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Air Accidents Investigation Branch

Aircraft Accident Report No: 3/2006 (EW/C2003/07/04)

Registered owner and operator: Excel Airways Limited

Aircraft Type and Model: Boeing 737-86N

Registration: G-XLAG

Location: Runway 06 Left, Manchester Airport

Date and Time: 16 July 2003 at 1408 hrs

All times in this report are UTC (equivalent to local time minus one hour) unless otherwise stated

Synopsis

G-XLAG, a Boeing 737-86N, with seven crew and 190 passengers on board, was undertaking a flight from Manchester Airport to Kos, Greece. Runway 06L was in use but the flight crew were not aware that this runway was being operated at reduced length. This was due to work-in-progress to remove rubber deposits at the far end of the runway, which was out of sight from the 06L threshold end as the runway is built over a slight rise in the ground. Due to a difference in interpretation of information passed between Air Traffic Control (ATC) and the flight crew, the aircraft entered the runway from holding point AG, rather than the expected holding point A, and the takeoff was conducted using a reduced thrust setting calculated for the assumed normal runway length. As the aircraft passed the crest of the runway, the flight crew became aware of vehicles at its far end but, as they were now close to their rotation speed, they continued and carried out a normal takeoff. The aircraft passed within 56 ft of a 14 ft high vehicle.

This serious incident was notified to the AAIB at 1724 hrs on 23 July 2003, seven days after it had occurred. The subsequent investigation revealed further incidents had occurred during the course of the work, the most significant being on the night of 15 July 2003. On this occasion ATC had instructed three commercial passenger aircraft to go-around after they had knowingly positioned them to land on the reduced length runway. The crews of all three aircraft were unaware of the reduced length available and, when informed, stated that it was insufficient for them to be able to land. The closest of the aircraft, a Tristar, was at a range of 2.5 nm when instructed to go-around.

The actions of Manchester Airport plc (MA plc) and National Air Traffic Services (NATS) Manchester, whilst not directly contributing to the event involving G-XLAG, raised additional concerns. In light of this, the scope of the investigation was extended to include the manner in which MA plc and NATS had planned and managed the rubber-removal operation.

The operator, MA plc and NATS have now taken considerable steps to address most of the issues raised in this report.

Six safety recommendations are made.

Causal factors

The crew of G-XLAG did not realise that Runway 06L was operating at reduced length due to work-in-progress at its far end, until their aircraft had accelerated to a speed approaching the rotate speed (V_R), despite:

- Being in possession of a NOTAM concerning the work-in-progress
- The ATIS broadcast relating to the work-in-progress
- ATC passing information on the takeoff distance available

At this point, the aircraft was approaching seven vehicles on the runway and was at a position which precluded an abort within the useable runway length remaining.

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-incided 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'.

2.0 Analysis

2.1 Planning (Flight crew)

Prior to a flight, as part of the planning process, flight crews are required to check all relevant NOTAMs. In addition, the aircraft operator requires that the departure ATIS is recorded on the flight navigation log.

The flight crew reporting time used by the operator of one hour prior to departure, whilst complying with the regulations, provided little extra time to resolve any problems which might arise in the planning phase of a flight. However, should more time be required by the flight crew, owing to unforeseen complications, then the operator does not hold the crew responsible for any delay in ensuring the safe despatch of the aircraft. Despite this, in this instance, the commander might well have felt under pressure not to delay the flight; the lack of time having, in part, been exacerbated by his own late arrival.

It is often the case that flight crews report earlier than required by the operator to ensure that planning is completed in good time, as was the case with G-XLAG's co-pilot on the day of the incident. On learning that the aircraft commander would be late, he attempted to avert any subsequent delay to the flight by completing sufficient planning to be able to pass the fuel uplift figure to the aircraft refuellers. As the co-pilot was solely interested in getting sufficient information to make this calculation, he looked only at those NOTAMs for the destination and diversion airfields.

When the commander arrived at the crew room, 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. Whilst the flight crew had the intention of reading all the relevant NOTAMs before departure, they missed the opportunity to thoroughly brief together in the crew room. Once on the aircraft, they were subject to the usual distractions involved in pre-flight preparation and the pressure of trying to make their allocated departure time. As a result, despite their stated intentions, the NOTAM of critical importance to their departure, detailing the work-in-progress on Runway 06L/24R, was never read. Although unaware of the content of this NOTAM, the ATIS provided both pilots with another opportunity to learn of the work-in-progress. The ATIS broadcast gives a letter allocation at the start and finish of the information to ensure that those listening are aware that they have received the full transmission. The weather information was heard by the co-pilot, as he noted it in the appropriate place on the navigation log, but it was not possible to establish if either pilot had listened to the information about the work-in-progress.

The weather information from the ATIS was used by the pilots to calculate their performance for the takeoff. This was done, however, using performance figures for Runway 06L at its normal length and not the reduced length in force at the time of their planned departure. The performance figures calculated were correct for the normal runway length and allowed for the reduced thrust takeoff which was subsequently performed. The pilots had no data available which would have allowed them to calculate their performance for the reduced runway length and they were not in a position to obtain this data at such short notice.

Subsequent calculation revealed that the crew correctly calculated their takeoff speeds based on their belief that they were using Runway 06L at its normal length. The aircraft was, however, more than nine tonnes overweight for a takeoff on the reduced length Runway 06L when using the calculated reduced thrust.

On 9 July, a member of the operator's ground staff had attended a monthly meeting held by the airport operator for airlines using the airport. The minutes of this meeting recorded that the APPM had advised that there would shortly be some runway restrictions in place on Runway 06L/24R, due to maintenance work involving the removal of rubber deposits, although precise details were not given. This information was not passed on to either the operator's pilot managers at Manchester or the company operations department at Gatwick, as it was considered the meeting was designed to cover issues of importance only to the ground staff; ie the terminal and ramp areas. It was considered that, if it was of importance to flight operations, the airport operator would pass the relevant information to the various operators through a different channel.

Therefore, in the absence of any detailed notification of the restrictions planned for Runway 06L/24R, neither the pilot managers at Manchester nor their operations department at Gatwick were in a position to notify their flight crews of the work and its implications, or to produce and disseminate revised performance figures for operation from Runway 06L/24R at reduced length.

It might have been expected that, once it became apparent that work had commenced, such actions would have been taken by the operator. It is also possible to argue, however, that there would be no benefit in doing so as all the necessary information concerning the work was already available to flight crews in the relevant NOTAM. In addition, the operator stated that they would not have provided revised performance tables in this case for such temporary work, as the full length of Runway 06R/24L was available as an alternative. Their pilots would, therefore, have had no choice but to use Runway 06R/24L for which revised performance figures were not required.

2.2 Planning (MA plc)

Attempts during the investigation to ascertain the level of planning that had been conducted prior to the rubber removal work commencing were hampered by the lack of records of meetings that had been held. It appeared that the work was discussed in meetings attended only by members of the airport operations team, and that any contact with ATC had been by telephone alone.

The airport operator had been aware since 2 July 2003 that further rubber removal operations might be necessary, at which time the work had been booked to start on 14 July 2003. The Runway Classification Survey interim report of 7 July confirmed that the work was necessary and the first meeting held to discuss its implementation was reportedly held two days later on 9 July.

Airports must be able to plan for long term projects, such as the re-surfacing of a runway, as well as emergency work required at very short notice, such as the repair of damage to a runway or taxiway.

The airport operations management considered that the planning of the rubber removal operation did not constitute a major project nor was it an emergency situation which would require immediate action. As such, despite appreciating the important nature of the work, it appears that it was treated as falling between these two extremes.

Despite having only twelve days available in which to plan the work, the first planning meeting didn't take place until five days before the operation was due to start. In addition, no planning work was conducted over the weekend immediately prior to the work starting, effectively allowing only three days for any plans and safety assessments to be completed. During this period, the proceedings of those meetings which did take place were not documented and only the airport's operations staff were in attendance. It is considered likely that the need to co-ordinate the work with ATC must have been immediately apparent and it might, therefore, have been expected that an ATC representative would have been invited to attend planning meetings from the outset. This did not occur.

Similarly, despite it not being a CAA requirement, the MA plc Operations Manual required that, whenever possible, the CAA should be consulted when it is necessary to reduce runway distances. The CAA only became involved in the planning phase a matter of hours before the work was due to take place when an inspector with the appropriate level of knowledge of the airport was available to check the re-declared distances. Nevertheless, the CAA was consulted prior to the work commencing.

OAN 08/03 provided limited information as a briefing document. It contained only the redeclared distances for Runways 06L and 24R, and date and times when these distances would apply. It neither gave a description of where the displaced runway threshold should be located, nor how it should be delineated. Also, it gave no instructions on the length of the clearway within this closed section which, in order to comply with runway climb out gradient requirements, should remain clear of obstructions, or how the extent of the TOCS should be marked. Whilst not an official requirement, it must have been appreciated that in order to protect the TOCS the work vehicles would only be able to operate in a limited part of the closed section of runway. It would therefore seem logical that this area should be defined and identified to those involved in the work. The OAN also made no mention of any lighting requirements.

The hazard analysis for the work was dated 14 July, the day that the work commenced. No evidence was discovered that other parties were consulted to ensure all hazards had been identified but, if they had been, it is possible that the issues of runway lighting, jet blast and TOCS delineation might have been raised. The GM and APPM have subsequently stated that jet blast was not considered to be an issue as the work complied with the regulations and airport Operations Manual, which contained provisions for dealing with these issues. It would still, however, be expected to be raised as an issue in a comprehensive risk analysis with the closing actions including the above.

Despite finishing the planning at such a late stage the operations department only disseminated the finalised OAN via the internal mail system. Furthermore, there was no system in place to ensure that the document intended to provide the necessary information had actually been received by the addressees. As a result, the operations department could not be assured that the relevant personnel were in possession of information about the work shortly to commence. Also, it was not established when the airport FRS, another addressee of importance, received their copy of the OAN.

The airfield GM did not consider that the short notice of the work given to the necessary personnel outside the operations department was a problem. His view was that departments such as the FRS planned on a daily basis and so would not be adversely affected by such late notification. Also, it was mistakenly believed by the APPM that aircraft using the shortened runway would be able to recalculate their takeoff performance requirements from the information supplied by the NOTAM or ATIS, without recourse to any other external resource. Thus, she considered that, as long as crews had been informed of the shortened runway and the new runway lengths available, there would be no effect on the ability of

flight crews to calculate their takeoff performance requirements, regardless of the length of notice provided.

Evidence from other sources contradicts these views. The lack of timely notice had certainly affected the ability of ATC to carry out adequate planning. The majority of operators would have needed sufficient notice to be able to revise performance figures to allow their aircraft to operate from the shortened Runway 06L. It was therefore apparent that senior members of the airport's operations team did not have an adequate understanding of aircraft operations and the planning requirements of other airport departments.

Included in Section 3.12.1.1 of the airport operator's own Operations Manual is a list of instances where accurate and timely information is required for dissemination to pilots, ATC and operations staff. Contained in this list is the subject of re-declared runway distances.

Throughout the work-in-progress, it was always intended that the full length Runway 06R/24L would also remain available. Aircraft, therefore, always had a choice of runways available to them and, whilst the use of Runway 06R/24L might have resulted in operational delays, the ability of aircraft to comply with their performance requirements was never compromised.

2.3 Planning (ATC)

A letter of agreement between NATS and the airport operator sought to ensure that NATS at Manchester Airport would receive adequate notification of planned aerodrome work, so that the safety impact of any such work could be assessed and appropriate instructions issued to ATC staff in sufficient time. On this occasion, the ATC Manager was given five days notice of the intended rubber removal work. However, this period included a weekend where, as with the airport operations managers, the ATC Manager involved in the planning was off duty, reducing the time available to effect a change in procedures to three days. He stated that his copy of the OAN did not arrive until the morning of Thursday 17 July, the fourth day of the work. He was aware that the work was taking place but, in the absence of the OAN, he made some significant and incorrect assumptions which he might not otherwise have made.

The ATC Manager responsible for overseeing the ATC aspects of the proposed work only communicated with the responsible airport operations managers by telephone and e-mail. Neither party met to discuss the matter and this, possibly, is one of the reasons behind the ATC Manager's stated belief that the work was only to be conducted on one day; Monday 14 July.

In addition to the short notice period and the perception that the work would only be for a period of one day, the ATC manager stated he had no sight of any written information from the airport operator on which to base his plans. On this basis, he decided he was not in a position to complete the prescribed planning process leading to the publication of a TOI. Instead, he elected to employ the 'Unusual Operating Procedures' in the Manual of Air Traffic Services (MATS) Part 2. He also intended to personally brief all controllers coming on shift at the affected times with the necessary information.

There was additional pressure placed on the ATC Manager to facilitate the work as, at the time of the incident with G-XLAG, he was aware of negotiations to renew the NATS air traffic control contract with the airport operator and that this would not have been a good time to appear 'un-cooperative' with an airport project.

2.4 Conduct of the flight

By the time the aircraft pushed back, both pilots were aware that work of some nature was being conducted on Runway 06L, this resulting largely from listening to ATC communications with other aircraft. The co-pilot believed the work was in the threshold area of Runway 06L; this was reinforced by his mistaken belief that ATC were instructing them to line up at an entry point part way up the runway. The commander stated he believed the work was at the far end of the runway in an area outside that affecting their takeoff performance. Runway 06L/24R slopes up from both ends towards the middle creating a slight hill effect, sufficient for the crews of B737 sized aircraft to be unable to see beyond the highest point until they are some way down the runway. Thus, the vehicles on the runway were not visible to the crew of G-XLAG as they lined up, denying them a final opportunity to become aware of the actual situation concerning the work-in-progress.

G-XLAG's initial taxi clearance from ATC did not specify the clearance limit, stating only that they were cleared to the "holding points" for Runway 06L. At that time, there was no requirement to specify a clearance limit; this is now a requirement and has been incorporated in to MATS Part 1. As a result of the original clearance, when ATC had asked if they could accept a departure off "THE REDUCED RUN AVAILABLE ON RUNWAY 06L" followed by the crew's reply of "YEAH FROM ALPHA GOLF", it is likely that the omission of the clearance limit meant that ATC believed the aircraft would be taxiing for holding point A1, whilst the crew believed they were expected to taxi to holding point AG.

The crew were used to operating from Manchester and, for Runway 06L, they were normally given takeoff clearance from the threshold. Indeed, the UK AIP

and MATS 2 require aircraft over 5,700 kg MTWA to commence their takeoff run from a position as close as possible to the south-western end of the runway. This required lining up via runway link 'A'.

On handover to the tower controller, the clearance was ambiguous in that the crew were merely cleared to "LINE UP AND WAIT ZERO SIX LEFT". The tone of 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, but this response was interpreted by the controller as a statement of intent rather than a question. However, it seems apparent that ATC were also concerned, as the flight crew seemed prepared to commit to a takeoff on a reduced length runway, but effectively made shorter by entering at holding point AG. As a result, when ATC replied with...."*IF YOU'RE HAPPY WITH THAT THAT GIVES YOU ER SIXTEEN SEVENTY METRES*" the crew were provided with another opportunity to become aware of the reduced takeoff run on Runway 06L. This information, which applied to a takeoff on the reduced length runway from holding point AG, was either missed by the crew or the ambiguity of the exchanges led them to mis-interpret this as the takeoff distance available from holding point AG at the normal runway length. It seems, therefore, that a mis-interpretation by both ATC and the flight crew of the other's intent, led to the aircraft lining up via holding point AG rather than, as both had expected, runway link 'A'.

One of the reasons stated by the crew explaining why they might have missed the significance of the takeoff run data passed by ATC, was that they were both used to dealing with performance figures specified in company documents in feet. The use of metres, when specifying the runway distance available in the NOTAM and the ATIS broadcast, conformed to standard international practice. Whilst a quick conversion from metres to feet would not have been difficult, at the time they were passed the information they were concentrating more on trying to determine exactly from which point ATC wished them to line up on Runway 06L. Hearing the distance in metres failed to raise the same question in their minds that might have occurred had they heard the figures in feet.

Although the crew both stated they believed there was nothing to affect their takeoff performance, neither was able to explain the captain's decision to make the non-standard circling turn when entering the runway in order to line up precisely next to their entry point, nor their choice of takeoff technique, which again was non-standard. Not only was it an abnormal technique to hold the aircraft on the brakes whilst applying initial power but, should a takeoff require such a technique because of restricted performance it might well be expected that this would be done in combination with the use of maximum takeoff thrust,

rather than the reduced thrust setting that was used. In the absence of a cockpit voice recording covering the takeoff, or clear explanation by the crew, these actions would seem to support the view that the crew had doubts about the location of the work-in-progress and its possible relevance to their takeoff. If this view is correct, then they did not seek to clarify the situation, relying on the use of non-standard procedures in an attempt to build a level of 'insurance' into their takeoff run. The extra takeoff run afforded by the line-up technique employed was, in the event, significant as analysis of data from the FDR indicated that, at the commencement of the takeoff run, had the distance between the aircraft and the rubber removal vehicle been reduced by 95 m, it is probable that a collision would have occurred.

The hump in the runway meant that, by the time the pilots saw the vehicles in front of them, it was too late to bring the aircraft to a stop without hitting them, so they had no option other than to continue the takeoff. By this point they had almost reached their calculated takeoff speed and the QAR data indicated that there was no attempt to rotate early. Indeed, the pilots stated that whilst they were surprised to see the vehicles on the runway they believed they had done nothing wrong and thought that they had cleared them by some margin.

2.5 Airport operations and ATC management issues

The first reported problem encountered in the management of the rubber removal work was the late resumption of full length operations on Runway 06L on 14 July. There was a discrepancy over the time this happened, but it was apparent that there was a conflict between ATC and the ADM over the use of Runway 06R after 2100 hrs. The ATC supervisor required the use of one full length runway but, by 2100 hrs, Runway 06L had not been returned to full length and he was being informed by the ADM that Runway 06R should no longer be used for environmental reasons. His decision to continue operations on both runways after 2100 hrs then left him with less than the required number of controllers to effectively support that situation.

The agreements governing the use of Runway 06R/24L, were contained in a policy document not readily available to either ATC or airfield staff at an operational level. The airport operator stated that this document allowed the use of Runway 06R/24L between the hours of 2200 hrs and 0600 hrs (local) only when Runway 06L/24R was closed for planned or unplanned maintenance, or when it was unsafe to use. It did not, however, make clear what authority was required to use Runway 06R/24L at these times.

The airport operator stated that whilst this information was not readily available, it would have been well understood by its operations staff, but this view is not supported by the comments made by the ADM in this instance. The need to keep Runway 06R open beyond 2100 hrs then presented manning problems for ATC. Also, operating Runway 06R/24L beyond the normal time of 2100 hrs would have had implications for FRS personnel stationed at the Runway 06R/24L satellite station.

The ATC Manager stated that he only became aware that the work would continue beyond Monday by the end of the first period of work that day. He, however, still decided against publishing a TOI, relying instead on personal briefings given either by himself or between controllers at shift changes. The result led to confusion, especially on the part of the deputy supervisor when he took over control of the tower on the evening of 15 July. He assumed control in the middle of the shift, not having been in the tower previously whilst the reduced runway operation was in progress. The deputy was briefed by the supervisor from whom he was taking over but, in the absence of any other documentation, had only the NOTAM to rely on for additional guidance. The supervisor had impressed upon him the importance of finishing operations on Runway 06R by 2100 hrs precisely, due to the previous night's comments by the ADM.

The deputy then made a specific point of ensuring that the first three arriving aircraft after 2100 hrs would be landing on Runway 06L. In order to achieve this, the aircraft were required to be directed to an approach for Runway 06L prior to 2100 hrs, at which time it was still operating at reduced length. The deputy was aware of this and became uncomfortable with the fact that a wide bodied aircraft had now been lined up to land on the shortened runway. He sought confirmation that his actions were correct, but in the absence of any specific brief had no guidance readily available. It was only by the controllers questioning the situation between themselves, and then crucially with the aircraft preparing to land that a potential accident was averted.

In providing the airport operator with suitable times for the runway work to be conducted, the ATC Manager had overlooked the fact that the start times he had provided coincided with the controllers shift change. He suggested these times as this was generally a quiet period of the day, one of the original reasons behind the choice of these times for the shift change.

The go-around incidents occurred on the second night of the work and, for the second time, mention was made of runway lighting being activated within the closed section of the runway. Despite these issues, no action was taken by either the airport operator or ATC, and the work continued exactly as it had the previous day.

The same ATC shift was on duty the next afternoon, 16 July, the third day of the work. Despite the previous night's confusion on the part of his deputy, the ATC supervisor was still happy to leave him in charge for part of that afternoon's shift. An oversight by a member of the airport operations team had resulted in a delayed start to the work. This, in turn, led to the agreement between the ADM and ATC supervisor to make up the lost time by permitting the rubber removal work to continue beyond the published time of 1430 hrs, to the new time of 1500 hrs. This deviation from the already limited planning information created the potential for further problems. No evidence was found of any action taken to ensure that the extension of the runway restrictions was reflected in the ATIS broadcast, as the period of runway length reduction now did not correspond to the times published in the relevant NOTAM.

The tower controllers were already wary of the reduced runway length operation after their experience the previous day. They found the sight of aircraft taking off towards vehicles on the runway distinctly uncomfortable. This was compounded by the knowledge that no TOI for the work had been raised, and they therefore considered, correctly, that no proper ATC safety review had been carried out. Despite this unease, they continued to operate, even when the BAe 146 appeared to have flown low over the vehicles in the closed section of the runway. When asked why they had chosen to continue to operate aircraft from Runway 06L, while clearly unhappy with the situation, the general response was that they felt powerless to do anything else. The work had been agreed by their own manager and they were in no position to question pilots who informed them that their aircraft had the necessary performance to operate from the runway's reduced length. The 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 dissension, with possible disciplinary consequences.

The crew of G-XLAG transmitted to ATC that they were able to take off from Runway 06L, entering from holding point AG. The controller's experience lead him to realise, from knowing the aircraft's destination, that it would have a high fuel load and would therefore be heavy. In this knowledge, he was surprised that the crew had declared that they would be able to use the shortened runway and even more surprised that they were content to further reduce the takeoff run available by starting from abeam holding point AG. Without any information to the contrary, the controller felt in no position to question the pilots' decision.

After the aircraft had taken off and come close to the vehicles on the runway, the APPM was informed by the ADM, but she chose to continue the operation, in the belief that there was nothing wrong with the way it had been implemented. Similarly, the ATC supervisor and deputy were equally aware of the situation, but their only immediate action was to limit the type of aircraft operating from Runway 06L whilst at its reduced length. In only allowing narrow body aircraft on short haul routes to use the shortened runway, the assumption was that they were likely to be light enough to have sufficient performance to take off well before the displaced end of the runway. Despite this, an entry in the ADM's log for that night reported that ATC had requested the removal of the vehicles prior to the departure of a Boeing 757. The logic behind this is not fully understood, following the decision made after the afternoon's incident, especially when the controllers had Runway 06R available at its full length.

That night, as a result of the serious incident with G-XLAG, the ATC supervisor contacted the ATC Manager by e-mail, raising concerns over the planning of the operation and, specifically, he criticised the lack of a TOI. No mention was made of the previous night's go-around incidents, although they had been entered in the ATC log. The day after the incident involving G-XLAG was the fourth day of the rubber removal operation. By now, both the APPM and ATC Manager were in possession of communications that clearly indicated serious problems existed with the way the runway work was being implemented. Despite this, only minimal action was taken by both managers to either review or stop the work in progress to re-evaluate the way it was being accommodated operationally.

There was only one further reduced length operation required to complete the rubber deposits removal from Runway 06L/24R, and the whole operation was completed for both runways on the evening of Thursday 17 July. No further incidents were reported during this period.

2.6 Lighting

The report by the ATC supervisor, on the night of 14 July, provided the first indication that no liaison had occurred between ATC and MA plc on the matter of runway lighting, whilst the work was in progress.

From the statement given by the GM and the APPM, it was never the intention of MA plc to operate at reduced length should runway lighting have been required. If this was indeed the case, no reference to this could be found in any of the documents relating to the work, including the OAN. Whatever was intended, it is apparent that there was a lack of understanding between ATC and MA plc operations staff as to the procedures on those occasions when lighting was required.

During the period of the work, official night started at about 2100 hrs, which co-incided with the planned end of each evening's rubber removal session. As runway lighting was likely to have been required prior to this time, it might have been expected that either written instructions would have been published, or the finish time of the evening session be brought forward.

2.7 Reduced runway length operations

Reduced length procedures allow the use of a runway that would otherwise be denied due to a known hazard being present at some point along its length. This can either be as the result of an unforeseen event, or a pre-planned requirement to close part of the runway. In either case, the use of clearly defined procedures can allow the remainder of the runway to remain safely in use. These procedures apply the same limitations on the shortened length of runway as apply to the full length, in terms of protected areas required at either end, and the protection of landing and climb-out paths.

Whilst this is an established, if infrequent, procedure the changed visual aspects presented to both pilots and controllers can be unsettling. Thus, an aircraft taking off towards a vehicle located beyond the end of a shortened runway does not inspire the same confidence, to a witness, as a takeoff where no obstacle is present, even if the runway length available in both cases is the same.

At Manchester Airport, the distance between the end of the full length Runway 06L to the first non-frangible object, is 267 m. The distances declared during the rubber removal work gave the minimum distance between the re-declared end of Runway 06L and any obstacle in the work area beyond it, as 485 m. It could be argued, therefore, that if an aircraft made full use of the runway length available when using the shortened runway, it would have an additional safety margin of 133 m. This must be reviewed against the fact that, where aircraft rotate at the same point on the runway, those operating reduced length procedures will be doing so closer to the runway end, reducing the length of clear runway ahead available for stopping. Whilst on this occasion the implementation of the reduced runway length actually increased the runway end safety area, on other occasions and at other airfields, this might actually be reduced.

In the course of this investigation it became clear that the views of the ATC controllers at Manchester Airport were shared by controllers spoken to at another major UK airport, where reduced length operations were routinely used during runway maintenance. It would seem, therefore, that despite complying

with a universally imposed set of requirements, irrespective of runway length, operations from restricted length runways inspire in controllers a lack of confidence in such operations.

2.8 NOTAMs

The version of CAP 683 current at the time of the incident described procedures for runway friction classification and monitoring, and contained a definition of Minimum Friction Level. 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 consequential severe operational limitations. This was the reason that lay behind the airport operator’s declared urgency in completing the rubber deposits removal. However, their failure to publish a relevant NOTAM or make alternative arrangements agreed by the CAA resulted in operators, potentially, using a runway, without their knowledge, in a degraded state. Over the period of the work, rain fell on two days and, on one of these days, a thunderstorm warning was in force. CAP 683 was substantially revised in 2004.

The operator involved in this serious incident received all its briefing material, including NOTAMs, from a company which subscribed to the AIS network. Although requests for NOTAMs are often processed and transmitted by the AIS within approximately ten minutes, the time taken for a company to incorporate this information in their own briefs can vary. It is possible that, even if a request had been sent by MA plc precisely at 1000 hrs (local), the NOTAM might not have been available to crews for up to an hour. It is possible, therefore, that some flight crews arriving at Manchester, during the first period of runway work, would not have been aware of, or had available to them, the relevant NOTAM.

Whilst it was not until the morning of 14 July that the runway reduced lengths had been confirmed, there was nothing to stop the airport operator publishing a NOTAM at an earlier date, warning that runway restrictions would be in place. This would, at least, have forewarned operators and crews using the airport and would have alerted them to seek the required information as soon as it became available. Similarly, no evidence was found that the relevant NOTAM had subsequently been cancelled when the work was completed, three days ahead of schedule. This is required under Eurocontrol standards to ensure that information appearing in any published NOTAM remains valid. This requirement was repeated in the Airfield Manual.

2.9 Manchester Airport Fire and Rescue Service cover

OAN 08/03 was known to have been received by the FRS, but not the time of its arrival. As it was not published until late in the morning of 14 July, it was quite possible that it had not arrived prior to the work commencing and, certainly, no system existed to confirm that the FRS had received notification of the work, whether by OAN, or from ATC or the operations department, prior to the work commencing. The Senior Airport Fire Officer highlighted the need for the FRS to be made aware of any work on the airfield in sufficient time for any necessary contingency plans to be drawn up. The work in this instance was of particular relevance, for two reasons.

Firstly, it required the manning of the South Station at a time when it would normally have been closed. Sufficient manning existed on the airfield to do this, however, an element of planning would have been desirable to redeploy personnel from other duties in good time. Despite the short notice provided, the FRS were always able to provide the appropriate level of cover required during the time the rubber removal work was being conducted. Confirmation that cover was in place was obtained by both ATC and MA plc operations staff prior to operations commencing from this runway.

The second reason was that there were potential implications for the FRS in meeting their requirement, as defined in CAP 168, to be able to respond to an incident up to 1,000 m beyond a runway threshold.

2.10 Subsequent reporting and investigation

The event involving G-XLAG was a serious incident and as such should, as required under *The Civil Aviation (Air Accidents and Incidents) Regulations 1996*, have been reported immediately to the Air Accidents Investigation Branch. Relevant notification of the incident to the CAA and NATS would also have been expected.

The pilots of the aircraft, whilst surprised by the presence of the vehicles on the runway, heard no mention from the tower controller after their takeoff that their departure had created an incident. They had also made enquiries on their return to Manchester, some hours later, but again no concerns were raised. They therefore believed that nothing untoward had happened and, as a result, made no report, either to their company, the CAA or the AAIB.

If, as the pilots stated, they believed that the full length of the runway was available to them for takeoff, then it is surprising that the presence of the vehicles

on the runway was not questioned by them to ATC once airborne, or that a report was not made on their return.

The ADM on duty at the time of the incident had spoken both to the ATC deputy supervisor and the APPM and the incident had also been seen by controllers in the tower. None of these individuals chose to file an official report on the event at the time. This was despite the ADM's log recording that two aircraft had passed over the work much lower than expected and that ATC had concerns for the workers' safety.

It was not until five days after the incident that a report was finally submitted by the ATC Manager, when he had become aware of the full nature of the event. This report was made to NATS who, at 1724 hrs on the afternoon of 23 July 2003 reported the matter as a serious incident to both the CAA and the AAIB.

As a result of AAIB enquiries, the airline operator quickly became aware of the incident and began an internal enquiry, immediately suspending the pilots involved. A CAA Flight Operations Inspector liaised with the operator to ensure appropriate action had been taken.

An internal investigation carried out by the NATS staff at Manchester resulted in an early decision being made that, due to the issues involved, an external investigation was required, and this was undertaken by an independent NATS safety review team.

When the AAIB began discussions about this incident with the airport operator, there was no indication of any internal investigation having been launched or that any action had been taken by the airport's CAA Inspector. An internal report into the incident compiled by the APPM was, however, later received. The Aerodrome Standards Department within the CAA, who attended an AAIB briefing on this incident, decided to take no further action at that time. The CAA have subsequently stated that as a result of this and other incidents, and significant senior management changes at the airport, the Aerodrome Standards Department, in conjunction with Air Traffic Standards Department, took a number of actions, including a joint special audit of the safety management system at Manchester Airport. As a direct result of this, several issues were identified that required remedial action to be taken by Manchester Airport.

The action taken by the operator, NATS and the CAA Flight Operations Department seemed an appropriate response to the situation. Whilst the airport operator carried out an investigation it is questionable whether, under the circumstances, the APPM provided the appropriate independence. There

appears to have been no involvement in their investigation of the Airfield Safety and Standards Manager, as might be expected, and no record of the incident or the subsequent report was found in the airport's Incidents File.

The CAA Aerodrome Standards Department's decision not to investigate the matter further at the time seems to stem from their view that procedures had been correctly followed and that these procedures had previously been audited by the CAA themselves. This investigation would indicate that, whilst procedures were in place, they had not all been followed or used as intended. Their decision appeared to be inconsistent with that of the CAA Flight Operations Department, who were involved from an early stage. However, the Aerodrome Standards Department has subsequently revised its procedures to now ensure a more consistent approach in its response to such events.

2.11 Follow-up actions

Following this incident, the pilots involved received appropriate re-training before returning to flying duties. The operator's own investigation, and that of their CAA Flight Operations Inspector, revealed no other issues requiring action.

Steps were taken to improve the safety culture within NATS at Manchester by, amongst other measures, introducing a more open and robust reporting regime. Assets have also been made available to create a new safety and development management post. At a national level, NATS has taken on several new initiatives to increase the level of information dissemination between their various ATC units and to provide safety staff with better training. NATS is also carrying out a study to assess the level of safety culture within its various units and to provide a means of tracking any changes.

The working relationship between NATS and MA plc has come under close scrutiny from both sides and as a result of changes has now improved considerably. In particular, both sides have worked jointly to provide better agreement on the process leading up to similar projects being undertaken in the future. This includes a joint hazard analysis process and better internal dissemination of information.

The CAA published two documents in 2003 relating to combined hazard procedures: CAP 726 (The Management of Safety) and CAP 729 (Guidance on Aerodrome Development Procedures). In addition, the CAA had published further and more up-to-date guidance on this subject in CAP 760 (Guidance on the Conduct of Hazard Identification, Risk Assessment and the Production of Safety Cases: for Aerodrome Operators and Air Traffic Service Providers).

The airport operator has taken the decision not to operate takeoffs or landings towards planned work in progress. They have stated that they have also improved the sharing of safety and operational lessons learned across the airport's group of which they are a member.

The considerable effort by these parties to address the issues raised in this report is noted and it is believed that the significant actions now taken largely address the issues raised.

3 Conclusions

(a) Findings

- 1 A classification survey carried out on 25 and 26 June 2003 identified friction levels on portions of Runway 24R touchdown zone exceeding 100 m in length, that were below Minimum Friction Level.
- 2 No NOTAM was published to advise that Runway 06L/24R was slippery when wet whilst portions of the runway were below Minimum Friction Level.
- 3 The airport operator contracted the rubber-removal operator on 2 July 2003.
- 4 The airport operator held the first planning meeting for the rubber-removal operation on 9 July 2003.
- 5 Hazard analysis conducted by the airport operator dated 14 July 2003 did not include all hazards associated with the rubber-removal operation.
- 6 No documented hazard analysis was conducted by Manchester ATC.
- 7 Operational Advice Notice 08/03, relating to the rubber-removal operation, published on the morning of 14 July 2003, contained only limited briefing information.
- 8 Manchester ATC did not publish a Temporary Operating Instruction relating to the rubber-removal work.
- 9 The request for NOTAM action was applied for by the airport operator approximately three hours prior to the commencement of the rubber-removal operation on 14 July 2003.
- 10 The CAA confirmed the correct reduced runway distances had been calculated when contacted by the airport operator on the morning of 14 July 2003.
- 11 Rubber-removal operations commenced at 1430 hrs on 14 July 2003 and were completed by 2053 hrs on 17 July 2003.

- 12 No evidence was found that the NOTAM detailing the work had been cancelled by the airport operator when the work had been completed ahead of schedule.
- 13 There were no markings to delineate the extent of the Take Off Climb Surface whilst Runway 06L was operating at reduced length.
- 14 Commencement of reduced runway operations coincided with the ATC shift change.
- 15 There was no blanking of runway lighting in the work-in-progress area of Runway 06L during reduced runway operations.
- 16 There was confusion between Manchester ATC and the airport operator operations staff over the planning restrictions in force limiting the operating time permitted for Runway 06R/24L.
- 17 There was no access to the planning restrictions in force on the use of Runway 06R/24L in any documents available to Manchester ATC or the airport operator at an operational level.
- 18 On 15 July three aircraft were lined up on the approach to land on Runway 06L by Manchester ATC whilst it was operating at reduced length, a length insufficient for them in which to land.
- 19 Work was in progress at the time of the incident at the end of Runway 06L.
- 20 The work-in-progress was promulgated by NOTAM and transmitted on the ATIS to which the two pilots had access.
- 21 The co-pilot listened to the ATIS broadcast, which contained details about the weather, bird activity and the work-in-progress, but only copied down details about the weather.
- 22 Manchester ATC advised the pilots of the reduced runway distance available for take off.
- 23 The pilots were properly licensed to conduct the flight.
- 24 The pilots did not read the NOTAMs relating to Manchester Airport prior to the aircraft's departure.

- 25 The pilots correctly determined the aircraft's takeoff performance for a takeoff from Runway 06L had it been at full length, but this was incorrect at its reduced length.
- 26 The pilots had no means of determining takeoff performance for the aircraft from Runway 06L at reduced length.
- 27 The aircraft was more than nine tonnes over-weight to conduct a reduced thrust takeoff from the reduced runway length available.
- 28 The taxi instructions issued to the flight crew by Manchester ATC did not include a specific holding point.
- 29 The version of MATS Part 1 current at the time of the incident did not require a specific holding point to be included in taxiing instructions.
- 30 The captain was handling pilot during the taxi.
- 31 Radio communications between Manchester ATC and the flight crew regarding the lining up point on Runway 06L were misinterpreted by both parties.
- 32 The aircraft was lined up on Runway 06L via holding point AG using a non-standard technique.
- 33 The co-pilot was the handling pilot during take off.
- 34 The pilots used a non-standard technique to set takeoff power at the commencement of the takeoff roll.
- 35 Seven vehicles associated with the work-in-progress were on Runway 06L at the time of takeoff; closest to the aircraft's point of rotation was a rubber-removal vehicle 14 ft high.
- 36 The pilots only became aware of the presence of vehicles as they crested the rise in the runway just prior to the aircraft attaining rotation speed, V_R .
- 37 The aircraft was rotated at the pilots' calculated V_R speed.
- 38 After becoming airborne, the aircraft passed within 56 feet of the vehicle.

- 39 The pilots did not believe they had been involved in a serious incident and so did not make a report to their company, the CAA or the AAIB.
- 40 Both MA plc and Manchester ATC senior management were made aware of the incident on the day of its occurrence, but did not necessarily appreciate its true significance at the time.
- 41 The incident was witnessed by some ATC and airport operations staff.
- 42 No report was made by any members of MA plc or Manchester ATC immediately following the incident.
- 43 The incident was reported seven days after its occurrence to the AAIB by NATS on receipt of a report by Manchester ATC.

(b) Causal factors

The crew of G-XLAG did not realise that Runway 06L was operating at reduced length due to work-in-progress at its far end, until their aircraft had accelerated to a speed approaching the rotate speed (V_R), despite:

- Being in possession of a NOTAM concerning the work-in-progress
- The ATIS broadcast relating to the work-in-progress
- ATC passing information on the takeoff distance available

At this point, the aircraft was approaching seven vehicles on the runway and was at a position which precluded an abort within the useable runway length remaining.

4 Safety Recommendations

The serious incident which triggered this investigation resulted from a non-adherence to established procedures by the flight crew, rather than a failing in the procedures themselves. The operator took early and appropriate action to prevent a reoccurrence by the crew involved.

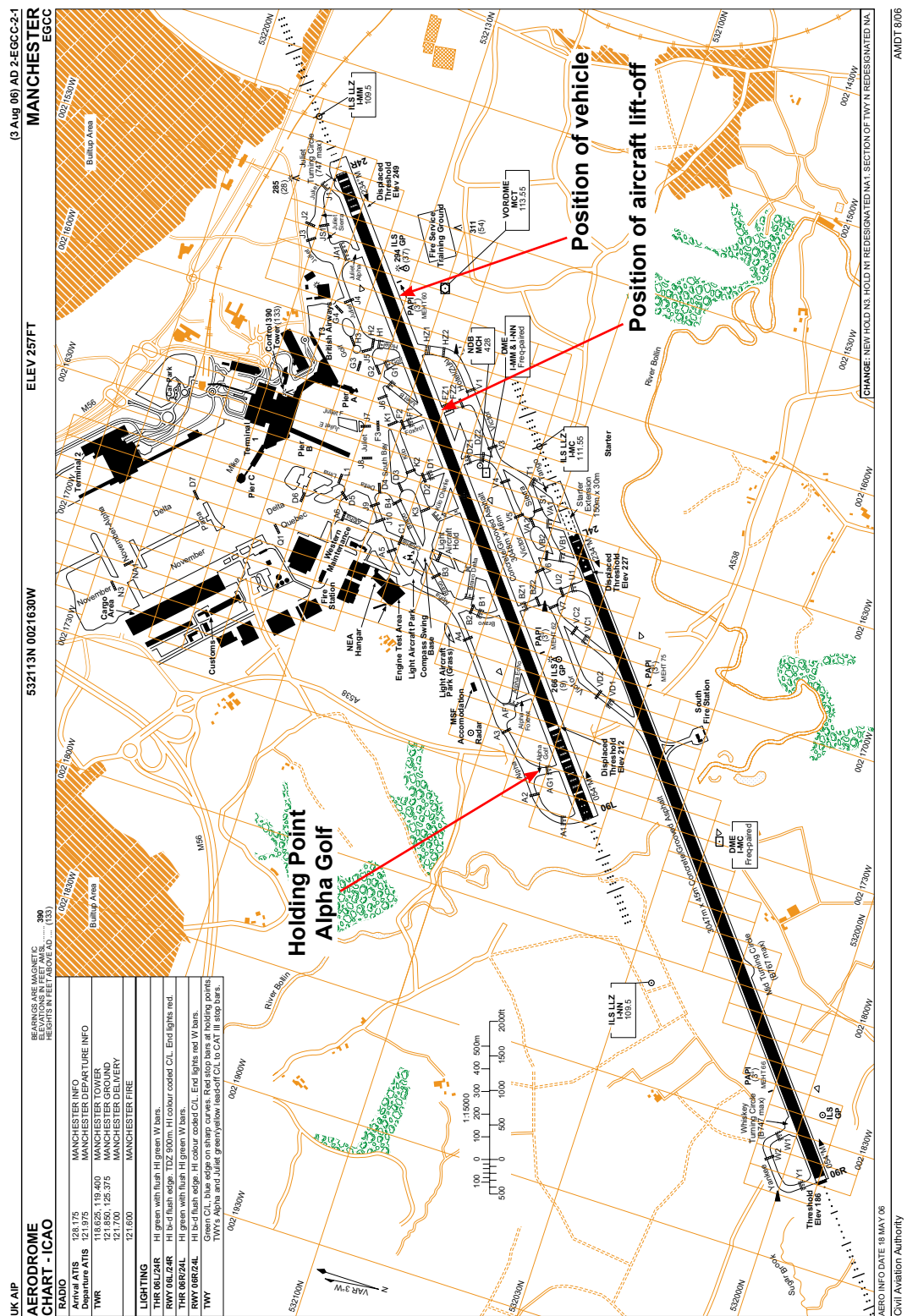
In investigating the event involving G-XLAG, the planning and management of the rubber-removal operation by MA plc and NATS Manchester raised additional concerns. They, too, largely centre on non-adherence to established procedures. Since the event, both these organisations have taken considerable action and, as a result, the majority of the issues identified in this report have now been resolved.

The following Safety Recommendations are made where it is believed further action by these, and other parties, remains necessary.

- 4.1 Safety Recommendation 2006-07:** It is recommended that the Civil Aviation Authority review the measures required to protect runway safety surfaces during reduced length runway operations.
- 4.2 Safety Recommendation 2006-08:** It is recommended that National Air Traffic Services consider the exclusion of operational staff in direct commercial negotiations where there is the potential for this to result in a conflict of interest between operational best practice and commercial considerations.
- 4.3 Safety Recommendation 2006-11:** It is recommended that the Civil Aviation Authority, in conjunction with National Air Traffic Services and other air traffic service providers, jointly review the current risk analysis associated with operations from runways when at reduced length, to ensure that it remains valid.
- 4.4 Safety Recommendation 2006-12:** It is recommended that Manchester Airport plc include appropriate guidance in the Airport Operations Manual on the local authority planning agreements governing the use of Runway 06R/24L.
- 4.5 Safety Recommendation 2006-13:** It is recommended that National Air Traffic Services incorporate appropriate guidance in the Manchester Airport Manual of Air Traffic Services (Part 2) on the local authority planning agreements governing the use of Runway 06R/24L.

4.6 Safety Recommendation 2006-14: It is recommended that Manchester Airport plc introduce a system which requires the timely dissemination and acknowledgement of any instruction issued containing operational information with safety implications, such as Operations Advice Notices.

P T Claiden
Principal Inspector of Air Accidents
Air Accidents Investigation Branch
Department for Transport
October 2006



Manchester International Airport - Aerodrome Chart

Appendix B

Date	Daily Rainfall (mm)
08/06/2003	4.7
09/06/2003	0.8
10/06/2003	trace
11/06/2003	1.4
12/06/2003	1.7
13/06/2003	0.2
16/06/2003	trace
17/06/2003	trace
18/06/2003	3.3
19/06/2003	trace
20/06/2003	trace
21/06/2003	0.1
22/06/2003	4.2
25/06/2003	trace
26/06/2003	0.1
27/06/2003	11.3
29/06/2003	10.2
30/06/2003	15.4
01/07/2003	0.8
02/07/2003	1.0
03/07/2003	0.2
07/07/2003	0.4
08/07/2003	0.0
09/07/2003	0.0
10/07/2003	0.0
11/07/2003	0.0
12/07/2003	0.0
13/07/2003	0.0
14/07/2003	0.0
15/07/2003	0.0
16/07/2003	6.6
17/07/2003	1.6
18/07/2003	0.0
19/07/2003	0.4
20/07/2003	0.6

Rainfall data for Manchester Airport, 8 June - 20 July 2003

Glossary

For the purpose of a runway surface friction assessment the following definitions apply:

Continuous Friction Measuring Equipment (CFME)	A device designed to produce continuous measurement of runway friction values.
Design Objective Level (DOL)	The target friction level to be achieved on a new or resurfaced runway within one year.
Friction Level	The overall average friction value calculated from a minimum of 10 average friction values obtained over a rolling distance of 100 metres within a portion of the pavement.
Maintenance Planning Level (MPL)	The friction level below which a runway maintenance programme should be undertaken.
Minimum Friction Level (MFL)	The friction level below which a runway shall be notified as 'may be slippery when wet'.
Portions Of The Pavement	One third of the declared runway width, referred to as the 'central' trafficked portion and two 'outer' portions.
Runway Surface Friction Assessment	The assessment of friction carried out under conditions of self-wetting using a CFME.
Wet Runway Surface	<p>A runway that is soaked but no significant patches of standing water are visible.</p> <p>Note: standing water is considered to exist when water on the runway surface is deeper than 3mm.</p>

Chapter 4 Evaluation of Runway Surface Friction Assessment Results

1 Introduction

- 1.1 The friction level values obtained should be compared with the following criteria:
- The Design Objective Level (DOL)
 - The Maintenance Planning Level (MPL)
 - The Minimum Friction Level (MFL)
- 1.2 The friction level values produced by different CFME vary slightly for any given runway surface friction characteristics; therefore, Table 3 indicates the correlation between the assessment criteria of CFME devices commonly in use in the UK.

Table 3 CFME and Friction Level Values

CFME	DOL	MPL	MFL
Mu-Meter	0.72 or greater	0.57	0.50
GripTester	0.80 or greater	0.63	0.55

2 Action to be taken as a result of a runway friction assessment

- 2.1 The aerodrome operator should review the results of each runway friction assessment and where appropriate take the following action:
- If the friction level is below the MPL, maintenance should be arranged to restore the friction level, ideally to a value equal to or greater than the DOL.
 - If the friction level indicates a falling trend, the Aerodrome Operator should increase the frequency of runway friction assessments in order to identify any further or rapid deterioration and, if appropriate, the action to be taken.
 - If the friction level is below the MFL, maintenance should be arranged urgently in order to restore the friction level and, in accordance with ICAO Annex 14 Volume 1 Paragraph 2.9.5, a NOTAM shall be issued advising that the runway may be slippery when wet.
 - If the friction level is significantly below the MFL, the aerodrome operator should consider withdrawing the runway from use for take-off and/or landing when wet.

3 Assessments made following maintenance activities

- 3.1 The friction characteristics of some runway surface materials can improve over time, commonly as a result of the dispersal of oils in the surface layers. However, if the runway surface friction assessment indicates that the friction characteristics of an area of the runway that has been subject to maintenance work are poorer than anticipated or fall below the MPL, additional assessments should be performed over a period of time to ascertain whether the friction characteristics remain stable, improve, or if additional work should be carried out.



Rubber Deposits Removal Vehicle

3.3.4.4 Runway Availability

Calculation of Reduced Declared Distances is the responsibility of the GM Airfield, this functions may be delegated to the APPM, ASSM or ADM. The reduced declared distances required to preserve the appropriate climb or approach surfaces and associated Runway End Safety Area will be calculated after the obstruction in both location and elevation have been established. Distances declared will be in accordance with CAP 168 criteria and laid down procedures in Section 3.6 of the Aerodrome Manual

When ever possible:

Aerodrome Standards (Central)
Civil Aviation Authority
Safety Regulation Group
Suite 5a, Manchester International Office Centre
Styal Road
Wythenshawe
Manchester
M22 5WB

are to be consulted. 0161 499 30



Airfield Duty Managers

It is the responsibility of all employers to ensure the attention of their employees is given to this notice. However individuals remain responsible for their own actions. Those persons whom require further information should consult their supervisor or manager.

OPERATIONAL ADVICE NOTE 08/03

REMOVAL OF RUBBER DEPOSITS ON RUNWAY 24R

A programme of works in order to remove rubber deposits on the touchdown zone of Runway 24R is scheduled to commence on Monday 14th – Sunday 20th July 2003. In order to facilitate this process, Runway 06L / 24R will be shortened (see Table 1) and the procedure for rubber removal will take place on the closed portion of the runway. It should be noted that Runway 06R / 24L will remain operational throughout the works and will be available at all times whilst the rubber removal is taking place. The works are scheduled to be undertaken at times which will create the least operational impact as follows:

Monday 14th – Friday 18th July	1400 – 1530 2000 – 2200
Saturday 19th July	1800 – 2200
Sunday 20th July	1000 – 1200

Note: All Times are local

Table 1.
REDECLARED DISTANCES RUNWAY 06L / 24R

Runway	TORA	TODA	ASDA	LDA
24R	1770	1922	1770	-
06L from A	1926	2186	2036	1193
06L from AG	1671	1931	1781	1193

For those aircraft able to depart from Runway 24R, the entry point to the runway is RET Juliet Bravo. For aircraft landing on Runway 06L, the final exit is JB.

Airfield Operations, Manchester Airport PLC, Manchester M90 1QX
Tel. 0161-489 2308 Fax. 0161-489 3512

Operational Advice Note (OAN) 08/03

Appendix G

Low Visibility Procedures

Work will cease during LVP and Runway 06L / 24R returned to full operational use.

NOTAM

A NOTAM will be issued prior to the start of the works.

General Manager Airfield

11th July 2003

MANCHESTER AIRPORT - Airfield Operations**FAX Request for NOTAM Action**

From:	Airfield Duty Manager	Date:	14 July, 2003
To:	NOTAM Office AIS	Time:	10:00
Company::	NATS	FAX :	

Message.

Please issue the NOTAM below.

Station :- **EGCC**

With effect from : 14/07/03

Until: 20/07/03

Subject : 06L/24R Shortened R/way (Rubber removal 24R TDZ)

Text : A programme of works as follows :

Monday 14/07/03 to Friday 18/07/03 inc 14:00 – 15:30hrs
20:00 – 22:00hrs

Saturday 19/07/03 18:00 – 22:00hrs

Sunday 20/07/03 10:00 – 12:00hrs

During these times a portion of R/way 06L/24R is closed between links J1 and G .

	TORA	TODA	ASDA	LDA
R/way 24R	1770	1922	1770	
R/way 06L (link A)	1926	2186	2036	1193
= = = (link AG)	1671	1931	1781	1193

A/C able to depart from 24R the entry point will be at RET JB

Final exit point 06L RET JB

Note: All times are local

ENDS

Regards

VOICE: 0161 489 3331 FAX: 0161 489 2889

Airfield Operations Tower, Manchester Airport , M90 1QX

Copy of Fax Request for NOTAM Action

Appendix I

EGCC RWY 06L/24R CLOSED BTN LINKS J1 AND G. RWY 24R NOT AVBL FOR LDG.

DECLARED DISTANCES:

	TORA	TODA	ASDA	LDA
RWY 24R	1770	1922	1770	
RWY 06L (LINK A)	1926	2186	2036	1193
RWY 06L (LINK AG)	1671	1931	1781	1193

FOR ACFT ABLE TO DEP 24R THE ENTRY POINT WILL BE RET JB, FINAL EXIT
POINT 06L WILL BE RET JB

WIP WILL CEASE DURING LOW VISIBILITY PROCEDURES

MON-FRI 1300-1430 1900-2100, SAT 1700-2100 AND SUN 0900-1100

VALID FROM 1300 14-JUL-2003 TO 1100 20-JUL-2003: (A1890/03)

NOTAM as it appeared on the pilots' briefing document

3.18 **PLANNING AND DEVELOPMENT**

3.18.1 **Policy**

3.18.1.1 It is the policy of Manchester Airport plc to ensure that careful consideration of the safety and operational implications of any development and works activities are assessed and planned by a competent person prior to approval. Consultation with parties likely to be affected by such activities forms an integral part of this process. Airside development and maintenance work will be planned in such a way as to minimise impact upon airport operations, and to comply with published safety policy and regulations.

3.18.2 **Project Management**

3.18.2.1 Projects which take place on the Airfield are subject to a number of mandatory legislative regulations, as such careful control of all works is vital. Major projects which may be undertaken may include for example:

- Resurfacing of a Runway
- Construction of a new Passenger Terminal

Whereas Minor projects may well include:

- Taxiway or Apron Pavement Repairs
- Aerodrome Ground Lighting Installation
- Repairs to Aerodrome Drainage

The size of the project notwithstanding, the management is largely the same.

3.18.2.2 Projects will be managed by the airport operator under an appointed Development Manager.

3.18.2.3 The GM Airfield will nominate a representative who will act as advisor, liaison and planner for Airfield Operations on such development schemes. This nominated person is the Airfield Policy and Planning Manager or in their absence, the Airfield Duty Manager. The nominee will attend meetings and working parties at all stages of the project from design concept to completion, and will have authority to implement changes and mandatory requirements where deemed necessary to comply with safety legislation or policy.

3.18.3 **Planning Process**

3.18.3.1 All schemes will be analysed with regard to their impact upon airport operations and safety. The nominee will ensure that proposals meet the criteria set out in CAP 168 and enable the airport operator to meet the commitment to CAP 642.

- 3.18.3.2 During the planning process, the nominated person will consult with all relevant parties upon whom the scheme will impact, or who holds any legislative powers with regard to aerodrome safety. Consultation with CAA Safety Regulation Group will be mandatory. Other such parties include NATS, Government Control Authorities, RFFS, Airlines, Handling Agents, MA Aviation Services Engineering or The airport operator Environment, and all affected tenants.
- 3.18.3.3 These consultations may be in the form of written proposals with suitable drawings, and/or a meeting convened by the nominee.
- 3.18.3.4 Under the Service Level Agreement between National Air Traffic Services and Manchester Airport Aviation Services, NATS will be invited to send a representative to attend meetings planning airside works or developments which constitute Significant Aerodrome Works, as defined in that document.
- 3.18.4 **Documentation**
- 3.18.4.1 **Safety Cases** - where major schemes impact upon the use of runways or their protected surfaces and strips, the APPM will ensure that an Operational Safety Case and associated Risk Assessment documents are produced and presented to CAA SRG for approval. This will be a detailed document covering the scope, procedures and accountabilities of all elements of the work having a significance for operational safety. All major development at an aerodrome requires CAA SRG approval and hence the production of a Safety Case.
- 3.18.4.2 **Operational Advice Note (OAN)** – major schemes which have a significant operational impact will require the promulgation of an OAN, signed by the GM Airfield.
- 3.18.4.3 **Airside Works Notice (AWN)** – where the scheme is not subject to an Operational Requirements document, the APPM will publish an Airside Works Notice. This will follow a numbered sequence within each calendar year, i.e. 1/02, 2/02 etc. The Airside Works Notice is intended for use by Operational and Engineering departments as a quick reference document and will give specific details of Access, Contractors procedures, contact numbers. It will be accompanied by drawings as necessary and signed by the APPM.
- 3.18.4.4 **Airside Works Permit** - all work taking place airside will be subject to an Airside Works Permit. This exists as a proforma and will form the basis of the permission to work airside and as a written briefing document. It will detail the Access, Safeguarding, Communications, Restrictions, and Safety Precautions to be adhered to by the Contractor. The proforma may be completed by any of the following:
- GM Airfield
 - Airfield Policy and Planning Manager
 - Airfield Safety and Standards Manager
 - Airfield Duty Manager
- The completed copy will be signed by the person issuing on behalf of Airfield Operations and by the Contractor. Copies of completed Airfield Operations Works Permits are kept on file by the APPM for a period of 12 months following expiry.

Appendix J

- 3.18.4.5 **Hot Works Permit** - where hot works are involved, a separate Hot Works Permit proforma will be completed by the contractor and signed by the Fire Protection Manager (ext. 3526).
- 3.18.4.6 **Crane Permit** – whenever a crane is required as part of an operations, the contractor must apply for a crane permit. Section 3.30 of this document deals with Aerodrome Safeguarding, which also covers Crane Permit authorisation.
- 3.18.5 **Approvals Process**
- 3.18.5.1 CAA SRG approval for a scheme to go ahead will be given verbally in most cases, and recorded in minutes of planning meetings. Any prerequisite elements with regard to aerodrome safety must be incorporated into the method statement produced by the appointed contractor. This method statement will then be approved by the nominated person.
- 3.18.5.2 CAA SRG approval is not required for minor works which do not either impact upon the Infrastructure of the Aerodrome, or alternatively, do not impact upon operational procedures.
- 3.18.6 **Promulgation**
- 3.18.6.1 Once approved, any airside works or developments will be promulgated. Aeronautical Information will be promulgated according to the procedure laid down in Part 3.12.
- 3.18.6.2 The GM Airfield will decide whether the scope of works warrants the issue of an Operational Advice Note.
- 3.18.7 **Work in Progress**
- 3.18.7.1 All work on the airfield, such as Taxiway Repairs or new Build is the subject of the permits and notification procedures as described previously in this section. As such, all works undertaken airside are inspected regularly by the ADM and ADO in order to ensure that all agreed procedures are adhered to and the works area is maintained in a safe manner for aircraft operations at all times. Should there be a need to do so, the ADM may suspend work at any time should it be believed that safety has been compromised. The Contractor may then be issued with an Improvement or Contravention Notice.
- 3.18.8 **Working on the Runway**
- 3.18.8.1 Any work undertaken on a runway or within a runway cleared and graded area may only take place under R/T escort by Permit A Holders from The airport operator Airfield Operations or MA Aviation Services, Airfield Systems Maintenance, and within the approval of the ADM.

GLOSSARY OF ABBREVIATIONS USED IN THIS REPORT

AAIB	Air Accidents Investigation Branch
ADM	Airfield Duty Manager
AFTN	Aeronautical Fixed Telecommunications Network
AG	Alpha Golf
AIC	Aeronautical Information Circular
AIP	Aeronautical Information Publication
AIS	Aeronautical Information Service
ATC(C)(O)	Air Traffic Control (Centre)(Officer)
APPM	Airfield Policy and Planning Manager
ATIS	Automatic Terminal Information System
CAA	Civil Aviation Authority
CVR	Cockpit Data Recorder
FDM	Flight Data Monitoring
FDR	Flight Data Recorder
FMS	Flight Management System
FRS	Fire and Rescue Service
ft	feet
GM	General Manager
hrs	hours (clock time as in 12:00 hrs)
m	metres
MA plc	Manchester Airport plc
MATS	Manual of Air Traffic Services
MTWA	maximum total weight authorised
NATS	National Air Traffic Services
nm	nautical mile(s)
NOTAM	Notice to Airman
OAN	Operational Advice Notice
QAR	Quick Access Recorder
RET JB	Rapid Exit Taxiway Juliet Bravo
SOP	Standard Operating Procedure
TOCS	Take Off Climb Surface
TOI	Temporary Operating Instruction
UHF	ultra high frequency
UTC	Co-ordinated Universal Time (GMT)
V _R	Rotation speed
VHF	very high frequency

MANCHESTER AIRPORT - Airfield Operations**FAX Request for NOTAM Action**

From:	Airfield Duty Manager	Date:	14 July, 2003
To:	NOTAM Office AIS	Time:	10:00
Company::	NATS	FAX :	

Message.

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With effect from : 14/07/03

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Final exit point 06L RET JB

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