SERIOUS INCIDENT

Aircraft Type and Registration:	Embraer E55P Phenom, D-COLT	
No & Type of Engines:	2 Pratt & Whitney Canada PW535E turbofan engines	
Year of Manufacture:	2014	
Date & Time (UTC):	12 March 2019 at 1505 hrs	
Location:	Runway 23R, Manchester Airport	
Type of Flight:	Private	
Persons on Board:	Crew - 1	Passengers - 3
Injuries:	Crew - None	Passengers - None
Nature of Damage:	None reported	
Commander's Licence:	Airline Transport Pilot's Licence	
Commander's Age:	44 years	
Commander's Flying Experience:	4,933 hours (of which 746 were on type) Last 90 days - 22 hours Last 28 days - 11 hours	
Information Source:	Aircraft Accident Report Form submitted by the pilot and further enquiries made by the AAIB	

Synopsis

While the aircraft was lining up on Runway 23R from intersection J1 at Manchester Airport, the sun's glare on the wet runway made it difficult for the pilot to see the runway markings. He aligned the aircraft with the runway edge stripe, rather than the centreline and, as instructed by ATC, commenced a rolling takeoff.

The ATCO noticed the misalignment and instructed the aircraft to abandon its takeoff, which it did without damage or injuries to those onboard. Several safety actions have been undertaken by the airport authority and the air traffic service unit.

Description of the event

The pilot was performing his third departure in D-COLT from Manchester Airport, the first on that day. He reported that while holding at holding point J1 (Figure 1), he received an ATC instruction to line up and wait on Runway 23R after a landing aircraft. He recalled that when lining up, he accepted an ATC request for a rolling takeoff[1] because of an aircraft on final approach. D-COLT was then cleared for takeoff.

Footnote

[1] A 'rolling takeoff' involves an aircraft taxiing on to the runway and commencing its takeoff roll without stopping. The air traffic services unit stated that this is not a standard phrase in use at Manchester and did not provide a recording or transcript to determine if it was used on this occasion.

The pilot reported rain and gusty conditions. While he was lining up, the sun breaking through the clouds caused glare from the wet runway, making it difficult to see. As he taxied past the angled edge of the turning circle, he perceived it to be the edge of the runway shoulder[2] (Figure 1). Then on sensing that the aircraft was running over runway lights, he thought the aircraft was on the centreline. He turned the aircraft accordingly and was facing the low sun as he began the takeoff roll.

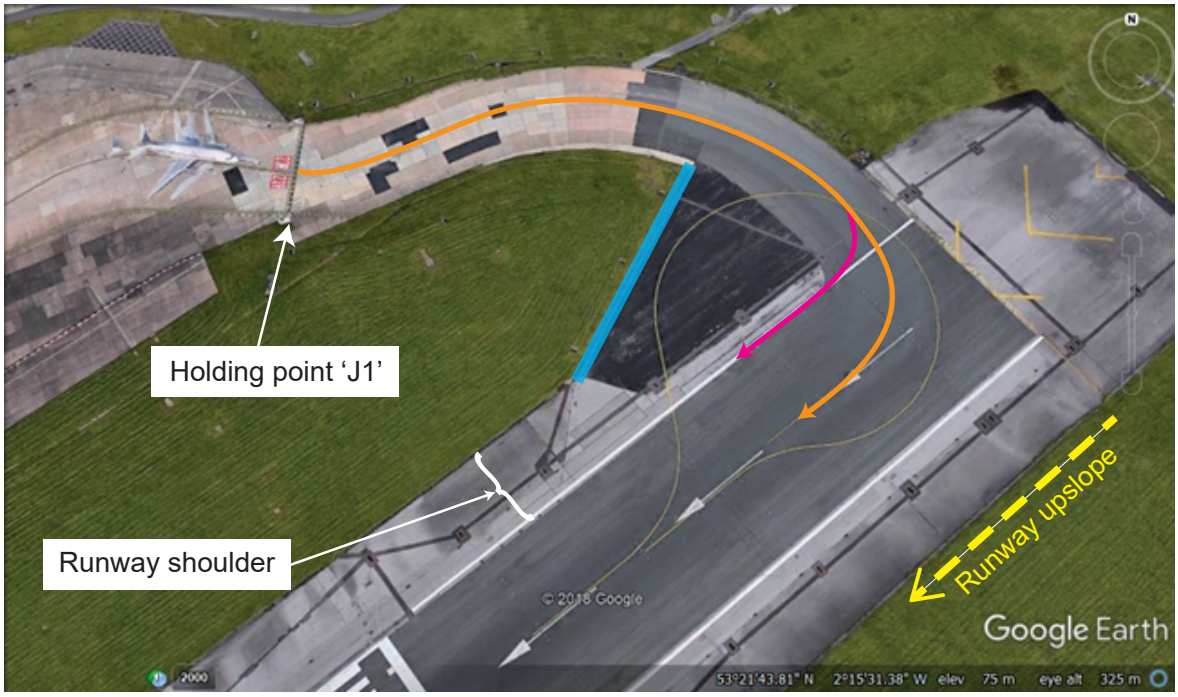

Figure 1

J1 intersection showing D-COLT's line-up track

The runway's lighting was on a 'day' setting which meant the runway edge lights were in operation, and the lead-on[3] lights were not.

The ATCO, watching from the visual control room (VCR), realised the takeoff didn't look "right". He checked the surface movement radar (SMR) which showed D-COLT tracking the right runway side stripe, so instructed the aircraft to stop and cancelled its takeoff clearance. He instructed the aircraft on final approach to go around.

Footnote

[2] An area between the edge of the runway and the adjacent surface, for assisting aircraft running off the pavement; drainage; and sometimes blast protection.

[3] Alternating green and yellow lights which guide aircraft on and off the runway.

D-COLT's pilot recalled hearing "D-COLT, stop taking off, stop taking off" from ATC so promptly rejected the takeoff[4]. He recalled the aircraft's airspeed to have reached around 80-90 KIAS. While decelerating, he realised the aircraft was misaligned on the runway. He reported that the aircraft came to a halt next to F1 (Figure 2), then after a conversation with ATC he taxied again for departure without delay.

Aircraft information

The Embraer E55P Phenom is a twin engine corporate jet flown in this case by a single pilot[5].

Airfield information

Aeronautical Information Publication

The UK Aeronautical Information Publication for Manchester Airport stated that Runway 23R was 45 m wide, with widened runway shoulders of 23 m on either side of the side stripe markings, giving a total paved width of 91 m.

It outlined *'Surface movement guidance and control system markings'*[6] including:

> *'Runway marking aid(s): …05L/23R: Runway designation. Runway threshold, runway centre-line, edge, TDZ and fixed distances. Runway width is designated by side stripe markings…*
>
> *Stopbars[7] at runway entrance points are in operation H24…*
>
> *Pilot attention is drawn to the use of additional paint markings at specified runway entrance and exit points. These markings are provided as an additional measure to raise situational awareness and to reduce the runway incursion risk.'*

Pilots' airport charts

The pilot was using commercially available airport charts[8] for Manchester[9].

Chart 10-1P2 '*Airport briefing*' – '*Taxi procedures*' section stated:

> *'RWY05L/23R has a turning circle at the Northeastern end, ABEAM Link J, for use by ACFT up to A380…*
>
> *All turning circles have unlit painted centerline and blue edge lighting beyond the RWY edges.'*

Footnote

4 This is a recollection and not a transcript of the words transmitted by the ATCO.
5 Referred to as a single-crew operation – as opposed to a multi-crew operation which requires two or more pilots.
6 AD 2.EGCC-1 (31 Jan 2019)
7 Stopbar – a set of unidirectional red lights embedded in the pavement across the width of the taxiway at runway holding positions. Aircraft should not cross stopbars when they are illuminated.
8 Airfield charts – booklets which present information from the AIP for operational use by pilots.
9 Accessed 15 Aug 2019 – some of the individual charts cited in this report had been amended after the date of the accident. However the information quoted was validated using Manchester's AIP, or because it referred to dimensions and structural characteristics of the runway surface, and therefore was unlikely to have changed.

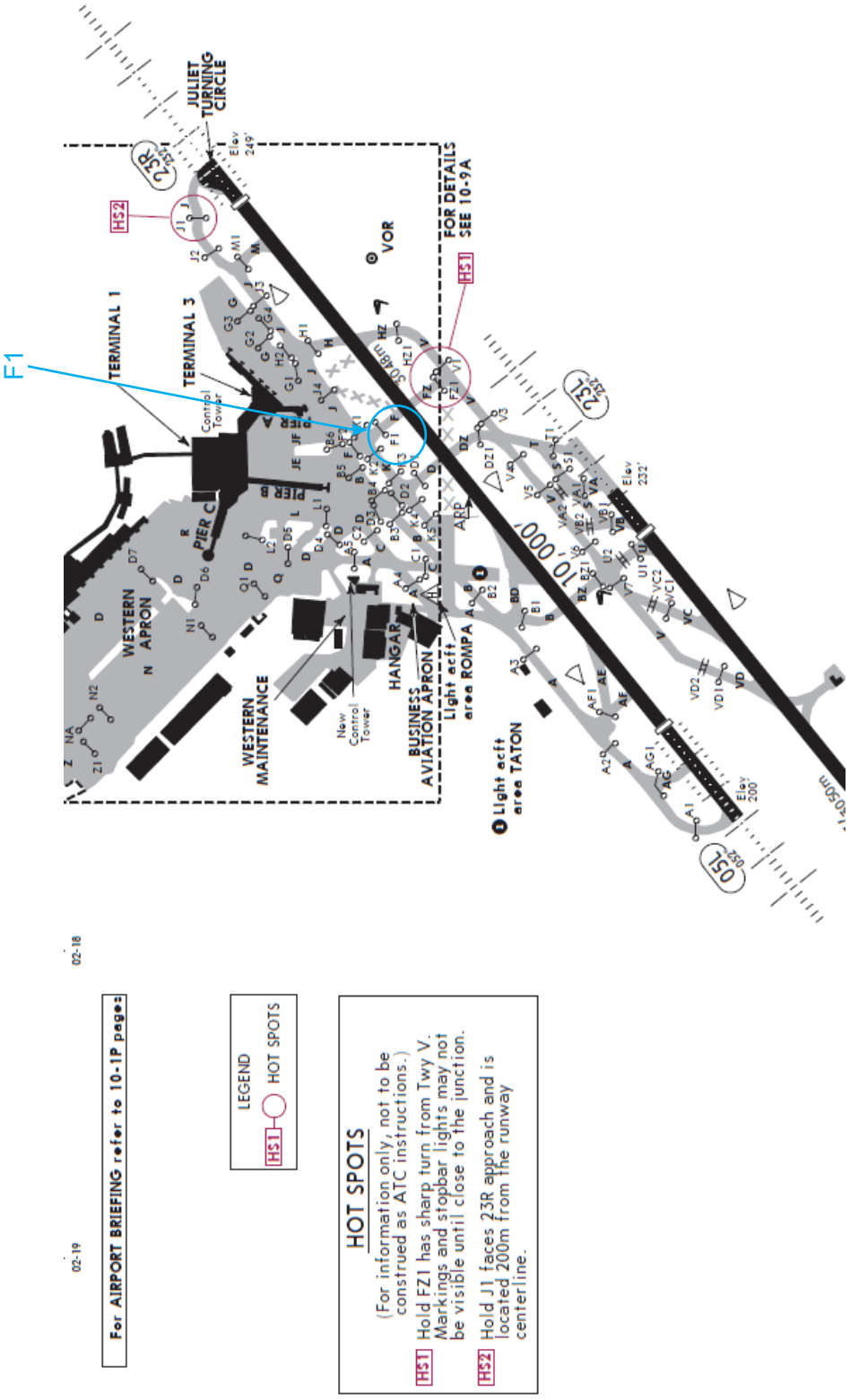

Figure 2

Excerpt from chart 10-9

The section later stated:

> *'RWY05L/23R: The hard shoulders outboard of the RWY side stripes have only 25% of the RWY bearing strengths and should not be used by ACFT turning on the RWY or when backtracking…'*

Chart 10-1P3 stated:

> *'Pilots should note that RWY05L/23R has a convex profile, the highest point is ABEAM TWY HZ.'*

Chart 10-1P6 stated:

> *'When lined up for take-off from RWY05L/23R, the full length of the RWY surface may not be visible from the flight deck.'*

The pilot used chart 10-9 during taxiing (Figure 2). Following is an excerpt of that plate, including Runway 05L/23R; Juliet turning circle; Hot Spot 2[10] and its definition; and HZ.

Previous event

On 7 March 2018 at 1527 hrs a Cessna Citation, S5-ICR, lined up on Runway 23R via intersection J1 and began its takeoff roll. The ATCO, who was the same person as the ATCO subsequently involved in the D-COLT occurrence, noticed S5-ICR appeared to be tracking the right runway side stripe. This was confirmed by checking the SMR. He reported attempting to alert the crew saying '[CALLSIGN] YOU APPEAR TO BE OFFSET TO THE RIGHT OF THE RUNWAY, CONFIRM YOU ARE CORRECTING TO THE CENTRELINE'. However, he stated that he used the incorrect callsign, and received no response. Then S5-ICR became airborne.

The air navigation service provider (ANSP) Management System Safety Report for that occurrence described the weather as 'good daylight', and the runway as mainly dry. It stated that the crew subsequently reported having no recollection of anything unusual.

Information from the pilot

D-COLT's pilot stated that when lining up he would normally taxi the aircraft forward to the runway centreline and then turn in the takeoff direction. In this event he believed he was distracted by a combination of the takeoff clearance discussion during line-up and the disorienting effect of the sun's glare on the wet runway. He was conscious of the inbound traffic, and the rolling takeoff reduced the opportunity to check his position.

Footnote

[10] A location on an aerodrome movement area with a history or potential risk of collision or runway incursion, and where heightened attention by pilots/drivers is necessary. (ICAO Doc 9870, Manual on the Prevention of Runway Incursions).

The pilot commented that he mainly operated D-COLT at smaller airfields with runway widths of less than 30 m. He indicated that he was aware of the convex profile of Manchester's Runway 23R but the "picture" of what he thought was the lit centreline in front of him, with 23 m of paved surface to the side, seemed normal to him.

The pilot reported the event has reminded him not to forget "aviation basics". He cited other ways to orientate the aircraft's position during lining up, including using the ILS localiser[11], the aircraft's synthetic vision system[12], and thorough briefing.

The sun's orientation could be considered in threat and error management[13] (TEM).

Information from ATC

Manchester air traffic services unit

The ATCO reported that while he saw D-COLT moving on to the runway he was also monitoring the aircraft vacating the runway and the aircraft on final approach. The General Manager of the air traffic services unit (ATSU) reported that it can be difficult to determine the precise position of aircraft entering the runway at J1, which is some distance from the VCR and involves a large expanse of tarmac. The ATCO stated that in both occurrences he used SMR to confirm the aircrafts' positions (Figure 3).

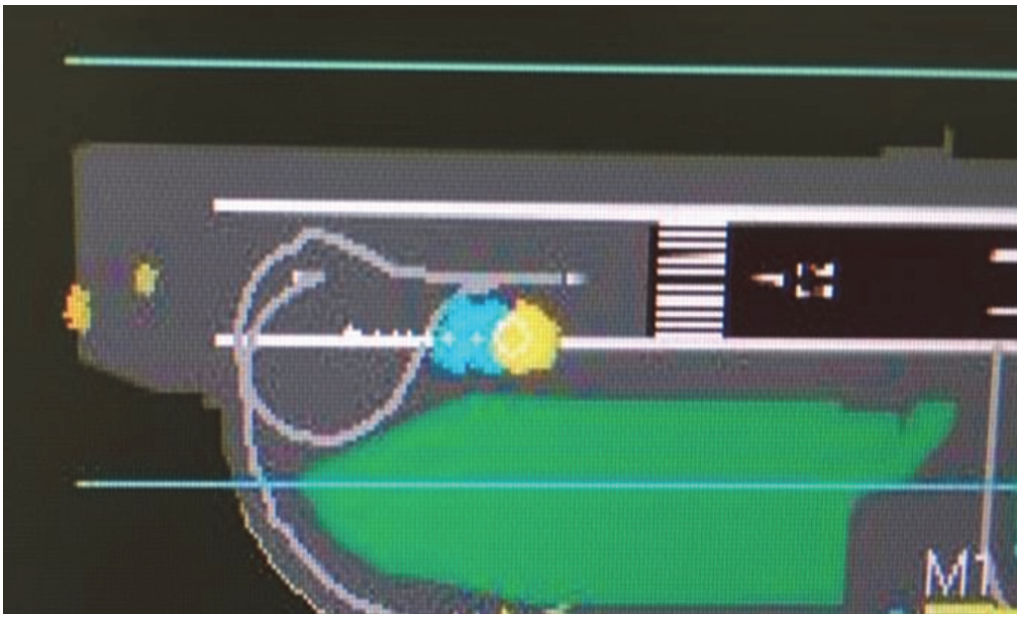

Figure 3

Image of SMR at the commencement of D-COLT's takeoff roll

Footnote

[11] The part of the instrument landing system which guides aircraft in azimuth.
[12] Combines three-dimensional data into intuitive displays, for improved situational awareness of flight crew.
[13] TEM – dynamic process by which pilots identify threats and potential errors, and implement strategies to manage them. TEM can be included in crews' departure and arrival briefings.

The ATCO stated that upon realising D-COLT was tracking the runway edge stripe, he considered its airspeed as being in the mid-range of its takeoff roll. Given the runway shoulder's lower load bearing strength, he was concerned about potential debris from it, so he instructed the aircraft to stop. He recalled it was in the vicinity of M1 (Figures 2 and 3) when he did so.

The ATSU Investigation Report for the D-COLT occurrence stated:

> *'The controller reacted swiftly and showed good scanning technique in observing the incorrect positioning of the aircraft at such an early stage.'*

Under the heading '…Learning points to be shared within unit and across NATS' that report stated:

> *'The importance of using the SMR to ensure that departing aircraft are correctly lined up on the runway prior to departure. This is especially pertinent when small aircraft are operating on large runways (and with large shoulder areas) like Manchester Runway 23R via HP. J1'*

Regulations

The CAA's CAP 493, Manual of Air Traffic Services (MATS), Part 1, states under *'Cancelling Take-off Clearance'*:

> *'…In certain circumstances the aerodrome controller may consider that it is necessary to cancel take-off clearance after the aircraft has commenced the take-off run. In this event the pilot shall be instructed to stop immediately and to acknowledge the instruction.*
>
> *…The cancellation of a take-off clearance after an aircraft has commenced its take-off roll should only occur when the aircraft will be in serious and imminent danger should it continue.*
>
> *…As the aircraft accelerates, the risks associated with abandoning the take-off increase significantly. For modern jet aircraft, at speeds above 80kt flight deck procedures balance the seriousness of a failure with the increased risk associated with rejecting the takeoff. For example, many system warnings and cautions on the flight deck may be inhibited during the take-off roll, and between 80kt and V1 most aircraft operators define a limited number of emergency conditions in which the take-off will be rejected. Consequently, at speeds above 80kt, the take-off clearance should normally only be cancelled if there is a serious risk of collision should the aircraft continue its take-off, or if substantial debris is observed or reported on the runway in a location likely to result in damage to the aircraft. The critical speed will be dependent on the aircraft type and configuration, environmental conditions and a range of other factors but, as a general rule, for modern jet aircraft, it will be in the region of 80kt airspeed. The typical distance at which a jet aircraft reaches 80kt is*

approximately 300m from the point at which the take-off roll is commenced. The unit MATS Part 2 shall contain further guidance on the likely position on the runway at which those aircraft types commonly using the aerodrome typically reach 80kt.'

Manchester's MATS, Part 2, stated under *'Cancellation of takeoff clearance'*:

'MATS Part 1 provides guidance for controllers when considering the cancellation of a take-off clearance after an aircraft has commenced its take-off roll.

There are very few circumstances in which it is appropriate to cancel a take-off clearance when an aircraft is travelling at significant speed. The following maps[14] present a guide to controllers on the points beyond which it is likely that an aircraft taking off will be travelling in excess of 80kt. If the aircraft has passed the appropriate point, the cancellation of a take-off clearance should only occur when the aircraft is in serious and imminent danger.'

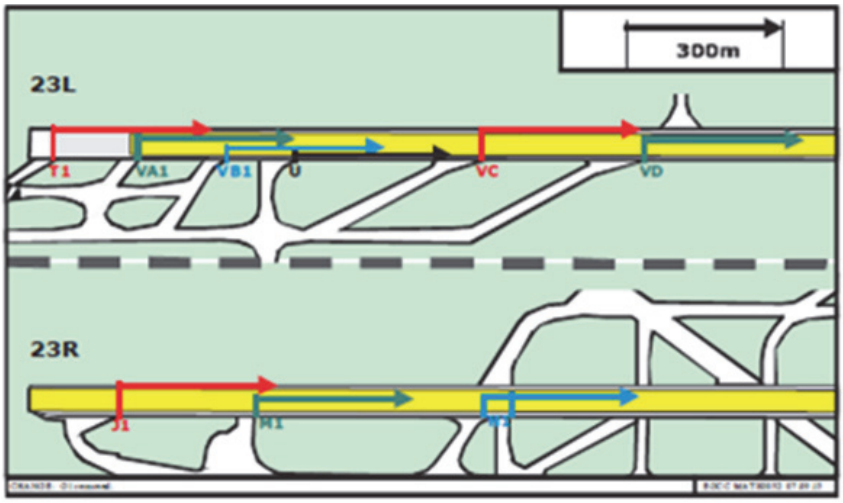

Figure 7 Cancellation of Take-Off Clearance map - Westerlies

Information from the airport authority

The airport authority reported that, in accordance with its procedure for runway excursions[15], a runway inspection was performed immediately after the event[16] and assessed the condition of the painted line leading on to the runway as "good". It explained that hot spots are normally associated with runway incursion[17] events.

Footnote

[14] Only the map for westerly takeoffs is included in this report because of its relevance to this serious incident.
[15] Runway excursion – A veer off or overrun of the designated runway surface.
[16] A runway inspection was also performed after the S5-ICR occurrence.
[17] Runway incursion – The incorrect presence of an aircraft, vehicle, or person on the designated runway surface.

Analysis

Lining up

Both the D-COLT and S5-ICR serious incidents involved aircraft lining up on the right edge stripe of Runway 23R, via intersection J1.

J1 was already a hot spot for runway incursions because of its obtuse orientation to, and distance from, the runway centreline. The shape of the turning circle, the 23 m widened runway shoulders, the lit runway edge lights and the unlit lead-on lights, may have contributed to the pilots' mis-perception of the centreline position. Furthermore, the relatively small size of both aircraft would have caused increased difficulty for the pilots seeing over the runway's convex profile, along its full length.

D-COLT's pilot was operating as the sole pilot, without what would be the additional support provided by a multi-crew operation. Despite the painted runway lead-on line, the sun's glare on the wet runway caused him difficulty in seeing. Further, the amended line-up clearance due to inbound traffic, and the prompt nature of the rolling takeoff, reduced his opportunity to check the aircraft's position. Therefore, though he had departed Manchester on two previous occasions, the pilot was unaware he was tracking the edge stripe until after he had been asked to stop by ATC. Because he was used to operating D-COLT from smaller airfields, lining up on a lit stripe with 23 m of paved surface to the side looked normal to him.

As a result of the two occurrences the airport authority has undertaken to instate a 'runway excursion' hotspot at J1, in addition to the incursion-related hotspot 2. It is reconfiguring its lighting so that J1's lead-on lights will always illuminate when its stopbar is lowered, regardless of the ambient light conditions. It intends to apply green paint to the areas of the J1 turning circle outside of the runway edge lighting, giving the impression of grass.

The ANSP confirmed it is undertaking safety action to promulgate the lessons from both occurrences across all its airport units, by including them in its upcoming annual refresher training course for ATCOs and otherwise. This will highlight the use of SMR for monitoring aircraft lining up, particularly small aircraft on large runways with wide shoulders.

That monitoring function would be particularly beneficial for aircraft operated by a single pilot.

The D-COLT and S5-ICR events occurred at a similar time of day, a similar time of year, and therefore with a similar orientation of the sun. Ambient light conditions could be included in threat and error management by pilots and ATCOs.

Further, aside from careful taxiing using airfield charts, the aircraft's line-up track could be briefed by pilots, and then confirmed by the localiser and synthetic vision system.

Cancelling of takeoff clearance by ATCOs

Despite it being difficult to determine the precise position of aircraft entering the runway at J1 as seen from Manchester's VCR, on both occasions the same ATCO noticed the involved aircraft's misalignment, checked SMR, and transmitted messages to alert the aircraft.

MATS parts 1 and 2 explain that the risks associated with abandoning the takeoff increase significantly as the aircraft accelerates. For speeds above 80 KIAS, most operators define a limited number of conditions which require the takeoff to be rejected. Therefore, ATCOs should only cancel a takeoff clearance for aircraft travelling above 80 KIAS if there is a serious risk of collision, or if substantial debris is observed or reported on the runway in a location likely to result in damage to the aircraft.

In the S5-ICR event, the ATCO attempted to alert the crew by describing the problem: "… YOU APPEAR TO BE OFFSET TO THE RIGHT OF THE RUNWAY, CONFIRM YOU ARE CORRECTING TO THE CENTRELINE". However, he used the incorrect callsign, which may be why he received no response.

In the D-COLT event, although the ATCO could not see any debris, he was concerned about the risk of it from the lower-strength runway shoulder, so instructed the aircraft to stop. The aircraft was in the vicinity of M1 – which is around the '80 KIAS' point described by MATS 2 – with a reported airspeed in the vicinity of 80 KIAS, when he did so. The aircraft stopped safely and taxied back for a second departure without delay.

Through effective scanning by the ATCO and aircraft handling by the pilot, and prompt reactions by both, the outcome of the D-COLT event was successful. However, in cases involving accelerating aircraft that are not in serious and imminent danger, it is possible that pilots would prefer to receive a concise description of the problem, similar to the message transmitted to S5-ICR. They can then make a 'stop or go' decision based on an assessment of airspeed, risk of stopping, and their operator's procedures.

Conclusion

The aircraft began taking off on the edge stripe of Runway 23R at Manchester after lining up via intersection J1. The sun's glare on the wet runway, and the orientation, dimensions and slope of the intersection and runway surfaces, contributed to the pilot misidentifying the centreline. The rolling takeoff reduced his opportunity to check the aircraft's position.

As a result of this and a previous similar event, the airport authority is implementing several safety actions to assist pilots lining up at J1.

The ANSP stated that it intends to include the lessons from both events in its annual refresher training for ATCOs, and in other training opportunities.

Safety actions

As a result of the D-COLT and S5-ICR serious incidents the following safety actions have been taken.

The airport authority has undertaken to:

- Instate a 'runway excursion' hotspot at J1.
- Reconfigure J1's lead-on lights so that they will always illuminate when its stopbar is lowered.
- Apply green paint to the areas of the J1 turning circle outside of the runway edge lighting, giving the impression of grass.

The ANSP has undertaken to:

- Promulgate the lessons learned from both occurrences across all its airport units, by including them in its upcoming annual refresher training course for ATCOs and otherwise; and by highlighting the use of SMR for monitoring aircraft lining up, particularly small aircraft on large runways with wide shoulders.