

1 Factual Information

1.1 History of flight

The aircraft was operating a charter flight, flight number XLA 2146, from Manchester Airport to Kos in Greece, with a total of seven crew and 190 passengers on board. The scheduled departure time for the flight was 1355 hrs.

In accordance with company procedures, the cabin crew reported for duty at 1225 hrs, one and a half hours prior to the scheduled departure time, at the company's crew room in Terminal Two at Manchester Airport. Having completed their briefing they made their way to the aircraft to carry out the cabin security and safety checks prior to boarding passengers.

The two pilots were due to report for duty at 1255 hrs, one hour before the scheduled departure time. The co-pilot arrived at about 1240 hrs and started to collect together the required paperwork for the flight. He then received a telephone call from the commander who explained that, due to traffic delays on his journey to the airport, he would be reporting slightly late. The co-pilot subsequently received a telephone call from the aircraft refuellers requesting the amount of fuel required, so that refuelling of the aircraft could commence. In an attempt to prevent any delays the co-pilot took it upon himself to calculate the fuel load required by reference to the flight plan, the enroute and destination weather forecasts and the destination NOTAMs¹. He did not however check for any NOTAMs relating to Manchester Airport, as he did not consider this necessary to complete the fuel calculation. Having completed his calculation the co-pilot passed the fuel quantity required to the refuellers by telephone and then left the crew room to make his way to the aircraft, a walk of approximately ten minutes.

The commander arrived about ten minutes after the scheduled report time and met the co-pilot as he was leaving the crewroom. The commander stated he checked the fuel figures at that time by reference to the flight plan and weather forecasts for the destination and alternate airports; however he did not read the relevant NOTAMs, deciding instead to check them once he was on the aircraft.

Once at the aircraft the co-pilot placed the flight paperwork on the flight deck instrument panel and went outside to complete the external checks. The commander remained on board to program the Flight Management System

¹ NOTAM – Notice To AirMen. NOTAMs are documents containing pertinent information for pilots when in the planning stages of a flight.

(FMS). On completing the external checks, the co-pilot returned to the flight deck to continue his part of the pre-flight preparations. This included, as laid down in the standard operating procedures (SOPs), listening to the departure ATIS and copying the information onto the flight log. This was then used by the commander to complete the programming of the FMS. The commander did not recall listening to the ATIS, stating he referred only to the information written by the co-pilot on the flight log. The co-pilot stated that whilst he listened to the ATIS he may well have been interrupted by other pre-flight activities going on at the time.

ATIS information 'Romeo' was current at the time and broadcast as follows:

*“THIS IS MANCHESTER DEPARTURE INFORMATION ROMEO AT TIME
ER ONE TWO FIVE ZERO THE RUNWAY IN USE FOR DEPARTING
AIRCRAFT IS ZERO SIX LEFT WIND IS ZERO SEVEN ZERO DEGREES
THIRTEEN KNOTS WEATHER CAVOK AIR TEMPERATURE PLUS
TWENTY-NINE, DEWPOINT PLUS FIFTEEN QNH ONE ZERO ZERO
FIVE MILLIBARS PILOTS BE ADVISED INTENSE BIRD ACTIVITY HAS
BEEN REPORTED IN THE VICINITY OF BOTH RUNWAYS PILOTS
SHOULD ALSO BE ADVISED DUE TO WORK IN PROGRESS ON ZERO
SIX LEFT STOP END REDUCED TAKE OFF RUN AVAILABLE FOR
ZERO SIX LEFT IS ONE THOUSAND NINE HUNDRED AND TWENTY-
SIX METRES FROM TIME THIRTEEN HUNDRED ZULU TO FOURTEEN
THIRTY ZULU AIRCRAFT UNABLE TO ACCEPT REDUCED TAKE OFF
RUN AVAILABLE ARE TO ADVISE DELIVERY ON FIRST CONTACT TO
ARRANGE A DEPARTURE ON ZERO SIX RIGHT REPORT AIRCRAFT
TYPE AND DEPARTURE INFORMATION ROMEO RECEIVED ON FIRST
CONTACT WITH MANCHESTER OUT”*

The flight log showed that only part of the departure ATIS had been copied, which was written in the appropriate section, as follows:

R 06L 070/13 CAVOK 29/15 1005

No record was found on any of the relevant paperwork of either the bird activity or the work-in-progress.

At 1339 hrs, the co-pilot called Manchester Delivery for departure clearance:

Aircraft: *“AH DELIVERY GOOD ER GOOD AFTERNOON IT’S EXPO TWO ONE FOUR SIX ER WE’VE GOT ROMEO WE’RE A SEVEN THREE SEVEN WE’RE ON STAND TWO OH SEVEN WE’RE LOOKING FOR OUR CLEARANCE TO KOS”*

Manchester Delivery: *EXPO TWO ONE FOUR SIX HELLO THERE WILL YOU BE ABLE TO ACCEPT THE REDUCED TAKE OFF RUN AVAILABLE ON ZERO SIX LEFT”*

Aircraft: *“YEAH FROM ALPHA GOLF EXPO TWO ONE FOUR SIX”*

Manchester Delivery: *“OKAY THAT’S COPIED AND YOUR CLEARANCE THEN IS TO KOS DESIG ONE SIERRA DEPARTURE SQUAWK OF FIVE TWO FIVE SIX AND ER QNH OF ONE ZERO ZERO FIVE”*

Aircraft: *“DESIG ONE SIERRA FIVE TWO FIVE SIX AND ER THE SQUAWK AND ONE ZERO ZERO FIVE EXPO TWO ONE FOUR SIX”*

Manchester Delivery: *“AND JUST CONFIRM THE SLOT IS ONE FOUR ONE ZERO”*

Aircraft: *“ONE FOUR ONE ZERO THAT’S COPIED EXPO TWO ONE FOUR SIX”*

This information, together with the weather information from the ATIS, was used by the pilots to individually calculate the takeoff performance from holding point Alpha Golf (AG) on Runway 06L, (using the takeoff tables carried on the aircraft), for the normal runway length. (See Appendix A for a plan of the airfield.) The pilots crosschecked their figures, which agreed, and these were used to finally complete the programming of the FMS and to prepare the aircraft for engine start. At 1350 hrs, the aircraft was ready for start and the co-pilot called ATC for clearance to push back to a remote stand to hold, awaiting their slot time. ATC replied, instructing him to change to the ground frequency to make the request. After a brief exchange with the ground controller the crew was cleared to start, without the need to hold at the remote stand, as they were now sufficiently close to their earliest cleared departure time of 1405 hrs.

By the time the aircraft pushed back, both pilots were aware that some work was being conducted on Runway 06L, largely as a result of listening to ATC communications with other aircraft. Later, neither pilot was able to elaborate further other than to say that they believed the work was either at the threshold end of Runway 06L, or in the stop end area, and that in either case it would not impinge on their performance requirements.

The crew carried out a normal start and called for taxi clearance, as follows:

Aircraft: *“EXPO TWO ONE FOUR SIX REQUEST ER TAXI”*

Manchester Ground: *“EXPO TWO ONE FOUR SIX ROGER ER ONCE THE ADRIA’S PARKED MAKE A RIGHT TURN ON TO TAXIWAY DELTA THEN ALPHA TO THE HOLDING POINTS RUNWAY ZERO SIX LEFT”*

Aircraft: *“ROGER DELTA AND ALPHA HOLDING POINT ZERO SIX LEFT EXPO TWO ONE FOUR SIX”*

The aircraft then taxied with the commander acting as handling pilot and the co-pilot operating the radio. On instruction from ATC, the co-pilot changed frequency to the Tower and contacted the tower controller, as follows.

Aircraft: *“TOWER GOOD AFTERNOON EXPO HM TWO ONE FOUR SIX”*

Manchester Tower: *“TWO ONE FOUR SIX AFTERNOON LINE UP AND WAIT ZERO SIX LEFT”*

Aircraft: *“LINE UP AND WAIT ZERO SIX LEFT EXPO TWO ONE FOUR SIX” PAUSE “AND TOWER EXPO TWO ONE FOUR SIX WE’RE TAKING IT FROM ALPHA GOLF²”*

Manchester Tower: *“IF YOU’RE HAPPY WITH THAT THAT GIVES YOU ER SIXTEEN SEVENTY METRES”*

Aircraft: *“ROGER”*

² The intonation in the co-pilot’s reply of *“WE’RE TAKING IT FROM ALPHA GOLF”* indicated that the crew had some doubts as to their runway entry point clearance. The response indicated that the controller had taken this as a statement of intent, by the crew, rather than a question.

The aircraft entered Runway 06L via holding point AG and made a turn to the right through 270° so that when it was lined up with the runway centreline for the start of its takeoff run, the nose of the aircraft was level with holding point AG. Once lined up, the co-pilot took over as handling pilot. ATC then cleared the aircraft for take off and the co-pilot held the aircraft on the brakes whilst applying 40% thrust. Once this was set, reduced thrust takeoff power was selected, as previously calculated on the basis of the normal length of the runway being available from holding point AG, and the brakes were then released.

Runway 06L is built on sloping ground such that it is not possible from the AG entry point to see the far end of the runway from the cockpit of a Boeing 737. On cresting this rise, the pilots saw vehicles ahead of them on the runway. At that point, as the aircraft's airspeed was close to rotation speed, V_R , a normal rotation was carried out at the appropriate speed. The aircraft passed very low over the vehicles on the runway and continued its departure. No comments relating to the incident were made by ATC to the crew who later stated they did not consider at the time that the aircraft had been in any danger. They completed the flight to Kos, returning that night to Manchester without further incident.

Following their return, in view of the fact they had seen the vehicles ahead, the flight crew made enquiries about their original departure from Manchester but were unable to find anyone who had reported any concerns. Consequently, as they believed nothing untoward had occurred on the takeoff, no report was made to either their company, the CAA or the AAIB.

1.2 Injuries to persons

Injuries	Crew	Passengers	Others
Fatal	0	0	0
Serious	0	0	0
Minor/None	7	190	

1.3 Damage to the aircraft

Nil.

1.4 Other damage

Nil.

1.5 Personnel Information

1.5.1 Commander

Male: Aged 38 years
Licence: Airline Transport Pilot's Licence
Aircraft Ratings: Boeing 737-300 to -800 series
HS748
SE & ME Land Planes
Last Licence Proficiency Check: 12 February 2003
Last Line Check: 24 July 2002
Last Medical: Class 1 issued 10 March 2003
without restriction
Flying Experience: Total all types: 5,319 hours
On Type: 2,300 hours
Last 90 days: 178 hours
Last 28 days: 72 hours
Last 24 hours: nil
Previous rest period: 14 hours 55 minutes

1.5.2 Co-pilot

Male: Aged 42 years
Licence: Airline Transport Pilot's Licence
Aircraft Ratings: Boeing 737-300 to -900 series
Last Licence Proficiency Check: 5 March 2003
Last Line Check: 7 April 2003
Last Medical: Class 1 issued 18 June 2003
without restriction
Flying Experience: Total all types 4,789 hours
On Type: 1,100 hours
Last 90 days: 163 hours
Last 28 days: 52 hours
Last 24 hours: nil
Previous rest period: 5 days

1.6 Aircraft Information

1.6.1 General information

Manufacturer:	Boeing Commercial Airplane Group
Type:	Boeing 737-86N
Aircraft Serial No:	33003
Date of construction:	April 2002
Power plants:	2 CFM 56-7B26 turbofan engines
Total airframe hours:	4,642 hrs
Total airframe cycles:	1,543
Certificate of Airworthiness:	Issued 29 April 2002, valid 5 years

1.6.2 The aircraft weight and centre of gravity were within normal limits.

1.7 Meteorological information

The recorded weather information broadcast at Manchester Airport at the time of the incident was:

*“SURFACE WIND 070°/13KT CAVOK TEMPERATURE PLUS 29°
DEW POINT PLUS 15° QNH 1005Mb”*

Appendix B presents the rainfall figures for Manchester Airport for the period 8 June, the date of the Monitoring and Classification Survey which first identified problems with runway friction levels, to 20 July, the end of the final work required to remove rubber deposits from the runway. There was also an entry in the Airfield Duty Manager’s (ADM) log at 1800 hrs on 16 July, of a weather warning in force, issued by the Met Office, of thunderstorms until 2200 hrs.

1.8 Aids to navigation

Not applicable.

1.9 Communications

VHF communications between the aircraft and Manchester ATC were recorded and provided for the purposes of this investigation by NATS. Communications between the ADM overseeing the rubber removal operations and Manchester ATC were conducted by telephone, or on a separate UHF frequency cross linked to the appropriate VHF frequency.

1.10 Aerodrome Information

1.10.1 Runways

Manchester Airport has two runways, Runway 06L/24R and Runway 06R/24L. Runway 06L/24R was the airport's original runway and Runway 06R/24L was completed in February 2001.

When dual runway operations are in force the preferential landing runways are 06R or 24R and the takeoff runways 06L or 24L³ as, whenever Runway 06R is used for takeoff or 24L used for landing, the absence of a full length taxiway requires aircraft to backtrack in order to enter or clear the runway.

The lower number of aircraft movements during the middle of the day, allows Runway 06R/24L to be closed for a period in the early afternoon. Local authority planning restrictions concerning noise issues, also normally prevent its use between 2200 hrs and 0600 hrs⁴.

1.10.2 Runway surface monitoring

At the time of the incident, there was work-in-progress in the area of the Runway 24R threshold, to remove a build up of rubber deposits from its surface. On the night of 8 June 2003, the monthly Monitoring and Classification Survey of runway friction levels on both runways revealed that on Runway 24R, areas in the touchdown zone some 1.5 m either side of the centreline were at Maintenance Planning Level and, 5 m either side of the centerline, were at Minimum Friction Level (Appendix C)⁵. As a result, a contractor was employed to undertake rubber removal between 22 and 24 June 2003 in the touchdown zones of both Runway 06R and Runway 24R, with the particular intention of rapidly restoring the friction level on Runway 06L/24R above the Minimum Friction Level (Appendix D).

As on previous occasions, this work was carried out at night in order to minimise disruption to runway operations. Whilst it was possible to close

³ In order to comply with ICAO rules on Segregated Operations on Closely Spaced Parallel Runways for operations at Manchester, aircraft are required to land on the nearest runway threshold.

⁴ MA plc provided the investigation with information on agreements governing the use of Runway 06R/24L, although these were contained in a policy document not readily available to either ATC or airfield staff at an operational level. MA plc stated that this document allowed the use of Runway 06R/24L between the hours of 2200 hrs and 0600 hrs (local), but only when Runway 06L/24R was closed for maintenance or was unsafe to use. It did not, however, make clear what authority was required to use Runway 06R/24L at these times.

⁵ A runway which in part or whole which did not meet the minimum level when wet should, at that time, have been treated for the purpose of performance calculations as 'icy' by aircraft operators, with a consequential severe operational limitations.

Runway 06R/24L for the work to be undertaken, it was not possible to do so for Runway 06L/24R and therefore the work on this runway was conducted between aircraft movements.

Following this operation, the annual Runway Classification Survey was carried out by another contractor between 25 and 26 June 2003. Interim reports provided to the airfield operator, MA plc, on 7 July 2003 identified that friction levels, exceeding 100 m in length on portions of Runway 24R touchdown zone had now deteriorated and were, in fact, below the Minimum Friction Level. No record was found of any NOTAM having been issued warning of these reduced friction levels.

Interpretation of the results of the survey, and a subsequent physical inspection of the runway, led to the conclusion that the reduced friction levels were a consequence of the previous rubber removal operation being only partially successful. At their regular operations management meeting held on 7 July, the airport operator stated that the matter had been discussed and a decision taken to recall the contractors to undertake further rubber removal work at the earliest opportunity. A further decision was taken by the airport operator that, to avoid the interruptions and problems associated with working in the dark experienced on the previous occasion, the work would be conducted during daylight hours with the runway closed.

The rubber removal contractor stated that he had already been contacted by the airport operator on 2 July, in the week prior to this meeting, and had agreed at that time to carry out more rubber removal work on Runway 06L/24R, starting on Monday 14 July.

Having decided to undertake the work, the Airfield Policy and Planning Manager (APPM) for the airport operator operations department then telephoned the manager of the airport's ATC services, on Wednesday 9 July, to investigate the impact on the airport's operating capacity of closing Runway 06L/24R during daylight hours. The ATC manager's understanding was that the work was to be carried out for one day only, on 14 July, and based his planning on this assumption. His initial findings indicated that closure of Runway 06L/24R during daylight hours would cause major air traffic delays due to the limiting capacity of Runway 06R/24L.

The APPM had also asked the ATC manager to identify times during the day when reduced runway capacity would have the least impact on flight operations, and this was determined to be between 1300 hrs and 1430 hrs, and after 1900 hrs. This information, together with the assessment of the operating capacity, was

communicated to the APPM by telephone later on 9 July. That evening, the ATC manager also sent a message to all ATC supervisors informing them of the intention by the airport operator to carry out rubber removal operations on Runway 06L/24R, on 14 July, and that further details would follow. He also expressed his surprise to them at the short notice provided, but explained that he had been informed by the APPM that the work could not wait.

As a result of the reply from the ATC Manager to their enquiries, the airport operator reviewed their decision to carry out the work with Runway 06L/24R closed. It was decided instead to keep the runway open, but to operate it at a reduced length. This would allow the rubber removal to continue uninterrupted in the closed off section, whilst at the same time, allowing aircraft with sufficient performance to continue operating on the remainder of the runway. This, together with the availability of Runway 06R/24L, would minimize any air traffic delays.

The airport operator completed the planning for the rubber removal operation and, late on Friday 11 July, drafted an Operational Advice Notice (OAN) concerning the works and the reduced distances available for takeoff and landing. This would involve two daily periods of operation with reduced runway length, from 1300 hrs to 1430 hrs and from 1900 hrs to 2100 hrs, between Monday 14 July and Friday 18 July, and a single daily period of two hours on both Saturday 19 July and Sunday 20 July. The rubber removal was to be carried out by a single contractor's vehicle, a specially adapted lorry which was 14 ft high (Appendix E). The airport operator also planned to take the opportunity to carry out some additional runway maintenance jobs at the same time, such as line painting. This meant that some of the airport operator's vehicles would also be present in the closed section of the runway during the planned work.

The OAN was not immediately promulgated as the airport operator wished to have the declared distances for the reduced length runway operation checked by their Civil Aviation Authority (CAA) aerodrome inspector, and it was too late in the day to be able to make contact with her. This was in accordance with their Operations Manual Section 3.3.4.4 (Appendix F) although it was not required by the CAA, who only need to be consulted when declared distances are increased. The reduced runway length chosen was defined as the distance between Rapid Exit Taxiway Juliet Bravo (RET JB) and the threshold of Runway 06L. The airport operator considered that by choosing RET JB as the cut off point, it would create a threshold far enough removed from the area of work to protect against jet blast from departing aircraft, should Runway 24R be used. A decision had been made by the airport operator that no landings would be permitted on Runway 24R whilst the runway was at reduced length.

On the morning of Monday 14 July, NATS contacted the airport operator to inform them that easterly operations were scheduled and that the proposed reduced runway distance would severely limit the number of aircraft able to use Runway 06L. The airport operator then agreed to review the figures, as a result of which it was decided to extend the length of the available runway beyond RET JB. No record could be found of any review of the effect this change would now have on jet blast affecting the work area, nor is there any mention of jet blast assessment in the airport operator's risk assessment document.

The OAN was then re-drafted and, at about 1000 hrs on Monday 14 July, the airport operator attempted to contact their CAA inspector, but again found she was unavailable. They then managed to contact another CAA aerodrome inspector who had knowledge of Manchester Airport and he confirmed that the reduced runway calculated distances were correct. The takeoff run available was declared as 1,926 m, and the minimum distance between the re-declared end of Runway 06L and any obstacle in the work area beyond it, was 485 m. For reference, the distance from the end of the normal full length 06L runway, to the first non-frangible object, is 267 m.

About three hours before the work was due to start, the airport operator published the final version of the OAN, OAN 08/03 (Appendix G), and issued a request for NOTAM action, detailing the work and the reduced runway distance available. OAN 08/03 provided limited information as a briefing document to airport staff. Whilst it gave reduced runway lengths it gave neither a description of where the 24R displaced threshold, or 06L runway stop end markings should physically be placed, or be delineated. In addition, it gave no instructions on how the start of the Take Off Climb Surface (TOCS)⁶ should be marked.

OAN 08/03 was distributed via the airport's internal mail system, but the ATC Manager stated that his copy was not received until the morning of Thursday 17 July. The GM and APPM have subsequently stated that all relevant information contained in the OAN had been faxed to the ATC Manager prior to the work commencing. The NATS Manager's statement confirms that he had received information on the re-declared distances, but not the additional information in the OAN that he required to publish a Temporary Operating Instruction (TOI). He instead decided to personally brief the on-coming ATC shift for the tower when they reported for duty. The shift change was co-incident with the planned commencement of the partial runway closure.

⁶ A specified surface area or inclined plane starting at and extending beyond the end of the runway, or clearway, in the direction of takeoff. Any immovable objects that project into this plane are required to be notified to the CAA. The start of the takeoff climb surface should be at a specified distance, typically 60 m, from the end of the takeoff run, or if a clearway is provided, the end of the clearway.

The APPM stated that she personally briefed the relevant airport operations personnel involved in the work. The rubber removal was also discussed at a scheduled meeting with some of the ADMs on the evening of 14 July, held at 1700 hrs. Not all the ADMs could be present due to shift considerations.

Chronology of events

Monday 14 July

The first partial runway closure of Runway 06L went ahead, as planned, at 1300 hrs and the runway was returned to normal full-length operations on schedule at 1430 hrs. Rubber removal operations were carried out between these times and no major problems were reported, either by the airport operator or ATC.

The APPM had contacted the ATC Manager to discuss the work, either during or at the end of this session and it was at this point that the ATC Manager realised the work was not a 'one day' event, as he had up to that point believed.

Runway 06L was then partially closed again, as planned, at 1900 hrs. The ADM report stated that the runway was then vacated and inspected by 2105 hrs. The ATC log, however, recorded that normal operations were not resumed on the runway until 2113 hrs.

In his report, the ATC supervisor stated that rubber removal was still being conducted at 2055 hrs. He considered that this would allow insufficient time to get the vehicles off the runway and carry out the necessary inspection in time for the runway to return to full length by 2100 hrs, as he had been expecting. He passed these concerns on to the ADM supervising the work on the runway, together with the fact that he was unhappy to revert to single runway operations on Runway 06L whilst the runway was at reduced length, especially in the view of the twilight conditions. He advised that ATC would therefore be continuing to operate both runways beyond 2100 hrs and had, at that time, committed two aircraft to depart, and one to land, on Runway 06R. The ATC supervisor reported that the ADM replied that they should not be operating on Runway 06R after 2100 hrs due to "local community [noise] issues". The ATC supervisor also reported that, whilst he could not be entirely sure, he was not aware of any runway lights in the closed section having been blanked off so that they would not be visible to aircraft. He did, however, recall that a line of red lights had been placed across Runway 06L at Link G. The ATC supervisor concluded his report by stating that the control tower did not have sufficient controllers available to continue two runway operations after 2100 hrs. No report was made in the ADM's log of any problems that evening with the operation of the airfield.

Tuesday 15 July

Rubber removal operations commenced on Runway 24R threshold at 1304 hrs but, shortly afterwards, at about 1315 hrs, the vehicle used for the work developed a hydraulic leak and spilt oil onto the runway. The vehicle was removed for repair and, once the oil had been cleared, the runway was returned to full length operations at 1409 hrs. No further rubber removal was conducted until 1900 hrs when Runway 06L was again reduced in length to allow the work to continue.

Shortly after 1900 hrs, the ATC supervisor on duty at the time handed over his position in the tower to his deputy. This was so that he could operate as the approach radar controller for the remainder of the shift, which was due to finish at 2100 hrs. Until this point, the deputy supervisor had been working the approach radar, which is housed in a separate room within the tower. This was the deputy's first shift that week and he had not been present during any of the previous occasions that the rubber removal work had been in progress. He had, however, been given a verbal brief by the supervisor and was also given a copy of the NOTAM relating to the work-in-progress. The supervisor also stressed to him the importance of ceasing operations on Runway 06R by 2100 hrs due to local noise restrictions.

At first, the deputy supervisor experienced no problems relating to the rubber removal work taking place, a fact he relayed to the ATC Manager who telephoned the tower at about 2000 hrs to ensure that there were no difficulties. Some time after this call, the deputy started to make arrangements to position inbound aircraft so that no aircraft would land on Runway 06R any later than 2100 hrs. As a result, three aircraft were lined up on the approach for Runway 06L, with the first expected to land at exactly 2100 hrs. These aircraft were, in order, a Lockheed Tristar, a Boeing 767 and an Airbus A319.

At the time the Tristar was established on final approach for Runway 06L the runway was still operating at reduced length, with the vehicles conducting the rubber removal yet to vacate.

Both the tower controller controlling the aircraft and the deputy supervisor were then concerned that the wide bodied aircraft would, as a result, have insufficient distance available to land. The deputy supervisor was unsure whether it was intended for aircraft to land on Runway 06L whilst it was at reduced length. He referred to the NOTAM, the only written information on the work he had available to him, and saw that it gave reduced landing distance available. He stated he therefore made the assumption that it was intended to be used for landing, although he still considered the distance inadequate for the Tristar to land. As a

result, the deputy supervisor then instructed the controller to ask the Tristar flight crew if they were aware of the work in progress and whether they could accept the reduced landing distance available. This the controller did and the crew replied that they were not aware of the work and could not land in the stated distance. As a result, at 2053 hrs, the Tristar was ordered to go-around when at a range of 2.5 nm. The same questions were then asked of the two following aircraft, neither of which reported they were able or willing to accept the reduced landing distance. As a result, they were also instructed, in turn, to go-around.

The deputy supervisor reported that a period of confusion then ensued in the tower. He had been told that Runway 06R should not be used after 2100 hrs, yet Runway 06L was still at a reduced length, inadequate for the incoming aircraft. The uncertainty about which runway should be used was causing problems for the controllers dealing with the aircraft going around and the additional incoming aircraft that were having to be instructed to hold. Comments by the deputy supervisor on duty at the time of the incident suggested a feeling that the controllers believed their only safe option was to refuse to operate aircraft on the reduced length runway at all, but he said to do so would have been seen as dissention, with possible disciplinary consequences.

This all co-incident with the ATC shift change. The on-coming supervisor offered his help in trying to resolve the situation, but the deputy supervisor stated that he was so busy that he did not even have the opportunity to reply.

The situation was resolved only by the return of Runway 06L to normal full length operation; the work vehicles vacating the runway whilst the aircraft were going round. The three aircraft were then given radar vectors to land on Runway 06L and the ATC shift change was completed.

The ADM's relevant log entry states the following, all times being local (UTC +1):

'At approx this time (21:53) ATC started to activate 06L r/way lights and we noticed a go around, no communication was made between ATC and ADM until the go around. ATC were under the impression they (sic) were to achieve single r/way ops at this time, there seems to have been a lack of communication within ATC. ADM informed tower supervisor (19:40) that we would ensure all vehicles would vacate 06L between 21:50 – 21:55 allowing for full length ops 06L for 22:00 or after. ADM also stressed that we should plan for no 06R departures at 22:00 or after. In total there were x3 forced go rounds because of the above.'

This records an additional problem that night whereby ATC activated the runway lighting before the runway had been fully re-opened. The lighting in the closed area of Runway 06L had not been blanked and this resulted in the lighting operating over the full length of the runway.

Wednesday 16 July

The ADM on duty from 0600 hrs was on his first day back at work after a period of leave. He was briefed on the rubber removal work by the off-going ADM and the APPM, and he read OAN 08/03.

As was normal practice, Runway 06R/24L had been closed during the middle period of the day as the traffic flow was light and one runway was adequate. Prior to commencing rubber removal operations on Runway 06L/24R, it was necessary to re-open Runway 06R/24L and, at about 1255 hrs, the ATC supervisor contacted the ADM to enquire why the pre-opening inspection had not been completed. This had been the result of an oversight by one of the members of the airport operations staff. The consequent delay in getting the inspection carried out meant that rubber removal work was delayed by 25 minutes, and now started at 1325 hrs. In order to make up the lost time an extension to the planned finishing time for that afternoon's work was agreed between the ADM and the ATC supervisor, extending it from 1430 hrs to 1500 hrs.

The ATC tower controllers on duty that afternoon were from the same shift that had been on duty during the previous evening's work. The supervisor again handed over control of the tower to his deputy so that he could work the approach radar, although he only did this after the rubber removal work had been started and all seemed to be going well. The deputy supervisor however reported that the controllers were unhappy with using Runway 06L at its reduced length. They described watching aircraft taking off towards the vehicles at the end of the runway as being particularly unnerving and made their feelings known to the deputy supervisor. Despite sharing their views, the deputy supervisor stated that at the time he felt powerless to act as he considered the work had been agreed at a higher level between ATC and airport management.

During the work that afternoon, a BAe 146 aircraft had taken off from Runway 06L and appeared to the controllers to pass low over the seven vehicles associated with the rubber removal operation. This was noted by the ADM who was supervising the vehicles on the runway at the time. Whilst he considered the aircraft was indeed low, he stated it did not concern him unduly. No communication was passed between ATC and the ADM about this aircraft, but the incident was of concern to the controllers.

Not long after this event, G-XLAG took off and passed very low over the vehicles on the closed section of the runway. The ADM had seen the aircraft as it came over the crest in the runway and jogged to the side. He stated he was not in a vehicle and was concerned about being hit by jet blast. In the event, he was unaffected, although two of the portable lights denoting the temporary end of the runway were blown over.

Having witnessed the aircraft's takeoff and realizing how close it had come to the vehicles, the ATC deputy supervisor immediately contacted the ADM. The deputy supervisor explained that he was extremely uncomfortable with the operation and irrespective of any published instructions would now be "taking matters into his own hands". He explained he would now only allow what he considered to be lightly loaded narrow bodied aircraft to depart from the reduced length Runway 06L⁷. He also contacted the shift supervisor to inform him of the incident.

The ADM then contacted the APPM to discuss the incident. The APPM later stated that the runway distances and procedures were once again checked and consultations were made with operations staff. It was her opinion at the time that there was no evidence of anything significant having taken place and, as the ADM seemed happy to continue, saw no reason to discontinue the operation.

The ADM's log recorded

'During the closure period 2 a/c ([XX] RJ100 and [XXXX] B737) both passed over the working party much lower than expected. ATC called to report their concern for our safety. APPM inf.'

The rubber removal work duly continued and Runway 06L was declared at full length again at 1458 hrs. No ATC or airport operations personnel reported the incident to the CAA or AAIB at that time.

Later that day, the ADM changed shifts and the on-coming ADM oversaw the resumption of rubber removal at 1905 hrs the same evening. He was aware of the incident that afternoon and recorded the following in his log:

'20:15 after XXX incident this afternoon ATC cautiously requested rubber removal machine which had lined up & commenced work adj (sic) H to pull over to edge of 06L due to an YYY B757 departing.'

⁷ What constituted a lightly loaded aircraft, in the controller's opinion, was an aircraft whose destination suggested that it was likely to be carrying a light fuel load.

The ATC shift had not changed since the afternoon's incident and the same deputy supervisor was in the tower for the duration of the work that night. This was completed at 2058 hrs.

An e-mail sent that night by the ATC supervisor to the ATC Manager complained about the lack of planning for the work and the poor decision making that had been a consequence. He highlighted the lack of a TOI and also raised concerns about the use of runway lighting on Runway 06L, which he stated was required that evening by 2015 hrs. Sunset that night was at 2029 hrs.

Thursday 17 July

The ADM's log records that at the daily meeting held at 0800 hrs with the General Manager (GM) of the airfield, the previous day's rubber removal operations were discussed. It was not established whether the incident with the aircraft was discussed but the ADM attending the meeting was the same manager that had been on duty at the time of the incident. No ATC representative was present.

The ATC Manager replied to the supervisor's e-mail of the previous night stating that, due to the current concerns, the planned rubber removal on Runway 06L would be cancelled that afternoon and would instead only take place during the evening. He also stated that, if runway lighting was required, it was unacceptable to have this displayed in the closed section of the runway. If the lights could not be inhibited, he took the view that the work would have to cease and the runway be returned to full length operation.

The GM and APPM have subsequently stated that it had always been the intention to cease the rubber removal operations should runway lighting be required. They stated that "this was agreed with ATC and briefed to the airfield duty managers, who were all aware of this fact". As a result, no arrangements were made to blank off the lights. No information on lighting was provided in the OAN and the ATC Manager cannot recall a lighting plan being discussed or agreed prior to receiving the supervisor's e-mail.

The log records that, at 1100 hrs, rubber removal commenced on the Runway 06L touch down zone, during which time the runway was closed. Work recommenced at 2000 hrs on the threshold of Runway 24R, the runway being closed between Taxiways J and G. During this period, Runway 24L was available for takeoffs and all landings, whilst the reduced length Runway 24R was available for takeoffs only. Work was completed by 2053 hrs.

Friday 18 July

The ADM's log recorded that, at 0800 hrs, a meeting was held, at which both the APPM and GM were present, to discuss the completion of the rubber removal. There was no indication of whether an application was made to withdraw the NOTAM. The log also recorded that friction runs were to take place that day.

Saturday 18 July

No record of activities relating to rubber removal or friction testing was evident in the log.

Sunday 19 July

The ADM's log recorded that, at 1620 hrs, due to passing showers, both runways were given as wet. The log also recorded that friction monitoring runs had been agreed with ATC to take place after midnight, but did not indicate whether these took place.

1.11 Flight recorders

1.11.1 FDR/CVR description

The aircraft was fitted with a 30 minute Cockpit Voice Recorder (CVR), a 25 hour Flight Data Recorder (FDR), and a Quick Access Recorder (QAR). The AAIB had been notified seven days after the event during which period the CVR and FDR data had been over-written. However, as part of the company Flight Data Monitoring (FDM) program, the information from the relevant sector had been downloaded from the QAR, and this information was provided to the AAIB. The QAR data parameters and sample rates were identical to those recorded on the FDR.

1.11.2 QAR Analysis⁸

The aircraft's start-up and taxi appeared normal, and it commenced its takeoff roll from abeam holding point AG. At this time, the rubber removal vehicle was located on the reciprocal runway touchdown markings some 2,210 m away. The takeoff run also appeared to be normal. The aircraft rotated at 152 kt and became airborne at between 164 kt and 168 kt, between Taxiways 'F' and 'JB', some 427 m to 305 m respectively before the vehicle. The calculated ground roll

⁸ The achieved takeoff roll and climb-out flightpath were derived from QAR data using the aircraft heading, radio altitude and integration of the groundspeed. The lift-off point was inferred from the mainwheel squat parameters. As the heading, groundspeed, radio altitude and mainwheel squat parameters were sampled only at one sample per second, the uncertainty in the derivation of the take-off roll distance is of the order of +/- 43 m.

was 1,770 m +/- 43 m. Due to the one second data sampling rate, radar altitude (radalt) data from the QAR could only indicate that, at the time the aircraft passed over the vehicle, it was at a height of between 28 ft and 71 ft. However, extrapolation of the data suggests that the aircraft's maximum height at the time it passed over the vehicle was 70 ft and, allowing for a vehicle height of 14 ft, the estimated maximum clearance between the aircraft and vehicle was 56 ft.

1.12 Wreckage and impact information

Not applicable.

1.13 Medical and pathological information

Not applicable.

1.14 Fire

The Manchester Airport Fire and Rescue Service (FRS) exceed the minimum required standards. The airport has one main fire station, the North Station, and one satellite station, the South Station. The satellite station is located close to Runway 06R/24L and is necessary in order for fire vehicles to meet the maximum response time to access sections of that runway which would otherwise be unachievable from the main station. Normally, the South Station is continually manned except for the period 1200 hrs (local) to 1500 hrs (local), when Runway 06R/24L is closed. However, sufficient manning exists and is readily available for the South Station to be permanently manned should the need arise.

The first reference to the FRS in connection with the work-in-progress found in either the ATC, ADM or FRS logs, appears in the FRS log for Monday 14 July, timed at 2043 hrs (local). It stated:

*'ATC INFORM LANDINGS ON 06R. DEPARTURES 06R + 06L.
DUE TO WORKS ON 06L.'*

Later entries also appear of ATC informing the FRS of changes to runway operation.

1.15 Survival aspects

Not applicable.

1.16 Tests and research

Not applicable.

1.17 Organisational and management information

1.17.1 Airline operator

Flight operations were controlled centrally at the operator's headquarters at Gatwick. At Manchester, the operator had appointed two pilots with management responsibilities to deal with local issues. In addition a further manager, who was not a pilot, held responsibility for passenger terminal and ground handling issues.

1.17.2 Airport operator

Airside operations at Manchester airport were the responsibility of the GM. His deputy held the title APPM and was responsible for the planning of airside work. Day to day running of airside operations was conducted by a team of staff lead by an ADM.

1.17.3 ATC

ATC services at Manchester Airport are contracted to NATS. In overall charge of all NATS services at Manchester Airport at that time was a General Manager (Air Traffic Services). Reporting to him were managers with various functions including the manager directly responsible for air traffic control at the airport, referred to in this report as the ATC Manager. ATC is conducted by a team of controllers, each shift being managed by a supervisor based in the tower. The supervisor is assisted by a deputy supervisor who is also qualified to act as supervisor when necessary.

At the time of the incident a new contract was being negotiated between NATS and MA plc. The ATC Manager was aware of these negotiations but stated that he was not playing an important role.

1.18 Additional Information

1.18.1 NOTAMs

A copy of the fax request for the NOTAM covering the period of runway work appears at Appendix H. The NOTAM, as it appeared to the pilots, is at Appendix I. The time appearing on the NOTAM request form is 1000 hrs (local) although it is not known when the form was actually sent by the airport operator.

The version of CAP 683 current at the time of the incident, described procedures for runway friction classification and monitoring, and contains the following definition of Minimum Friction Level:

‘The friction level which, when measured over a length of a portion of the runway of 100 m or more, below which will normally require the runway to be notified by NOTAM as ‘liable to be slippery when wet’, unless otherwise agreed by the Authority’.

NOTAM requests are sent to the Aeronautical Information Service (AIS) who review the request and, if there are no points requiring clarification, will code and transmit the information on the Aeronautical Fixed Telecommunications Network (AFTN) within approximately 10 minutes. Once transmitted, the information is instantaneously available to those subscribing to the network and this includes companies supplying aeronautical briefing information to operators. However the time taken for these additional providers to subsequently include new information transmitted in their own briefs is variable. The operator involved in this serious incident received all its briefing material from one such company.

The Airfield Manual at Manchester Airport contained the following information:

‘3.12.4 Accuracy of Information

a. Accuracy and currency of NOTAMs will be checked daily by the ADM against the NOTAM summary published in the Flight Briefing Units. Any errors or omissions will be notified to CAA AIS at Heathrow Airport for immediate correction.’

1.18.2 Time

ATC and aircraft flight crews were operating using UTC time, whereas the airport Operations Department and the FRS used local time (equivalent to UTC+1 at the time of the incident).

1.18.3 Planning (Aircraft operator)

The operator provided aircraft performance information to its flight crews in the form of paper tables stored on the flight deck. These are produced by a performance department at the operator’s headquarters. This department checks NOTAMs twice a week for all the airports used by the operator for changes that

might affect performance requirements of their aircraft. This was in addition to information gathered from other sources passed directly to them by the operations department.

1.18.4 Planning (Airport operator)

Manchester Airport's Aerodrome Manual lays out the requirements for the planning of work on the airfield, a copy of the relevant section appears at Appendix J. This section provides clear guidance on the planning of airfield work, including the requirement to examine its impact upon airport operations and safety. The inclusion of ATC in such planning is incorporated into the Service Level Agreement between NATS and MA plc.

Section 3.12.1.1 of the airport operator's Operations Manual states:

'Furthermore, the safety of aircraft operations is dependant upon accurate and timely information being available for dissemination to pilots, ATC and operations staff.'

1.18.5 Planning (ATC)

Procedures for change to normal air traffic operations at the time of the incident were outlined in the Airport ATC Operations Procedure (MATC/UI/07/041), dated 16 May 2003. This document defined all the guidance and procedures required to implement temporary changes in procedures, culminating in the publication of a TOI. The whole process, and in particular the safety analysis, was most comprehensive. Not only did it rely on consultation with staff to identify potential risks, but also the formation of a group to formulate procedures to minimise such risks. In view of the time implications to conduct such tasks, a letter of agreement between NATS and the airport operator contained the following sections:

'A4) This agreement seeks to ensure that:

a) NATS at Manchester Airport receives adequate notification of planned aerodrome work so that the safety impact of the work can be assessed and appropriate instructions prepared for ATC staff in sufficient time.

B6) Notice Period for Significant Aerodrome Works – The airport operator will ensure that notification of intended significant

aerodrome works is given to NATS Manager Operations at the earliest possible opportunity. It is not possible to be completely prescriptive as to notice periods but the aim is to ensure that NATS receive a minimum of 14 days notice prior to the earliest possible date for work commencement’.