
Emerging Risk Report – 2015
Innovation Series

TECHNOLOGY

Drones Take Flight

Key issues for insurance

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Key contacts

➔ **Trevor Maynard**
Head, Exposure Management & Reinsurance
trevor.maynard@lloyds.com

➔ **Nick Beecroft**
Manager, Emerging Risks & Research
nick.beecroft@lloyds.com

➔ **For general enquiries about this report
and Lloyd's work on emerging risks,
please contact**
emergingrisks@lloyds.com

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Executive summary

As early as 1946, American magazine *Popular Science* concluded that: “Drones, as the radio-controlled aircraft are called, have many potentialities, civilian and military.”¹

Seventy years later that potential is now being realised. Exponential advances in sensor technology; satellite positioning systems; communication links and computer processing power have given drones a wide range of applications, many unthought-of even a decade ago. Such innovative applications fall into two key areas:

- **Measurement, including environmental monitoring, photography and filming**

For example, the BBC World Service now uses drones,² Kenya is deploying drones to monitor poaching on game reserves,³ and the first marketing companies have been censured for using drones to collect and monitor cell-phone activity.⁴

- **Transport, including targeted delivery**

Drones have been used to deliver textbooks⁵ and medicine to remote locations.⁶ In Japan, around 40% of the rice crop is sprayed using drones.⁷ And, in cities such as London, the first drone delivery services are already in operation.⁸

The potential of drones is hard to deny. However, concerns around safety, security and surveillance could pose significant risks to users of this nascent technology. This is, of course, true of many emerging technologies. However, drones are expected to receive particular scrutiny because of the technology’s military heritage and surveillance capabilities. Adequate insurance coverage will likely be of particular importance to protect users against emerging risks.

This report identifies five fundamental risks facing the sector:

- **Negligent or reckless pilots:** the ‘human factor’ will be a key consideration for insurers. The development of training and licensing schemes will be important to provide assurance of the capability of operators. Insurers can be expected to have particular concerns about moral hazard, as operators on the ground could feel disassociated from risks occurring in the air. Lead insurers may require a higher risk retention unless/ until the operators can demonstrate responsible and safe behaviour.



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- **Patchy regulatory regimes:** regulation is developing but is inconsistent between international jurisdictions. A robust regulatory framework is expected to be crucial to the provision of insurance for drone operations. Harmonised international standards and clarity on third-party liability will likely be important factors determining the effectiveness of any regulatory regime.
 - **Poor enforcement:** the industry is growing too rapidly and unevenly for regulators to provide strong oversight without technological support. Tracking/monitoring technology could also help operators avoid breaking laws in the first place, such as by supporting the development of 'geo-fencing' technology to ensure drones do not stray into controlled airspace.
 - **Vulnerability to cyber attack:** drones could be vulnerable to cyber attack with some reports suggesting a thriving community of 'drone hackers' is already established. Cyber security measures will likely be increasingly significant for underwriters' risk assessment of commercial drone operations.
 - **Privacy infringement:** this is perhaps the most cited public concern about drones. Professional indemnity insurance can cover the cost of damages awarded for breach of privacy against drone operators. Key requirements for insurance are expected to include the completion of privacy impact assessments, and compliance with applicable regulations and laws.

Drones have the potential to enhance a huge range of activities. However, manufacturers, regulators and early adopters will need to work together, on a global basis, to ensure this technology is used safely and responsibly. Lloyd's, by putting a price on risk, intends to work to support and inform those conversations.

Introduction

Drone technology is now available for a diverse array of users and tasks, and effective risk management is expected to be critical for the integration of drones into society. This is true of many emerging technologies. However, Lloyd's expects risk management for drones to receive particular scrutiny due to public concern about the technology's military heritage and its capacity for surveillance and data-gathering. Insurance will likely be a key component of the risk management framework, and this report outlines the key issues in the development of insurance solutions for drones.

Applications of drones

The drone sector has been identified as the most dynamic component of the global aviation industry, with global expenditure on drones acquisition expected to double to \$91bn in the 10 years to 2024.⁹ Military applications continue to dominate the drones sector. However, civil usage is growing and meeting an expanding range of applications, as illustrated below:

Current insurance coverage

Insurance products are being developed to meet the needs of drone manufacturers, distributors and operators. Standard drone insurance programmes cover third party liability (compulsory in the EU for drones above 20kg),¹⁶ physical loss and damage to the system components during operation or transit. These policies can be tailored to suit individual exposures, and may also include Directors' and Officers' liability, professional indemnity, employers' liability, product liability, cargo liability, terrorism, war and hijacking.

For insurance purposes, drones could present the properties of an aviation risk and/or a liability risk. While the market for drone insurance is relatively small at present, the projected expansion of the market, and the diversity of potential applications, means that Lloyd's anticipates significant growth in the need for insurance solutions. Insurers are expected therefore to require detailed insight into potential risks to enable accurate risk-based pricing, and to manage aggregate exposure.

Sector	Applications	Example
Agriculture	Crop monitoring	Drones can survey at a much higher resolution than satellites and at a third of the cost. ⁶ More accurate monitoring of crop growth is generating efficiencies, for example in the use of fertiliser, estimated to have increased revenue by ~ EUR50. ⁶
	Precision agriculture	In Japan, around 40% of the rice crop is sprayed using drones. Over 2,400 drones are now in service. ⁷
Public Services	Border control	Predator drones patrol the US borders with Mexico and Canada. They have been credited as a major contribution to border security. ¹⁰
	Assisting emergency services	In the UK, the West Midlands Fire Service uses drones to collect information for use in firefighting, such as surveying the extent of the fire, identifying access points and locating casualties. ¹¹
Logistics	Parcel deliveries	In Australia, drones have been used for over a hundred test deliveries of textbooks. ⁵
	Delivery of medical supplies	In Germany, a drone has been used to deliver medicine to remote locations. ⁶
Wildlife protection	Prevention of poaching/hunting	Kenya is due to deploy drones into all of its national parks following a successful pilot project where the use of drones reduced poaching by 96%. ³
Media	News production	News media organisations are increasingly making use of drones to enhance their coverage. ¹²
	Film and entertainment	Drones have been used for the production of several feature films including 'Wolf of Wall Street' and 'Skyfall'. ¹³
Research	Data gathering	Researchers have used drones since 2010 to collect breath samples from sperm whales as part of the Cetacean Health and Life History Programme to assess their health. ¹⁴
	Analysis	Archaeological mapping of a former Inca settlement in Peru has been achieved by a drone equipped with a high resolution camera. ¹⁵

Regulation

Effective regulation is a key factor for insurers' confidence in any emerging technology. Regulatory authorities around the world are already considering how drones can be integrated into existing airspace controls and legal frameworks. Here, we identify the shape that regulation could take in order to mitigate risk.

Enforcement

The rapid expansion of drone ownership and operation could present a significant challenge to regulators. A regulatory system that relied heavily on responsible behaviour and/or the threat of sanctions could generate significant uncertainty for insurers, owing to the difficulty in monitoring compliance. This could make some operations or territories not suitable for insurance. A key measure that could assist insurers' confidence in the effectiveness of regulation includes the development of central databases of approved operators,¹⁷ and the use of serial numbers marked on fire-proof plates to assist in identifying operators after an incident.¹⁸

Additional technological measures could also assist in the enforcement of regulation, notably:

- Tracking/monitoring technology, incorporated as an integral component of platform design, could provide an effective means to gather evidence of transgressions.

- 'Geo-fencing' technology could reduce the risk of a drone straying outside a defined area, or into controlled airspace.

Licensing

The ability to assess operator competence is an essential consideration for the provision of insurance. As the number and diversity of individuals and organisations operating and manufacturing drones grows, so the requirement for mandatory, standardised licensing is expected to become increasingly important. Initiatives such as the Basic National Unmanned Aircraft Systems Certificate – Small (BNUC-S, commissioned by the UK Civil Aviation Authority) and the Remote Pilot Qualification – Small (RPQ-S) are very positive developments.

The projections for the growth in drone operations mean that these types of licensing schemes – together with enforcement – will likely be required on a greater scale, and with as much consistency as possible around the world. This could provide insurers with a tangible measure of operator risk, and allow a key source of risk uncertainty to be quantified and managed. This also raises the difficult question of how such licensing schemes would be paid for, which is unclear at the present time.

Third party liability

Liability considerations are expected to become increasingly significant for drone operations as they expand in scope.¹⁹ Third party liability could be especially prominent, as the greater intensity of use and variety of tasks will likely mean that drone operations interact with a much greater range and value of third party interests. Two recent examples demonstrate the potential exposure.

Third party liability incidents involving drones

- April 2014: an Australian triathlete sustained minor head injuries after a drone fell from the sky. The photographer operating the vehicle claimed that an attacker had wrested control from him.²⁰
- December 2014: a patron at a restaurant in New York was injured by a drone being used to take images of diners.²¹

The above examples reflect recent liability incidents involving drones that could give rise to a third party claim – however, as the technology continues to develop and commercialise, larger damages are an increasing threat. For example, substantial damages and legal fees could be incurred if a drone were to collide with a commercial passenger aircraft, causing it to crash.

The potential legal costs attached to third party claims would be an important risk rating factor for insurers, and are likely to vary in proportion to the scale of damages. A study commissioned by the European Commission found that drone operations do carry the potential to generate liability claims requiring lengthy and complex legal proceedings.²² A further consideration for insurers is the potential for moral hazard among drone operators. This is predominantly an issue with individual operators who will have a variety of different skill and experience levels of flying drones. Commercial insurers have the opportunity to encourage good practice in commercial operators by varying terms and conditions, risk retention (deductibles or excess) and premiums on the basis of the quality of clients' risk management.

In the EU, commercial operators using drones of greater than 20kg mass must comply with Regulation (EC) 785/2004 on Insurance Requirements for Air Carriers and Air Operators.²³ This regulation establishes minimum third party insurance requirements linked to the size (maximum take-off mass) of any aircraft, including drones. Given the relatively small size of the aircraft, drones generally attract the lowest band of third party insurance requirement, approximately £0.7m.²⁴ This can be considered to be a very low limit, given the considerations described above, and many clients choose to purchase higher limits of cover on specialist advice.

Harmonisation

As regulatory regimes develop, the degree of international harmonisation could be a key factor in enabling the development of standard insurance wordings and cover for drone operations.

The degree of co-ordination between regulators and insurers, and consistency between international regimes, is expected to have a very significant influence on the development of the market for drone insurance. Different national authorities have, to date, pursued different approaches to the regulation of drones, and this serves to add complexity and uncertainty for insurers.²⁵ Effective collaboration and a consistent multinational approach would be of benefit to all parties with an interest in the regulation of drones. The advantages of harmonisation should not, however, be interpreted as a basis for a 'one-size-fits-all' approach: the diversity of tasks undertaken by drones means that the permissions and competence required should be tailored according to the varying level of risk attached to different classes of operation.⁶

Safety

Statistics on safety incidents involving civilian drones are sparse. The absence of historical data is an impediment to insurers, but risk assessment can be achieved through examination of variables other than past accident rates. Two safety factors are expected to be key considerations for insurers.

The human factor

The technology component of drones has developed rapidly in recent years, and, as with much new technology, the human operators' capacity to learn and adopt safe operational procedures can be a critical factor driving the rate of safety incidents. Mandatory licensing of operators linked to comprehensive training could be expected to greatly enhance insurers' ability to assess the risk attached to drone operations. A recent initiative announced in the Netherlands for a drone training facility catering for both military and commercial operators²⁶ is an example of development in this area.

Training and certification schemes are being developed, and they show promise for providing a level of certainty that a drone will be operated by a competent individual. In the UK, the Civil Aviation Authority (CAA) recognises the BNUC-S and RPQ-S as evidence of competence suitable for permission to operate drones

for commercial purposes. BNUC-S is also recognised in other jurisdictions. Both of these qualifications consist of a ground-based knowledge exam, a test flight to determine proficiency, and requirements to maintain a logbook and complete an annual renewal.^{26,27}

Collision avoidance

Many of the applications envisaged for drones, especially those in urban areas, will require them to operate in busy airspace. The Federal Aviation Authority estimates that over 7,000 aircraft are airborne within US airspace at any given time,¹³ and the safe integration of drones with other aircraft operations will emphasise the importance of drones having a robust 'sense and avoid' capability. This technology is in development, but is not yet mature enough to meet the requirements of regulators such as the CAA.²⁸

The potential for increased drone operations to raise the threat of collision between aircraft will likely be a key risk aggregation issue for insurers. Reports of 'near miss' events involving drones have begun to appear, and effective airspace control and collision avoidance technology will therefore be essential requirements for the insurance of drones operating in busy airspace.



Security

Cyber attack

Drones are exposed to a range of methods of cyber attack, and the expanding variety and value of tasks they undertake are expected to make them a target of interest for a growing range of hostile actors.²⁹

Most civilian drones rely on unencrypted data links for command and control and navigation, meaning they are particularly vulnerable to jamming, interception and manipulation. Researchers have highlighted the ease with which drones can be attacked electronically,³⁰ and some reports have suggested that a thriving community of 'drone hackers' is already established.³¹ Equipment capable of generating 'spoof' signals that enable a third party to control or disrupt a drone, together with jamming equipment able to block the satellite navigation signals that many drones rely on, is widely available at relatively low cost.

Vulnerability to cyber attack has not yet emerged as a major factor for insurers' assessment of drone risks, but it is likely that cyber security will be an increasingly important consideration for commercial drone operations.

Privacy breach

In the UK, the Information Commissioner's Office has included the use of drones within its 2014 CCTV Code, describing them as having a high potential for collateral intrusion due to inadvertent filming of individuals.³² The CCTV Code suggests that operators perform robust privacy impact assessments before operating drones for surveillance purposes; as part of this there is a recommendation that the recording system is not continuous to help avoid inadvertent and unnecessary filming.³² In the future it is possible that privacy impact assessments will become an integral part of authorisation to operate drones with surveillance capabilities.

Privacy concerns related to drone operations have become a particularly strong issue in the USA; some observers believe that this has been a key factor inhibiting the adoption of drones, and some local jurisdictions have debated legislation designed to authorise individuals to shoot down drones believed to be infringing privacy.³³

Professional indemnity insurance can cover the cost of legal fees and damages awarded for breach of privacy against drone operators. Demand for this type of cover is emerging, and key requirements for insurance will likely be the completion of privacy impact assessments and compliance with applicable regulations and laws (such as the Data Protection Act in the UK).³²

Drone manufacturers

Innovation and intellectual property

The growth in applications for drones relies predominantly on innovation by manufacturers. Intellectual property theft is a growing concern for many sectors in the context of emerging cyber threats, and insurance cover for drone manufacturers increasingly contains an element of intellectual property cover.

Product Liability

Past experience has shown that emerging technology often suffers some degree of malfunction or failure. Experience from other manufacturing sectors shows that manufacturers' liability does not end with the product leaving the production line - in the case of drones, rigorous research and testing before a product is released are essential to minimise risk.

Liability in the event of damage or bodily injury arising from an incident involving a drone is subject to some uncertainty. Regulatory requirements generally dictate that a human operator maintains active control of the aircraft, meaning that strict liability is retained by the operator. Nevertheless, a technical malfunction or failure (or indeed malicious attack, as described in Cyber attack) outside of the operator's ability to control could generate a significant incident and lead to claims for liability against a wider range of parties. Product liability therefore has the potential to be a significant risk exposure for drone manufacturers. Insurance solutions are available from specialist insurers, and these rely very heavily on drone manufacturers adopting robust testing, quality control and risk assessment procedures.

Conclusion

Drone technology has significant potential but is a particularly novel – and controversial – emerging technology. Insurance is expected to be a key component of the risk management framework that will need to be developed for the systems to operate safely and with due regard for third party interests. This report has identified three key areas that are likely to influence the availability of insurance solutions:

- **Regulation** is developing, albeit inconsistently between international jurisdictions. A robust regulatory framework is expected to be crucial to the provision of insurance for drone operations. Enforcement, licensing, harmonisation and clarity on third party liability will likely be important factors determining the effectiveness of any regulatory regime.
- **Safety** is expected to be a key public concern. As the technology matures, operator competence is likely to be the most important factor determining safety. Training and licensing schemes are emerging, and it is expected that these will be essential for the insurance of commercial drone operations. The integration of drones into busy airspace will likely also require further enhancements in ‘sense and avoid’ technology in order to achieve satisfactory de-confliction with other aircraft.
- **Security** risk has emerged owing to the vulnerability of drones to cyber attack, and their potential to infringe privacy. Cyber security could become an increasingly important consideration for the insurance of drones. Privacy considerations are driving demand for professional indemnity insurance, and management of this risk will likely require privacy impact assessments as well as compliance with applicable legislation.

As the market for drones continues to expand, manufacturers can expect to face increasingly complex and high value risk exposures. Protection of intellectual property and the management of product liability will also likely need to be considered in the scope of insurance cover.

Drones have the potential to enhance a significant range of activities. However, manufacturers, operators and regulators will need to work together, on a global basis, to ensure this technology is used safely and responsibly. Lloyd’s, by putting a price on risk, intends to work to support and inform these conversations.

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