Compartment firefighting:

Compartment firefighting is one of the most challenging and dangerous aspects of modern firefighting. Training for such environments often involves exposure to conditions and risks that have to be carefully controlled whilst preparing firefighters for the conditions they will experience at incidents. Gary Fleming, an expert in compartment firefighting, weighs the pros and cons of the two primary methods of training.

Cosmetic smoke can be added to LPG units to provide an element of realism, although this does not react in the same way as fire smoke when firefighting techniques are applied. Photo by Sinisa Jembrih, Zagreb Fire Department, Croatia.

There isn't a more endearing image of firefighting than that of a firefighter entering a smokey building, clutching a hose while wearing breathing apparatus and full firefighting regalia. Serving officers will recognise a different aspect to this image, however. That of the huge risk to which our crews are exposed to from the second they decide to deploy to the moment the re-emerge from a building.

Within the UK the Health and Safety Executive (HSE) recognises the hazards faced by firefighters. In its document *Striking the balance between operational and health and safety duties in the Fire and Rescue Service* (2009) the HSE states, "[HSE]... recognises that firefighters and managers face difficult moral dilemmas and have to make decisions in what are sometimes extremely hazardous, emotionally charged and fast moving situations."

Over the past two decades the use of training venues to simulate these conditions has become more common as part of training regimes for firefighters and officers alike.

At incidents the initial assessment of a fire compartment can be a good indication of the tactics to be deployed at the scene. Experience tells us that in a multi-compartment fire the partial ventilation of a building can have a significant effect on the internal fire behaviour once entry has been made. The skills of personnel in reading these signs and symptoms is paramount as once this assessment is made and crews make entry, the firefighter is often acting solely on their own knowledge, skills and experience. We must therefore consider how we prepare our firefighters to deal with such conditions.

Over the past two decades training for fire service personnel in responding to these conditions has become globally established. Awareness of the nature of the risks faced has significantly improved training. Our firefighters and fire service professionals now readily understand the phenomena of "backdraught" and "flashover".

Typically this training is delivered at fire simulation units held locally or at central training centres. In deciding how to deliver this training for personnel fire departments will need to consider the resources available; nature and size of the training need; and the environmental impact of any solution.

The two main types of system generally deployed tend to be either carbonaceous (wood based) or LPG (gas based).

Carbonaceous units emerged in the late 1980s and early 90s. Typically they are converted shipping containers, however later systems are now emerging as bespoke built systems. They provide a training environment that replicates aspects of fire development and behaviour that would normally be found within a compartment fire.

Generally chipboard or laminated wood is burned. Some of the units offer the opportunity for firefighters to observe fire development to the point of flashover or backdraught. This has the advantage of providing the full experience of how such phenomenon occur. Firefighters are also taken through the extinguishing techniques applied to deal with these events.

The provision of carbonaceous systems, although providing the most realistic environment for firefighter training, should be considered against issues such as:

- Potential wood supply
- Storage for fuel wood and the space to cut it to size for units
- Staffing costs for fireground and instructor staff
- Facility to dispose of post-burn waste.

The environmental impact of such systems depends on location, type of fuel used and level of use. It is widely understood that the smoke issued from this type of fire is often rich in carbon and is best described as a cocktail of gases based on the type of glue used to bond the board and the surface coating material.

Many departments have found remote locations for units such as airfields or industrial areas. Local surroundings are obviously a consideration – as is the impact on neighbours. For airport fire services it should be remembered that carbonaceous systems can produce a large amount of carbon rich smoke, not ideal if located near a runway. Not only would wind direction have an impact on the ability to use the units, but it might also raise alarm with incoming passengers observing plumes of

ABOUT THE AUTHOR

Gary Fleming is a serving fire officer with Essex County Fire and Rescue Service in the UK. In his career he has undertaken many functions that are at the heart of the firefighting profession including the introduction of new breathing apparatus systems and operational guidance and procedures. He served as a lead instructor at the Service Flashover and Backdraught training establishment for several years where as part of a team he advanced the techniques and understanding of compartment firefighting. As part of this team he lead national instructor training programmes for UK and international flashover and backdraught instructors. He is now a Senior Commander within the service with responsibility for a large geographical operational area.

carbonaceous or LPG systems?

smoke issuing form the airport site. In this instance the use of LPG systems is a consideration.

Although realistic, there are drawbacks to the use of carbonaceous systems. Once lit the fire will run its course. Instructors do have some control over the fire through the use of controlled vents, but it is not possible to "start again" if an exercise goes awry as it would be with an LPG system. Additionally once used the unit takes time to cool down before staff can gain access to remove the remains of the last burn and reload for the next. The energy use in providing the wood (transport, cutting, loading, storage, disposal of waste) should also be considered.

These factors should be borne in mind when considering the volume of students required to pass through the system and the number of units provided. Nevertheless a medium-sized brigade of 2,000 personnel should be able to manage a full training programme for its staff with four units covering the varying training aspects.

The units generally used for carbonaceous training systems are constructed to withstand extreme temperatures as well as the sudden cooling effect of firefighting water sprays and jets. Experience has shown that this has led to advanced corrosion and a subsequent limited life span. This has often been overcome through the provision of a raised roof to provide protection from the elements.

Many FRSs, including Essex County Fire and Rescue Service in the UK, have taken forward the concept of multi compartment training using carbonaceous systems. These advances have provided a new dimension to the previously one dimensional, single compartment approach to these types of system.

LPG systems

The other common fuel for systems is gas. These fire-training simulators are designed to create fire conditions using LPG (usually propane). The provision of these systems is not hindered by many of the issues impacting on the use of carbonaceous systems. They allow for greater flexibility in the design stages. This is due to the removed need to load large amounts of wood into the fire area and a reduced impact on them from the effects of the full fire cycle that carbonaceous systems are subjected to. They tend to be constructed of modular steel units and can create a familiar domestic or industrial environment to that experience at incidents.

A piped gas system is run through the structure and provides a flamed outlet at various points. These are controlled by instructors who respond to the application of water from firefighting crews.

Many of the new systems focus on clean burn technology for reduced pollution. Whilst the systems do not provide the fire development, heat experience and smoke conditions of a carbonaceous system, they do have the advantage of being able to be more easily sited, accommodate a large throughput of trainees and require a low level of maintenance and ongoing costs in relation to the carbonaceous systems, although initial set up costs tend to be higher.

Feedback from two UK-based FRSs using different systems identified that, in the LPG system, reported injury levels were lower with only 13 recorded injuries in the units (mostly slips and trips), with no burn injuries over a 24-month period. Photo by Sinisa Jembrih, Zagreb Fire Department, Croatia.

The environmental impact is a significant difference between the two types of system. There are no objectionable plumes of smoke with gas, and so therefore it might be considered as a suitable option for locations where perception and image might be a consideration. Additionally there is no waste to dispose of after each burn – again an environmental advantage.

The fires are centrally controlled with instructors on hand to support crews. However the staffing level are less in these than in carbonaceous systems for like-for-like sessions.

Cosmetic smoke can be added to provide an element of realism although this does not react in the same way as fire smoke when firefighting techniques are applied.

Both types of system can be provided with data recording facilities that support instructors when debriefing crews. For the carbonaceous systems the graphs produced show temperature changes that can be directly related to the application of cooling techniques applied during the drills.

The health and safety controls applied when using these systems need to carefully monitor the welfare of crews and instructors. Feedback from two UK-based FRSs using different systems identified that in the LPG system reported injury levels were lower with only 13 recorded injuries in the units – mostly slips and trips – with no burn injuries over a 24-month period. This is in comparison to a similar sized FRS using a carbonaceous system which had recorded 22 injuries in 18 months with 21 being reported as "reddening of the skin", and five days were lost to sickness.

The focus on the training must of course be on skills and the ability to control and extinguish fires and not "burn to learn", as this poses an unacceptable risk to trainees.

In summary, the choice of system is a personal one for each service. Many employ both in order to gain different aspects of the training experience, and to reduce the environmental impact of training. It is often down to three issues; volume against realism; long-term costs; and environmental considerations. The need for services to consider the environmental impacts of its activities is now higher on the agenda that at any other time and the need to support the sustainability agenda must be considered.