



▲ Firefighting vehicle at Spaceport America, where Virgin Galactic successfully completed its first passenger flight in July.

Space launch emergency response

Safety is a key consideration for space launch services, which is why it is commonplace to move operators and spectators well away from a launch site prior to lift-off. Facilities and procedures at long-established launch centres such as Kennedy Space Center and Baikonur are routine but this is not necessarily the case for the growing plethora of spaceports across the world. Using the UK - where a number of new spaceports are vying for regulatory approval - as an example, safety expert Chris Thain reviews the regulatory framework and legislation for the basics of fire safety and emergency response, which applies to spaceports as much as to airports and similar facilities.



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The effective provision and management of on-site emergency response plans and resources, fire safety, fire prevention and asset protection are among the core responsibilities of all spaceport Launch Site Operators (LSOs) anywhere in the world.

In the UK, LSO licensees are regulated and licensed by the UK Space Agency (UKSA) and

must satisfy the agency that they have conducted a thorough assessment of risks to the health and safety of those taking part in spaceflight activities and to have taken all reasonable steps to reduce risks to the health, safety and property of other persons to 'as low as reasonably practicable' (ALARP). Thus, being able to demonstrate that operations are conducted at an ALARP level acceptable to the regulator is crucial to obtaining a launch site licence.



While in the UK and some other countries the current space industry regulatory framework does not prescribe what the emergency response capabilities for each launch site must comprise, from a health and safety perspective, any risk identified through the risk assessment process must be mitigated in a manner that is both appropriate and proportionate.

In addition, the residual risks, even if the operator has met the ALARP test, must also be acceptable to the regulator, or else a license will not be granted.

Legislation

Under the UK Space Industry Regulations enacted on 29 July 2021 as part of the Space Industry Act 2018 (SIA), UK-based launch site operators are required, as a condition of the terms of their license, to have an approved Emergency Response Plan in place.

Furthermore, while safety is always the paramount consideration, under Section 11 of the SIA, LSOs are also required to consider the environmental impacts of the spaceflight activities in an Assessment of Environmental Effects (AEE). In turn, this assessment informs the level and type of emergency response that the LSO will need on-site to satisfy the requirements of the regulator. This includes the type of firefighting media to be employed, which can include foam, dry powder, water, etc.

The LSO must also be aware of the requirements of the Civil Contingencies Act 2004 and be prepared to work with the Emergency Services and other multi-agency responders. This includes risk assessment, planning and exercising for emergency incidents.

Horizontal and vertical launch sites

The emergency response plan for each LSO application will differ depending upon the mode of spaceflight activity that the launch site expects to undertake.

For Horizontal Launch Site Operators (HLSOs), whose rockets and their payloads are propelled into sub-orbital trajectories or low Earth orbits from carrier aircraft, such operations normally occur from existing aerodromes or airports.

In the UK, these sites (comprising one or more runways, hangar buildings, air traffic control centres) operate under the regulatory authority of the Civil Aviation Authority (CAA) and are subject to established international safety and operational regulations and procedures. These include the provision of on-site Aircraft Rescue and Fire Fighting (ARFF) services based upon the category of the aerodrome and the size and type of aircraft that utilise the facility. ARFF services operate under International Civil Aviation Organization (ICAO) regulations and standards which, under the UK CAA, comprise CAP168 – Licensing of Aerodromes and CAP699 – Standards for the competence of rescue and firefighting services.

▲ Members of the US National Transportation Safety Board (NTSB) Go-Team inspect a tail section of Virgin Galactic's SpaceShipTwo experimental spaceflight test vehicle, which suffered a catastrophic in-flight breakup during a test flight and crashed in the Mojave Desert in October 2014, killing the co-pilot and seriously injuring the pilot. It was the first major in-flight failure of the burgeoning commercial human spaceflight industry, and it provided significant lessons for emergency medical response. After investigating the accident, the NTSB advised that commercial operators should “work with local emergency response partners to revise emergency response procedures and planning” and “to facilitate this cooperation, local emergency responders need to understand the unique challenges of commercial human spaceflight.”



▲ Above: Continual skills training is essential for an effective firefighting response.

Right: G3 Systems firefighters provide first line emergency response cover for high hazard clients.



For Vertical Launch Site Operators (VLSOs), however, no such emergency response standards currently exist. The UK Space Agency (UKSA) is leading the development of operational requirements for vertical launch sites and is working closely with the CAA, LSO and industry specialists to define the emergency response services that may be required for such sites.

While the UKSA is currently not being prescriptive about the emergency response services that will need to be in place for spaceflight activities to be conducted safely, VLSOs may need to consider the installation of fire detection and alarm systems and fixed deluge firefighting systems around the launch platform and fuel storage areas, along with their mobile emergency response and firefighting crews.

It is important for both HLSOs and VLSOs around the world to recognise that, as commercial spaceflight operators, they cannot rely upon local authority fire and rescue services to provide stand-by emergency response cover for their spaceflight activities.

The UK CAA is working closely with the UKSA to further develop the standards and operational procedures required for both horizontal and vertical LSOs. One area that will require consideration involves the unusual risks associated with different types of rocket propellants and hazardous chemicals that may be used in spaceflight activities. The storage, transfer and fuelling of rockets with highly reactive or explosive fuels, coupled with the potential release of highly toxic gases and poisonous products of combustion from these fuels in the event of a launch site fire, will require specialist knowledge and training for emergency responders.

Other diverse risks specific to spaceport LSOs include the number and proximity of tourists that wish to witness the launch site activities and the potential for environmental harm from fire if the launch site is situated in or around peat moorland.

Emergency response provision

Under the UK Space Industry Regulations 2020 (Pt 9, c.8 - 154.1), a spaceport licensee must ensure that rescue and firefighting personnel are provided at the spaceport in a timely manner.

The cost of maintaining and operating an on-site Rescue and Fire Fighting Service (RFFS) or, for airports, an Aircraft Rescue and Fire Fighting (ARFF) service, to fully meet compliance and operational license requirements for commercial spaceflight activities, will need to be carefully considered by the LSO within its planning and budgeting process.

Failure to fully comply with and maintain emergency response services to defined standards or agreed levels will prevent the LSO from gaining or keeping its license to operate and, in the event of an incident, potentially expose the LSO to serious financial liability and significant reputational risk. Insurers will of course demand that any identified risk is minimised and mitigated before they provide insurance cover for the site and its operations.

Notwithstanding the availability of local or municipal resources to react in the event of

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an emergency or serious incident, the on-site RFFS, which will provide the vital 'first response' to any incident, is generally a choice between two main options: an 'employed' service or an 'outsourced' service.

Some VLSOs may elect to invest in their own fire and rescue services, while HLSOs will probably contract with the existing Airport ARFF service which normally includes a dedicated fire station, skilled personnel, response vehicles and life-saving equipment. Others will need to consider outsourced or subcontracted service providers, to enable them to meet their operational needs in a more cost effective and compliant manner.

So, what are the factors that will influence the decision to outsource the emergency response function and how should LSOs choose between these options?

In-house or outsource?

The requirement and resources for an on-site fire and rescue service will be determined chiefly by the type of activity that the LSO is involved in a given facility, the assessment of the risks associated with the processes or activities that occur on-site and the impact that any emergency incident may have on the business, its employees and on the surrounding communities.

Ultimately, however, the motivation for investment in an on-site fire and rescue resource is like an insurance policy which is rooted in the avoidance of loss; it can be organisational, financial, reputational and/or personal in nature and based on a need to ensure the ongoing stability, security and resilience of the launch facility. Regulatory compliance, business continuity reassurance and client 'peace of mind' are the benefits of such an investment, but as with any insurance policy it is sincerely hoped that the fire and rescue service will never need to be called upon in a real-life emergency situation.

Indeed, recruiting, training, resourcing and supporting an employed on-site fire and rescue service can be a relatively expensive operational cost for the LSO. The day-to-day management of an employed fire, rescue and safety service can sap the LSO managers of time and energy that, while imperative to the safe, legal and ultimately profitable operation of the facility, is not actually a core function of the business itself.

Moreover, fire crews must be qualified and experienced and must train constantly to maintain their skills and competence, because 'skills fade' is a very real and recognised phenomenon that one does not wish to suddenly become aware of during an emergency.

The decision to outsource services may thus be driven by purely financial or economic motives, as LSOs seek to reduce costs and enhance their commercial competitiveness. The positive aspect of this is that outsourcing the firefighting and rescue service provision enables an LSO to focus on its core business while delegating essential but non-core processes to external specialist providers. This releases internal resources that can be put to more effective use for other purposes, leading to greater overall efficiency and competitiveness.

The question is, could an outsourced service provider deliver the required functions, tasks and regulatory responsibilities; maintain and improve launch site safety; respond effectively to any emergency incident and add value to the organisation at a more cost-effective rate than directly employing and maintaining an on-site team? As a representative of such an independent provider, G3 Systems, the author would clearly answer this question in the affirmative. That said, there are several good reasons to choose this option.

Specialist knowledge

Launch site licensees cannot realistically be experts in every business function, process and discipline, as it is simply uneconomic to cover

Commercial spaceflight operators cannot rely upon local authority fire and rescue services to provide stand-by emergency response cover for their spaceflight activities

▼ Fire safety and prevention are as important as emergency response.



G3 Systems



Clive Simpson



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▲ NASA's long-established fire teams monitor a scrub blaze caused by a lightning strike at Kennedy Space Center in Florida.

all these bases. By utilising outsourced fire and rescue service (FRS) providers, an LSO can leverage a global knowledge base and resources, while accessing world-class capabilities, expertise, technical skills and experience.

Managed FRS providers often have access to a wider, more highly-skilled and diverse talent pool than the client themselves and will already have in place the requisite interview and selection processes designed to select only the strongest, most appropriately qualified and experienced staff. Training and competence management will reflect global best practice, while space industry and launch site-specific risks will be recognised, evaluated and reflected in the ongoing training provided to the FRS staff members.

Shared experiences coupled with specialist skills, learning and best working practices also enable the outsourced service provider to add value and resilience to and further reduce risk within the client's operation.

Although the LSO must retain its duty of care to operate in a safe and environmentally responsible manner, delegating FRS responsibilities to external providers can release companies of day-to-day management functions that are difficult to administer and control, while still realising the inherent benefit the FRS provides and crucially maintaining operational compliance and certification.

As specialists in their field, outsourced FRS providers generally are much better at deciding how to cost-effectively avoid risk in their areas of expertise without compromising safety than perhaps a fully employed on-site team might be. This is because the incentive to deliver a high level of service, and to maintain their professional reputation and credibility while remaining profitable, is arguably stronger for the outsourced provider. A further consideration if, unfortunately, something does go wrong may be

that the responsibility and possible contractual liability could be shared with the service provider, rather than borne by the contracting client alone.

Decisions

The decision to resource the fire and rescue service for a spaceport cannot be made lightly. A thorough and detailed examination of the associated risks, costs and benefits must be investigated during preparation for the licensing process and as part of the site's comprehensive safety case. However, if a decision to outsource is positive, then careful selection of the partner organisation is essential.

Certainly, during the initial stages of spaceport development, the relative low number of space launches means that the cost of an emergency service may seem quite high, although it will of course be amortised as the increasing frequency of launches makes the overall provision more cost-effective.

One way to offset the early costs of the service is for LSOs to collaborate to share costs. Collaborative working is a hallmark of the UK space industry and given that UK space launches will need to be deconflicted from a timing and location perspective, there is little reason why two or more LSOs could not agree to share an emergency response provision, thus saving money and mitigating their insurance liability while also maintaining their regulatory compliance. ■

About the author

Chris Thain manages fire & rescue service business development for G3 Systems Ltd, a UK-based company that provides fully-managed and compliant on-site Fire and Rescue Services for industrial, aviation and military clients around the world. A wholly owned subsidiary of IAP Worldwide Services Inc, it specialises in operations in austere and hostile working environments and is a global provider of services to government and commercial customers. Chris previously worked with Devon & Somerset Fire & Rescue Service, where he successfully managed the commercial trading business of the Fire Authority.

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