DATA SUMMARY

LOCATION

Date and time	**Thursday, 8 September 2006; 22:00 h (UTC)**
Site	**Madrid-Barajas Airport**

AIRCRAFT

Registration	**A7-ABV**
Type and model	**AIRBUS 300-600 (B4–622R) MSN 690**
Operator	**Qatar Airways**

Engines

Type and model	**PRATT & WHITNEY PW 4158**
Number	**2**

CREW

	Pilot in command	Copilot
Age	**52 years old**	**50 years old**
Licence	**ATPL QT 0876 TA**	**ATPL QT 0387 TA**
Total flight hours	**11,900 h**	**15,081 h**
Flight hours on the type	**1,420 h**	**3,708 h**

INJURIES

	Fatal	Serious	Minor/None
Crew			**13**
Passengers		**1**	**204**
Third persons			

DAMAGE

Aircraft	**Minor**
Third parties	**None**

FLIGHT DATA

Operation	**Scheduled – International – Passenger flight**
Phase of flight	**Taxi prior to takeoff**

REPORT

Date of approval	**27 October 2010**

1.1. Summary of operation

The crew of the aircraft, an A-300-600 registration A7-ABV, established radio contact with the Clearance office at the Madrid-Barajas Tower at 20:40[1] to start flight QTR 068. The airplane was parked at the T1 stand at the southern end of the airport, where it had been since its arrival from Doha (Qatar), to where it was returning after a three-hour stopover.

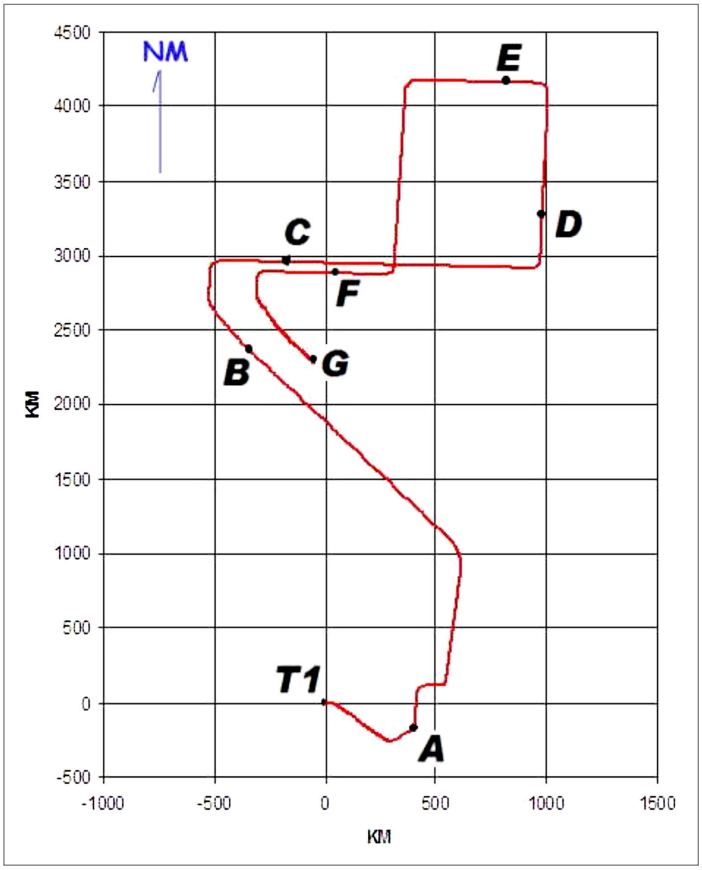
With its flight plan approved and duly notified of the taxi instructions to the head of runway 36 at the northeast end of the airport, it was assigned a radar squawk. It was cleared for engine start, pushback and, finally, to taxi under GMC (Ground Movement Control) at 20:59.

GMC at Madrid-Barajas is divided into several sectors, which flight QTR 068 contacted on various radio frequencies as it taxied. The diagram of the route taken shows several concrete points of interest to the investigation where brake temperatures in the rear wheels of the left leg started to exhibit problems.

At point A, shortly after pushback, the aircraft stopped momentarily when it encountered a certain resistance as it attempted to turn north onto taxiway C-5. Communications were with GMC S-NORTH on a frequency of 121.85 MHz.

At point B, at 21:11, the aircraft was under GMC Central-South Control on 121.975 MHz. As stated by the crew, the temperatures on wheels 5 and 6 (rear wheels on the LH gear) were at 150 °C, while those for the other tires were only at 100 °C. The aircraft had traveled some four kilometers since the chocks were removed.

At point C, at 21:15, also under GMC Central-South control on



Trayectoria A7-ABV

[1] Note: All times in this report are UTC.

121.975 MHz, the aircraft reported problems with the brake temperatures. It was later discovered, throughout the crew statements, that they had risen to 225 °C on wheels 5 and 6.

By point D, at 21:17, after having traveled some six kilometers, the brake temperatures on 5 and 6 were already above 300 °C. An ECAM warning, "Brakes above 300 deg - Delay take off", was received in the cockpit. The crew reported to control that they would have to delay the takeoff while the brake packs cooled. Control requested that they continue taxiing. As revealed from taped conversations, it was then that the crew decided to cancel the takeoff as they continued advancing north.

At 21:21, after turning left, to the west, they arrived at point E, seven Km away from their departure gate. The brake temperatures had reached 485 °C in the LH leg. They stopped for about ten minutes and requested assistance from the fire brigade to inspect the left gear. They were told by control that they would be assigned a parking place in the south of the airport where they could receive technical support from their handling company. When the temperature dropped to 400 °C, they started taxiing back south to the T1 stand from which they had departed.

At point F, at 21:42, they stopped again to let the brake temperatures, which had risen to 500 °C in wheels 5 and 6, cool. A few minutes later control was transferred to GMC S-NORTH on 121.85 MHz.

At 21:58, as they were reaching point G, other traffic alerted GMC that they saw fire under the left leg. That report was made in Spanish and immediately relayed by the controller to the crew of QTR 068 in English. The fire brigade was also notified.

The crew reported after the accident that, just prior to receiving the call from the controller, they felt two or three bumps, described as tires deflating, meaning the aircraft was stranded and unable to move under its own power. With the aircraft stopped on taxiway A-12, the captain, who had no cockpit indication of a fire, called the Tower to confirm its presence. He also requested assistance from the fire brigade once again. The controller reported that the brigade was en route and sent a marshaller's car to taxiway A-12 to verify directly whether the left gear was on fire.

At 22:00, control confirmed to the crew of QTR 068 that, as reported by the FOLLOW ME car, there was a fire in the left leg. In the passenger cabin, the purser had also noticed the presence of smoke and fire from the L3 door. The captain acknowledged this confirmation and reported that they would be evacuating via the right side. The captain ordered the emergency evacuation and relayed it to the cabin crew over the PA, stipulating only that the right-side doors be used.

At 22:02, the controller asked the crew to change frequency to 121.700 MHz, another Ground sector (called Taxi South). A minute later the controller reported that the fire brigade had arrived at taxiway A-12.

The fire was extinguished by the fire brigade, whose presence beside the aircraft was also noted by the crew upon opening the right-side doors and before initiating the emergency evacuation.

Several passengers received minor injuries during the evacuation, though one was seriously injured.

The fire damaged wheels 5 and 6, the brake assembly on both tires, several hydraulic pipes in the rear part of the gear bogie and the gear door that was attached to the left leg. The rims on tires 5 and 6 were also damaged from rolling on deflated tires.

Appendix 1 shows a chart of the airport with the path and taxiways taken by the aircraft.

1.2. Personnel information

Both members of the flight crew were starting their flight activity with this flight after a four-day rest period.

The passenger cabin crew consisted of an instructor, a cabin steward, two first-class flight attendants (FA), two business-class FAs and five FAs in tourist or economy class.

Based on the available information, the activity at the Madrid-Barajas Tower from the start of communications with flight QTR 068 until 21:00 was considered normal. The various control positions were filled as follows:

Tower – Local

- Arrival Control: 2 people.
- Takeoff Control: 2 people.

Tower – Taxi-Ground

- Taxi/Ground Control: 2 people.
- Clearances: 2 people.

After 21:00, at the supervisor's discretion, the number of controllers is normally reduced by half as the flight activity at the airport decreases.

1.3. Aircraft information

Manufacturer:	Airbus Industrie
Model:	A 300-600 series (A 300B4-622R)
Production number:	690
Year of manufacture:	1993
Registration:	A7-ABV
Owner:	Ansett Worlwide Aviation Netherlands B.V.
Operator:	Qatar Airways

Airworthiness Certificate

Class:	Transport Category (Passenger)
Issue/Renewal date:	14-03-06 and 13-03-2007

Maintenance record

Certificate of last Maintenance Inspection:	31-08-2006
Last A2 inspection:	03-08-2006 with 38,571:46 h/13,870 cycles

There were no notes in the deficiency/deferred maintenance book regarding the landing gear or brakes or of any outstanding tasks involving these systems. Only one note, written fifteen days before the accident, was found in the Technical Flight Logbook involving high temperatures in the left leg. It was solved in Doha by providing cooling to the brakes.

Maintenance of main landing gear

The landing gear legs are subject to a scheduled maintenance program with an overhaul life limit of 12,000 cycles or 8 years, whichever comes first, as specified in Airbus documentation.

The operator confirmed that during the gear overhauls, systematic inspections are conducted of the hydraulic and electrical components in the legs, and that the necessary checks, repairs or replacements are made.

The status of the maintenance program is reflected in the following table:

	LH MLG	RH MLG
P/N	D22497020-7	D22498020-7
S/N	B331	B324
Date of last overhaul	November 2001	November 2001
TSN	40,767	40,767
CSN	16,836	16,836
TSO	18,990	18,990
CSO	5,143	5,143

Where:

TSN = Time Since New
TSO = Time Since Overhaul
CSN = Cycles Since New
CSO = Cycles Since Overhaul

The next overhaul of the aircraft was scheduled for November 2009.

Spectrographic analysis of hydraulic fluids

The operator drew hydraulic fluid samples from the three systems, blue, green and yellow, for spectrographic testing as specified in AMM ATA 29. The results were satisfactory for the samples from the green and yellow systems. The sample from the blue system, however, exhibited a number of particles slightly in excess of tolerance values in the 25-50 and >100 micron range. The results were acceptable and within limits in every other regard.

Weight and balance

The Weight and Balance sheet prepared for dispatch reflected a takeoff weight (TOW) of 168,269 kg, the maximum structural MTOW permitted being 170,500 kg.

The center of gravity at takeoff was at TOW % MAC 30.5.

The total fuel weight was 46,300 kg.

1.3.1. *System descriptions and limitations*

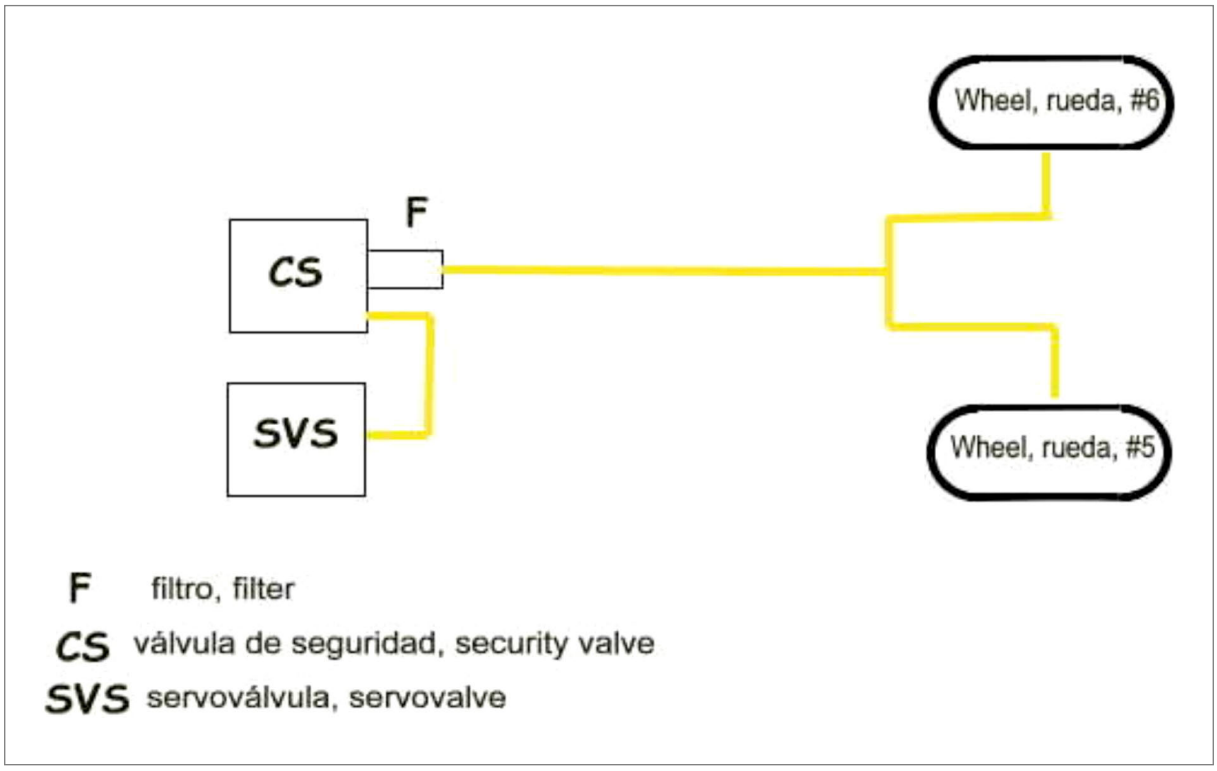
Both main gear legs, LH and RH, have four-wheel bogies on two axles, forward and rear. Each bogie wheel features hydraulically-actuated carbon fiber brake packs. The aircraft has three hydraulic systems, referred to as blue, green and yellow. The green system supplies the normal brake system, while the yellow system supplies hydraulic fluid pressure to the alternate brake system.

The alternate system hoses are paired, providing pressure through a servovalve, a safety valve and a filter in the line supplying pressure to a set of wheels, for example, wheels 5 and 6. The hydraulic hoses are flexible in the leg's moving and articulated parts.

The brake packs are housed in the curved portion of the wheel, which features a heat shield to minimize the heat that is transferred to the tires. The wheel itself has fusible plugs that melt in the event of an overheat condition to deflate the tires and avoid an uncontrolled blowout.

The fusible plugs are normally set to melt at 200 °C.

The carbon discs can withstand temperatures in excess of 600 °C.



Scheme alternate brake system

The thermocouples for measuring the brake temperatures are housed inside the brake packs, which function as a heat sink.

This airplane was not equipped with wheel cooling fans.

The FCOM, in Operating Limitations (2.01.40, pg 4, Rev 29, seq 521), establishes a brake temperature limit for takeoff: The maximum allowed temperature for takeoff 300º C (with brake fan OFF if installed).

The ECAM high brake temperature warning (BRK HOT) appears when any brake temperature reaches 300 °C, in keeping with the above limitation. This is so as to prevent fires in the wheel well during the flight while reserving a large enough margin to enable the absorption of energy in the event of a rejected takeoff (RTO). The ECAM system (Electronic Centralized Aircraft Monitoring) provides, among other indications, brake temperature warnings and the actions required, if any.

In the FCOM section on abnormal operations (2.05.32, pg 6, Rev 24, SEQ 110), Brake temperature hi: BEFORE TAKEOFF, if brake fan available, turn ON and delay takeoff. Delay takeoff until the BRK HOT warning clears if the brake fan is OFF, or until the temperature drops below 150 °C if the fan is ON. If, while taxiing, the difference between brakes on the same gear exceeds 150 °C and the temperature on one brake is above 600 °C, this may indicate a brake binding. In this case the aircraft must be stopped so as to avoid a possible fire and taxi back should not be done as long as the BRK HOT warning is illuminated. The aircraft must remain stopped as long as the high brake temperature warning (BRK HOT) remains lit. In every other case, taxi may continue. This will improve brake cooling and may prevent a deflation of the tire until the aircraft comes to a stop. Use of the parking brake is not recommended while the BRK HOT warning is lit.

1.4. Meteorological information

The weather information provided through the 20:30 METAR for Madrid-Barajas Airport was as follows:

Wind:	From 340° 05 kt
Visibility:	Unlimited (in excess of 10 km). Night
Skies:	Clear
Temperature:	26 °C
Dewpoint:	7 °C
QNH:	1,018 hPa

The temperature at Doha when the airplane departed there on the same day had been 40 °C.

1.5. Communications

1.5.1. *Frequency of 130.075 MHz – Clearance East (CLR East)*

The crew established radio contact from their parking position on the T1 stand with Barajas Tower at 20:40 on the clearance frequency, 130.075 MHz. During this communication the engine start and flight were authorized. At 20:41 the exchange ended with the indication to change frequency to 121.850 MHz.

1.5.2. *Frequency of 121.850 MHz – Ground Movements South-North (GMC S-North)*

The first communication on this new frequency took place at 20:58 to request taxi. The controller indicated the taxiways to the hold point for the 36R threshold: taxiways A, C5, M, M-7 and M to the 36R hold point.

Shortly after pushback, at 20:59 hours, the crew informed the aircraft stopped momentarily, apparently when they encountered a certain resistance as the aircraft attempted to turn north sharply onto taxiway C-5.

Later, at 21:09, the controller contacted the aircraft to indicate a change of frequency to 121.975 MHz.

1.5.3. *Frequency of 121.975 MHz – Ground Movements Central-South (GMC Central-South)*

A few seconds later the crew made contact on the new frequency to confirm the takeoff runway. At 21:15, the controller asked flight QTR 068 to continue taxiing to Y1 (the aircraft had stopped at point D at the end of taxiway M). The crew reported it had a temperature problem and that it had to delay the takeoff until the temperature dropped.

Control requested that flight QTR 068 continue to Y2 and asked for a time estimate for the temperature to drop. The crew replied it would be at least ten minutes.

Two minutes later, at 21:17, the crew asked control if they could be assigned a position to wait, followed by a request for technical assistance to cool the brakes. Control replied that it would be best if they returned to the stand if they needed technical assistance.

The crew said that they could not return to the stand because the temperature was too high, and understood that they had permission to wait.

Over the next few minutes the crew and controller discussed the best way to turn around and return to parking (Y3 or NY12 or N12, on which they eventually turned around to return).

At 21:20, the crew reported that they would stop the aircraft after turning on N12 (they stopped at point E) and requested that a fireman go and inspect the rear wheel on the left landing gear leg. The controller ended the communication by acknowledging "left leg, rear tire".

A minute later the Tower asked flight QTR 068 if they had talked with their handling agent. The crew replied that they had not and that they were still trying.

At 21:24, the crew reported that it could not establish radio contact with its company and therefore could not radio in their request for technical assistance. They requested that the controller telephone Ineuropa, the airline's handling agent.

At 21:29, the crew reported that they were resuming taxi. The controller for his part indicated that he was calling the agent and arranging for a new parking stand for the aircraft. The crew replied that it was not necessary and that they wanted to return.

At 21:33 the Tower informed flight QTR 068 to taxi right on N, all N taxiways.

At 21:38 the Tower called again to inform that they could continue on N until they came to taxiway A on the right, and that their parking position would be T1.

At 21:41 the crew reported that they had to stop due to a high temperature in the left landing gear leg (point F on trajectory). The controller acknowledged and requested to be informed when they resumed taxi.

At 21:51 the crew of QTR 068 called to report that it was continuing its taxi run on taxiway A. The controller acknowledged and directed them to continue taxiing on taxiway A.

At 21:56 the Tower called to inform the crew to switch to 121.85 MHz.

1.5.4. *Frequency of 121.850 MHz – Ground movements South-North (GMC S-North)*

A few seconds after being transferred, the crew contacted control, which repeated the previous taxi instructions (continue on taxiway A and proceed to stand T1 for parking).

This contact was made at 21:56:38, but the crew did not acknowledge the clearance. Control repeated the call at 21:56:59, to which the crew replied simply "Stand by" at 21:57:03.

A minute later, at 21:58:06, Pluna flight 802 reported to ground control in Spanish seeing a fire in the LH leg of the Qatar Airways airplane, which was alongside it at that moment. The tower immediately notified flight QTR 068, followed shortly by a notification that the fire brigade was on the way.

A minute later, at 21:59, the crew asked the controller two times if he could confirm that fire was on the left side. The controller replied that he had no visual confirmation of the fire, but that it had been reported by other traffic.

At 22:00 control, which was in contact with a follow-me car alongside the aircraft on taxiway A-12, confirmed the presence of a fire in the left leg, and relayed this to the crew. The captain stated that in that case they would be conducting an emergency evacuation via the right side of the aircraft.

At 22:02, the controller asked flight QTR 068 to change frequency to 121.750 MHz.

The Tower then confirmed with the follow-me car that the fire was being combated. The latter further reported that the emergency evacuation would be conducted using the inflatable slides.

At 22:04, the Tower informed other traffic, AMX 022, to hold its position until further notice due to the evacuation of QTR 068.

1.5.5. *Frequency of 121.700 MHz – Ground movements South-SouthNorth (GMC S-South)*

The crew made contact on the new frequency and the controller confirmed the presence of firefighters and ground teams next to the aircraft. At 22:05, the controller called again to inquire about the crew and asked to be notified if the crew required assistance with any eventuality. The crew replied that they were still continuing with the evacuation. This was the last radio communication with flight QTR 068 on the Barajas Tower frequencies.

1.6. Airport information

Madrid-Barajas airport has two sets of parallel runways, 15L/33R and 15R/33L, and 18L/36R and 18R/36L. It also has four terminal buildings and a satellite terminal. All

of the terminals and terminals are located on a flat expanse of land over 10 km in length.

Initially, aircraft A7-ABV was parked at stand T1, located south of terminal 1, which is in turn located at the south of the airport. The runway in use for takeoffs on the day of the event was 36R, at the north end of the airport. Due to these locations, the aircraft had to taxi a distance of 7 km to reach the head of the runway (see airport chart in Appendix A).

All of the taxiway and runway signaling and lighting systems were working normally and there was no indication of any discrepancies. There was also no information reported concerning any foreign objects on the taxi surfaces.

1.7. Flight recorders

The accident was reported within an hour following the event. An effort was made to ensure that all of the information relative to the event was compiled before moving the aircraft to facilitate the perimeter circulation of traffic at the airport. The aircraft, however, was energized during the damage check and initial evaluation for a temporary repair that would allow for it to be moved to a parking stand. The fuses were not removed from the electrical circuits of either recorder.

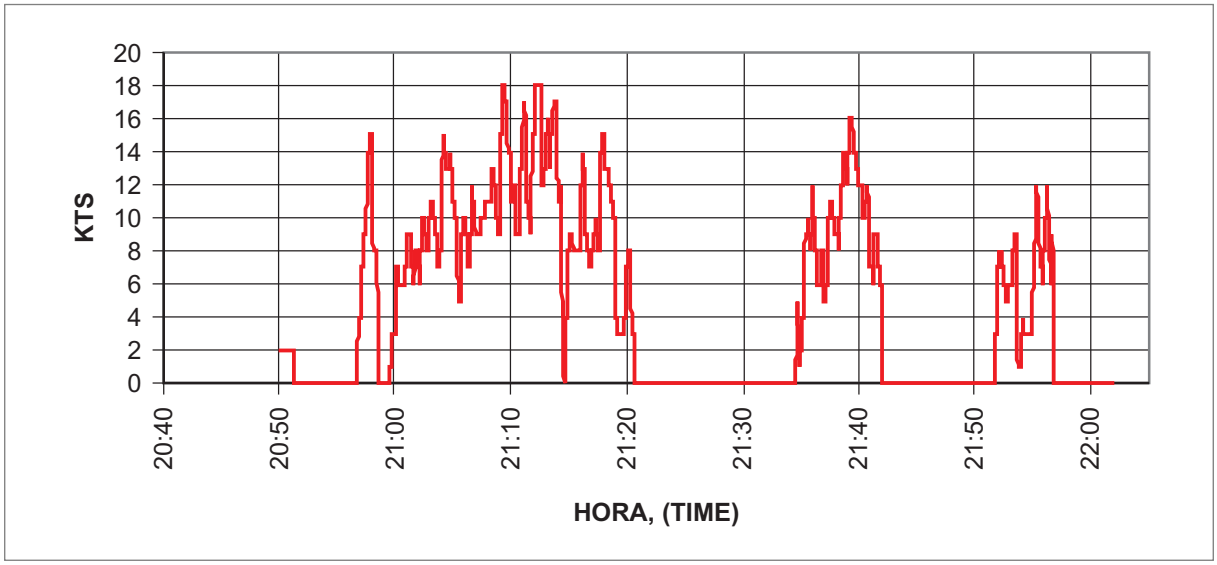
The CVR tape has an approximate recording capacity of 30 minutes. On it the cockpit sounds and communications channels are taped in a constant loop, with new recordings being taped atop the old when the recording capacity is exceeded. The system is activated when the airplane is energized. Since the fuses were not pulled, the CVR recording of the event was lost when it was taped over during the subsequent maintenance period.

The information recorded on the DFDR was extracted and analyzed. There were no data recorded relative to brake system pressures or temperatures, which would have been useful in the analysis of this event.

Data on magnetic heading and GS, among other parameters, were available however. The integration of the speed vector allowed for a reconstruction of the airplane's trajectory, as shown in Section 1.1, and which confirms that the crew accurately followed the taxi instructions received from control.

The FDR time stamps were synchronized with those on the ATC communications recordings. The times in this section and in the FDR parameter graphs are based on the same ATC reference time.

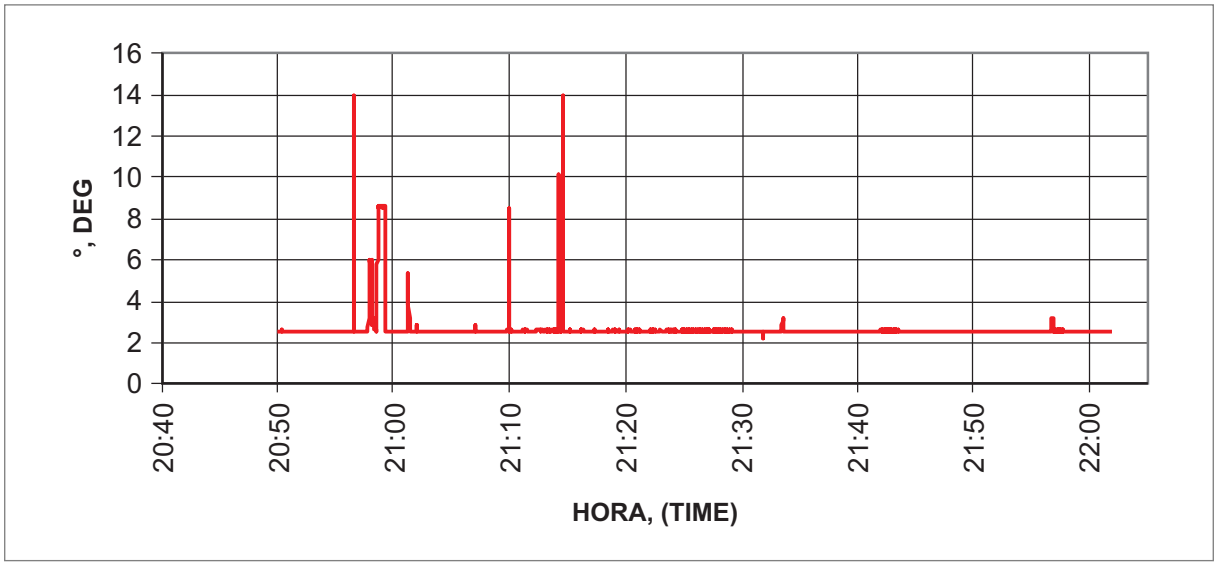
The speed graph shows the values recorded for this parameter while taxiing. It did not exceed 18 kt. Noticeable are the stops in the taxi run at certain times, and of 12 and 9 minute waits at points E and F on the trajectory graph. Taxiing was resumed after the last wait period at 21:51:41.



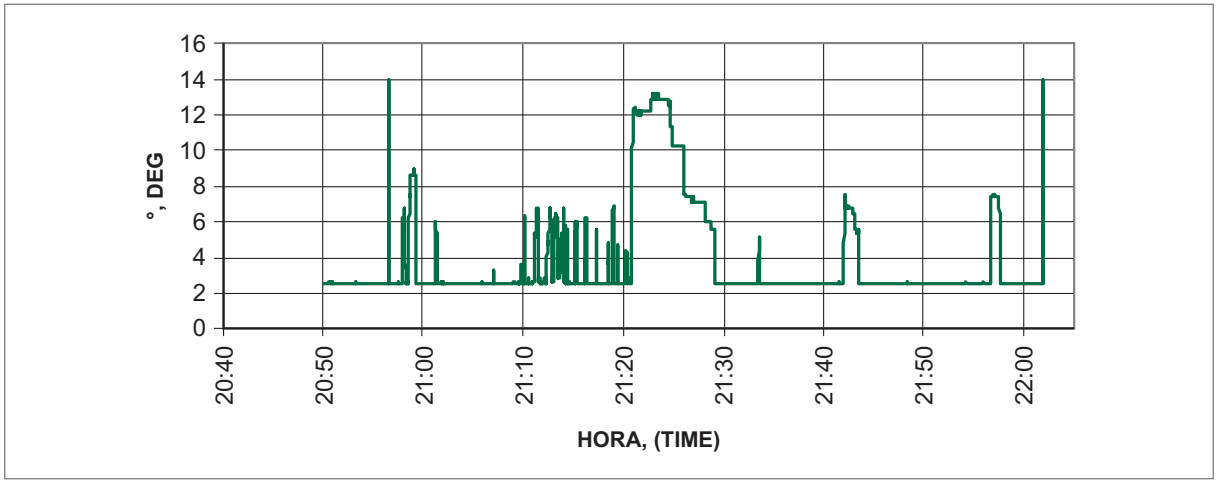
Taxi speed (kt)

The brake pedal input recording shows the use that was made of the brakes while taxiing. From 21:14 on, there were practically no inputs to the left brake.

In light of the FDR data, it may be added that the three hydraulic systems were at normal pressure during the entire operation.

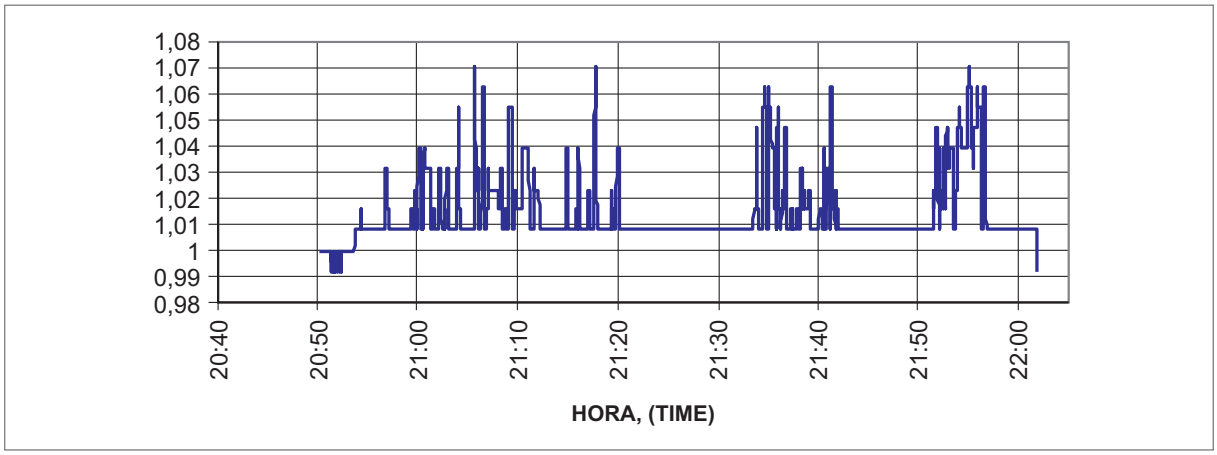


LH brake pedal

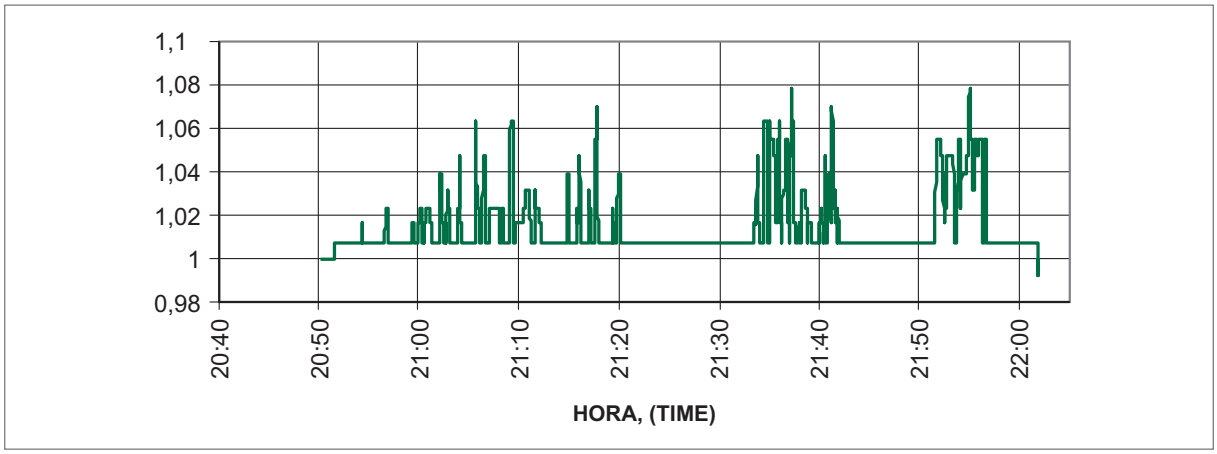


RH brake pedal

Lastly, the two graphs that follow show the engine power levels used to taxi. At no time was thrust in excess of 1.08 EPR used and the two engines were used simultaneously.



EPR_1



EPR_2

In the seconds prior to the deflation of tires 5 and 6 and to the stopping of the aircraft, the airplane was taxiing at 9 kt and a power of 1.06 EPR in both engines. The thrust was immediately reduced to 1.008 EPR and an input was made to the right brake pedal. The aircraft taxied some ten meters on the rims of wheels 5 and 6.

Based on the synchronization of the ATC audio recordings and the FDR, it was estimated that the tires deflated and the airplane came to a final stop at 21:56:44.

1.8. Aircraft information

With assistance from the Operator and Manufacturer, the aircraft was examined, in particular the hydraulic systems, so as to locate and isolate a possible brake system malfunction before any components were disassembled or replaced, with the exception of several hoses that had apparently been damaged by the fire.

After several functional tests, the following fault was reproduced, whose effects on the landing gear are similar to those manifested during the accident. When actuating and releasing the parking brake and the pedals with the BSCU switch in OFF (in both cases the brakes are supplied by Yellow hydraulics system, the emergency or alternate brake), the rear wheels (5 and 6) on the LH bogey remained slightly braked. The remaining wheels rotated freely but 5 and 6 offered some resistance that did not prevent hand rotation, but which caused them to stop rapidly when the applied torque was removed.

Due to the type of fault, the hydraulic system involved and the design of the brake system, and so as to confirm and find the root cause of this malfunction, it was decided to disassemble and analyze the servovalve in the alternate system for the rear wheels in the LH leg, the brake packs in the two affected wheels and the damaged hoses.

The inspection of the number 5 and 6 wheel brake assemblies conducted at Messier Services revealed that they were in good condition and gave no indication as to the possible cause of the malfunction.

The pressure test of the damaged hoses from both the Green (normal) and the Yellow (alternate) hydraulic systems confirmed that all had hydraulic fluid leaks in the shape of a liquid that was seeping along the length that had been damaged by the fire, and not confined to one spot.

The analysis of the servovalve, which had been installed on the aircraft since its manufacture in 1993, showed that the original seal was intact and in apparently good condition. The valve was bench tested in accordance with CMM and other procedures in order to reproduce its operation during the accident. No anomalies were noted and there was no evidence of any binding or obstruction in its operation.

In an effort to find evidence in the interior of the servovalve, it was disassembled at the facilities of the manufacturer, IN-LHC Zodiac. A large scratch was found in the spool between the edges corresponding to the U and R doors in the second stage. No other anomalies were found in the interior of the valve. The spool itself moved freely and fell under its own weight.

It is probable, therefore, that the residual pressure in the alternate system hydraulic lines that was acting on the no. 5 and 6 wheel brake assemblies was due to binding and obstruction in the servovalve from contamination and particles in the fluid of the Yellow (alternate) system. Although the malfunction in the servovalve was reproduced in the tests following the event, it quickly disappeared, leaving behind as the only proof the deep scratch on the surface of the spool.

1.9. Statements from experts on tire fires

Tire manufacturers were consulted about the possibility of the rubber in the tires combusting spontaneously.

The information received indicates that, in general, the rubber by itself, even at high temperatures, does not catch on fire but it simply melts. If, however, the rubber is kept at temperatures above 300 °C, volatile white fumes are generated that can ignite on their own, but only if the ambient temperature is above 300 °C.

While these conditions can be reproduced in a laboratory oven, they are not present in a wheel with a deflated tire rolling on its rim. It can be assumed that the environment around a rolling tire had a relatively low temperature, making spontaneous ignition unlikely. The same considerations are applicable in the case of rubber particles coming into contact with the brakes.

Figure 1. Condition of tires on wheels 5 and 6

It is highly improbable, therefore, that a deflated tire would cause a fire without the presence of other inflammable liquids. One possible scenario conceived by these experts is if the carcass is torn up and disintegrates while rolling flat and damages a nearby hydraulic hose.

The two deflated and burned tires were found as shown in Figure 1, which reveals no loss of integrity of the rubber.

1.10. Prior events involving Airbus

The information received from Airbus and compiled by Airbus and the BEA on fire events in A-300 brake assemblies was analyzed.

The case history analyzed at the 155th ARM (Airworthiness Review Meeting) includes a dozen cases that were jointly reviewed by Airbus and the EASA.

The causes of the fires in many of these events are unknown or simply attributed to grease and inflammable liquids coming into contact with the brakes. In only one of the cases considered was a hose broken by impacting pieces of tire.

In light of the cases considered, the ARM concluded that the impact on airworthiness by fires on takeoff (RTO) or on landing was not considered "major" if the fire were rapidly extinguished by the fire brigade, that no design deficiencies were identified and that the safety objectives associated with brake fire events were being met.

1.11. Evacuation and survival

The captain ordered an emergency evacuation upon receiving confirmation of the fire in the LH landing gear, giving instructions that the evacuation proceed only via the right side of the airplane.

When the FAs opened the right-side doors, they saw the signs being made by some fire brigade members to stop the emergency evacuation. The chief FA indicated that despite these signs, it was decided to continue with the evacuation since it had already started and there was the potential for confusion, and thus to exacerbate the risk of injury to passengers, if it was stopped.

The two members of the flight crew did not evacuate since the situation was under control.

2. ANALYSIS

2.1. Causes of fire and of brake heating

2.1.1. *The Fire*

The events involved this accident point to a fire breaking out in the rear wheels, numbers 5 and 6, on the LH main gear leg, which drove the decision of the aircraft's captain to evacuate the 204 passengers and the 13 crew onboard. One person was seriously injured during the evacuation, hence the event being classified as an accident.

A timeline of the occurrences leading up to the fire reveals the following key events:

20:59:00 Taxi starts

21:14. Last time the aircraft stopped using LH brake to decelerate

21:15:19 Crew indicated they will have to delay takeoff

21:17 Crew requested technical assistance to have the brake cooled down

21:20 Crew requested firemen inspection for the left gear

21:29:33 Crew reported the aircraft resumed the taxi run after a first stop to cool down the brakes

21:41:45 Second stop on taxi run going back to the parking

21:51:41 After stopping to let the brakes cool, the taxi run resumes.

21:56:40 Control makes a call to QTR 068 that goes unanswered.

It is in this timeframe that the fusible plugs on both wheels melt

21:56:59 Control repeats its call.

21:57:03 QTR 068 replies with a brief "stand by".

21:58:06 From its cockpit, another aircraft crew sees the fire in the LH wheel of QTR 068 and calls it in.

The fusible plugs melted within five minutes of resuming the taxi and some 84 seconds later the flames from the fire were observed. In the meantime, the crew's silence to the call from Control suggests that the abnormality somehow became apparent. Both the flight and cabin crew felt bumps while taxiing.

It is likely that the fire started at the same time that the airplane lurched down while taxiing at 9 kt, as the tires deflated. The low speed and the absence of mechanical impact damage or of bending or pulling stresses rules out the hypothesis that pieces of rubber from the tires severed hydraulic hoses. The damage noted on the hydraulic lines after the accident was due, according to the workshop analysis, to the fire itself since there was no mechanical damage. As a result, the hypothesis that the fire was caused by a break in the hydraulic lines as the airplane dipped down and the tires deflated can be dismissed.

A second hypothesis is that the fire initiated before the fusible plugs melted while taxiing, in which case it would be the fire itself (a fire prior to the blowout) that furnished the additional heat to cause the tires to warm enough for the plugs to melt.

It is an accepted and established fact that a fire can spontaneously ignite given two conditions: the existence of combustible material and a heat source whose temperature exceeds the material's ignition or flashpoint temperature.

The rubber in the tires can provide the combustible material for a fire of a certain size, but it needs temperatures in excess of 400 °C to ignite. The fusible plugs on both rear wheels of the LH leg would have melted long before that temperature was reached, preventing a fire. It is possible, therefore, that another material, either hydraulic fluid or grease from a wheel axle bearing flowed and came into contact with hot components on the brake discs. The temperatures recorded by the probe in those brake assemblies reached values of 500 °C, and it is reasonable to assume that the temperatures at some points on the carbon discs were even higher. The flashpoint of hydraulic fluid and of grease is around 400 °C, meaning this may have been the scenario which created the initial flames that later spread to the tires.

Although the damage noted on the hoses was the result of the fire itself, the possibility that liquid seeped out of those hoses prior to the fire, or that there was grease left over from a maintenance action or excess lubricant applied to the wheel bearings, cannot be ruled out.

In previous wheel fire incidents or accidents, the presence of fluids has been suspected, even lacking direct evidence. In this case, the extraordinary duration of the exposure to high temperatures and the pressurization of the alternate brake system may have resulted in fluid accumulating from a small leak or in the seepage of grease from inside the bearings. The presence of such greases or fluids, while imperceptible when the airplane is dispatched, could eventually leak onto hot surfaces after an hour of taxiing.

The existence of an entry in the Flight Report Book made fifteen days earlier involving heating of the LH leg brakes and the reproduction of the phenomenon during operational tests after the event indicate that the problem had been present for some time, though it may have been reoccurring, because the seizing caused in the brakes for those two wheels was only partial and induced a residual pressure that absorbed relatively little energy at ambient and fluid temperatures below 60 °C.

On a short taxi run from the stand to the takeoff point, the problem would not have manifested itself. Without reaching 300 °C, the airplane would have taken off and completed its flight operation. In the first part of its taxi run, however, the airplane in this event was already experiencing asymmetric heating. That is why a recommendation is issued to the manufacturer, requesting that it provide additional instructions and criteria to differentiate problems with brake seizures, and provide advice on the best way to proceed in those cases.

There is a different way to set out the scenery, the aircraft start taxi for takeoff with cold brakes, and having such level of temperature with barely using the associated brake for

a long period of time was a clear indication of a technical problem, and relay on basic airmanship to stop the aircraft. But different crews into a different conditions as no operator technical support there or hardly hot or cold environments could take different decisions and is in this way the SR expressed in the previous paragraph is also supported.

2.1.2. *Brake heating*

The only common cause for brakes seizing in wheels 5 and 6 of the LH leg was found in the improper pressure of the alternate brake system (yellow hydraulics) after the parking brakes were released at the start of the operation. Three components, the safety valve, filter and servovalve, could have been responsible for the condition that was reproduced during the operational tests conducted after the event. The workshop inspections of the disassembled components were not definitive, but they do provide an indication that foreign particles clogged the pressure return in the servovalve. Moreover, the pressure that was sustained for over an hour, from the time of engine startup when the hydraulic systems are pressurized, could have resulted in the hydraulic fluid seeping out and building up on an external surface.

The FDR data show that the brakes on the LH leg were not used once the temperature problems became evident, meaning that the use of the brakes in no way contributed to the temperature increase in the brake assemblies of the number 5 and 6 wheels of the LH landing gear.

It was also noted that the heating cycles during the final taxi phase were more rapid in that the brakes quickly became hot again when resuming taxiing after stopping to allow them to cool. The reasons are thought to be, on the one hand, the increased friction caused by the residual pressure in the alternate hydraulic system resulting from being subjected to elevated temperatures, and, on the other, the thermal inertia, that is, the disappearance of the heat sink when, after nearly an hour of taxiing, the entire leg had become hot.

The aircraft was not equipped with cooling fans for the brake packs. These fans are used to reduce the temperature increase experienced by the brakes on landing and allow for a short stopover time. It is possible that had the airplane been equipped with such fans, the temperature readings would have been lower, though this would only have served to mask an ongoing problem.

2.1.3. *Contamination of the hydraulic system and maintenance considerations*

The spectrographic analysis confirmed that the hydraulic fluid in the systems was practically free from contamination. The marks and scratches noted on the internal spool of the servovalve, however, indicate that a high-hardness particle such as a grain of sand

or silica must have been lodged inside the valve. Due to the way the system is designed and conceived, there is no fluid flow at the end of the valve, only pressure transmitted by way of pistons to the actuating pistons in the brake assemblies. Only if a component were replaced and the system purged would the fluid emerge, and then only after having passed through a filter that would retain any impurity. It is logical to assume that the contaminant was introduced to the fluid during a change out of a landing gear component, in particular of one situated downstream of the servovalve. As a consequence, a safety recommendation is issued specific to the Operator to improve its maintenance processes.

In addressing another maintenance aspect and so as to keep elevated and prolonged heating events involving brake assemblies from resulting in tire fires, we note the rigorous need to clean any grease and to check for hydraulic fluid leaks, not allowing even the slightest leakage, and to avoid the excessive lubrication of the bearings. These observations are applicable not only to technical maintenance personnel but also to the flight crew during the performance of the walk around check.

2.2. Execution of operation

Over the course of its operation and movement on the taxiways at Madrid-Barajas airport, the aircraft covered some ten kilometers in 62 minutes before the tires deflated and caught on fire. There was ample time for the crew to ponder its decisions calmly and for ATC as well, since there was seemingly not much traffic to control.

The crew quickly noted the problem before reaching the halfway point of its taxi run to the runway for takeoff. They took the precaution of not stepping on the LH brake pedal and keeping the taxi speeds low.

During the second half of the taxi out, the crew was correct to postpone the takeoff and request a parking space from ATC where they could stop and receive help. Control did not appreciate the complexity of the situation and made the aircraft advance another kilometer, possibly to free up access for other aircraft to take off from runway 36R. It could be argued that the accident would not have occurred had the airplane promptly received the assistance the crew requested. A large airport should have remote, strategically positioned parking areas where airplanes with technical or other problems affecting its safety or security can be segregated and serviced. The airport has 12 far off parking positions, between path points D and E, just to the left of taxiway M, and further on there is a deice platform for runway 36R.

By the time the aircraft approached the vicinity of the runway 36R threshold, the situation had become untenable. With the affected brake assembly temperatures reaching 485 °C, the crew decided to cancel the takeoff, park the airplane and receive technical aid as well as assistance from the fire brigade.

In the absence of an emergency declaration from the crew, Control evaded the question of providing fire brigade assistance. As for the technical assistance, Control decided that it had to be provided by the operator's handling agent at the parking stand from which the airplane had departed. Judging by the conversations held with the various controllers on different frequencies, ATC was undoubtedly aware of the difficulties surrounding flight QTR 068; however, each controller only had a partial vision of the problem and never fully understood the crew's requests.

The previous paragraph must be understood in the sense that the assistance given by control to aircraft could have been improved. This department could have paid attention to the difficulties the aircraft encountered without declaring emergency. For these reasons a safety recommendation is issued to AENA to revise the control procedures when an aircraft require the assistance of the fire brigade, so as to gather all the necessary information for a clear assessment of the situation and provide the adequate answers.

Given the condition of the aircraft, reaching the distant point E had proven arduous. On the way back, the crew faced the even more difficult task of returning to its point of departure, made more precarious this time by having to taxi with already hot brakes. The aircraft should not have been moved from its position at point E, though the decision to return to parking can be explained given their situation: in the open field and with no building in the vicinity in an unknown airport, without their operating company's support and without receiving the aid they were requesting.

During the return the brake temperature quickly rose again to 500 °C at point F, forcing the aircraft to pause once more. When they resumed taxiing, and after rolling for some five minutes, the aircraft approached point G. It was then that two of the tires deflated, thus precluding any further movements and frustrating the attempt to return to parking stand T1. At that time, 21:57, Control's clearance to continue taxiing went unanswered by the crew which, when prompted by Control, replied simply with a "stand by", a sign that something had gone wrong in the cockpit.

The FCOM makes reference to a temperature limit of 600 °C, which must not be exceeded under any circumstances. The FCOM also sets a maximum brake temperature of 300 °C before initiating the takeoff run. It does allow for the abnormal & asymmetric heating of the brakes on the A-300, establishing a maximum difference of 150 °C between them, as may be the case during a partial seizing of the brake in one of the wheels.

This accident, however, shows that prolonged heating with temperatures below 500 °C under continuous taxi conditions with the tires building up heat as a result of rolling deformation can result not only in the fusible plugs melting while taxiing, but also in the appearance of a fire due to the presence of combustible material igniting the rubber in the tires. The crew, despite having noted the abnormal and asymmetric heating of

the brake assemblies, did not interpret the FCOM instructions correctly when assessing the gravity of the situation.

It would be expedient for operators and crews to have more thorough instructions on how to proceed in these cases. New taxi limitations could be established, for example, similar to those already used for takeoff. Only the 600º limit is imposed during taxi as the temperature limit that is not to be exceeded under any conditions.

Any problems involving seizing of the brakes will first be noticed by the crew. Logically, such seizures cannot occur simultaneously on all the wheels and operators should be able to discern, from the first indication of asymmetric heating, whether there is a technical problem of whether the differences are due to other circumstances, such as, for example, operating in a cross wind. Once the problem is isolated, even if the absolute temperature limits are not exceeded, actions should be taken to prevent extreme heating conditions, especially during long taxi scenarios.

The 600° C maximum temperature limit for any wheel may be realistic in events involving a short-duration heating of the brakes, as might occur when braking hard on landing. Such limits are not deemed conservative, however, in prolonged heating events, where the heat sink offered by the metallic mass of the leg is no longer effective.

A safety recommendation is issued in this regard to the manufacturer so that guidance and operational limits below 600 °C be issued with regard to the use of brakes in situations involving long operations on the ground.

2.3. Evacuation

The fire was declared two minutes after the tires deflated and one minute after a pause in the communications between the crew and Control.

It was another aircraft that first reported, in Spanish, the existence of a fire in the left leg. Once this information was relayed to the crew in English, the captain made the decision to evacuate the aircraft.

The fire was not confirmed by control, which could only see the right side of the aircraft, until it received this information from a FOLLOW ME car that was in the area and that accessed the 121.85 frequency. The fire brigade vehicles were just arriving at that time, but they were on a different frequency. The firefighters were quickly able to bring the fire under control and extinguish it. When the control tower asked the aircraft for a frequency change to 121,700 MHz, which was not assigned to this taxi area, this prevented from listen to the fire brigade both in the area frequency of 121,85 MHz as in the emergency frequency of 122,795 MHz

Although the firefighters' car attempted to communicate using signals with the cabin crew that had opened the doors of the airplane to try to stop the evacuation, it was decided to continue so as not to cause further confusion.

The deplaning of the passengers may have been halted had there been better communication among the crew, the TWR and the firefighters, although the decision made is deemed logical and reasonable since the cancellation could have led to confusion among the passengers and resulted in additional problems.

Throughout the entire taxi operation, there were over five changes in radio frequency, involving different controllers who each knew only part of the difficulties being experienced by the aircraft. The frequent control changes hindered the tower's ability to monitor the operation.

In the initial moments of the evacuation, control relayed to the aircraft the instruction to change communications to a different GMC frequency. In the meantime, Control remained in radio contact with the FOLLOW ME car and another aircraft in the area, which was relaying information in Spanish on the progress of the evacuation.

It is likely that more fluid and coordinated communications between the various controllers handling the different frequencies and the crew would have enabled the crew to make better decisions, possibly even avoiding the appearance of the fire. This, along with a fire warning issued in a language known by all the parties involved, could even have prevented the emergency evacuation that resulted in injuries to some of the passengers. That's the reason a safety recommendation is issued for improving the frequency changes procedures when difficulties, anomalies or emergencies arise with the taxiway traffics.

3. CONCLUSIONS

3.1. Findings

- The aircraft experienced an asymmetric heating of the brake assemblies on wheels 5 and 6.
- The aircraft had to taxi a long distance, as required by the length of the Madrid-Barajas airport.
- Brake temperatures in excess of 300 °C were reached. Takeoff with such high temperatures is not permitted.
- The crew decided to continue its taxi run while stopping occasionally so as not to exceed the FCOM temperature limits (600 °C). By stopping before the reading exceeded 500 °C, they were well within FCOM limits.
- Temperatures of 500 °C were reached while returning to parking. There were no data recorded related to brake system pressures or temperatures.

- The aircraft was not provided with a nearby parking stand, nor was it provided assistance from the firefighters as requested since the presence of firemen was not asked by control tower.
- Communications were handled on different frequencies. The last frequency change resulted in the crew not receiving information relevant to the evacuation.
- Many conversations on the tower frequency with other stations were held in Spanish, which prevented the crew from being immediately aware of what was happening.
- A fire was declared affecting the rear wheels on the LH leg.
- The fire was promptly reported by another taxiing aircraft, and quickly fought and brought under control.
- An evacuation was ordered, during which several passengers were injured, one of them seriously.
- The crew decided not to halt the emergency evacuation of the passengers so as not to create confusion among the passengers and avoid further complications.

3.2. Causes

During the long taxi out for takeoff, it became apparent that the brakes for wheels 5 and 6 were overheating. In light of this, the crew decided to cancel the takeoff and to taxi in to return to the assigned parking stand. The two tires, however, deflated and a fire broke out.

- The brakes on wheels 5 and 6 heated due to residual pressure trapped in the alternate brake system caused by a stuck servovalve for this pair of wheels and resulting from the presence of a high-hardness particle in the hydraulic fluid.
- The fire is likely to have resulted from the large build-up of heat in the affected wheels, without a prior leak of inflammable liquids, after the tires had deflated.

4. RECOMMENDATIONS

REC 08/10. While the FCOM in point 2.05.32 provides instructions on determining whether the brakes are seized, the crew, based on these criteria, decided to continue the taxi run and a fire eventually broke out. As a result, it is recommended that the manufacturer improve its "Brake Temperature HI" Abnormal Procedure so as to aid crews faced with gradual but prolonged increases in temperature and that it lower the brake temperature limit so as to avoid the possibility of the wheels catching on fire.

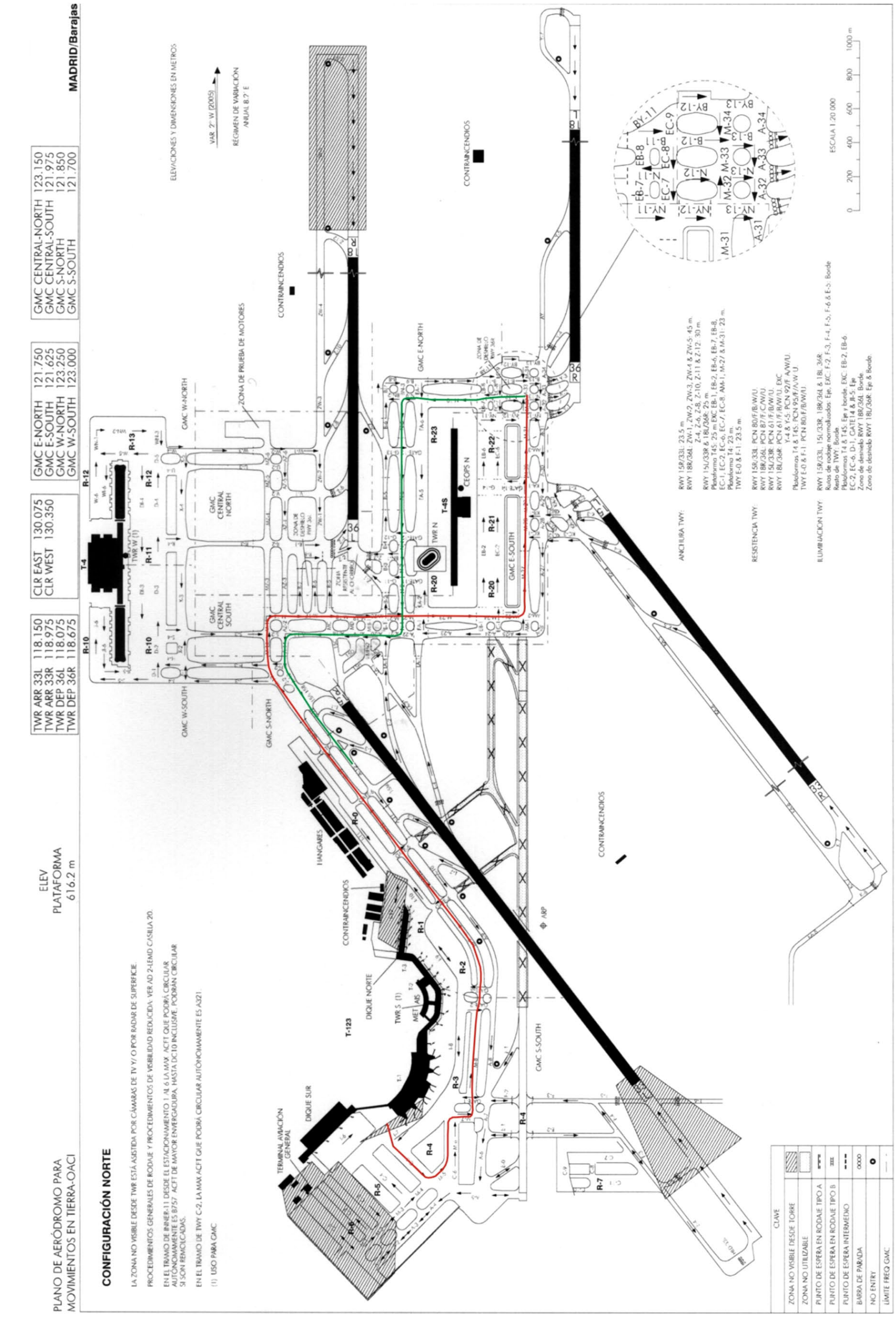
REC 09/10. It is recommended that the Operator enhance the training of its A-300 pilots so as to improve their ability to determine the existence of seized brakes and that it adopt those actions and procedures that aid in the efficient combat of this abnormal condition.

REC 10/10. It is recommended that the Operator re-evaluate and improve the conditions under which hydraulic system replacements and fluid recharges are made under any environment so as to ensure that these tasks do not allow for the contamination, especially by high hardness particles, of hydraulic systems.

REC 11/10. It Is recommended that AENA improve the procedures in case of aircraft with difficulties, anomalies and emergencies, to guarantee in these cases that the information and coordination interchange between the controllers and the crew be more efficient. It is also recommended to avoid the changes in frequency and to maintain the communications in a language known by all the parts involved, especially by all the aircraft in frequency.

REC 12/10. It is recommended that AENA revise the control procedures when an aircraft require the assistance of the fire brigade, so as to gather all the necessary information for a clear assessment of the situation and provide the adequate answers.

APPENDIX 1
Barajas Airport Chart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ELEV PLATAFORMA 616.2 m
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TWR ARR 33R 118.975
TWR DEP 36L 118.075
TWR DEP 36R 118.675
CLR EAST 130.075
CLR WEST 130.350
GMC E-NORTH 121.750
GMC E-SOUTH 121.625
GMC W-NORTH 123.250
GMC W-SOUTH 123.000
GMC CENTRAL-NORTH 123.150
GMC CENTRAL-SOUTH 121.975
GMC S-NORTH 121.850
GMC S-SOUTH 121.700
MADRID/Barajas
CONFIGURACIÓN NORTE
CONTRAINCENDIOS
HANGARES
T-123
T-4
T-4S
DIQUE NORTE
DIQUE SUR
TERMINAL AVIACIÓN GENERAL
ZONA DE PRUEBA DE MOTORES
CLAVE