station, UK.
- Vauxhall Station, UK.

Road tunnels
- Palm Jumeirah Vehicle Tunnel, Dubai (detailed design).
- A303 Stonehenge Tunnel, UK (to Approval in Principle stage).
- A3 Hindhead Tunnel, UK (Category 3 check).
- A57 Mottram Tunnel, UK (structural fire analysis).
- Business Peal Podium, Dubai.
- Medway Tunnel refurbishment, UK.
- A739 Clyde Tunnel refurbishment, UK.
- New Tyne Crossing – method statements for safe operation and maintenance, UK.
- Aden to Amran Highway Tunnels, Yemen.
- Primary Tunnel Safety, Highways Authority, UK.
- Post-Incident Recovery, Highways Authority, UK.

Military installations
- Hangar 143 at RAF Cosford, including a new training building, UK.
- TopHat building, Ministry of Defence, UK.
- RAF St Athan, UK.
- MoD Corsham, UK.

Nuclear installations
- Independent Technical Assessment of diesel pool fires in a nuclear facility (Devonport Royal Dockyard).
- UKAEA Aldermaston
- SDP/BTF/EPS3, Sellafield
- Hunterston SILWE

Industrial Installations
- Ras Laffan LNG Terminal, Qatar.
- Cruachan Power Station, UK.