Airbus A321-211, G-SMTJ and Boeing 737-2E7, EI-CJI

AAIB Bulletin No: 11/2004	Ref: EW/C2004/02/05	Category: 1.1 1.1
INCIDENT		
Aircraft Type and Registration:	1) Airbus A321-211, G-SMTJ 2) Boeing 737-2E7, EI-CJI	
No & Type of Engines:	1) 2 CFM56-5B3/P turbofan engines 2) 2 Pratt & Whitney JT8D-17 turbofan engines	
Year of Manufacture:	1) 2003 2) 1982	
Date & Time (UTC):	29 February 2004 at 1038 hrs	
Location:	Manchester Airport	
Type of Flight:	1) Public Transport (Passenger) 2) Public Transport (Passenger)	
Persons on Board:	1) Crew - 8 2) Crew - 5	Passengers - 220 Passengers - 122
Injuries:	1) Crew - None 2) Crew - None	Passengers - None Passengers - None
Nature of Damage:	Nil	
Commanders' Licence:	1) Airline Transport Pilot's Licence 2) Airline Transport Pilot's Licence	
Commanders' Age:	1) 43 years 2) 44 years	
Commanders' Flying Experience:	1) 11,500 hours (of which 2,600 were on type) Last 90 days - 155 hours Last 28 days - 58 hours 2) 12,400 hours (of which 6,000 were on type) Last 90 days - 180 hours Last 28 days - 80 hours	
Information Source:	AAIB Field Investigation	

Synopsis

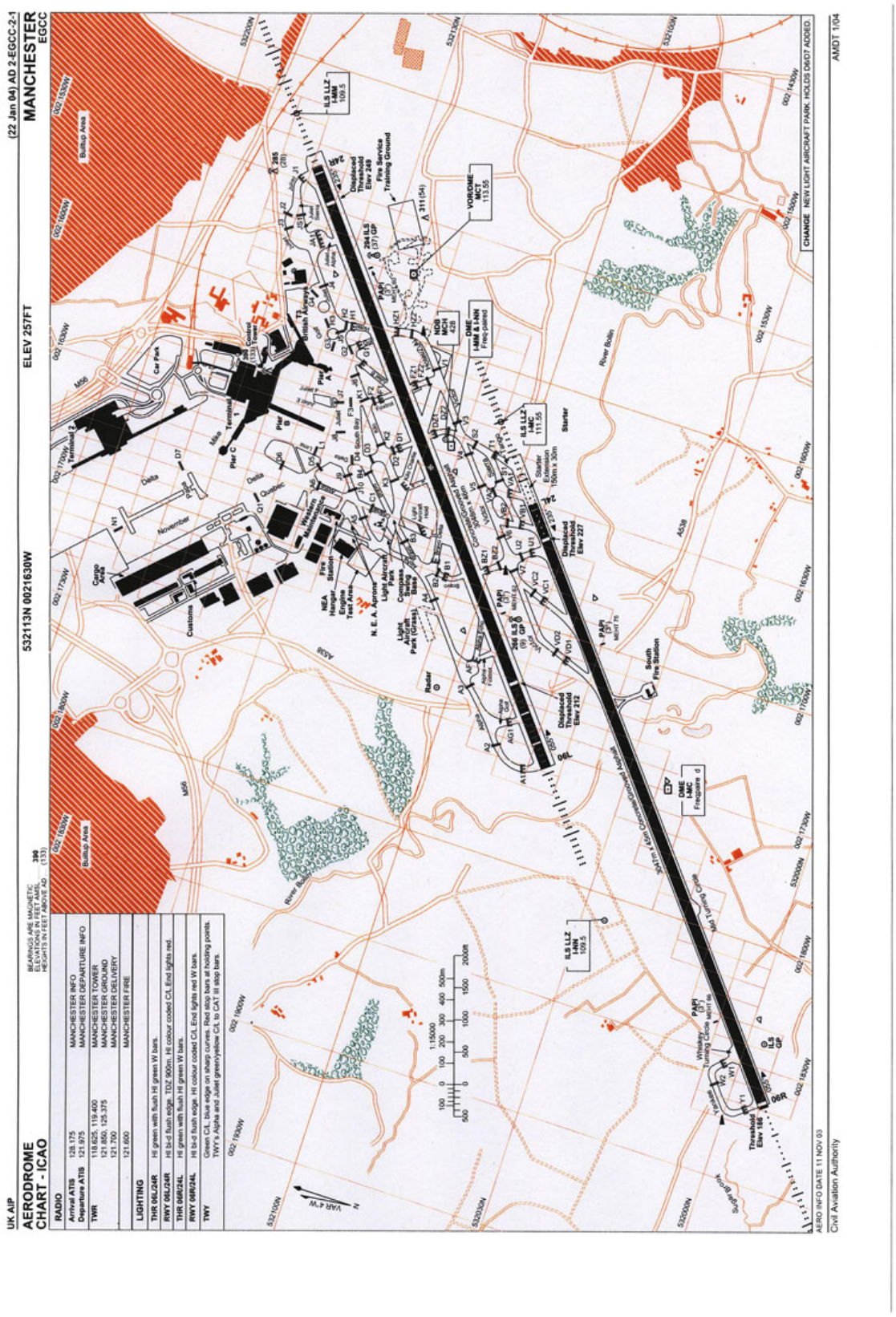
The incident occurred when G-SMTJ was accelerating for takeoff on Runway 06 Left (L) and EI-CJI taxied across the runway ahead of it; both aircraft had been cleared by Air Traffic Control to execute their respective manoeuvres. The flight crew of G-SMTJ rejected their takeoff thus averting the risk of a collision. The ATC procedures at Manchester and other airports controlled by National Air Traffic Services controllers are being reviewed with a view to increasing standardisation.

Airport procedures

On the morning of 29 February 2004, Manchester Airport had been using 'Segregated Operations' on both runways since 0645 hrs. This involved using Runway 06L for takeoff and Runway 06R for landing. Each runway had a controller using a dedicated VHF frequency. The two controllers were seated adjacent to each other in the Visual Control Room atop the 'Tower' and faced south towards the runways; 'Air 1', on the left, was controlling Runway 06L and 'Air 2 was controlling Runway 06R. Another controller, 'Ground Movement Control' (GMC) was seated at a desk behind them. 'GMC' had responsibility for the control of aircraft between the parking stands and Runway 06L and used a third discrete radio frequency. These controllers were part of a complete 'Watch' on duty in Air Traffic Control. A map of Manchester Airport is included at Appendix 1.

Figure 1 Manchester Airport

Appendix 1



The normal procedures for departing aircraft involved taxiing under the control of 'GMC' and then being transferred to 'Air 1' as they approached Runway 06L. Landing aircraft would be under the

control of 'Air 2' until they vacated Runway 06R and then would be transferred to 'Air 1'. 'Air 1' would co-ordinate and control aircraft crossing Runway 06L and then transfer them to 'GMC'.

'Air 1' and 'Air 2' each had a transmit and receive facility on both a dedicated VHF frequency and a UHF ground vehicle movement channel. The two controllers conversed between each other by direct speech, which is not recorded. In front of each, there was a Surface Movement Radar (SMR) display and an Aerodrome Traffic Monitor (ATM)/ Approach Monitoring Aid (AMA) display. Each dedicated display was adjusted to personal preferences by the individual controller. In the incident involving G-SMTJ and EI-CJI, both SMR displays showed the ground movements of both aircraft during the incident. One additional facility on the SMR was the incorporation of a Runway Incursion Monitoring (RIM) system. This device was active on both SMR displays at the time of the incident.

In accordance with NATS (National Air Traffic Services) procedures, the controllers used a system of Flight Progress Strips (FPS) to facilitate monitoring the movement of aircraft around the airport. A FPS was dedicated to each aircraft and included all the necessary information relating to the associated flight, including the callsign and the current clearance. For an outbound aircraft using Runway 06L, the FPS was generated by Manchester ATC personnel and held by 'GMC' for appropriate clearance and taxi instructions. As the aircraft approached the departure runway, 'GMC' would transfer control of the aircraft to 'Air 1' and pass the FPS, via a 'chute', to the controller. After takeoff, 'Air 1' would transfer control of the aircraft to the appropriate airborne agency and then discard the FPS. For an inbound aircraft, the FPS was generated and passed to 'Air 2'. Once the aircraft had landed and was clear of Runway 06R, the controller would transfer control of the aircraft to 'Air 1' and hand over the FPS. Then, once 'Air 1' had controlled the aircraft across Runway 06L, he would transfer control of the aircraft to 'GMC'. As an additional visual aid, the FPS holders would be coloured blue for outbound aircraft and orange for inbound aircraft.

On the desk in front of 'Air 1', was a recess to receive the FPS. In the recess, 'Air 1' would insert a runway designator strip ('Active Runway') with the active runway information. Above this strip would be located those FPS associated with aircraft which had not been cleared to enter the runway. As a procedure, the controller would clear an aircraft to enter the active runway and then move the appropriate FPS to the bay below the 'Active Runway'. The size of this active bay was adjustable and limited by a metal strip inserted by 'Air 1'. More than one FPS could be in that bay. For example, if an aircraft was cleared for takeoff, the appropriate FPS would be positioned in the 'Active Runway Bay' but if other aircraft had been given conditional line-up clearance or had been cleared to cross the runway after a departing aircraft, additional FPS would be positioned there. The lowest positioned FPS would be the aircraft with the highest priority using the basic principle of '*Bottom to Top'*. Manchester Airport's 'Manual of Air Traffic Services' (MATS) Part 2 procedure was that the controller would move the FPS of aircraft cleared for takeoff or landing to the bottom of the bay below the 'Active Runway'. MATS Part 2 also required that inbound traffic waiting to cross Runway 06L should be '*interlaced with the outbounds in the central active bay'*.

History of the incident

At 1033 hrs, a Boeing 747 landed on Runway 06R and control was transferred to 'Air 1'. One minute later, a Boeing 737 landed and vacated the runway at the first available exit; control of this aircraft was also transferred to 'Air 1'. At 1036 hrs, EI-CJI was advised, while on final approach, that the aircraft was cleared to land and clear to roll to the end of Runway 06R to vacate. The ATC intention was that EI-CJI would then be ahead of the previously landed Boeing 737. At 1037 hrs, EI-CJI had landed and once clear of the runway, was transferred to 'Air 1'. Before transfer, the aircraft had been advised to keep its speed up and that it was now ahead of the Boeing 737. The aircraft was cleared to the hold at 'DZ1', one of the crossing points for Runway 06L.

Meanwhile, G-SMTJ had taxied for Runway 06L and control had been transferred from 'GMC' to 'Air 1'. At 1036 hrs, the controller instructed G-SMTJ to line up and wait on Runway 06L. The controller then cleared the inbound Boeing 747 to cross Runway 06L and to hold at 'D3', a point to the north of the runway. Once the aircraft had called clear of the runway, the controller cleared G-SMTJ

for takeoff at 1037 hrs. Just after this instruction was acknowledged, EI-CJI checked in on the same frequency and confirmed his clearance to 'DZ1'. After some slight confusion, 'Air 1' acknowledged this message and cleared the aircraft to cross Runway 06L. There was then a double transmission involving EI-CJI and another aircraft, which was probably one that had just been transferred from 'GMC'. 'Air 1' then repeated the clearance to EI-CJI and asked the other aircraft to pass their message. After this message and the subsequent acknowledgement by 'Air 1', there was a transmission from G-SMTJ of "*Stopping*". By then EI-CJI had entered the runway.

Weather information

At the time of the incident, the weather was good. The Automatic Terminal Information Service (ATIS) broadcast 'Kilo', timed at 1020 hrs, included the following information: Runway 06R was in use for landing; the surface wind was 340°/ 06 kt, variable in direction between 280° and 030°; visibility was 40 km; cloud was FEW at 2,500 feet and BKN at 4,000 feet; and the QNH was 1023 Mb. The ATIS broadcast also advised that all hold short instructions were to be acknowledged and read back.

Controller information

'Air 1' had been a qualified controller since 1996. He had been at Manchester since 2000 and was fully validated in all positions in the 'Tower' and 'Approach'. Additionally, he was a current 'On the Job Training Instructor' (OJTI).

The controller had completed a period of duty the previous day at 1200 hrs and returned to duty for a planned start at 0700 hrs on the day of the incident. After self-briefing on the weather and other relevant information, he was assigned as 'Air 2' and took over those duties at about 0655 hrs. The air traffic was very light during the initial part of his duty and he was released from duty for a 30 minute break at 0800 hrs. From 0830 hrs to 0930 hrs, he took the duties of Ground Movement Planning (GMP) and then had a further 30 minute break. At 1000 hrs, he took the position of 'Air 1' and was due to be relieved at 1130 hrs. During his time on duty, he considered that the traffic was light to medium. He also confirmed that there were no visitors during the time of the incident and that he had not been distracted by any telephone calls.

In an honest report, the controller stated that he remembered giving G-SMTJ line-up clearance but did not remember giving subsequent take-off clearance; he recalled that he placed the associated FPS into the 'Active Runway Bay'. His recollection was that he had given EI-CJI priority for crossing Runway 06L and his attention was on that aircraft as it approached the runway, particularly as the Boeing 747, which had previously crossed was holding north of the runway. The controller thought that he had placed the FPS for EI-CJI in the first priority position in the 'Active Runway Bay' ie closest to his body. When G-SMTJ came into his view from the right along the runway, his initial thought was that it had taken off without clearance and he looked down at the FPS to identify the aircraft. His initial action was to instruct EI-CJI to hold position but by then, the aircraft had crossed the runway and G-SMTJ had called "*Stopping*". The controller could not remember seeing the RIM activate. Shortly afterwards he was relieved from duty.

Pilot reports

G-SMTJ

As the commander of G-SMTJ lined up on Runway 06L, he saw EI-CJI vacating Runway 06R. He was then given take-off clearance and the crew commenced their normal procedures including standard calls between the two pilots. With G-SMTJ accelerating, the commander then heard a clearance for EI-CJI to cross Runway 06L. His impression was that the aircraft accelerated very rapidly past 'DZ1' and onto the runway. As EI-CJI entered the runway, G-SMTJ was at a speed of greater than 100 kt and the commander made the decision to abort the takeoff and carried out the

appropriate actions. G-SMTJ had stopped before Taxiway 'D' and was then given clearance to vacate the runway at 'F'. When asked, the commander stated that the aircraft's external lights were switched on.

EI-CJI

On approach to Runway 06R, the crew were advised that, after landing, they could roll to the end of the runway and vacate at 'Tango'. On landing, the crew saw a preceding Boeing 737, which had vacated the runway, taxiing on 'Victor'. They were instructed to keep up their speed to get in front of that aircraft. Once clear of Runway 06R, EI-CJI was instructed to proceed to 'DZ1' and was transferred to 'Air 1'. On the new frequency, the crew were instructed to cross Runway 06L and hold at 'D1'. The crew did not hear any reference to a take-off clearance on that frequency, although the commander was aware of transmissions before he checked-in. The commander's recollection was that he had looked to his left along the runway to confirm that it was clear as he approached the entry point. However, as EI-CJI entered the runway, both flight crew looked to the left and saw an aircraft approaching from their left with the spoilers deployed. The commander stated that the oncoming aircraft did not have any external lights switched on.

ATC displays

Surface Movement Radar

The SMR was recorded and available for replay. This indicated that the separation distance between G-SMTJ and EI-CJI was 873 metres when EI-CJI entered Runway 06L and 600 metres away when EI-CJI vacated the runway. As EI-CJI approached the runway, the RIM function activated. The point at which G-SMTJ initiated his stopping manoeuvre could not be determined. Calculations indicated that EI-CJI had an average ground speed of 33 kt between clearing Runway 06R to entering Runway 06L.

Runway Incursion Monitoring (RIM)

The RIM function checks whether the runway is clear for arriving and departing traffic. It applies only to Runway 06L/ 24R. A RIM confliction alarm will occur when:

1 An aircraft approaching the runway is within 1,000 metres of the threshold and the runway is not clear in 'normal' visibility.

2 An aircraft approaching the runway is within 2 nm of the threshold and the runway is not clear in 'low' visibility.

NB. The visibility mode is set to 'low' when 'Low Visibility Procedures' are in use, otherwise it is set to 'normal'.

3 A departing aircraft's speed exceeds 40 kt and the runway is not clear ahead of its roll.

When a RIM conflict occurs, the controller is alerted by the labels of the tracks involved turning to the alarm colour (default red). The labels of the conflicting tracks keep the alarm colour until the conflict situation is no longer present. There is no audible alert.

MATS Part 2 requires that RIM shall be enabled at the Air Controller displays at all times except with the permission of the Tower Supervisor. Discussions with ATC personnel at Manchester indicated that the system is susceptible to spurious alerts. Nevertheless, the system was enabled during the incident and activated under the parameters of Para 3 above. However, neither 'Air 1' nor 'Air 2' was aware that the alert had activated.

Voice recordings

ATC

A full recording was available of the RTF frequencies for both 'Air 1' and 'Air 2'. This confirmed that EI-CJI was given landing clearance at 1036:10 hrs, together with a clearance to roll to the end of the runway. Subsequently, at 1037:23 hrs, EI-CJI was cleared to "*Keep your speed up you'll overtake the Turkish on your left taxi Delta Zulu One hold short of Zero Six Left"*, and at 1037:34 hrs was transferred to 'Air 1'. These ATC instructions were correctly acknowledged by EI-CJI.

G-SMTJ checked in on the 'Air 1' frequency at 1035:50 hrs. The aircraft was subsequently cleared to line-up on Runway 06L at 1037:20 hrs and was cleared for takeoff at 1037:46 hrs. G-SMTJ acknowledged this instruction and, one second later EI-CJI checked in with his clearance to 'DZ1'. 'Air 1' initially replied at 1038:02 hrs with a response to a different aircraft but then transmitted to EI-CJI "*Thank you and er you may as well er cross Runway Zero Six Left now hold behind the European Seven Four".* The subsequent acknowledgement by EI-CJI was overlaid by a transmission by another aircraft checking in with 'Air 1'. 'Air 1' then confirmed the crossing clearance for EI-CJI and asked "*Who else was calling*". At 1038:20 hrs, this other aircraft passed its message and G-SMTJ called "*Stopping*" immediately after the response by 'Air 1'. At 1038:30 hrs, 'Air 1' instructed EI-CJI to hold position and this was acknowledged.

The recording was also evaluated to determine if the precise movement of the FPS could be determined. While the sound of the FPS being moved could be heard, it could not be determined which FPS strip was being moved or where it had been moved.

Cockpit Voice Recorder (CVR)

There was no requirement for the CVR of either aircraft involved in the incident to be impounded but the CVR of G-SMTJ was recovered by the parent company and held for the AAIB. This proved useful in determining the relevant transmissions which could be heard by the crew of G-SMTJ.

Following the clearance to takeoff, the crew of G-SMTJ commenced normal cockpit checks during takeoff; this included verbal cross-checking of instrument and annunciation displays. This intra-cockpit communication was concurrent with the initial runway crossing instruction and acknowledgement with reference to EI-CJI. However, the repeat message to cross occurred during a silent period in the cockpit and resulted in the decision to stop by the commander of G-SMTJ. The 'Stop' decision was made shortly after the crew had cross-checked their ASIs at 100 kt.

Other relevant information

Following the incident, investigators visited the NATS initial training establishment and another major NATS airport to compare the use of FPS with those at Manchester. This showed that, while the basic principles are common, some differences have evolved.

Prior to the incident, Manchester ATC had already recognised an increase in the number of runway incursions and were involved in a review of their FPS procedures. This review included an examination of the procedures at another major NATS airport with the possibility of establishing the same procedures at Manchester. Following the incident, NATS also carried out a review of the FPS procedures in use at all their airports and are in the process of establishing a NATS common standard.

The International Civil Aviation Organisation (ICAO) has recognised that runway safety is a vital component of aviation safety as a whole. Accordingly, there has been an action plan produced by European organisations representing all areas of aerodrome operations entitled 'European Action Plan for the Prevention of Runway Incursions'. The introduction to this document includes the information that *'Over recent years there has been a number of runway incursions across the European region, which resulted in two actual collisions, with a significant loss of life. Analysis of the available data indicates that there is one runway incursion every three to four days within the region.'* The

document included recommendations to relevant organisations including national authorities, aerodrome operators and aircraft operators. The time frame for completion of the various recommendations varied from December 2003 to June 2008. The plan highlighted the importance of continued situational awareness, based on effective working procedures at the airport, effective communications between pilots and controllers, and effective communications between controllers and vehicles on the airport. Manchester Airport and both of the operating companies of the aircraft involved in this incident were recipients of the document and were using the content to update their staff.

Discussion

The incident occurred following a human error by a controller. However, human errors will always occur and effective safety relies on a back-up system which either makes it difficult to make a mistake or immediately highlights the fact that a mistake has been made. Within aviation, the demand for greater utilisation of resources results in less time to recognise and correct mistakes. Therefore, back-up systems have to be robust and regularly reviewed to retain their effectiveness.

In the situation at Manchester ATC, the introduction of a second runway increased the aircraft movement rate but this increase was accompanied by the complications inherent in parallel runway operations. While the FPS procedures were based on the basic NATS principles, there were slight adaptations to cater for the local situation. For the incident on 29 February, the controller stated that he had forgotten that he had given take-off clearance to G-SMTJ when he subsequently cleared EI-CJI to cross the runway. This would indicate that he had not placed the FPS for G-SMTJ in the priority position or had subsequently placed the FPS for EI-CJI below it. Evaluation of the RTF recording could not resolve this aspect. However, at the time there were other activities that could have caused some distraction to 'Air 1'. These included the Boeing 747 which crossed the runway and was holding at 'D3'. Additionally, the controller was aware that EI-CJI was clearing Runway 06R, was now ahead of the previously landed Boeing 737 and its operator was known to have a company culture of expeditious taxiing. Finally, in his initial response to the check-in call from EI-CJI, 'Air 1' used a different aircraft callsign which was probably for an aircraft that was on transfer from 'GMC' to 'Air 1'. All these factors resulted in the potential for distraction to 'Air 1' and it is considered highly likely that the controller lost situational awareness at a critical time. Once this had happened, the system relied initially on procedures to highlight to the controller that he had made a mistake. On this occasion, the procedures were not effective. A review of the procedures and RTF phraseology/discipline would therefore be sensible. ATC at Manchester is already carrying out a review and NATS have also become involved with an intention of standardising procedures throughout their airports. The aim is to use a standardised procedure but also to make use of the experiences and ideas from all airports. With the action already in progress, it is not considered necessary to make a formal recommendation in this respect.

Once the controller had made the mistake and because he did not immediately become aware of it, the defence against the incident becoming an accident relied primarily on the flight crew of the two aircraft. The clearance for G-SMTJ to takeoff was legitimate and correctly acknowledged. The opportunity for this crew to recognise the mistake was when EI-CJI was subsequently given crossing clearance. Evaluation of the CVR shows that the clearance to EI-CJI was transmitted concurrently with the crew of G-SMTJ making standard internal cockpit calls. Therefore, it is understandable that EI-CJI's clearance was not assimilated by G-SMTJ's pilots. However, the repeated clearance message was heard and it was the initial 'trigger' for the aircraft's commander to recognise the situation and commence action. Although the ground speed was above 100 kt, evaluation of the RTF and SMR indicated that the prompt action of the commander of G-SMTJ effectively removed any risk of a collision.

The actions of the crew of EI-CJI were also evaluated to determine if they could have made an early appreciation of the situation. Without a CVR, it could not be determined if the take-off clearance to G-SMTJ was transmitted when EI-CJI was on the 'Air 1' frequency. The commander of EI-CJI stated that he waited for another transmission to cease before checking in with 'Air 1'. This transmission

could only have been the take-off clearance or perhaps the latter part of it. The crew of EI-CJI would have been involved in after landing checks and it is understandable that the significance of the preceding transmission was not appreciated. However, the aircraft then entered the active runway with an aircraft accelerating towards it. A review of the location indicated that G-SMTJ would have been visible as EI-CJI approached the crossing position. Although the commander of EI-CJI considered that he had looked to his left, this was not effective. Additionally, the high ground speed (33 kt average) of EI-CJI may have made a late stop more difficult. Checks with the operating company of EI-CJI confirmed that the maximum ground speed whilst taxiing should be 30 kt. However, the flight crew had been requested to "*Keep your speed up*" and were complying with the ATC request. It may also be relevant that the Air 1 and Air 2 controllers were aware that the crews of the operating company of EI-CJI were expeditious on the ground. The operating company has undertaken to use the circumstances of this incident as a training aid for their crews.

It was also noted from the RTF recording that a double transmission occurred just after 'Air 1' had cleared EI-CJI to cross the active runway. The response by EI-CJI was overlaid by another aircraft checking-in on frequency. The crew of this aircraft had apparently not listened before checking-in because the normal procedure would have been to allow an acknowledgement to be transmitted. The result was additional RTF and an unnecessary distraction for the controller.

Summary

The incident occurred following a human error by a controller. While procedures are continually evaluated to minimise the opportunities for error, human errors will occur. The defence against this incident becoming an accident was the use of effective situation awareness by a flight crew. Whilst the risk of a collision was averted, the incident shows the importance of all crews and controllers maintaining maximum situational awareness at all times.

No safety recommendations were made as a result of this incident because NATS and Manchester ATC had already taken appropriate measures to review, standardise and improve their procedures. The operator of EI-CJI has also undertaken to use the circumstances of this incident as a training aid for its flight crews.