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Grounded aircraft: An airfield operations perspective of the challenges of resuming flights post COVID

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ABSTRACT

The global COVID pandemic, national lockdowns and unprecedented decline in passenger demand worldwide has led to airlines cancelling services, furloughing staff, applying for financial support and placing aircraft into temporary storage. However, with finite space available, and up to two-thirds of the world's total passenger fleet grounded for an indeterminate period of time, airlines have been forced to park their aircraft in unusual places, sometimes at airports they do not normally serve and in volumes never normally experienced. The aim of this paper is to investigate the extent of grounded aircraft at UK airports and explore the challenges, from an airfield operations perspective, of resuming flights post-COVID.

1. Introduction

Air travel is a derived demand and an activity which reflects the health of the global economy. Although consumer demand for flight is cyclical, the long-term trend since the 1950s has been for continued and accelerated growth. Although commercial aviation has experienced a number of external shocks, including the 9/11 terror attacks, the 2003 SARS virus, and large volcanic eruptions, which have temporarily disrupted normal traffic flows and suppressed passenger demand (on which see [Blalock et al., 2007](#); [Pine and McKercher, 2004](#); and [Budd et al., 2011](#)), airline passengers have always returned, and in ever-increasing numbers. The indications with respect to the present situation concerning COVID-19 are very different, with predictions suggesting that it could take several years for traffic to recover to pre-crisis levels ([Harper, 2020](#)) during which time the airline industry will have undergone a dramatic reconfiguration ([Parker, 2020](#)).

Early academic analyses of the impact of the pandemic on air travel has included considerations of the dramatic implications for global passenger traffic ([Iacus et al., 2020](#)) and the ways in which future demand for air travel among particular consumer groups may be affected ([Graham et al., 2020](#)). Certainly, the 2020 COVID-19 pandemic and the international travel restrictions and dramatic decline in consumer demand that resulted from it, have already had an unprecedented impact on passenger aviation worldwide (see [Suau-Sanchez et al., 2020](#)). [Lee et al. \(2020\)](#) report that 194 countries introduced some form of cross

border control measure in response to the coronavirus pandemic which included travel and visa restrictions as well as complete border closures. As a consequence of these restrictions, in April 2020 IATA forecast that airlines will lose \$314 billion in passenger revenue owing to the coronavirus outbreak while the Director General described the loss of 50% of the sector's business as 'catastrophic' (cited in [Harper, 2020](#)). National 'stay at home' restrictions combined with the shutdown of large sections of the global economy (including the manufacturing and service sectors) plus individual consumer concerns about contracting the virus, have caused passenger demand to evaporate. Airlines responded to the sudden reduction in reservations, revenues and overcapacity by rationalising their network, cutting services, furloughing staff and/or making staff redundant, placing aircraft into temporary storage, and lobbying national Governments for financial support.

By the end of March 2020, it was estimated that the world's airlines had collectively requested US\$300bn in financial support in addition to US\$200bn requested by IATA ([Parker, 2020](#)). By mid-April 2020, it was reported that, worldwide, 17,000 aircraft (accounting for approximately 64% of the world's total passenger fleet) had been inactive for at least a week and had been placed in temporary storage ([Doyle, 2020](#)). By early May, airlines and original equipment manufacturers were announcing significant job losses. Virgin Atlantic announced it was cutting almost a third of its UK workforce while General Electric was reported to be considering cutting up to a third (or 13,000 jobs) of its global aviation workforce ([Webber, 2020](#)).

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In Europe, as the virus began to peak and passenger demand disappeared, airlines responded to the overcapacity by quickly taking aircraft out of service. However, with aircraft parking charges at major European airports often exceeding £200 per hour for the largest airframes, less expensive storage sites were required (see [Batchelor, 2020](#)). Some aircraft were dispatched to long-established desert storage locations in the US, while others were parked in a more ad-hoc manner wherever space permitted (see [Doyle, 2020](#); [Walton, 2020](#)) or ‘smart parked’ wingtip to wingtip on runways, taxiways and ramps of airports around the world ([Kotoky et al., 2020](#)).

Mass groundings of passenger aircraft occurred during the 2nd and 3rd week of March and, by Friday April 17, 2020, nearly 5000 passenger aircraft were being stored in 39 countries across the Eurocontrol area ([Eurocontrol, 2020](#)). Nearly a fifth of these (948) were in the UK with large numbers also stored in Germany (709), France (525) and Turkey (470). Three-figure numbers were also reported in Norway, Sweden, Switzerland, Belgium, Spain, Italy, the Netherlands, Austria, Portugal, Denmark and the Republic of Ireland ([Eurocontrol, 2020](#)). Interestingly, the location of these aircraft was not static and changed on an almost daily basis as airlines moved their assets between countries as the crisis developed (*Ibid*, 2020). The sudden need to store large numbers of aircraft for an unknown period of time posed unique and immediate challenges for airlines and airports alike.

In order to safely preserve an aircraft during an indeterminate period of inactivity, it is necessary to place them in a parked condition. This involves ensuring the aircraft is fuelled so that each tank has a minimum of 10% of its capacity (although operators may choose to uplift more to support ground engine and APU running, especially if the aircraft is stored at a location where there is no facility to refuel the aircraft or at a site where fuel hydrants have been temporarily deactivated). The weight not only acts as ballast but also ensures fuel seals and pumps remain adequately lubricated. Aircraft in a parked condition must also be powered down and engines and all external angle of attack and temperature sensors, vents, static ports and probes need to be covered to prevent contamination or ingestion of foreign objects such as dust, sand, insects or birds. Hydraulic and brake systems should also be periodically cycled to keep fluid circulating and aircraft should be secured with chocks rather than the parking brake in case the latter seizes on during long periods of inactivity ([Batchelor, 2020](#)).

Longer periods of inactivity may also require windshields, brakes and landing gear to be covered and protected in accordance with the aircraft manufacturer’s recommendations and airline-specific maintenance procedures. However, despite being in a parked condition, aircraft still require a basic level of care and maintenance support. This may include towing the aircraft to rotate the tyres to prevent flat spots, periodic ground engine runs and inspections of air conditioning units, steering and electrical systems. KLM detailed the level of support required for aircraft in its ‘Active Storage Programme’ (see [Cornelije, 2020](#)) and Virgin Atlantic reported that it was inspecting each of its grounded aircraft once every 7, 14 and 30 days ([Batchelor, 2020](#)). The process of placing an aircraft into parked condition is time consuming. It is estimated that it can take up to 60 h to place an A320 aircraft into parked condition, and a similar length of time to return it to active service ([Walton, 2020](#)).

Generally, the longer the period of parking (determined by the intervals stated in the Aircraft Maintenance Manual), the less periodic maintenance intervention is required. Longer term storage generally requires aircraft to be flown to remote locations where third-party MRO (Maintenance and Repair and Overhaul) companies are engaged to place aircraft into ‘deep storage’. This process may involve oil and fuel being drained from the engines and replaced with inhibiting fluids to reduce the need for periodic engine runs.

When deciding where to store their aircraft, airlines have to consider a number of factors. These include, but are not limited to:

- Space constraints (aircraft, even when parked ‘smartly’, take up a lot of airport real estate);
- The cost of parking the aircraft (some airports, including Amsterdam Schiphol, did not charge airlines to park aircraft there during the crisis (see [Cornelije, 2020](#)));
- The physical location of storage sites vis-a-vis airline maintenance facilities, technicians (whether own staff or third party contractors) and proximity to existing operating bases to maintain airframes and permit a rapid resumption of flights should demand rebound;
- The infrastructure constraints at particular airports in relation to the physical dimensions and weight of the airframes needing to be stored (particularly concerning runway length and the pavement bearing strength of taxiways which are not usually used for static storage);
- The availability of aircraft-type specific ground support equipment at (or ease of transporting it to) the intended storage location;
- The ownership of the airframes and its engines (whether they are owned outright or leased may have a bearing on where the airframes are stored);
- The safety and integrity of the airframe/s and their likely exposure to meteorological and climatic risk factors. For example, the spring climate in Europe is relatively humid and therefore not conducive to long-term aircraft storage on account of the corrosion risk. Spring is also bird breeding season which requires engines and sensors to be covered and checked regularly for signs of nesting activity. Airlines may also prefer to park aircraft at inland locations to prevent possible damage from exposure to saline coastal environments ([Batchelor, 2020](#)).

The data on aircraft groundings shows that even airlines based largely within one country have adopted very different strategic approaches to storage. Jet2 (a UK charter/low cost carrier) placed all their fleet into storage whereas easyJet and Ryanair retained around 30% of their fleet in active mode and dispersed the rest to their multiple European bases ([Eurocontrol, 2020](#)). Some of the airframes that are remaining active are being used to maintain a limited degree of air service connectivity. In the UK, for example, even at the peak of the crisis, a limited number of flights continued to operate between Belfast, Dublin, London, the Isle of Man, the Channel Islands and Scotland. UK full service carriers, meanwhile, prioritised storing larger, older, out of production models, or aircraft which were acquired as the result of take-overs or mergers and which are not aligned with the core fleet and are more expensive to operate. All 7 of Virgin Atlantic’s B747-400 fleet and 44 of British Airways ‘Very Large Aircraft’ (which includes A380, B747-400, and B777 models) were parked as of May 1, 2020 ([Eurocontrol, 2020](#)).

Virgin Atlantic has announced it is retiring its A340-600 and 747-400 fleet (as of mid-May 2020 the former were all at Bournemouth with a new owner while the latter were parked at Manchester). British Airways reportedly parted out one of its older B747-400 models in early May ([Needham, 2020](#)) and this pattern is being replicated worldwide. KLM is accelerating the retirement of its B747-400 passenger fleet while, in the US, American Airlines is retiring B767-300 ER aircraft and phasing out A330-200s and E190s while Delta are bringing forward the retirement of their MD-88s/90s ([Needham, 2020](#)). Although it is possible that some of these airframes may be converted into freighters (see [Budd and Ison, 2017](#)), given the sudden increase in supply of suitable airframes, it is likely that many will not fly again.

The mass global grounding of aircraft not only has major and wide-ranging implications for airlines and their employees but also for airports, air navigation service providers, maintenance contractors, third party handling agents and all the other sectors of the global economy (including international business travel and tourism) which rely on the provision of quick and efficient air services. While much of the focus of the crisis on aviation to date has understandably been on the disruption to passengers, loss of employment, dislocation of tourists, and financial impact on airlines (and to a lesser extent, perhaps, airports), the aim of

this paper is to investigate the extent of grounded aircraft and explore the challenges, from an airfield operations perspective, of resuming flights post-COVID. Since the UK is currently temporary home to the largest number of aircraft stored in the Eurocontrol area, the country is used as a case study to exemplify the broader challenges facing airfield operations teams when flights begin to restart after the pandemic peaks and international travel restrictions begin to be eased.

2. Data

In order to understand the scale and location of the aircraft groundings, empirical data was derived from EUROCONTROL's Performance Review Unit (PRU). The PRU collected details of every aircraft (registration, type, category and owner) that last landed in the EUROCONTROL area between the 15th February and May 1, 2020 and which have been inactive since (Eurocontrol, 2020). Inactivity was determined by the lack of a flightplan filed for an individual aircraft. The PRU data excludes military flights, circular flights, unknown operators and special operators but includes aircraft registered to private jet operators. The data is assigned to the operator of the last flight (which may be different to the owner of the aircraft). Data is available for all European airlines, European registered aircraft and airports within the Eurocontrol area. For the purposes of this paper, data pertaining to UK airports was extracted. The UK was selected as at the time the analysis was conducted the country had the greater number of stored airframes in Europe.

3. Findings and discussion

As of May 1, 2020, 5208 aircraft were grounded across Europe. Of these, 873 (17% of the European total) were grounded in the UK. Although the aircraft were dispersed around the country, 20 airports collectively accounted for the majority of storage locations with 754 airframes (86% of the UK total) grounded at these sites. Table 1 shows the type of passenger aircraft which were stored at these 20 sites.

The largest number of aircraft were stored at London Gatwick LGW

(114), followed by London Heathrow LHR (83) and London Stansted STN (81). The highest density and concentration of stored aircraft in England was in London and the southeast. Smaller clusters were evident in the northwest of England, the Midlands and Southwest. In Scotland, only two airports, Edinburgh and Glasgow, were in the top 20. 14 aircraft were stored in the Welsh capital, Cardiff. Two of these airports – Biggin Hill (BQH) and Farnborough (FAB) – are private business aviation airports and do not handle scheduled commercial flights. Although not featuring in the top 20 locations, smaller numbers of aircraft were also reported as being stored at London City and Newcastle airports (Eurocontrol, 2020). The scale of these groundings presents a number of key challenges to both airlines and airports. In the subsections that follow, the implications of the short-term storage of aircraft are discussed before the longer-term challenges, from an airfield operations perspective, are considered.

3.1. Storage location

By cross referencing the Eurocontrol data on the location of stored aircraft with pre-COVID airline schedules, it is apparent that airlines have parked some of their aircraft at airports that they do not normally serve with commercial flights (see Table 2). Of the 569 grounded aircraft that were registered to UK-based airlines, 507 (89%) were parked at airports where the operating airline has a regular commercial operation. 5 of the 8 UK airlines also temporarily parked aircraft at airports that they do not serve with commercial flights. 2 Virgin Atlantic aircraft were parked at airports the airline operates a seasonal service from.

Bournemouth airport, for example, which does not normally have any scheduled British Airways (BA) flights, was the storage location chosen for a large number of BA's narrow-body Airbus fleet. Virgin Atlantic aircraft were likewise recorded at Bournemouth and Doncaster Sheffield airports, neither of which supports commercial Virgin Atlantic services. Jet2 and TUI Airways have also stored aircraft at locations they do not normally serve. Another interesting feature of the data is that some airports which do support commercial operations by UK airlines

Table 1
Location and types of all passenger aircraft stored at UK airports, May 1, 2020.

Rank	ICAO/IATA Code	Airport	Type of aircraft					Total	
			Commuter (turboP)	Narrow Body	Other	Regional Jet	Very Large		Wide Body
1	EGKK/LGW	London Gatwick		97				17	114
2	EGLL/LHR	London Heathrow		32			15	36	83
3	EGSS/STN	London Stansted		64	14	3			81
4	EGCC/MAN	Manchester	8	48		4	4	8	72
5	EGHH/BOH	Bournemouth		37	15	3	8		63
6	EGGW/LTN	London Luton		30	7	5			42
7	EGPF/GLA	Glasgow	3	26	4	4			37
8	EGKB/BQH	Biggin Hill			24	11			35
9	EGSH/NWI	Norwich		10		18			28
10	EGMC/SEN	London Southend		19		6			25
11	EGCN/DSA	Doncaster Sheffield	13	5			4	22	
12	EGGD/BRS	Bristol	17	4				21	
13	EGBB/BHX	Birmingham	6	13	1		20		
14	EGGP/LPL	Liverpool		16	4			20	
15	EGPH/EDI	Edinburgh	8	8	2			18	
16	EGLF/FAB	Farnborough		7	9			16	
17	EGNX/EMA	East Midlands		12	4			16	
18	EGNM/LBA	Leeds Bradford		15				15	
19	EGFF/CWL	Cardiff				6	8	14	
20	EGTE/EXT	Exeter	7	5				12	
Grand Total	32	457	94	65	33	73	754		

Table 2
The storage location of aircraft grounded by UK registered airlines at UK airports.

Airline	Number of Grounded Aircraft			Grand Total
	At airports with a Commercial Operation	At airports Without a Commercial Operation	At airports with a Seasonal Commercial Operation	
BA Cityflyer	16	2		18
British Airways	123	48		171
easyJet	151			151
Jet2.com	88	3		91
Loganair	17			17
Ryanair	53			53
TUI UK	43	1		44
Virgin Atlantic	16	6	2	24
Grand Total	507	60	2	569

appear to be underutilised as storage locations. Examples include Newcastle, Southampton and Prestwick.

There are likely to be a multitude of reasons for this including availability of space and cost of parking. Taking the former point - some airports, including Heathrow, have a relatively small physical footprint and aircraft parking space is at a premium. Other sites also already have a number of aircraft in storage following the failures of Thomas Cook and Flybe and the global grounding, for safety reasons, of the Boeing 737MAX which further limit their parking capacity. For example, former Flybe aircraft were already in storage at Exeter and Southampton before the Eurocontrol data was compiled and so they are not recorded. Likewise, the three former Thomas Cook A330 airframes and five TUI B737MAXs at Manchester are not captured by the data. Given the number of aircraft on the ground and the lack of flights, some aircraft have been parked on regular stands adjacent to terminal buildings or placed on remote stands. However, as demand increased, aircraft increasingly had to be 'smart parked' on ramp areas not usually reserved for parking. At some sites, including Bournemouth and Glasgow, aircraft have been parked on taxiways.

In terms of aircraft parking charges, it is likely that airports have waived some or all of the parking costs and not charged airline operators the published rates for storing their aircraft. Commercial as well as practical considerations could therefore have influenced airlines' choice of storage location but the impact of charges on airline decision making cannot be determined owing to the commercial sensitivity of any deals. It is worth noting, however, that where aircraft are parked at regular operating bases, there is often a commercial clause in the contract between the airline and airport operator which states the number and type of aircraft which can be based (and hence parked) at the site and for which no additional fee could be levied. The fact that large numbers of aircraft are grounded and stored in often atypical locations has important implications for aircraft maintenance (and thus labour), logistics, and future airport operations.

3.2. Maintenance and labour implications

The fact that aircraft are stored in unprecedented numbers and often in the 'wrong' places poses a number of immediate practical challenges as well as longer-term issues. In the short term, the airlines and their support teams may not have sufficient quantities of aircraft chocks and engine covers, even at major maintenance bases. In Finland, for example, it was reported that Finnair had to commission a local carpentry firm to make enough chocks to secure their grounded fleet (as that number of aircraft had never before been on the ground all at the same time). Other issues arise if different types of aircraft to normal are stored at particular locations as each airframe requires type-specific ground service equipment (such as ground power units and towbars) which may not be available at all sites. In addition, aircraft engineers are type-qualified and although some are qualified to operate on multiple types, others are not and in the event of staff being furloughed there may not be the required complement of qualified staff at each site and so staff may be obliged to travel to other locations to service the aircraft, with all

the time and additional costs this practice will incur.

Longer-term labour issues, which may manifest themselves when operations begin to restart, concern the validity of airside passes, airside driving permits and the currency of flight and cabin crew. For security reasons, staff airside passes in the UK are 'parked' and deactivated if they have not been used for 60 days. In response, to COVID-19, the UK Department for Transport extended this period to 120 days. Airports are also extending the validity of airside driving permits, although at the time of writing owing to UK social distancing requirements, they cannot undertake new tests or perform revalidation checks. In terms of flight and cabin crew, there is substantial evidence that long layoffs in safety critical sectors such as medical surgery and aviation impact on an individual's skills and staff need to retain (or regain) professional 'currency' before resuming normal duties (see [Hardie and Brennan, 2020](#)). For pilots and cabin crew, high fidelity flightdeck and cabin simulators may be required to retain currency (see [Budd and Adey, 2009](#)).

A further challenge will concern staff redundancies and furlough periods across other job roles and job families. In the UK, companies including British Airways, easyJet, Rolls Royce, Airbus and Ryanair announced thousands of redundancies by June 2020, despite the fact that many of them had accessed the UK Government's Coronavirus Job Retention Scheme (CJRS) which paid the salaries of furloughed staff at 80% up to a maximum threshold of £2500 a month ([Parliament.uk, 2020](#)). Many of these redundancies were made to highly-skilled and well remunerated roles including aerospace engineers and flight crew. However, lower paid, and already relatively insecure employment, in third party ground handling, aircraft catering, airport security search and cleaning roles have been affected by redundancies (see [Chapman and Wheatley, 2020](#)) and furloughs and attracting staff to these less aspirational roles when flights resume could be challenging. In addition, airlines often contract engineering services (particularly those performed away from base) to third party MRO companies such as Storm at Manchester. The majority of ground handling, catering, and refuelling activity is also subcontracted. All elements of the delivery chain will have to function in a coordinated manner for aircraft to be returned to service. Depending on the speed at which flight operations recommence there may be a challenge in aligning all these third parties. It also depends on all of the companies surviving until operations restart. Cross cutting all of these issues of course is the fact that if staff are trained to a particular aircraft type (for example cabin crew), this could exacerbate the skills and numbers shortage when operations restart.

The potential loss of skilled and experienced operational staff may also impact the resumption of services. Airline and airport operations rely on tacit knowledge (i.e. on experience, intuition and information which cannot formally be taught) and finding creative solutions to operational challenges (see [Broekel and Boschma, 2012](#)). Anecdotal evidence suggests that in times of disruption commercial interests are put to one side and people employed by different companies are prepared to work together for the common good (see [Kwong and Lee, 2009](#)). With many staff furloughed or having been made redundant, this knowledge base risks being depleted.

A further complication to add to an already challenging situation

concerns the ownership of particular airframes and engines. Worldwide, aircraft leasing has become a major component of the airline industry (see Boeing, 2019). While leasing offers a number of important financial benefits to airlines, it complicates the issue of storage, particularly where different companies own the engines and airframes. There is a legal obligation for airlines returning aircraft off-lease or terminating leases early to return airframes in the condition in which they were received. This may mean performing engine changes on grounded aircraft to reunite airframes with particular engines. In the case of former Thomas Cook and Flybe aircraft, some airframes are still waiting for administrators to find new owners or determine their ultimate fate. This too has implications for airfield operations as parting out (scrapping) non-airworthy airframes on an active airfield is far from ideal owing to the disruption and safety risk posed by the reclamation process and the foreign object debris it would inevitably generate.

Some airlines have, however, been able to use the unscheduled 'downtime' of aircraft to perform deep cleans and time-consuming C and D checks which are heavy maintenance tasks which have to be performed at approximately 2- and 6-year intervals (Batchelor, 2020). Normally aircraft have to be taken out of service for these tasks to be performed so being able to do them when there is no requirement for the aircraft to be in revenue service is one minor benefit for some airlines.

4. Challenges of resuming flights post -COVID

As previously noted, not all airlines have grounded their entire fleet of aircraft. As of May 1, 2020 31% of the BA and Ryanair fleets remained active. This means these airlines may be more agile and able to resume flights more quickly than competitors who have parked 100% of their fleet. Keeping a proportion of the fleet in active mode is not without its costs in terms of labour, maintenance and fuel, but it does mean airlines that do can respond to changes in restrictions or an upturn in passenger demand before their competitors and so potentially gain market share and enjoy first mover advantage. By dispersing aircraft between airports (and, in Ryanair's case only storing those that are parked at existing bases) also arguably offers more flexibility when it comes to resuming services. EasyJet have already indicated that they intend to resume limited domestic services within the UK and France in mid-June 2020 (Partridge, 2020) with other airline operators likely to follow suit soon afterwards if regulations permit.

The resumption of services will have a significant impact on airfield operations staff and the need for safe coordination in a time-critical period will arguably never be more acute. Aircraft may need to be towed around the airfield to free up space or to enable them to undergo maintenance in a hanger before being returned to service. The movement of aircraft that will not be returned to service (either in the short term or those that have been permanently withdrawn from use) will also require careful coordination.

Other short-term impacts may result from the possible need for aircraft to undergo additional cleaning and disinfection between flights as this will increase turnaround times and stand utilisation times and make airport assets less efficient in addition to increasing airline costs. Although it is possible that the first wave of post-COVID services might depart with no catering, regulations still require airlines to carry potable water.

Ultimately the way in which operations resume will have to be location-specific and take in account the unique site and situation of the airport in question. Some airports have phased out the use of one or more terminals and runways through COVID-19 (for example Manchester is only operating T1 out of the usual three, London Gatwick is only operating the North Terminal and operations from second runways have also temporarily ceased). Multi terminal and multi-runway airports could potentially plan for a phased return of assets in which terminals and airfield assets are progressively brought back into operation as demand dictates, but given airlines have lounges and equipment in particular terminals, and simultaneous multi-runway operations place

additional requirements on rescue and fire fighting services and airfield operations teams, this too could prove problematic. The challenges of processing passengers through check-in and security in a timely manner to facilitate on-time departures given the likely continuation of social distancing should also not be underestimated.

5. Conclusion

The commercial air transport industry is facing an unprecedented challenge and considerable uncertainty remains over when, if, and under what conditions, passenger flights will resume and passenger demand return to pre-COVID levels. Airlines responded to the downturn by grounding aircraft. The location that was chosen for parking the aircraft was informed by both practical geographical and logistical considerations but also by financial ones with airlines seeking to minimise outgoings while parking their aircraft in near 'flight ready' condition.

When the decision is taken to resume services, airfield operations will be central to the safe resumption of flights. Careful coordination will be required to protect the safety and integrity of the airfield and the aircraft parked on it while ensuring as easy and as safe a transition back to normal operations as possible. A return to operations 'as normal' is likely to take time and the staggered timing of the start of the outbreak and its peaks in different countries mean that the impact on passenger demand will continue for far longer than it did after previous pandemics as border and travel restrictions remain and passengers remain cautious about flying. Whereas airlines have previously been adept at stimulating demand for flights through low fares, evidence from China, where loss-leading \$20 fares could not stimulate demand, suggest passengers remain cautious (Parker, 2020). Until consumer confidence returns in sufficient volumes and international regulators and Governments agree a coordinated response, the air passenger sector will continue to face a challenging future.

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