Report

Serious incident on **16 August 2008**
on **take-off from Paris Charles de Gaulle Airport (95)**
to the **Boeing 737-800**
registered **SU-BPZ**
operated by **AMC Airlines**

BEA
Bureau d'Enquêtes et d'Analyses
pour la sécurité de l'aviation civile
Ministère de l'Écologie, du Développement durable, des Transports et du Logement

Foreword

This report expresses the conclusions of the BEA on the circumstances and causes of this serious incident.

In accordance with Annex 13 to the Convention on International Civil Aviation and with European Regulation n° 996/2010, the investigation was not conducted so as to apportion blame or to assess individual or collective responsibility. The sole objective is to draw lessons from this occurrence which may help to prevent future accidents.

Consequently, the use of this report for any purpose other than for the prevention of future accidents could lead to erroneous interpretations.

SPECIAL FOREWORD TO ENGLISH EDITION

This report has been translated and published by the BEA to make its reading easier for English-speaking people. As accurate as the translation may be, the original text in French is the work of reference.

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Glossary

ADP	Aéroports de Paris
AIP	Aeronautical Information Publication
AMC	Aircraft Maintenance Company Airlines
ATIS	Automatic Terminal Information Service
CRM	Crew Resource Management
CVR	Cockpit Voice Recorder
DGAC	French general civil aviation directorate
DSNA	Air traffic service department
DTI	Technical innovation department
EIS	Safety impact study
FDR	Flight Data Recorder
FMC	Flight Management Computer
FOD	Foreign Object Debris
IATA	International Air Transport Association
IOSA	IATA Operational Safety Audit
LAA	Laboratory of applied anthropology
MAC	Mean Aerodynamic Chord
NOTAM	Notice To Airmen
OPT	Onboard Performance Tool
PCR	Aeronautical area command post
PF	Pilot Flying
PM	Pilot Monitoring
RESA	Runway End Safety Area
QAR	Quick Access Recorder
QRH	Quick Reference Hand book
SMS	Safety Management System
SNA	Air traffic service
SNA-RP	Air traffic service – Paris region
RFFS	Rescue and Fire fighting Service
STNA	Air traffic technical service

Synopsis

Date
Saturday 16 August 2008 at 22 h 57[1]

Place
Take-off from runway 27L
at Paris Charles de Gaulle (95)

Type of flight
Public transport of passengers
International charter flight
AMV6104 Paris – Luxor

Aircraft
Boeing 737-86N
registered SU-BPZ

Owner
Aircraft Maintenance Company Airlines (AMC) (Egypt)

Operator
Aircraft Maintenance Company Airlines (AMC) (Egypt)

Persons on board
2 flight crew, 5 cabin crew, 169 adult and 16 child passengers

[1] All times in this report are UTC, except where otherwise specified. Two hours should be added to obtain the legal time applicable in mainland France on the day of the incident.

Summary

At night in VMC conditions, the crew of flight AMV6104 to Luxor lined up from intersection Y11 on runway 27L at Paris Charles de Gaulle Airport. The runway distance available for take-off was temporarily reduced because of construction work. During the takeoff run, the airplane struck some provisional lights at the end of the runway then, during the rotation, destroyed some markers on the safety-barrier positioned in front of the construction zone. It took off before a provisional blast fence and continued its flight to its destination.

Consequences

	People			Equipment	Third Parties
	Killed	Injured	Unhurt	Airplane slightly damaged	Provisional ground lighting damaged
Crew	-	-	7		
Passengers	-	-	185		

1 - FACTUAL INFORMATION

1.1 History of Flight

The Boeing 737-86N, registered SU-BPZ from Marsa Alam (Egypt), arrived at 21 h 25 at its parking space at area Q at Paris Charles de Gaulle Airport three hours late[2]. During taxiing, the Captain asked the police to intervene to question a passenger who had smoked in the toilets.

During the stopover, the co-pilot programmed the FMS for the following flight. The Captain handled the police presence and asked the ground handling company agent to complete the weight and balance sheet.

The police left the airplane at around 22 h 15.

The crew listened to the ATIS, then the Captain keyed in the data to the OPT for the takeoff performance calculation. He planned a take-off from runway 27L from taxiway Y11. The dimensions of the runway were reduced by about one third because of construction at the runway end.

The airplane left its parking space for runway 27L at 22 h 45. The Captain was PF.

During taxiing, the ground controller proposed a line-up at Y12 or Y11. The crew indicated that they preferred to use Y11. The controller agreed and stated the remaining distance from this intersection. As they approached Y11, the crew was cleared for takeoff by the LOC controller.

At the end of its takeoff run, the airplane struck some provisional runway end lights. It continued its run and, during the rotation, hit some provisional plastic markers. Four markers were thrown towards the K2 taxiway. The airplane flew over the blast fence at a low height.

The crew realised that they had struck objects on the ground. They carried out a system and parameters review then decided to continue the flight to destination. The crew did not inform the controller of the anomalies encountered during take-off.

On 17 August 2008, at around 2 h 30 in the morning, flight BIE250 was cleared after landing to cross runway 27L via the K2 taxiway. The crew indicated to ATC that this was impossible, given the presence of debris ahead. The ground controller initiated an inspection of the area, during which it was reported that several marker beacons from the works zone situated at the end of runway 27L were damaged. A part from a B737-800 was also found among the debris. The air traffic service informed the operators of all B737's having taken off since the last runway inspection. An AMC official then indicated that SU-BPZ had been damaged by FOD on the runway. It was only several days after the event that information processing confirmed that SU-BPZ had struck the ground lighting during takeoff.

[2]The delay was due to the late arrival of the airplane in Marsa Alam, for operational reasons. The Marsa Alam – Paris Charles de Gaulle trip was the first during the crew's duty period.

1.2 Damage to the Aircraft

The airplane had sustained slight damage on the engine number 1 fairing and on the trimmable horizontal stabilizer. One of the nose gear tyres had been cut and a piece of the left main landing gear harness had become detached (see 1.10.1).

1.3 Other Damage

Some provisional elements on the worksite (plastic markers and lights marking the provisional end of the runway and K2 taxiway) were damaged (see 1.10.2).

1.4 Personnel Information

The two members of the flight crew were B737 rated captains for AMC.

1.4.1 Captain

Male, aged 43

- Air Transport Pilot License ATPL issued by Egypt on 7 October 1999, valid until 30 September 2008. He held B737-300/400/500/800 and A300 type ratings
- B737-800 type ratings issued in March 2006
- Last line check performed on 23 March 2008
- Medical certificate valid until 30 September 2008
- CRM training certificate issued by AMC on 14 April 2008
- Last English language aptitude test, level 4, carried out on 31 July 2007 at Egyptair's training centre[3]
- Flying hours:
  - total: 9,150 flying hours
  - on type: 1,900 flying hours
  - in the previous 30 days: 90 hours
  - in the previous 7 days: 26 hours

[3]The Captain was tested again, successfully, following the event.

The Captain worked for Egypt Air (on B737-200/500), as co-pilot then as Captain, until 2000; he then worked for various operators, including Luxor Air and Heliopolis, on B737-400/500 and from April 2005 worked for AMC (on A300 then B737-800).

1.4.2 Co-pilot

Male, aged 39

- Air Transport Pilot License ATPL issued by Egypt 14 May 2003, valid until 30 November 2008
- He held B737-800 (issued in June 2008) and A320 type ratings
- Medical certificate valid until 30 April 2009

- CRM training certificate issued by AMC on 14 April 2008
- Last English language aptitude test, level 4, carried out on 19 July 2007 at Egyptair's training centre
- Flying hours:
  - total: 5,950 flying hours
  - on type: 140 flying hours
  - in the 30 previous days: 69 hours
  - in the 7 previous days: 17 hours

The co-pilot had previously flown for Lotus Air on A320. He had joined AMC six months before the event.

1.5 Aircraft information

1.5.1 Airframe

Manufacturer	Boeing
Type	B737-86N
Serial number	35213
Registration	SU-BPZ
Entry into service	June 2007
Certificate of Airworthiness	Issued 26 June 2007, valid until 25 June 2009
Utilisation as of 16 August 2008	4,234 flying hours

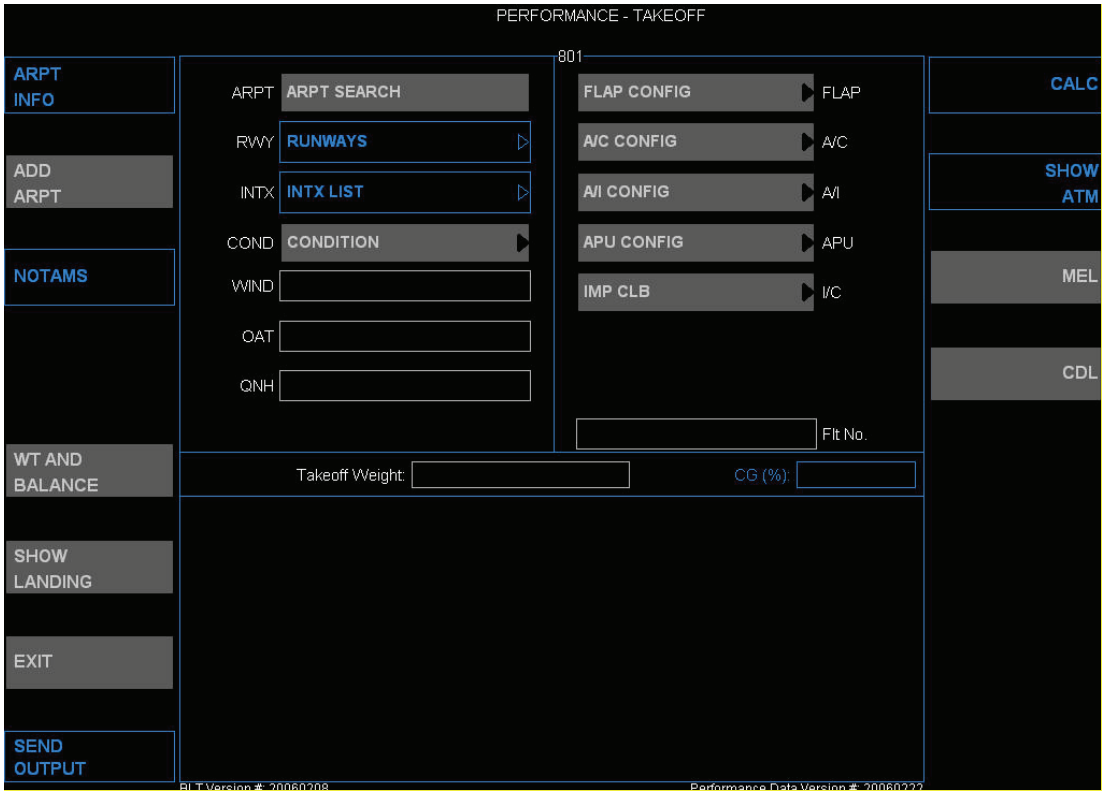
1.5.2 Engines

	Engine n°1	Engine n°2
Manufacturer	SNECMA	SNECMA
Type	CFM56-7B26/3G05	CFM56-7B26/3G05
Serial number	894698	894705
Installation date	26 June 2007	26 June 2007
Total running time	4,234 hours	4,234 hours
Cycles since installation	1,323 cycles	1,323 cycles

1.5.3 OPT System

The operator AMC required its crews to use the OPT software supplied by Boeing to determine the configuration and the characteristic speeds (V1, Vr and V2) according to the thrust selected for takeoff. This software was installed on laptop computers used on board by the crew. The illustration that follows shows the main PERFORMANCE-TAKE OFF page in the "class 3" configuration, recommended by the manufacturer. AMC uses this configuration, with the further addition of a tab, not shown below, allowing the choice of maximum thrust.

Note : There are three classes of EFB (Electronic Flight Bag) systems and equipment. The OPT is part of the EFB system. EFB Class 1 consists of a software programme installed on a laptop computer that can only be connected via the airplane's electrical power supply. Class 2 corresponds to equipment installed on the airplane, linked to the airplane's systems via an interface module. Equipment referenced in class 3 is permanently installed on the airplane and interfaces directly with its systems. This latter class is subject to aircraft type certification. The OPT used in the case at hand is installed on class 1 equipment (laptop) but the associated software is regularly integrated into class 3 systems, offered as an option on current production B737's.



The greyed tabs allow access to special pages, for example for the selection of an aerodrome or for keying in data on the load.

It's necessary to select, from a list proposed by the system, the departure airport, and then the in-service runway and the taxiway planned for takeoff. The choices offered depend on the configuration adopted by the operator. AMC used the database supplied by Jeppesen and, when the in-service runway was 27L at Paris Charles de Gaulle Airport, only the Y12 and Y13 taxiways were proposed. AMC indicated that taxiway Y11 did not appear as it was a high speed exit. The SNA RP clarified that this intersection is an exit taxiway for runway 09R, but that it was authorised for use for line-up at 27L[(4)]. The database used by AMC was up to date at the time of the incident and the operator had not, when subscribing, chosen the option of temporary restrictions being taken into account by specific updates.

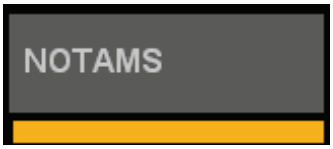
The following parameter values, among others, must be keyed in manually for the speed calculation and the computation of configuration: the number of passengers on board by zone, the load in each hold, the fuel load quantity, the meteorological data broadcast on ATIS and the use restrictions for the chosen runway.

[(4)]Taxiway Y11 is considered as a line-up taxiway in the aeronautical publication.

There are 2 features that can be used jointly to enter the use restrictions. One allows the system administrator to enter the restrictions appearing in a NOTAM, these then being imposed on crews. AMC does not use this feature. The other allows the administrator to give the crews access to the temporary NOTAM page, from the NOTAM tab on the main page. This feature was designed to take restrictions into account in the short-term. AMC crews had to use this feature. The temporary NOTAM page appeared as follows:

N.B: The parameters given on this page are used by the system as long as they are not reset.

Once the data is entered, the NOTAM tab appears, underlined in amber.



Thus, in the configuration selected by AMC, for a takeoff at 27L at Paris Charles de Gaulle from taxiway Y11 and as 1,240 m of runway was unusable because of works, the crew had to:

- choose runway 27L and a taxiway for line-up, for example Y12 (this was usual, according to the chief pilot and the crew),
- select the NOTAM tab to access the dedicated window,
- key in the runway length to be subtracted from the nominal value in order to take into account all the restrictions. In the example given, a length of 280 m had to be subtracted, corresponding to a line-up from Y11, plus the 1,240 m that were unusable because of works, making a total length of 1,520 m.

Note: Given the NOTAM (see 1.12), the data on the unusable distance during the works was not directly accessible. During flight preparation, the crew was supposed to deduct it from the distance normally available and from the data on the runway distance available from the taxiway selected featuring on the temporary map of the aerodrome (see appendix 1).

Then, the crew had to choose the flap and slat configuration, activation or not of air bleeds (conditioned air and anti icing), the choice of a method of calculation of V1 (optimum, balanced) as well as the activation of the optimised climb mode. These choices had to be made in accordance with the policy defined by the operator. Furthermore, AMC crews could choose maximum thrust between: maximum thrust of 26K or maximum thrust limited to 24K or 22K[5].

From this data, the OPT determined the limit speeds, as well as a possible assumed temperature, or indicated that the takeoff was impossible given the selected parameters. The crew had to take these values into account for the preparation of the airplane by entering them into the FMC, as the OPT was not connected to the FMC.

Note: The distance required for takeoff was not indicated by the system in the configuration selected by AMC. The OPT user's manual stated that one feature, activated by the system administrator, allowed the crews access to the necessary distances for takeoff from the airport page. However, in this same manual, one warning mentions that this feature is of little use to crews and should be used by managers, particularly in order not to encourage pilots to improvise takeoff procedures based on this data.

1.5.4 Weight and balance

The Alyzia company assists AMC crews of at the stopover by providing the load data and by carrying out the passenger count.

To complete the loading documents, the handling agency uses the values provided by AMC, including a set weight of 75 kg per adult and 35 kg per child[6]. The hold baggage is weighed.

On the weight and balance sheet for the incident flight, the following values were shown:

- Basic weight: 42,475 kg,
- Fuel weight: 15,800 kg,
- Number of passengers: 169 adults and 16 children (distributed as follows: sector OA: 24, sector OB: 83, sector OC: 78),
- Weight of hold load: 2,931 kg (in zone 3),
- Takeoff weight: 74,441 kg (for a gross structural takeoff weight of 79,015 kg).

The operator indicated that the reference values used by the handling agency were similar to those selected in the OPT for the configuration of the software.

N.B: The basic weight was determined by the operator from an empty weight of 41,557 kg increased by a set amount corresponding to a crew of nine people with baggage (288 kg for 3 flight crew, 390 kg for 6 cabin crew)[7] and by a cargo of spare wheels and a tool box (240 kg). The empty weight used was that of the SU-BPG, the first B737-800 acquired by AMC (the last weighing, carried out by the manufacturer before delivery, indicated an empty weight of 41,579 kg for SU-BPZ).

[5] The letter « K » corresponds to the notation used by the manufacturer to indicate engine thrust, one unit corresponding to 1,000 lbs.

[6] The minimum weights set by the EU-OPS are, for a charter flight, 76 kg for an adult and 35 kg for a child.

[7] For the same empty weight but with a crew of two flight crew and five cabin crew, the basic weight used by the operator was 42,249 kg.

These values were consistent with the data on the load established by Alyzia.

The balance calculated for the flight of 16 August 2008 was at 22.2% of the MAC, within the limits defined by the manufacturer (for this weight, the limits of the envelope were around 15% and 30.5% of the MAC).

1.6 Meteorological Conditions

The 22 h 30 observation indicated a wind of 210° for 7 kt, CAVOK, a temperature of 19 °C, a dew point of 10 °C, a QNH of 1009 hPa. No significant changes were forecast for the following two hours. The 23 h 00 observation did not show any significant changes in the meteorological parameters.

1.7 Telecommunications

The transcript of the radio communications between the crew and ATC on the pre-flight frequencies, SOL then LOC as well as ATIS are represented in italic hereafter.

The ATIS Sierra message, in English, recorded at 22 h 30, repeated the fact that there were works in progress on runway 27L/09R and requested that crews check, on the pre-flight frequency, the runway distance available for takeoff :

"This is Charles de Gaulle information Sierra recorded at two two three zero UTC, expected approach ILS, landing runway two seven right and two six left, take off runway two seven left and two six right, expect departure one Alpha one Bravo one Yankee, caution works in progress on taxiways, works in progress on runway zero nine right two seven left, check take off run available on preflight frequency.../…"

UTC time	Broadcasting Station	Receiving Station	Message
22 h 50 min 03	CDGSOL	AMV6104	*Alpha Mike Victor six one zero four after November taxi by Delta for holding point two seven left, which intersection do you like?*
22 h 50 min 12	AMV6104	CDGSOL	*You're calling six one zero four?*
22 h 50 min 14	CDGSOL	AMV6104	*Alpha six one zero four you taxi by Delta after November and eh would you like* ***Yankee one one Yankee twelve*** *for departure?*
22 h 50 min 21	AMV6104	CDGSOL	*A* ***Yankee eleven*** *will be OK*
22 h 50 min 22	CDGSOL	AMV6104	*Roger Alpha Mike Victor six one zero four, Yankee one one* ***two thousand three hundred sixty meters***
22 h 50 min 27	AMV6104	CDGSOL	*Copied thank you, via Delta to Yankee eleven eh two seven left, Alpha Mike Victor six one zero four*

During the first contact, the crew did not announce the information that they had found out[8]. They requested take off from runway 27L, without asking for confirmation of the takeoff distance available. The pre-flight controller accepted and cleared the crew for a LANVI 1A departure.

(8) According to the history of the flight as described by the crew, they likely listened to the ATIS S.

During taxiing, the ground controller asked the crew if they preferred to line up from taxiway Y11 or taxiway Y12. The crew requested Y11. The controller cleared them to line up from Y11 and stated then that 2,360 m of runway remained from this taxiway.

As they approached Y11, the crew was cleared by the LOC controller to line up and take off.

There was no communication relating to any problem encountered by the crew during takeoff.

1.8 Aerodrome Information

1.8.1 Aerodrome/History

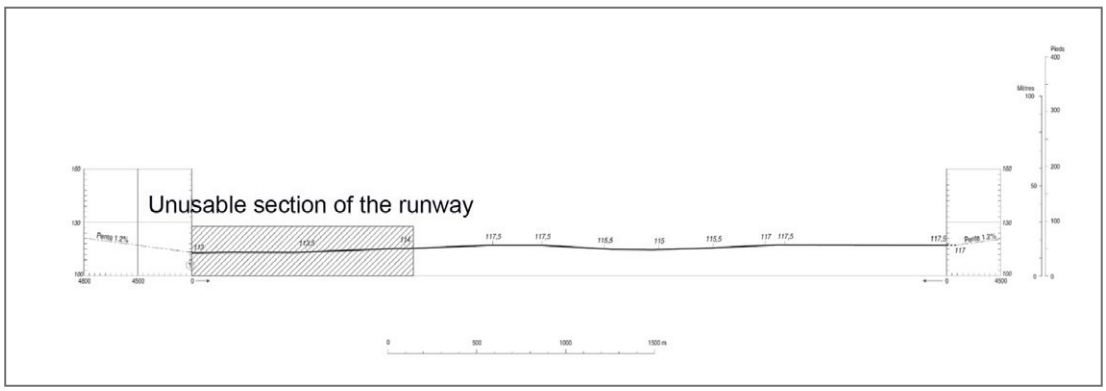
Paris Charles de Gaulle is a controlled aerodrome open to public air traffic. It is operated by Aéroports de Paris. It has two parallel dual runways:

- 08L/26R runway is 4,215 m long, 45 m wide;
- 08R/26L runway is 2,700 m long, 60 m wide;
- 09L/27R runway is 2,700 m long, 60 m wide;
- 09R/27L runway is 4,200 m long, 45 m wide.

The aerodrome reference altitude is 392 ft. The threshold altitude of runway 27L is 385 ft. The exact QFU of runway 27L is 266°.

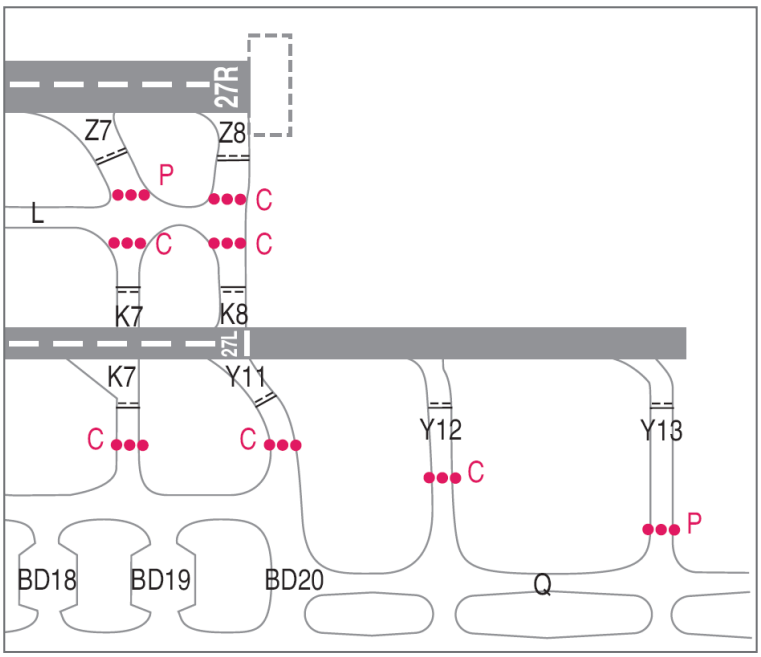
Runway 27L is the closest to parking area Q.

Repair works on runway 09R/27L were in progress between 4 and 20 August 2008. During this period, the last 1,240 metres of runway 27L were closed for flight operations. The provisional threshold altitude of runway 09R was 376 ft. The profile of runway 27L defined for the duration of the works was characterized by a zero slope in the first two fifths, a depression of around ten feet in the next two fifths and a descent in the last fifth.



Profile of runway 27L

At the time of the event, the take-off distance available (TODA) and accelerate-stop distance available (ASDA) were respectively 2,960 m from the threshold, 2,640 m for a line-up from Y12 and 2,360 m for a line-up from taxiway Y11.



1.8.2 Description of the equipment installed at the time of the works on runway 09R/27L

At the time of the works, the runway centreline lighting was unavailable. The runway edge lighting was working. The provisional end of runway 27L was defined by a line of nine unidirectional red lights. To indicate runway threshold 09R a line of seventeen unidirectional lights had also been installed[9].

The provisional lights were powered electrically in parallel. They were connected to the lighting circuits that powered the runway edge lights. These circuits were controlled by a monitoring system used by the lighting system service and the control tower. No fault in the regulators was reported or recorded on the circuits during the night of 16 August 2008. The SOL and LOC controllers on duty in the central tower could not see the runway end lighting or that of the works zone.

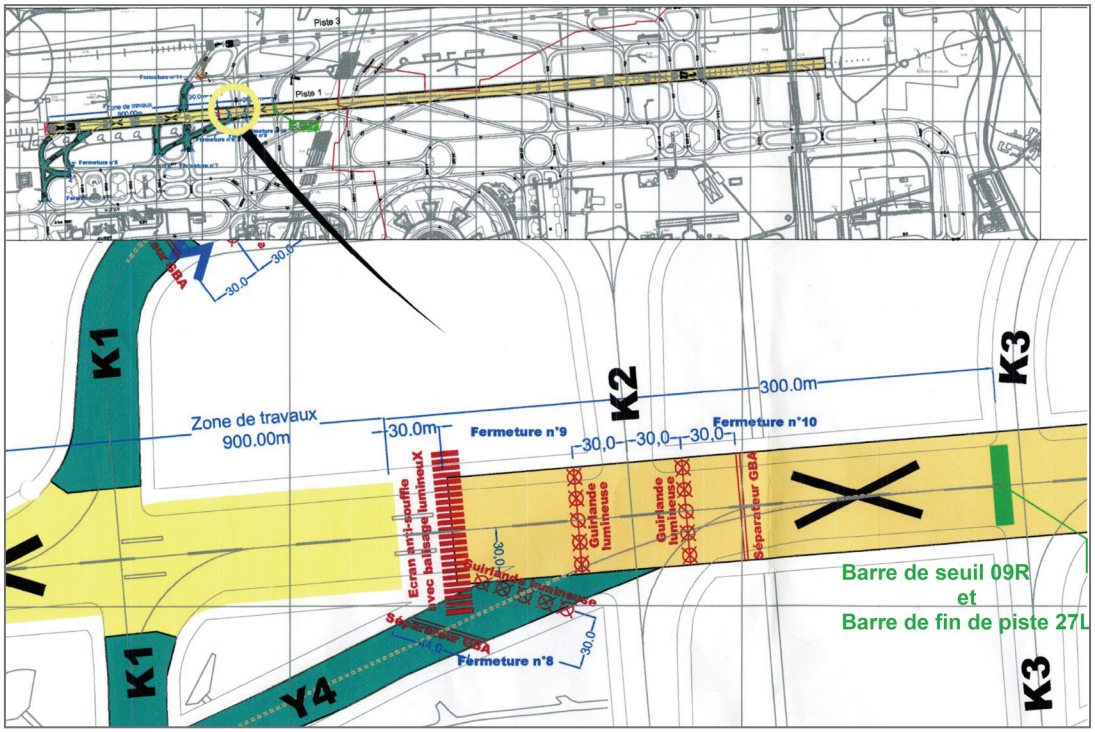
Before the provisional end of runway 27L and after the works zone, a RESA and an extended RESA had been defined, covering a zone 240 m long and 120 m wide.

[9] During the works, runway 09R was closed for landings. This line of lights had been installed in case of an emergency landing.

The RESA, ninety metres long in accordance with international standards, started sixty metres after taxiway K3, thus making a clear area of 150 m. It was separated from the extended RESA, 150 metres long, by a separator made up of fifty-five polyethylene markers (GBA)[10], red or white in colour. The markers were positioned about sixty metres from the centre line of taxiway K2 and placed in such a way as to alternate the white and red colours. They were weighted with water and linked by a connecting part clad in a reflecting strip visible over 360°. Each marker measured 1.25 metres long, 0.55 metres wide and 0.80 metres high. A blast fence 2.44 m high, fitted with a lighting system with eleven red lights separated the extended RESA from a zone, of about 36 m wide[11], for the workers' traffic. The works zone then stretched for a length of about 900 m.

Taxiways K2 and K3 were usable. The edges of runway K2 were lit at night by the presence on each side of a string of lights connected in series.

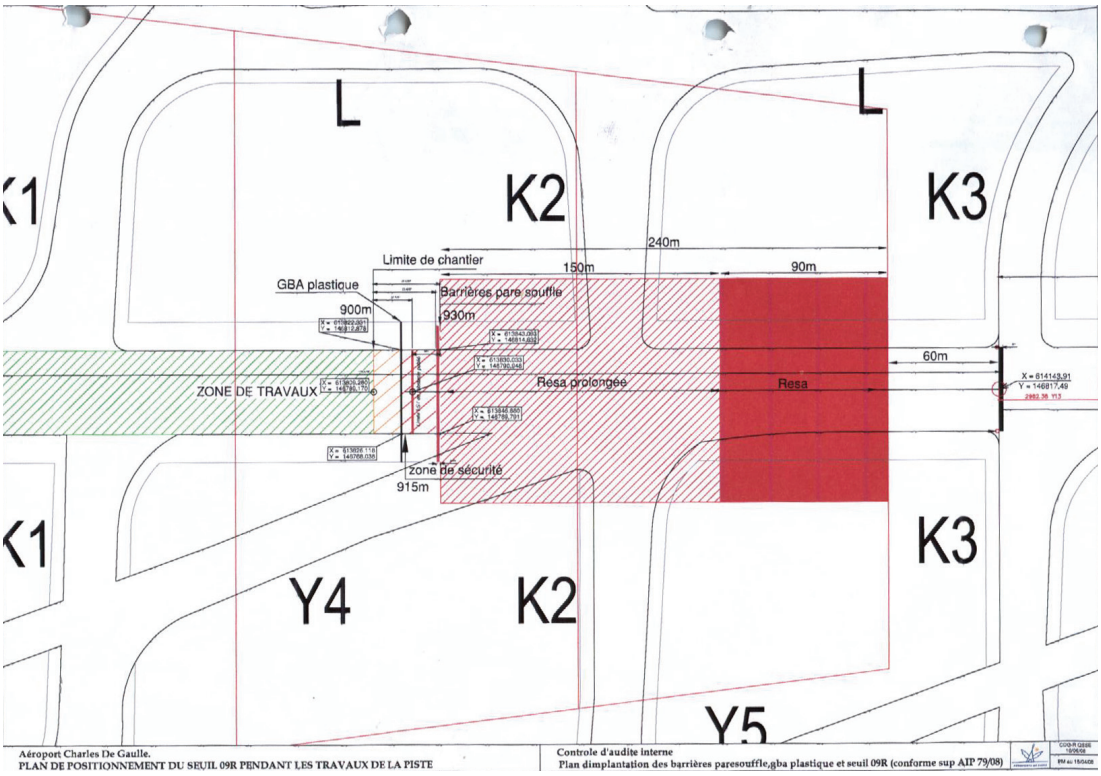
The two plans that follow were supplied by ADP. On the first, the workers' traffic zone, 36 m wide, arranged between the extended RESA and the works zone, is incorrectly positioned.



Plan by ADP for the taxi and runway closures

[10]The term GBA (reinforced concrete barrier) is, strictly speaking, reserved for markers made of concrete. The term is used commonly to describe plastic markers, which look similar. Such markers are usually used for roadworks.

[11]This value is measured from the plan drawn up for the internal audit. A value of 30 m is indicated on the same plan.



Plan by ADP for an internal audit

1.9 Flight Recorders

On 17 August 2008, the BEA notified the Egyptian investigation authority of the probable implication of a B737 from AMC in a collision with ground markers during takeoff from Paris Charles de Gaulle on the night of 16 August 2008. The readout of the flight recorders was requested. Despite several attempts via separate channels of communication, it appears that this request did not reach the Egyptian authority. A second request was issued on 19 August, this time with some success. The Egyptian investigation authority then indicated that as the airplane had flown more than 25 hours since the event, the recorded data had not been conserved.

On its part, AMC had been informed by the Paris ATC that a part of SU-BPZ had been found on the runway. The operator indicated that, based on the flight personnel report and the reported damage, it had initially estimated that SU-BPZ had struck some FOD left by a previous airplane; consequently the operator decided not to remove the recorders. Furthermore, the operator did not generally record the data keyed into the OPT or use a QAR (see 1.12).

N.B: According to Boeing, there are two ways to configure the OPT system in order to systematically save the data entered and calculations made. However their application requires the administrator to have an in-depth knowledge of the system.

1.10 Wreckage and Impact Information

1.10.1 Damage to aircraft

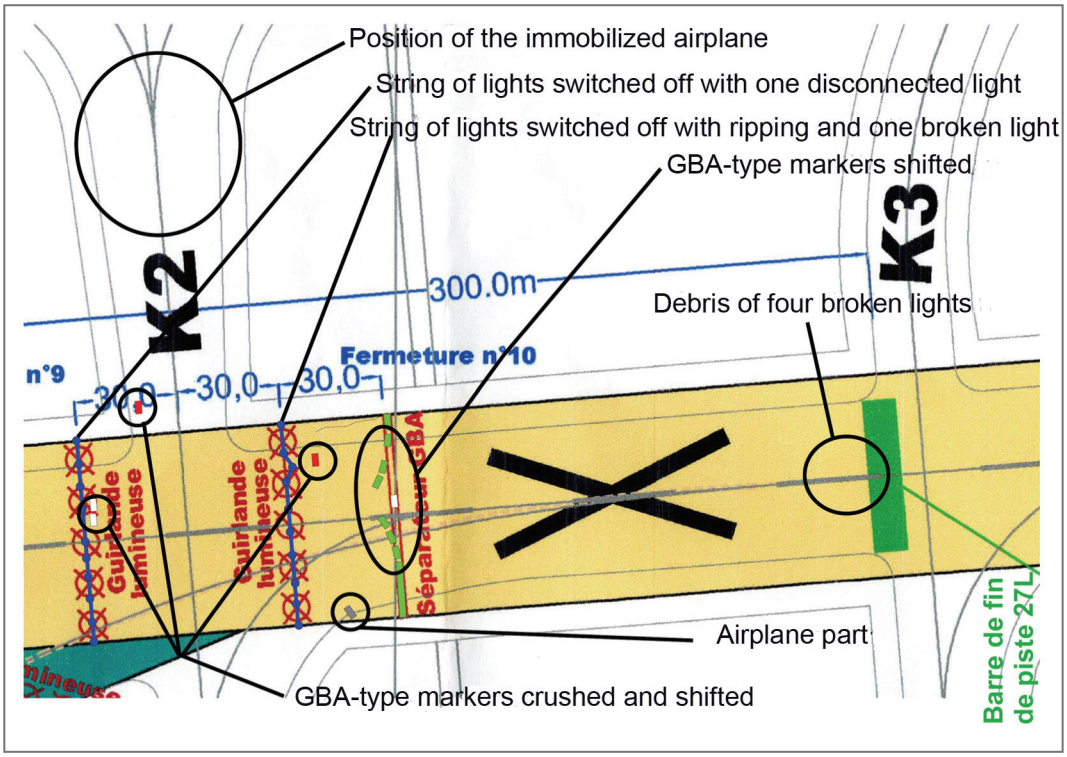
The following damage was reported on the airplane by AMC mechanics, after the Captain requested an inspection of the airplane in an incident report completed at destination.

Engine cowl number 1 had been damaged on one surface of about 4 cm x 2.5 cm and another of about 1.5 cm x 1.5 cm. The lower part of the leading edge of the trimmable stabilizer was damaged on both sides. One piece, the left main landing gear harness support had been detached from the airplane.

The equipment report mentioned a cut on one of the tyres of the nose landing gear. No examination could be carried out by BEA investigators on this tyre, the AMC officials having indicated that it had not been kept after being replaced and that no photo had been taken.

1.10.2 Damage on ground

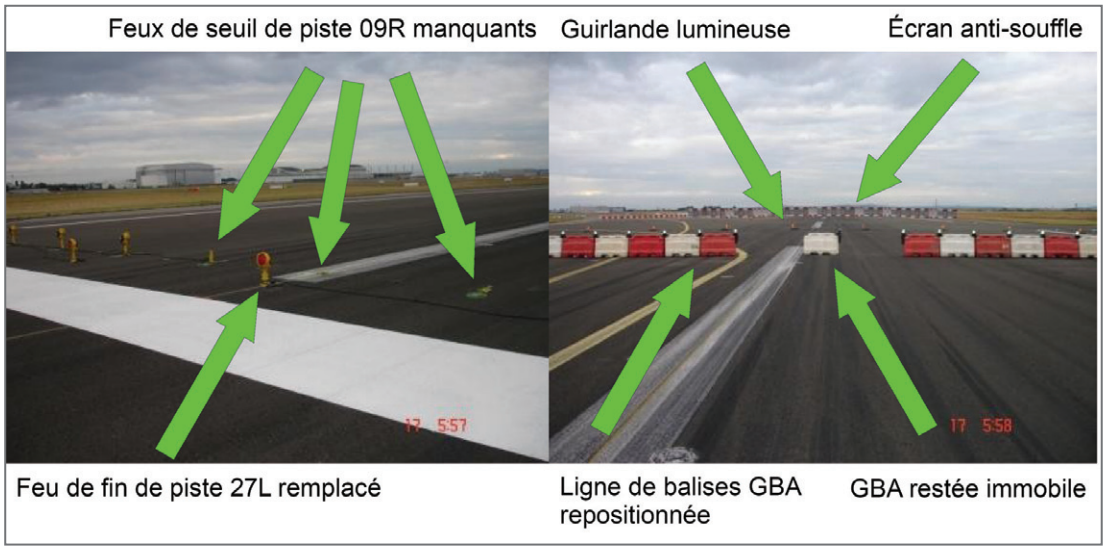
Two PCR coordinators visited the site at 02 h 37 on the 17 August, in order to clear the debris blocking track K2. ATC had been informed by flight BIE250 which should have used this taxiway (see diagram below).



The agents found two crushed white-coloured GBA's in the runway centreline on track K2 next to the lights situated furthest west. Switched off, it had not been displaced and a light had been disconnected without any sign of impact. A third GBA, crushed and red in colour, was on the North side of track K2 and to the South of the stop barrier, in front of any crossing airplane.

Once track K2 had been cleared, the agents visited the unusable part of the runway. On the other lights, also switched off, they reported that one light had been displaced towards the east and that another had been broken and violently torn out. They also found on the runway, to the North of the centreline, a fourth GBA, crushed and red-coloured as well as the left main landing gear harness support from SU-BPZ[12] on the South boundary, two metres fifty from the lights. At the level of the GBA line, three markers had been displaced, on each side of a white marker situated near the centreline and which had not moved. The markers thus displaced formed a "funnel". Debris originating from the lights positioned at the end of the runway was found. It corresponded to the lights at the end of runway 27L nearest to the runway centreline and to the three 09R threshold lights situated closest to the centreline.

At 3 h 47 a team visited the site in order to replace the runway centreline end light and to line up the GBA's again. They left a space equivalent to two GBA's on either sides of the white marker that had not moved (this marker stayed positioned 0.45 m from the runway centreline). Two runway end lights situated on the far left that had not been working on the night of 16 August 2008 were also replaced.



N.B: These photographs were taken some days after the event.

1.11 Tests and Research

1.11.1 Study of airplane paths on 16 August 2008

1.11.1.1 Radar recording

In the absence of FDR data, the ground radar data from Paris Charles de Gaulle Airport was used to reconstitute the flight paths of the airplanes on runway 27L. This data was extracted from the SNER[13] recording from specifications on the recording format. Hereafter are some elements on their type and on the accuracy obtained in reproducing the tracks from this data.

[12] It was possible to determine the origin of this part from its serial number.

[13] Radar data recording system installed in the main French ATC centres.

ASTRE2000 is a secondary radar for monitoring airplanes around an aerodrome. It operates on the KU band at a speed of 60 rpm.

The AVISO system performs the digitizing, extraction and fusion of ASTRE2000 radar data, of multi-lateration mode S system surface radars, of SYLETRACK[14] system and of CAUTRA[15] flight plan data. It provides the controller with the position and identification of vehicles and airplanes on the ground, at takeoff and on approach.

The data is sampled with a variable time lapse of less than one second. The standard lateral position accuracy is 7.5 m in 95% of cases, the tests performed in real conditions show better accuracy.

The recommendation for accuracy to determine speed is 5 m/s in 95% of cases for a monitoring system of this type. However, the performance analyses undertaken with the aid of vehicles fitted with a recognized accurate GPS receiver showed that in practice this accuracy is in the 1 to 2m/s range (no similar test has been carried out with airplanes).

Regarding altitude, the data was provided by the onboard transponder. The accuracy standard for this type of device is 80 ft.

1.11.1.2 Study of movements on the site from radar recordings

The BEA examined the AVISO radar tracking of the airplanes at departure between 15 h 38 on 16 August, the time of the last runway inspection and 2 h 32 on 17 August, the time of the call to ATC by the crew of flight BIE250 about the impossibility of continuing to taxi on the track K2.

During this period, no vehicle and none of the airplanes that took off on runway 09R or that crossed K2 or K3 taxiways entered the closed zone of the protective equipment on runway 27L.

In the same timeslot, visualization of the radar tracking of the twelve airplanes that took off from runway 27L showed they lined up on the runway from taxiway Y11. Four of these airplanes seemed to take off "long", all of them B737-800s: flight THY3492 at 20 h 34, flight AMV6404 at 21 h 57, flight AMV6104 at 22 h 57 and flight AMV6004 at 23 h 26. The radar data of these four flights was analyzed.

The data for flights THY3492 and AMV6004 (that took off empty) show that these airplanes left the ground about four hundred metres before the provisional end of the runway.

The imprecision associated with the data for flight AMV6404[16] does not make it clear if this airplane did in fact take off in the length of runway available.

The takeoff distance for SU-BPZ (passage at 35 ft) cannot be assessed with accuracy from the radar data. On the other hand, it is possible to determine the approximate length of the distance of the takeoff run, with an accuracy of about 80 m as well as the rotation speed from the speed changes at the end of the takeoff run, with the accuracy described in 1.11.1.1. The following values can be deduced from observation of the radar data:

[14]SYLETRACK, is a system that identifies vehicles and sounds an alarm onboard in case of intrusion in the runway service areas.

[15]CAUTRA is the ATC system installed in French en-route control centres.

[16]The takeoff weight of flight AMV6404 was 66.6 t.

- SU-BPZ left the ground about 160 m beyond the provisional end of the runway, after a takeoff run of around 2,520 m[17] ;
- rotation speed was around 165 kt, a speed reached about 30 m from the end of the runway,
- speed was in the 158 kt range about two seconds flying time before the end of the runway.

[17]Note that the GBA's were located about 2,530 m from the Y11 intersection.

Note: Except for SU-BPZ, the crews performed rolling take-offs. They thus reduced by about 150 m the distance available at takeoff. The crew of SU-BPZ lined up roughly twenty metres from the Y11 intersection with the runway (there thus remained a length of about 2,360 m available for takeoff).

For information, the reconstituted trajectory of SU-BPZ from AVISO data appears in appendix 2.

The imprecision of recorded radar does not thus identify if the runway end lights were damaged during the takeoff of flight AMV6404 or of flight AMV6104 (SU-BPZ).

1.11.2 Summary of observations about impact

The examination of data makes it possible to conclude that only the two Boeing B737-800's of flights AMV6404 and AMV6104 could have damaged the runway end lights and the GBA.

Progress photos of the worksite were taken automatically from the North control tower of Paris Charles de Gaulle aerodrome, every 20 minutes. These photos show that the GBA defined zone was penetrated between 22 h 48 and 23 h 08. The only airplane that took off in this timeslot and approached the works zone was SU-BPZ. The damage shows moreover that at the time of impact the airplane was in rotation phase, which is coherent with the assessment made from the radar data of the position at which SU-BPZ achieved rotation.

The central lights were damaged by a nose landing gear. AMC indicated that the only damage observed on the airplanes having served Paris Charles de Gaulle on 16 August, was that to SU-BPZ, including a cut on one of the nose landing gear tyres. Examination of the debris showed that the first impact on these lights was violent and of the kind to damage a tyre. It is thus likely that SU-BPZ destroyed the central lights and then that the debris, small in size, was dispersed, one of the main landing gears then running over it.

The left main landing gear harness support on SU-BPZ was damaged before the airplane's impact with a GBA. Observations on this part and on the lights allow the conclusion that SU-BPZ struck the runway end light to the left of the centreline; this would also explain, given the position of the airplane at impact, the damage on the threshold light situated to the right of the centreline. However, it cannot be ruled out from these observations alone that this last light was damaged previously, during flight AMV6404's takeoff.

1.11.3 Tests on the OPT

1.11.3.1 Theory

The manufacturer and the operator were contacted in order to clarify which parameters should be keyed into the OPT for performance at takeoff to correspond to that observed on flight AMV6104, namely:

- that the OPT calculates a value of VR close to that assessed from the radar data. The use of data makes it possible to estimate that VR was about 165 kt;
- that the takeoff distance all engines running be consistent with the fact that SU-BPZ struck the GBA and took off before the blast screen (namely a takeoff length of more than 2,600 m).

To this end, the choices made by the crew for the configuration of the airplane had to be clarified, in particular regarding: the determination of V1, the activation of air bleeds, the activation of the optimized climb mode, the setting of flaps and the determination of obstacles.

The chief pilot indicated that he recommended that crews use the following values for a takeoff from Paris Charles de Gaulle in the conditions on that day:

- V1: OPTIMUM,
- air conditioning: OFF,
- anti-ice: OFF,
- optimized climb (I/C mode): OPTIMUM.

He also stated that there were no other obstacles to take into account apart from those included in the database.

N.B: It was not possible to determine with certitude on the basis of their testimony if the crew had activated the optimized climb mode.

1.11.3.2 Maximum thrust selected

The flight report filled in by the Captain at the end of the flight, mentioned that the following parameters were used during takeoff[18]: the takeoff had been undertaken with a maximum thrust at 24 K and N1 reduced to 91% corresponding to an assumed temperature of 41 °C. However, in their testimony, the crew indicated that they had selected a maximum thrust of 26K (see 1.13.1.1).

Boeing confirmed that the acceleration, estimated between the start of the takeoff run and the moment when the airplane reached 150 kt, corresponded to reduced thrust.

Note: Furthermore, it was noted that for a choice of a maximum thrust of 26K, the takeoff distances with all engines running and the rotation speeds calculated by the OPT, were not consistent with the data collected, no matter what restriction on the runway length was entered in relation to the works, no matter which line-up intersection (Y11 or Y12), regardless of the state of activation of the optimized climb mode. The takeoff values were in fact less than 2,189 m and the rotation speeds less than 155 kt. Taking into account a line-up from Y11 and the restriction associated with the works led to a VR value of 144 kt, a takeoff distance of 2,189 m and provided an assumed temperature of 32 °C; the optimum flap deflection was 15°. The choice of a deflection of 5° or less, all other parameters unchanged, provided a VR in the range of 149 kt, the temperatures being practically unchanged. Thus, the rotation speeds remained, according to the deflection choice, below 150 kt.

[18] The Captain stated that he filled in these figures from memory, in the absence of any recording.

1.11.3.3 Calculation of performance at reduced maximum thrust

Different scenarios were considered concerning the crew's keying in a restriction on the usable runway length associated with the works and to the selection of a line-up intersection. The calculations were carried out both in the case of activation of optimised climb mode and in the case of its de-activation. The maximum thrust selected for the calculations is 24K. In fact, the selection of a maximum thrust of 22K would lead to performances that were incompatible with those observed, specifically, the airplane would have struck the blast screen.

The results can be summarized as follows, the takeoff lengths being calculated with all engines running.

It was not possible to select a maximum thrust limited to 24K after having accounted for the runway limitations associated with a line-up from Y11 and with the works. The OPT indicated in this case to the crew that the takeoff was not possible given the limitations of the runway, regardless of the activation of the climb mode.

The selection of a maximum thrust limited to 24K, associated with a line-up from Y12 and accounting for the whole length of the works provided speed values and a takeoff distance that was inconsistent with the data collected.

Accounting for the whole length of the runway, without considering the works, from Y12 or Y11, associated with the selection of a maximum thrust limited to 24 K provided, regardless of the state of activation of the optimized thrust mode, an assumed temperature of 41°, a takeoff length of 2,645 m and a VR value of 164 k, V1 being 163 kt. These values are close to those obtained by the examination of the data collected. The optimum flap deflection was then 1°[19].

[19] The other flap settings available are 5°, 10°, 15°, 25° and 40°.

1.11.3.4 Additional Information

Examination of the performances set with the aid of the OPT taking into account the relative data for flight AMV6404 shows that the hypothesis of damage to the threshold light situated on the right of the centreline during this airplane's takeoff would imply that the crew had entered an erroneous value on the restriction of the runway length, as well as a thrust of 22K.

For information, similar calculations to those carried out for flight AMV6104, but taking into account the load of flight AMV6404 (namely a weight of 66.6 t), show that for a choice of maximum thrust of 26K, the consideration of restrictions associated with a line-up from Y11 and with the works leads to a takeoff distance of less than 1,900 m, whatever the climb mode, flap setting deflection mode or the calculation of V1 selected. A distance of 1,682 m is found with the activation of the OPTIMUM calculation mode of the flap deflection, a calculation in OPTIMUM mode of V1 and the activation of the optimized climb mode; rotation speed is then 135 kt.

1.11.4 Summary of examinations and research

The information collected during the investigation did not bring to light any malfunction of the airplane. Further, it has been established that the maximum thrust selected in the FMC by the crew was 24K.

The supposition that an insertion of values significantly lower than the reality of the load data or erroneous values on meteorological parameters would make it possible to explain how the crew selected a maximum thrust limited to 24K, still taking into account all the restrictions of use of the runway. However, such an error would have led the PF to initiate rotation well before the end of the runway, not noticing any effect of his action. Yet, the pilots did not indicate any anomaly during the takeoff sequence, until they noticed what they thought to be debris, that is when the airplane reached the provisional end of the runway, their speed then being close to V1 and VR (see 1.13.1). That is moreover consistent with the observations on the debris, which show that the rotation started after the end of the runway. The use of radar data made it possible to determine that the airplane's speed was then about 165 kt.

N.B: Further, regarding the meteorological parameters, it is noted that the values entered remain displayed on the PERFORMANCE – TAKE OFF page (see 1.6), which facilitates verification during the use of OPT.

Two cases can be considered with regard to the flap setting to explain the takeoff length :

- erroneous flap setting after a correct determination of the takeoff parameters, i.e. considering the restrictions of use of the runway,
- selection by the crew of a given flap setting for the calculations with the OPT, instead of OPTIMUM mode which provides a deflection of 15°, for selection of the correct parameters.

These two cases would imply a selection of a thrust of 26K for the calculations. Yet, as seen, the value of rotation speed calculated by the OPT is then less than 150 kt and the assumed temperature is in the range of 30 °C. Note that the Captain said on the equipment report that he had selected an assumed temperature of 41 °C for takeoff. Consequently these scenarios do not seem probable.

Entry of correct values into the OPT for the specification of takeoff parameters for a line-up from Y11, imposed a choice of maximum thrust of 26K and provided a V1 value of 148 kt and an assumed temperature of 32 °C. The supposition of an appropriate specification of takeoff parameters by the crew then of an erroneous entry of these parameters in the FMC, would suppose that the crew made three simultaneous errors, entering a triplet of values close to (24K, 165 kt, 41°C) instead of (26K, 148 kt, 32 °C), which hardly seems likely.

Consequently, examination of the data leads us to conclude that a failure to take into account the runway restriction during the use of the OPT explains the performances at takeoff of SU-BPZ.

1.12 Information on Organisation and Management

1.12.1 The AMC airline

1.12.1.1 Background

AMC is an Egyptian airline performing charter flights, in particular to European countries. It frequently serves secondary aerodromes, especially in Europe. Its fleet has been completely renewed and, since then, it has been operating four B737-800s. The first 2 were delivered at the start of 2006, the following 2 during the summer of 2007.

1.12.1.2 Flight safety programme

The flight safety programme described in the AMC operating manual states the tasks of the person in charge of flight safety. In particular it is noted that the latter must be constantly informed of changes under way within the airline, particularly the evolution of the fleet or arrival of new personnel.

This manual seems however to have a more general impact, describing general theories, following the example of a manual-writing guide but it does not explicitly interpret the situation or the operator's organization at the date of the event.

Concerning questions of flight analysis, AMC did not choose to fit its airplanes with QAR. The operations manual describes the objectives of a flight analysis programme and the need to download flight data from predefined thresholds. For the moment, AMC does not have the capacity to read out the data recorded on an FDR. The readout of this data is carried out exclusively as part of investigations led by the Egyptian authorities. To this end, the CVR and FDR of the fleet must be checked regularly.

AMC has been audited and certified as part of the IOSA programme. The audit underlined the fact that AMC did not have a structure for recorded flight data analysis. Consequently, conformity to the IOSA programme was judged in reference to alternative means of compliance, authorised until 31 December 2009, which, for the operator, consist of systematically collecting, correlating and analysing information coming from the crews' reports, from internal quality audits, from maintenance reports etc. An AMC official specified that during the investigation, in order to comply with international demands by the 31 December 2009, an agreement for provision of service was being negotiated between AMC and a service contractor capable of analysing recorded flight data. The Egyptian authorities stated during the safety investigation that authorisation for an extension to the use of this type of device had been granted until December 2010.

In practice, AMC's flight safety official receives the crews' reports and, where appropriate, gathers testimony from flight crew, maintenance reports or from the results of quality audits and on the basis of the information thus supplied, writes safety bulletins. In the case of the event flight, no bulletin was written at first, the crew having indicated that the damage was due to the collision with FOD during takeoff. The AMC flight safety official indicated that after AMC understood the true nature of the event, it was expecting further information

from the investigation in order to write a safety bulletin. On 7 June 2009, AMC issued a safety bulletin indicating that the event had been the result of an incorrect entry on the restrictions concerning the use of runway 27L, while the crew had not followed the cockpit preparation procedures defined by the operator.

1.12.1.3 Issuance of authorisation to operate on French territory

Standard 3.2.7 from Annex 6 in force at the time of the event states that operators of airplanes with a maximum certified takeoff weight of more than 27,000 kg must introduce a flight data analysis programme as part of their safety management system. The decree of 3 June 2008 relative to the operating programmes of air services requires, for operators wishing to operate in France, the issuing of documents, including a technical questionnaire, allowing a check of the candidate's compliance with international standards. The DGAC has however specified that owing to limited resources, it has exempted operators serving France before 2005, such as AMC Airlines, from this measure; service by these operators on French territory is in line with "grandfather's rights". It is noted that the DGAC specified that the absence of a flight analysis programme justifies a case for refusal of traffic rights.

1.12.1.4 Procedure for cockpit preparation

The manufacturer indicated that it did not recommend any particular procedure for the use of the OPT, as the software can be configured in various ways. It is thus up to the operator to define the appropriate procedures.

As regards the cross checking of the data taken into account for takeoff during cockpit preparation, AMC's operations manual mentions that the co-pilot must obtain the information related to weight and balance after the Captain's signature of the weigh and balance sheet. The Captain must check the takeoff data separately from the tables contained in the operating manual. Lastly, the co-pilot and the Captain must carry out a cross check of the data entered in the FMC (Flight Management Computer). This procedure does not take into account the use of the OPT.

Concerning procedures for OPT use, the operator requests crews to use the documentation supplied during training for the issue of the B737-800 type rating. There is no corresponding chapter in the airline's operating manual, which has not been updated to recognise the integration of B737-800s in the fleet. During the investigation, AMC officials and the crew specified that they applied the following procedure: the co-pilot entered the data and started the calculation of performance data then the Captain reset the software and entered the data again to check that the previous calculations were correct.

1.12.2 Another B737-800 operator's procedure using the OPT

For reasons of comparison, the procedures of another operator using the OPT, with a larger structure and more resources than AMC, are described below.

For this operator, the OPT is used exclusively by the operations department. This service provides the crews with sets of simplified performance tables for each aerodrome served. These tables come from calculations carried out with the OPT. For a given table, the parameters concerning the runway (its state and the declared takeoff lengths) and the configuration of the airplane (flap setting, position of the pressurization packs, engine thrust) are set.

The crew checks on the chosen table that the selected weight for takeoff is not restrictive given the wind values and temperature transmitted via ATIS. From the table they deduce the takeoff speeds and compare them to those displayed by the FMS.

When no table corresponds to the situation encountered (in case of diversion to an aerodrome not anticipated during flight preparation for example), the crews contact the airline's operations department, which provides a calculation of performances extracted from the OPT that are appropriate to the new situation. When limitations associated with works are known sufficiently early before departure, the operations service updates the performance tables accordingly.

1.12.3 Safety Management Systems

1.12.3.1 Paris Charles de Gaulle Airport

The decree dated 30 November 2006 *concerning the establishment of a Safety Management System (SMS) by aerodrome operators*, applicable by 1st April 2008, states that they must put in place an SMS. Article 12 states that *"the aerodrome operator ensures that the modifications connected to the use of the aerodrome are assessed with regard to the impact they can have on safety, and that the appropriate measures are taken"*.

The Paris Charles de Gaulle airport safety certificate was amended on the 25 April 2008 in order to take into account the entry into force of the SMS.

Note: Regulation 1108/2009 of the Parliament and the Council, dated 21 October 2009, extends the provisions of Regulation 216/2008 to aerodromes. This regulation is intended to harmonize requirements related to aerodrome operations on a European scale. Specifically, it makes it mandatory for aerodrome operators to oversee the activities and modifications in their environment that can lead to unacceptable risks to safety in the area of the aerodrome and to take steps, with their field of competence, to limit any risks where necessary. Aerodrome operators must establish a management system to ensure compliance with the essential requirements for aerodromes and improve safety in a continuous and planned manner.

The SMS is described in chapter 6 of the Paris Charles de Gaulle aerodrome manual. Paragraph 6.3.3 is dedicated to the assessment and alleviation of risks during modifications relatives to use:

"In order to assess all possible risks, a safety impact study is carried out in advance relating to all modifications affecting the use of the airport. These modifications concern the infrastructure, equipment and procedures. They can be long-lasting or provisional.

The study draws on an analysis of risk events. These events themselves are also generated by one (or several) failings, the origin of which may concern the airport operator, the ATC service provider or the user airlines".

In May 2008, the DGAC distributed a guide for drafting an impact analysis on airport safety. This guide made provision for identification of "airport" risk events having the following definition:

"Event which affects the aerodrome or its use and which has as a possible consequence an incident or accident. It's an undesirable event in the eyes of the services (expected by the users) supplied at the aerodrome".

Each risk event is the subject of a risk assessment and an examination of alleviation measures. The results are presented with the help of a risk acceptability model, introduced in chapter VII of the guide. If the risk event occurs in the green zone of the model *"the risk is acceptable and the modification can be implemented"*. If it is in the orange or red zone *"the modification cannot be implemented as it is. The risk must be reassessed by introducing measures to reduce risks"*.

Frequency / Initial seriousness	Very high	High	Occasional	Rare	Improbable
Catastrophic					
Serious					
Major					
Minor					
Negligible					

1.12.3.2 ATC operator

Regulation 2096/2005 of the European Commission, establishing the common requirements for providing ATC services, requires that ATC operators systematically carry out an identification of dangers, an assessment of risks and undertake corrective measures when a change in their "functional system" occurs (which includes a modification of the conditions of runway use). The criteria for risk assessment are detailed in paragraph 3.2.4 of appendix II to the 2096/2005 regulation. The method introduced by the SNA-RP draws on these criteria. Regulation 1315/2007 of the European Commission, relative to the monitoring of safety in air traffic management, moreover provides that the monitoring authority examines proposals for change when the level of threat, corrected by the implementation of alleviation measures, is assessed at 1 or 2.

Safety management is associated, in the DSNA manual, with quality and security management. Paragraph 3.5.3 of the manual, relative to the assessment of risks connected with changes, is completed by two documents:

- a procedure for the assessment and alleviation of risks;
- a methodology for the assessment and alleviation of risks of changes of the ATM system. This relies in particular on a grid of risk acceptability according to seriousness. It is specified that *"the grey zone is where the risk is considered unacceptable. However, considering the relatively qualitative character of the analysis, events held to be "acceptable" but bordering on the unacceptable zone must be subject to analysis and monitoring"*.

	Very frequent	Frequent	Occasional	Rare	Extremely rare
1 - accident					
2 - serious					
3 - major					
4 - significant					
5 - no effect					

Two steps were developed:

- the preliminary safety impact study
- a safety dossier.

The study is, firstly, intended to allow a decision as soon as possible, by a preliminary assessment, on whether a safety dossier should be constituted. The safety dossier then acts as a detailed study of the risks. This assessment is based on the scale of the modification, on the overall appreciation of the resulting risk and on the detailed analysis of the identified risk events. Where the setting up of a safety dossier is not considered necessary, the study acts as a safety study associated with the planned change.

1.12.4 Studies Carried out for the Implementation of Works on Runway 09R/27L

1.12.4.1 Coordination

The table in appendix 3, based on information provided by ADP, summarises the chronology of this operator's implementation of SMS regarding the planning of restoration works of runway 09R/27L.

As part of a coordination protocol between ADP and the SNA-RP in works and maintenance operations, a task group met from January 2007 in anticipation of the works on runway 09R/27L, its activity in line with the implementation of ADP SMS. The oversight authority and Air France were included in this task group. This group held bimonthly meetings, some specific meetings as well as informal exchanges. Its aim was to discuss the features of the works and the procedures to put in place with a view to the constitution de different files, particularly those relative to the warning sign system. ADP and the SNA-RP stated that at that time they dealt with safety aspects. The investigation

however showed that the group's work mainly considered the statutory aspects, the identification of dangers as defined by the SMS not being covered in an explicit and formal way.

The SNA-RP and ADP drew specifically on the results of these consultations in order to carry out their respective safety studies.

1.12.4.2 Safety impact study– ADP

To carry out the study, ADP stated that it used the preparation guide proposed by the DGAC for the first time. The study introduced nine risk events:

1. Incursion onto runway in use by an ADP vehicle or third party;
2. Incursion onto a taxiway by a third party vehicle;
3. Incursion onto the radio utilities by an ADP vehicle or third party (companies);
4. Incursion by work site personnel onto the runway or taxiway utilities;
5. Difficulties encountered by RFFS to access runway 09L/27R, in case of intervention;
6. Difficulties for RFFS to access the neighbouring aerodrome zone for an intervention to the northwest of the airport. Blockage of the route by moving or broken down vehicles;
7. Temporary obstacle (crane) set up in within service area without authorisation;
8. Obstacle obstructing the takeoff funnel;
9. Final approach 09R, while the runway is closed to landing.

For the identification of these risk events, ADP took into account both an internal feedback system and knowledge relating to events. In particular, the study was fuelled by experience acquired during previous works conducted on the runways, particularly as regards incursions by work site vehicles.

A takeoff after the end of runway 27L was not identified as a risk event by ADP and so was not subject to a specific process of risk assessment. However, a longitudinal runway excursion during takeoff was considered an event prior to risk event n°8[(20)]. ADP proposed, as a risk alleviation measure connected to this risk event, the extension of the RESA to 240 metres (a zone 90 m long, corresponding to the international standard, increased by a zone of 150 m decided on the basis of a compromise between safety and operational requirements). As a consequence of this measure, it was decided to limit the scope of vertical movements by the work site machines, in order not to block the takeoff funnel. Further, among the possible causes of risk event n°8, ADP identified misinformation by crews on the presence of obstacles. As a result, several channels of information were selected as measures for the alleviation of risks: broadcasting of NOTAM, SUP AIP, messages to Air France and FedEx[(21)] as well as information on the Extranet site.

Initially, the level of risk connected to risk event n°8 was considered unacceptable as regards the seriousness assessed as "catastrophic" and the probability assessed as "rare". Once the attenuation measures were taken into account, the probability was estimated as "improbable" and the level of risk considered acceptable.

[(20)]The takeoff funnel was defined from the end of runway 27L, from the ground.

[(21)]The messages to these two operators simply drew their attention on the publication of the SUP AIP concerning the works. Air France, from its side, completed this information, by asking SNA RP for the operational instruction addressed to controllers (see 1.12.4). This information was sent to all the operator's crews in the form of a detailed publication.

The study was finalized on 18 July 2008.

It is noteworthy that this work did not concern an assessment of the margin that airplane using this runway had, for example by the definition of a "critical airplane".

N.B: Boeing indicated that for a B737-800, fitted with CFM56-7B24 engines (maximum thrust of 24K), all engines running, at the maximum takeoff weight, balanced maximum forward, with a flap setting of 5° and given a temperature of 19 °C, an aerodrome elevation of 400 ft, the accelerate-stop distance would be 2,786 m on a wet runway. This gives an approximate value of the maximum distance necessary for the takeoff of a B737-800.

1.12.4.3 Preliminary safety impact study– SNA RP

The planning of the works led the SNA-RP to draft a study.

Five risk events were identified during this study:

- Runway 09L/27R incursion by a works vehicle;
- Aborted takeoff;
- Line-up on 27L/09R centreline;
- Clearing runway 27R via taxiway Z1;
- Change of procedures in poor visibility.

The identification of risk events by the SNA-RP is based on an internal feedback approach. The incidents that occurred during works previously undertaken on the runways were taken into account.

Before considering the elements for risk reduction, risk event n°2 (acceleration stop) was already considered acceptable, with a "significant" level of seriousness and an "extremely rare" frequency. Two measures for the reduction of risks were selected, namely the publication of the SUP AIP and the reminder, during pre-flight contact, of the distance available for takeoff. With these two measures taken into account, the seriousness of the risk event was brought to the minimum level, i.e. "no impact".

Takeoff after the end of runway 27L was not identified as a risk event by the SNA-RP and so was not subject to a process of risk assessment.

The study was finalised on the 5 May 2008.

When the attenuation measures were considered, the five risk events were connected to a seriousness level of 4 or 5 and no safety file was required.

1.12.4.4 Oversight Authority

The oversight authority did not, considering the conclusions of the study, examine the safety study conducted by the SNA-RP. Further, it is not responsible for approving studies undertaken by ADP. The oversight authority however stated that it had exercised oversight, particularly by checking that all the parties concerned by the change had been consulted.

1.12.5 Instructions on the Aerodrome Operations ATC during Works

Note: European Regulation n°1108/2009, as mentioned above, lays down that:

- The data used as a source for aeronautical information shall be of sufficient quality, complete, current and provided in a timely manner.
- Aeronautical information shall be accurate, complete, current, unambiguous and be of adequate integrity in a suitable format for users.

1.12.5.1 Air Traffic Services

An operational instruction concerning the use of runway 09R/27L was issued on the 10 July 2008 by the SNA-RP for the duration of the works. This instruction was within the framework of strategic management. It was considered that the performance of most heavy airplanes made it impossible for them to take off on runway 27L. Also, the guiding principle described consists of proposing the North runway only to medium-size aircraft, with a preferential departure from taxiway Y12. However, the ground controller in the North tower could adopt a tactic to minimise the wait for departure[22].

[22]Use of taxiway Y12 may cause a delay for aircraft on departure because of the wake turbulence from aircraft on arrival on the parallel runway.

Regarding pre-flight communications with the controller, the temporary operational instruction required medium-size airplanes on departure towards the North or on standardized EVX or NIPOR departures, to be directed towards runway 08R/26L when the distance they needed for takeoff exceeded 2,640 m (these departures are usually associated with runway 09R/27L). It is notable that the LANVI departures, related to routes towards the South, were not mentioned in this temporary instruction. They were thus implicitly related to a departure from runway 26R, which corresponded to the operational procedures for the runways facing west, in general (for low-noise airplanes capable of maintaining a climb path above 6.5%), such as are described in section 9.3.5 of the Paris Charles de Gaulle tower operations manual. The LANVI 1A departure, which corresponded to a departure towards the South on runway 27L, was in fact only used at night and during week-ends or on ATC instructions; it was not taken into account during the preparation of the temporary operational instruction.

It was stated that the ground controller indicates to all aircraft the TORA corresponding to their departure taxiway. He can propose taxiway Y11, on condition that the pilot accepts, or taxiway Y13, taking account the fact that the use of this taxiway causes delays at departure owing to wake turbulence generated by the airplanes on arrival on the adjacent runway.

The tower chief is also required to indicate in the ATIS message:

- "attention travaux sur piste 09R/27L, vérifier la TORA nécessaire à la fréquence PREVOL";
- "caution work in progress on runway 09R/27L, check your TORA on PREFLIGHT frequency".

ATC issues this type of information at the latest twenty-four days before it comes into effect in order to adapt to the controllers' activity (group of 2 teams with cycles of 12 days per team).

1.12.5.2 Aerodrome

A NOTAM concerning Paris Charles de Gaulle Airport in force at the time of the event indicated the presence of works on runway 09R/27L and referred to SUP AIP number 079/08 (see appendix 4). The NOTAM did not state the lengths declared usable, this appearing only in the SUP AIP.

The temporary Jeppesen chart 20-9-01A (yellow) in force at the time of the incident repeated the SUP AIP instructions and stated the lengths declared usable; on map 20-9-01, some crosses indicated the works zone.

The information issued on the AIP was prepared by the SNA-RP with ADP.

The SUP AIP specified, for information, that:

- the first 900 metres of runway 09R were closed to operations because of works;
- the 09R threshold had been moved to be level with K3;
- the lengths of usable runway were given.

2.1 Distances declared

Runway 09R

Departures:			
TWY K3	TORA 2960	TODA 3020	ASDA 2960
Y2; Y3; K1; K2	closed to operations.		
Landings:	Forbidden		

Runway 27L:

Departures:			
27L	TORA 2960	TODA 2960	ASDA 2960
TWY Y12	TORA 2640	TODA 2640	ASDA 2640
TWY Y11	TORA 2360	TODA 2360	ASDA 2360
TWY K7	TORA 2200	TODA 2200	ASDA 2200
TWY K6	TORA 1940	TODA 1940	ASDA 1940
Landings:	Forbidden		

Extract from AIP SUP 079/08 – Published 05 June

In section 3 Operation of this supplement, crews were furthermore requested to confirm on the pre-flight frequency that the TORA in 09R/27L was sufficient.

It is notable moreover that the SUP AIP mentioned a preferential line-up from Y11, contrary to the temporary operational instruction intended for controllers (see 1.12.5.1). When questioned on this difference, the SNA-RP indicated that the information for drafting the AIP had been sent to the Aeronautical Information Service on the 23 April 2008 (for an instruction published on 5 June), to follow the cycle of distribution of AIRAC - namely a dispatch at least 42 days before publication and 84 days before coming into force. It was only later that the SNA-RP considered that given the distance available for takeoff from taxiway Y11, the traffic would have been disrupted owing to the numerous refusals by crews. Consequently it drafted the temporary operational instruction for the attention of controllers, indicating a preferential line-up from Y12.

1.13 Additional Information

1.13.1 Testimonies

1.13.1.1 Crew Testimony

The Captain was PF. The crew did not notice anything abnormal during cockpit preparation. The turnaround time was comparable to that which they were used to[23]. The co-pilot programmed the FMS for the return. He did not leave the cockpit. The Captain managed the conflict between a flight attendant and a passenger. When the Captain returned to the cockpit, the crew listened to the ATIS then the Captain inserted the takeoff parameters in the OPT for a line-up from Y11, as he usually did during night flights when he was parked at Q zone. He specifically chose the OPTIMUM configuration for the flap setting system. He indicated having checked the limitations of the usable runway length by referring to the temporary Jeppesen map. Both pilots stated that they were aware of the restrictions in force. The co-pilot indicated that he had checked the data inserted into the OPT. The two pilots thought they had selected a maximum thrust of 26K.

The crew lined up normally, without executing a rolling take off. The PF had applied full thrust. The takeoff run seemed normal to them. They indicated that at approximately V1/VR they struck something with the nose landing gear and heard a loud noise. They mentioned the possibility of debris, perhaps coming from the lights.

The crew then turned their attention to following the standardized departure path and handling the systems check. They indicated that their work load did not allow them to inform ATC. Not noting anything abnormal, they decided to continue to their destination. In Luxor, they noticed a deep cut on a nose landing gear tyre. The Captain completed an equipment report mentioning FOD.

The crew did not inform the controller, since immediately after takeoff, they were dealing with the checks.

The co-pilot stated that during the takeoff run, he could make out a line of red lights in the distance that he estimated corresponded to the end of the runway. The profile of the runway helped to make these lights clearly visible.

Both pilots were familiar with Paris Charles de Gaulle Airport and were used to taking off on short runways, particularly in Europe. However they had not landed in Paris during the period of works until 16 August.

The pilots considered that the amber colour of the NOTAM tab of the OPT, when the corresponding heading was called up, constituted a sufficiently prominent visual indication to attract their attention at the cross checking phase.

The crew stated that they did not know the distance necessary at takeoff in the conditions on the day and in the chosen configuration and that they referred to the OPT data. A QRH was available on board, the first volume of which contained the performance tables that the crews only use on the ground when the aerodrome data were not recorded in the OPT database.

The crew added that the indications provided by the NOTAM and ATIS were not clear enough in relation to the restrictions for use of runway 27L.

[23] In comparison, the timesheets for AMC flights on the day showed that the crews' turnaround time in Paris was between one hour and one hour fifteen minutes.

1.13.1.2 Testimony of the handling agent

The handling agent explained that when he arrived at the airplane, the Captain was on edge because of a passenger who had been smoking in the toilets. He was waiting for the police to arrive and asked him to fill in the weight and balance sheet for him as he had not had the time to take care of it. The agent did this task for the first time. He stated that the Captain took the time to check the sheet before signing it.

1.13.2 Study on the Use of Erroneous Parameters at Takeoff

In April 2008 the BEA published a study on the errors made at the time of entering and calculating takeoff parameters as well as the impact of these errors on certain incidents and accidents[24]. This study was inspired by the increase in events linked to the use of new onboard computing tools.

All the events examined in this study originated from confusion or errors in the weight parameters used for computerized calculations. No insertion errors relating to the takeoff distance available had been noted. However, the errors that were analysed and the circumstances in which they occurred and were corrected, were of a general nature. Some of the conclusions of the study are mentioned later.

The study brought to light the particular circumstances of the flight preparation phase, conducive to the occurrence of data entry errors. The crew is subject to a considerable work load which they must complete with reduced deadlines and while being disrupted by outside events.

The checks in the "calculation of takeoff parameters" function can prove to be inefficient as they consist in checking the entry of the value but not necessarily the accuracy of the value itself.

The pilots' general knowledge of the values of parameters determined by empirical methods is the most frequently mentioned strategy for avoiding major errors.

As part of this study, the BEA recommended that:

"The DGAC ensure that the French operators:
1. make their pilots and ground personnel aware of the process of specific flight departure errors, the decline in performance and the risks linked to the use of erroneous parameters for takeoff,
2. have set up robust preparation and validation procedures of the parameters used for takeoff by the flight crew."

1.13.3 Study of Crew Fatigue

In this section, the times are given in local Egyptian time, in order to take account of the crew's biorhythms.

It was noted that the crew did not have to face any significant jetlag during the days preceding the event. However, given the time of the incident, the BEA tried to discover if a link could be established between the crew's work schedule and their level of alertness during the event.

[24] See the BEA website (www.bea.aero) for the Safety Recommendation dated 21 April 2008, as well as the study undertaken by the BEA and the "Laboratoire d'Anthropologie Appliquée" (LAA) entitled "Use of Erroneous Parameters at Takeoff"..

The crew gave the following details concerning their activity-rest cycles.

The pilots exchanged piloting duties on each of the two legs.

The pilots were informed of the scheduling of their flights seven days in advance. The activity time corresponded to the time spent between the first departure and the last arrival of the trip, increased by two hours (1 h 30 of flight preparation and a half-hour for closing the flight).

During the week prior to 15 August, the Captain carried out one trip, to Spain, on the day of the 10th. During the first fifteen days of August, the co-pilot was on holiday at the seaside. He had a rest with his family.

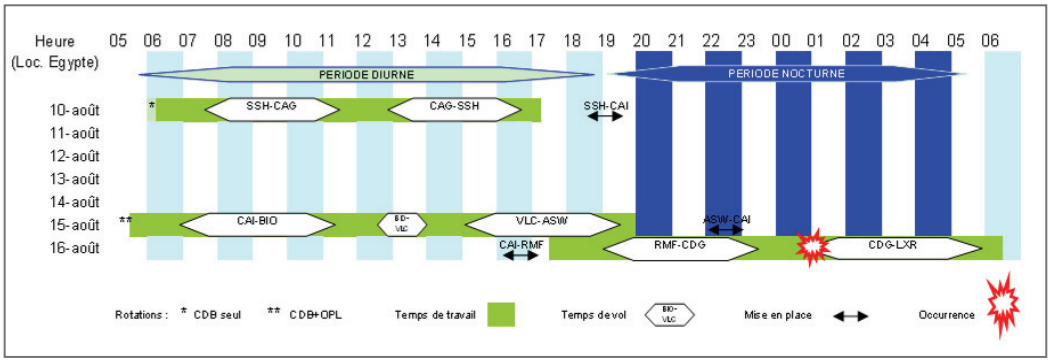
On 15 August, the pilots made a trip together. At the end of this, they returned to their homes, at about 20 h (from Aswan).

On 16 August, they waited at home, in Cairo, to get information on the arrival time of the airplane to Marsa Alam, before taking a flight. The flight between Cairo and Marsa Alam lasted about one hour[25].

When he was not flying, the Captain's average sleep was about nine hours, regardless of the time he went to bed. The co-pilot indicated that when he was not flying, he got up at around midday and went to bed after midnight.

AMC stated that the limit on duty times for the crew was 13 h 15 for the trip on 16 August 2008 and that, taking into account the delay on departure and the absence of any alternative solution, the operator warned the Authority that the pilots' duty time, calculated as 14 h 10 on 16 August and as 6 h 05 on 17 August, would exceed this limit by 2 h 40 on arrival. This time included the waiting time at Cairo and the trip time from Cairo to Marsa Alam on 16 August.

The review of the crew's activity-rest cycles the week preceding the event is summarized in the following table:



The planning for the Marsa Alam – Paris – Luxor trip, delayed until the afternoon as well as the airplane's lateness, made the pilots' activity period clash with their biorhythms in relation to the preceding week. Consequently the time the event occurred corresponded to a period in which the crew's performance was likely impaired.

[25] For the flight to Marsa Alam, the crew travelled in an air taxi company's airplane, specially chartered by AMC.

1.13.4 Corrective actions taken by AMC

After the event, the pilots undertook 10 training flights as well as 8 simulator sessions. In addition, the operator stated that during the investigation it had worked on developing a detained training course on the use of the OPT.

The bulletin issued by AMC on 7 June 2009 (see 1.12.1.2) recommended that crews strictly adhere to the flight deck preparation procedures, to back up data entered in the OPT and asked dispatch agents to draw crews' attention to any possible restrictions on the use of runways. AMC stated that an update of the procedures described in the operations manual relating to the introduction of this new computer tool was being developed. Specifically, it stated that procedures should ensure the possibility of backing up data entered into the OPT.

Among the new user procedures, AMC said that it had implemented the OPT INTX function, making it possible to calculate performance for a takeoff from a given intersection in a predefined list.

2 - ANALYSIS

2.1 Scenario

During flight preparation, the crew had scheduled a takeoff from runway 27L, as they usually did when the airplane was in parking slot Q.

The information issued on the ATIS required checking the runway distance available for the use of 27L with the pre-flight controller. At least 2 factors could have contributed to the fact that this check was not carried out. On the one hand, the crew were not aware of the takeoff distance that they needed, this information not having been directly provided to the crews by the OPT as configured by AMC. On the other hand, responding to the crew's request to take off from the runway 27L, the controller cleared a standard LANVI 1A departure, corresponding to a departure to the South from the North runway. This departure only being used when proposed by ATC, at night on the week-end, it was not taken into consideration in the temporary operations instruction distributed to controllers for the duration of the works, for which, implicitly, all departures to the South should have been carried out from the South runway (see 1.12.5.1). The instruction to controllers to check the distance available with crews thus did not apply in this case.

The pilots indicated that when they were filling in the OPT to determine the takeoff parameters, they planned a line-up from Y11, the nearest, as usual. The AIP instructions relating to the use of runways during works, summarized by Jeppesen, mentioned taxiway Y11 as the preferential intersection for line-up. This information, in contradiction with the strategy developed in the SNA RP instruction, thus tended to reassure the crew on their plan of action. Given the OPT configuration chosen by AMC, the choice of Y11 required the selection of another taxiway, in this case Y12, then the insertion of a restriction on the runway length taking into account both the works and the distance between Y11 and Y12. Yet the crew did not enter the appropriate restrictions, as research mentioned in 1.11 showed. This error allowed the selection of a maximum thrust limited to 24K. Several factors probably contributed to this error. The pilots indicated in fact that they had experienced difficulties in understanding the restrictions in force, whether listening to the ATIS or reading the Jeppesen charts and the NOTAM. Their level of comprehension of the English language had been assessed as complying with international requirements. Their difficulties should thus be judged in the context of the flight and the quality of the information available.

The calculation of the exact value to take into account required the crew to make a deduction as the operator did not provide its pilots with directly usable results or inform them of the OPT fields related to the NOTAMs reserved for the administrator. The fact of calculating, even for simple operations, requires a mental alertness that the crew may have lacked. In this case, it is notable that

the crew's performance level was probably impaired by the specific conditions of this flight. Time pressure, increased by the incident with a passenger that the Captain had to handle during the turnaround as well as the physiological strain caused by their flight schedule had affected the pilots' capacity to handle a delicate phase of the flight together.

N.B: Following the investigation into an incident that occurred on 22 May 2006 at Metz Nancy Lorraine aerodrome, the BEA recommended to the DGAC that it should systematically and explicitly repeat in the NOTAM the modifications that have consequences on operational performances, particularly the usable runway lengths.

From the regulatory point of view, only the lengths declared usable have to be supplied to operators. It was noticed that the use of new onboard tools for performance calculations may require that crews have supplementary information. It would not be realistic, however, to require that aerodrome operators or ATC respond systematically to this type of request, unless, at certification level, a synchronisation of these systems' ergonomics was considered.

It seems that in the end the crew did not select any restriction connected with the works. They did not examine the values in detail to allay their doubts, on seeing information that appeared inconsistent or inaccurate. Yet this was the essential parameter for the success of takeoff.

Note: It cannot be ruled out that the crew used parameter values entered by a previous flight crew. Note that in fact the entered values for an aerodrome in the NOTAM field accessible to crews are used by the system as long as they are not modified or deleted. However, the confusion and error mechanism explained above apply equally to a previous flight crew.

Once the data was entered and the takeoff parameters determined by the OPT, the cross checks did not make it possible for the crew to detect the error made. The verification procedure described by the crew assumed the entering of data again, generating a considerable work load. AMC did not define its own procedure for OPT use, particularly with regard to cross checks. Further, the composition of the crew – the two pilots being captains for AMC, led to uncertainty as to the division of tasks, which impaired the pilots' availability and the efficiency of this phase of flight preparation. The greater seniority at AMC of the pilot carrying out the duties of Captain also probably contributed to impairing the other pilot's ability to carry out his duties as PM.

During taxiing towards runway 27L, the ground controller informed the crew of the available runway length from Y11. Here again, this precaution referred to information that was not accessible to the crew. It is notable that a possible change of strategy would involve the pilots filling in all the OPT fields again, which may have discouraged them from calling into question their choices at this stage of the flight.

During the takeoff run, the crew did not seem to realise they were getting closer to the provisional end of the runway, the line of red lights placed on the blast screen probably being more visible than the lights on the ground. The crew was conscious of having struck something, without being able to identify it but they did not inform the controller of this.

2.2 Systemic Failures

2.2.1 AMC Operations

The airline AMC had had to manage the renewal of its fleet with modern airplanes. Without true change management, such a development introduced uncertainty, particularly in matters relating to operational procedures and crew training. It was noticed, for example, that AMC's operations manual at the date of the event had not been amended to take into account the introduction of the OPT into flight preparation. The operator required crews to comply with the method they were taught during their type rating training. Yet the configurable nature of the software, particularly on its interface level, assumed that operators would set up specific procedures. The operator did not make available to crews any operational back up for the use of this new tool, to lighten their work load during the filling out of data in the OPT. The crew of flight AMV6104 thus found themselves in a situation that required a significant capacity to adapt, whether to take into account the aerodrome's temporary use restrictions or to determine each person's tasks in OPT use.

The absence of flight analysis contributed to AMC not identifying the type of error that occurred during the event. Without the BEA's investigation, the operator would not, in this event, have noticed a warning on the dangers concerning entering erroneous data in the OPT.

2.2.2 Impact studies

Studies for the restoration of runway 09R/27L were undertaken in 2006. ADP and the SNA RP jointly determined the measures to implement in order to meet the statutory constraints connected with the works and to maintain a suitable level of safety.

The implementation of the ADP SMS took place during this phase of the study, while the SNA RP's had already been carried out. Each of the two operators restated and justified in their impact studies the measures discussed since 2006, according to the format anticipated by its risk analysis preparation guide.

ADP and the SNA RP considered that the measures they had taken on a regulatory basis, enhanced by additional safety margins assessed previously, guaranteed an acceptable level of safety. The respect of regulatory constraints in a nominal situation, as well as in an exceptional situation for example during the works, was certainly supposed to ensure that the operation remained at an appropriate safety level. Nevertheless, limited to this approach, an impact study loses some of its meaning, as the regulatory norms define the perimeter of the analysis. Such a study must examine the risks inherent in the transition itself between two given states of operations. In the case of the introduction of works, it was a question of ADP and the SNA RP considering the difficulties that an operator or a flight crew could have in taking into account the published information. The size of the works, reducing the length of the runway available by about one third, required the airlines to exceed the framework of the ordinary operational adjustments. Some operators had to define runway use criteria, for example according to conditions of the day, while the runway dimensions are not usually restrictive. The maintenance of

an acceptable level of safety during such a development pre-supposes an immediate and total adaptation by all the operators of their new restrictions. Consequently, not mastering this adaptation, ADP and the SNA RP did not have the capacity to assess the acceptability of risks associated with the works at the end of the runway. The risk management was transferred to the airlines, drawing mainly on the information that they received. In the case of AMC, consideration of the new situation was directly carried out at flight crew level, its effectiveness being sensitive to operational restrictions.

It is also notable that, rushed by publication constraints within the AIRAC cycle, the SNA RP further published information on the preferential line-up taxiway which had then been reassessed without informing the operators.

Further, the preparation of safety studies by these two operators within the framework of their SMS was not the subject of specific coordination. Thus, for example, the reduction of the TORA was connected by the SNA-RP to the risks linked to aborted takeoffs and, by ADP, to the risks linked to the obstruction of the takeoff funnel by a works site machine. If, in the first case, the level of risk was initially considered acceptable, in the second case, it was only found to be so from the moment when additional means of information had been implemented.

Although the 2 operators had discussed safety measures during task group meetings (see 1.12.4.1), these discussions did not explicitly concern the formal identification of risks. Thus, carrying out safety studies did not allow for a detailed exploration of the works situation in terms of risk.

For example, the distance necessary for takeoff for a B737-800, depending on the conditions on the day and its engines, could be about 2,786 m (see 1.12.4.2, this value corresponding to an acceleration-stop), a distance above the length available from Y12 during the works. ADP and the SNA RP were not aware of such limitations. Though the SNA RP had included the operational constraints associated with the handling of takeoff performances of heavy airplanes or of some medium-haul airplanes lined up at Y11, this thinking was not developed in the impact study. More generally, the absence of formalisation and of specific analysis of the risks linked to takeoff performance did not lead the SNA RP and ADP to determine the airplane types with critical performance considering the runway length available for takeoff or to assess the level of safety offered by the attenuation measures decided on. In this particular case, it is uncertain whether in the case of an engine failure after V1, SU-BPZ would have avoided the work site machines if they had still been in the works zone during takeoff or whether it would not have struck the blast screen in case of an aborted takeoff.

It emerged from the investigation furthermore that the method used by ADP and the SNA RP to draw up their safety studies led them to place some risk events on a frequency–severity matrix when they did not have enough objective data to allow such an assessment. The experience acquired by these operators during previous works allowed them to justify the assessment of

some risks, for example those associated with runway incursions. But for most of the other risk events identified, they did not have workable quantitative data and had to call on their respective collective memories. Once the attenuation measures had been adopted, these risk events were repositioned in a block of acceptable risk level on the risk matrix. Such a mode of representation, when it is without a true quantitative basis, is likely to bias analysis.

The fact of qualitatively assessing a risk to be high-level, then of adopting attenuation measures with non-quantifiable effects, must influence the decision process as such. The inherent doubt in such an assessment is in itself a factor take into account and a source of furthering analysis. In these conditions, the risk is considered under control when, considering all the discussions, the decision-maker is reasonably drawn to consider that the attenuation measures planned meet the specific demands of precaution that the identified risk requires.

The development of safety management systems by all operators should lead them to enlarge the collection and consideration of data relevant for risk assessment. In their safety management process, each operator should start talks when planning a change, with the aim of identifying as far as possible the constraints on the representative protagonists of their operational environment. In a complex environment, like an airport system, the danger identification phase and risk assessment must draw on a dialectic process allowing the comparison of different points of view.

This investigation highlighted the difficulty that operators from different cultures can encounter, in successfully handling such a process. The discrepancies between regulatory frameworks organising the SMS does not favour such synergy.

However, consideration should be given to the fact that SGS was only required from 1st April 2008 onwards and that these were the first studies undertaken by ADP. It is difficult to evaluate the risks associated with imperfect adaptation by air transport operators to a considerable change in the operating conditions of a runway.

3 - CONCLUSIONS

3.1 Findings

- The crew possessed the licences and qualifications required to undertake the flight;
- The airplane was airworthy;
- Works were under way on runway 27L between 4 and 20 August 2008;
- The AIP mentioned various usable lengths for runway 27L, in particular that from intersection Y11;
- The information published in the AIP indicated that line-up was preferable from Y11, contrary to the instruction addressed to controllers by the SNA RP;
- The controller told the crew the remaining distance from intersection Y11;
- Calculations for the takeoff parameters were performed by the crew using the OPT software;
- AMC had not established any procedures for the use of the OPT;
- This flight was the first for the pilots on departure from Paris Charles de Gaulle during the works but other AMC crews had previously served the aerodrome during this period;
- AMC had not taken any specific measures for the duration of the works in order to ensure that the restrictions on use of the runway were correctly taken into account by its crews;
- The composition of the crew induced some uncertainty as to task sharing during the preparation of the flight;
- The pilots' performance level was likely impaired due to the constraints imposed on their biorhythms by the flight scheduling;
- The crew did not take into account the reduction in the length of the runway caused by the works under way;
- The takeoff distance calculated by the OPT was not known to the crew;
- AMC does not have any flight analysis programmes; such a programme is required in order to operate on French territory;
- The safety impact studies carried out by the SNA RP and ADP did not make it possible to identify a takeoff beyond the new runway limits as a high-risk event;
- The impact studies were carried out in an insufficiently coordinated manner by ADP and the SNA RP;
- These impact studies did not take into account the risks inherent in incomplete adaptation to change by some airlines.

3.2 Causes

The event was caused by the crew's failure to take into account the length of the runway available for takeoff.

The following factors may have contributed to the event:

- the inadequacy of the OPT utilisation procedures set up by the operator AMC to prevent such an error;
- the impaired level of crew performance, specifically related to the pilots' fatigue.

4 - SAFETY RECOMMENDATIONS

In accordance with the provisions of article 17.3 of European Regulation (EU) N° 996/2010 of the European Parliament and of the Council of 20 October 2010 on the investigation and prevention of accidents and incidents in civil aviation, a safety recommendation shall in no case create an assumption of blame or liability for an accident, serious incident or incident. The addressee of a safety recommendation shall inform the safety investigation authority which issued the recommendation of the actions taken or under consideration, in accordance with the provisions of article 18 of the aforementioned regulation.

Study on Insertion Errors

The problem raised by this event in relation to data entry errors echoes the conclusions of a study undertaken by the BEA, the DGAC and the LAA on the subject. This study revealed that failings related to entering takeoff weight data. This event shows another type of potential error, associated with entering the length of runway available. The development of computerized performance calculation tools must be accompanied by better knowledge of associated failings.

Consequently, the BEA recommends

- **that the DGAC, in the context of the State Safety Plan, take into account the risks associated with operators introducing new computer tools.**

- **that EASA conduct a study on the standards that should be taken into account during certification of onboard performance calculation systems, in order to ensure that their ergonomics and procedures for use are compatible with the requirements of safety.**

5 - ACTIONS TAKEN DURING THE INVESTIGATION

The first guide to developing an impact evaluation for airport safety dates from May 2008, that's to say 3 months before the incident. The investigation and the feedback from airport operators showed the difficulties of performing this type of study. This led to amendments to the first guide. In addition, the DSAC produced a guide on coordination in case of modifications to airport operations – Version 1 of 12 January 2009, specifically dedicated to the necessary coordination between the different parties involved in case of works at an airport.

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Appendix 3

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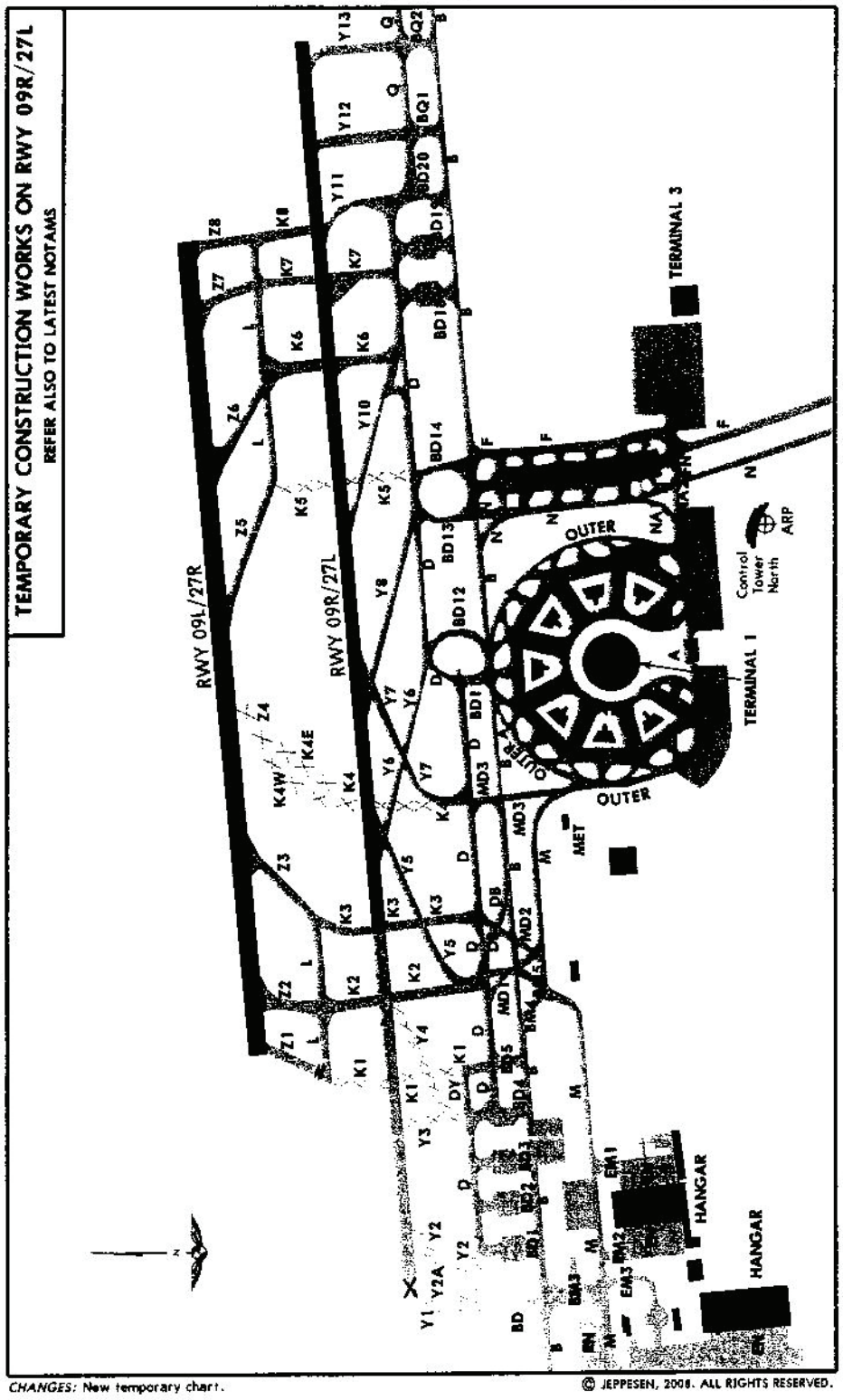
Appendix 4

NOTAM n°A2949/08 and SUP AIP 079/08 in effect at the time of the event, relating to works at Paris Charles de Gaulle aerodrome

Appendix 1

Jeppesen chart in effect on 4 August, concerning provisional works on runway 09R/27L at Paris Charles de Gaulle aerodrome



TEMPORARY CONSTRUCTION WORKS ON RWY 09R/27L

REFER ALSO TO LATEST NOTAMS

The first 900m of rwy 09R are closed.
Threshold moved to twy K3.
Due to the low turning radius of 131'/40m between twys Z1 and L, crews shall particular care, over-steering is recommended.
On rwy 09R the approach lights, TDZ lights and PAPI are not available.
Axial lighting marks of rwy 09R/27L are not available.
ILS rwy 09R/27L not available.
Landing rwy 09R/27L forbidden.
LVTO procedures are suspended.

TAKE-OFF RUN AVAILABLE

RWY 09R:		RWY 27L:	
from twy K3 int	9711' (2960m)	from rwy head	9711' (2960m)
		twy Y12 int	8661' (2640m)
		twy Y11 int	7743' (2360m)
		twy K7 int	7218' (2200m)
		twy K6 int	6365' (1940m)

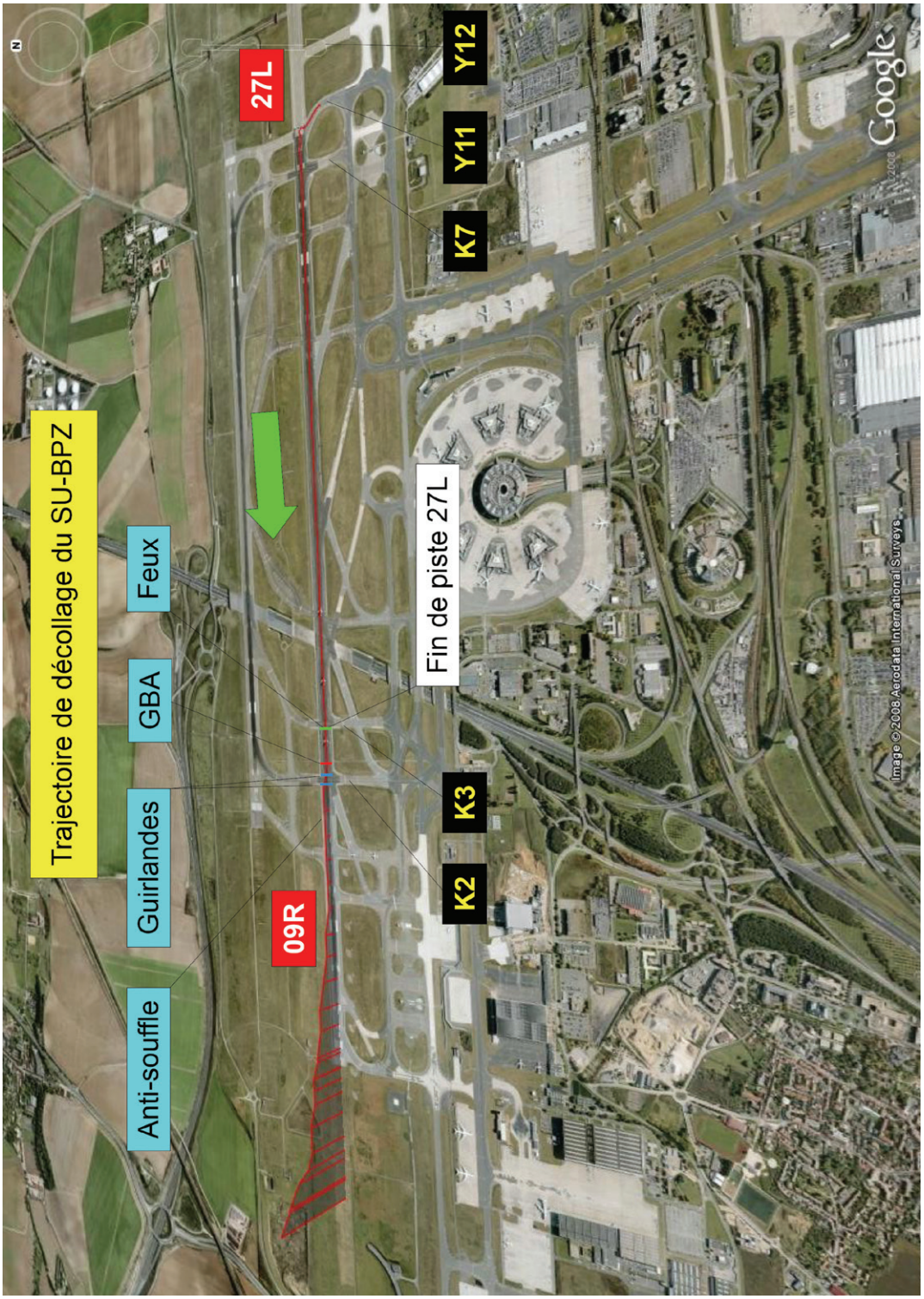
OPERATION
Confirm on pre-flight frequency that TORA 09R/27L is enough.
Crossing rwy 09R/27L will performed through twys K2 or K3 on CTL clearance.

RWY 09R
Departures are possible, exclusively through twy K3.

RWY 27L
Departures through preferential twys Y11 and K7.
Departures through twys Y12 and Y13: Provide delays due to wake turbulence with outer rwy.

CHANGES: New temporary page.

Appendix 2
Track of SU-BPZ reconstituted based on AVISO data



Appendix 3
Table summarizing stages in implementation of ADP SMS in relation to the schedule for the works on runway 09R/27L

DATE	SMS implementation steps	Actions concerning the work site
16/09/2005	Presentation of ADP' SMS project to the DGAC in anticipation of regulation.	
17/11/2005	Preparatory meeting with the SNA-RP and the airlines: presentation of interactions between these operators in the framework of their SMS.	
2006		Start of a study on repairs to runway 09R/27L (after report of failings during 2003 works). Two phases were defined following this study: - phase 1: carrying out of repairs to the central and east section of runway 09R/27L on 2,700 m (complete closure of the runway for 23 days). - phase 2: supervision of a study to repair the west section of runway 09R/27L on the remaining 900 m (failings of a different kind).
26/10/2006		Start of three months of exchanges with Air France on the use of a reduced runway taking into account: - a 240m RESA; - known limitations for the whole of the Air France fleet relative to a work site obstacle.
19/12/2006	Publication of the 30 November 2006 decree on aerodrome operators' SMS.	
10/01/2007		Production of a review of DAC Nord consultation project for advice on the remaining operational section and concerning SNA-RP advice on the project
18/01/2007		First meeting of a specific task group, including the DAC Nord and the SNA-RP to: - examine the measures to take on the section remaining operational; - define a runway strip with a 240m RESA.
22/01/2007		Response from the DAC Nord on the modifications to make on the origin of 09R takeoffs
02/2007		Decision to postpone works to further examine failings reported on the west section of runway 09R/27L
26/03/2007	Correspondence from the DCS concerning a guide to SMS implementation by aerodrome operators	
24/09/2007		Meeting with DAC Nord and SNA-RP to relaunch the project for realisation in summer 2008 with the measures enacted on 18/01/2007
11/10/2007		Meeting between ADP and the SNA-RP on the realisation of the SUP AIP in relation to the works on runway 09R/27L

17/12/2007		Exchange between ADP and the DAC Nord about the validated plan
31/01/2008		Dispatch of full dossier to the DAC Nord with mention that this dossier was conducted jointly with the SNA-RP, the DAC Nord and Air France
18/03/2008		GT implementation for the final draft of the EIS (note: at this period no defined framework to carry out the EIS)
23/04/2008		Dispatch of SUP AIP project concerning phase 2 works by the SNA-RP to the SIA for publication
22/05/2008		Dispatch of the dossier to the DAC Nord by ADP, including SNA-RP's EPICA
29/05/2008	First version of the EIS development guide transmitted by the DAC Nord	
18/07/2008		Dispatch of the final version of SNA-RP's EIS and EPICA
04/08/2008		Start of the works on the 900 m of the west section of runway 09R/27L

Appendix 4
NOTAM n°A2949/08 and SUP AIP 079/08 in effect at the time of the event, relating to works at Paris Charles de Gaulle aerodrome

Texte du NOTAM LFFA A2949/08

(A2949/08 NOTAMN
Q)LFFF/QFAXX/IV/NBO/A /000/999/4901N00233E005
A)LFPG B)0808042130 C)0808200300
E)WIP ON RWY 09R/27L AND ASSOCIATED TWY :
SEE SUP AIP NR 079/08
CORRECTIONS :
- PARAGRAPH 2.1 : READ 'Y1' IN ADDITION TO Y2, Y3, K1, K2.
- PARAGRAPH 1.2 AND ANNEXES 1 AND 3 :
TWY BD1 CLOSED AS WELL AS TWY BD, Y1, Y2, Y2A, Y3, K1, Y4.
AVAILABLE ON WWW.SIA.AVIATION-CIVILE.GOUV.FR)

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AFTN : LFFAYNYX

AIP SUP 079/08

PUB : 05 JUIN

LIEU(X) : **AD Paris Charles de Gaulle AD (LFPG)**

VALIDITE : **Du 04 au 20 Août 2008**

OBJET : Travaux sur RWY 09R/27L et TWY associés

Du 04 août 2008, à 22.00 UTC, au 20 août 2008, à 03.00 UTC, auront lieu des travaux sur la piste 09R/27L de Paris Charles de Gaulle et sur les voies de circulation associées. (*Voir annexe 1*)

Pendant cette période:

- Un congé de raccordement particulier sera mis en service entre la voie Z1 et la voie L (*voir annexe 2*). En raison du faible rayon de virage (40 m) une attention toute particulière est demandée aux équipages. Il est recommandé de pratiquer l'oversteering.
- Un point d'arrêt intermédiaire sera mis en service sur la voie L, en limite de servitudes des voies Z2 et K2.

1 INFRASTRUCTURES, ET ÉQUIPEMENTS RENDUS INDISPONIBLES (*voir annexe 3*)

1.1 Les 900 premiers mètres de la piste 09 R sont fermés à l'exploitation. Le seuil 09R est déplacé au niveau de la voie de circulation K3.

1.2 Les voies de circulation BD, Y1, Y2, Y2A, Y3, K1, Y4 sont fermées à l'exploitation.

1.3 Les aides visuelles lumineuses, rendues indisponibles sont :
- La rampe d'approche 09R
- La TDZ 09R
- Le balisage axial lumineux de la piste 09R/27L
- Le PAPI 09R

1.4 Les aides radio électriques indisponibles, sont :
- L'ILS 09R
- L'ILS 27L

2 EQUIPEMENTS PROVISOIRES

Les aides visuelles lumineuses, provisoires sont implantées pour la durée des travaux pour matérialiser:
- Le seuil 09R
- l'extrémité de la piste 27L

2.1 Distances déclarées :

Piste 09R :

Départs :

TWY K3	TORA 2960	TODA 3020	ASDA 2960

Y2; Y3; K1; K2 fermées à l'exploitation

Atterrissages : Interdits

Piste 27L :

Départs :

27 L	TORA 2960	TODA 2960	ASDA 2960
TWY Y12	TORA 2640	TODA 2640	ASDA 2640
TWY Y11	TORA 2360	TODA 2360	ASDA 2360
TWY K7	TORA 2200	TODA 2200	ASDA 2200
TWY K6	TORA 1940	TODA 1940	ASDA 1940

Atterrissages : Interdits

3 **EXPLOITATION**

- Confirmer sur la fréquence pré-vol que la TORA 09R/27L est suffisante,
- La traversée de la piste 09R/27L, s'effectuera par les voies K2 ou K3, sur clairance du CTL.

Piste 09R

Départs possible, exclusivement par la voie d'alignement K3.
Procédures LVTO suspendues.
Atterrissages interdits.

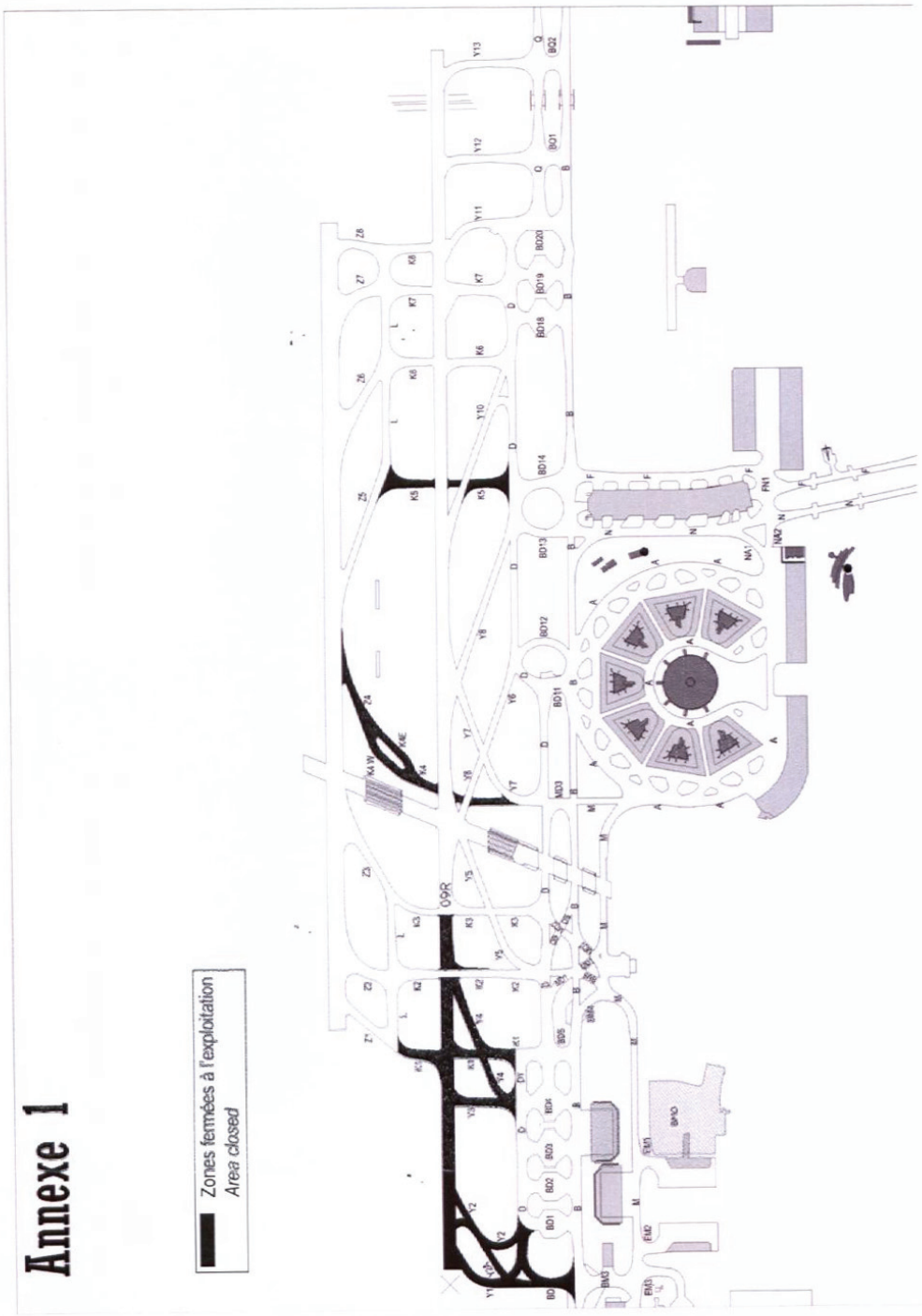
Piste 27L

Départs via les voies d'alignement préférentielles Y11 et K7.
Départs Y12 et Y13 : Prévoir délais cause turbulence de sillage avec la piste extérieure.
Procédures LVTO suspendues
Atterrissage : interdits.

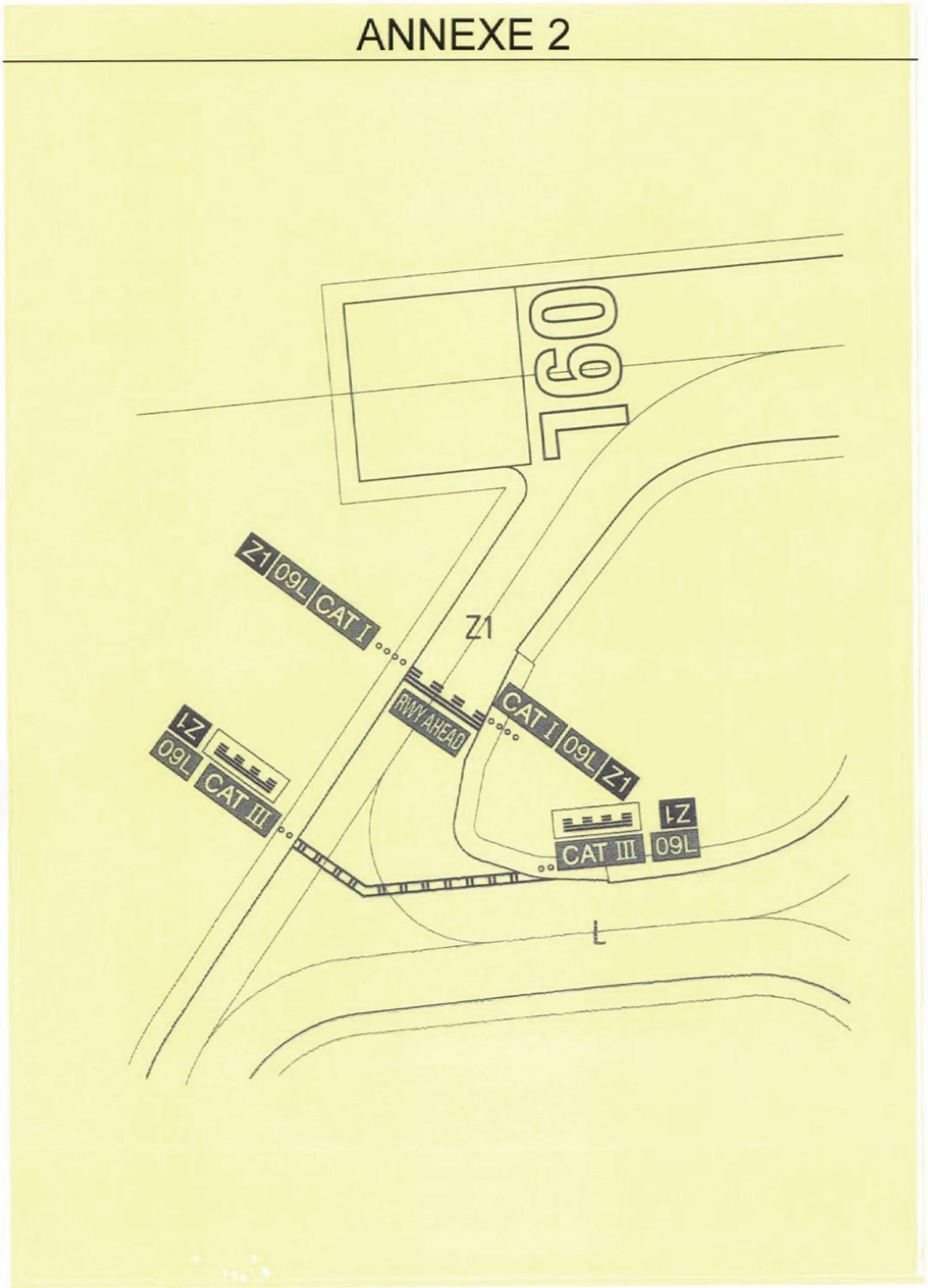
4 **Obstacle(s) :**

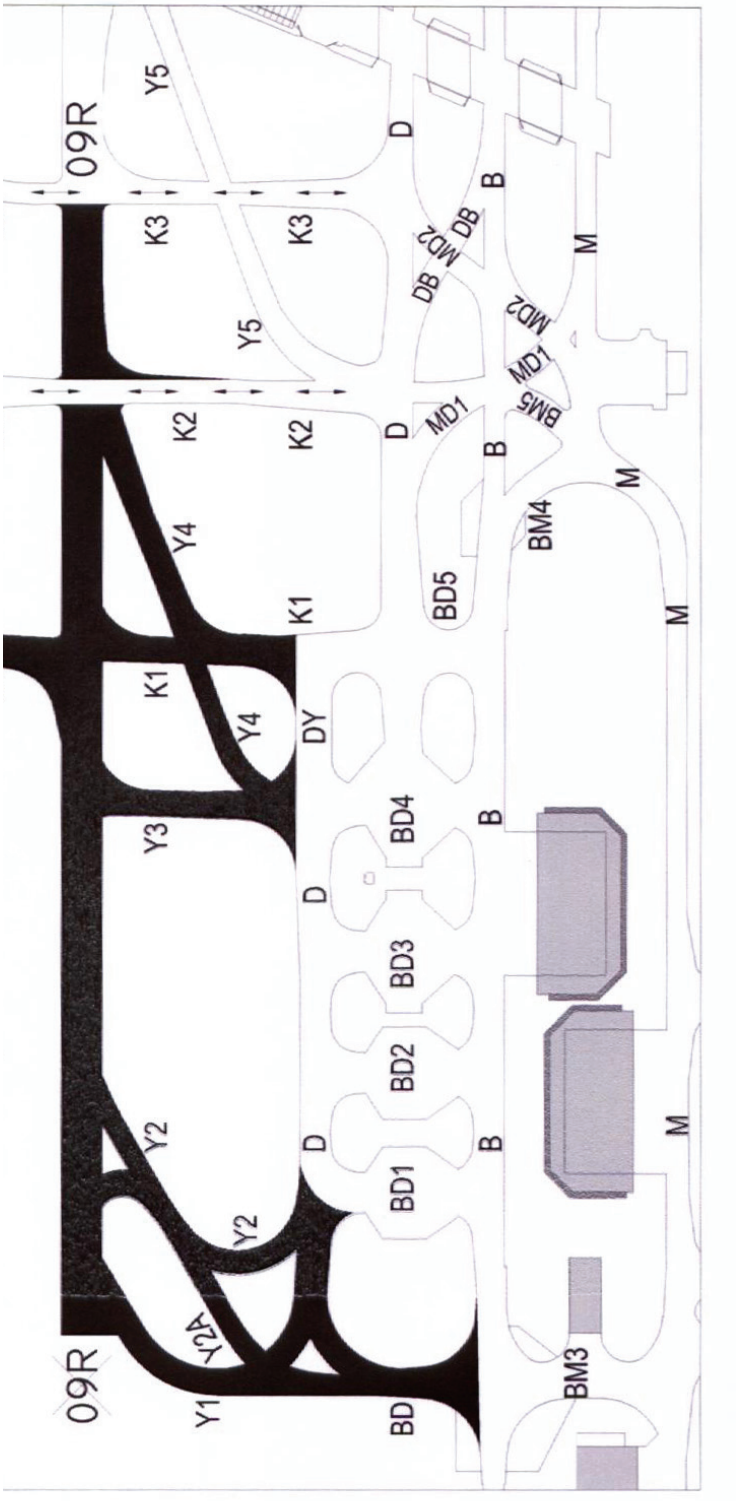
Obstacle (véhicules et engins de travaux publics) grevant la trouée de décollage à 1.2%.
Obstacle : Engins de travaux publics
Position : N 49°01'16.65" – E 002°31'32.89"
Située à 315 m de la DER 27L, RDL 266°
Altitude : 411 ft
Hauteur : 11 m AGL
Balisage : Gyrophare

Annexe 1



ANNEXE 2




09R
Y5
K3
K3
Y5
K2
K2
Y4
K1
K1
Y4
DY
Y3
Y2
Y2
Y2A
Y1
09R
BD
BD1
BD2
BD3
BD4
BD5
D
B
M
MD2
DB
MD1
BM5
BM4
BM3

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