# CUSTOMER CARE

**Fathi Tarada** and **Mike Deevy** describe the fire safety design behind Hackney Council's new customer service centre in northeast London

HACKNEY COUNCIL'S new customer service centre (CSC) will have one of the largest smoke extract capacities of any building the UK, and its façades have been engineered to protect neighbouring buildings in case of a fire.

Construction of the CSC is nearly complete. With 15,850m$^2$ gross internal area, the five-storey building, which is located behind Hackney's grade-II listed Town Hall, will be the centrepiece of the Council's public building campus. There will be a 'one stop shop', along with a public reception area and a call centre on the ground floor, with council staff offices and meeting rooms on other floors.

The CSC is designed with environmental considerations high on the agenda, and incorporates the latest in sustainable design. The large internal atrium will form a natural ventilation system, reducing the requirement for mechanical air supply. Natural lighting will be provided by the glass roof and walls, with energy-efficient interior lighting providing the balance. The building's energy supply will be partially provided by solar panels, and hot water and heating will come from a wood-burning, carbon-neutral boiler. Construction materials have been selected to be non-polluting, recycled, or made from renewable sources, wherever possible.

In proposing a fire safety strategy for the building, a number of significant challenges had to be overcome. At an early stage in the project, and with the approval of the Council's insurers, it was decided not to install sprinklers. Yet the office floors are largely open to the atrium, with the potential for fire and smoke spread within the building. In addition, the CSC is adjacent to council and other properties, and has a largely glazed façade. The risk of fire spread to adjacent buildings therefore had to be contained to acceptable levels.

## Smoke management

In case of a fire in the base of the atrium or within the office floors, it is important to draw the smoke upwards within the atrium and away from the occupied spaces. This strategy maximises the tenability of the environment for human survival, improves the visibility, and provides opportunities for escape and firefighting.

The calculation procedure provided by BS 7346-4: 2003: *Components for smoke and heat control systems. Functional recommendations and calculation methods for smoke and heat exhaust ventilation systems, employing steady-state design fires. Code of practice* has been followed, and the guidance in BRE 368: *Design methodologies for smoke and*

Fire engineering challenges for the CSC included office floors being largely open to the atrium, and the centre's close proximity to other properties


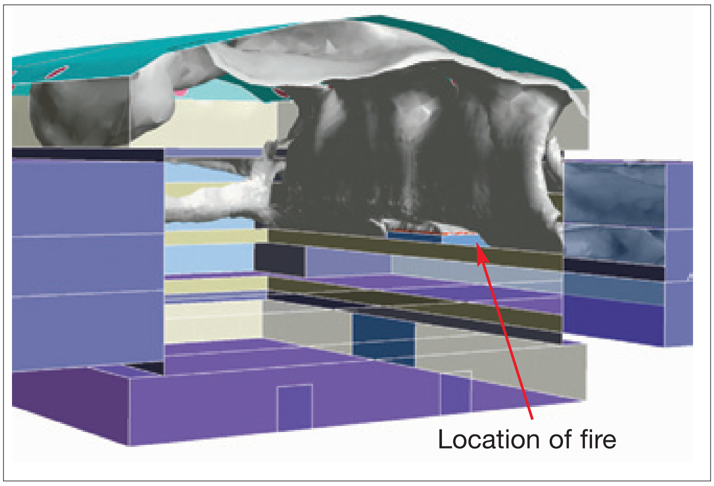


Figure 1: CFD calculations of smoke spread in the atrium

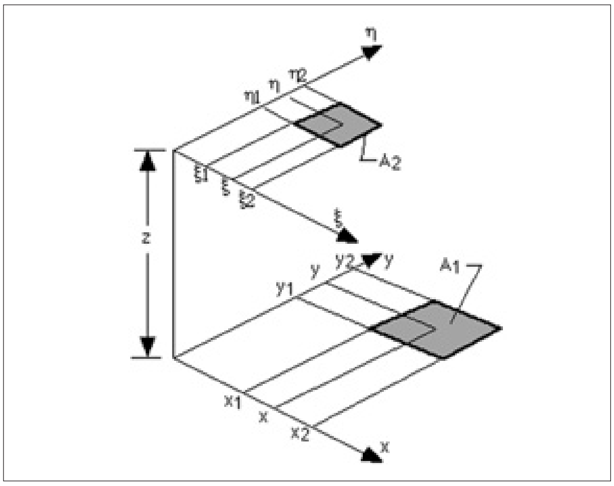


Figure 2: Rectangle to rectangle radiation – after Ehlert and Smith

*heat exhaust ventilation* (1999) has been used to calculate the extract requirements for the smoke ventilation system.

The smoke volume flow rate into the atrium has been calculated as 250m$^3$/s, provided by ten fans, each of 25m$^3$/s capacity. The ten extract points were designed to prevent plug-holing, where fresh air is extracted in addition to smoke. The basis for the smoke production is an 8MW fire, as recommended by Table 3.3 of BRE 368.

In addition, the inlet area required for the smoke venting system was designed to be 65m$^2$, provided by automatic openings. The fire alarm system, designed as a Category L1 system to BS 5839-1: 2002: *Fire detection and fire alarm systems for buildings. Code of practice for system design, installation, commissioning and maintenance*, will drive all make-up air sources to open in case of fire. In the case of a power failure, all make-up air sources will fail-safe to the open position.

Working closely with the project architects, computational fluid dynamics (CFD) was used to consider the effects of different locations for the design fire, including the effect of breaking of the glazed balustrades and windows near the fire. The general-purpose CFD code, ANSYS CFX10, was used to model the fire scenarios. A three-dimensional computer-aided design model, developed by the project architects, was imported into the CFD mesh generation software and used as a basis for the unstructured mesh. The design fire was modelled using the eddy-dissipation combustion model, the k-ε model was used to model turbulence, and the equations were discretised using a second-order upwind biased convection scheme. Figure 1 shows an iso-surface of smoke from a fire on the second floor. Smoke within this surface has concentration equivalent to less than 10m visibility.

The results of the CFD analysis showed that for certain fire scenarios, smoke was likely to spread to the floor above the fire, and hence fire spread was also possible. Glazing was installed to separate the top floor from the atrium, thus increasing the size of the smoke reservoir and assisting tenability on the top floor. This solution allowed for the design of open floors on the ground floor and first three storeys, while achieving the required level of fire safety.

### Neighbouring buildings

Two buildings, Christopher Addison House and 2 Hillman Street, lie to the north of the CSC, and are owned and operated by London Borough of Hackney. In accordance with the guidance in Volume 2, Clause 13.6 of Approved Document B (ADB) to the Building Regulations in England and Wales, and due to the fact that these buildings are not used for residential or assembly and recreation purposes, the risk of fire spread by radiation has been discounted for these buildings, since they are located on the same site. This interpretation of building control guidelines was confirmed by building control.

Radiation calculations were undertaken to assess the risk of fire spread through radiation from the CSC to the Town Hall, which is located to the east of the centre, and also to the properties to the south. The upper limit considered for radiative flux was 12.6kW/m$^2$, corresponding to the piloted ignition of cellulosic products, as per ADB. The radiation intensity from all unprotected openings was assumed to be 84kW/m$^2$, equivalent to a 'black body' temperature of 1,105K.

A number of approaches to estimate the radiative heat flux based on the methods described in ADB were attempted, but none of them were found to be sufficiently reliable or accurate for this particular task. Instead, two alternative approaches were developed. The first of these approaches was to model the buildings within Airpak, a CFD tool developed for heating, ventilation and air-conditioning applications, and thereby extract the radiative view factors. The overall heat flux at a 'target' located on a neighbouring building could then be calculated in a spreadsheet, with all the radiation contributions from the individual floors summed up.

The CFD approach initially indicated that the heat flux at the buildings to the south of the CSC was likely to exceed 12.6kW/m$^2$. A solution was proposed based on compartmenting out the fourth floor from the atrium, using impact glazing (rated to Class A of BS 6206: 1981: *Specification for impact performance requirements for flat safety glass and safety plastics for use in buildings*) installed around the atrium edge. Since the fourth floor will be isolated from smoke flowing upwards through the atrium, the risk of vertical fire spread to the fourth floor was considered remote. In addition, the extent of unprotected areas on the ground-floor south-facing façade was reduced by the design of larger upstands and downstands. Based on these approaches, the maximum radiative heat flux at the target buildings was reduced to $12.6 kW/m^2$. This solution was approved by the London Fire and Emergency Planning Authority.

In order to confirm the CFD results, radiation calculations were undertaken using the view factor formulae developed by Ehlert and Smith (Ehlert, J. R. and Smith, T.F., View Factors for Perpendicular and Parallel, Rectangular Plates, J. Thermophys. Heat Trans., Vol. 7, no. 1, pp173-174, 1993). A $1m^2$ target was located on adjacent buildings at the closest location to Hackney CSC, approximately mid-way in terms of building height.

The finite-to-finite radiation configuration factor for two parallel planes (*see Figure 2*) is given by:

$$F_{1-2} = \frac{1}{(x_2 - x_1)(y_2 - y_1)} \sum_{l=1}^{2}\sum_{k=1}^{2}\sum_{j=1}^{2}\sum_{i=1}^{2} (-1)^{(i+j+k+l)} G(x_i, y_j, \eta_k, \xi_l)$$

where

$$G = \frac{1}{2\pi}\left( \begin{array}{l} (y-\eta)\left[(x-\xi)^2+z^2\right]^{1/2} \tan^{-1}\left\{\dfrac{y-\eta}{\left[(x-\xi)^2+z^2\right]^{1/2}}\right\} \\ +(x-\xi)\left[(y-\eta)^2+z^2\right]^{1/2} \tan^{-1}\left\{\dfrac{x-\xi}{\left[(y-\eta)^2+z^2\right]^{1/2}}\right\} \\ -\dfrac{z^2}{2}\ln\left[(x-\xi)^2+(y-\eta)^2+z^2\right] \end{array} \right)$$

The spreadsheet calculations based on the analytical configuration factors confirmed the CFD results to within 1%, and were accepted by the independent checkers acting on behalf of building control.

Hackney's CSC has been designed to satisfy high standards of sustainability and fire safety. Its large atrium, acting as its lungs during normal operation, emphasises the need for special precautions in terms of smoke extract and façade engineering, in order to ensure the safety of occupants and to prevent fire spread to other buildings ■