Runway Overrun During Landing On Taipei Sungshan Airport, Transasia Airways Flight 536, A320-232, B-22310, October 18, 2004

Micro-summary: **A320 overruns end of runway.**

Event Date: **2004-10-18 at 1959 Taipei local time**

Investigative Body: **Aviation Safety Council (ASC), Taiwan**

Investigative Body's Web Site: **http://www.asc.gov.tw/**

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Aviation Safety Council

Taipei, Taiwan

GE 536 Occurrence Investigation Report

Runway Overrun During Landing On Taipei Sungshan Airport

TRANSASIA AIRWAYS FLIGHT 536

A320-232, B-22310

October 18, 2004

ASC-AOR-06-03-002

Content[1]

[1] Note-If there are differences in interpretation the Chinese text prevails.

Tables

Figures

1. Factual Information

1.1 History of Flight

On October 18, 2004, at 1959[2] Taipei local time, TransAsia Airways (TNA) flight GE 536, an A320-232 aircraft, registration No.B-22310, departed from Tainan Airport (RCNN), rolling off from the stopway in the end of Runway 10, stopped with its nose gear trapped in a ditch during landing roll on Taipei Sungshan Airport (RCSS). The sliding tube of nose landing gear was broken, number two engine contacted with ground and damaged, none of the 2 pilots (CM-1 and CM-2), 4 cabin crewmembers, and100 passengers aboard were injured.

The flight departed from RCNN at 1924. The pilot-in-commend (CM-1) was on the left seat as the pilot monitor (PM), the first officer (CM-2) was on the right seat as the pilot flying (PF). The aircraft employed RCSS Instrument Landing System (ILS) approach Runway 10. At 1958:12, the flight received landing clearance. At 1928, the Automatic Terminal Information service, (ATIS) broadcast for RCSS were "…expect ILS Approach. Runway one zero in use; wind variable at three; visibility four thousand five hundred meters; light rain; cloud scattered eight hundred feet, broken one thousand eight hundred feet, overcast three thousand five hundred feet; temperature two three; dew point two two; QNH one zero zero eight hactopascals; wind shear on runway one zero; Low Level Wind Shear Advisory in effect, moderate to severe…".

According to the Flight Data Recorder (FDR) and Cockpit Voice Recorder (CVR) data:

Total landing weight were 55,140 kilogram, flaps selected "3", approach speed selected "137 knots", ground spoilers "ARMED", autobrake selected "MEDIUM", antiskid selected "ON" at final approach.

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[2] All of the times herein are in Taipei local time on the 24-hour clock.

At 1959:04, radio altitude 282 feet, auto-pilot disengaged, autothrottle activated. The CVR recorded “RETARD” sound four times between radio altitude 20 feet and the main landing gear touched ground.

At 1959:27, the main landing gear touched ground, air speed 138 knots, ground speed 146 knots, heading 093 degrees, wind direction 297 degrees, wind speed 11 knots, the number 1/2 throttle level angle positioned at 19.7/22.5 degrees. Three seconds later, nose gear touched ground, the number 1/2 throttle level angle positioned at -22.5/22.5 degrees.

At 1959:32, the autothrottle disconnected, number one thrust reverser deployed, number two thrust reverser not deployed.

At 1959:37 CM-1 called out “no brake”, until 1959:50, CM-1 called “no brake” five times. In the meantime, air speed 112 knots, ground speed 109 knots.

At 1959:42, the left/right brake pedal angle positioned at 28/46 degrees. After eight seconds until its full stop, all of the brake pedals angle were positioning between 62 degrees to 80 degrees.

The ground spoilers did not extend.

The aircraft touch down at 1,750 feet on Runway 10, and rolling off 321 feet from the end of Runway 10. The aircraft stopped in the northern side of the stopway with heading 002 degrees, the distance from stopway to the main landing gear was 72 feet.

According to the records in the Technical Log Book of the aircraft: The number 2 engine thrust reverser system was malfunctioned and was transferred to deferred defect (DD) item and the thrust reverser was deactivated in accordance with the procedures in the Minimum Equipment List.

1.2 Injury to Persons

There were two pilots, four cabin crews and one hundred passengers aboard. No one sustained injury.

The injury distribution is summarized in Table 1.2-1.

Table 1.2-1 Injury table

Injuries	Crew	Passengers	Others	Total
Fatal	0	0	0	0
Serious	0	0	0	0
Minor/None	6	100	0	106
Total	6	100	0	106

1.3 Damage to Aircraft

The aircraft rolled off Runway 10 and came to rest in a muddy area. Aircraft longitude axis 90 degrees to the runway heading（Figure 1.3-1）. The NLG entered a drainage ditch （approx 1m deep）（Figure 1.3-2） and sliding tube of the nose gear was broken(Figure 1.3-3), number two engine nacelle bottom came in contact with the ground(Figure 1.3-4), damage the RH pylon structure and some engine fan blades were evident.

Figure 1.3-1 The aircraft rolled off runway and came to rest in a muddy area 90 degrees to the runway heading

Figure 1.3-2 The NLG entered a drainage ditch (approx 1m deep)

Figure 1.3-3 Sliding tube of the nose gear was broken

Figure 1.3-4 Both engine nacelles came in contact with the ground

1.4 Other Damage

From the observation of the tire marks, the nose gear passed through two runway threshold lights （Figure 1.4-1）. The right main landing gear passed through two electrical handholds. Wreckages of the damaged electrical handholds were shown in Figure 1.4-2.

Figure 1.4-1 Damaged runway threshold lights

Figure 1.4-2 Damaged electrical handholds

1.5 Personnel Information

1.5.1 Backgrounds and Experiences of Pilots

1.5.1.1 CM-1

CM-1 is a national of Republic of China who had served in military as a pilot and his total flight time was 2,686:20 during his military service. He joined TNA in September 1990 as a first officer of ATR42/72, was promoted to captain of ATR42/72 in January 1992, the flight time on ATR42/72 was 1,502:54. CM1 completed transition training of A320 captain at Aeroformation Airbus Training Organization, France in August 1993, and became instructor pilot of A320/A321 in April 1997, and check pilot in April 1998. His total flight time was 12,918:17 which included 8,729:17 on A320/A321.

1.5.1.2 CM-2

CM-2 is a national of Republic of China who had served in military as a pilot and his total flight time was 2,163:30 during his military service. He joined TNA in May 1994 as a first officer of ATR42/72, the flight time on ATR42/72 was 1,219:51. CM2 completed transition training of A320 first officer at Aeroformation Airbus Training Organization, France in April 1996. His total flight time was 10,431:56 which included 7,048:35 on A320/A321.

Table 1.5-1 Basic Information of Pilots

Item	CM-1	CM-2
Gender	Male	Male
Age as of accident	51	45
Date of joining in TNA	SEP 11, 1990	MAY 24, 1994
License type	Airline Transport Pilot No.101016	Airline Transport Pilot No. 101475
Type rating Expire date	A320/A321 JUL 18, 2005	A320/A321 F/O APR 16, 2005
Medical class Expire date	1st class airman MAR 31, 2005	1st class airman DEC 31, 2004
Latest flight check	OCT 16, 2004	MAY 10, 2004
Total flight time	12,918 hrs 17min.	10,431 hrs 56 min.
Flight time in last 12 months	793 hrs 38 min.	777 hrs 50 min.
Flight time in last 90 days	152 hrs 40 min.	141hrs 44 min.
Flight time in last 30 days	59 hrs 57 min.	61 hrs 53 min.

Flight time in last 7 days	28 hrs 30 min.	24 hrs 48 min.
A320/A321 flight time	8,729 hrs 03 min.	7,048 hrs 35 min.
Flight time on the day of accident	3 hrs 11 min.	3 hrs 11 min.
Rest time period before accident	Over 24 hrs	Over 24 hrs

1.5.2 Training and Rating Records of Pilots

1.5.2.1 CM-1

Transition training

CM1 completed ground academic courses training and simulator training of A320 captain at Aeroformation Airbus Training Organization, France from May 19 to June 30, 1993 and passed the type rating. He completed the training and passed the rating of the performance and flight route between July 12 to August 6 of the same year, passed the deferential training of A320/A321 in July 1995.

Qualifications training

Completed instructor pilot qualifications training and simulator training of A320/A321 at Hyderabad Training Center, India from February 24 to March 1, 1997 and passed the rating of the performance and takeoff/landing skills on March 5.

Completed A320/A321's check pilot qualifications training from April 7 to April 8, and passed the check pilot flight route check on April 21.

Recurrent training

The simulator recurrent training of TNA pilots had been conducted either at the Airbus Training Center, Toulouse, France, or at Airbus Training Center, Miami, U.S.A., between 1994 and 1996. From 1997, it changed to the Hyderabad Training Center, India; at Asia Pacific Training & Simulator PTE Ltd., Singapore, between 1998 to 2000; and has changed to at GE Capital Aviation Training (GECAT) or at Dragonair Training Center, Hong Kong, since 2001. The pilots are trained by TNA instructor pilots and examined by TNA designated examiners designated by CAA.

CM-1 passed all of the recurrent training and rating, and no abnormal records since he completed the transition training of A320/A321.

1.5.2.2 CM-2

Transition training

The ground academic courses training of A320/A321 of the first officer was

conducted by TNA instructor pilots at TNA classroom from December 1995 to January 31 1996. He completed the simulator training and differential training of A320/A321 on November 27 at Airbus Training Center, and passed the rating of first officer on performance and flight route in April of the same year.

Recurrent training

CM-2 passed all of the recurrent training and rating, and there were no abnormal records since he completed the transition training of A320/A321.

1.5.3 Pilots' Ground School Recurrent Training

A one day ground school of recurrent training for TNA flight crew is conducted prior to the twice-per-year's recurrent trainings. The curriculum of the ground school training program includes:

Civil aviation regulations, one hour;

Crew resources management (CRM), one hour;

Standard operation procedures (SOP), two hours

Controlled flight into terrain/approach and landing accident reduction/ground proximity warning system/traffic alert and collision avoidance system (CIFT/ALAR/GPWS), one hour;

Abnormal operations of aircraft systems (including emergency procedures, abnormal attitude recovery, low level windshear warning system and avoidance), two hours;

Special flight operations, three hours;

Adverse weather, one hour;

Check pilot's briefing, one hour;

Other curricula that need to be replenished or reinforced; and

Tests; one hour.

1.5.3.1 CM-1

CM-1's ground academic courses training records in recent two years TNA showed the dates and tests scores as follows: 95 points on October 7, 2004; 100 points on February 17, 2004; 95 points on June27, 2003; and 100 points on January 19, 2003.

1.5.3.2 CM-2

CM-2's ground academic courses training records in recent two years showed the dates and tests scores as follows: 100 points on October 7, 2004; 100 points on April 20, 2004; 100 points on November 5, 2003; and 100 points on April 7, 2003.

1.5.4 Pilots' Physical Conditions

1.5.4.1 CM-1

The item of limitations on the Airman Medical Certificate issued by CAA to CM-1 noted: "Holder shall wear correcting glasses"

1.5.4.2 CM-2

The item of limitations on the Airman Medical Certificate issued by CAA to CM-2 noted: "none".

1.5.5 Pilots' Activities in 72 hours prior to the Accident

1.5.5.1 CM-1

October 15: Conducted training and check on simulator in Hong Kong from1430 to 2000, departed from Hong Kong at 2145 and backed to home in Taipei at around 0100 (midnight).

October 16: Stayed at home resting.

October 17: Picked up his family from CKS Airport at 1300 and back to home.

October 18: Went swimming after got up, finished lunch, and reported to Sungshan Airport for duty at 1300.

1.5.5.2 CM-2

October 15: Stayed at home resting.

October 16: Stayed at home resting.

October 17: Stayed at home in the daytime, attended a dinner party at 1800 and back to home around 2000.

October 18: Stayed at home resting in the morning. After finished lunch, reported to Sungshan Airport for duty at 1300.

1.6 Aircraft Information

The aircraft basic information is shown in Table 1.6-1.

Table 1.6-1 Aircraft basic information

No	Title	Description
1	Type of Aircraft	A320-232
2	Registration Mark	B-22310
3	Manufacturer	Airbus Industries
4	Manufacturer's Serial Number	0791
5	Date Manufactured	February 1998
6	Delivery Date	June 24, 1998
7	Operator	TransAsia Airways
8	Owner	Winner Leasing Company Ltd.
9	Certificate of Airworthiness Number (Validity Date)	93-04-041 (March 31,2005)
10	Total Flight Hours	12,124：31 Hours
11	Total Cycles	16,248
12	Date of Last "A" Check	August 13, 2004
13	Flight Hours/Cycles Elapsed Since Last ''A'' Check	331：56 Hours/ 395 Cycles

Basic information of the two IAE (International Aero Engines) V2527-A5 engines is shown in Table 1.6-2.

Table 1.6-2 Basic information of the engines

Position	Serial Number	Date Installed	Total Hours	Time Since Overhaul	Total Cycles
1	V10174	September.8, 2003	12,879:53	2,039:24	17,827
2	V10578	November 6, 2001	9,116:27	5,384:33	12,598

1.6.1 Maintenance Records

The relevant maintenance records to the brakes、engine thrust reversers and spoilers in the Technical Log Book are stated below:

1.6.1.1 Brakes

In 30 days prior to the occurrence, there was no record of brakes replacement.

On October 6, 2004, there was a defect report regarding the failure of the Channel 1 of Brake/ Steering Control Unit （BSCU）. This defect was closed after the BSCU connector was cleaned and passed the self-test in accordance with AMM[3] 32-46-00.

1.6.1.2 Engine Thrust Reverser

The defect report in 90 days prior to the occurrence for both engine thrust reverses are shown in Table 1.6-3 and 1.6-4:

Table 1.6-3 1 Engine 1 thrust reverser defect report

Item No	Defect Reports	Date （Flight ）	DD[4] item Number	Maintenance Actions
1	Eng No.1 reverse fault light on	Sept.27 （GE355）	No	IAW[5] AMM 78-31-00 Perform eng FADEC[6] 1 electrical check. All check normal.
2	Engine 1 reverse after landing amber. Check N2 no work.	Oct. 9 （GE538）	No	Cleaned No.1 engine HCU[7] then IAW AMM 78-31-00 Operating the system through 10 times and all function normal.

Table 1.6-4 Engine 2 thrust reverser defects report

Item	Defect Reports	Date (Flight)	Deferred Number	Maintenance Actions
1	#2 Reverse Fault	Oct. 10 (GE529)	Nil	IAW AMM 78-31-00 Ground tested. Check normal
2	Engine #2 Reverse Amber	Oct.10 (GE532)	Transferred to DD #27588	IAW A320 MEL[8]78-30-01 A/C dispatch.No.2 eng thrust reverser deactivated and transferred to DD.

[3] AMM: Aircraft Maintenance Manual

[4] DD: Deferred Defect

[5] IAW: In Accordance With

[6] FADEC: Full Authority Digital Engine Control

[7] HCU: Hydraulic Control Unit

[8] MEL-Minimum Equipment List 78-30-01 states the category C should be completed in 10 days..

3	DD#27588 Transfer No.2 engine reverse amber	Oct.12 (GE572)	DD#27588 Closed	IAW AMM 78-31-00 1.Recheck locking actuator connector loose & some oil 2.Clean up & operation several times ok
4	#2 Reverse fault	Oct.13 (GE532)	Nil	IAW AMM 78-31-00,No.2 engine reverse operation test normal
5	#2 Engine reverse fault	Oct.13 (GE571)	Transferred to DD#27589	Per MEL 78-30-0 #2 T/R deactivated
6	Transfer from DD#27589	Oct.13 (GE538)	DD#27589 Closed	IAW AMM 78-32-48 & 78-31-00 replaced # 2 R/H side non-locking actuator & check normal. Operation of No.2 thrust reverse system normal & no hydraulic leak found
7	#2 Engine reverse fault	Oct.15 (GE563)	Transferred to DD#27590	IAW MEL78-30-01 #2 T/R deactivated
8	DD#27590,NO.2 engine reverse deactivated	Oct .16 (GE532)	DD#27590	IAW AMM 78-30-00 deactivation No.2 eng rev t/r & function check ok pleases keep observe further
9	Info NO.2 T/R works normal	Oct .16 (GE570)	DD#27590	Noted and thanks
10	#2 Engine reverse fault after operated	Oct16 (GE538)	DD#27590	IAW AMM 78-32-48 L/H No.2 non-locking actuator was replaced. Inspect reverser IAW AMM 78-31-00.keep observes.

1.6.1.3 Spoilers

In 30 days prior to the occurrence, there was no malfunction report regarding the spoiler system.

1.6.1.4 Repeat Item and Its Handling Procedures

In accordance with the contents of the Aircraft Maintenance Control Manual （June 30,2003） the definition and handling procedures of the repeat item are listed as below:

Repeat item: The same defect that occurred again after the last maintenance action was fixed in three days would be considered as a repeat item.

Handling procedures:

5.1 Maintenance and Control Center

5.1.1 Monitor and record all the maintenance actions of the aircraft. If there is a repeat item occurred, record in the daily review record and will discuss it on the next day morning briefing.

5.1.2 Follow up the last maintenance action of the repeat item and discuss the cause of the defect and the effective corrective action with the maintenance crew to avoid the defect repeated.

5.1.3 Collect all the repeat item records in each month and list them in tables to Quality Control Center for the review of Reliability Control Board Meeting.

5.2 Reliability Control Board Meeting

5.2.1 Review the cause and corrective actions and preventions of the repeat items and monitor the result of the actions.

5.2.2 Share the information to the working unit to be the reference of the future maintenance actions and recurrent training materials.

5.3 The Engineering Section and the aircraft manufacturer will provide technical assistance whenever is needed.

5.4 The maintenance unit that found the defects came from the misconduct or human error during the maintenance actions should inform the person who conducted the corrective actions and list the facts on the training materials to avoid that kind of misconduct happening again.

5.5 The item on the deferred defects log would not be considered as repeat item when the defect was occurred again.

1.6.2 Aircraft Systems related to Deceleration

In this section, the systems related to deceleration are introduced, these systems are spoilers, braking, and thrust control systems.

1.6.2.1 Spoilers

A320 has five spoilers numbered 1 thru 5 inboard to outboard （Refer to Figure 1.6-1）. Five spoiler surfaces are provided on each wing to achieve the functions below:

- Roll spoiler（surfaces 2 to 5）;
- Speedbrake（surfaces 2 to 4）;
- Ground spoilers（all surfaces）。

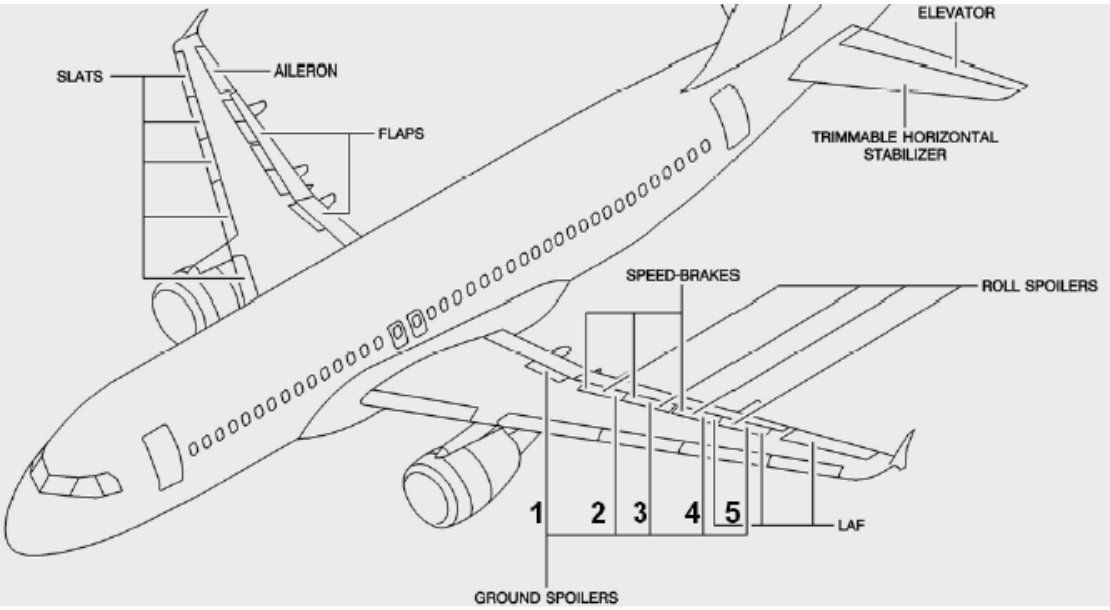

Figure 1.6-1 Spoilers

These surfaces are manually controlled from the side stick controllers （roll spoilers）, speedbrake control lever （speedbrake）or automatically in autopilot and ground spoiler function.

Each surface is controlled by one servocontrol supplied from the Green, Yellow or Blue system and signaled from the SEC 1（Spoiler and Elevator Computer #1）, SEC 2 or SEC 3.

Mechanism to activate ground spoilers functions

The purpose of ground spoilers is to increase the effect of deceleration when aircraft on the ground. The activation logic of this function is shown in Figure 1.6-2. Depend on flight phase, ground spoilers activate at two circumstances.

Case 1: Landing phase and meet the following conditions:

1. Speedbrake lever pre-selected at “ARM” position or at least one thrust reverser operated;
2. Both engine at idle position（Throttle Lever Angle, TLA <20 degrees）;

3. Both main landing gear[9] from “not pressed” to “pressed” and RA < 6 feet.

Case 2: When aircraft rejects takeoff and meet the following conditions:

1. Speedbrake lever pre-selected at “ARM” position or at least one thrust reverser operated;

2. Both engine at idle position（Throttle Lever Angle, TLA <20 degrees）;

3. Wheel speed higher than 72 knots.

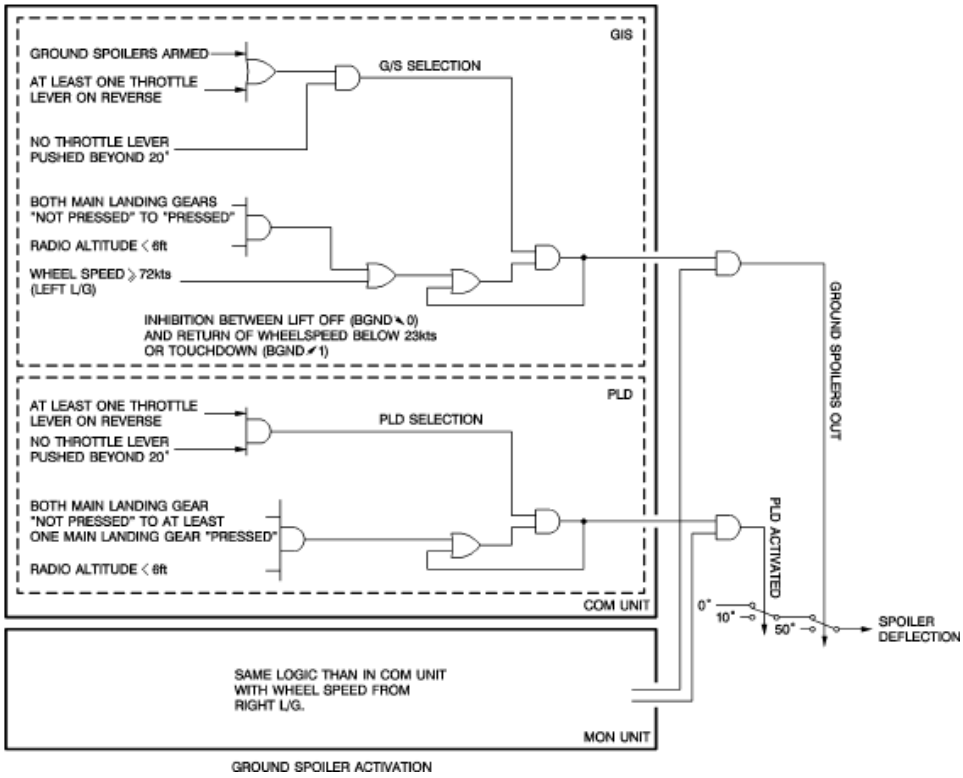

Figure 1.6-2 Ground spoiler activation logic diagram

1.6.2.2 Braking System

In auto brake mode, the selection of AUTO/BRK P/BSW（LO, MED or MAX）sets a program to give a set deceleration rate. The BSCU automatically starts the program when the aircraft configuration is correct and then controls the pressure sent to the brakes. In manual brake the movement of the brake pedals operates the brake-pedal transmitter unit. The transmitter unit sends a signal to the BSCU, which in turn sends the required input signal to the

[9] If only single main landing gear from “not pressed” to “pressed”, ground spoilers extend 10 degrees. If both main landing gears from “not pressed” to “pressed”, ground spoilers extend 50 degrees.

servo-valves. The servo-valves let a pressure, in proportion to the pedal travel go to the brakes. The BSCU also controls the anti-skid system; brake release orders generated from BSCU are sent to the servo-valves in the event of any wheel speed does not consist of aircraft ground speed.

Braking Modes

During landing and taxi rolls, three braking modes available depend on hydraulic system used and the position of the A/SKID & N/W STRG switch and PARK BRK control switch.

1. Normal Barking

- Supply of green hydraulic high pressure is normal;
- A/SKID & N/W STRG switch is in the “ON” position;
- PARK BRK control switch is in the “OFF” position.

Normal Braking is activated either by the movement of pedal or the activation of auto braking system. Brake pressure is regulated by normal servo-valves.

2. Alternate Braking with Anti Skid

The alternate braking with anti-skid associates the Yellow high-pressure hydraulics regulated by the anti-skid system. It is activated in case of green hydraulic system malfunction. The braking modes are shown on the upper ECAM（Electronic Centralized Aircraft Monitor） DU（Display Unit）. The alternate braking command is applied by pedals only and the pressure is supplied by an auxiliary low-pressure hydraulic-system. The pressure supplied to brakes is shown on a brake Yellow-pressure triple-indicator which was installed on the center instrument panel.

3. Alternate Braking without Anti Skid

The Alternate braking without anti skid differs from the above modes in that the anti skid regulation is no longer available, It could be:

- Disconnected electrically（A/SKID & N/W STRG switch in the OFF position or power supply failure）;
- Disconnected hydraulically if only the brake Yellow-pressure accumulator supplies the brakes（the A/SKID & N/W STRG switch can be in any position）.

The Yellow system interconnects the power accumulator. A fully charged accumulator can provide hydraulic pressure at minimum seven applications of fully braking.

Auto Brake

The system decreases the number of flight crew actions if an acceleration-stop （MAX mode）occurs when takeoff, or keeps the

deceleration to a pre-set limit（LOW or MED）when landing. The Auto Brake control panel is shown as Figure 1.6-3.

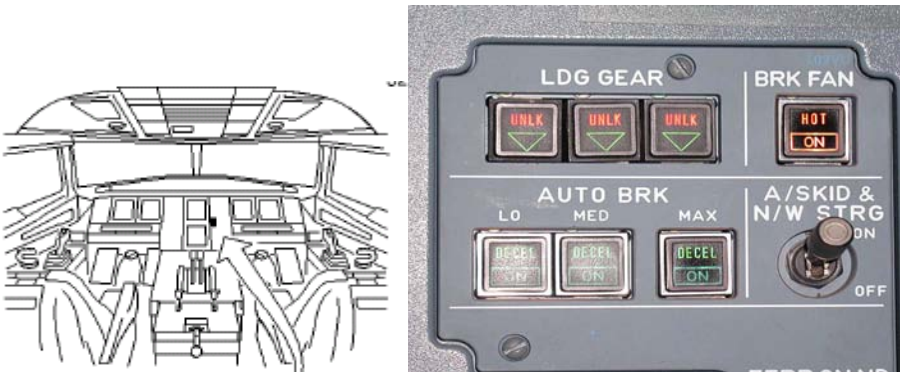

Figure 1.6-3　Auto Brake control panel

The flight crew pushes the LO, MED or MAX[10] pushbutton switch to arm the system. The ON legend on the lower half of the pushbutton switch comes on if the Normal braking is operational. In the automatic mode the selection of an AUTO/BRK P/BSW （LO, MED or MAX）sets a program to give a set deceleration rate. The BSCU automatically starts the program and then controls the pressure sent to the brakes. The ground spoiler extension command starts the braking action. The Green DECEL legend on the upper half of the pushbutton switch comes on while decelerating rate reaches 80% of programmed.

The auto brake system is disengaged and disarmed at the following conditions:

- If ground spoiler return to stow, or;
- If crew apply sufficient pressure to the pedals with the aircraft on the ground（takeover through brake pedals）.

The failure of the auto brake is shown on the upper ECAM DU before and after the selection.

1.6.2.3　Thrust control and Throttle lever position

The throttle control lever moves over a range of 65 degrees from -20 degrees to 45 degrees（TLA）. It includes 3 stops and 3 detents, -20 degrees（MAX REVERSE stop）, -6 degrees（REVERSE IDLE detent）, 0 degree（IDLE stop which could be overridden when using thrust reverser）, 25 degrees（MAX CLIMB）, 35 degrees（MAX CONTINUOUS /FLEX TAKEOFF detent）, and 45 degrees（MAX TAKEOFF stop）, as indicated in Figure1.6-4. When both throttle control levers are between IDLE to MAX CONTINUOUS（0 degrees to

[10]Three default decelerating rates as: 2m/s^2（LOW）. 3m/s^2（MED）and 0.27 g（MAX）.

35 degrees TLA）the autothrust function can be activated if engaged. This range corresponds to the selection of MAX CLIMB or MAX CONTINUOUS thrust limit mode, except the FLEX TAKE OFF mode. If the autothrust is engaged and active, the engines are controlled by the Autothrust system. If the autothrust is not engaged, the engine is manually controlled by the throttle control lever, as shown in Figure 1.6-5. In automatic landing, the Flight Warning Computer, FWC, auto call out delivers a “RETARD” message at 10 feet RA. The pilot then moves the throttle control levers to the IDLE position to take manual control of the thrust for landing. With the A/THR engaged but not in the automatic landing conditions, the “RETARD” warning message will be delivered at 20 feet RA.

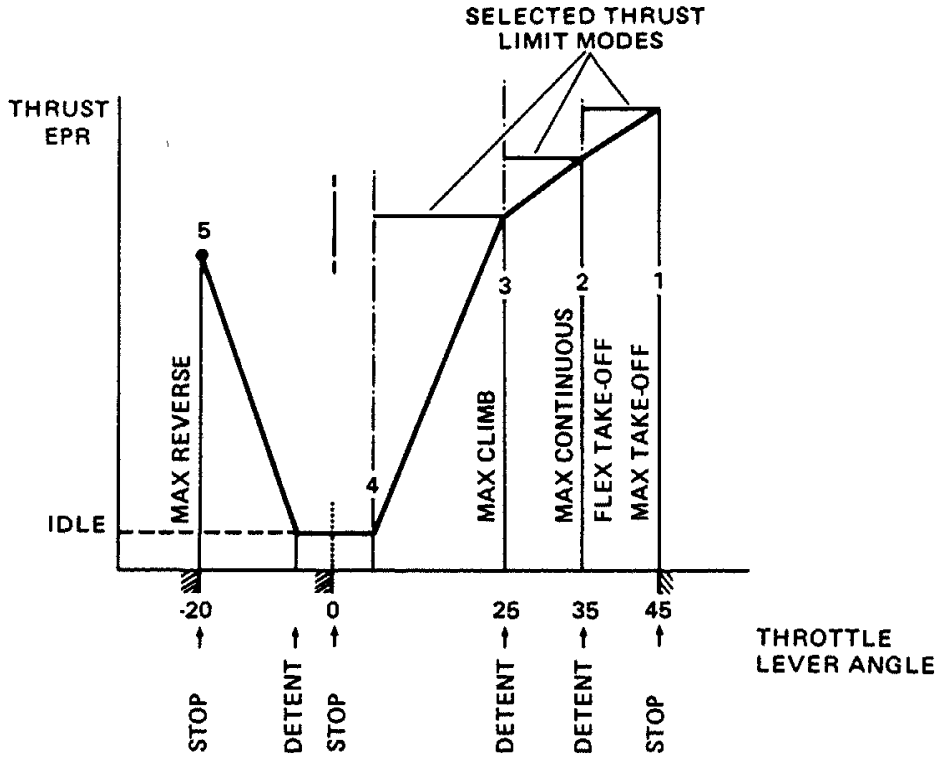

Figure 1.6-4 Thrust control lever angle and associated function

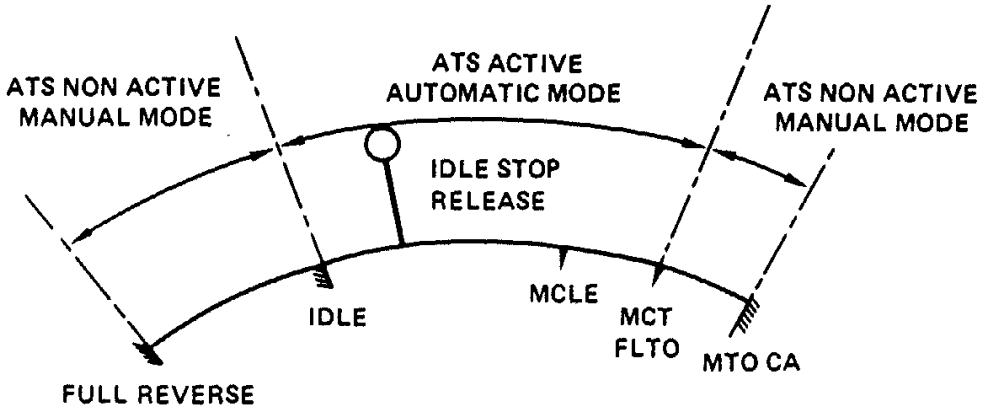

Figure 1.6-5 Throttle control lever vs. manual/autothrust active area

1.6.3 Weight and Balance

The maximum takeoff weight of this aircraft was162,038 pounds, the maximum landing weight was142,196 pounds, the maximum zero fuel weight was 134,480 pounds. The center gravity of takeoff and landing were in limit. See Table 1.6-5 for weight and balance data.

Table 1.6-5 GE536 Weight and Balance Data

Zero Fuel Weight	112,707 lb
Takeoff Fuel	12,400 lb
Takeoff Weight	125,050 lb
Center Gravity of Takeoff	25.6% M.A.C.
Takeoff Trim	0.6
Consumed Fuel in Flight	3,596 lb
Landing Weight	121,454 lb
Center Gravity of Landing	26.3% M.A.C.

1.7 Weather information

1.7.1 General information of the typhoon

Typhoon Tokage centered at 23.0N and 126.9E, about 586 kilometers east-southeast of Taipei/Sungshan Airport at 2000, October 18, moving north-northwestly at 15 km/hr and then north-northeastly at 20 km/hr. Maximum wind speed of the storm was 43 knots gusting 53 knots, radius of the storm (average wind speed at 15 meter/sec) was 200 km, and pressure of the storm center was 965 hPa. Figure 1.7-1 and 1.7-2 are Infrared satellite imagery at 2023 and surface analysis chart at 2000 respectively.

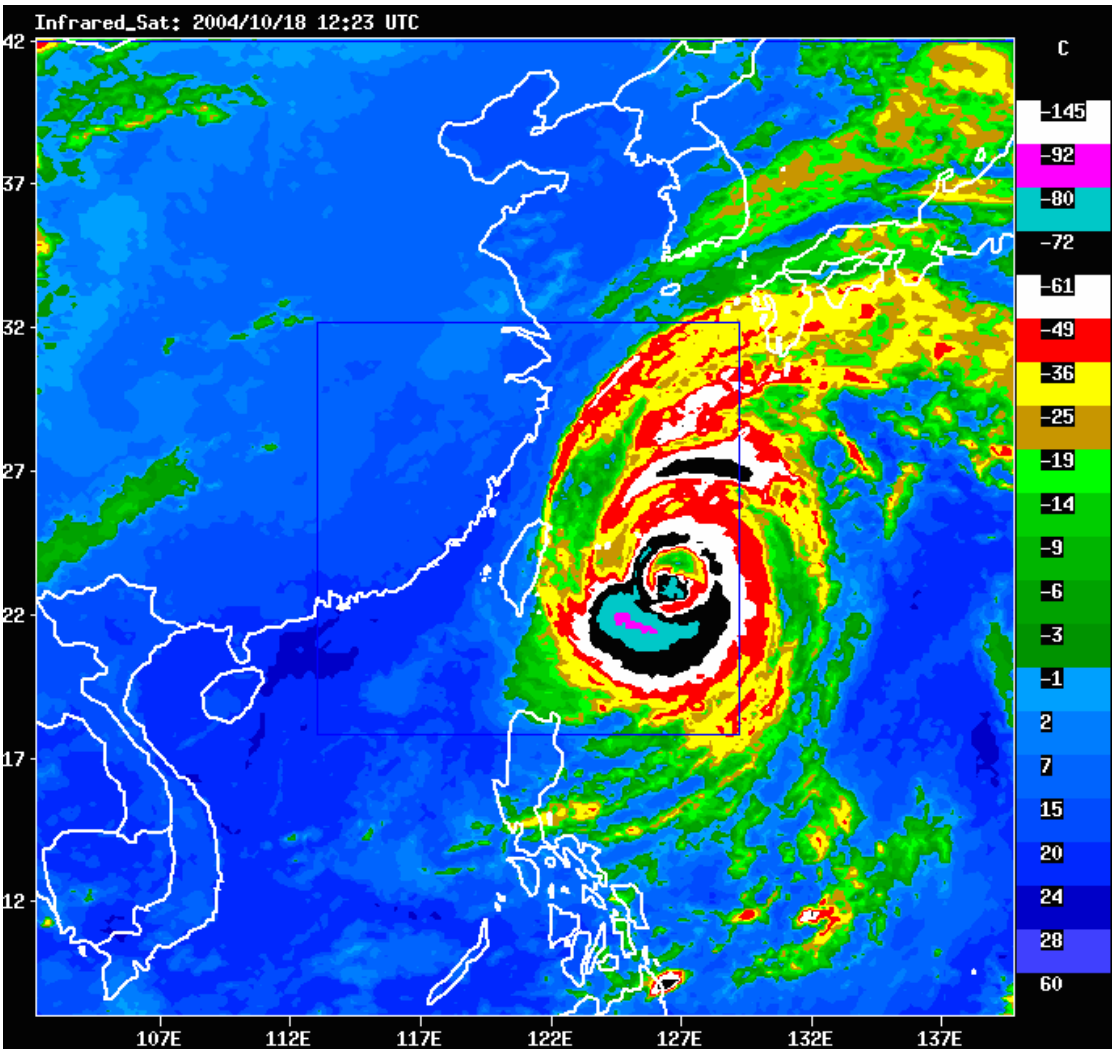

Figure 1.7-1 Infrared satellite imagery at 1223 UTC

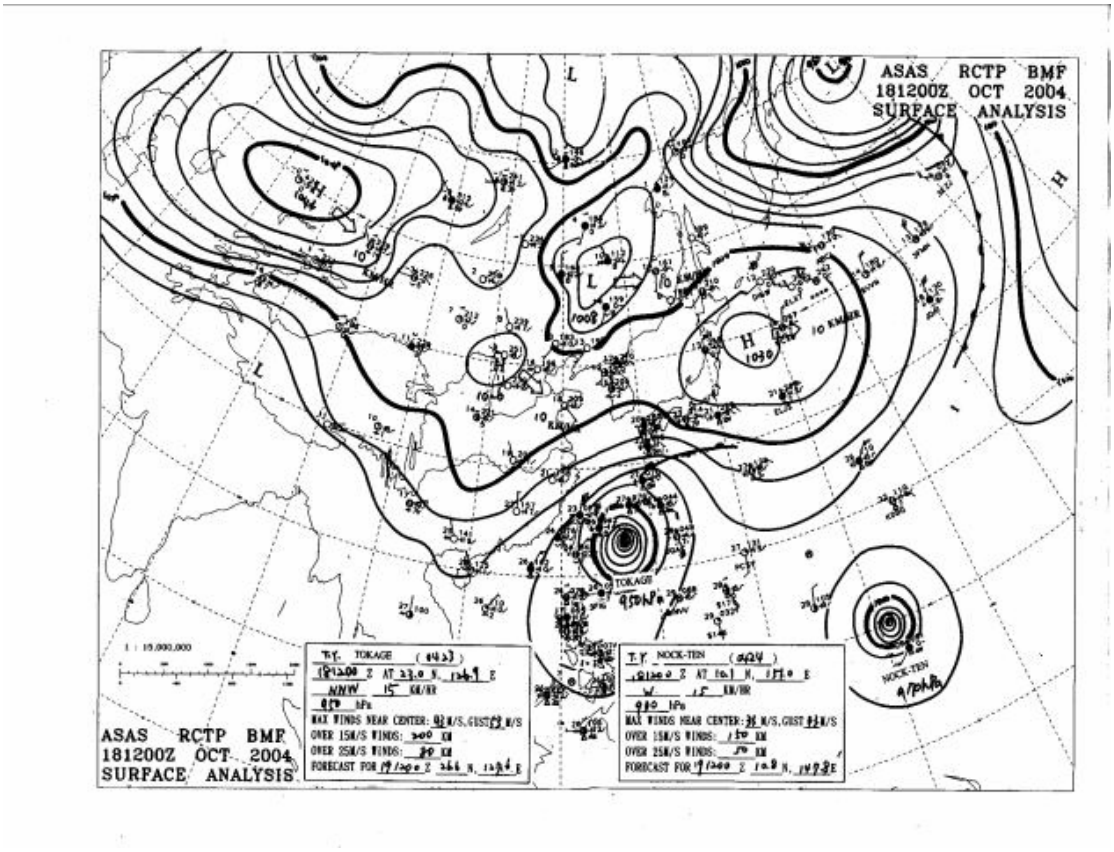

Figure 1.7-2 Surface analysis chart at 1200 UTC

1.7.2 Surface Weather Observations

The Taipei/Sungshan Weather Station surface weather records indicated the following:

1930: Wind variable at 3 knots; Visibility—4,500 meters; Present Weather—light rain; Clouds—scattered 800 feet, broken 1,800 feet, overcast 3,500 feet; Temperature—23 degrees Celsius; Dew Point—22 degrees Celsius; Altimeter Setting—1008 hPa; Supplementary information—RWY 10 windshear; Trend Forecast—no significant change.

2000: Wind variable at 2 knots; Visibility—4,500 meters; Present Weather—light rain; Clouds—few 800 feet, broken 1,800 feet, overcast 3,500 feet; Temperature—22 degrees Celsius; Dew Point—22 degrees Celsius; Altimeter Setting—1008 hPa; Supplementary information—RWY 10 windshear; Trend Forecast—no significant change; Remark—rain amount 0.75 millimeters.

There was no low level windshear detected by Low Level Windshear Alert System（LLWAS）of Taipei/Sungshan Airport from 1900 to 2005. The following is the recorded information of Taipei/Sungshan Airport Automated Weather Observing System（1 second average）:

Table 1.7-1 Recorded information of Taipei/Sungshan Airport Automated Weather Observing System

Time	RWY 10 Wind （degree/knot）	RWY 28 Wind （degree/knot）
1952	304/01	023/06
1953	315/03	338/03
1954	354/05	349/02
1955	034/05	034/06
1956	360/03	017/09
1957	068/01	321/00
1958	360/00	017/03
1959	248/00	354/04
2000	332/02	006/03
2001	073/04	349/04

1.7.3 Wind Shear Information of METAR/SPECI

1.7.3.1 Wind Shear information of METAR/SPECI of Sungshan Airport

The supplementary information of RWY 10 windshear was included in METAR/SPECI of Sungshan Airport from 1220 to 2030. The following is the windshear information of AIREP and LLWAS[11] from 1220 to 2030.

Table 1.7-2 Windshear information of AIREP and LLWAS from 1220 to 2030

Time	AIREP	LLWAS
1220	An MD82 encountered windshear at altitude of 1500-2000 feet, 5-6 nm from Sungshan Airport	
1251		Windshear alert-RWY 10 arrival
1252		Windshear alert-RWY 10 arrival and departure
1255		Microburst alert-RWY 10 arrival
1502-1503		Windshear alert-RWY 10 arrival
1516-1517		Windshear alert-RWY 10 arrival
1520	An MD90 made a go round by the influence of low level windshear	

[11]From the records of Sungshan Weather Station, the windshear information was obtained from Air Reports (AIREPs) received by Sungshan Tower or low level windshear / microburst alerts of LLWAS.

1539-1540		Windshear alert-RWY 10 arrival
1543-1544		Windshear alert-RWY 10 arrival and departure
1553-1554		Windshear alert-RWY 10 arrival and departure
1624		Windshear alert-RWY 10 arrival and departure
1637-1638		Windshear alert-RWY 10 arrival
1705		Windshear alert-RWY 10 arrival and departure
1710-1712		Microburst alert-RWY 10 arrival and departure
1713		Windshear alert-RWY 10 arrival and departure
1753-1755		Microburst alert-RWY 10 arrival and departure
1852-1853		Windshear alert-RWY 10 arrival

1.7.3.2 The associated regulations concerning windshear information of METAR/SPECI

Chapter 4. METEOROLOGICAL OBSERVATIONS AND REPORTS of ICAO ANNEX 3:

4.4 Coordination of requirements for observations and reports between the meteorological and ATS authorities

Recommendation. — An agreement between the meteorological authority and the appropriate ATS authority should be established to cover, amongst other things:

e) Meteorological information obtained from aircraft taking off or landing (for example, on wind shear)

4.12 Observing and reporting of supplementary information

4.12.1 Recommendation. — Observations made at aerodromes should include the available supplementary information concerning significant meteorological conditions, particularly those in the approach and climb-out areas, and specifically the location of cumulonimbus or thunderstorm, moderate or severe turbulence, wind shear, hail, severe squall line, moderate or severe icing, freezing precipitation, severe mountain waves, sandstorm, duststorm, blowing snow or funnel cloud (tornado or waterspout). Where practicable, the information should identify the vertical extent and direction and rate of movement of the phenomenon. As icing, turbulence and to a large extent, wind shear, for the time being cannot be satisfactorily observed from the ground, evidence of their existence should be derived from aircraft observations during the climb-out or approach

phases of flight to be made in accordance with Chapter 5, 5.5 and 5.6.

Chapter 5. AIRCRAFT OBSERVATIONS AND REPORTS of ICAO ANNEX 3:

5.6 Other non-routine aircraft observations

5.6.1 When other meteorological conditions not listed under 5.5, e.g. wind shear, are encountered and which, in the opinion of the pilot-in-command, may affect the safety or markedly affect the efficiency of other aircraft operations, the pilot-in-command shall advise the appropriate air traffic services unit as soon as practicable.

5.6.2 Recommendation. — When reporting aircraft observations of wind shear encountered during the climb-out and approach phases of flight, the aircraft type should be included.

5.6.3 Recommendation. — Where wind shear conditions in the climb-out or approach phases of flight were reported or forecast but not encountered, the pilot-in-command should advise the appropriate air traffic services unit as soon as practicable unless the pilot-in-command is aware that the appropriate air traffic services unit has already been so advised by a preceding aircraft.

Chapter 7. SIGMET AND AIRMET INFORMATION, AERODROME WARNINGS AND WIND SHEAR WARNINGS of ICAO ANNEX 3:

7.6 Wind shear warnings

7.6.1 Wind shear warnings shall give concise information of the observed or expected existence of wind shear which could adversely affect aircraft on the approach path or take-off path or during circling approach between runway level and 500 m (1 600 ft) above that level and aircraft on the runway during the landing roll or take-off run. The warnings shall be prepared and disseminated for aerodromes where wind shear is considered a factor in accordance with local arrangements with the appropriate ATS authority and operators concerned and by the meteorological office designated to provide service for the aerodrome or disseminated directly from automated ground-based wind shear remote-sensing or detection equipment referred to in 7.6.2 a) and b). Where local topography has been shown to produce significant wind shears at heights in excess of 500 m (1 600 ft) above runway level, then 500 m (1 600 ft) shall not be considered restrictive.

Note 3. — Information on wind shear is also to be included as supplementary information in local routine and special reports and routine and special reports in the METAR/SPECI code forms in accordance with 4.12.1, 4.12.4 and 4.12.5.

7.6.6 Recommendation. — Wind shear warnings for arriving aircraft and/or departing aircraft should be cancelled when aircraft reports indicate that wind shear no longer exists, or alternatively, after an agreed elapsed time. The criteria for the cancellation of a wind shear warning should be defined locally for each aerodrome, as agreed

between the meteorological authority, the appropriate ATS authority and the operators concerned.

Chapter 3. AIRPORT TRAFFIC CONTROL - TERMINAL of AIR TRAFFIC CONTROL PROCEDURE:

Section 1.GENERAL

3-1-8 LOW LEVEL WIND SHEAR ADVISORIES,

a. When low level wind shear is reported by pilots or detected by the Low Level Wind Shear Alert Systems (LLWAS) or Weather Systems Processor (WSP), controllers shall issue the alert to all arriving and departing aircraft until the alert is broadcast on the ATIS and pilots indicate they have received the appropriate ATIS code. A statement "LOW LEVEL WIND SHEAR ADVISORIES IN EFFECT" shall be included on the ATIS for 20 minutes following the last report or indication of wind shear.

1.8 Aids to Navigation

This accident was unrelated to aids to navigation.

1.9 Communications

This accident was unrelated to communications.

1.10 Airport Information

1.10.1 General

Sungshan Airport is sited on 2.6 nautical miles northeast of Taipei metropolis. The location of airport reference point is 25。04'10''N/121。33'06''E. The aerodrome reference code in this airport is 4D[12]。

According to Aeronautical Information Publication (AIP) -Taipei Flight Information Region（Version of RCCS 2-1, 18th March 2004）, a runway in Sungshan Airport is designated 10/28. Runway 10/28 is 60 meter wide, 2,605 meter long. Non-grooved asphalt concrete was overlayed on runway pavement. The airport elevation is 8ft. The stopway of Runway 10 is 60 meter wide and 160 meter long. And the stopway of Runway 28 is 60 meter wide and 60 meter long.

1.10.2 Runway Safety Area

According to AIP, the runway strip is 300 meter wide（990ft）and 2,765 meter long（9,072ft）. The nearest distance from north fence（9 ft height）to the centerline marking and its extension of Runway10 is 44.89 meter, as shown in Figure 1.10-1（RCSS AD 2-40, revised edition on 09/02/2004.）.

According to ASC's survey, the airport fence is composited of hollow bricks and reinforced concrete. It is located 15 meter to the north of Runway 28 threshold edgeline marking and irregular extension in parallel with runway. Its surface is coloured in alternatively red and white. The area from airport fence to 150 meter to the north of the runway centerline marking and its extension exists some houses constructed with steel and sheet metal, and junk yards some discarded vehicles and materials were stored. There is an uncovered ditch in parallel with runway. The ditch is located on 43 to 69 meter to the north of the centerline of Runway 10 stopway. It is about 1.4 to 2.5 meter wide and 1 to 1.5 meter depth.

There is no information regarding Runway End Safety Area in AIP.

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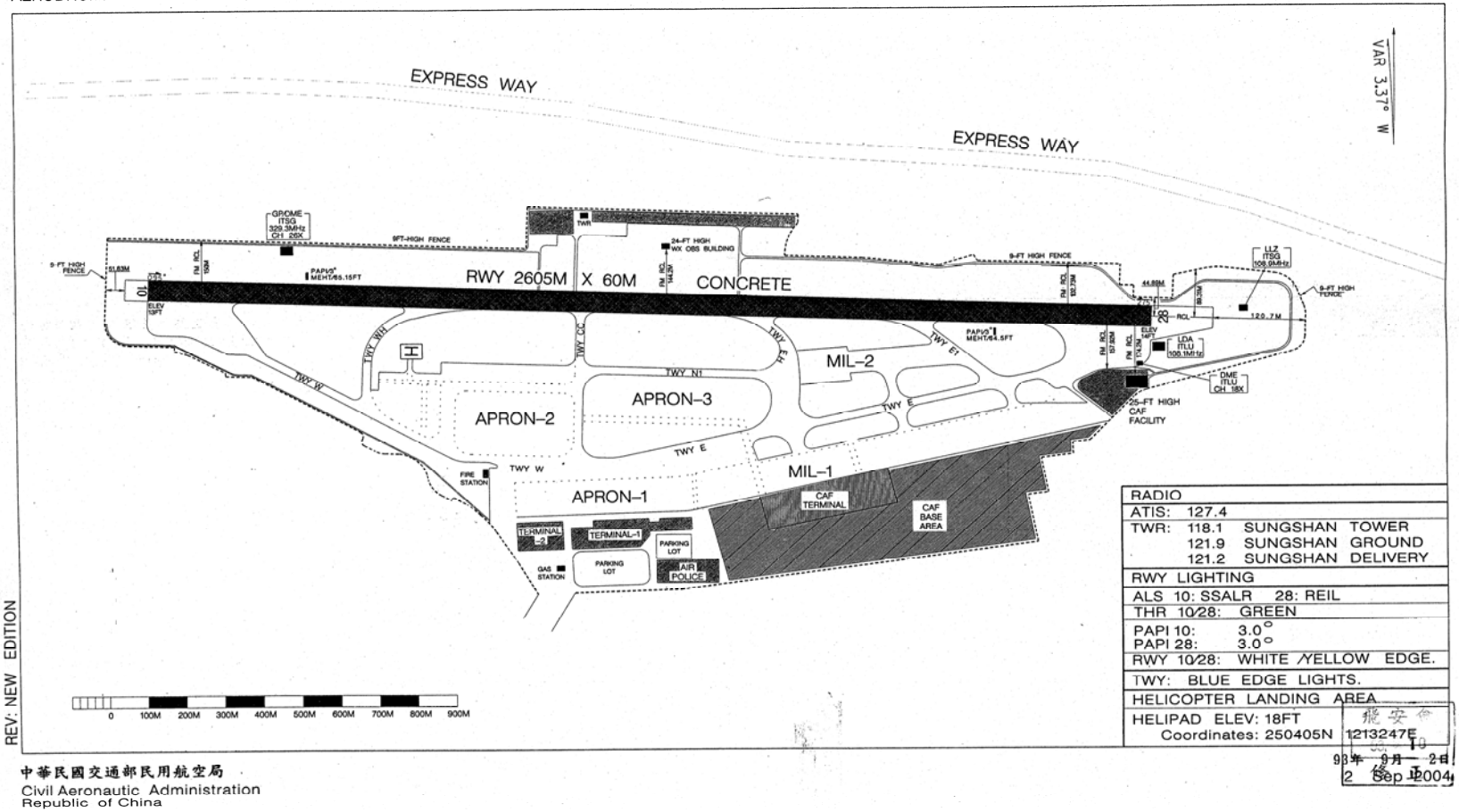
[12] 4(Aerodrome reference code number): The highest value of the aeroplane reference field length of the aeroplanes for which the runway is intended is 1800m and over； D(Aerodrome reference code letter)：The greatest wing span whichever gives the more demanding code letter of the aeroplanes for which the facility is intended is 36m up to but not including 52m, or the greatest outer main gear wheel span is 9m up to but not including 14m.

機場圖
AERODROME CHART

ELEV 18 FT
ARP: 250410N 1213306E

TAIPEI/SUNGSHAN AD



RADIO		
ATIS:	127.4	
TWR:	118.1	SUNGSHAN TOWER
	121.9	SUNGSHAN GROUND
	121.2	SUNGSHAN DELIVERY
RWY LIGHTING		
ALS 10: SSALR 28: REIL		
THR 10/28: GREEN		
PAPI 10: 3.0°		
PAPI 28: 3.0°		
RWY 10/28: WHITE /YELLOW EDGE.		
TWY: BLUE EDGE LIGHTS.		
HELICOPTER LANDING AREA		
HELIPAD ELEV: 18FT		
Coordinates: 250405N 1213247E		

REV: NEW EDITION

飛安會 93年 9月 2日 2 Sep 2004

中華民國交通部民用航空局
Civil Aeronautic Administration
Republic of China

Figure 1.10-1Layout of Sungshan Airport

1.10.3 Regulations Regarding Runway Safety Area

According to 「Civil Aerodrome Design and Operation Standard」（v1.1, July 2004）, paragraph 3.3.2：

"A strip shall extend before the threshold and beyond the end of the runway or stopway for a distance of at least：

- 60m where the code number is 2,3,4…."

Paragraph 3.3.3：

"A strip including a precision approach runway shall extend laterally to a distance of at least：

- 150 m where the code number is 3 or 4."

Paragraph 3.3.8：

"That portion of a strip of an instrument runway within a distance of at least：

- 75m where the code number is 3 or 4…

from the centre line of the runway and its extended centre line shall provide a graded area for aeroplanes which the runway extended to serve in the event of an aeroplane running off the runway.

Note. – Guidance on the grading of a great area of a strip including a precision approach runway where the code number 3 or 4 is given in Attachment A, section8. " (See Figure1.10-2)

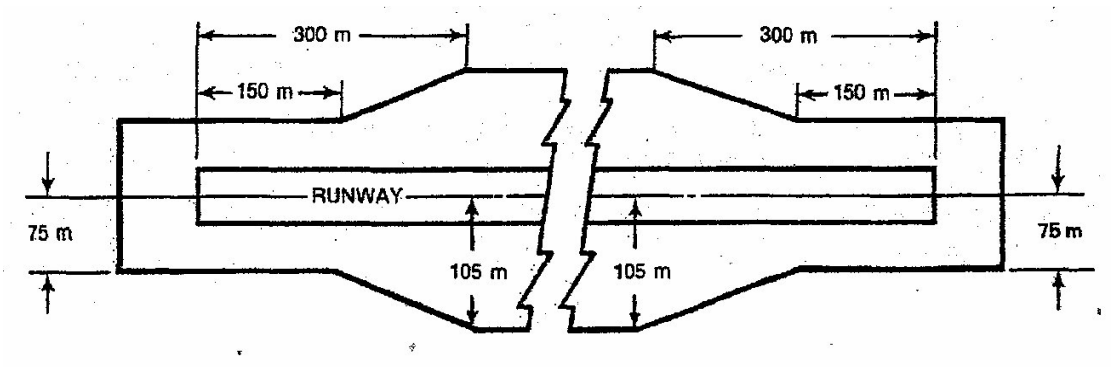


Figure 1.10-2Graded portion of a strip including a precision approach runway where the code number is 3 or 4

Paragraph 3.4.1：

“A runway end safety area shall be provided at each end of a runway strip where the code number is 3 or 4.”

Paragraph 3.4.2：

“A runway end safety area shall extend from the end of a runway strip to a distance of at least 90m.”

Paragraph 3.4.4：

“The width of a runway end safety area shall be at least twice that of the associated runway.”

Paragraph 3.4.7：

*“*A runway end safety area should provide a cleared and graded area for aeroplanes which the runway is intended to serve in the event of an aeroplane undershooting or overrunning the runway ”*

Paragraph 8.7.1：

“Unless its function requires it to be there for air navigation purpose, no equipment or installment shall be:

a) on a runway stripe, a runway end safety area, a taxiway strip or within the distances specified in Table 3-1, column 11, if it would endanger an aircraft; ”

Paragraph 8.7.2：

“Any equipment or installation required for air navigation purposes which must be located

b) on a runway end safety area, a taxiway strip or within the distances specified in Table 3-1;”

Paragraph 8.7.3：

“Existing non-visual aids need not meet the requirement of 8.7.2 until January 2010 ”

Paragraph 8.7.4：

*“*Any equipment or installation required for air navigation purposes which must be located on the non-graded portion of a runway strip should be regarded as an obstacle and should be frangible and mounted as low as possible. ”*

1.11 Flight Recorders

1.11.1 Cockpit Voice Recorder

This aircraft was equipped with a Solid State Cockpit Voice Recorder (CVR), model Fairchild A200S, part number S200-0012-00, serial number 01471. The recording of 120-minute duration was downloaded properly. Quality of the recording was good.

The last 30 minutes of the recording was transcribed as in Appendix 1. The transcript was synchronized with the Digital Flight Data Recorder (FDR) data based on the FDR time parameter[13]. The transcript contained the GE 536 climbing to the cruising level, cruising, descending, landing, landing rolling, skidding off the runway and the flight crew asking for ground support. After the aircraft skidding off the runway, the CVR was temporarily stopped resulting from shutdown of the engine by the flight crew and resume power after the Auxiliary Power Unit (APU) activated. The CVR finally stopped as the flight crew pulled the Circuit Brake (CB).

1.11.2 Flight Data Recorder

This aircraft was equipped with a Flight Data Recorder (FDR), manufacturer L3 Communication Inc, part number S800-3000-00, serial number 00703, and have the ability to record 50 hours of data.

According to the converting algorithms[14], totally 179 parameters were recorded in theFDR. All the recorded parameters were listed in Appendix 2. Detail results are plot in Figure 1.11-1 ~ Figure 1.11-2. Summary of the FDR Readout as follows:

1. The Flight Data Recorder complies with Civil Aviation Law- “07-02A Aircraft Flight Operation Management Regulations,” and ICAO Annex 6 “Type 1” Flight Data Recorder, satisfactory to record the 32 mandatory parameters.
2. The GE 536 flight started recording at 1930.

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[13] The CVR and FDR recordings were synchronized by VHF keying before the recorders stopped. The time format for the transcript has been transferred to Taipei local time while the DFDR data were described in UTC format.

[14] Source BEA Flight Recorders Lab, A/C:A320/200 Engine: IAE V2527-A5；FDIU SAGEM P/N ED43A1D5；ARINCE 573/717 128 Word/s

3. According to earlier CVR recording, at 1917:21. The first officer said: “brake test” and the captain replied: “check”. After comparing with the FDR data, the brake pedal position and brake pressure quantity varied during 1917:21 to 1917:23 due to the execution of this check item.

4. During final approach, GE536 engaged autopilot and autothrottle. The deceleration rate of Auto Brake armed at “Medium[15]” before landing; “Anti-skid selector” set at “ON”; Three Hydraulic pressures of “Hydraulic pressure Yellow/Green/Blue” are “Normal”; “Normal brake fault” is “no fault”; “Alternate braking” didn’t activate; “Antiskid fault” is “no fault”.

5. At 1940:29, GE536 started descent, airspeed 319 knots.

6. At 1956:45, ground spoiler armed, airspeed 158 knots, radio altitude 1576 feet, magnetic heading 081 deg, wind 001 deg at 43 knots.

7. Configuration of Slat/flap lever position- at 1957:11 flap configured at “3”, flap position 20 deg, with airspeed 151.9 knots, radio altitude 1751 feet, magnetic heading 079 deg, wind 001 deg at 43 knots.

8. At 1959:04, autopilot was disengaged, airspeed 144 knots, radio altitude 282 feet, magnetic heading 094 deg, wind 009 deg at 42 knots. Both Thrust Lever angle (TLA) were 22.5 deg.

9. At 1959:14, radio altitude 100 ft, airspeed 137.6 knots, magnetic heading 092 deg, and wind 340 deg at 7 knots. Both TLAs were22.5 deg.

10. At 1959:21, radio altitude 50 feet, airspeed 135.8 knots, magnetic heading 093 deg, and wind 338 deg at 5 knots. Both TLAs were 22.5 deg.

11. At 1959:23, radio altitude 23 feet, airspeed 141.6 knots, magnetic heading 094 deg, and wind 305 deg at 8 knots. Both TLAs were 22.5 deg.

12. 1 second (1959:26) prior to main landing gear touched ground, airspeed 133.8 knots, radio altitude -1 feet, magnet heading 094 deg, wind 297 deg at 11 knots. Left- and right- TLA were19.7 deg, and 22.5 deg, respectively.

13. At 1959:27, main landing gear touched ground, maximum vertical acceleration 1.38 G, the parameter of “Compressed shock absorber” switched from “Air” to “Ground”, with airspeed 137.6 knots, radio altitude -2 feet, magnetic heading 093 deg, wind 297 deg at 11 knots. Left- and right- TLA were 19.7 deg, and 22.5 deg, respectively,

14. 3 seconds posterior to main landing gear touched ground (1959:30), nose gear touched ground, airspeed 140 knots, magnetic heading 095 deg, wind 269 deg at 4 knots. Left- and right- TLA were -22.5 deg, and 22.5 deg, respectively.

15. At 1959:32, auto-throttle disengaged (posterior 5 seconds to main landing touched ground), airspeed 139.6 knots, magnetic heading 095 deg, Left- and right- TLA were -22.5 deg, and 22.5 deg, respectively.

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[15] Medium deceleration: its deceleration rate is set at 3.0 meter/s^2

16. Since main landing touched ground (1959:27) until GE536 stopped (2000:47), the ground spoilers have not been deployed.

17. From 1959:32 to 2000:35, Left- Thrust Reverser was full deployed, and right- Thrust Reverser was retracted. The relevant parameters of magnetic heading, TLA and EPR listing in Table 1.11-1:

Table 1.11-1 The relevant parameters of magnetic heading, TLA and EPR

Time	Left-TLA (deg) Left- EPR (%)	Right -TLA (deg) Right - EPR (%)
1959:32 | 1959:38	-22 ~ -22 0.99 ↑ 1.03	22.5 ~ 22.5 1.08 ~ 1.08
	Magnetic heading: 95.3 → 94.6 →96.3	
1959:39 | 1200:00	-8 ~ -8 1.03 ↓ 0.99	22.5 ~ 22.5 1.08 ~1.08
	Magnetic heading: 97.0 → 94.0 →98.4	
1200:01 | 1200:12	-20 ~ -20 0.99 ↑ 1.06	22.5 ~ 22.5 1.08 ~1.08
	Magnetic heading: 97.0 → 95.3 →51.0	
1200:13 | 1200:35	--8 ~ -8 1.05 ↓ 1.00	22.5 ~ 22.5 1.08 ~1.08
	Magnetic heading: 39.4 → 13 →1.4	
Note: ↑ Increase；↓Decrease		

18. During landing roll operation, the relevant parameters of brake pedal position (BPP), normal brake pressure(NBP) and ground speed are listing in Table 1.11-2:

Table 1.11-2 The relevant parameters of BPP, NBP and ground speed

Time	Left-BPP(deg)/ Left-NBP(psi)	Right-BPP(deg)/ Right-NBP (psi)	Ground speed (GS) Deceleration Rate (DR)
1959:30 | 1959:39	0 ~ 0 0 ~ 0	2 ~ 10 0 ~ 64	GS146 knots ~ 131 knots average DR 1.0 m/s2
1959:40 | 1959:44	28 ~ 16 192 ~ 256	46 ~ 78 192 ~ 320	GS128 knots ~ 124 knots average DR 1.3 m/s2
1959:45 | 1959:48	54 ~ 72 256 ~ 512	78 ~ 80 192 ~ 384	GS121 knots ~ 115 knots average DR 1.6 m/s2

Time	Left-BPP(deg)/ Left-NBP(psi)	Right-BPP(deg)/ Right-NBP (psi)	Ground speed (GS) Deceleration Rate (DR)
1959:49 | 2000:00	78 ~ 80 860 ~ 1536	78 ~ 80 384 ~ 1088	GS111 knots ~ 75 knots average DR 1.9 m/s2
2000:01 | 2000:15	78 ~ 80 1280 ~ 192	78 ~ 80 640 ~ 256	GS69 knots ~ 12 knots average DR 2.0 m/s2
2000:16 | 2000:47	78 ~ 72 2496 ~ 64	70 ~ 74 1792 ~ 64	GS12 knots ~ 0 knots average DR 1.0m/s2
Note: Brake pedal position Resolution = 2 deg Normal brake pressure Resolution = 64 Psi			

19. After touched ground, between 2000:08 and 2000:48, rudder position is recorded at right 25 deg; between 2000:10 and 2000:13, the roll operating of F/O's side stick reached maximum right roll of 20 deg.

20. At 2000:05, GE536 started drifted to left-side. (after main landing gear touched ground 39 seconds), airspeed 56.6 knots, ground speed 55 knots, heading 93.5 deg.

21. Between 2000:15.75 to 2000:17, GE536 stopped rolling, airspeed 0 knots, ground speed decreased from 12 knots to 1 knots, magnetic heading left drafted from 13 deg to 01.4 deg. During this period, the parameter "Compressed shock absorber" transit from "Ground" to "Air".

22. Between 2000:37 to 2000:40, right-TLA retracted to IDLE position (22.5 deg retracted to -3 deg).

23. At 2000:4, FDR stopped recording, airspeed 0 knots, ground speed 0 knots, and magnetic heading 002 deg.

The touched ground position and timing is determined by parameters of "Landing Gear RH/LH Compressed Shock Absorber" and maximum vertical acceleration, as shown in Figure 1.11-3. At 1959:27, main landing gear touched ground at 1,750 feet beyond the threshold of runway 10. At 1959:37, Captain called out "No brake", the GE536 located at 4,000 ft beyond the threshold of Runway 10.

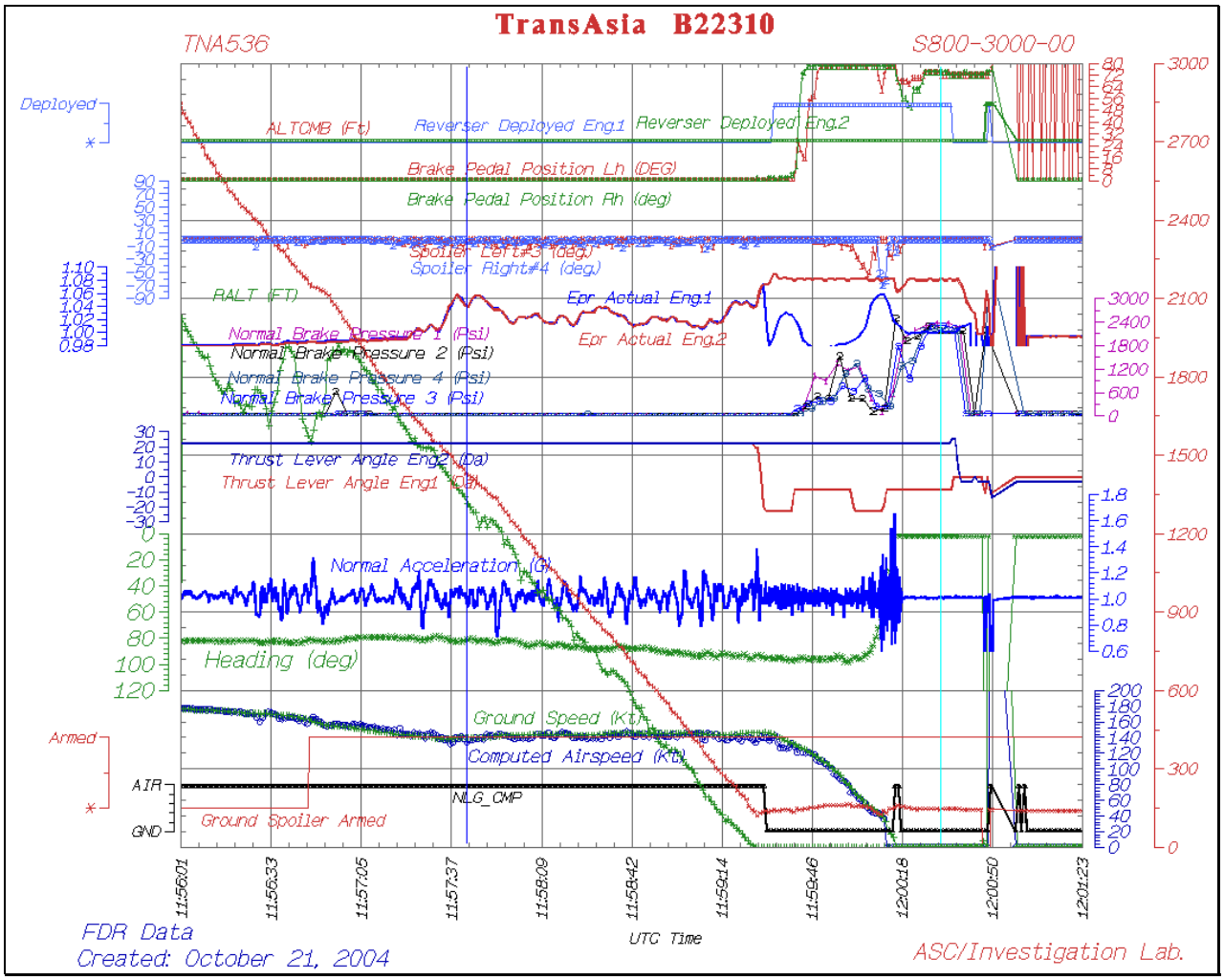


Figure 1.11-1 Flight Data Plot[16] (Final Approach, Landing and Deceleration)

[16] The flight data were all plotted in UTC time format.

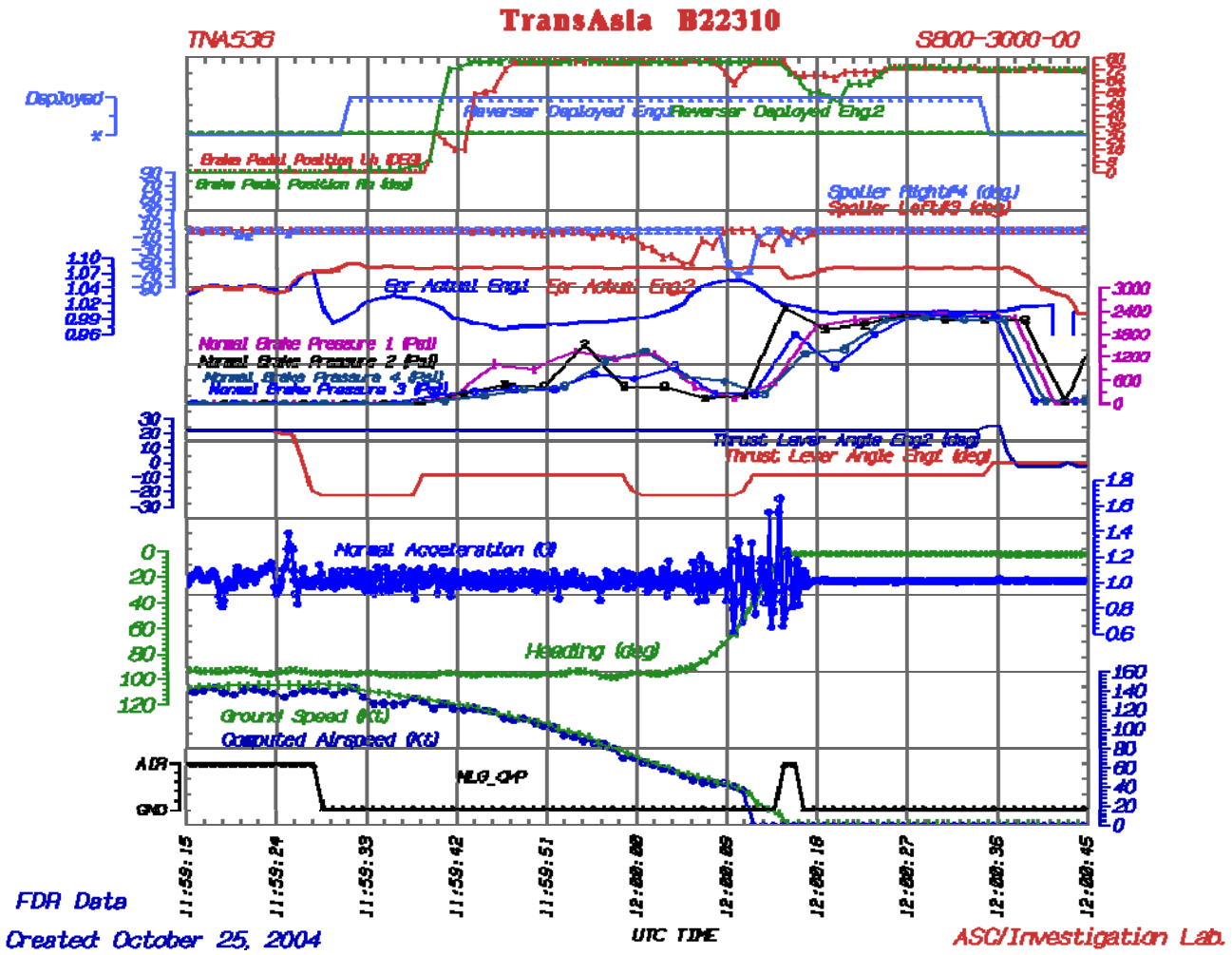
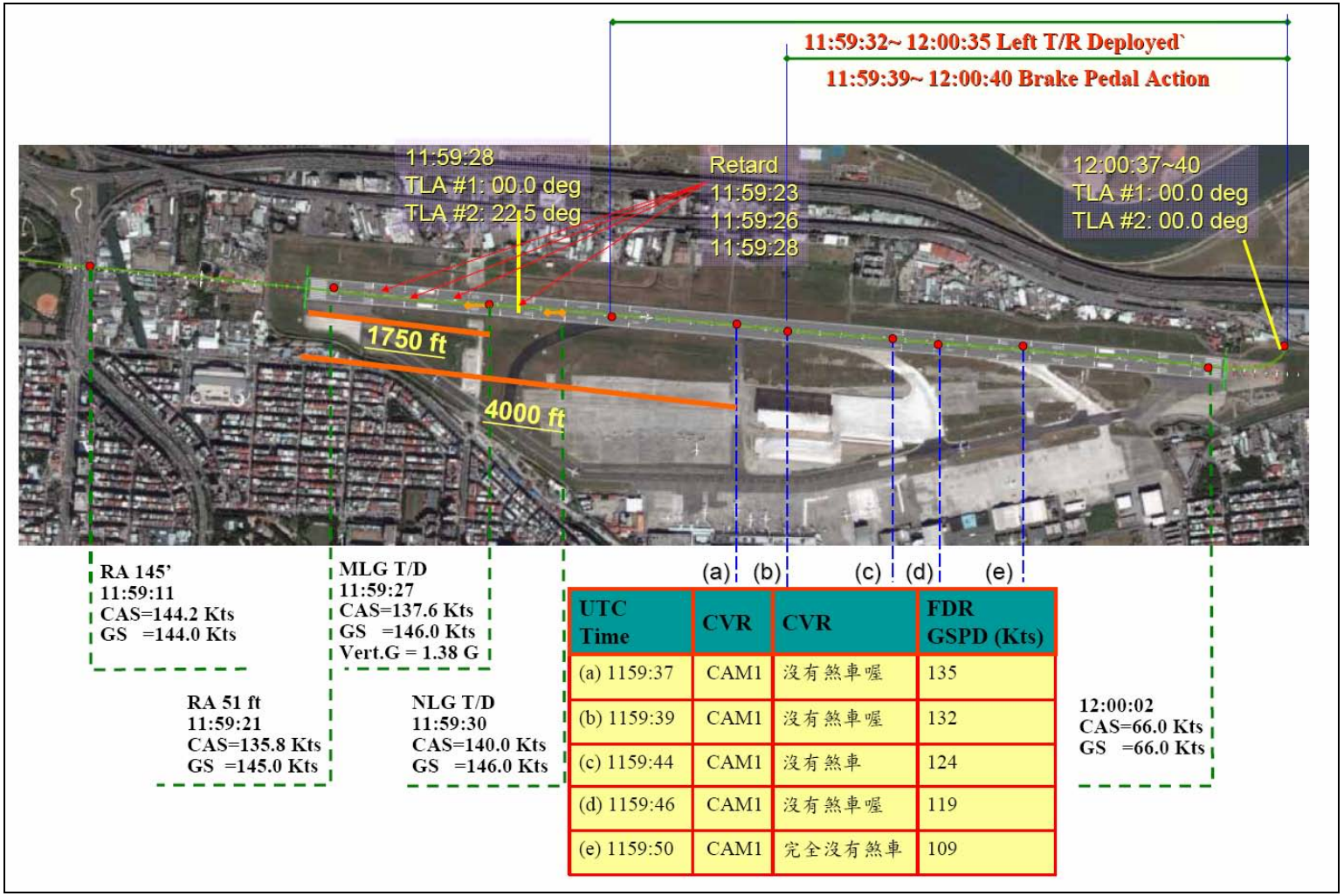


Figure 1.11-2　Flight Data Plot（Landing and Deceleration）



UTC Time	CVR	CVR	FDR GSPD (Kts)
(a) 1159:37	CAM1	沒有煞車喔	135
(b) 1159:39	CAM1	沒有煞車喔	132
(c) 1159:44	CAM1	沒有煞車	124
(d) 1159:46	CAM1	沒有煞車喔	119
(e) 1159:50	CAM1	完全沒有煞車	109

Figure 1.11-3 Superpose of Flight Path and Satellite Image（Time, Flight Path, FDR Parameters, and CVR Transcripts）

1.12 Wreckage and Impact Information

The following damage assessment is based upon A320 AMM task 05-51-24 as a basis.

1.12.1 Damaged and Contaminated Areas

The damaged（red point） and contaminated area （blue point）of the aircraft are shown in Figure 1.12-1.

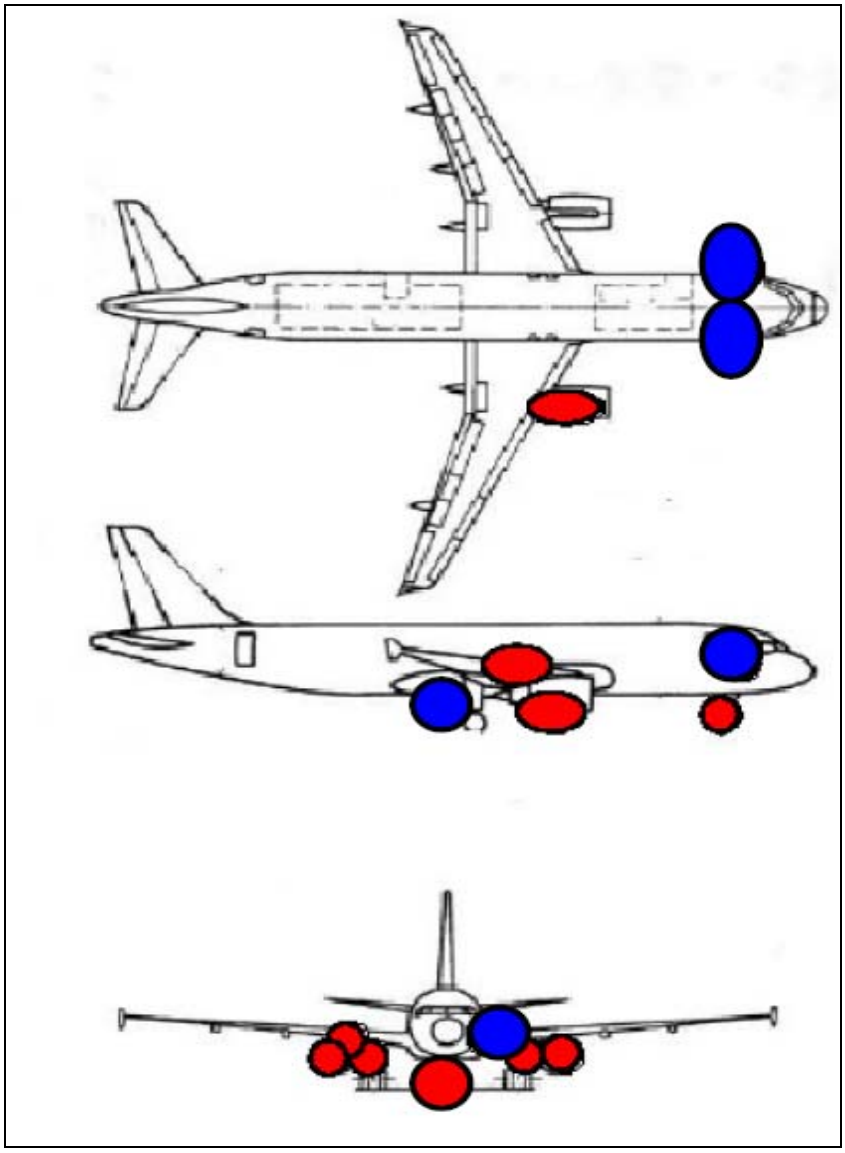


Figure 1.12-1The damaged and contaminated area of the aircraft

Fuselage Area

- No fuselage impacts noted.
- Contamination observed at the pitot/ static ports and air conditioning pack intakes.
- Anti collision light lens chipped.

Nose Landing Gear Area

- No visual damage noted at the NLG attachment or to the bay structure.
- Sliding tube broken and associated harnesses destroyed（Figure 1.12-2,3）.
- NLG Aft door (LH and RH) damaged during recovery（Figure 1.12-4）.

Figure 1.12-2NLG Sliding tube broken and associated harnesses destroyed

Figure 1.12-3NLG without broken sliding tube

Figure 1.12-4Deformation and dent to NLG Aft doors

Main Landing Gear Area

- No visual damage noted at the MLG attachments or to the bay structure.
- Damage noted to LH tire due to contact with runway object.
- LH and RH MLG experienced damage to the electrical and hydraulic systems on the casing during recovery. Compression of the systems against casing has scratches to the surface of both assemblies（Figure 1.12-5, 6）
- LH MLG door minor seal detachment noted. Not considered occurrence related.

Figure 1.12-5LH MLG electrical and hydraulic systems damage

Figure 1.12-6LH MLG Scratches – max depth 0.5mm

LH Engine

- Three fan blades and cone damage（Figure 1.12-7, 8）;
- 5 damage locations noted on the LH Nose cowl (four on the inner surface and one external)（Figure 1.12-9, 10）.

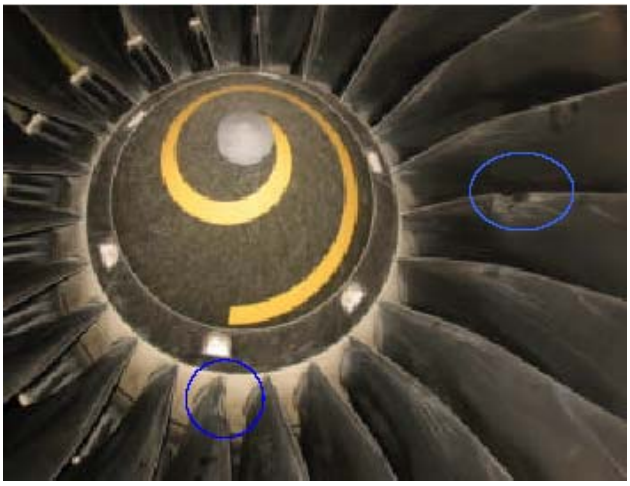


Figure 1.12-7Fan damage

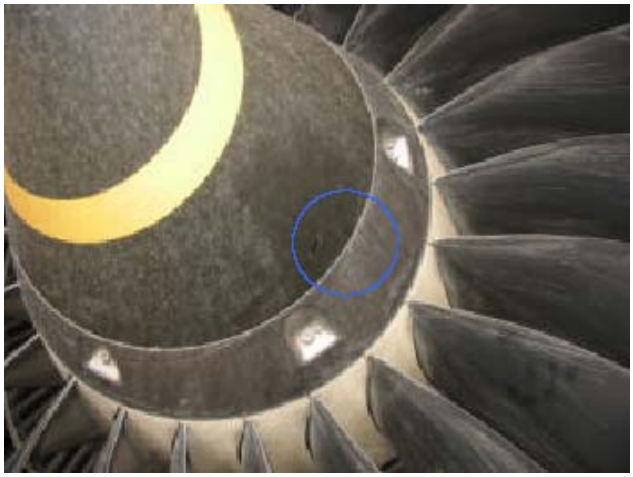


Figure 1.12-8Cone scratch

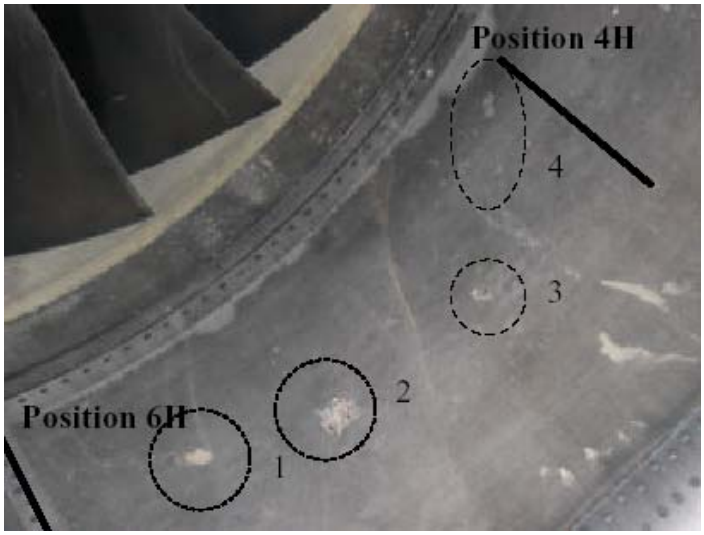


Figure 1.12-9Inner Surface damage

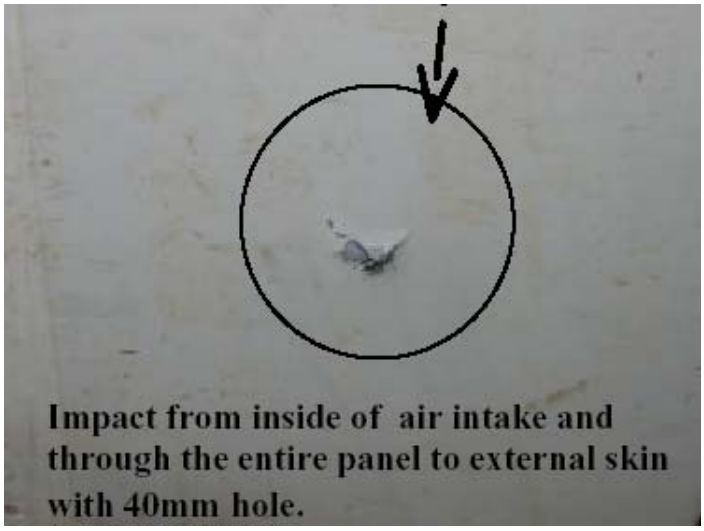


Figure 1.12-10 External Damage

LH Nacelle Area

- No visual damage noted to the pylon structure.

LH Wing

- Landing light damaged（Figure 1.12-11）

Figure 1.12-11　Landing light damaged

RH Engine

- Two fan blades noted damaged（Figure 1.12-12）.
- Piping bent, lower drain missing（Figure 1.12-13）.
- Lateral cooler damaged（Figure 1.12-14）.
- Extensive damage noted on the nose cowl, fan cowl and thrust reverser（Figure 1.12-15）.

Figure 1.12-12　Fan damage

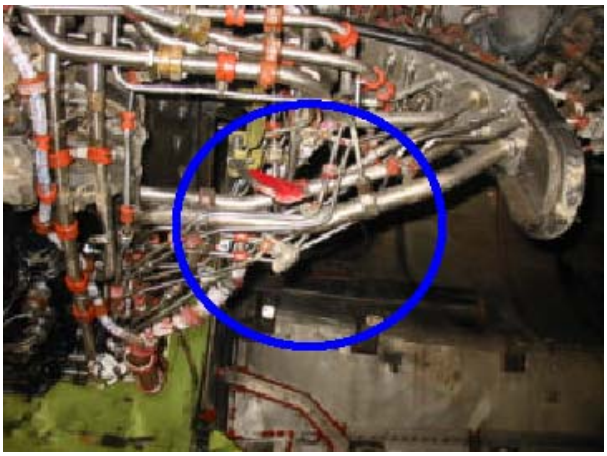


Figure 1.12-13 Bent Pipes, lower drain missing

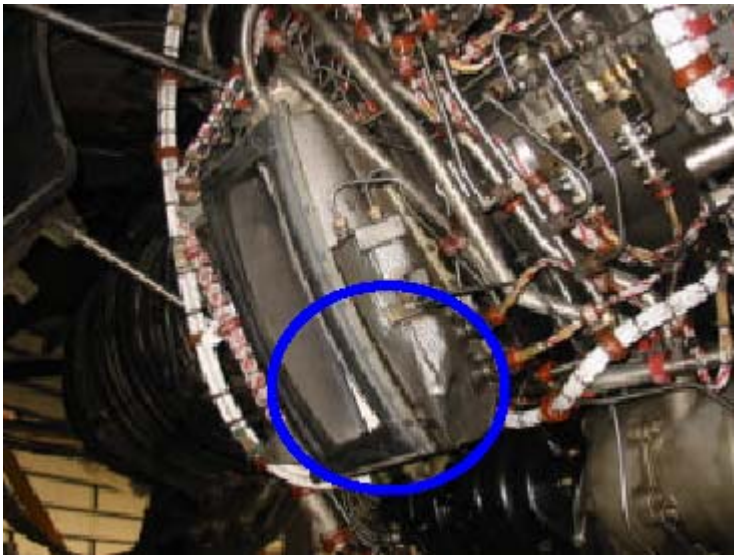


Figure 1.12-14 Lateral cooler damaged

Figure 1.12-15 Nacelle Overview

RH Pylon

- No visible damage to the attachment points.
- Lateral panel deformation and fastener pulling（Figure 1.12-16）.
- Upper panel deformation/ fastener pulling（Figure 1.12-17~20）
- Closing panel and fairing damage（Figure 1.12-21）.
- Cantilever deformation（Figure 1.12-22）

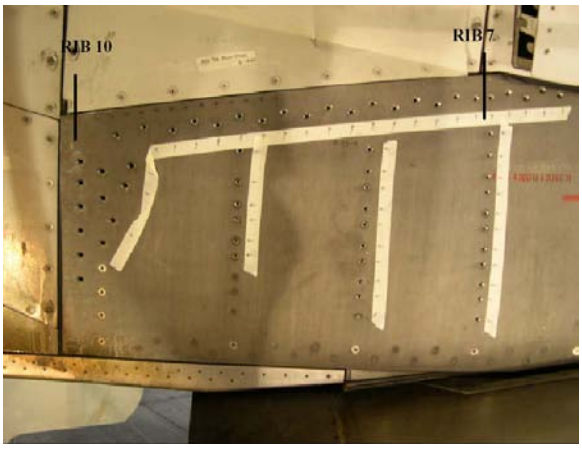


Figure 1.12-16 Lateral Panel Pulled fasteners

Figure 1.12-17 Upper Panel Pulled fasteners

Figure 1.12-18 Internal profile deformed.

Figure 1.12-19 Twisting of the lower profile

Figure 1.12-20 Vertical Profiles deformed

Figure 1.12-21 Fairings deformed

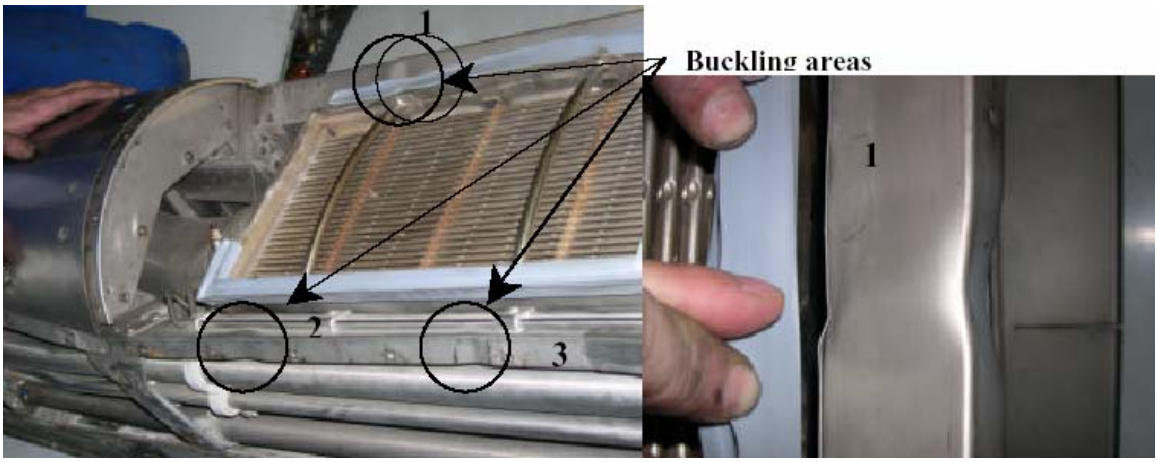


Figure 1.12-22 Upper cantilever angle buckling

RH Wing

- Damage noted to No. 1 Slat near pylon, leading edge lower skin exhibited a 25mm ×75mm dent（Figure 1.12-23）, leading edge upper skin exhibited a 25mm ×90mm dent（Figure 1.12-24）.

Figure 1.12-23 leading edge lower skin exhibited a 25mm ×75mm dent

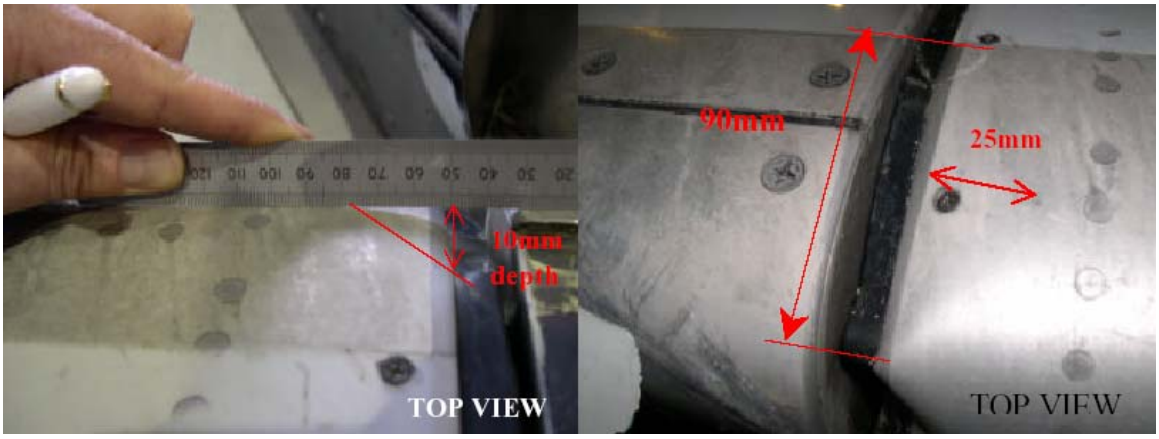


Figure 1.12-24 leading edge upper skin exhibited a 25mm ×90mm dent

1.13 Medical and Pathology

The CM-1 and CM-2 got an alcohol test at 2135 on the accident date. The results of the test showed the their alcohol levels were normal. .

1.14 Fire

There was no fire in this occurrence.

1.15 Survival Factors

Based on the tower control transcript, CVR transcript, and pilot interview records, it is noted that the CM-1 informed tower for help after the aircraft veer-off the runway. The CM-1 used the PA to announce “attention crew at station”. The pilots then shut down the engines and started APU to supply power. CM-1 told the purser to prepare to evacuate the passengers.

Based on the CVR transcript and the purser’s interview record, she sensed the aircraft speed was not reduced as usual during the landing roll. She sensed more severed vibration and noise than routing flight. The aircraft stopped approximately 20 second after touch down. There was no loud bang during the final impact. She heard the announcement of “attention crew at station” from cockpit via PA. The cabin crew judged that the situation was a “forced landing without preparation”. The purser stated that four cabin crews stayed at their designated positions and judged whether their exits were safe for evacuation. The purser used interphone to verify the exit conditions after the visual check with the other cabin crews. The responses from the cabin crews indicated no fire and smoke at the exterior of exits. The purser comforted the passengers and ask them to stay in the seat for further instruction. The CM-1 called the purser to the cockpit and told her that the ground support would arrive very soon. The CM-1 suggested the purser to evacuate passengers from the rear exits via the airport service stairs.

After leaving the cockpit, the purser opened 1L exit and talked to firemen who were on the ground. The firemen and the purser exchanged information to confirm that the aircraft did not catch fire and cabin was safe.

Although the purser was told to evacuate passengers from the rear exit via the airport service stairs, she considered that the height of the rear exit was not suitable to use the airport service stairs. After discussion with the ground handling personnel and other cabin crews, the purser decided to evacuate passengers by 1L door slide, then informed CM-1 and announced it to the passengers.

The purser briefed the passengers of the way to jump slide and asked to

remove all sharp stuffs before stepping on the slide. The purser stated that the situation was not in emergency, and allowed passengers to take their personal belongings, except the big and heavy ones, to jump onto the slide. After all passengers evacuated, the cabin crew gathered the passengers and examined them for injury. No passenger reported injury during the evacuation. The purser stated that there did not use flashlight or megaphone because the electric power supply was normal and the cabin PA system was normal during evacuation.

1.16 Test and Research

1.16.1 Ground Spoilers Test

To test the automatic extension function of ground spoilers, on November 3, 2004, the investigation team performed tests at Transasia Airlines Hangar. There is no dedicated ground test procedure in A320 Aircraft Maintenance Manual for ground spoilers automatic extension function. Instead, the manufacturer provided a procedure of this test（refer to Appendix 3）. The methodology of this test is to drive the tachometers on each wheel with special tools. It simulated the wheel speed higher than 72 knots. When all wheel speed are higher than 72 knots and both throttle control levers are at idle positions, then all ground spoilers would automatically extend. When all wheel speed are higher than 72 knots and both throttle control levers are at climb position, all ground spoilers should stay at neutral position.

First test: Following is the initial conditions of automatic function test,

- Aircraft on ground;
- Speedbrake control lever at ARM position;
- Both throttle control levers at MCT T.O.（engines not running）; and
- Driving all four tachometers about 1,000RPM（589RPM is about ground speed 72 knots）.

While aircraft is at the above mentioned conditions, the test engineer moved both throttle control levers from MCT T.O. to idle position. While both throttle control levers at idle position, all ground spoiler automatically extended.

Second test: Following is the initial conditions of automatic function test,

- Aircraft on ground;
- Speedbrake control lever at ARM position;
- Both throttle control levers at MCT T.O.（engines not running）; and
- Driving all four tachometers about 1,000RPM.

While aircraft was at the above mentioned conditions, no.1 throttle control lever was moved from MCT T.O. to idle position. All ground spoilers stayed at neutral position. No.2 throttle control lever was moved to 22.5 degrees all ground spoilers stayed at neutral position. Continued to move no.1 throttle control lever to REV MAX position, all ground spoilers stayed at neutral position. The next step was to move no.2 throttle control lever toward idle position slowly. While no.2 throttle control levers passed 14.9 degrees, all ground spoiler automatically extended.

Under same initial conditions, the test engineer moved no.2 throttle control lever to idle position. All ground spoilers stayed at neutral position. No.1 throttle control lever was moved toward idle position. When no.1 throttle control lever passed 15 degrees, all ground spoilers automatic extended.

This test successfully demonstrated the relationships between throttle control lever position and automatic function of ground spoiler extension. One throttle control lever at 22.5 degrees and the other one throttle control lever stays at idle position or reverse thrust range, all ground spoilers stay at neutral position. When aircraft conditions are met and both throttle control levers position are less than 15 degrees, all ground spoiler extend automatically.

1.16.2 Condition Checks of Wheel & Brake and Thrust Reverse System

To verify the conditions and functions of wheel & brake and thrust reverse systems. Investigation team performed associated tests at Transasia Airlines Hangar from October 19, 2004 to October 27, 2004.

1.16.2.1 Wheel & Brake System

Main tires inspection

All four tires had deep cut damage (depth up to tread reinforcing ply) and diagonal scratch marks, as shown in Figure 1.16-1. There is no tread rubber reversion present.

Figure 1.16-1Deep cut damage and diagonal scratch marks

Tires pressure check

Main tires: tire1 175 psi, tire2 185 psi, tire3 185 psi and tire4 185 psi

Nose tires: L/H tire 160 psi, R/H tire165 psi

Brake hydraulic pressure

The test engineers pressurized the 3 hydraulic systems by using AC Motor Pump and Power Transfer Unit and then measured hydraulic pressure form brake pressure line as following:

No.1：Yellow system 2,600 psi, Green system2,500~2,600 psi

No.2：Yellow system 2,600 psi, Green system2,500~2,600 psi

No.3：Yellow system 2,600 psi, Green system2,500~2,600 psi

No.4：Yellow system 2,600 psi, Green system2,500~2,600 psi

Brake assemblies

The Council conducted brake assembly inspections in accordance with TNA brake shop task card. There was no abnormal finding.

BSCU

A malfunction signal[17] was logged, when reviewed the BSCU fault history. The result of BSCU self test was passed.

The Council conducted the following 2 operation tests in accordance with Aircraft Maintenance Manual. There was no abnormal finding.

- Lost of Normal Braking Without Warning Indication;
- Operational Test of Alternate Braking System with Anti-skid.

1.16.2.2 Engine Thrust Reverse Operation Test

Operational test of Engine 1 thrust reverse was conducted in order to verify its function. Test result was in compliance with AMM 78-31-00.

1.16.3 Throttle Control Lever Position and Indication

To obtain an accurate reading of the throttle lever angle, TLA, for ground spoilers test as indicated in paragraph 1.16.1, on October 26, 2004, the investigation team performed the throttle control lever position and indication test at Transasia Airlines Hangar. The TLA value was read from Multi-purpose Control and Display Unit, MCDU, via Aircraft Integrated Data System, AIDS.

[17] The fault was logged by BSCU after the occurrence.

However the AIDS recognized the alpha “TRA” rather than “TLA”. According to Aircraft Maintenance Manual, AMM, 76.11-00 the relationship between TLA and TRA is linear, as indicated in Figure 1.16-2.

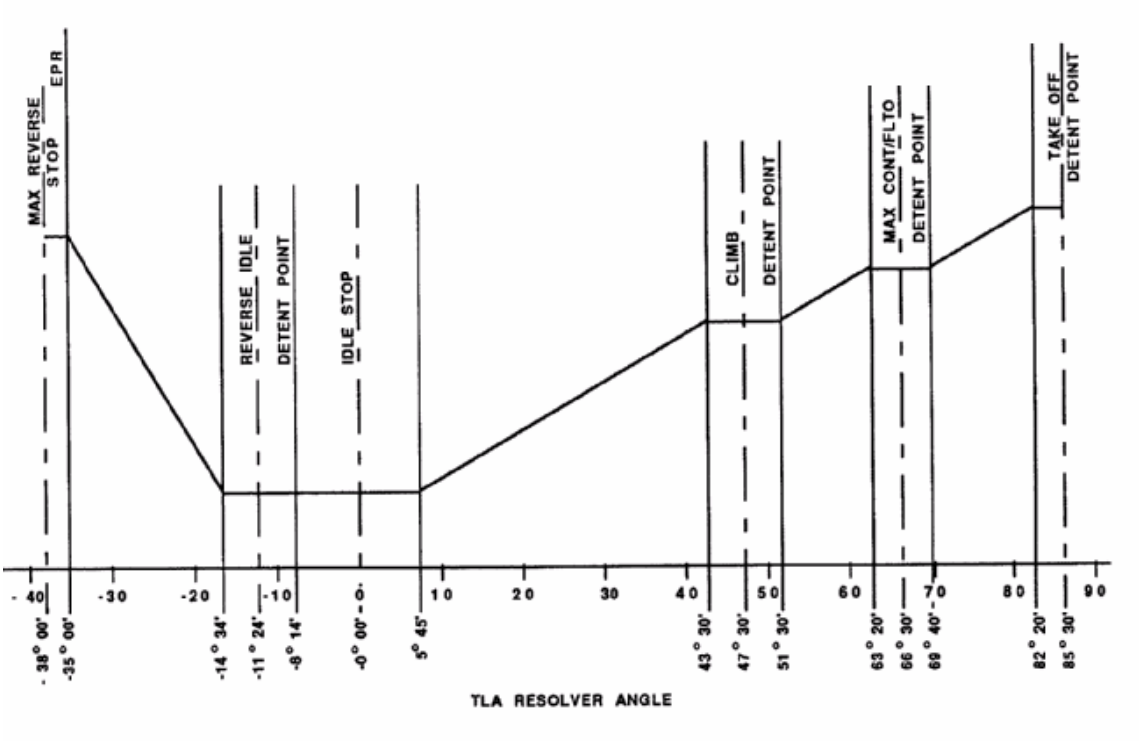


Figure 1.16-2Relationship between TLA and TRA

To understand the relationship between physical position of throttle control lever and the TRA display on MCDU, investigation team performed a test by moving the throttle control lever at full travel and recorded the TRA value. The physical positions and associated TRA reading is recorded in Table 1.16-1. This test indicated the physical positions from REV MAX to TO GA and associated TRA reading from -20 degrees to +45 degrees. The recorded range of TRA conforms the range of TLA. Therefore the indication of TRA on MCDU is TLA.

Table 1.16-1 Physical positions of throttle control lever and reading on MCDU

Physical positions of throttle control lever	MCDU data parameter	Data source	Indication
REV MAX	TRA	EEC1 EEC2	-20.1 -20.2
REV IDLE	TRA	EEC1 EEC2	-6.0 -6.0
IDLE	TRA	EEC1 EEC2	0.0 -0.1
CLIMB	TRA	EEC1 EEC2	25.0 25.0
FLX MCT	TRA	EEC1 EEC2	34.9 34.9

Physical positions of throttle control lever	MCDU data parameter	Data source	Indication
TO GA	TRA	EEC1 EEC2	44.7 44.8

1.17 Organizational and Management Information

1.17.1 Organization and Management pertaining to TNA

TNA is composed of Security & Safety Office, System Operation Center, and Flight Operations Department among other units. See Figure 1.17-1 for details.

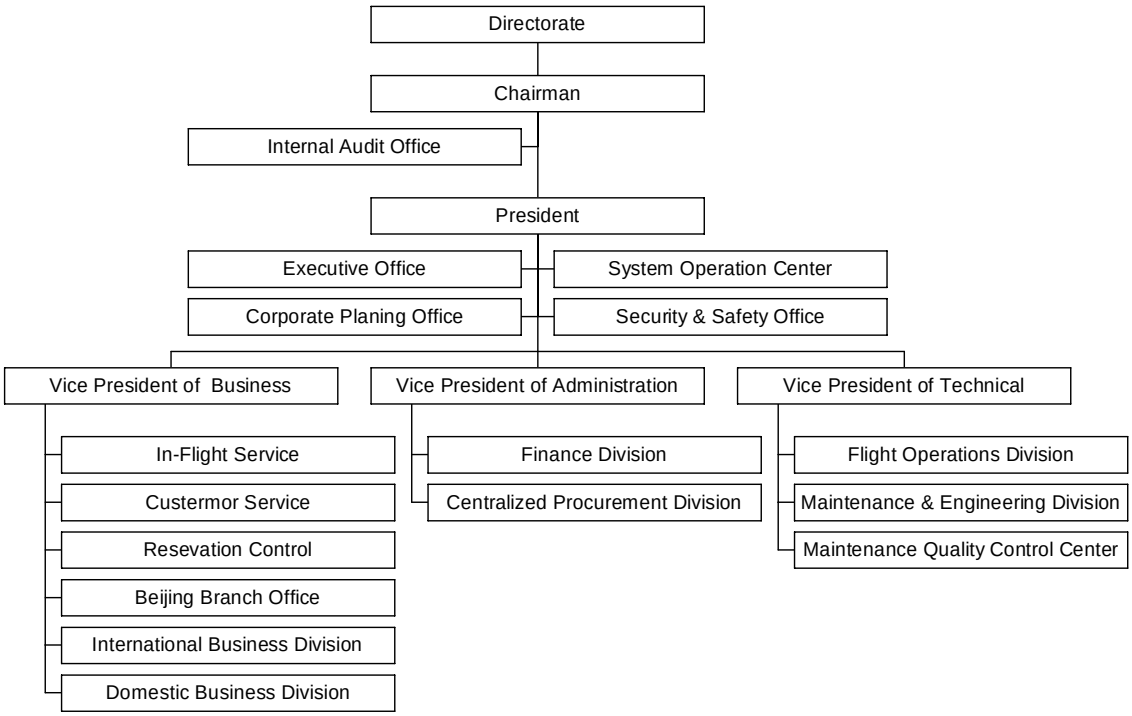


Figure 1.17-1 TNA Organizational Chart

1.17.1.1 Security & Safety Office（SSO）

The Flight Safety Office was under TNA's Flight Operations Department in the past. It was separated and transferred to under the Executive Office in May 1995. The functions of security protection and labors safety were incorporated into the Safety Control Office to become Security & Safety Office (SSO) on January 1, 2002, which are manned with 6 persons: 1 Director, 2 Officers, 2 Engineers and 1 Staff Member.

The functions of Safety Control Office involve units of flight operation, engineering and maintenance operation, QC, and ground services. Its main tasks include:

1. Carry out the analysis of the Line Operations Monitor System (LOMS) of the Flight Operations Quality Assurance (FOQA) and dealing with general

business regarding flight safety;

2. The LOMS operation is divided into two parts: the SCO is responsible for operation management and analysis of overall trend, and the Flight Operations Department designating pilots to provide assistance in confirming incidents and handling the follow-on work;
3. Participating daily maintenance meeting to have an awareness of operating conditions;
4. Directing each of the related department to conducting self-inspection operations, and collect the records submitted to Executive Office on a regular time schedule;
5. Implementing hazardous material education to all employees of TNA;
6. Organizing a mobile education team to instill the concept of “all-employees flight safety” in which each unit is responsible for flight safety of its own; and
7. Flight Operations Department is responsible for handling “flight crew reports” while units involving flight safety are providing assistances together with SCO.

1.17.1.2 Flight Operations Department（FOD）

The Flight Operations Department（FOD）is subordinated to Deputy General Manager for Flight/Maintenance. According to Operations Manual of TNA FOD, its functions include:

1. Promoting Flight Operation policy;
2. Assuring flight safety;
3. Developing and implementing relevant operating manuals and procedures;
4. Implementing manpower planning, training, employment, evaluation and management of flight pilots; and
5. Assigning and implementing flight missions.

The establishment of FOD includes Fleet Management Department (FMD) and Standard & Training Department (STD). The FMD is composed of AIRBUS fleet, ATR fleet and Crew Scheduling Management Section. Under the STD department, there are three sections: Academic Courses Planning, Standard & Training, and Planning & Development.

The (deputy) assistant vice president of FOD acts as the leader of FOD whose responsibilities include:

1. Overseeing internal affairs and communicating with other units;

2. Supervising and developing policies and procedures of TNA flight operations;
3. Supervising the implementation of flight operations;
4. Supervising training of flight crew members;
5. Supervising and planning policies to ensure flight safety; and
6. Supervising, evaluating and managing subordinates.

1.17.1.2.1 Fleet Management Department

AIRBUS fleet contains 8 AIRBUS 320/321 aircrafts with 28 captains (of which 2 CAA designated examiners, 3 check pilots and 3 instructor pilots) and 26 first officers with 54 in total. ATR fleet has 10 ATR72 passenger aircraft.

According to Operations Manual of TNA Flight Operations Department, the responsibilities of chief pilot include:

1. Implementing test and evaluation of pilots;
2. Conducting selection review of new pilots, pilots for advanced training and pilots for transfer training, and manpower planning;
3. Attending and supervising required study classes;
4. Management of fleet personnel including pilot flight skills, disciplines and habits in daily life;
5. Conducting checks on various skills and evaluation of annual individual pilot performance; and
6. Handling “Flight Crew Member Report”

1.17.1.2.2 Standard & Training Department（STD）

Standard & Training Section (STS)

STS is staffed with Director, one Staff Member, and a task-based team composed of check pilots and instructor pilots.

According to Operations Manual of TNA Flight Operations Department, the functions of STS include:

1. Revising and enlarging various standard flight operation doctrines such as Standard Operations Procedures, Flight Operations Manual, Flight Training Management Manual, Flight Training Manual and Route Manual;
2. Collecting and compiling teaching material and questions pool regarding ground academic training, simulator training and flight training of each

type of aircraft;

3. Supervising the instructor pilots in conducting training, qualifying techniques and skills, evaluating training results and tracking shortcomings, as well as conducting checks on lag of training progress and events of poor grade examination and raising suggestions;

4. Taking part in the process of selecting and evaluating new pilots and pilots for advanced and transferring training, and attending the fleet manpower appraisal meeting; and

5. Holding meetings to check pilots' flight competence and skills.

According to Operations Manual of TNA Flight Operations Department, the responsibilities of Check pilots and Instructor Pilots of the task-based team include:

1. Conducting checks and tests on various pilot techniques and skills;

2. Implementing various flight trainings (including flight-related ground academic subjects and civil aviation regulations and laws);

3. Reflecting training problems and improving training or operational procedures;

4. Appraising and checking the qualifications of pilots; and

5. Participating regular instructor pilot meetings as well as personnel techniques and skills appraisal meetings.

Academic Courses Planning Section

Academic Courses Planning Section (ACPS) is staffed with Director, Deputy Director and one Staff Member.

According to Operations Manual of TNA Flight Operations Department, the functions of ACPS include:

1. Developing training programs and tracking the implementation of them.

2. Coordinating with Dispatch Center to arrange the recurrent training of pilots;

3. Safekeeping, sorting out and replenishing training material, books and training equipment;

4. In charge of various flight and ground academic trainings, and collecting and assessing the opinions from instructors and trainees.

5. Arranging trainees for simulator recurrent training and handling information; and

6. Tracking trainees' stage trainings and their examination records.

1.18 Additional Information

1.18.1 Site Survey

The result of site survey was presented on the airport satellite image as shown in Figure 1.18-1. The ground tracks of left main landing gear, right main landing gear and nose gear were represented with green, orange and red lines respectively.

According to the site-survey result, the nose gear of the occurrence aircraft skipped off the pavement of the stopway at 321 feet outward the threshold of Runway 28. The nose gear stopped in the uncovered ditch at about 130 feet in the north of the stopway (Figure 1.18-2). The aircraft stopped with heading 002 and nose downward slightly.

The tire marks of the aircraft could be tracked from the grass area, via the pavement of the stopway, continuously to the runway threshold markings of Runway 28 (Figure 1.18-3). No apparent tire marks of the occurrence aircraft could be found on the runway.

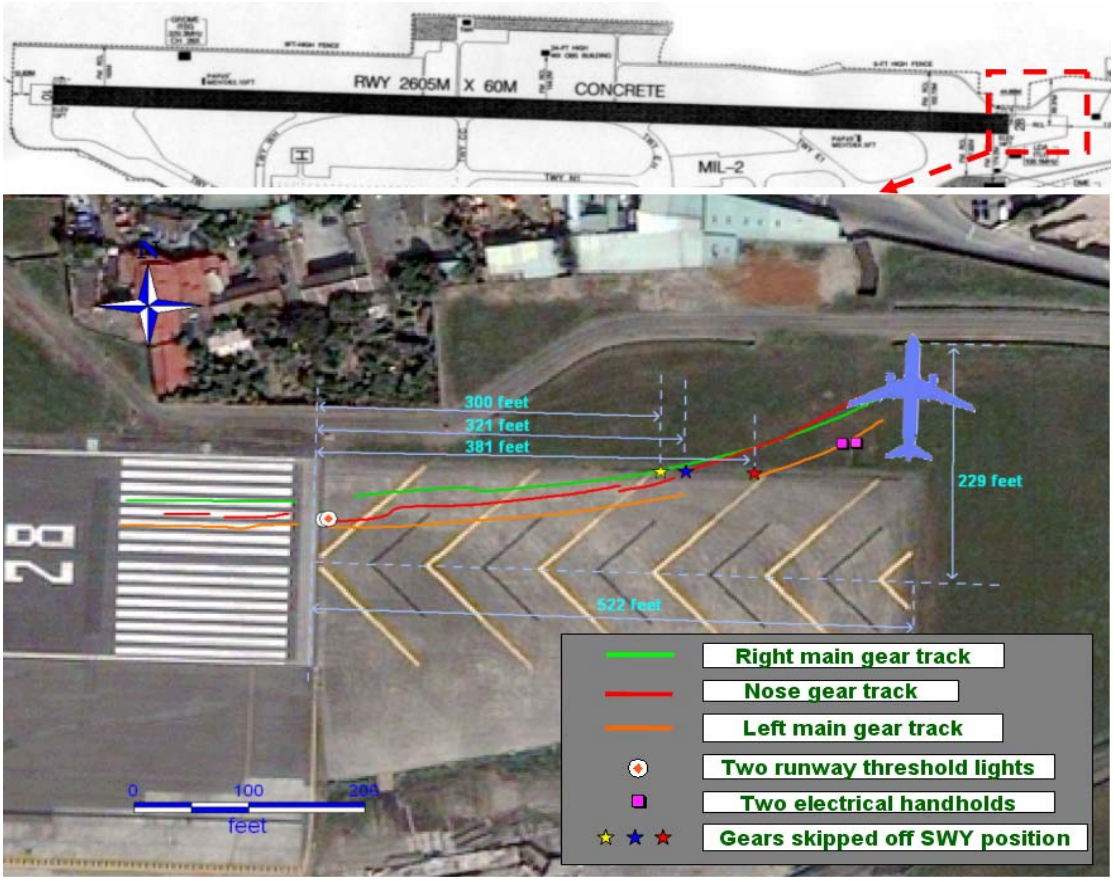


Figure 1.18-1Sungshan airport chart and site-survey results with the satellite image

Figure 1.18-2The nose gear stopped in the ditch

Figure 1.18-3Ground tracks from the stopway pavement to the grass area

1.18.2 Aircraft Recovery

Recovery of the aircraft was performed by TNA. An airbag was placed at the RH wing root but did not have sufficient height to enable recovery. The lifting of

the fuselage was carried out with slings at Frame 15, 21 and 62（Figure 1.18-4）. With the damaged NLG resting on a trolley and slings around the two main landing gear the aircraft was pulled directly backwards with a vehicle to a solid surface（Figure 1.18-5）.

Figure 1.18-4　Aircraft with slings at Frame 15, 21 and 62

Figure 1.18-5　Aircraft towing with straps around both MLG casings

1.18.3　Summary of Interview with Pilots

1.18.3.1　CM-1

He stated that he was told the number two engine thrust reverser of B-22310 was deactivated while he reported to the System Operations Center, so he briefed to the CM-2 that the thrust reverser fault meet the dispatch standard but should pay attention to the deceleration and direction control at landing roll.

He stated the ATIS reported the visibility at Sungshan Airport was 5 miles, ceiling at 1,800 ft and their existed low level windshear and moderate turbulence on final. Then he agreed with CM-2's selections of flaps 3 and autobrake medium.

They received landing clearance at around 1,000 ft, on final approach had turbulence, and the visibility was good. He stated the aircraft's touch down was normal, he called out "Spoiler, one reversal green" once and "no brake" several times after landing, but the deceleration were not enough, so he applied the brake pedal also. He stated that CM-2 did advance the number one throttle lever and then pull it full back.

The aircraft rolled off from the left side of stopway into grass, the speed decreased rapidly and came into a full stop while the nose gear collapsed into a ditch. He shut down both engines and broadcasted "Cabin crew at station" for three times by Public Address (PA) system. Then he started the Auxiliary Power Unit (APU) after checked there was no fire warning, and then contacted tower to request the ground support.

He talked to purser regarding the situation and released the passenger via slide out from the left passenger front door because the ladder at the rear exit could not be linked to the aircraft.

1.18.3.2 CM-2

He stated the ATIS reported the visibility at Sungshan Airport was 5 miles, ceiling at 1,800 ft, wind speed varies at 3 knots and windshear existed on Runway 10. The approach briefing was conducted following the card; the approach speed was computed as 137 knots, set flaps 3 and select autobrake at medium. Auto-pilot was engaged.

On final approach, at about 400 feet, the auto-pilot was disengaged due to unstable wind. CM-1 call out "reverse one green" after the number 1 thrust reverser was applied at landing. He applied the brake immediately after CM-1 call out "no brake", but even with more brake pedal actions, the aircraft did not effectively deceleration. He could felt that the CM-1 was applied the brake simultaneously.

He decreased the thrust of number one thrust reverser to try to control the aircraft's direction, and then, advanced the thrust to the maximum.

The aircraft decelerated rapidly after rolling toward the left side stopway. From the aircraft landed till full stop, the CM-1 did not announce that he took over the control.

1.18.4 Summary of Flight Crew Operating Manual

A/THR ACTIVATION

The A/THR is active when it controls thrust or speed. The position of the thrust lever determines the maximum thrust that the A/THR system can command (except in α-floor condition).

R The A/THR being armed, is activated :

- when the pilot sets both thrust levers between the CL and IDLE detents (two engines operative)
- when the pilot sets one thrust lever between the MCT and IDLE detents (one engine inoperative).

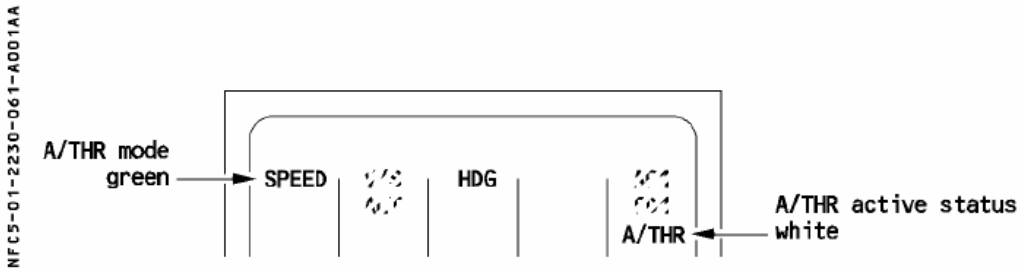
R The A/THR being disconnected, is activated when the pilot pushes the FCU pushbutton while the thrust levers are within the active range, including IDLE position.

R *Note : When the pilot sets both thrust levers to IDLE position, the A/THR disconnects but, if the pilot pushes the A/THR pushbutton of the FCU, he will simultaneously arm and activate the autothrust. Due to the thrust levers position, IDLE thrust will be maintained.*

- when ALPHA FLOOR is activated, regardless of the initial status of A/THR and the position of the thrust levers.

When A/THR is active :

- The A/THR pushbutton on the FCU lights up.
- R The FMA displays A/THR mode in green in the first column and A/THR in white in the fifth column.



EFFECTS OF THRUST LEVER MOVEMENT WHILE A/THR IS ACTIVE

- When both thrust levers are set above the CL detent (both engines operative) or one thrust lever is set above MCT (one engine operative) the A/THR reverts from active to armed. "A/THR" turns to blue on the FMA and the thrust levers control the thrust directly. The FMA displays "MAN THR" white in its first column.
  The thrust levers provide the crew with an immediate increase of thrust when both thrust levers are pushed above the CL detent (2 engines) or the active thrust lever above the MCT detent (one engine operative).
- When both thrust levers are set below the CL detent (both engines operative) or one thrust lever is set below MCT (one engine operative), a repeating warning (amber caution, single chime, ECAM message "A/THR LIMITED") is activated every 5 seconds until the pilot moves the lever back into the detent. "THR LVR" green is displayed on the FMA
  "LVR CLB" (both engines operative) or "LVR MCT" (one engine operative) flashes white in the first column of the FMA.
  This device reminds the crew that the normal operating position of the thrust levers, when A/THR is active, is the CL detent (2 engines) or the MCT detent (one engine operative).
- When one thrust lever is in the CL detent and the other one out of the detent, the "LVR ASYM" amber message comes up until both levers are set in the CL detent (only with both engines operative).

A/THR DISCONNECT

When the A/THR is disconnected, it is neither armed nor active.
The A/THR can be disconnected in two ways :

* Standard disconnection
  - The pilot pushes the instinctive disconnect pushbutton on the thrust levers (which immediately sets the thrust corresponding to the lever positions) or
  - The pilot sets both thrust levers to IDLE detent.
* Non-standard disconnection
  - The pilot pushes the A/THR pushbutton on the FCU while A/THR is armed/active, or
  - The system loses one of the arming conditions.

R **Below 100 feet radio altitude**

R When the radio altitude is below 100 feet and the pilot sets both thrust levers above the
R CL detent or one above the MCT detent, the autothrust will disconnect. It will rearm
R automatically when at least one of the thrust levers is set to TOGA.
R If the PF sets the thrust levers slightly above CL detent but below TOGA and come back
R to CL detent, the A/THR will disconnect and remain disconnected. As a result, the thrust
R will increase up to CLIMB thrust. The crew has to manually set the appropriate thrust for
R landing (or go around).

CAUTION

If the pilot pushes and holds one instinctive disconnect pushbutton for more than 15 seconds, the A/THR system is disconnected for the remainder of the flight. All A/THR functions including ALPHA FLOOR are lost, and they can be recovered only at the next FMGC power-up (on ground).

THRUST LOCK FUNCTION

The THRUST LOCK function is activated when the thrust levers are in the CL detent (or the MCT detent with one engine out) and the pilot pushes the A/THR pushbutton on the FCU or the A/THR disconnects due to a failure.

- "THR LK" flashes amber on the FMA.
- ECAM "ENG THRUST LOCKED" flashes every five seconds.
- ECAM displays "THR LEVERS..... MOVE"
- A single chime sounds and the Master Caution Light flashes every five seconds.

The thrust is locked at its level prior to disconnection. Moving the thrust levers out of CL or MCT suppresses the thrust lock and gives the pilot manual control with the thrust levers. All warnings cease when the pilot moves the thrust levers out of the detent.

A/THR DISCONNECT CAUTION

		A/THR DISCONNECTION	
		BY INSTINCTIVE DISCONNECT OR SETTING TWO LEVERS TO IDLE (if above 50 ft RA)	**BY OTHER MEANS**
CONSEQUENCE	MASTER CAUTION	illuminated-3 sec max	illuminated
	ECAM MESSAGE	amber A/THR OFF message 9 sec maximum	Flashing "ENG THRUST LOCKED" (amber AUTO FLT A/THR OFF THR LEVERS..... MOVE (blue)
	AUDIO	single chime	single chime
	CLR pushbutton on ECAM CONTROL PANEL	extinguished	illuminated
ACTION	MASTER CAUTION pushbutton	extinguishes MASTER CAUTION light erases ECAM message	extinguishes MASTER CAUTION light
	CLR puhbutton on ECAM CONTROL PANEL	No effect	extinguishes MC light and CLR pushbutton, erases ECAM message calls status
	INSTINCTIVE DISCONNECT pushbutton	extinguishes MASTER CAUTION light erases ECAM message	extinguishes MASTER CAUTION light
ECAM STATUS MESSAGE		NO	YES

R – Standard disconnection triggers temporary ECAM message and caution light. Single
R chime sounds.
R – Non standard disconnection triggers caution light and ECAM message removed only by
R a pilot action. Single chime sounds.

A/THR MODES

Except in takeoff and go around situations, normal operation of the A/THR system requires the thrust levers to be :

- In the CL detent for the two-engine configuration. If they are not set in the CL detent, "LVR CLB" flashes white on the FMA.
- In MCT detent when in the one-engine-out configuration. If the appropriate lever is not set in the MCT detent, "LVR MCT" flashes white on the FMA.

The A/THR modes are selected automatically in conjunction with the AP/FD modes (except for ALPHA FLOOR).

A/THR in THRUST mode	AP/FD pitch mode maintains the speed : OP CLB - OP DES - CLB - EXP CLB◁ - EXP DES◁ - SRS - FLARE and DES (IDLE path)
A/THR in SPEED/MACH mode	If neither AP nor FD is engaged
	If AP/FD controls a vertical path V/S-FPA-ALT*- ALT CST*-ALT-ALT CRZ-G/S* -G/S-FINAL and DES (geometric path)
A/THR in RETARD mode	Automatic landing (AP engaged in LAND mode).

THRUST mode

- In THRUST mode, autothrust commands a specific thrust level in conjunction with the AP/FD pitch mode. This thrust level is limited by thrust lever position.

FMA display	Meaning
THR MCT	Single engine thrust in climb. The live engine is at maximum continuous thrust (thrust lever in MCT detent)
THR CLB	Climb thrust two engine configuration (at least one thrust lever in the CL detent, the other one below CL)
THR LVR	Undetermined thrust (neither CLB or MCT thrust)
THR IDLE	Minimum thrust (both engines at IDLE thrust)

Note : When the A/THR is armed for takeoff or go around, the FMA displays "MAN TOGA" (or "MAN FLX") in white to remind the crew that the thrust levers have been positioned properly.

RETARD MODE

The RETARD mode is only available during automatic landing (AP engaged in LAND mode). At approximately 40 feet RA, the RETARD mode engages and remains engaged after touchdown. The A/THR commands IDLE thrust during the flare, and the FMA and engine warning display "IDLE". If the autopilot is disengaged during the flare before touchdown, the SPEED mode replaces the RETARD mode, and the pilot has to manually reduce thrust.

Note : In an automatic landing, the system generates a "RETARD" callout at 10 feet radioaltitude (RA), which prompts the pilot to move the thrust levers to IDLE in order to confirm thrust reduction. In manual landing conditions, the system generates this callout at 20 feet RA, as a reminder.

ALPHA FLOOR

ALPHA FLOOR is a protection that commands TOGA thrust, regardless of the thrust levers' positions. This protection is available from lift-off to 100 feet RA on approach.
ALPHA FLOOR calls up the following indications :
- "A FLOOR" in green, surrounded by a flashing amber box on the FMA, and in amber on the engine warning display, (as long as α-floor conditions are met).
- "TOGA LK" in green, surrounded by a flashing amber box on the FMA, when the aircraft leaves the α-floor conditions. TOGA thrust is frozen.

To cancel ALPHA FLOOR or TOGA LK thrust, the pilot must disconnect the autothrust.

SPEED/MACH mode

In SPEED/MACH mode, the A/THR adjusts the thrust in order to acquire and hold a speed or Mach target.
The speed or Mach target may be :
- Selected on the FCU by the pilot.
- Managed by the FMGC.

When in SPD/MACH mode, the A/THR does not allow speed excursions beyond the following limits, regardless of the target speed or Mach number :
- For a selected speed target, the limits are VLS and VMAX (VMO-MMO, VFE-VLE, whichever applies).
- For a managed speed target, the limits are maneuvering speed (Green Dot, S, F, whichever applies) and maximum speed (340/.80-VFE-VLE, whichever applies).

The changeover from SPEED to MACH mode is either automatic, performed by the FMGC, or manual, with the pilot pushing the SPD/MACH changeover pushbutton.
The FMA displays "SPEED" or "MACH".

Approach autothrust :

R Below 3200 feet radioaltitude, with at least CONF 1, the A/THR logic is modified to be more responsive to speed variation. This is referred to as approach autothrust.

GROUND SPOILER CONTROL

Spoilers 1 to 5 act as ground spoilers.
When a ground spoiler surface on one wing fails, the symmetric one on the other wing is inhibited.

Arming

The pilot arms the ground spoilers by pulling the speedbrake control lever up into the armed position.

Full extension

The ground spoilers automatically extend during rejected takeoff, at a speed greater than 72 knots, or at landing when both main landing gears have touched down, when :

R · Ground spoilers are armed and all thrust levers are at or near idle, or
· Reverse is selected on at least one engine (other thrust lever at or near idle), if ground
R spoilers were not armed.

Note : · In autoland, the ground spoilers fully extend at half speed one second after both main landing gear touch down.

R *· The spoiler roll function is inhibited when spoilers are used for the ground spoiler*
R *function.*

Partial extension

The ground spoilers partially extend (10°) when reverse is selected on at least one engine (other engine at idle), and one main landing gear strut is compressed. This partial extension, by decreasing the lift, eases the compression of the second main landing gear strut, and consequently leads to full ground spoiler extension.

Retraction

The ground spoilers retract :
· After landing, or after a rejected takeoff, when the ground spoilers are disarmed.

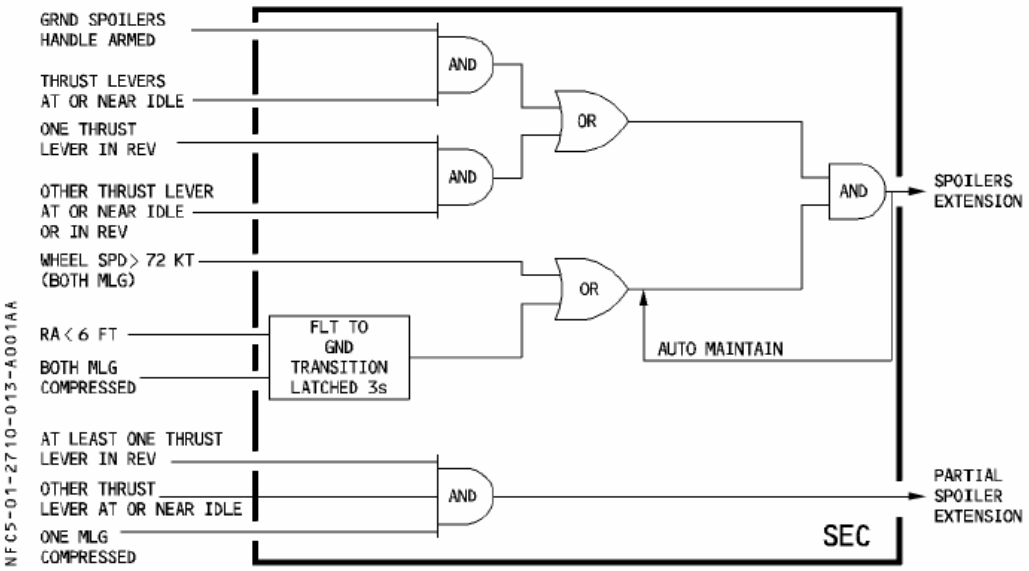
Note : If ground spoilers are not armed, they extend at the reverse selection and retract when idle is selected.

· During a touch and go, when at least one thrust lever is advanced above 20°.

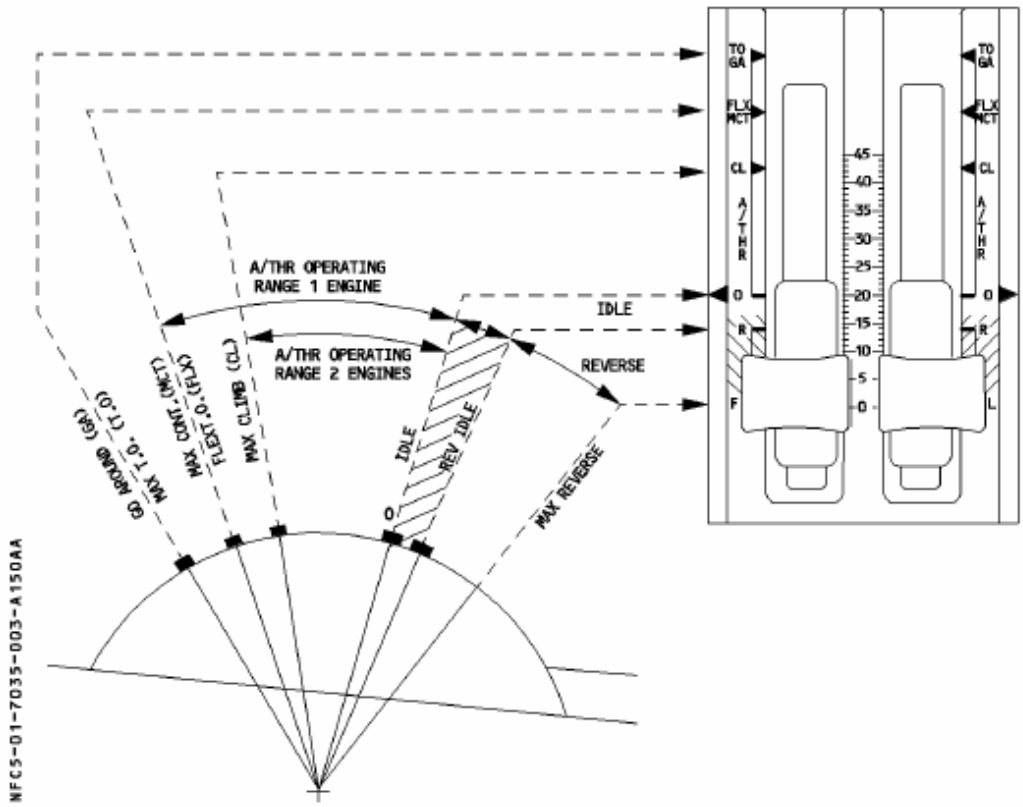
Note : After an aircraft bounce, the ground spoilers remain extended with the thrust levers at idle.

FOR INFO

R *The landing gear touchdown condition is triggered for both main landing gear, either when*
R *their wheel speed is greater than 72 knots, or when their landing gear struts are*
R *compressed and the radio altitude is very low (RA < 6 feet).*
R *For the ground spoiler logic, idle signifies :*
R *Thrust lever position < 4° or < 15° when below 10 ft*
R



THRUST LEVERS



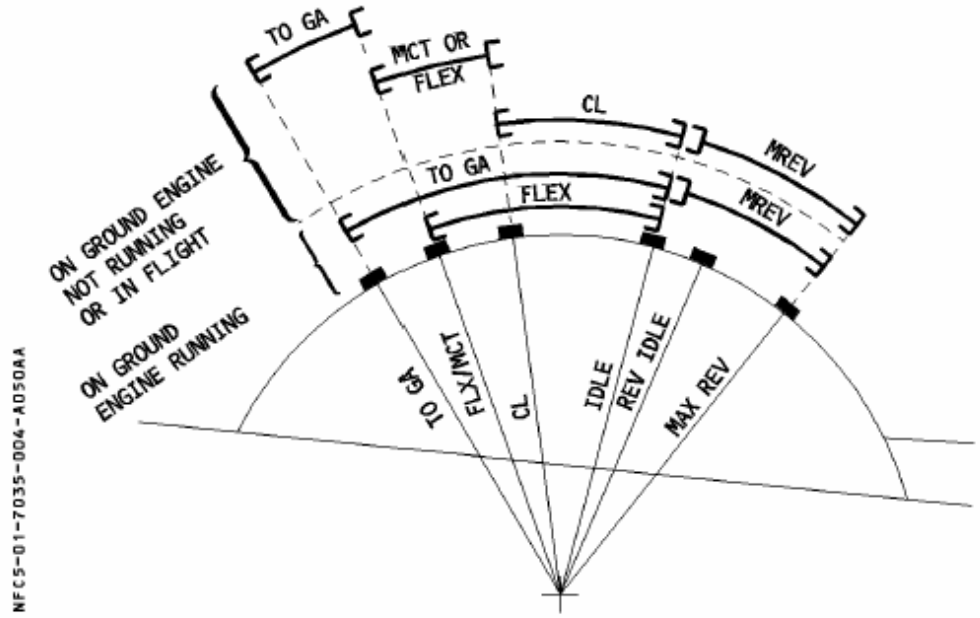
The thrust levers can only be moved manually.
They move over a sector that is divided into four operating segments.
The sector has five positions defined by detents or stops.
Thrust lever position is transmitted to the FADEC, which computes and displays the thrust rating limit and the N1 for that Thrust Lever Angle (TLA).

Note : There is no reverse idle detent. When the pilot moves the lever out of the idle stop by pulling up the reverse lever on the front of the thrust lever, he selects reverse idle.

THRUST RATING LIMIT

The FADEC computes the thrust rating limit for each thrust lever position, as shown below.
If the thrust lever is set in a detent, the FADEC selects the rating limit corresponding to this detent.
If the thrust lever is set between two detents, the FADEC selects the rating limit corresponding to the higher detent.

RATING LIMITS :



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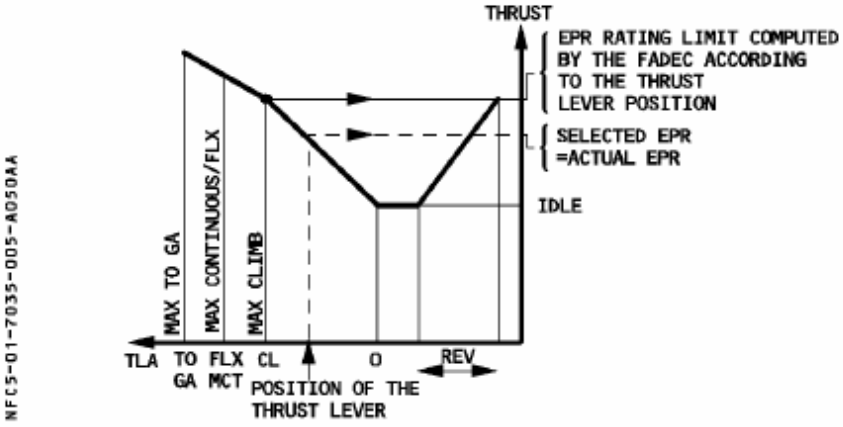
THRUST CONTROL

MANUAL MODE

The engines are in the manual mode provided the A/THR function is :
– not armed or
– armed and not active (thrust lever not in the A/THR operating range and no alpha floor).
In these conditions, each engine is controlled by the position of its thrust lever.
The pilot controls thrust by moving the thrust lever between IDLE and TOGA positions. Each position of the thrust lever within these limits corresponds to an EPR.
When the thrust lever is in a detent, the corresponding EPR is equal to the EPR rating limit computed by the FADEC for that engine.



When the thrust lever is in the FLX/MCT detent :

– **On the ground**
The engine runs at the flex takeoff thrust rating if the crew has selected a flex takeoff temperature on the MCDU that is higher than the current Total Air Temperature (TAT). Otherwise the engine produces Maximum Continuous Thrust (MCT).

Note : A change in FLEX TEMP during the takeoff has no effect on the thrust.

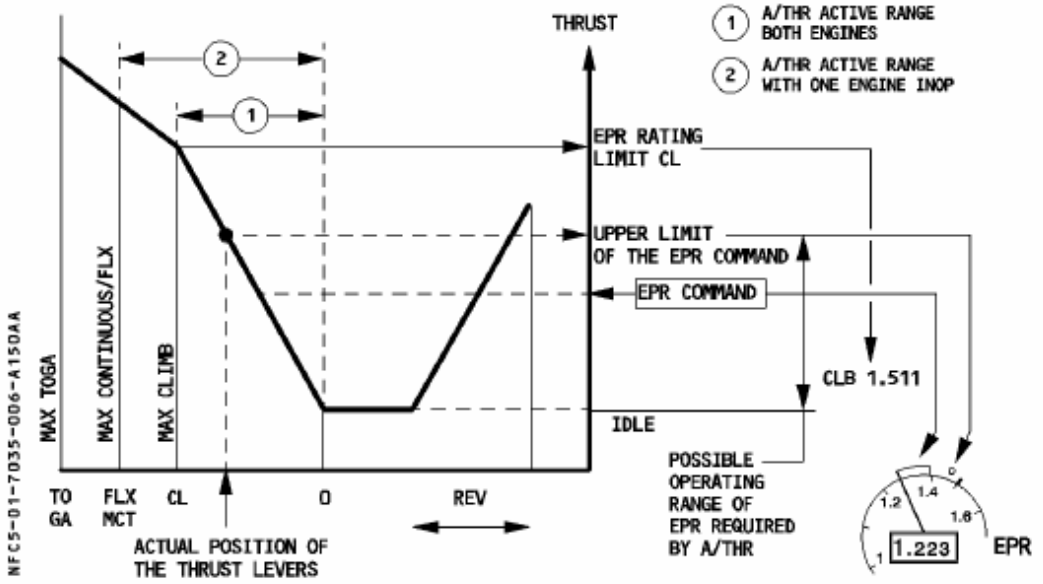
– **After takeoff**
The pilot can change from FLX to MCT by moving the thrust lever to TOGA or CL, then back to MCT. After that, he cannot use the FLX rating.

R *Note : Setting the thrust lever out of FLX/MCT detent without reaching TOGA or CL*
R *detent has no effect.*

The pilot can always get MAX TO thrust by pushing the thrust lever all the way forward.

AUTOMATIC MODE

In the autothrust mode (A/THR function active), the FMGC computes the thrust, which is limited to the value corresponding to the thrust lever position (unless the alpha-floor mode is activated).



INDICATIONS ON FMA

The FADECs monitor the positions of the thrust levers, and trigger appropriate indications on the FMA.

LVR ASYM : appears in amber (3rd line on the FMA) if, with A/THR active and both engines running, one thrust lever is set out of the CLB detent.

LVR CLB : flashes white (3rd line on the FMA) if the thrust levers are not in CL position while the aircraft is above the altitude of thrust reduction with both engines running.

LVR MCT : flashes white (3rd line on the FMA) if the thrust levers are not in MCT position after an engine failure (with speed above green dot).

1.18.5 Summary of A320 SOP

● **At touchdown:**

– **REV** ..... **MAX**

- Select MAX REV immediately after the main landing gear touches down.
  If the airport regulations restrict the use of reversers, select and maintain reverse idle until taxi speed is reached.
  A slight pitch-up, easily controlled by the crew, may appeared when the thrust reversers are deployed before the nose landing gear touches down.
  Lower the nosewheel without undue delay if MED is selected.
- In case of engine failure, the use of the remaining reverser is recommended.
- Braking may be commenced before nosewheel is down, if required for performance reasons, but when comfort is the priority it should be delayed until the nose wheel has touched down.
  During roll out, sidestick inputs (either lateral or longitudinal) should be avoided.
  If directional control problems are encountered, reduce thrust to reverse idle until directional control is satisfactory.
- After reverse thrust is initiated, a full stop landing must be made.

– **GROUND SPOILERS** ..... **CHECK**

Check that the ECAM WHEEL page shows the ground spoilers fully deployed after touchdown. Announce "Ground spoilers" then "reverse green"

– **DIRECTIONAL CONTROL** ..... **ENSURE**

- Use rudder pedals for directional control.
- Do not use the nose wheel steering control handle before reaching taxi speed.

– **BRAKES** ..... **AS RQRD**

- Monitor the autobrake, if it is on. When required, brake with the pedals.
- Although the green hydraulic system supplies the braking system, if pedals are pressed quickly a brief brake pressure indication appears on the BRAKE PRESS indicator.

● **At 80 knots:**

– **THRUST levers** ..... **REV IDLE**

70 knots is the minimum recommended speed with full reverse thrust.

CAUTION
Avoid using high levels of reverse thrust at low airspeed, because gases re-entering the compressor can cause engine stalls that may result in excessive EGT.

1.18.6 Summary of Quick Reference Hand Book

LANDING	
PF	PNF
At 20 feet :	
FLARE . . . . . PERFORM	ATTITUDE . . . . . MONITOR
THRUST LEVERS . . . . . IDLE	
At touchdown :	
REV . . . . . MAX	ANNOUNCE . . . . . "GRND SPLRS"
BRAKES . . . . . AS REQD	ANNOUNCE . . . . . "REVERSE GREEN"
At 70 knots :	
REV . . . . . IDLE	ANNOUNCE . . . . . "70 KT"
At taxi speed :	
REV . . . . . STOW	
Before 20 knots :	
AUTOBRK . . . . . DISENGAGE	

GO AROUND (WITH FD ON)	
PF	PNF
THRUST LEVERS . . . . . TOGA	
ANNOUNCE . . . . . "GO AROUND-FLAPS"	
ROTATION . . . . . PERFORM	FLAPS . . . . . RETRACT ONE STEP
ANNOUNCE . . . . . FMA	ANNOUNCE . . . . . "POSITIVE CLIMB"
ORDER . . . . . "GEAR UP"	L/G . . . . . UP
	ANNOUNCE . . . . . "GEAR UP-FLAPS"
	NAV or HDG . . . . . SELECT
At GA thrust red. altitude :	
THRUST LEVERS CL	
At GA accel altitude :	
SPEED . . . . . MONITOR	FLAPS . . . . . RETRACT ON SCHEDULE

GO AROUND (WITH FD OFF)	
PF	PNF
THRUST LEVERS . . . . . TOGA	
ANNOUNCE . . . . . "GO AROUND-FLAPS"	
ROTATION . . . . . 15° OF PITCH	FLAPS . . . . . RETRACT ONE STEP
	ANNOUNCE . . . . . "POSITIVE CLIMB"
ORDER . . . . . "GEAR UP"	L/G . . . . . UP
	ANNOUNCE . . . . . "GEAR UP-FLAPS"
At GA thrust red. altitude :	
THRUST LEVERS . . . . . KEEP TOGA	
At GA accel altitude :	
SPEED . . . . . SELECT	
PITCH . . . . . + 10°/12°	
THRUST LEVERS CL	
A/THR (if GA alt < 100 feet) . . . . . ENGAGE	FDs . . . . . ON
	NAV or HDG . . . . . SELECT
	OPEN CLIMB . . . . . ENGAGE
	FLAPS . . . . . RETRACT ON SCHEDULE
ANNOUNCE . . . . . FMA	

1.18.7 Summary of A320 Minimum Equipment List

78 EXHAUST

1. SYSTEM & SEQUENCE NUMBER ITEM	2. RECTIFICATION INTERVAL	3. NUMBER INSTALLED	4. NUMBER REQUIRED FOR DISPATCH	5. REMARKS OR EXCEPTIONS
78-30 THRUST REVERSER				
30-01 Thrust Reverser	C	2	0	* **(m) (o)** One or both may be inoperative provided: 1) The inoperative reverser is deactivated and secured in the stowed position, and no operation or procedure is predicated on thrust reversers use, and 2) No REV PRESSURIZED warning is displayed on ECAM.
OPERATING PROCEDURES **AT LANDING:** **Note:** *It is recommended not to select reverse thrust on the affected engine.*				
30-02 Reverser Inhibition Relay Switch	C	4	0	One or more may be inoperative provided the associated reverser is deactivated. Refer to **78-30-01.**
30-03 Reverser Indication	C	2	0	One or both may be inoperative provided the associated reverser is deactivated. Refer to **78-30-01**
30-04 Thrust Reverser Shut Off Valve *(Applicable to **B22310, B22311, B22606** and **B22607** only)*	C	2	0	One or both may be inoperative in open position.

ALL

2. Analysis

2.1 General

Both of pilots possess valid licenses in compliance with the requirements of ROC civil aviation regulations. Their working and resting tempo within the 72 hours before the event were normal. There was no evidence indicating that they were influenced by drugs or alcohol, or had any psychological or physiological problem when the event took place. The weight and balance of the aircraft in question were within the limited range. The airworthiness directives were all conducted and no any abnormal maintenance records were found. The structural damages to the aircraft were caused by the impact during this event and no evidence showed that the event had anything to do with mechanical factors.

The analysis is conducted based on the evidences collected during the investigation which include weather, flight operations, touchdown distance, relevant aircraft systems, and runway safety areas as follows.

2.2 Weather

2.2.1 Cancellation of Wind Shear Warning

According to FDR data, the aircraft had not encountered wind shear from approach to touchdown, as the Low Level Wind Shear Alert System (LLWAS) at Sungshan airport registered no wind shear records from 1854 to the accident occurred.

According to Sec. 7.6.2 of ROC Aeronautical Meteorological Specification (AMS), the information regarding wind shear warning over Sungshan airport is getting from air report, LLWAS and the warning issued by weather observer after the analysis of weather information are provided by controller or Automatic Terminal Information Services, ATIS (the weather information reported by ATIS is the same as METAR/SPECI) to the arriving and departing aircraft.

Sec. 7.6.6 of ICAO Annex III, which is dealing with the cancellation of wind shear warning recommends:

> *"Wind shear warnings for arriving aircraft and/or departing aircraft should be cancelled when aircraft reports indicate that wind shear no longer exists, or alternatively, after an agreed elapsed time. The criteria for the cancellation of a wind shear warning should be defined locally for each aerodrome, as agreed between the meteorological authority, the appropriate ATS authority and the operators concerned."*

Sec. 7.6.6 of AMS stipulates:

> *"Wind shear warnings for arriving aircraft and/or departing aircraft should be cancelled when aircraft reports indicate that wind shear no longer exists."*

In addition to the air report of non-existence of wind shear, the regulation with regard to the criteria for cancellation of wind shear warning is stated only in Sec. 3-1-8a, Air Traffic Control Procedures (ATP):

> *"When low level wind shear is reported by pilots or detected by the Low Level Wind Shear Alert Systems (LLWAS) or Weather Systems Processor (WSP), controllers shall issue the alert to all arriving and departing aircraft until the alert is broadcast on the ATIS and pilots indicate they have received the appropriate ATIS code. A statement "LOW LEVEL WIND SHEAR ADVISORIES IN EFFECT" shall be included on the ATIS for 20 minutes following the last report or indication of wind shear."*

However, Sec. 7.6.2 of AMS stipulates:

> *Evidences of the existence of wind shear should be derived from:*

a) *Ground-based wind shear remote-sensing equipment, for example, Doppler radar;*

b) *Ground-based wind shear detecting equipment, for example, a system of surface wind and/or pressure sensors located in an array monitoring a specific runway or runways and associated approach and departure paths.*

c) *aircraft observations during climb-out or approach phases of flight to be made in accordance with Chapter 5, 5.6.1; or*

d) *other meteorological information, for example, from appropriate sensors located on existing masts or towers in the vicinity of the aerodrome or nearby areas of high ground.*

Table 1.7-2 “Wind shear information of AIREP and LLWAS from 1220 to the time of the accident” reveals that during the time interval, there were 6 periods of time up to 20 minutes in which there is no wind shear warning from air report or LLWAS. Of which the sixth period starting from 1854 to the occurrence of the accident was even more than one hour. However, the METAR/SPECI and the ATIS continued issuing information of wind shear warning over Runway 10.

To sum up, the air traffic services unit did not cancel the wind shear warning after a period of 20 minutes without having any report or indication of wind shear, as per ATP. But the ATP are different from the associated operations of wind shear warning under the AMS, which does not include the watch of local weather observer.

2.2.2 In-flight Aircraft Report

Sec. 5.6.1 of AMS and Sec. 5.6.1 of ICAO Annex III stipulate:

> *“When other meteorological conditions not listed under 5.5, e.g. wind shear, are encountered and which, in the opinion of the pilot-in-command, may affect the safety or markedly affect the efficiency of other aircraft operations, the pilot-in-command shall advise the appropriate air traffic services unit as soon as practicable.”*

Also, the Sec. 5.6.3 of AMS stipulates and Sec. 5.6.3 of ICAO Annex III recommends:

> *“Where wind shear conditions in the climb-out or approach phases of flight were reported or forecast but not encountered, the pilot-in-command should advise the appropriate air traffic services unit as soon as practicable unless the pilot-in-command is aware that the appropriate air traffic services unit has already been so advised by a preceding aircraft.”*

The above notification requirement enable the air traffic services unit to obtain most recent information about wind shear in a timely manner and thus enhance the safety or operational efficiency of arriving and/or departing aircraft.

According to the records of Taipei aviation weather station, during the time between 1220 and the accident, 2 reports of encountering wind shear by arriving aircraft were received while no report of non-encountering wind shear was recorded. This reflects that some of the aircraft pilots did not report information about the low level wind shear as required by the aforesaid regulations.

2.3 Flight Operations

2.3.1 Weather Conditions, Landing Configuration, and System Settings

At 1928, the day of the event, the automatic terminal information service at Sungshan airport recorded: "…runway one zero in use, wind variable at 3 knots, visibility 4,500 meters, light rain, cloud scattered 800 feet, broken 1,800 feet, overcast 3,500 feet; temperature 23°C, dew point 22°C, altimeter setting 1008 hacto pascal, wind shear on runway 10… " Total landing weight of the aircraft was 55,000 kgs.

The pilots of the aircraft set the approach mode as follows: flaps "3", approach speed "137" knots, ground spoilers "ARM", autobrake "MED", anti-skid "ON". A checking with relevant flight operating manual of this type aircraft, all of the settings as described above meet Standard Operating Procedures.

2.3.2 Touchdown Point

The touchdown point[18] mentioned in this report refers to the time the shock absorber of either of the main landing gears is compressed when the main landing gear touches down the land.

The time synchronous accuracy between CVR and FDR referred in this report is ±0.5 second. At 1959:27.15, the parameter of main landing gear shock absorber[19] changed from "AIR" to "GROUND" (the main landing gear touched down on runway), when the aircraft rolling past through 1,750 feet[20] from the runway threshold of Runway 10.

At 1959:27.8, the thrust lever angle of number 1 was zero degree when the aircraft was 1,890 feet from the runway threshold of Runway 10.

At 1959:30.15, the parameter of nose landing gear shock absorber changed

---

[18] As stated in Sec.1.11, the touchdown point of the aircraft is determined by the Landing Gear RH/LH Compressed Shock Absorber and compares with two parameters of normal acceleration and vertical acceleration.

[19] Landing Gear Nose/RH/LH Compressed Shock Absorber, Word Location:20, recording time offset: 0.15 sec。

[20] Within 0.5 second from 1959:26.16, the vertical acceleration increased from 1.1g to 1.38g when the distance to the runway 10 threshold was approx. 1,480 feet and the parameter of main landing gear compressed shock absorber was "AIR" as described in Section 1.11.2 and Annex 4; the data provided by Transasia was 1,450 feet.

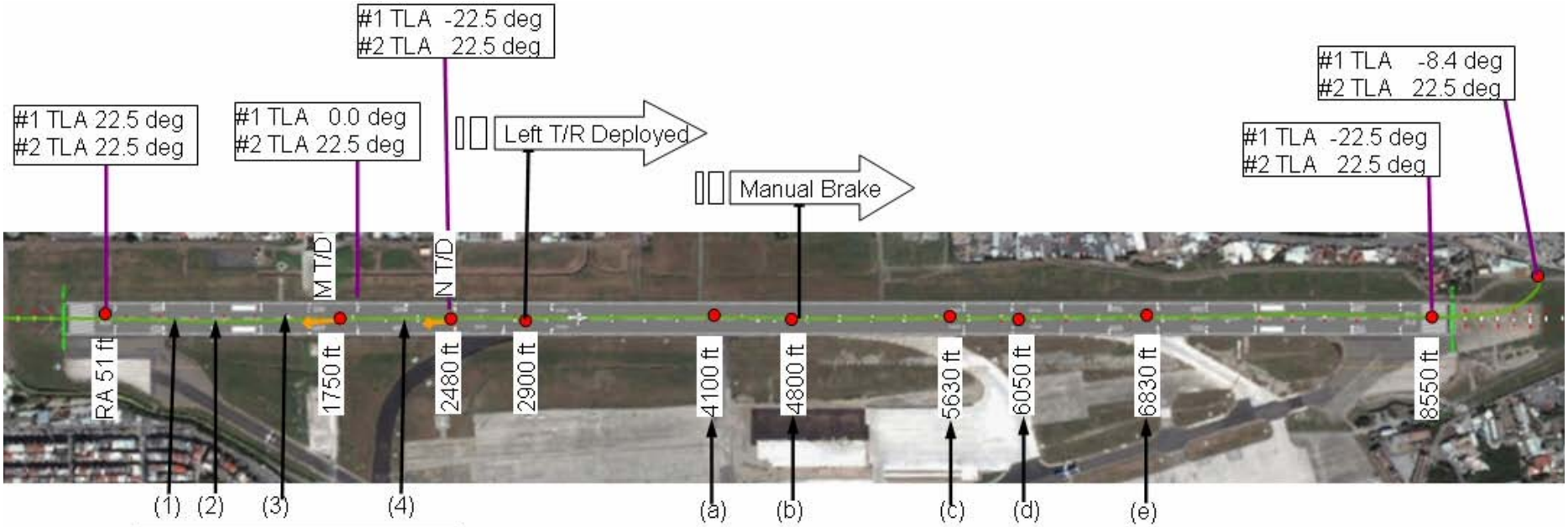
from “AIR” to “GROUND” when the aircraft was 2,480 feet from the runway threshold of Runway 10. See Figure 1.11-4.

Therefore, the touchdown point of the aircraft at 1,750 feet from the runway threshold is adopted as the actual touch down point in this report, and the touchdown point is considered normal.

2.3.3 Touchdown Operation

After converting the CVR audio data[21] into spectrogram, it is compared with FDR records. See Fig. 2.3-1 for the result of comparison.

[21] The sound inside the flight deck and pilot‘s dialogue during the time from aircraft touch down to CVR stop recording are listed in Appendix 5. .



Local Time	CVR
(1) 1959:23.4	Retard
(2) 1959:25.4	Retard
(3) 1959:26.9	Retard
(4) 1959:29.0	Retard

Local Time	Transcripts	GS
(a) 1959:37.5	沒有煞車喔	135
(b) 1959:39.9	沒有煞車喔	132
(c) 1959:44.4	沒有煞車	124
(d) 1959:46.1	沒有煞車喔	119
(e) 1959:49.8	完全沒有煞車	109

Figure 2.3-1 The relative locations determined by the CVR and FDR recorded data during landing phase.

2.3.3.1 Thrust Levers Retarding

An overall review of FDR and CVR records that the aircraft was using instrument landing system to perform the approach to runway 10, Sungshan airport, and received landing clearance at 1958:12. At radio altitude 282 feet, the autopilot was disengaged and auto thrust were maintained during approach when the positions of two thrust levers were at 22.3 degrees (somewhere between Idle and Maximum Continuous Thrust/Flexible Takeoff detent). Between the time from radio altitude 20 feet to touchdown of the aircraft main landing gears, the flight warning computer had made four audible "RETARD" callouts in the cockpit through central warning system. One second before the main wheel touched down, the position of thrust lever 1 was pulled back from 22.5 to 19.7 degrees, and one second after its touchdown, to 0 degree, and three seconds (nose wheel touched down) after the main wheel touched down, to -22.5 degrees. During the same time span, the position of thrust lever 2 was remained still at 22.5 degrees.

Section 22-4 "Landing" of Transasia's A320/321 Standard Operation Procedures includes the following description:

> ●*At about 30 feet：*
>
> - *FLARE……PERFORM*
> - *ATTITUDE……...MONITOR*
> - *THRUST levers……..IDLE*
>
> *In manual landing conditions, the call out "RETARD" is generated at 20 feet RA as a reminder. Commence a gentle progressive and allow the airccraft to touch down without prolonged float.*

According to Sec. 4.27 "SUPPLEMENTARY TECHNIQUES" of Vol. III, A320 Flight Crew Operating Manual, the description about Landing Mode is quoted as follows:

> *"……He should pull the thrust levers back at 20 feet, and the landing should occur without a long flare. Touchdown quality is better and more repeatable at fairly flat attitudes. An audible "RETARD" callout reminds the pilot if he has not pulled back the thrust levers when the aircraft has reached 20 feet."*

The pilots did not follow aforesaid standard operation procedures or supplementary techniques to pull back thrust lever 2 to "Idle" position when the aircraft was below 20 feet radio altitude and the "Retard" callouts were triggered.

The pilots were pulling back thrust lever 1 only without pulling back thrust lever 2 to Idle position while neglecting to pull both of thrust levers back to Idle positions simultaneously.

2.3.3.2 Activation of Ground Spoilers and Automatic Braking

The analysis of FDR recorded data shows that thrust lever 1 was at the positions of 0, -19.7 and -22.5 degrees in sequence within 1 to 3 seconds after the main landing gear touched down. 1 second later, i.e. at 1159:32 hr, thrust lever 2 was still remained at the position of 22.5 degrees. The in-coordination stemmed from different engine pressure ratios corresponding to the positions of the two thrust levers caused the function of auto thrust disengaged and changed to manual thrust operating mode. Meanwhile, the thrust lever 2 still stayed at the position of 22.5 degrees, amid the range of climbing thrust. Therefore, the thrust output of engine 2 was locked at EPR 1.08 before touchdown.

According to Sec. 27.10 “FLIGHT CONTROLS” of Vol. I, A320 Flight Crew Operating Manual, the description about the full extension of ground spoiler control is as follows:

Full extension

The ground spoilers automatically extend during rejected takeoff, at a speed greater than 72 knots, or at landing with both main landing gears have touched down, when:

- *Ground spoilers are armed and all thrust levers are at or near idle, or*
- *Reverse is selected on at least one engine (other thrust lever at or near idle), if ground spoilers were not armed.*

FOR INFO

The landing gear touchdown condition is triggered for both main landing gear, either when their wheel speed is greater than 72 knots, or when their landing gear struts are compressed and the radio altitude is very low (RA $<$ 6 feet).

For ground spoiler logic, idle signifies:

Trust lever position $<$ 4° or $<$ 15° when below 10 ft

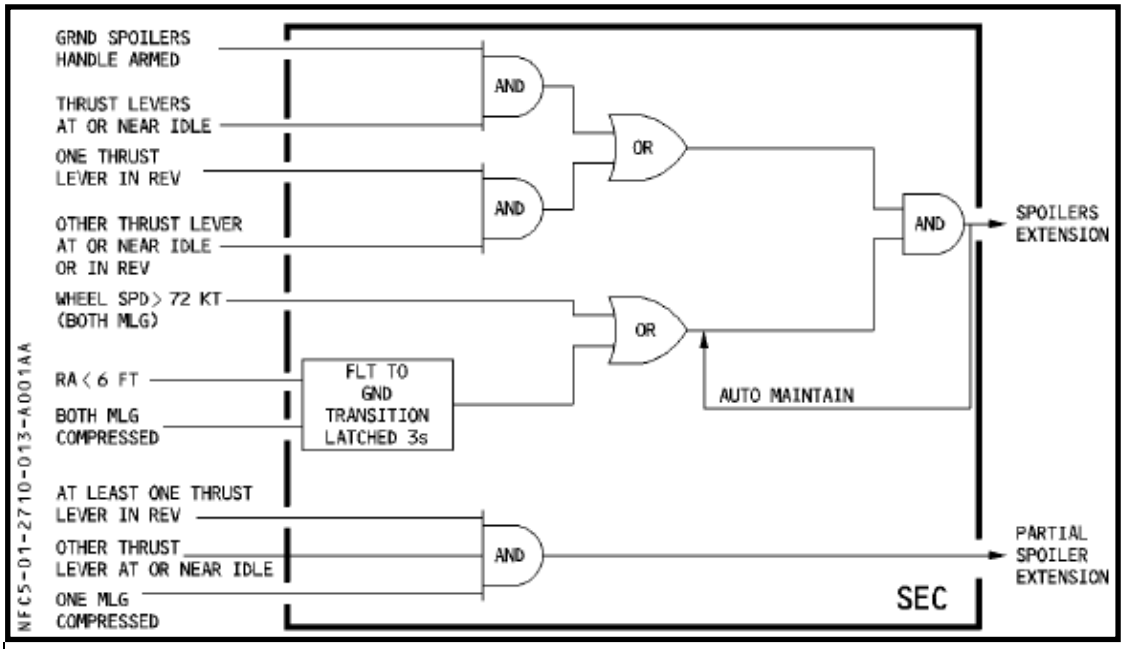


Figure 2.3-2 Ground Spoiler full extension logic

Figure 2.3-2 shows ground spoiler full extension logic: A full extension of ground spoiler has to meet the following conditions: (1) the ground spoiler handle is in Armed notch and the thrust levers are in or near “Idle” position, or one thrust lever is in reverse and the other one is at or near “Idle” position; (2) the wheel speed of both main landing gear is greater than 72 knots, or the radio altitude of aircraft is below 6 feet and both of the main landing gear struts are compressed from the manner of uncompressed.

When the auto thrust function was disengaged, thrust lever 2 was at 22.5 degrees and remained at the position which caused the ground spoiler not activated though it is at Armed position.

The auto braking function will work according to the deceleration mode preset on the auto braking control panel after the BSCU has received signal of ground spoilers deployment. The ground spoilers of the aircraft in question were not deployed, therefore, the auto braking function was not activated.

2.3.3.3 Check and announce

Sec. 22-4 “Landing” of TransAsia A320/321 Standard Operation Procedures, specifies checking ground spoilers at touchdown as follows:

> *Check that the ECAM WHEEL page shows the ground spoilers fully deployed after touchdown. Announce “Ground spoilers” then “reverse green”*

When the ground spoiler is deployed during normal touchdown, the indications to which the arrow pointed on ECAM WHEEL PAGE, see Figure 2.3-3, are green; if the ground spoilers are not deployed, the indications are such as shown in Figure 2.3-4 and the symbols “ - “ are green.

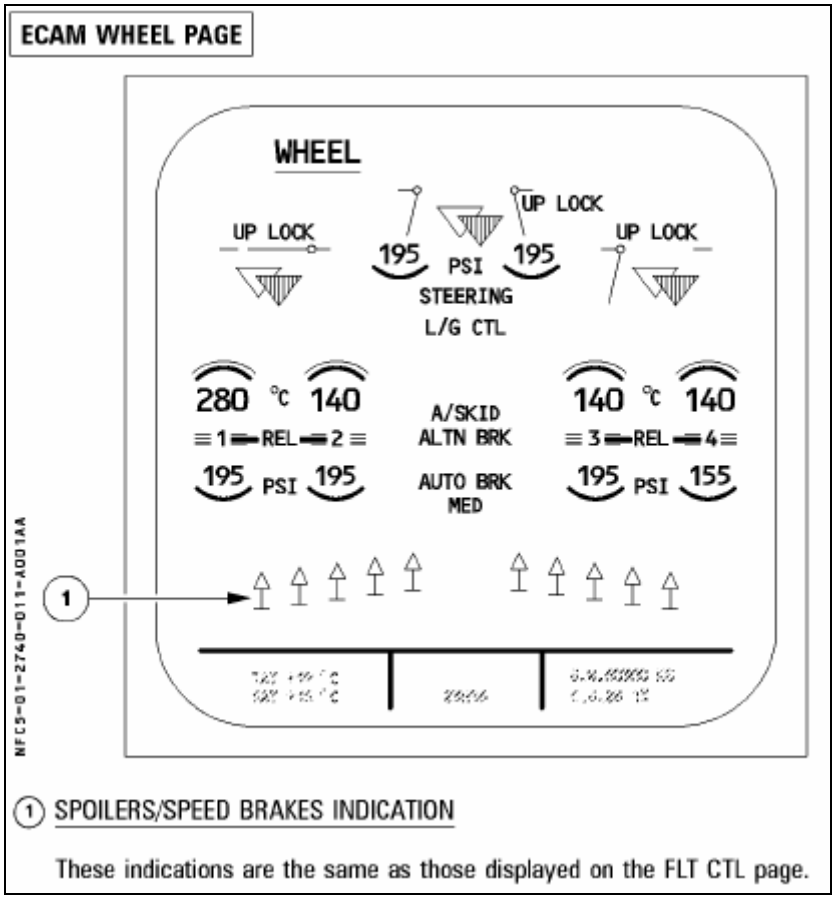


Figure 2.3-3 An ECAM display shows the ground spoilers are extended

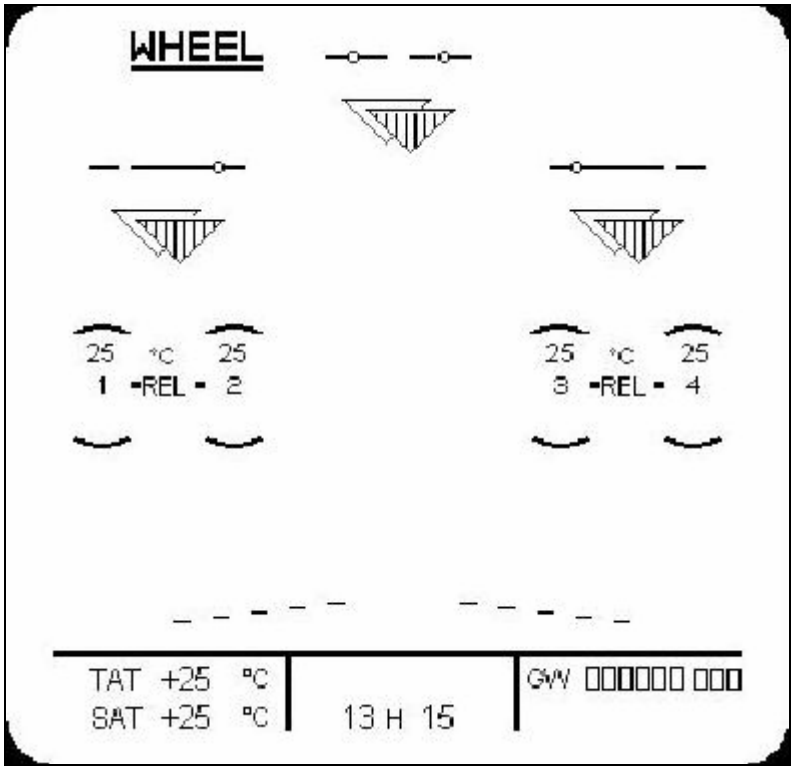


Figure 2.3-4 An ECAM display shows the ground spoilers are not extended

At 1959:27hr, the LH/RH landing gears touched down simultaneously. At 1959:29 hr, CM-1 declared “spoiler one reverse green and”. According to the analysis of Sec.2.3.3.2, as the ground spoilers were not activated and extended, the indications on ECAM screen should be “-”, as figure 2.3-4 shows. While his flight hours have exceeded 8700 hours, CM-1 is supposed to be quite familiar with the touchdown announcing practice. The ECAM page has shown that the ground spoilers were not extended, but “spoiler” was announced automatically, without any effective ECAM check. This could be translated into that the pilot did not check ECAM indications according to the requirements of SOP before announcing. Also, due to raining, tail wind, and at that time only the reverser in one side of the aircraft could be activated which tended to cause excursion, the pilots’ attention was focused on the rolling direction and deceleration, thus the retraction of ground spoilers was ignored.

The operating and security of the aircraft are captain’s full responsibilities which include ensuring every step on procedural listing is carried out [22]. The captain of this flight, acting as the pilot monitoring (PM) not only has to control overall operations and security, but also to perform the duties as a supervisor throughout the flight. Though it is not unusual to face situations which one can’t handle simultaneously, the priority shall play its role. The pilot monitoring, in terms of task sharing, shall perform his duty to check the ground spoiler indications on ECAM display according to the procedures.

2.3.3.4 Reducing Speed and Stopping Aircraft

The aircraft’s distance from the runway threshold when approaching to runway 10, its deceleration and time reference points are described as follows:

- 1959:27, 1,750 ft, main landing gears touched down;
- 1959:29, around 2,200 ft, CM-1 declared: “spoiler one reverse green and” (See Sec. 2.3.3.3 for analysis of checking and announcing;
- 1959:30, approx. 2,480 ft, nose wheel touched down;
- 1959:32, approx. 2,900 ft， reverser 1 deployed;
- 1959:37.5, approx. 4,100 ft, CM-1 said: “there’s no brake”;
- 1959:39.9，approx. 4,550 ft, CM-1 said: “there’s no brake” ;
- 1959:40, approx. 4,800 ft, started using manual brake;
- 1959:44.4, approx. 5,630 ft, CM-1 said: “ no brake”;
- 1959:46.1, approx. 6,050 ft, CM-1 said: “there’s no brake”;
- 1959:49.8, approx. 6,830 ft, CM-1 said: “No brake at all”.

Two seconds after nose wheel touched down, reverser 1 deployed. 5

[22] Item 10, Article 2, and Item 2, Article 140 of Aircraft Flight Operations Management Regulations

seconds after the deployment, CM-1 declared “no brake” for the first time when he learned the deceleration was abnormal.

The Landing Performance in Sec. 1-27 “Flight Controls” of TransAsia’s A320 Minimum Equipment List states that if the ground spoilers are not extended, the landing distance of this type of aircraft (A320-232 B22310) shall increase by 15%.

To sum up, when approaching at 20 ft radio altitude, only thrust lever 1 was pulled back and the “Retard” warnings was neglected as thrust lever 2 was not pulled back to “Idle” position. The aircraft’s landing speed was not decreased efficiently as a result of inactivation of ground spoilers and auto braking system after touchdown. Meanwhile, because the thrust output of engine 2 was remained at EPR 1.08 and the wet runway became slippery, the aircraft was not able to achieve substantial speed reducing on the residual runway and overrun the runway though the maximum manual braking was applied[23].

[23] No physical actions on brake pedals were recorded in the early 13 sec after touchdown.

2.4 Landing Distance

According to the valid version of Taipei Flight Information Region (AIP) as of the date when accident took place, the available landing distance[24] of Runway 10 is 8,550 feet.

Based on the FDR recorded data, landing weight, and landing configurations,[25] the required landing distance[26] at different deceleration conditions are calculated and presented in Appendix 4 and Appendix 6.

According to the FDR recorded data and such conditions as－no auto braking, manual braking being applied 15 seconds after main landing gear touchdown, spoilers not deployed, using maximum reverse thrust of engine 1, and the thrust output of engine 2 fixed at EPR 1.08,[27] the ground rolling distances[28] the aircraft requires analyzed under different wet runway conditions[29] are listed in Table 2.4-1.

Table 2.4-1 Landing distances calculated under different surface conditions

Scenario No.	Surface	Touch Down pnt (ft)	Manual brake	spoilers	Engine 1	Engine 2 EPR	Rolling distance (ft)	LDA (ft)	Speed at #28 runway excursion (kt/hr)
1	Dry	1,750	Auto Brake	Deployed	REV max	1.00	3,770	6,800	Sufficient for stop
2	Wet	1,750	Auto Brake	Deployed	REV max	1.00	3,770	6,800	Sufficient for stop
3	Wet	1,750	T/D+ 15 s	Retracted	REV max	1.08	7,810	6,800	67[30]
4	Water 1/4"	1,750	T/D+ 15 s	Retracted	REV max	1.08	9,270	6,800	81
5	Water 1/2"	1,750	T/D+ 15 s	Retracted	REV max	1.08	9,270	6,800	53

[24] Landing Distance Available（LDA） refers to CAA publicized runway length available for touched down aircraft rolling.

[25] 55,140 kg, Flap 3，Air Speed 136 kt/hr at 50 ft RA, Ground Speed 146 kt/hr at touch down, Pressure altitude 28 ft, Runway slope -0.21%, Temperature 25°C, Wind 0.00 kt.

[26] Landing Distance（LD） refers to the horizontal distance between the point when the aircraft is at 50 ft RA and the point where aircraft fully stops on the runway.

[27] The thrust output at Idle is EPR 1.00. The thrust is based on the FDR data where the thrust lever was at 22.5 degree.

[28] Ground Rolling Distance refers to the horizontal distance between the main wheel touch down point and full stop of rolling.

[29] The aircraft manufacturer's flight performance analysis program is applied to analyzing the FDR data.

[30] Squaring with FDR records

In summary, with a dry/wet runway and the thrust lever no.2 at Idle, applied auto braking regardless of the ground spoilers are deployed or not, the available landing distance of Runway 10 is well sufficient for the aircraft to decelerate to a full stop. However, under the conditions of wet runway, thrust lever no. 2 remained at EPR 1.08, ground spoilers retracted, and auto braking system inactivated and manual braking being used 15 seconds after touchdown, the landing distance available on runway 10 is not sufficient for the aircraft to decelerate to a full stop.

2.5 Relevant aircraft systems

2.5.1 Automatic extension function of ground spoilers

The test conducted according to Sec. 1.16.1 Ground Spoiler Test has shown that all of the ground spoilers will not automatically extend if any of the thrust control levers is remained at 22.5 degree while the other one is at idle position or within the range of reverse though all other conditions meet the normal requirements. If the two levers are pulled back to a position less than 15 degrees, all of the ground spoilers will extend. The test has revealed that the automatic extension function of ground spoilers worked normally.

The FDR records indicate that all of the ground spoilers were not extended during the time from the aircraft touched down to complete stop. Sec. 1.6.2 points out that one of the conditions for ground spoilers to extend is “the angle of both thrust control levers has to be less than 20 degrees.” At 1959:26 （1 second before the main landing gear touched down）, thrust control lever no.2 was at the position of 22.5 degree. At 2000:37 the aircraft completely stopped, the lever was pulled back to -3 degrees from 22.5 degrees. The ground spoilers were not extended automatically because the thrust control lever no.2 was at a position greater than 20 degrees.

2.5.2 Braking system

Table 1.11-2 “The relevant parameters of BPP, NBP and ground speed” indicates that the angle of left and right brake pedal began increasing from 1959:40, the braking pressure increased significantly and the speed decelerated accordingly. The examination under Sec. 1.16.2 indicates that the braking pressure of the braking system and the condition of tires have been normal. Before landing, the autobrake mode was set at MED position which showed the pilots’ intention using the automatic braking system to decelerate the aircraft after touchdown. Sec. 1.6.2 indicates that the auto braking system can only be activated when the ground spoilers are extended. But in this occurrence, the ground spoilers didn’t extend, therefore the automatic braking system was not activated to decelerate aircraft.

The above analysis indicates that after the aircraft touched down, the ground spoilers were not extended automatically because the thrust control lever no.2 was at a position greater than 20 degrees, which also led to automatic braking system not activated.

2.5.3 Reversers

According to FDR recorded data and the post-occurrence test (see Sec. 1.16.2.2), the function of thrust reverser no.1 was normal. Before flight the thrust reverser no.2 was inoperative. As per MEL instruction, the thrust reverser no.2 was deactivated and the defect was logged into deferred defect items.

2.5.4 Throttle Position Alert Device

As mentioned above, the ground spoilers and auto braking system were not activated timely to decelerate aircraft due to thrust control lever no.2 was not pulled to idle position. Though the Flight Warning Computer （FWC） had delivered four “RTARD” aural alerts at 20 ft RA before the aircraft touched down, the pilots did not pulled the thrust control lever no.2 back to idle position.

When auto throttles are used under normal conditions, if any of thrust control levers is not pulled to idle position, no matter using the automatic landing or the manual landing, at 10 ft or 20 ft RA the FWC will deliver “RETARD” aural alert and then automatically stop when both thrust control levers are pulled back to idle position. From 1959:23(at 23 ft RA), the FWC began to deliver “RETARD” aural alert. After four times alert, it automatically stopped but not caused by the both thrust control levers at idle position. According to the documents provided by the aircraft manufacturer, the reason of “RETARD” stop was caused that the thrust control lever no.1 was at reverse position. When the FWC detected an internal signal of TLA inhibition which includes either thrust control lever at REV position and then FWC stopped the aural “RETARD” alert.

During landing, the FWC has delivered four aural “RETARD” alerts and then after touchdown two seconds it came to stop. But at this moment the thrust control lever no.2 was not pulled back to idle or reverser position yet. In this situation, one of thrust control lever is not in proper position but the aural “RETARD” alert already stopped. The aural “RETARD” alert should continue or there should be other ways to remind the pilots of pulling back thrust control lever to reduce the probability of an accident caused by human error.

2.6 Runway Safety Area

In order to reduce risk factors to prevent aircrafts from damages that may occur due to undershooting or overrunning and to improve the safety of aircraft during take-off or landing phase, the Civil Aerodrome Design and Operation Standard (CADOS) calls for the establishment of Runway Safety Area which include: 1. runway stripe; 2. the graded portion of runway stripe; 3. runway end safety area, as shown in Figure 2.6-1. Unless its function requires it to be there for air navigation purpose, no equipment or installations are allowed within the Runway Safety Area (see Section 8.7.1), even which shall use fragile material (see Section 8.7.2, 8.7.3 and 8.7.4). Also, the graded portion of runway stripe shall be a flat, non-obstacle area (see Section 3.3.8 and 3.4.7). The purposes of these restrictions lie in minimizing the casualties and damages to aircraft in case of an aircraft excursion or overrun.

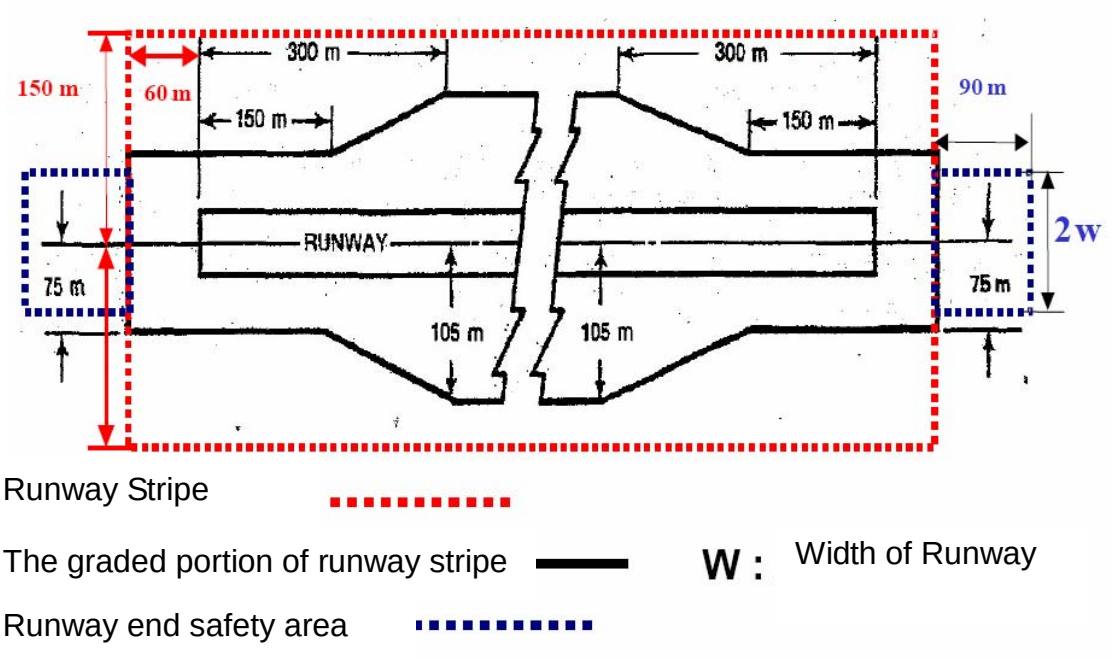


Figure 2.6-1 Runway Safety Area including aprecision approach runway when the code number is 3 or 4

According to Section 3.3.2、3.3.3、3.3.8、3.4.1、3.4.2 and 3.4.4 of the CADOS, the Runway 10/28 of Sungshan Airport shall be a rectangular region 2,945 meters in length[31] and 300 meters in width.[32] The runway end safety area shall extend from the end of the runway stripe to a distance of at least 90m.

[31] It is the sum of AIP declared runway length 2,605 meters, plus 60/160 meters of buffer zone at the ends of runway10/28, and a 60 meters length extension at each end of both buffer zones.

[32] Extending 150 meters laterally from both the runway central line and its extension line

The width of the runway end safety area shall be at least 120m[33], see Figure 2.6-2. However, there is a fixed fence about 15 meters to the north of the sideline of Runway 28 threshold. In case of an aircraft excursion, the fence and the civilian houses outside the fence could be stricken. In addition, there is an east-west uncovered drainage ditch extended irregularly at the site 43 to 69 meters to the north of central line of runway and its stopway. The ditches do not meet the requirements which call for flatness within the graded portion within the runway stripe.

In summary, part of Runway Safety Area in Sungshan airport does not meet the requirements of the CADOS.

In reference to AC150/5220-22 Engineered Material[34] Arresting System introduced by U.S. Federal Aviation Administration, the employment of such system in the runway of shall to a certain degree reduce the damage and casualties in case of an aircraft excursion, as the Runway Safety Area has not met the official requirements temporarily due to the limits of city development and natural obstacles.

[33] Extending 60 meters laterally from both the runway central line and its extension line.

[34] Engineered Material means high energy absorbing materials of selected strength, which will reliably and predictably crush under the weight of an aircraft.

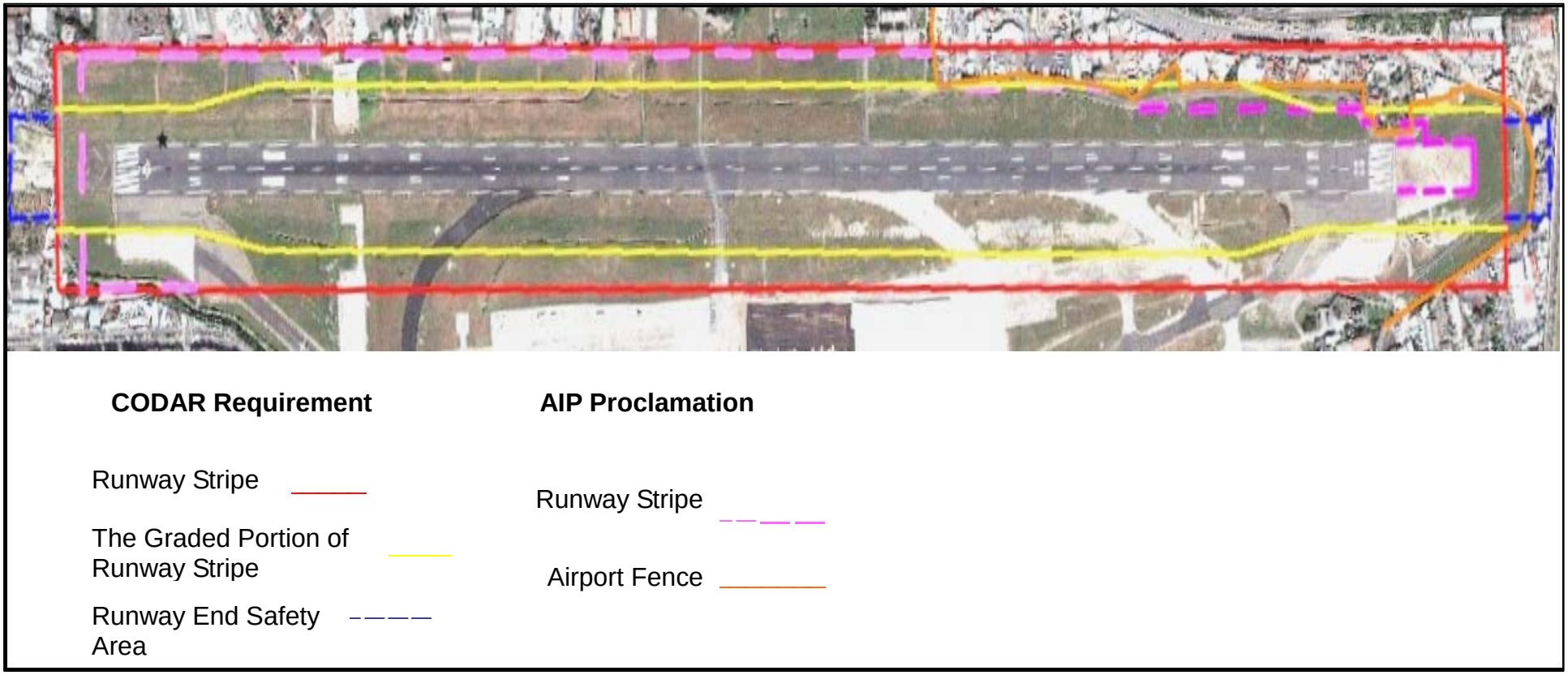


Figure 2.6-2 A comparison between official Runway Safety Area requirements and AIP Proclamation

3. Conclusions

In this Chapter presents the findings derived from the factual information gathered during the investigation and the analysis of this accident. The findings are presented in three categories: findings related to probable causes, findings related to risk, and other findings.

The findings related to the probable causes identify elements that have been shown to have operated in the accident, or almost certainly operated in the accident. These findings are associated with unsafe acts, unsafe conditions, or safety deficiencies that are associated with safety significant events that played a major role in the circumstances leading to the accident.

The findings related to risk identify elements of risk that have the potential to degrade aviation safety. Some of the findings in this category identify unsafe acts, unsafe conditions, and safety deficiencies that made this accident more likely; however, they can not be clearly shown to have operated in the accident. They also identify risks that increase the possibility of property damage and personnel injury and death. Further, some of the findings in this category identify risks that are unrelated to the accident, but nonetheless were safety deficiencies that may warrant future safety actions.

Other findings identify elements that have the potential to enhance aviation safety, resolve an issue of controversy, or clarify an issue of unresolved ambiguity. Some of these findings are of general interest and are not necessarily analytical, but they are often included in ICAO format accident reports for informational, and safety awareness, education, and improvement purposes.

3.1 Findings Related to Probable Causes

1. When the aircraft was below 20 ft RA and Retard warnings were sounded, the pilot flying didn’t pull thrust lever 2 to Idle detent which caused the ground spoilers were not deployed after touchdown though they were at Armed position, therefore the auto braking system was not triggered. Moreover, when the auto thrust was changed to manual operation mode automatically after touchdown, the thrust lever 2 was remained at 22.5

degrees which caused the Engine 2 still had an larger thrust output (EPR1.08) than idle position's. Thereupon, the aircraft was not able to complete deceleration within the residual length of the runway, and deviated from the runway before came to a full stop, even though the manual braking was actuated by the pilot 13 seconds after touchdown. （1.11.2、2.3.2、2.3.3、2.4）

2. The pilot monitoring announced "spoiler" automatically when the aircraft touched down without checking the ECAM display first according to SOP before made the announcement, as such the retraction of ground spoilers was ignored. (2.3.3)

3.2 Findings Related to Risk

1. After touchdown, when the thrust lever 2 was not pulled back to Idle position and the Retard warning sounds have ceased, there were no other ways to remind pilots to pull back the thrust lever.（2.5.4）

2. The diminution of Runway Safety Zone proclaimed by Sungshan airport, and the fixed objects of non auxiliary aviation facilities and uncovered drainage ditch within the area do not meet the requirements of Civil Airports Designing and Operating Regulations.（2.6）

3.3 Other Findings

1. Both pilots have the valid licenses in compliance with the requirements of ROC civil aviation regulations. Their working and resting tempo within the 72 hours before the accident were normal. There was no evidence indicating that they were affected by drugs or alcohol, or by any psychological or physiological problem when the accident took place.（1.5、2.1）

2. The weight and balance of the aircraft in question were within the range of limits. Its flightworthiness directives were all performed and no abnormal maintenance records were noted. The structural damages were caused by the impact in this accident and no evidence showed the accident had any connection with mechanical factors.（1.6、1.12、2.1）

3. The regulations regarding issuing and canceling wind shear warning in Aviation Control Procedures and in Aviation Meteorology Regulation are inconsistent.（2.2.1）

4. All of the arriving and departing pilots in Sungshan airport have received wind shear warning from 1220 to the time the event occurred, but none of them followed the Aviation Meteorology Regulations to inform their flight service units as they had not encountered wind shear.（2.2.2）

5. The settings of landing configuration, speed and relevant systems of the aircraft met the requirements of related manuals of this type aircraft.（2.3.1）

4. Safety Recommendations

In this chapter, safety recommendations derived as the result of this investigation are listed in Section 4.1. Safety actions that have been accomplished, or are currently being planned by the stakeholders as the result of the investigation process are listed in Section 4.2. It should be noted that the Safety Council has not verified the safety actions. Therefore, those recommendations is still listed even they have already been implemented.

4.1 Recommendations

4.1.1 Interim Flight Safety Bulletin

Document No.: ASC - IFSB - 04 - 10 - 001

Issued date: 20 October 2004

1. Improving pilots' operation skills on aircraft landing on wet runway; strengthening training and rating on aircraft deceleration systems; and promoting crew cooperation and their familiarity with consulting and employing the aircraft performance information.
2. Conducting special review of maintenance and quality assurance operations of aircraft deceleration system.
3. Review runway friction coefficient and tire scraps cleaning operation procedures, and conducting a specific check of the runway friction coefficient.

4.1.2 Safety Recommendations

To TransAsia Airways (TNA)

1. Strengthening education and training on "the design and control logic of thrust lever and ground spoilers" for the pilots of A320/A321fleet.（ASC-ASR-06-03-001）
2. Demanding fleet pilots to perform checking and announcing procedures

when performing landing according to the standard operation procedures and the requirements specified in relevant flight manual.（ASC-ASR-06-03 -002）

To Civil Aeronautics Administration, ROC (CAA)

1. Reviewing the operating regulations and procedures in regard of issuing and canceling wind shear warning.（ASC-ASR-06-03 –003）
2. Reviewing the regulations and procedures for the aviation operators to notify information about wind shear, and demanding the operators to closely follow them.（ASC-ASR-06-03 –0043）
3. Continuing to improve the Runway Zone, Runway Leveling Zone and Runway Threshold Safety Zones to meet the requirements set forth in Civil Airports Designing and Operating Regulations.（ASC-ASR-06-03–005）

To Airbus Company

1. Reviewing the design of stop mode of Retard warning sounds or accommodating other warning methods to ensure that the warning will continue before the thrust levers are pulled back to Idle notch after a touchdown has affirmed.（ASC-ASR-06-03 –006）

4.2 Safety Actions Taken or Being Planned[35]

According to the Airbus Company

1. In response to: *Reviewing the design of stop mode of Retard warning sounds or accommodating other warning methods to ensure that the warning will continue before the thrust levers are pulled back to Idle notch after a touchdown has affirmed*.

Airbus Company Response:

Airbus has developed a specific warning when one throttle is set to reverse while the other is above idle. This warning generates an ECAM warning "ENG x THR LEVER ABV IDLE", a continuous repetitive chime (CRC), and lights the red master warning light. This new warning is implemented in the FWC standard "H2F3".

A Service bulletin will be issued very soon on this subject.

[35] The Safety Actions Taken or Being Planned of TNA and CAA are listed in the Chinese version of the Final Report.

Appendix 1 GE536 CVR Transcript

Legend:

CM1: radio communication from captain (pilot not flying)

CM2: radio communication from first officer (pilot flying)

CAM: sounds from cockpit area microphone

CAM1: captain voice from CAM

CAM2: first officer voice from CAM

PA: recording of public address

KHH：Kaohsiung approach

TCH：Taichung approach

ACC: Taipei area control center

APP: Taipei approach

TWR: Sungshan tower

---: source unknown

…: content unintelligible

*: communication not related to operation

() : remarks

~: communication interrupted

CAL616、CAL678、CAL688、CPA401、EVA228、FEA082、FEA137、MDA280、MDA732、MDA747、TNA242、TNA374、TNA535、UNI615、UNI829、UNI830、UNI831、UNI93 stand for other flights appeared in the recording

Time	Source	Content	Translation
1931:32	PA	各位貴賓現在扣緊安全帶的警示燈已經熄滅了 但是為了要預防突然間不穩定的氣流所以請您在座位上將安全帶扣好 在機艙內請不要使用行動電話及相關電子用品 謝謝您的合作(以台語複述)ladies and gentlemen please fasten your seat belt whenever seated according to last CAA regulation may we remind you cell phone radio transmitter remote control for any other electronic devices must not be used please kindly switch it off thank you for your cooperation 各位貴賓在本段的航程中我們將提供您選擇的飲料有熱咖啡熱烏龍茶柳橙汁以及熱的蜂蜜菊花茶希望您對我們的服務感到滿意謝謝	(public address in Chinese, Taiwanese and English)
1931:34	KHH	（KHH 與 UNI829 間對話）	(communication between KHH and UNI829)
1931:37	UNI829	（KHH 與 UNI829 間對話）	(communication between KHH and UNI829)
1931:40	KHH	transasia five tree six climb and maintain flight level one niner zero	
1931:43	CM1	climb and maintain flight level one niner zero transasia five tree six	
1931:47	KHH	（KHH 與 AR55 間對話）	(communication between KHH and AR55)
1932:02	CAM	（不明聲響）	(unknown sound)
1932:13	CAM2	它在我們後面一點	It's just behind us
1933:12	CAM2	*	
1933:15	KHH	（KHH 與 UNI829 間對話）	(communication between KHH and UNI829)
1933:17	CAM1	*	
1933:19	CAM2	*	
1933:21	UNI829	（KHH 與 UNI829 間對話）	(communication between KHH and UNI829)
1933:24	KHH	（KHH 與 UNI829 間對話）	(communication between KHH and UNI829)

Time	Source	Content	Translation
1933:31	UNI829	（KHH 與 UNI829 間對話）	(communication between KHH and UNI829)
1933:33	CAM1	*	
1933:34	CAM2	*	
1933:36	CAM1	*	
1933:38	KHH	transasia five tree six contact taichung approach one two niner point six	
1933:42	CM1	嗯 taichung approach one two niner point six good day ma'am transasia five tree six	Uh taichung approach one two niner point six good day ma'am transasia five tree six
1933:48	KHH	（KHH 與 MDA280 間對話）	(communication between KHH and MDA829)
1933:49	CAM1	*	
1933:54	CAM2	*	
1933:59	CAM1	*	
1934:09	CM1	taichung approach good evening transasia five tree six climbing to flight level one niner zero	
1934:14	TCH	transasia five tree six taichung approach roger	
1934:18	CAM1	*	
1934:22	CAM2	*	
1934:23	CAM1	*	
1934:25	UNI615	（TCH 與 UNI615 間對話）	(communication between TCH and UNI615)
1934:30	TCH	（TCH 與 UNI615 間對話）	(communication between TCH and UNI615)
1934:33	UNI615	（TCH 與 UNI615 間對話）	(communication between TCH and UNI615)
1934:42	CAM2	*	
1934:59	CAM1	*	
1935:04	TCH	（TCH 與它機間對話）	(communication between TCH and an unknown aircraft)
1935:25	CAM2	*	
1935:29	CAM1	*	
1935:30	TCH	（TCH 與 UNI615 間對話）	(communication between TCH and UNI615)
1935:33	UNI615	（TCH 與 UNI615 間對話）	(communication between TCH and UNI615)
1935:46	CAM1	*	
1936:33	TCH	（TCH 與 UNI9631 間對話）	(communication between TCH and UNI615)
1936:50	CAM1	*	
1936:56	CAM2	*	
1936:58	CAM1	*	

Time	Source	Content	Translation
1937:18	CAM1	你先用那個天氣吧 我這個還收不到 喔 來了 那我來收	You use that weather report first I haven't received the ATIS yet uh it's coming I'll take it
1937:21	CAM2	…	
1937:21	ATIS	three thousand five hundred feet temperature two three QNH one zero zero eight hacto pascal low level wind shear advisory in effect moderate to sever ~mation zulu sungshan airport information zulu one one two eight zulu expect ILS approach runway one zero in use wind variable at three ~five hundred meter light rain cloud scatter ~ one thousand eight hundred feet overcast three thousand ~ temperature two three dew point two two QNH one zero zero eight hacto pascal wind shear on runway one zero low level wind shear advisory in effect moderate to severe inform taipei approach or sungshan tower~	
1937:26	CAM	（機械聲）	(mechanical sound)
1937:27	CAM1	you have radio please	
1937:27	TCH	transasia five tree six contact taipei control one two six point seven good day	
1937:32	CM2	five tree six good day	
1937:39	CM2	taipei control good evening transasia five tree six flight level one niner zero four nine dme to houlung identing	
1937:46	ACC	transasia five tree six taipei control roger	
1937:54	ACC	（ACC 與 CAL616 間對話）	(communication between ACC and CAL616)
1938:00	CAL616	（ACC 與 CAL616 間對話）	(communication between ACC and CAL616)
1938:06	ACC	（ACC 與 CAL616 間對話）	(communication between ACC and CAL616)
1938:25	ACC	（ACC 與 TNA374 間對話）	(communication between ACC and TNA374)

Time	Source	Content	Translation
1938:29	TNA374	（ACC 與 TNA374 間對話）	(communication between ACC and TNA374)
1938:31	CAM1	還是一樣 low level wind shear moderate turbulence	Still the same low level wind shear moderate turbulence
1938:37	CAM2	sir moderate turbulence	
1938:37	ACC	（ACC 與 CAL688 間對話）	(communication between ACC and CAL688)
1938:38	CAM	（機械聲）	(mechanical sound)
1938:41	CAL688	（ACC 與 CAL688 間對話）	(communication between ACC and CAL688)
1938:42	CAM1	I have radio sir	
1938:47	CAM1	現在台北 control 好	Now at taipei control okay
1938:49	CAM2	對	Right
1939:04	ACC	（ACC 與 CAL688 間對話）	(communication between ACC and CAL688)
1939:08	PA	晚安各位先生各位女士這是副機師報告 歡迎各位搭乘復興航空第五三六班次由台南飛往台北松山 我們現在飛行的高度是一萬九千英呎 Average 的地速大約每小時八百公里 目前松山天氣嗯多雲下雨地面氣溫二十三度 C 預計抵達的時間大約在晚間的八點鐘左右 感謝各位的搭乘 全體組員敬祝各位身體健康旅途愉快謝謝 good evening ladies and gentlemen this is the first officer speaking welcome board transasia airways flight number five thee six from tainan to sungshan and now we are flying at nineteen thousand feet average ground speed is about eight hundred kilometer per hour with forecast at sungshan is raining now ground temperature about twenty three degrees and estimate arrival at eight o’clock PM thanks for flying with us have nice trip thank you	(public address in Chinese and English)
1939:09	CAL688	（ACC 與 CAL688 間對話）	(communication between ACC and CAL688)

Time	Source	Content	Translation
1939:41	ACC	（ACC 與 CPA401 間對話）	(communication between ACC and CPA401)
1939:47	CPA401	（ACC 與 CPA401 間對話）	(communication between ACC and CPA401)
1940:03	ACC	transasia five tree six descend and maintain flight level one five zero descend now	
1940:08	CM1	descend to one five zero we are leaving transasia five tree six	
1940:17	CAM1	VS descend flight level one five zero	
1940:18	ACC	(communication between ACC and TNA374)	
1940:21	CAM2	sir cruise checklist complete…	
1940:26	CAM2	weather at sungshan wind shear VMC …approach speed... radio nav houlung zero five two anpu lima kilo oscar progress... MDA two six three... approach chart... ITSG... outer marker position two thousand… houlung one zulu after houlung via zero five two radial zonli four thousand cross zonli descend three thousand five hundred feet until tazan inbound course zero niner five go around procedure oscar lima uniform ...oscar lima uniform four thousand hold at lima uniform or radar vector... cleared for approach flight director autopilot autothrust decelerate approach one thousand stable in case go around I will call out ...	
1940:26	TNA374	(communication between ACC and TNA374)	
1940:31	ACC	(communication between ACC and CAL688)	
1940:36	CAL688	(communication between ACC and CAL688)	
1940:58	ACC	(communication between ACC and EVA228)	

Time	Source	Content	Translation
1941:03	EVA228	(communication between ACC and EVA228)	
1941:06	ACC	(communication between ACC and EVA228)	
1941:09	ACC	(communication between ACC and TNA374)	
1941:13	TNA374	(communication between ACC and TNA374)	
1941:22	CAL678	(communication between ACC and CAL678)	
1941:26	ACC	(communication between ACC and CAL678)	
1941:31	CAL678	(communication between ACC and CAL678)	
1941:37	ACC	(communication between ACC and MDA280)	
1941:39	PA	各位貴賓我們正經過不穩定的氣流請務必留在座位上扣好安全帶謝謝 (同時以國語、台語及客語複述) ladies and gentlemen we are now passing through turbulence please fasten your seat belt thank you	(public address in Chinese, Taiwanese, Hakka and English)
1941:41	MDA280	(communication between ACC and MDA280)	
1941:55	ACC	transasia five tree six contact taipei approach one one niner point seven	
1942:00	CM1	one niner point seven good night sir five tree six	
1942:04	ACC	Right	
1942:04	APP	(communication between APP and FEA082)	
1942:06	FEA082	(communication between APP and FEA082)	
1942:07	CAM1	you have control	
1942:09	CAM2	yes I have control	
1942:10	CAM1	VS descend to one five zero	
1942:11	CAM2	check	
1942:11	APP	(communication between APP and FEA137)	
1942:12	CAM1	我把速度減到…	I reduce the speed to…
1942:14	FEA137	(communication between APP and FEA137)	
1942:21	APP	(communication between APP and FEA137)	

Time	Source	Content	Translation
1942:24	FEA137	(communication between APP and FEA137)	
1942:29	CM1	taipei approach good evening transasia five tree six descend flight level one five zero	
1942:34	APP	transasia five tree six taipei approach ident taipei QNH one zero zero niner	
1942:39	CM1	one zero zero niner transasia five tree six	
1942:45	TNA535	(communication between APP and TNA535)	
1942:56	APP	(communication between APP and TNA535)	
1942:58	TNA535	(communication between APP and TNA535)	
1943:02	APP	(communication between APP and TNA535)	
1943:05	TNA535	(communication between APP and TNA535)	
1943:08	APP	(communication between APP and MDA747)	
1943:11	MDA747	(communication between APP and MDA747)	
1943:13	APP	(communication between APP and MDA747)	
1943:14	MDA732	(communication between APP and MDA732)	
1943:17	APP	(communication between APP and MDA732)	
1943:19	MDA732	(communication between APP and MDA732)	
1943:20	APP	(communication between APP and TNA242)	
1943:24	TNA242	(communication between APP and TNA242)	
1943:28	CM1	taipei approach transasia five tree six approaching flight level one five zero	
1943:32	APP	transasia five tree six descend and maintain five thousand	
1943:36	CM1	descend five thousand five tree six	
1943:39	APP	(communication between APP and TNA242)	
1943:42	CAM2	idle descend five thousand	

Time	Source	Content	Translation
1943:42	TNA242	(communication between APP and TNA242)	
1943:43	CAM1	check	
1943:44	APP	(communication between APP and TNA242)	
1943:48	TNA242	(communication between APP and TNA242)	
1943:52	APP	(communication between APP and TNA242)	
1943:53	APP	transasia five tree six proceeding ATR over putin speed two one zero	
1943:57	CM1	TCAS contact we are adjust our speed transasia five tree six	
1944:11	APP	(communication between APP and FEA082)	
1944:17	FEA082	(communication between APP and FEA082)	
1944:26	MDA280	(communication between APP and MDA280)	
1944:30	CAM2	idle descend	
1944:31	CAM1	check	
1944:31	APP	(communication between APP and MDA280)	
1944:38	MDA280	(communication between APP and MDA280)	
1944:42	CAM2	one zero zero niner…	
1944:43	APP	transasia five tree six cleared ILS runway one zero approach	
1944:46	CAM1	check	
1944:48	CAM2	教官 我們許可 ILS	Sir we are cleared for ILS
1944:51	CM1	cleared ILS runway one zero approach transasia five tree six	
1945:20	APP	(communication between APP and FEA082)	
1945:24	FEA082	(communication between APP and FEA082)	
1945:44	APP	(communication between APP and FEA137)	
1945:48	FEA137	(communication between APP and FEA137)	
1945:49	APP	(communication between APP and FEA137)	
1945:51	APP	(communication between APP and MDA280)	

Time	Source	Content	Translation
1945:54	MDA280	(communication between APP and MDA280)	
1945:57	APP	(communication between APP and MDA280)	
1946:03	PA	各位貴賓 我們已經開始航機的下降了 受到天氣的影響下降的氣流不穩定 請您務必扣好安全帶 靠椅扶正 面前的餐桌歸回原處 (同時以國語及台語複述) ladies and gentlemen we are now descending due to turbulence please fasten your seat belt kindly put your seat upright and lock your tray table in place thank you	(public address in Chinese, Taiwanese and English)
1946:03	MDA280	(communication between APP and MDA280)	
1946:09	APP	(communication between APP and MDA280)	
1946:13	MDA280	(communication between APP and MDA280)	
1946:14	CAM1	with ATR speed	
1946:14	APP	(communication between APP and MDA280)	
1946:17	MDA280	(communication between APP and MDA280)	
1946:25	CAM	(unknown sound)	
1946:25	CAM2	approach checklist please sir	
1946:26	CAM1	yes sir	
1946:28	APP	(communication between APP and FEA082)	
1946:28	CAM1	briefing	
1946:29	CAM2	confirmed	
1946:30	CAM1	status	
1946:31	CAM2	no status	
1946:33	CAM1	v bugs	
1946:34	CAM2	set	
1946:35	CAM1	seat belt	
1946:36	CAM2	on	
1946:36	CAM1	QNH MDA	
1946:37	FEA082	(communication between APP and FEA082)	
1946:38	CAM2	one zero zero niner MDA two six three	
1946:41	CAM1	TAD on ND	
1946:42	CAM2	…	

Time	Source	Content	Translation
1946:43	CAM1	engine mode select	
1946:44	CAM2	normal	
1946:45	CAM1	checklist completed	
1946:56	CAM1	*	
1947:37	CAM2	*	
1947:38	CAM1	*	
1947:39	APP	transasia five tree six say airspeed	
1947:42	CM1	speed two five zero	
1947:45	APP	roger	
1947:46	APP	(communication between APP and FEA082)	
1947:50	FEA082	(communication between APP and FEA082)	
1947:54	APP	(communication between APP and FEA082)	
1947:57	FEA082	(communication between APP and FEA082)	
1948:09	CAM1	*	
1948:19	FEA082	(communication between APP and FEA082)	
1948:20	CAM1	*	
1948:22	APP	(communication between APP and FEA082)	
1948:26	CAM	(unknown sound)	
1948:26	FEA082	(communication between APP and FEA082)	
1948:29	APP	(communication between APP and FEA082)	
1948:30	CAM1	*	
1948:57	APP	(communication between APP and MDA280)	
1949:01	MDA280	(communication between APP and MDA280)	
1949:10	FEA678	(communication between APP and FEA678)	
1949:18	CAM2	*	
1949:21	CAM1	*	
1949:23	APP	(communication between APP and FEA678)	
1949:26	FEA678	(communication between APP and FEA678)	
1949:36	CAM1	*	
1951:32	APP	(communication between APP and MDA280)	
1951:35	MDA280	(communication between APP and MDA280)	
1951:38	APP	(communication between	

Time	Source	Content	Translation
		APP and MDA280)	
1951:49	CAM	(unknown sound)	
1951:53	TNA242	(communication between APP and TNA242)	
1951:56	APP	(communication between APP and TNA242)	
1951:59	TNA242	(communication between APP and TNA242)	
1952:00	APP	(communication between APP and TNA242)	
1952:14	CAM2	zonli three thousand five	
1952:15	CAM1	check	
1952:16	CAM2	activate approach phase	
1952:21	CAM1	嗯奇怪你為什麼不再等一下呢 等 automatically activate approach phase	Uh why don't you keep waiting until it automatically activates approach phase
1952:28	CAM2	看他已經進去了 速度又減	Yeah the preceding traffic is established and the speed is reducing
1952:28	CAM1	對呀 你看你現在也到啦	See we reach the point (automatically activates approach phase)
1953:06	UNI830	(communication between APP and UNI830)	
1953:14	APP	(communication between APP and UNI830)	
1953:16	CAM2	heading	
1953:17	CAM1	check	
1953:18	CAM2	glide slope loc blue cat three dual	
1953:21	CAM1	check	
1953:21	CAM2	cat three dual autopilot one and two	
1953:22	CAM1	check	
1953:22	UNI830	(communication between APP and UNI830)	
1953:45	APP	(communication between APP and MDA280)	
1953:50	MDA280	(communication between APP and MDA280)	
1953:52	CAM2	flap one sir	
1953:53	CAM1	speed check flap one	
1954:50	CAM2	loc alive	
1954:51	CAM1	check	
1954:52	CAM2	loc star	
1954:53	CAM1	check	
1954:58	UNI93	(communication between APP and UNI93)	

Time	Source	Content	Translation
1955:04	CAM2	glide slope star four thousand set	
1955:05	APP	(communication between APP and UNI93)	
1955:05	CAM1	check	
1955:10	UNI93	(communication between APP and UNI93)	
1955:15	CM1	taipei approach transasia five tree six establish	
1955:23	CAM2	flap two	
1955:24	APP	transasia five tree six contact tower one one eight point one	
1955:27	CM1	contact tower good night mam five tree six	
1955:34	CM1	sungshan tower good evening transasia five tree six ILS approach and ten mile on final	
1955:40	TWR	good evening transasia five three six sungshan tower runway one zero wind zero one zero at four QNH one zero zero eight continue approach	
1955:49	CM1	one zero zero eight runway one zero continue approach five three six	
1955:56	CAM2	么洞洞八	One zero zero eight
1955:57	CAM1	check	
1955:59	CAM1	RA alive	
1956:00	CAM2	check	
1956:26	CAM	(unknown sound)	
1956:34	CAM	(mose code sound - outer marker signal)	
1956:38	CAM2	outer marker	
1956:39	CAM1	check two thousand	
1956:40	CAM2	gear down	
1956:41	CAM1	gear down	
1956:42	CAM	(sound similar to landing gears down)	
1956:47	PA	各位貴賓我們即將降落 請扣緊安全帶豎直椅背收回桌子 謝謝 組員請就座 (同時以國語及台語複述) ladies and gentlemen we are about to land please fasten your seat belt kindly put your seat	(public address in Chinese, Taiwanese and English)

Time	Source	Content	Translation
		upright and lock your tray table in place thank you	
1957:05	CAM2	flap three	
1957:05	CAM1	three	
1957:09	CAM1	final set	
1957:11	CAM2	landing checklist	
1957:12	CAM1	before landing cabin crew	
1957:13	CAM2	advised	
1957:14	CAM1	auto thrust	
1957:15	CAM2	speed	
1957:15	CAM1	go around altitude	
1957:17	CAM2	four thousand set	
1957:17	CAM1	landing memo	
1957:18	CAM2	no blue	
1957:19	CAM1	correct runway	
1957:20	CAM2	runway one zero	
1957:21	CAM1	standby landing clearance	
1957:21	TWR	(communication between TWR and TNA242)	
1957:25	TNA242	(communication between TWR and TNA242)	
1957:28	TWR	(communication between TWR and TNA242)	
1957:30	TNA242	(communication between TWR and TNA242)	
1958:03	CAM2	one thousand	
1958:03	CAM1	stable	
1958:11	---	…	
1958:12	TWR	transasia five tree six the wind calm cleared to land	
1958:15	CM1	wind calm cleared to land five tree six	
1958:18	CAM2	wind calm cleared to land	
1958:19	CAM1	yah	
1958:51	CAM	four hundred (altitude alert)	
1958:51	MDA280	(communication between TWR and MDA280)	
1958:53	CAM1	hundred above minimum	
1958:55	TWR	(communication between TWR and MDA280)	
1958:56	CAM2	land green	
1958:58	CAM1	check	
1959:01	MDA280	(communication between TWR and MDA280)	
1959:02	CAM	three hundred (altitude alert)	
1959:02	CAM2	insight landing	
1959:03	CAM1	cleared to land	
1959:04	CAM	cricket cricket cricket (sound	

Time	Source	Content	Translation
		of autopilot disengaged)	
1959:05	CAM	(morse code sound - middle marker signal)	
1959:05	UNI831	(communication between TWR and UNI831)	
1959:06	CAM	two hundred (altitude alert)	
1959:08	TWR	(communication between TWR and UNI831)	
1959:10	UNI831	(communication between TWR and UNI831)	
1959:15	CAM	one hundred (altitude alert)	
1959:21	CAM	fifty (altitude alert)	
1959:23	CAM	twenty (altitude alert)	
1959:23	CAM	retard retard	
1959:26	CAM	(sound similar to landing gears touching down)	
1959:26	CAM	retard	
1959:27	CAM	(mechanical sound)	
1959:28	CAM	retard	
1959:29	CAM1	spoiler one reverse green and	
1959:37	CAM1	沒有煞車喔	No brake
1959:37	TWR	(communication between TWR and UNI831)	
1959:39	CAM1	沒有煞車喔	No brake
1959:40	UNI831	(communication between TWR and UNI831)	
1959:43	TWR	(communication between TWR and UNI831)	
1959:44	CAM1	沒有煞車	No brake
1959:46	CAM1	沒有煞車喔	No brake
1959:47	UNI831	(communication between TWR and UNI831)	
1959:50	CAM1	完全沒有煞車	No brake at all
1959:50	TWR	(communication between TWR and UNI831)	
1959:53	CAM1	煞車	Brake
1959:54	CAM2	怎麼回事兒教官	What's going on sir
1959:55	CAM1	我不知道	I have no idea
1959:57	CAM1	哇噻	Wow
1959:57	CAM	(sound similar to impact)	
1959:58	CAM	(sound similar to impact)	
1959:59	CAM	chime (single chime)	
2000:01	CAM2	嗯	Uh
2000:03	CAM1	哇噻	Wow
2000:03	CAM	(sound similar to impact)	

Time	Source	Content	Translation
2000:04	CAM1	哇噻	Wow
2000:05	CAM	(sound similar to impact)	
2000:06	TWR	transasia five three six ground	
2000:08	CM1	我們沒有煞失效煞車	We have no brake brake failed
2000:10	CAM	(sound similar to impact)	
2000:11	CAM	(sound similar to impact)	
2000:15	CAM	(sound similar to impact)	
2000:15	TWR	教官請問你們出跑道了嗎	Sir are you off the runway
2000:17	CAM	chime (single chime)	
2000:18	CM1	我們需要地面支援	We need ground support
2000:19	TWR	roger	
2000:20	CAM	chime (single chime)	
2000:21	CM1	attention crew at station attention crew at station	
2000:22	CAM	chime (single chime)	
2000:24	CM1	attention crew at station	
2000:31	CAM1	唉	Sigh
2000:34	CAM	(mechanical sound)	
2000:34	MDA280	(communication between TWR and MDA280)	
2000:36	PA	組員請就位	Crew at station
2000:37	CAM	(mechanical sound)	
2000:37	CAM	chime (single chime)	
2000:38	TWR	(communication between TWR and MDA280)	
2000:40	CAM2	關車嗎	Shall we shutdown
2000:41	CAM1	關車	Shutdown
2000:42	CAM	(sound of switch)	
2000:43	CAM	(sound of switch)	
2000:46	MDA280	(communication between TWR and MDA280)	
2000:48		(recording stopped)	
2002:15[36]		(recording restarted)	
2002:15	CM1	需要這個在目前的地點疏散旅客	We need to evacuate passengers right here
2002:20	TWR	復興五三六 roger 我們會請相關人員支援	Transasia five three six roger we will send the ground support
2002:20	PA	各位貴賓我們現在已經看過外界的狀況 目前我們是在跑道頭這邊停下來了 很抱歉造	Ladies and gentlemen we have checked the situation outside we stopped at the

[36] Time reference of restarting recording is according to the ATC time.

Time	Source	Content	Translation
		成各位讓各位受驚 那麼外界目前的狀況看嗯是 看起來目前看起來是安全正常的 那麼各位先保持在您的座位上 我們機長已經在跟相關單位做一個聯絡~	end of the runway sorry for the frightening the situation seems safe and normal so far please stay on your seat our captain is contacting with related agencies right now~
2002:41	TWR	(communication between TWR and TNA280)	
2002:42		(recording ended)	

Appendix 2 B-22310 Flight Parameters List

A/C:A320/200 Engine: IAE V2527-A5

FDIU SAGEM P/N ED43A1D5 ARINCE 573/717 128 Word/s

	Ident	Bus	Label/SDI	Description
1	A01a01	Clock	260/00	Day of Date
2	A02a01	FWC	126/01	Flight Phase
3	A03a01	DMC	233/01	Flight Number
4	A05a01	DMC	230/01	Data Base Update
5	A06a01	DMC	075/01	Gross Weight
6	A07a01			Fleet Identification
7	A07c01			A/C Type
8	A07d01			A/C Tail Number
9	A07f01			Result Parameter Check
10	A07g01			FDIU BITE
11	A08a01	DMC	046/01	Engine 1 Ident
12	A08a02	DMC	046/01	Engine 2 Ident
13	M01a01	Clock	125/00	UTC Hours
14	M01a04	Clock	150/00	Clock Synchronized by GPS
15	M01b01			Frame Counter
16	M02a01	DMC	203/XX	Altitude standard fine
17	M02a02	DMC	203/XX	Altitude standard coarse
18	M03a01	DMC	206/XX	Indicated Airspeed
19	M04a01	DMC	320/XX	True Heading
20	M04b02	FWC	126/10	Warning HDG Discrepancy
21	M05a01	SDAC	333/01	normal acceleration
22	M06a01	DMC	324/01	Pitch attitude
23	M06a02	FWC	124/01	Warning Pitch discrepancy
24	M07a01	DMC	325/XX	Rall attitude
25	M07a02	FWC	124/01	Warning Roll discrepancy
26	M08a01	SDAC	002/01	VHF Keying
27	M08a02	SDAC	002/01	HF Keying
28	M09a01	DMC	346/01	N1/EPR Actual Eng 1
29	M09a02	DMC	346/10	N1/EPR Actual Eng 2
30	M09tl01	DMC	133/01	Throttle Lever Angel Eng 1
31	M10a01	FWC	137/00	Flaps Position
32	M11a01	FWC	127/00	Slats Position
33	M11tl01	SDAC	046/01	Lever Position (Matrix 1)
34	M12a01	DMC	270/01	Reverser Unlock Eng 1
35	M12a02	DMC	270/01	Reverser Unlock Eng 2
36	M12a05	DMC	270/01	Rev Deployed Eng 1
37	M12a06	DMC	270/01	Rev Deployed Eng 2
38	M13a03	FCDC	043/01	Left Spoiler 1 Out
39	M13a04	FCDC	043/01	Right Spoiler 1 Out
40	M14a01	DMC	211/XX	True Air Temperature (TAT)
41	M15a01	DMC	276/01	A/P 1 Engaged
42	M15a02	DMC	276/01	A/P 2 Engaged
43	M15a09	DMC	271/01	ATS Thrust N1 Mode
44	M15a0l	DMC	271/01	ATS Speed Mach Mode Activated
45	M15a10	DMC	271/01	Thrust EPR Mode
46	M15a35	DMC	301/01	H/Path submode NAV engaged

	Ident	Bus	Label/SDI	Description
47	M15a36	DMC	301/01	HDG submode NAV engaged
48	M15a38	DMC	301/01	VOR submode NAV engaged
49	M15a39	DMC	301/01	Loc submode Runway engaged
50	M15a3l	DMC	301/01	Track submode NAV engaged
51	M15a40	DMC	301/01	Track submode Runway engaged
52	M15a41	DMC	300/01	Roll out submode LAND TRACK engaged
53	M15a42	DMC	300/01	Align submode LAND TRACK engaged
54	M15a43	DMC 3	02/01	Altitude Capture Mode
55	M15a44	DMC 3	02/01	Altitude Track Mode
56	M 18a0	FCDC	314/0	Left Elevator Position
57	M 19a0	FCDC	315/01	Stabilizer Position
58	M15a45	DMC	302/01	G/S Track Mode
59	M15a46	DMC	302/01	G/S Capture Mode
60	M15a48	DMC	302/01	Expedite Climb Mode
61	M15a49	DMC	302/01	Immediate Climb Mode
62	M15a4l	DMC	302/01	Open Climb Mode
63	M15a50	DMC	302/01	Open Descent Mode
64	M15a51	DMC	302/01	Expedite Descent Mode
65	M15a52	DMC	302 /01	Immediate Mode
66	M16a01	SDAC	331/01	Longitudinall Acceleration
67	M17a01	SDAC	332/01	Lateral Acceleration
68	M18a02	FCDC	334/01	Left Elevator Position
69	M18a05	FCDC	041/01	Right Elevator Position
70	M18c01	SDAC	312/00	Rudder Position
71	M18c02	FWC	126/00	Yaw Damper 1 fault
72	M18c03	FWC	126/00	Yaw Damper 2 fault
73	M18c04	FCDC	304/01	Rudder pedal Position
74	M18c05	FWC	313/01	Rudder trim Position
75	M18tl03	FCDC	310/01	Left Aileron Position
76	M18tl04	FCDC	330/01	Right Aileron Position
77	M18tl20	FCDC	363/01	Left Spoiler 3 Position
78	M18tl21	FCDC	374/01	Right Spoiler 4 Position
79	M20a01	DMC	164/01	Radio Altitude 1
80	M21a01	DMC	174/01	Glide Slope Deviation 1
81	M22a01	DMC	173/01	Localizer Deviation 1
82	M23a01	DMC	274/01	Marker Beacon Passage
83	M24a02	FWC	126/00	APU Fire
84	M24a03	FWC	126/00	Engine 1 Fire
85	M24a04	FWC	126/00	Engine 2 Fire
86	M24a05	FWC	126/00	Cabin Press Warning
87	M24a06	FWC	126/00	Avionic Smoke Warning
88	M24a18	FWC	126/00	Red Warning
89	M24a19	FWC	126/10	A/P oft Warning
90	M24a20	FWC	126 /11	Sidestick not in T.O. configuration
91	M24a21	FWC	126/11	L+R elevator fault
92	M24a22	FWC	126/11	Gear not downlocked
93	M24a23	SDA	002/00	Parking brake oft
94	M24a24	FCDC	044/01	Left sidestick fault
95	M24a25	FCDC	044/01	Right sidestick fault
96	M28a01	FWC	016/01	GPWS Warning
97	M28tl01	DMC	307/01	Capt EGPWS valid

	Ident	Bus	Label/SDI	Description
98	M28tl02	DMC	307/10	F/O EGPWS valid
99	M28tl03	DMC	307/01	Capt WXR valid
100	M28tl04	DMC	307/10	F/O WXR valid
101	M28tl05	DMC	307/01	Capt EGPWS installed
102	M28tl06	DMC	307/10	F/O EGPWS installed
103	M28tlol	SDAC	002/00	EGPWS TERR ON ND switch
104	M29a01	DMC	221/XX	Angle of Attack LH
105	M2la03	FWC	021/01	LDG Squat Switch LH
106	M30a01	FWC	126/00	Hyd Low Press Yellow
107	M30a02	FWC	126/00	Hyd Low Press Green
108	M30a03	FWC	126/00	Hyd Low Press Blue
109	M31a01	DMC	312/XX	Ground Speed
110	M32b01	FWC	022/01	Gear Up locked
111	M32b02	FWC	020/01	Gear down locked
112	R01d01	DMC	310/DD	Present Pos Latitude Fine
113	R01d02	DMC	310/DD	Present Pos Latitude Coarse
114	R01d03	DMC	311/DD	Present Pos Long Fine
115	R01d04	DMC	311/DD	Present Pos Long Coarse
116	R01e01	DMC	307/01	GPS Primary Capt
117	R01e02	DMC	307/10	GPS Primary F/O
118	R02a02	BSCU	331/01	Left brake pedal angle
119	R02b06	SDAC	026/01	Alternate braking
120	R02b08	SDAC	002/00	Antiskid Selector ON
121	R02b09	FWC	126/11	Normal brake fault
122	R02bOl	FWC	126/11	Antiskid fault
123	R02c01	BSCU	300/01	Normal brake pressure 1
124	R02c02	BSCU	301/01	Normal brake pressure 2
125	R02c03	BSCU	302/01	Normal brake pressure 3
126	R02c04	BSCU	303/01	Normal brake pressure 4
127	R02c05	BSCU	304/01	Normal brake pressure 5
128	R02c06	BSCU	305/01	Normal brake pressure 6
129	R02c08	BSCU	307/01	Normal brake pressure 8
130	R02cOl	BSCU	306/01	Normal brake pressure l
131	R03b01	DMC	345/01	EGT Eng 1 (1 495)
132	R03c01	DMC	244/01	Fuel flow Eng 1
133	R05b01	DMC	350/01	Pred W/S internal failure
134	R05b02	DMC	350/01	Pred W/S external failure
135	R05b03	DMC	350/01	Pred W/S alert/terrain Caution Capt
136	R05b04	DMC	350/10	Pred W/S alert/terrain Caution F/O
137	R05b05	DMC	350/01	Pred W/S warning/terrain warning Capt
138	R05b05	DMC	350/01	Pred W/S warning/terrain warning Capt
139	R05b06	DMC	350/10	Pred W/S warning/terrain warning F/O
140	R05b08	DMC	350/01	Pred W/S oft
141	R05bOl	FWC	16/00	Pred W/S pinprog
142	R06a04	DMC	276/10	Altitude STDQHNQFE F/O
143	R09b05	DMC	271/01	Mach Selection
144	R12c01	DMC	276/01	Heading0rack Selection
145	R14a34	DMC	307/01	Radar/EGPWS operating Mode Capt
146	R14a35	DMC	307/01	Radar/EGPWS operating Mode F/O
147	R15a19	DMC	275/01	System page origin
148	R17a02	SDAC	002/01	AC 1 bus ON

	Ident	Bus	Label/SDI	Description
149	R17a03	SDAC	002/00	AC ess bus ON
150	R18a03	SDAC	004/11	DC ess bus ON
151	R19a05	SDAC	067/01	Eng 1 HPV not fully closed
152	R19a06	SDAC	066/01	Eng 2 HPV not fully closed
153	R19a08	SDAC	066/01	Eng 2 PRV not fully closed
154	R19a11	SDAC	055/01	Cross Feed Valve Eng 1l2 not fully closed
155	R19a12	SDAC	003/01	Pack 1 flow control valve not fully closed
156	R19a13	SDAC	003/10	Pack 2 flow control valve not fully closed
157	R19a14	SDAC	003/01	Eng 1 anti ice P/B On
158	R19a15	SDAC	003/10	Eng 2 anti ice P/B On
159	R19a16	SDAC	003/11	wing anti ice P/B off
160	R19a18	SDAC	001/00	Eng 2 AntiIce valve not fault
161	R19al7	SDAC	001/11	Eng 1 AntiIce valve not fault
162	R19aOl	SDAC	067/01	Eng 1 PRV not fully closed
163	R21b01	FWC	126/00	Slats Fault
164	R21b02	FWC	126/00	Flaps Fault
165	ROlb02			Constraint Altitude (SSM)
166	R21c01	FWC	126/11	Engine 1 FADEC fault
167	R21c02	FWC	126/11	Engine 2 FADEC fault
168	R21d01	SDAC	006/01	GPWS terrain det. Fault
169	R28d01	DMC	033/01	ILS1 Frequency I MMR 1 frequency I channel modes(coarse)
170	R28d02	DMC	033/01	ILS1 Frequency I MMR 1 frequency I channel modes (fine)
171	R28d03	DMC	033/01	MMR 1 modes
172	R28d04	DMC	033/10	ILS2 Frequency I MMR 2 frequency I channel modes(coarse)
173	R28d05	DMC	033/10	ILS2 Frequency I MMR 2 frequency I channel modes (fine)
174	R28d06	DMC	033/10	MMR 2 modes
175	R28e01	DMC	032/01	ADF 1 Frequency 100khz, 10khz, 1khz
176	R28e02	DMC	032/01	ADF 1 Frequency 1000khz, 0.5khz
177	R28e03	DMC	032/10	ADF 2 Frequency 100khz, 10khz, 1khz
178	R28e04	DMC	032/10	ADF 2 Frequency 1000khz, 0.5khz
179	R30a01			Event Marker

Appendix 3 AIRBUS Ground Spoilers Test Procedure

Subject: TNATPE/60/05 TNA A320 MSN 791 Runway Excursion - Ground Spoiler Extension Procedure

Please find following a Ground Spoiler Extension procedure, as requested by the ASC, which has been verified on a production aircraft here in Toulouse.

This procedure requires the use of a Main Landing Gear Wheel Tachometer Driving Tool part number 355M03190000.

Procedure:

1) Aircraft configuration:

> > 1.1 Energize the aircraft electrical circuits.

> > 1.2 Do the IR alignment procedure.

> > 1.3 On the panel 23 VU verify that the SEC1 SEC3, ELAC1 P/B are engaged.

> > 1.4 On the panel 24VU verify that the SEC2, ELAC 2 P/B are engaged.

> >

> > 2) Test :

> > 2.1 Install the MLG WHEEL TACHYMETER DRIVING TOOL (355M03190000) on the wheel 1 and wheel 4

> > 2.2 Pressurize the 3 hydraulic systems (elec. pump and power transfer unit)

> > 2.3 on the cockpit put the throttle control levers to the idle position and pre-select the speed brake control lever

> > 2.4 on the driving tool set a wheel speed around 1000 rpm and verify that the spoilers 1, 2 and 5 are extended;

> > 2.5 in case of problem perform a ground scanning and record the maintenance message

> > 2.6 on the cockpit put the throttle control levers to climb position and verify that the spoilers 1,2 and 5 reach the neutral position.

> > 2.7 depressurize the 3 hydraulic systems.

> > 2.8 remove the MLG WHEEL TACHYMETER DRIVING TOOL to the

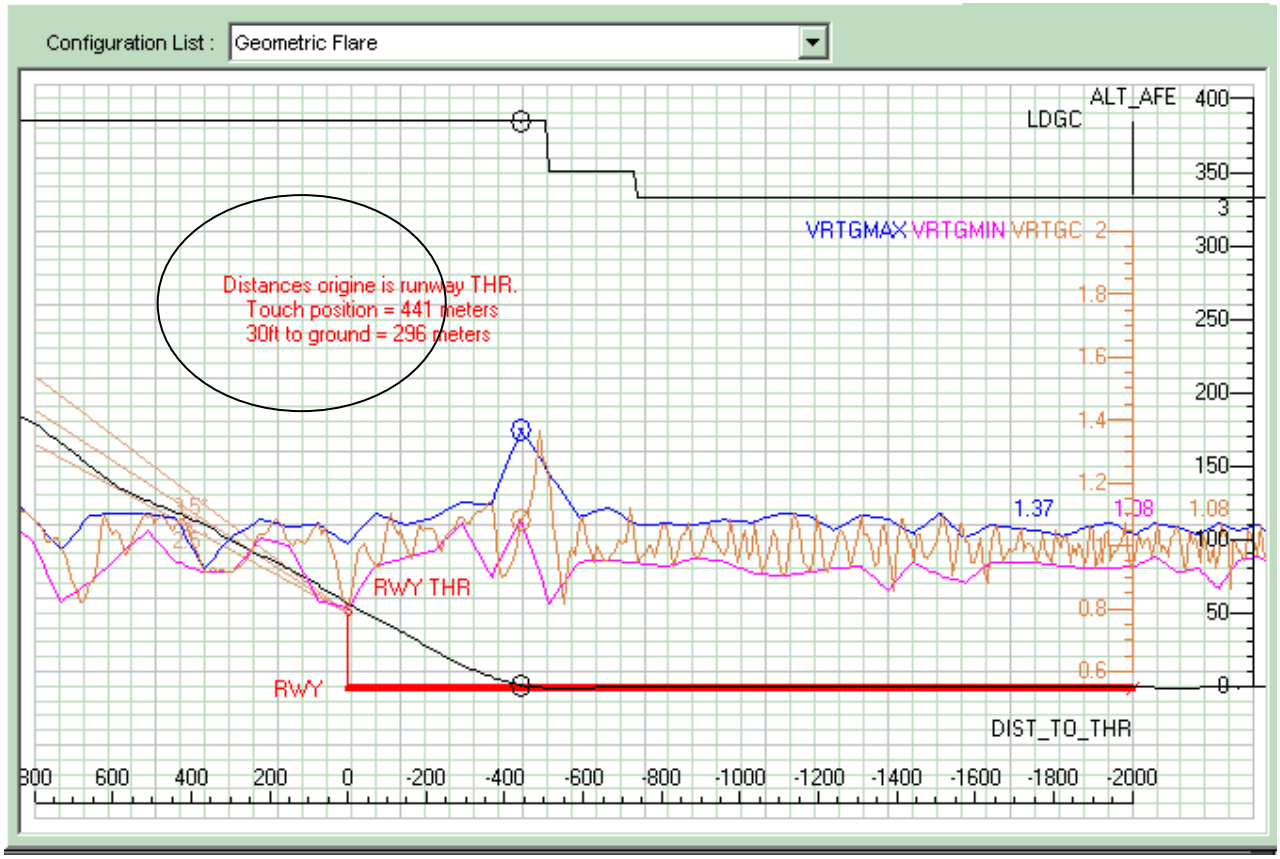
wheels 1 and 4 and install it on the wheels 2 and 3

> > 2.9 repeat the test cited in ?2.2 to ?2.6 the spoilers 3 and 4 must move.

Appendix 4 Analysis Report for the Touchdown Position and the Required Landing Distance （TransAsia Airways）

一、著陸點位置(Touch Down Position)

- 計算工具:飛航監視系統(Line Operations Monitor System,LOMS),Ver. 2.6.6
- 資料來源:Flight Data Recorder
- 著陸點之定義:飛機主輪著陸瞬間,且主輪之減振支柱未壓縮之位置,該距離參考零點為跑道端(Runway Threshold),且飛機離地高 50 呎(參考 Radio Alt)。



計算結果:

GE536 之著陸點位置距 10 跑頭端約 1,450 呎(441 公尺)

一、必要落地距離

◆ 計算工具：Airbus OCTOPUS, ver. 23

◆ 輸入資料：

- Runway: Dry, Wet
- Wind (runway) : 0 knots
- CG Code: Basic
- Pressure Alt: 0 ft
- Configuration: CONF 3
- Weight: 55103 kg

scenario	Runway	Reversers	Antiskid	Braking	Spoilers	Ground idle failed	Tachometer failure	Landing Distance (ft)	Required. Landing Distance (ft)
1	dry	Both reversers inoperative	ON	Normal	All spoilers operative	No	No	2,636	4,393
2	dry	Both reversers inoperative	ON	Normal	All spoilers inoperative	No	No	3,194	5,324
3	wet	Both reversers inoperative	ON	Normal	All spoilers operative	No	No	2,636	5,052
4	wet	Both reversers inoperative	ON	Normal	All spoilers inoperative	No	No	3,194	6,122

Required Landing Distance (dry) = Actual Landing Distance x 1.667

Required Landing Distance (wet) = Actual Landing Distance x 1.917

Case #1 (dry)

```
c:\program files\pep\sessions\fm\session 1.res

 OCTOPUS VERSION : 23.0.0
 ---------------

 REGULATION NAME : JAA
 ---------------

 AIRCRAFT NAME : AE232C01  A320-232   /V20
 -------------

                              ------------------------------
                              I INPUT DATA RECAPITULATION  I
                              ------------------------------

Runway condition                          : DRY
Pressure altitude                         :       28.000 FT
Wind(runway)                              :        0.000 KT
Configuration                             : CONF 3
CG code                                   : Basic
Weight                                    :    55140.000 KG
k(V/VS)                                   :        1.230
Delta V (CAS)                             :        0.000 KT

- SPECIAL CASES ARE INDICATED WITH A STAR (*) -
Reversers credit                          : ALL REVERSERS INOPERATIVE
Antiskid                                  : ON
Braking failed                            : 0 BRAKE INOPERATIVE
Spoilers                                  : ALL SPOILERS OPERATING
Ground idle failed                        : NO
Tachometer failure                        : NO



                    CALCULATION NAME : LANDING DISTANCE
                    ----------------

                              APPROVED

                                                        13-JUL-05


      POINT CALCULATION
      -----------------

 I--------------I--------------I--------------I--------------I--------------I
 I LD           I REGUL COEF   I REGUL LD     I VFA CAS      I VFA IAS      I
 I--------------I--------------I--------------I--------------I--------------I
 I FT           I              I FT           I KT           I KT           I
 I--------------I--------------I--------------I--------------I--------------I
 I       2636.0 I        1.667 I       4393.3 I      127.531 I      127.531 I
 I--------------I--------------I--------------I--------------I--------------I


 I--------------I
 I BRK ENER AEO I
 I--------------I
 I %            I
 I--------------I
 I         38.5 I
 I--------------I
```

Case #2 (dry)

```
c:\program files\pep\sessions\fm\session 1.res

 OCTOPUS VERSION : 23.0.0
 ---------------

 REGULATION NAME : JAA
 ---------------

 AIRCRAFT NAME : AE232C01  A320-232   /V20
 -------------

                              ------------------------------
                              I INPUT DATA RECAPITULATION  I
                              ------------------------------

Runway condition                          : DRY
Pressure altitude                         :       28.000 FT
Wind(runway)                              :        0.000 KT
Configuration                             : CONF 3
CG code                                   : Basic
Weight                                    :    55140.000 KG
k(V/VS)                                   :        1.230
Delta V (CAS)                             :        0.000 KT

- SPECIAL CASES ARE INDICATED WITH A STAR (*) -
Reversers credit                          : ALL REVERSERS INOPERATIVE
Antiskid                                  : ON
Braking failed                            : 0 BRAKE INOPERATIVE
Spoilers                                 *: ALL SPOILERS INOPERATIVE
Ground idle failed                        : NO
Tachometer failure                        : NO



                    CALCULATION NAME : LANDING DISTANCE
                    ----------------

                              APPROVED

                                                          13-JUL-05


      POINT CALCULATION
      -----------------

 I--------------I--------------I--------------I--------------I--------------I
 I LD           I REGUL COEF   I REGUL LD     I VFA CAS      I VFA IAS      I
 I--------------I--------------I--------------I--------------I--------------I
 I FT           I              I FT           I KT           I KT           I
 I--------------I--------------I--------------I--------------I--------------I
 I       3194.3 I        1.667 I       5323.8 I      127.531 I      127.531 I
 I--------------I--------------I--------------I--------------I--------------I


 I--------------I
 I BRK ENER AEO I
 I--------------I
 I %            I
 I--------------I
 I         40.1 I
 I--------------I
```

Case #3 (wet)

```
c:\program files\pep\sessions\fm\session 1.res

 OCTOPUS VERSION : 23.0.0
 ---------------

 REGULATION NAME : JAA
 ---------------

 AIRCRAFT NAME : AE232C01  A320-232   /V20
 -------------

                              ------------------------------
                              I INPUT DATA RECAPITULATION  I
                              ------------------------------

Runway condition                          : WET
Pressure altitude                         :       28.000 FT
Wind(runway)                              :        0.000 KT
Configuration                             : CONF 3
CG code                                   : Basic
Weight                                    :    55140.000 KG
k(V/VS)                                   :        1.230
Delta V (CAS)                             :        0.000 KT

- SPECIAL CASES ARE INDICATED WITH A STAR (*) -
Reversers credit                         *: ALL REVERSERS INOPERATIVE
Antiskid                                  : ON
Braking failed                            : 0 BRAKE INOPERATIVE
Spoilers                                  : ALL SPOILERS OPERATING
Ground idle failed                        : NO
Tachometer failure                        : NO



                    CALCULATION NAME : LANDING DISTANCE
                    ----------------

                              APPROVED

                                                          13-JUL-05


      POINT CALCULATION
      -----------------

 I--------------I--------------I--------------I--------------I--------------I
 I LD           I REGUL COEF   I REGUL LD     I VFA CAS      I VFA IAS      I
 I--------------I--------------I--------------I--------------I--------------I
 I FT           I              I FT           I KT           I KT           I
 I--------------I--------------I--------------I--------------I--------------I
 I************* I        1.917 I       5052.3 I      127.531 I      127.531 I
 I--------------I--------------I--------------I--------------I--------------I


 I--------------I
 I BRK ENER AEO I
 I--------------I
 I %            I
 I--------------I
 I         38.5 I
 I--------------I
```

Case #4 (wet)

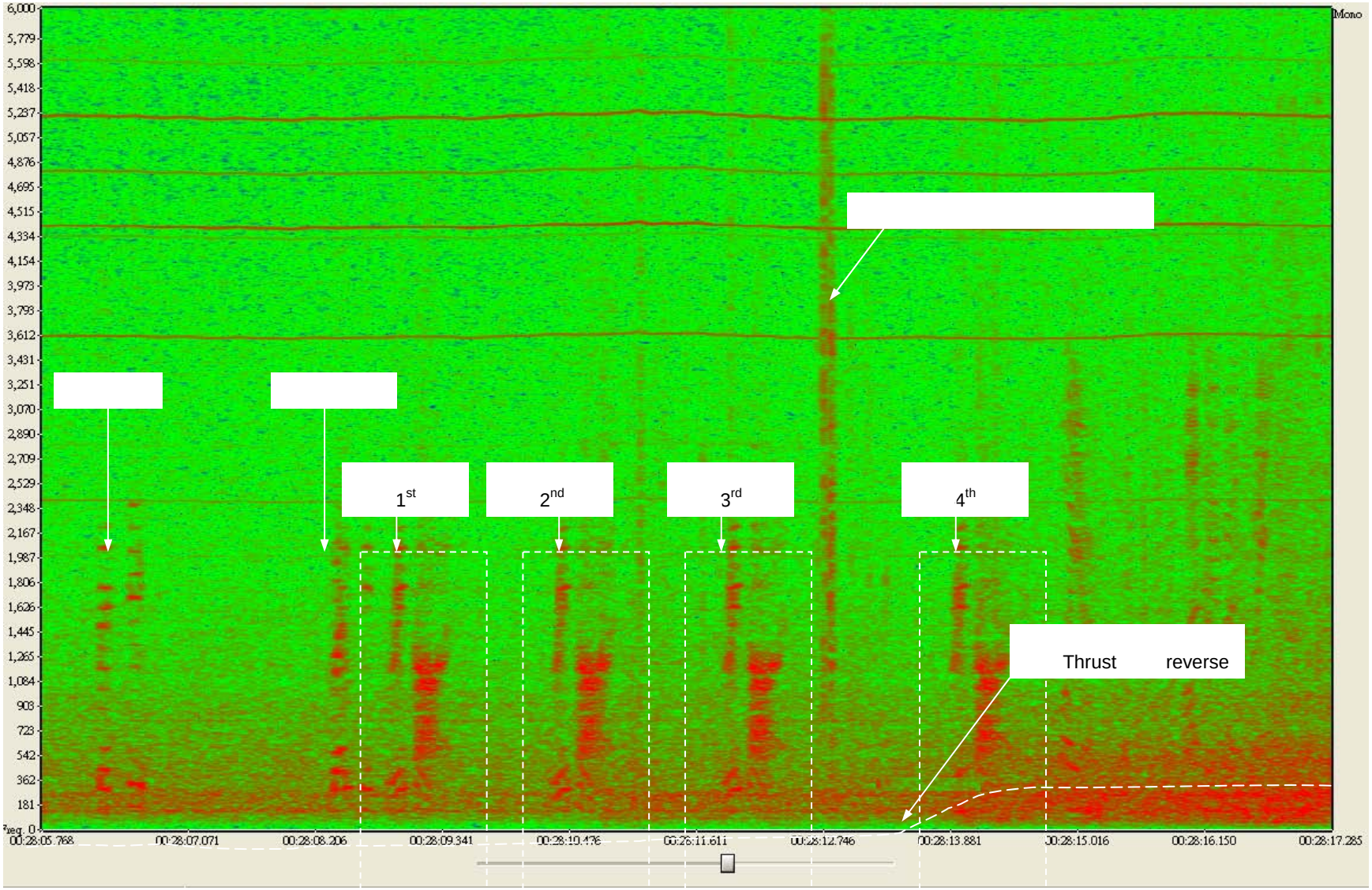
```
c:\program files\pep\sessions\fm\session 1.res

 OCTOPUS VERSION : 23.0.0
 ---------------

 REGULATION NAME : JAA
 ---------------

 AIRCRAFT NAME : AE232C01  A320-232   /V20
 -------------

                              ------------------------------
                              I INPUT DATA RECAPITULATION  I
                              ------------------------------

Runway condition                          : WET
Pressure altitude                         :       28.000 FT
Wind(runway)                              :        0.000 KT
Configuration                             : CONF 3
CG code                                   : Basic
Weight                                    :    55140.000 KG
k(V/VS)                                   :        1.230
Delta V (CAS)                             :        0.000 KT

- SPECIAL CASES ARE INDICATED WITH A STAR (*) -
Reversers credit                         *: ALL REVERSERS INOPERATIVE
Antiskid                                  : ON
Braking failed                            : 0 BRAKE INOPERATIVE
Spoilers                                 *: ALL SPOILERS INOPERATIVE
Ground idle failed                        : NO
Tachometer failure                        : NO



                    CALCULATION NAME : LANDING DISTANCE
                    ---------------

                              APPROVED

                                                          13-JUL-05

      POINT CALCULATION
      -----------------

 I--------------I--------------I--------------I--------------I--------------I
 I LD           I REGUL COEF   I REGUL LD     I VFA CAS      I VFA IAS      I
 I--------------I--------------I--------------I--------------I--------------I
 I FT           I              I FT           I KT           I KT           I
 I--------------I--------------I--------------I--------------I--------------I
 I************* I        1.917 I       6122.4 I      127.531 I      127.531 I
 I--------------I--------------I--------------I--------------I--------------I


 I--------------I
 I BRK ENER AEO I
 I--------------I
 I %            I
 I--------------I
 I         40.1 I
 I--------------I
```

Appendix 5 Spectrum Analysis of the Cockpit Sound

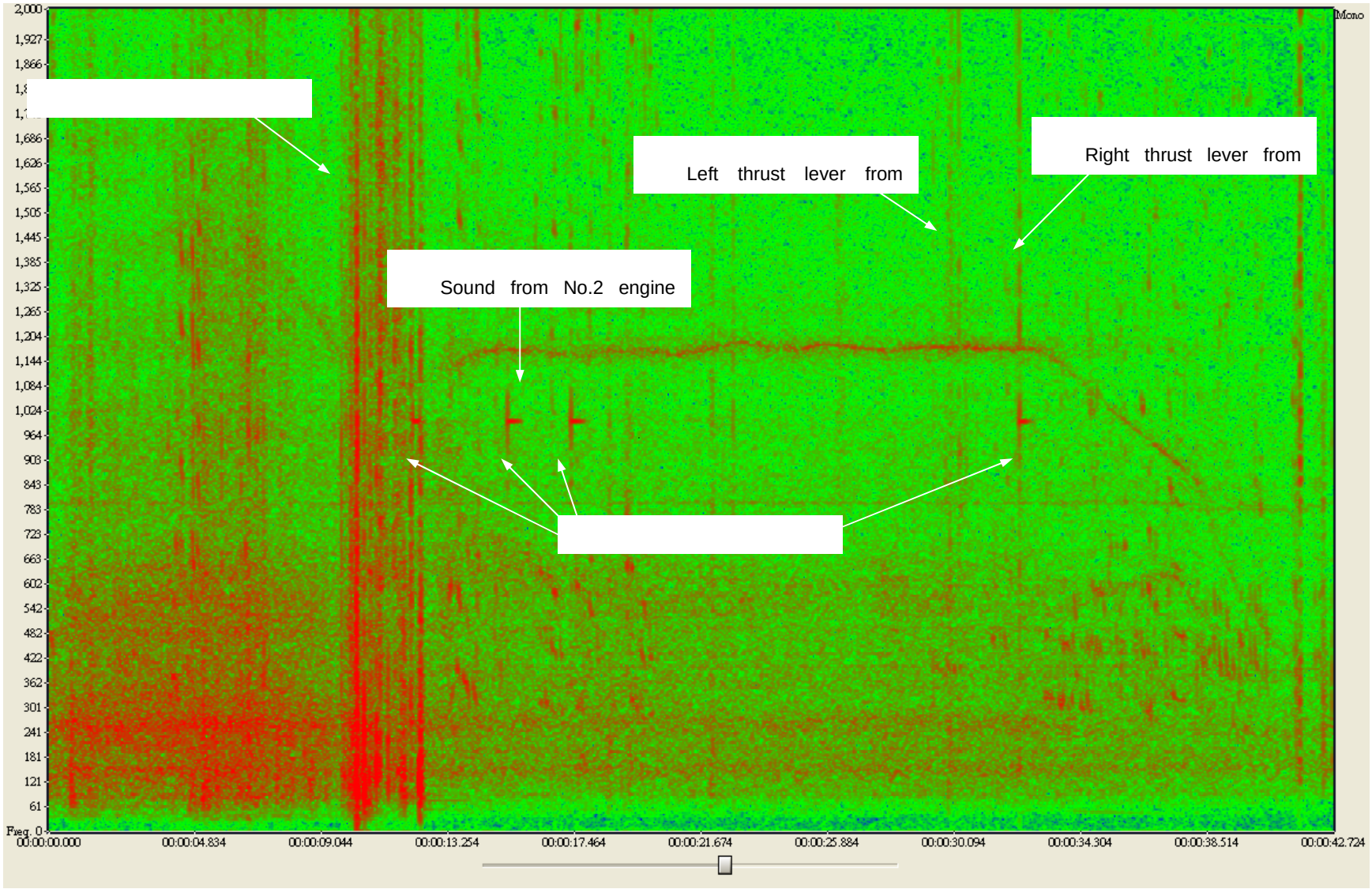
GE536 班機著陸至 CVR 停止記錄期間之聲音內容

起始時間	來源	內容	結束時間	長度（秒）
19:59:23.4	CAM	Retard	19:59:24.9	.0.5
19:59:25.4	CAM	Retard	19:59:26.9	0.5
19:59:26.9	CAM	Retard	19:59:27.4	0.5
19:59:27.8	CAM	（機械聲）	19:59:28.0	0.2
19:59:27.8	CAM	（疑似觸地聲）	19:59:27.9	0.1
19:59:29.0	CAM	Retard	19:59:30.0	1.0
19:59:29.8	CAM1	Spoiler one reverse green and	19:59:33.7	3.9
19:59:37.5	CAM1	沒有煞車喔	19:59:38.2	0.7
19:59:39.9	CAM1	沒有煞車喔	19:59:41.0	1.1
19:59:44.4	CAM1	我們沒有煞車	19:59:45.0	0.6
19:59:46.1	CAM1	沒有煞車喔	19:59:46.9	0.8
19:59:49.8	CAM1	完全沒有煞車	19:59:50.9	1.1
19:59:53.9	CAM1	煞車	19:59:54.3	0.4
19:59:54.6	CAM2	怎麼回事兒教官	19:59:55.3	0.7
19:59:55.4	CAM1	我不知道	19:59:55.9	0.5
19:59:57.1	CAM1	哇塞	19:59:57.6	0.5
19:59:57.1	CAM	（疑似撞擊聲）	19:59:57.3	0.2
19:59:58.6	CAM	（疑似撞擊聲）	19:59:58.8	0.2
19:59:59.8	CAM	噹（單聲警示聲）	20:00:00.1	0.3
20:00:01.7	CAM2	嗯	20:00:01.9	0.2
20:00:03.0	CAM1	哇塞	20:00:03.7	0.7
20:00:03.5	CAM	（疑似撞擊聲）	20:00:03.8	0.3
20:00:04.6	CAM1	哇塞	20:00:05.2	0.6
20:00:05.7	CAM	（疑似撞擊聲）	20:00:05.9	0.2
20:00:07.0	TWR	transasia five three six ground	20:00:08.0	1.0
20:00:08.9	CM1	我們沒有煞失效煞車	20:00:10.2	1.3
20:00:09.5	CAM	（疑似一連串之撞擊聲）	20:00:15.6	6.1
20:00:15.6	TWR	教官請問你們出跑道了嗎	20:00:17.1	1.5
20:00:17.2	CAM	噹（單聲警示聲）	20:00:17.5	0.3
20:00:18.2	CM1	我們需要地面支援	20:00:19.3	1.1
20:00:19.8	TWR	Roger	20:00:20.1	0.3
20:00:20.2	CAM	噹（單聲警示聲）	20:00:20.6	0.4
20:00:21.1	CM1	attention crew at station attention crew at station attention crew at station	20:00:25.4	4.3
20:00:22.4	CAM	噹（單聲警示聲）	20:00:22.8	0.4
20:00:31.1	CAM1	唉	20:00:31.8	0.7
20:00:34.4	CAM	（機械聲）	20:00:35.3	0.9

起始時間	來源	內容	結束時間	長度（秒）
20:00:36.3	PA	組員請就位	20:00:37.1	0.8
20:00:37.0	CAM	（機械聲）	20:00:37.3	0.3
20:00:37.0	CAM	噹（單聲警示聲）	20:00:37.6	0.6
20:00:40.1	CAM2	關車嗎	20:00:40.8	0.7
20:00:41.5	CAM1	關車	20:00:41.9	0.4
20:00:42.4	CAM	（開關聲）	20:00:42.5	0.1
20:00:43.1	CAM	（開關聲）	20:00:43.2	0.1
20:00:48.0		（CVR 記錄中斷）		
20:02:15.0		（CVR 重新開始記錄）		
20:02:15.6	CM1	需要這個在目前的地點疏散旅客	20:02:19.3	3.7
20:02:20.1	TWR	復興五三六 roger 我們會請相關人員支援	20:02:22.8	2.7
20:02:20.5	PA	各位貴賓我們現在已經看過外界的狀況 目前我們是在跑道頭這邊停下來了 很抱歉造成各位讓各位受驚 那麼外界目前的狀況看嗯是 看起來目前看起來是安全正常的 那麼各位先保持在您的座位上 我們機長已經在跟相關單位做一個聯絡~	20:02:42.5	22.0
20:02:42.5		（記錄終止）		



圖一　觸地時之譜頻能量圖



圖二　撞擊前後之譜頻能量圖

Appendix 6 Analysis Report for the Landing Distance at Different Deceleration Conditions（Airbus Company）

計算條件：

A320-232	V2527-A5		AE232C02
Pressure altitude 28.000 FT			:
Runway slope -0.21 %			:
Temperature OAT= 25°C			
Wind(runway) 0.000 KT			:
Configuration			: CONF 3
CG 40%			=
Weight 55140.000 KG			:
Ground speed at touch/down = 146 kt			

Scenario N°	Runway state	Braking Mode	spoilers	Engine1	Engine2	Ground distance (m)	Available Distance after T/D (m)	Speed at runway excursion (kt)
1	DRY	A/B MED	deployed	REV max	1.08 EPR	1140	2029	OK
2		A/B MED	deployed	REV max	ground idle	1107	2029	OK
1	WET	A/B MED	deployed	REV max	1.08 EPR	1190	2029	OK
2		A/B MED	deployed	REV max	Ground idle	1107	2029	OK
3		A/B MED	retracted	REV max	1.08 EPR	1907	2029	OK
4		A/B MED	retracted	REV max	Ground idle	1482	2029	OK
5		A/B MED starting at 72 Kt GS	retracted	REV max	1.08 EPR	7180	2029	119
6		A/B MED starting at 72 Kt GS	retracted	REV max	Ground idle	2872	2029	91
7		No braking	retracted	REV max	1.08 EPR	No deceleration		
8		No braking	retracted	REV max	Ground idle	5892	2029	91
1	WATER 1/4 "	A/B MED	deployed	REV max	1.08 EPR	1655	2029	OK
2		A/B MED	deployed	REV max	Ground idle	1319	2029	OK
3		A/B MED	retracted	REV max	1.08 EPR	2600	2029	79
4		A/B MED	retracted	REV max	Ground idle	1825	2029	OK
5		A/B MED starting at 72 Kt GS	retracted	REV max	1.08 EPR	5190	2029	109
6		A/B MED starting at 72 Kt GS	retracted	REV max	Ground idle	2619	2029	81
7		No braking	retracted	REV max	1.08 EPR	No deceleration		
8		No braking	retracted	REV max	Ground idle	5094	2029	81
1	WATER 1/2 "	A/B MED	deployed	REV max	1.08 EPR	1533	2029	OK
2		A/B MED	deployed	REV max	Ground idle	1242	2029	OK
3		A/B MED	retracted	REV max	1.08 EPR	2261	2029	50
4		A/B MED	retracted	REV max	Ground idle	1660	2029	OK
5		A/B MED starting at 72 Kt GS	retracted	REV max	1.08 EPR	3746	2029	96
6		A/B MED starting at 72 Kt GS	retracted	REV max	Ground idle	2280	2029	62
7		No braking	retracted	REV max	1.08 EPR	No deceleration		
8		No braking	retracted	REV max	Ground idle	4440	2029	68

A320-232
Weight = 55140 kg CONF 3 - CG = 15%

Runway state	Scenario N°	Brake action	spoilers	Engine1	Engine2	Ground speed at T/D	Ground distance (m)	Available Distance (m)	Speed at runway excursion (kt)
WET	1	T/D +15 s	RETRACTED	EPR = 1.08	REV max	146 Kt	2380	2029	80
	2						2380	2072	76
	3						2380	2154	67
WATER 1/4"	1	T/D +15 s	RETRACTED	EPR = 1.08	REV max	146 Kt	2825	2029	89
	2						2825	2072	86
	3						2825	2154	81
WATER 1/2"	1	T/D +15 s	RETRACTED	EPR = 1.08	REV max	146 Kt	2825	2029	65
	2						2825	2072	60
	3						2825	2154	53

Ground distance = theoretical distance from Touch-down to aircraft full stop with the assumptions of an unlimited runway

Speed at runway excursion = speed reached at the end of the available distance

LDA = 2605 m

Scenario N°	Touch down point		Available distance (m)= LDA - Touch down point
	Distance (ft)	Distance (m)	
1	1890	576	2029
2	1480	451	2154
3	1750	533	2072

C

Appendix 7 Response from Airbus Company for the Stop of “Retard”

Please find following the responses to the second set of questions concerning this event.

- **1/ Can you give a clear translation of the CFDIU troubleshooting coded data?**

The Troubleshooting data provided does not correspond to the event, please see attached message.

- **2/ Why does the message "Retard" stop 2 s after the nose gear touched down? Is it as per design?**

As soon as one TLA is set to REVERSE (whatever the other TLA position), the internal FWC signal "TLA inhibition" becomes true. If "TLA inhibition" is true, RETARD is inhibited.

- **3/ Does the antiskid work when the aircraft slides on ground?**

When the brake pedals are depressed (approx 15s after touch-down), the brake pressures progressively increased up to 1000-1500 psi. That level of pressure does not seem to be abnormal, even if quite high, considering that the aircraft is on a wet runway with ground spoilers not deployed. (It should be noted that the low refresh rate of the data, 1 per 4 secs, may not reflect the precise AntiSkid activity, and the precise level of the brake pressures).

Between 12:00:15 and 12:00:20, the brake pressures decreased below 500 psi on the 4 wheels (again, that is based on 1 measure per 4 seconds...). As the runway is reported to be very wet (heavy rain conditions reported by the crew), this seems to be the normal behaviour of the Anti-Skid function, in order to avoid the wheels locking. In addition, the aircraft has left the runway at about 12:00:16, which has contributed to the loss of a normal adherence.

After 12:00:20, the brake pressures increased again. As the aircraft speed is below 20 kts, the Anti-Skid function is inhibited, and then the brake pressures increased to comply with the brake pedal position.

We hope that the above answers your questions, and we remain at your disposition for any further information you may require.

1/ TLA corresponding to point #4 on chart #003.1/76-11-00 dealing with "Throttle Control System"

Please refer to the attached AMM pages 76-11-00 Page 5 Figure 003, and 73-20-00 Page 42 Figure 021. As you will see 73-20-00 shows TRA angles. The 5°45' position corresponds to point #4 on figure 003 of 76-11-00. Knowing that 1° TLA = 1.9 TRA we can see that corresponding TLA will be 3° (Please note that DFDR resolution for TLA is 2.821°).

2/ Landing distance in the conditions specified by the ASC

Please refer to the attached table Landing Distances.

It should be noted that the scenario AUTO-BRK MED with GROUND SPOILER

retracted has no practical meaning, as AUTO-BRK MED will not operate when spoilers are not extended, and this is included as per ASC request for illustration only.

Also the calculations have been made using models which exist, and where 1/2" of standing water on the runway would be the maximum normally seen.

The calculations take into account the main following assumptions :

WIND = 0 Kt (shifting wind direction < 10 kt and small impact on performance calculations) Runway State : WET, WATER 1/2 inch, WATER 1/4 inch

ENGINE 1 => T/R MAX

ENGINE 2 => Ground idle

or

EPR = 1.08

PLEASE NOTE. Modelling of the thrust associated with EPR = 1.08 is not precise as the thrust is usually modelled for well-known fixed ratings (as MCL, MCT, TOGA, Ground IDLE, etc ...), and this leads to potential minor uncertainties on the results. Also the ENGINE 1 at T/R MAX assumes REVERSE MAX is used down to 70 knots, and then REVERSE IDLE is used from 70 knots down to 0 knots, as per normal procedure.

3/ Thrust in relation with EPR

We cannot provide this information as in order to accurately compute this we would require the N1 for the Engine 1 in reverse, and this is not recorded, and also there would be some time spent in unusual transitory phases between REV MAX and REV IDLE. For the Engine 2 at 1.08 EPR the thrust would be of the order of 3000 DaN. (Please see NOTE to previous reply).

4/ Possible way of testing correct functioning of the ground spoilers

We are currently working on this and a procedure has been developed, and this now requires testing here in Toulouse prior to it being made available.

Nevertheless we understand that the ASC have released the aircraft to TNA after performance of the following procedure. reference ASM 27-90-00-101-05,27-92-00-101-25 (see attached GRND SPLR.pdf)

1.a/c on ground

2.energize a/c electrical circuits

3.three IRS in ATT mod

4.HYD elec pump Y and B on

5.GND SPLR armed

6.rotate four main wheel tachymeter over 900 RPM

-refer AMM 32-42-00-720-002 connect main wheel driving adaptor

(98d32403004000)with the drilling machines 7.thrust level idle

- spoilers full extention

- each one TLA advance over 15 degree spoilers retract

5/ Specification of the maximum TLA allowing spoilers' operation.

Please see attached FCOM 1.27.10.

6/ Autothrottle behaviour

The TSD that were provided, cannot help in ATHR behaviour explanation since there are not related with the RWY excursion time. Nevertheless, a lab test was performed to complete/confirm the ATHR analysis:

ATHR BEHAVIOUR :

The ATHR has worked as per design.

The ATHR involuntary disconnection is explained by the incorrect operational use of the throttles. This incorrect use leads to the ATHR disconnection by the EPR target comparison monitoring.

Explanation :

The disconnection logic is such that ATHR disconnection is normally obtained at touch down when both throttles are set to IDLE, without ATHR warning .

If not, another ATHR reset condition can allow the ATHR to be disengaged :

-If the THR TARGET feedback of one FADEC is different by 0.15 EPR from the ATHR EPR TARGET limited to the corresponding EPR TLA, the ATHR is disconnected after 1.8 sec. This condition triggers the ATHR warning. This condition has been triggered before the previous one during that landing.

The FADEC transmission of the EPR TLA becomes NCD when the corresponding throttle is selected in reverse range , the FMGC ARINC acquisition behaviour (per design) in case of NCD is to keep the last EPR TLA valid value (0.98 during lab test in the conditions of the TAN landing). On an other hand the FADEC EPR TARGET FEEDBACK in reverse is reduced to about 0.75 EPR. Such a difference is due to the fact that: when no alpha floor condition is present, the FADEC EPR TARGET FEEDBACK is upper limited to EPR TLA which is set, when TLA is at or below idle, to EPR IDLE. The EPR IDLE is reduced by 0.2 when the thrust reverser has deployed more than 15%.

Consequently the EPR comparison becomes invalid and the ATHR is disconnected after 1.8 sec with the corresponding warning .That involuntary ATHR disconnection allowed the thrust to be frozen on engine2 whose lever was at CLB notch !

The required delay between the TLA movement within REV area and the ATHR Engagement deletion on FMA is consistent with the DFDR.

-End-

Aviation Safety Council

Taipei, Taiwan

GE 536 Occurrence Investigation
Factual Data Report

Runway Overrun During Landing On Taipei Sungshan Airport

TRANSASIA AIRWAYS FLIGHT 536

A320-232, B-22310

October 18, 2004

Content

Tables

Figures

1 Factual Information

1.1 History of Flight

On October 18, 2004, at 1959[1] Taipei local time, TransAsia Airways (TNA) flight GE 536, an A320-232 aircraft, registration No.B-22310, departed from Tainan Airport (RCNN), rolling off from the stopway in the end of Runway 10, stopped with its nose gear trapped in a ditch during landing roll on Taipei Sungshan Airport (RCSS). The sliding tube of nose landing gear was broken, both engine nacelles came into contact with ground and damaged, none of the 2 pilots (CM-1 and CM-2), 4 cabin crewmembers, and100 passengers aboard were injured.

The flight departed from RCNN at 1924. The pilot-in-commend (CM-1) was on the left seat as the pilot monitor (PM), the first officer (CM-2) was on the right seat as the pilot flying (PF). At 1928, the Automatic Terminal Information service, (ATIS) broadcast for RCSS were "…expect ILS Approach. Runway one zero in use; wind variable at three; visibility four thousand five hundred meters; light rain; cloud scattered eight hundred feet, broken one thousand eight hundred feet, overcast three thousand five hundred feet; temperature two three; dew point two two; Q-N-H one zero zero eight hactopascals; wind shear on runway one zero; Low Level Wind Shear Advisory in effect, moderate to severe…". The aircraft employed RCSS Instrument Landing System (ILS) approach Runway 10. At 1958:12, the flight received landing clearance.

According to the Flight Data Recorder (FDR) and Cockpit Voice Recorder (CVR) data:

Total landing weight were 55,140 kilogram, flaps selected "3", approach speed selected "137 knots", ground spoilers "ARMED", autobrake selected "MEDIUM", antiskid selected "ON" at final approach.

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[1] All of the times herein are in Taipei local time on the 24-hour clock.

At 1959:04, radio altitude 282 feet, auto-pilot disengaged, autothrottle activated. The CVR recorded “RETARD” sound four times between radio altitude 20 feet and the main landing gear touched ground.

At 1959:27, the main landing gear touched ground, air speed 138 knots, ground speed 146 knots, heading 093 degrees, wind direction 297 degrees, wind speed 11 knots, the number 1/2 throttle level angle positioned at 19.7/22.5 degrees. Three seconds later, nose gear touched ground, the number 1/2 throttle level angle positioned at 22.5/22.5 degrees.

At 1959:32, the autothrottle disconnected, number one thrust reverser deployed, number two thrust reverser not deployed.

At 1959:37 CM-1 called out “no brake”, until 1959:50, CM-1 called “no brake” five times. In the meantime, air speed 112 knots, ground speed 109 knots.

At 1959:42, the left/right brake pedal angle positioned at 28/46 degrees. After eight seconds until its full stop, all of the brake pedals angle were positioning between 62 degrees to 80 degrees.

The ground spoilers did not extend.

The aircraft touch down at 1,750 feet on Runway 10, and rolling off 321 feet from the end of Runway 10. The aircraft stopped in the northern side of the stopway with heading 002 degrees, the distance from stopway to the main landing gear was 72 feet.

According to the records in the Technical Log Book of the aircraft: The number 2 engine thrust reverser system was malfunctioned and was transferred to deferred defect (DD) item and the thrust reverser was deactivated in accordance with the procedures in the Minimum Equipment List.

1.2 Injury to Persons

There were two pilots, four cabin crews and one hundred passengers aboard. No one sustained injury.

The injury distribution is summarized in Table 1.2-1.

Table 1.2-1 Injury table

Injuries	Crew	Passengers	Others	Total
Fatal	0	0	0	0
Serious	0	0	0	0
Minor/None	6	100	0	106
Total	6	100	0	106

1.3 Damage to Aircraft

The aircraft rolled off Runway 10 and came to rest in a muddy area 90 degrees to the runway heading（Figure 1.3-1）. The NLG entered a drainage ditch （approx 1m deep）（Figure 1.3-2） and sliding tube of the nose gear was broken（Figure 1.3-3）, both engine nacelles came in contact with the ground （Figure 1.3-4）. Damage the RH pylon structure and some engine fan blades were evident.

Figure 1.3-1 The aircraft rolled off runway and came to rest in a muddy area 90 degrees to the runway heading

Figure 1.3-2 The NLG entered a drainage ditch (approx 1m deep)

Figure 1.3-3 Sliding tube of the nose gear was broken

Figure 1.3-4 Both engine nacelles came in contact with the ground

1.4 Other Damage

From the observation of the tire marks, the nose gear passed through two runway threshold lights （Figure 1.4-1）. The right main landing gear passed through two electrical handholds. Wreckages of the damaged electrical handholds were shown in Figure 1.4-2.

Figure 1.4-1 Damaged runway threshold lights

Figure 1.4-2 Damaged electrical handholds

1.5 Personnel Information

1.5.1 Backgrounds and Experiences of Pilots

1.5.1.1 CM-1

CM-1 is a national of Republic of China who had served in military as a pilot and his total flight time was 2,686:20 during his military service. He joined TNA in September 1990 as a first officer of ATR42/72, was promoted to captain of ATR42/72 in January 1992, the flight time on ATR42/72 was 1,502:54. CM1 completed transition training of A320 captain at Aeroformation Airbus Training Organization, France in August 1993, and became instructor pilot of A320/A321 in April 1997, and check pilot in April 1998. His total flight time was 12,918:17 which included 8,729:17 on A320/A321.

1.5.1.2 CM-2

CM-2 is a national of Republic of China who had served in military as a pilot and his total flight time was 2,163:30 during his military service. He joined TNA in May 1994 as a first officer of ATR42/72, the flight time on ATR42/72 was 1,219:51. CM2 completed transition training of A320 first officer at Aeroformation Airbus Training Organization, France in April 1996. His total flight time was 10,431:56 which included 7,048:35 on A320/A321.

Table 1.5-1 Basic Information of Pilots

Item	CM-1	CM-2
Gender	Male	Male
Age as of accident	51	45
Date of joining in TNA	SEP 11, 1990	MAY 24, 1994
License type	Airline Transport Pilot No.101016	Airline Transport Pilot No. 101475
Type rating Expire date	A320/A321 JUL 18, 2005	A320/A321 F/O APR 16, 2005
Medical class Expire date	1st class airman MAR 31, 2005	1st class airman DEC 31, 2004
Latest flight check	OCT 16, 2004	MAY 10, 2004
Total flight time	12,918 hrs 17min.	10,431 hrs 56 min.
Flight time in last 12 months	793 hrs 38 min.	777 hrs 50 min.
Flight time in last 90 days	152 hrs 40 min.	141hrs 44 min.
Flight time in last 30 days	59 hrs 57 min.	61 hrs 53 min.

Flight time in last 7 days	28 hrs 30 min.	24 hrs 48 min.
A320/A321 flight time	8,729 hrs 03 min.	7,048 hrs 35 min.
Flight time on the day of accident	3 hrs 11 min.	3 hrs 11 min.
Rest time period before accident	Over 24 hrs	Over 24 hrs

1.5.2 Training and Rating Records of Pilots

1.5.2.1 CM-1

Transition training

CM1 completed ground academic courses training and simulator training of A320 captain at Aeroformation Airbus Training Organization, France from May 19 to June 30, 1993 and passed the type rating. He completed the training and passed the rating of the performance and flight route between July 12 to August 6 of the same year, passed the deferential training of A320/A321 in July 1995.

Qualifications training

Completed instructor pilot qualifications training and simulator training of A320/A321 at Hyderabad Training Center, India from February 24 to March 1, 1997 and passed the rating of the performance and takeoff/landing skills on March 5.

Completed A320/A321's check pilot qualifications training from April 7 to April 8, and passed the check pilot flight route check on April 21.

Recurrent training

The simulator recurrent training of TNA pilots had been conducted either at the Airbus Training Center, Toulouse, France, or at Airbus Training Center, Miami, U.S.A., between 1994 and 1996. From 1997, it changed to the Hyderabad Training Center, India; at Asia Pacific Training & Simulator PTE Ltd., Singapore, between 1998 to 2000; and has changed to at GE Capital Aviation Training (GECAT) or at Dragonair Training Center, Hong Kong, since 2001. The pilots are trained by TNA instructor pilots and examined by TNA designated examiners designated by CAA.

CM-1 passed all of the recurrent training and rating, and no abnormal records since he completed the transition training of A320/A321.

1.5.2.2 CM-2

Transition training

The ground academic courses training of A320/A321 of the first officer was

conducted by TNA instructor pilots at TNA classroom from December 1995 to January 31 1996. He completed the simulator training and differential training of A320/A321 on November 27 at Airbus Training Center, and passed the rating of first officer on performance and flight route in April of the same year.

Recurrent training

CM-2 passed all of the recurrent training and rating, and there were no abnormal records since he completed the transition training of A320/A321.

1.5.3 Pilots' Ground School Recurrent Training

A one day ground school of recurrent training for TNA flight crew is conducted prior to the twice-per-year's recurrent trainings. The curriculum of the ground school training program includes:

Civil aviation regulations, one hour;

Crew resources management (CRM), one hour;

Standard operation procedures (SOP), two hours

Controlled flight into terrain/approach and landing accident reduction/ground proximity warning system/traffic alert and collision avoidance system (CIFT/ALAR/GPWS), one hour;

Abnormal operations of aircraft systems (including emergency procedures, abnormal attitude recovery, low level windshear warning system and avoidance), two hours;

Special flight operations, three hours;

Adverse weather, one hour;

Check pilot's briefing, one hour;

Other curricula that need to be replenished or reinforced; and

Tests; one hour.

1.5.3.1 CM-1

CM-1's ground academic courses training records in recent two years TNA showed the dates and tests scores as follows: 95 points on October 7, 2004; 100 points on February 17, 2004; 95 points on June27, 2003; and 100 points on January 19, 2003.

1.5.3.2 CM-2

CM-2's ground academic courses training records in recent two years showed the dates and tests scores as follows: 100 points on October 7, 2004; 100 points on April 20, 2004; 100 points on November 5, 2003; and 100 points on April 7, 2003.

1.5.4 Pilots' Physical Conditions

1.5.4.1 CM-1

The item of limitations on the Airman Medical Certificate issued by CAA to CM-1 noted: "Holder shall wear correcting glasses"

1.5.4.2 CM-2

The item of limitations on the Airman Medical Certificate issued by CAA to CM-2 noted: "none".

1.5.5 Pilots' Activities in 72 hours prior to the Accident

1.5.5.1 CM-1

October 15: Conducted training and check on simulator in Hong Kong from1430 to 2000, departed from Hong Kong at 2145 and backed to home in Taipei at around 0100 (midnight).

October 16: Stayed at home resting.

October 17: Picked up his family from CKS Airport at 1300 and back to home.

October 18: Went swimming after got up, finished lunch, and reported to Sungshan Airport for duty at 1300.

1.5.5.2 CM-2

October 15: Stayed at home resting.

October 16: Stayed at home resting.

October 17: Stayed at home in the daytime, attended a dinner party at 1800 and back to home around 2000.

October 18: Stayed at home resting in the morning. After finished lunch, reported to Sungshan Airport for duty at 1300.

1.6 Aircraft Information

The aircraft basic information is shown in Table 1.6-1.

Table 1.6-1 Aircraft basic information

No	Title	Description
1	Type of Aircraft	A320-232
2	Registration Mark	B-22310
3	Manufacturer	Air Bus Industries
4	Manufacturer's Serial Number	0791
5	Date Manufactured	February 1998
6	Delivery Date	June 24, 1998
7	Operator	TransAsia Airways
8	Owner	Winner Leasing Company Ltd.
9	Certificate of Airworthiness Number (Validity Date)	93-04-041 (March 31,2005)
10	Total Flight Hours	12,124：31 Hours
11	Total Cycles	16,248
12	Date of Last "A" Check	August 13, 2004
13	Flight Hours/Cycles Elapsed Since Last ''A'' Check	331：56 Hours/ 395 Cycles

Basic information of the two IAE (International Aero Engines) V2527-A5 engines is shown in Table 1.6-2.

Table 1.6-2 Basic information of the engines

Position	Serial Number	Date Installed	Total Hours	Time Since Overhaul	Total Cycles
1	V10174	September.8, 2003	12,879:53	2,039:24	17,827
2	V10578	November 6, 2001	9,116:27	5,384:33	12,598

1.6.1 Maintenance Records

The relevant maintenance records to the brakes、engine thrust reversers and spoilers in the Technical Log Book are stated below:

1.6.1.1 Brakes

In 30 days prior to the occurrence, there was no record of brakes replacement.

On October 6, 2004, there was a defect report regarding the failure of the Channel 1 of Brake/ Steering Control Unit （BSCU）. This defect was closed after the BSCU connector was cleaned and passed the self-test in accordance with AMM[2] 32-46-00.

1.6.1.2 Engine Thrust Reverser

The defect report in 90 days prior to the occurrence for both engine thrust reverses are shown in Table 1.6-3 and 1.6-4:

Table 1.6-3 1 Engine 1 thrust reverser defect report

Item No	Defect Reports	Date （Flight ）	DD[3] item Number	Maintenance Actions
1	Eng No.1 reverse fault light on	Sept.27 （GE355）	No	IAW[4] AMM 78-31-00 Perform eng FADEC[5] 1 electrical check. All check normal.
2	Engine 1 reverse after landing amber. Check N2 no work.	Oct. 9 （GE538）	No	Cleaned No.1 engine HCU[6] then IAW AMM 78-31-00 Operating the system through 10 times and all function normal.

Table 1.6-4 Engine 2 thrust reverser defects report

Item	Defect Reports	Date (Flight)	Deferred Number	Maintenance Actions
1	#2 Reverse Fault	Oct. 10 (GE529)	Nil	IAW AMM 78-31-00 Ground tested. Check normal
2	Engine #2 Reverse Amber	Oct.10 (GE532)	Transferred to DD #27588	IAW A320 MEL[7]78-30-01 A/C dispatch.No.2 eng thrust reverser deactivated and transferred to DD.

[2] AMM: Aircraft Maintenance Manual

[3] DD: Deferred Defect

[4] IAW: In Accordance With

[5] FADEC: Full Authority Digital Engine Control

[6] HCU: Hydraulic Control Unit

[7] MEL-Minimum Equipment List 78-30-01 states the category C should be completed in 10 days..

3	DD#27588 Transfer No.2 engine reverse amber	Oct.12 (GE572)	DD#27588 Closed	IAW AMM 78-31-00 1.Recheck locking actuator connector loose & some oil 2.Clean up & operation several times ok
4	#2 Reverse fault	Oct.13 (GE532)	Nil	IAW AMM 78-31-00,No.2 engine reverse operation test normal
5	#2 Engine reverse fault	Oct.13 (GE571)	Transferred to DD#27589	Per MEL 78-30-0 #2 T/R deactivated
6	Transfer from DD#27589	Oct.13 (GE538)	DD#27589 Closed	IAW AMM 78-32-48 & 78-31-00 replaced # 2 R/H side non-locking actuator & check normal. Operation of No.2 thrust reverse system normal & no hydraulic leak found
7	#2 Engine reverse fault	Oct.15 (GE563)	Transferred to DD#27590	IAW MEL78-30-01 #2 T/R deactivated
8	DD#27590,NO.2 engine reverse deactivated	Oct .16 (GE532)	DD#27590	IAW AMM 78-30-00 deactivation No.2 eng rev t/r & function check ok pleases keep observe further
9	Info NO.2 T/R works normal	Oct .16 (GE570)	DD#27590	Noted and thanks
10	#2 Engine reverse fault after operated	Oct16 (GE538)	DD#27590	IAW AMM 78-32-48 L/H No.2 non-locking actuator was replaced. Inspect reverser IAW AMM 78-31-00.keep observes.

1.6.1.3 Spoilers

In 30 days prior to the occurrence, there was no malfunction report regarding the spoiler system.

1.6.1.4 Repeat Item and Its Handling Procedures

In accordance with the contents of the Aircraft Maintenance Control Manual （June 30,2003） the definition and handling procedures of the repeat item are listed as below:

Repeat item: The same defect that occurred again after the last maintenance action was fixed in three days would be considered as a repeat item.

Handling procedures:

5.1 Maintenance and Control Center

5.1.1 Monitor and record all the maintenance actions of the aircraft. If there is a repeat item occurred, record in the daily review record and will discuss it on the next day morning briefing.

5.1.2 Follow up the last maintenance action of the repeat item and discuss the cause of the defect and the effective corrective action with the maintenance crew to avoid the defect repeated.

5.1.3 Collect all the repeat item records in each month and list them in tables to Quality Control Center for the review of Reliability Control Board Meeting.

5.2 Reliability Control Board Meeting

5.2.1 Review the cause and corrective actions and preventions of the repeat items and monitor the result of the actions.

5.2.2 Share the information to the working unit to be the reference of the future maintenance actions and recurrent training materials.

5.3 The Engineering Section and the aircraft manufacturer will provide technical assistance whenever is needed.

5.4 The maintenance unit that found the defects came from the misconduct or human error during the maintenance actions should inform the person who conducted the corrective actions and list the facts on the training materials to avoid that kind of misconduct happening again.

5.5 The item on the deferred defects log would not be considered as repeat item when the defect was occurred again.

1.6.2 Aircraft Systems related to Deceleration

In this section, the systems related to deceleration are introduced, these systems are spoilers, braking, and thrust control systems.

1.6.2.1 Spoilers

A320 has five spoilers numbered 1 thru 5 inboard to outboard （Refer to Figure 1.6-1）. Five spoiler surfaces are provided on each wing to achieve the functions below:

- Roll spoiler（surfaces 2 to 5）;
- Speedbrake（surfaces 2 to 4）;
- Ground spoilers（all surfaces）。

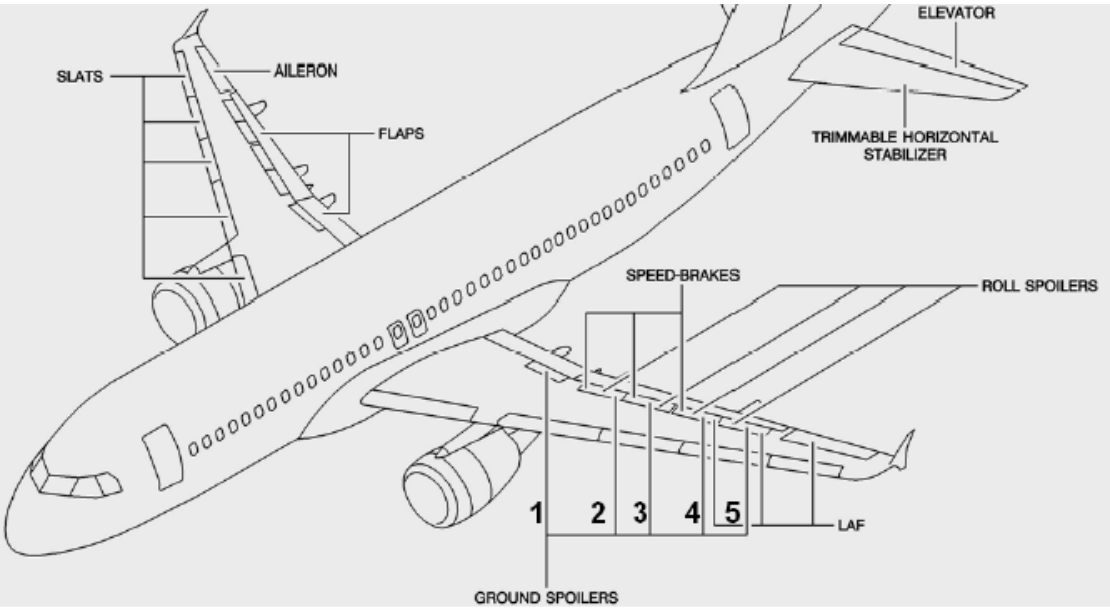


Figure 1.6-1 Spoilers

These surfaces are manually controlled from the side stick controllers （roll spoilers）, speedbrake control lever （speedbrake）or automatically in autopilot and ground spoiler function.

Each surface is controlled by one servocontrol supplied from the Green, Yellow or Blue system and signaled from the SEC 1（Spoiler and Elevator Computer #1）, SEC 2 or SEC 3.

Mechanism to activate ground spoilers functions

The purpose of ground spoilers is to increase the effect of deceleration when aircraft on the ground. The activation logic of this function is shown in Figure 1.6-2. Depend on flight phase, ground spoilers activate at two circumstances.

Case 1: Landing phase and meet the following conditions:

1. Speedbrake lever pre-selected at “ARM” position or at least one thrust reverser operated;
2. Both engine at idle position（Throttle Lever Angle, TLA <20 degrees）;

3. Both main landing gear[8] from “not pressed” to “pressed” and RA < 6 feet.

Case 2: When aircraft rejects takeoff and meet the following conditions:

1. Speedbrake lever pre-selected at “ARM” position or at least one thrust reverser operated;

2. Both engine at idle position（Throttle Lever Angle, TLA <20 degrees）;

3. Wheel speed higher than 72 knots.

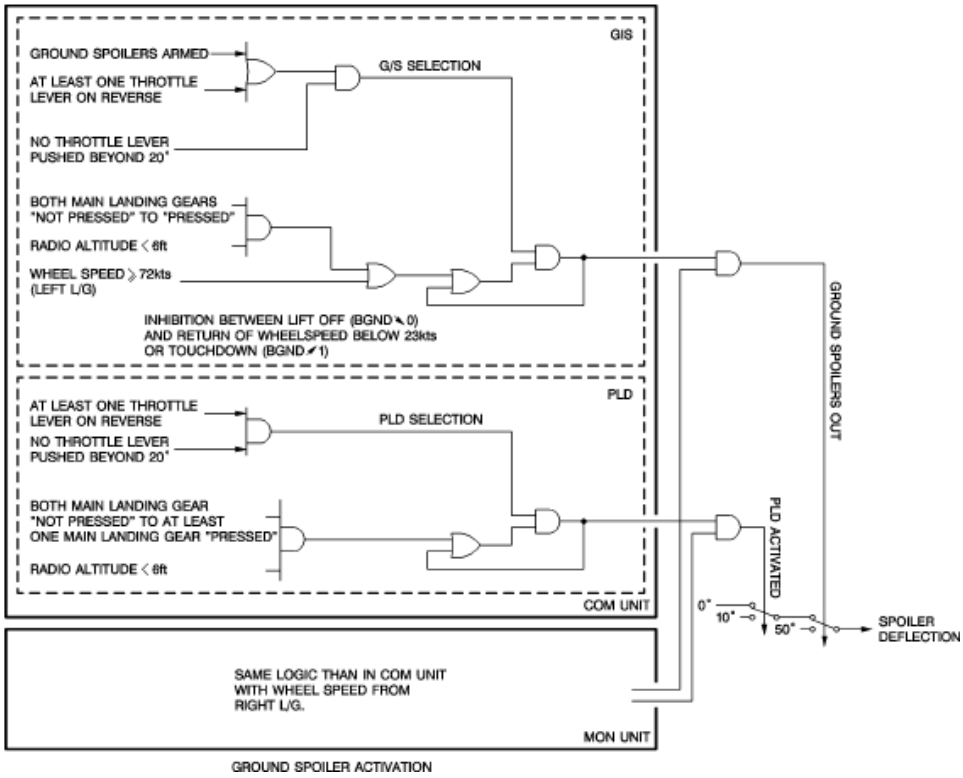


Figure 1.6-2 Ground spoiler activation logic diagram

1.6.2.2 Braking System

In auto brake mode, the selection of AUTO/BRK P/BSW（LO, MED or MAX）sets a program to give a set deceleration rate. The BSCU automatically starts the program when the aircraft configuration is correct and then controls the pressure sent to the brakes. In manual brake the movement of the brake pedals operates the brake-pedal transmitter unit. The transmitter unit sends a signal to the BSCU, which in turn sends the required input signal to the

[8] If only single main landing gear from “not pressed” to “pressed”, ground spoilers extend 10 degrees. If both main landing gears from “not pressed” to “pressed”, ground spoilers extend 50 degrees.

servo-valves. The servo-valves let a pressure, in proportion to the pedal travel go to the brakes. The BSCU also controls the anti-skid system; brake release orders generated from BSCU are sent to the servo-valves in the event of any wheel speed does not consist of aircraft ground speed.

Braking Modes

During landing and taxi rolls, three braking modes available depend on hydraulic system used and the position of the A/SKID & N/W STRG switch and PARK BRK control switch.

1. Normal Barking

- Supply of green hydraulic high pressure is normal;
- A/SKID & N/W STRG switch is in the “ON” position;
- PARK BRK control switch is in the “OFF” position.

Normal Braking is activated either by the movement of pedal or the activation of auto braking system. Brake pressure is regulated by normal servo-valves.

2. Alternate Braking with Anti Skid

The alternate braking with anti-skid associates the Yellow high-pressure hydraulics regulated by the anti-skid system. It is activated in case of green hydraulic system malfunction. The braking modes are shown on the upper ECAM（Electronic Centralized Aircraft Monitor） DU（Display Unit）. The alternate braking command is applied by pedals only and the pressure is supplied by an auxiliary low-pressure hydraulic-system. The pressure supplied to brakes is shown on a brake Yellow-pressure triple-indicator which was installed on the center instrument panel.

3. Alternate Braking without Anti Skid

The Alternate braking without anti skid differs from the above modes in that the anti skid regulation is no longer available, It could be:

- Disconnected electrically（A/SKID & N/W STRG switch in the OFF position or power supply failure）;
- Disconnected hydraulically if only the brake Yellow-pressure accumulator supplies the brakes（the A/SKID & N/W STRG switch can be in any position）.

The Yellow system interconnects the power accumulator. A fully charged accumulator can provide hydraulic pressure at minimum seven applications of fully braking.

Auto Brake

The system decreases the number of flight crew actions if an acceleration-stop （MAX mode）occurs when takeoff, or keeps the

deceleration to a pre-set limit（LOW or MED）when landing. The Auto Brake control panel is shown as Figure 1.6-3.

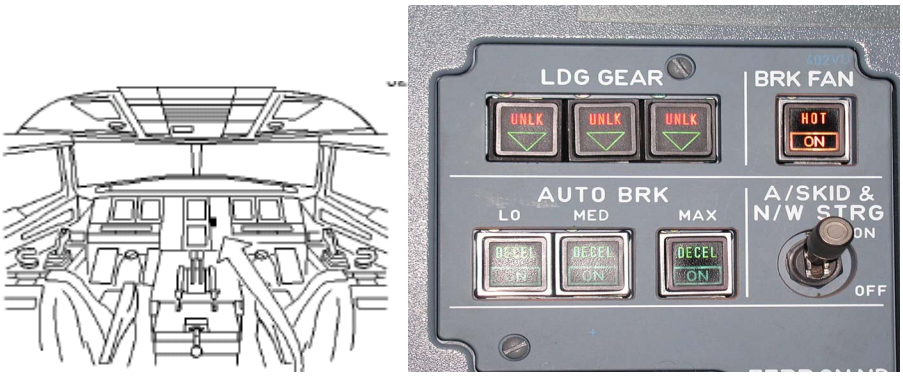


Figure 1.6-3　Auto Brake control panel

The flight crew pushes the LO, MED or MAX[9] pushbutton switch to arm the system. The ON legend on the lower half of the pushbutton switch comes on if the Normal braking is operational. In the automatic mode the selection of an AUTO/BRK P/BSW （LO, MED or MAX）sets a program to give a set deceleration rate. The BSCU automatically starts the program and then controls the pressure sent to the brakes. The ground spoiler extension command starts the braking action. The Green DECEL legend on the upper half of the pushbutton switch comes on while decelerating rate reaches 80% of programmed.

The auto brake system is disengaged and disarmed at the following conditions:

- If ground spoiler return to stow, or;
- If crew apply sufficient pressure to the pedals with the aircraft on the ground（takeover through brake pedals）.

The failure of the auto brake is shown on the upper ECAM DU before and after the selection.

1.6.2.3　Thrust control and Throttle lever position

The throttle control lever moves over a range of 65 degrees from -20 degrees to 45 degrees（TLA）. It includes 3 stops and 3 detents, -20 degrees（MAX REVERSE stop）, -6 degrees（REVERSE IDLE detent）, 0 degree（IDLE stop which could be overridden when using thrust reverser）, 25 degrees（MAX CLIMB）, 35 degrees（MAX CONTINUOUS /FLEX TAKEOFF detent）, and 45 degrees（MAX TAKEOFF stop）, as indicated in Figure1.6-4. When both throttle control levers are between IDLE to MAX CONTINUOUS（0 degrees to

[9]Three default decelerating rates as: 2m/s^2（LOW）. 3m/s^2（MED）and 0.27 g（MAX）.

35 degrees TLA）the autothrust function can be activated if engaged. This range corresponds to the selection of MAX CLIMB or MAX CONTINUOUS thrust limit mode, except the FLEX TAKE OFF mode. If the autothrust is engaged and active, the engines are controlled by the Autothrust system. If the autothrust is not engaged, the engine is manually controlled by the throttle control lever, as shown in Figure 1.6-5. In automatic landing, the Flight Warning Computer, FWC, auto call out delivers a “RETARD” message at 10 feet RA. The pilot then moves the throttle control levers to the IDLE position to take manual control of the thrust for landing. With the A/THR engaged but not in the automatic landing conditions, the “RETARD” warning message will be delivered at 20 feet RA.

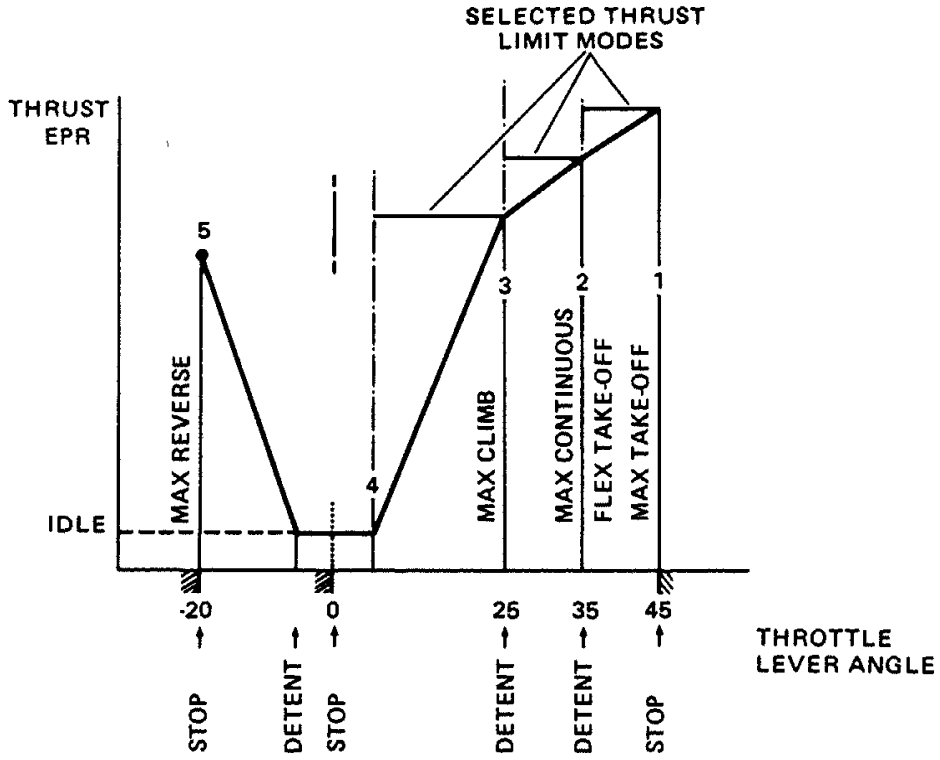


Figure 1.6-4 Thrust control lever angle and associated function

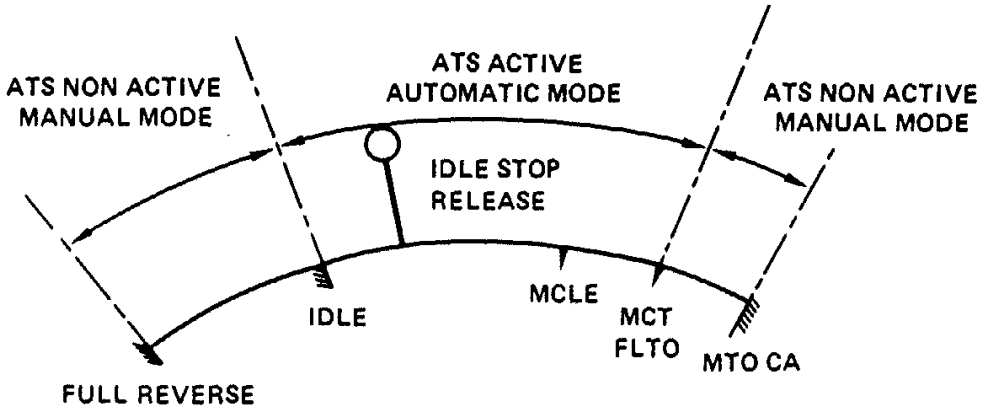


Figure 1.6-5 Throttle control lever vs. manual/autothrust active area

1.6.3 Weight and Balance

The maximum takeoff weight of this aircraft was162,038 pounds, the maximum landing weight was142,196 pounds, the maximum zero fuel weight was 134,480 pounds. The center gravity of takeoff and landing were in limit. See Table 1.6-5 for weight and balance data.

Table 1.6-5 GE536 Weight and Balance Data

Zero Fuel Weight	112,707 lb
Takeoff Fuel	12,400 lb
Takeoff Weight	125,050 lb
Center Gravity of Takeoff	25.6% M.A.C.
Takeoff Trim	0.6
Consumed Fuel in Flight	3,596 lb
Landing Weight	121,454 lb
Center Gravity of Landing	26.3% M.A.C.

1.7 Weather information

1.7.1 General information of the typhoon

Typhoon Tokage centered at 23.0N and 126.9E, about 586 kilometers east-southeast of Taipei/Sungshan Airport at 2000, October 18, moving north-northwestly at 15 km/hr and then north-northeastly at 20 km/hr. Maximum wind speed of the storm was 43 knots gusting 53 knots, radius of the storm (average wind speed at 15 meter/sec) was 200 km, and pressure of the storm center was 965 hPa. Figure 1.7-1 and 1.7-2 are Infrared satellite imagery at 2023 and surface analysis chart at 2000 respectively.

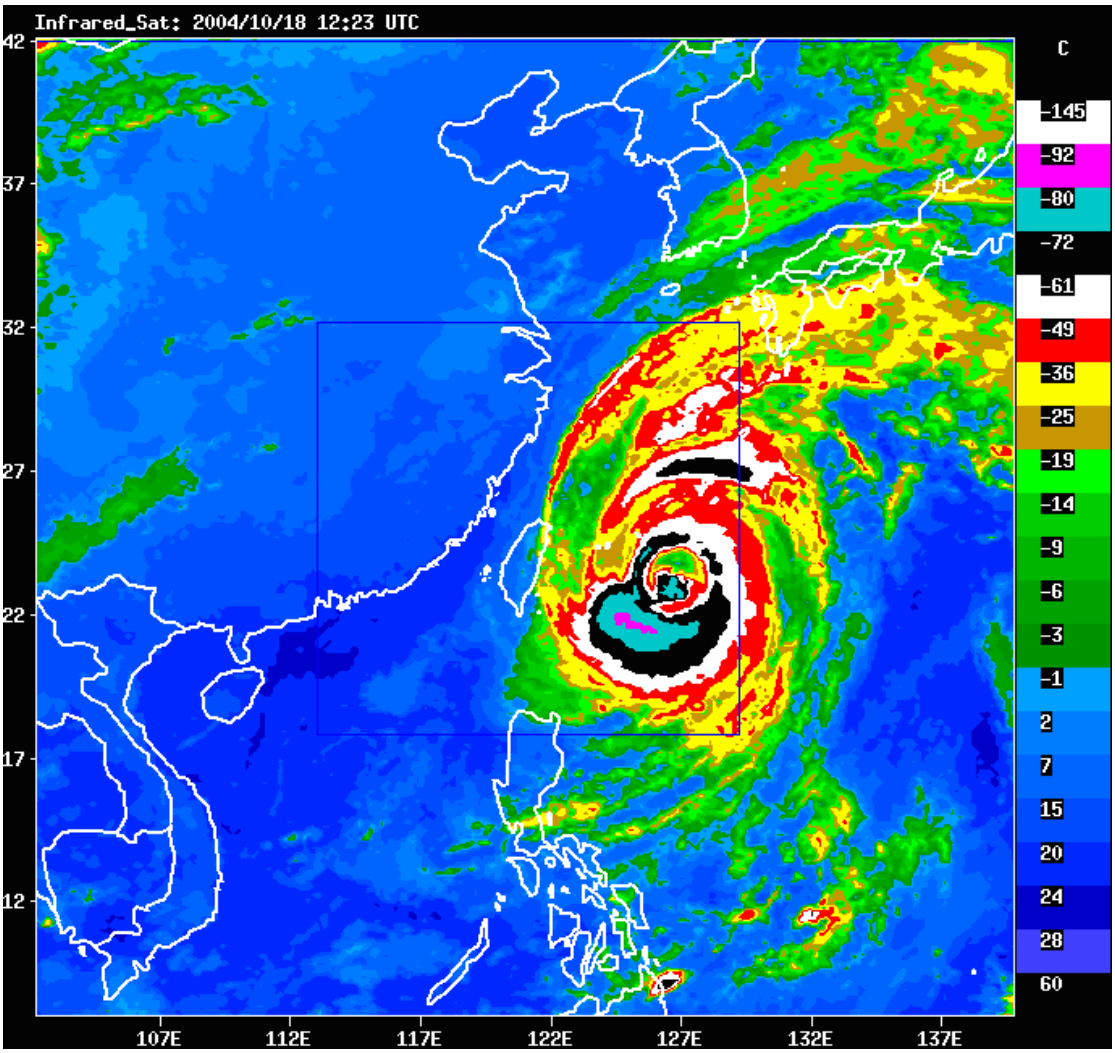


Figure 1.7-1 Infrared satellite imagery at 1223 UTC

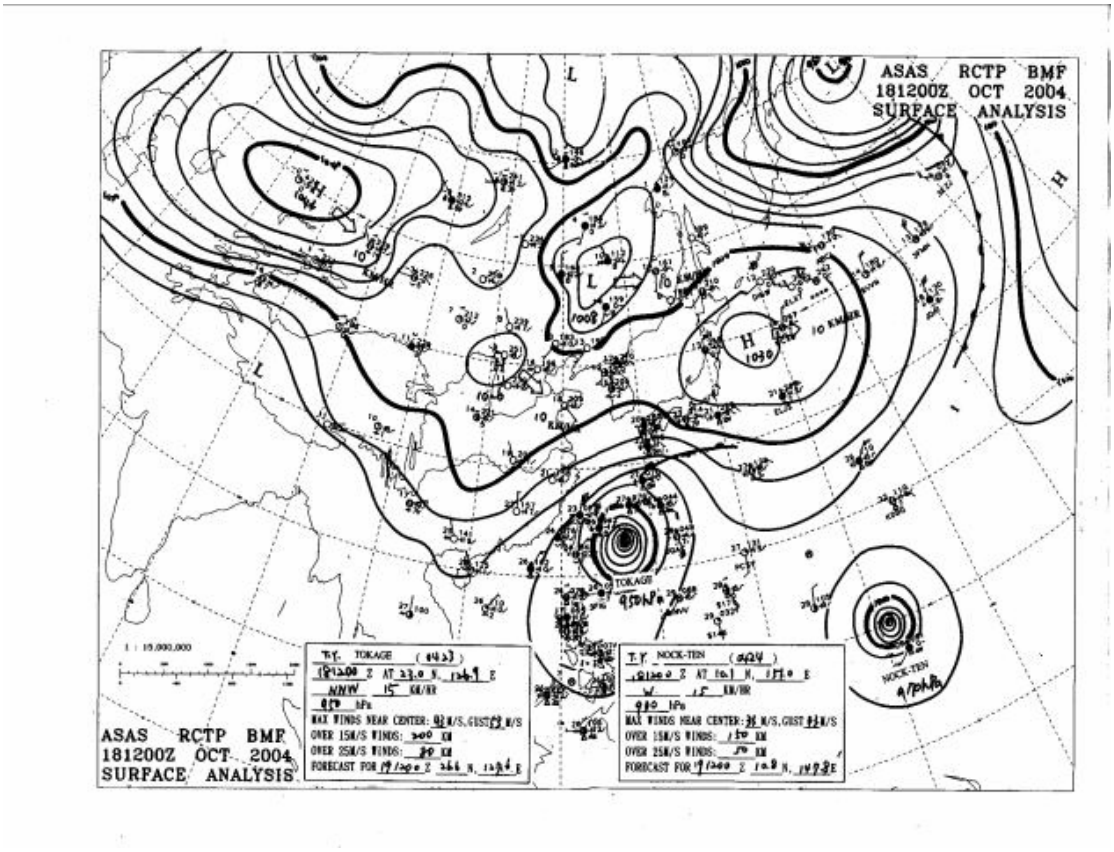


Figure 1.7-2 Surface analysis chart at 1200 UTC

1.7.2 Surface Weather Observations

The Taipei/Sungshan Weather Station surface weather records indicated the following:

1930: Wind variable at 3 knots; Visibility—4,500 meters; Present Weather—light rain; Clouds—scattered 800 feet, broken 1,800 feet, overcast 3,500 feet; Temperature—23 degrees Celsius; Dew Point—22 degrees Celsius; Altimeter Setting—1008 hPa; Supplementary information—RWY 10 windshear; Trend Forecast—no significant change.

2000: Wind variable at 2 knots; Visibility—4,500 meters; Present Weather—light rain; Clouds—few 800 feet, broken 1,800 feet, overcast 3,500 feet; Temperature—22 degrees Celsius; Dew Point—22 degrees Celsius; Altimeter Setting—1008 hPa; Supplementary information—RWY 10 windshear; Trend Forecast—no significant change; Remark—rain amount 0.75 millimeters.

There was no low level windshear detected by Low Level Windshear Alert System（LLWAS）of Taipei/Sungshan Airport from 1900 to 2005. The following is the recorded information of Taipei/Sungshan Airport Automated Weather Observing System（1 second average）:

Table 1.7-1 Recorded information of Taipei/Sungshan Airport Automated Weather Observing System

Time	RWY 10 Wind （degree/knot）	RWY 28 Wind （degree/knot）
1952	304/01	023/06
1953	315/03	338/03
1954	354/05	349/02
1955	034/05	034/06
1956	360/03	017/09
1957	068/01	321/00
1958	360/00	017/03
1959	248/00	354/04
2000	332/02	006/03
2001	073/04	349/04

1.7.3 Windshear information of METAR/SPECI

1.7.3.1 Windshear information of METAR/SPECI of Sungshan Airport

The supplementary information of RWY 10 windshear was included in METAR/SPECI of Sungshan Airport from 1220 to 2030. The following is the windshear information of AIREP and LLWAS[10] from 1220 to 2030.

Table 1.7-2 Windshear information of AIREP and LLWAS from 1220 to 2030

Time	AIREP	LLWAS
1220	An MD82 encountered windshear at altitude of 1500-2000 feet, 5-6 nm from Sungshan Airport	
1251		Windshear alert-RWY 10 arrival
1252		Windshear alert-RWY 10 arrival and departure
1255		Microburst alert-RWY 10 arrival
1502-1503		Windshear alert-RWY 10 arrival
1516-1517		Windshear alert-RWY 10 arrival
1520	An MD90 made a go round by the influence of low level windshear	

[10]From the records of Sungshan Weather Station, the windshear information was obtained from Air Reports (AIREPs) received by Sungshan Tower or low level windshear / microburst alerts of LLWAS.

1539-1540		Windshear alert-RWY 10 arrival
1543-1544		Windshear alert-RWY 10 arrival and departure
1553-1554		Windshear alert-RWY 10 arrival and departure
1624		Windshear alert-RWY 10 arrival and departure
1637-1638		Windshear alert-RWY 10 arrival
1705		Windshear alert-RWY 10 arrival and departure
1710-1712		Microburst alert-RWY 10 arrival and departure
1713		Windshear alert-RWY 10 arrival and departure
1753-1755		Microburst alert-RWY 10 arrival and departure
1852-1853		Windshear alert-RWY 10 arrival

1.7.3.2 The associated regulations concerning windshear information of METAR/SPECI

Chapter 4. METEOROLOGICAL OBSERVATIONS AND REPORTS of ICAO ANNEX 3:

4.4 Coordination of requirements for observations and reports between the meteorological and ATS authorities

Recommendation. — An agreement between the meteorological authority and the appropriate ATS authority should be established to cover, amongst other things:

e) Meteorological information obtained from aircraft taking off or landing (for example, on wind shear)

4.12 Observing and reporting of supplementary information

4.12.1 Recommendation. — Observations made at aerodromes should include the available supplementary information concerning significant meteorological conditions, particularly those in the approach and climb-out areas, and specifically the location of cumulonimbus or thunderstorm, moderate or severe turbulence, wind shear, hail, severe squall line, moderate or severe icing, freezing precipitation, severe mountain waves, sandstorm, duststorm, blowing snow or funnel cloud (tornado or waterspout). Where practicable, the information should identify the vertical extent and direction and rate of movement of the phenomenon. As icing, turbulence and to a large extent, wind shear, for the time being cannot be satisfactorily observed from the ground, evidence of their existence should be derived from aircraft observations during the climb-out or approach

phases of flight to be made in accordance with Chapter 5, 5.5 and 5.6.

Chapter 5. AIRCRAFT OBSERVATIONS AND REPORTS of ICAO ANNEX 3:

5.6 Other non-routine aircraft observations

5.6.1 When other meteorological conditions not listed under 5.5, e.g. wind shear, are encountered and which, in the opinion of the pilot-in-command, may affect the safety or markedly affect the efficiency of other aircraft operations, the pilot-in-command shall advise the appropriate air traffic services unit as soon as practicable.

5.6.2 Recommendation. — When reporting aircraft observations of wind shear encountered during the climb-out and approach phases of flight, the aircraft type should be included.

5.6.3 Recommendation. — Where wind shear conditions in the climb-out or approach phases of flight were reported or forecast but not encountered, the pilot-in-command should advise the appropriate air traffic services unit as soon as practicable unless the pilot-in-command is aware that the appropriate air traffic services unit has already been so advised by a preceding aircraft.

Chapter 7. SIGMET AND AIRMET INFORMATION, AERODROME WARNINGS AND WIND SHEAR WARNINGS of ICAO ANNEX 3:

7.6 Wind shear warnings

7.6.1 Wind shear warnings shall give concise information of the observed or expected existence of wind shear which could adversely affect aircraft on the approach path or take-off path or during circling approach between runway level and 500 m (1 600 ft) above that level and aircraft on the runway during the landing roll or take-off run. The warnings shall be prepared and disseminated for aerodromes where wind shear is considered a factor in accordance with local arrangements with the appropriate ATS authority and operators concerned and by the meteorological office designated to provide service for the aerodrome or disseminated directly from automated ground-based wind shear remote-sensing or detection equipment referred to in 7.6.2 a) and b). Where local topography has been shown to produce significant wind shears at heights in excess of 500 m (1 600 ft) above runway level, then 500 m (1 600 ft) shall not be considered restrictive.

Note 3. — Information on wind shear is also to be included as supplementary information in local routine and special reports and routine and special reports in the METAR/SPECI code forms in accordance with 4.12.1, 4.12.4 and 4.12.5.

7.6.6 Recommendation. — Wind shear warnings for arriving aircraft and/or departing aircraft should be cancelled when aircraft reports indicate that wind shear no longer exists, or alternatively, after an agreed elapsed time. The criteria for the cancellation of a wind shear warning should be defined locally for each aerodrome, as agreed

between the meteorological authority, the appropriate ATS authority and the operators concerned.

Chapter 3. AIRPORT TRAFFIC CONTROL - TERMINAL of AIR TRAFFIC CONTROL PROCEDURE:

Section 1.GENERAL

3-1-8 LOW LEVEL WIND SHEAR ADVISORIES,

a. When low level wind shear is reported by pilots or detected by the Low Level Wind Shear Alert Systems (LLWAS) or Weather Systems Processor (WSP), controllers shall issue the alert to all arriving and departing aircraft until the alert is broadcast on the ATIS and pilots indicate they have received the appropriate ATIS code. A statement "LOW LEVEL WIND SHEAR ADVISORIES IN EFFECT" shall be included on the ATIS for 20 minutes following the last report or indication of wind shear.

1.8 Aids to Navigation

This accident was unrelated to aids to navigation.

1.9 Communications

This accident was unrelated to communications.

1.10 Airport Information

1.10.1 General

Sungshan Airport is sited on 2.6 nautical miles northeast of Taipei metropolis. The location of airport reference point is 25。04'10"N/121。33'06"E. The aerodrome reference code in this airport is 4D[11]。

According to Aeronautical Information Publication (AIP) -Taipei Flight Information Region（Version of RCCS 2-1, 18th March 2004）, a runway in Sungshan Airport is designated 10/28. Runway 10/28 is 60 meter wide, 2,605 meter long. Non-grooved asphalt concrete was overlayed on runway pavement. The airport elevation is 8ft. The stopway of Runway 10 is 60 meter wide and 160 meter long. And the stopway of Runway 28 is 60 meter wide and 60 meter long.

1.10.2 Runway Safety Area

According to AIP, the runway strip is 300 meter wide（990ft）and 2,765 meter long（9,072ft）. The nearest distance from north fence（9 ft height）to the centerline marking and its extension of Runway10 is 44.89 meter, as shown in Figure 1.10-1（RCSS AD 2-40, revised edition on 09/02/2004.）.

According to ASC's survey, the airport fence is composited of hollow bricks and reinforced concrete. It is located 15 meter to the north of Runway 28 threshold edgeline marking and irregular extension in parallel with runway. Its surface is coloured in alternatively red and white. The area from airport fence to 150 meter to the north of the runway centerline marking and its extension exists some houses constructed with steel and sheet metal, and junk yards some discarded vehicles and materials were stored. There is an uncovered ditch in parallel with runway. The ditch is located on 43 to 69 meter to the north of the centerline of Runway 10 stopway. It is about 1.4 to 2.5 meter wide and 1 to 1.5 meter depth.

There is no information regarding Runway End Safety Area in AIP.

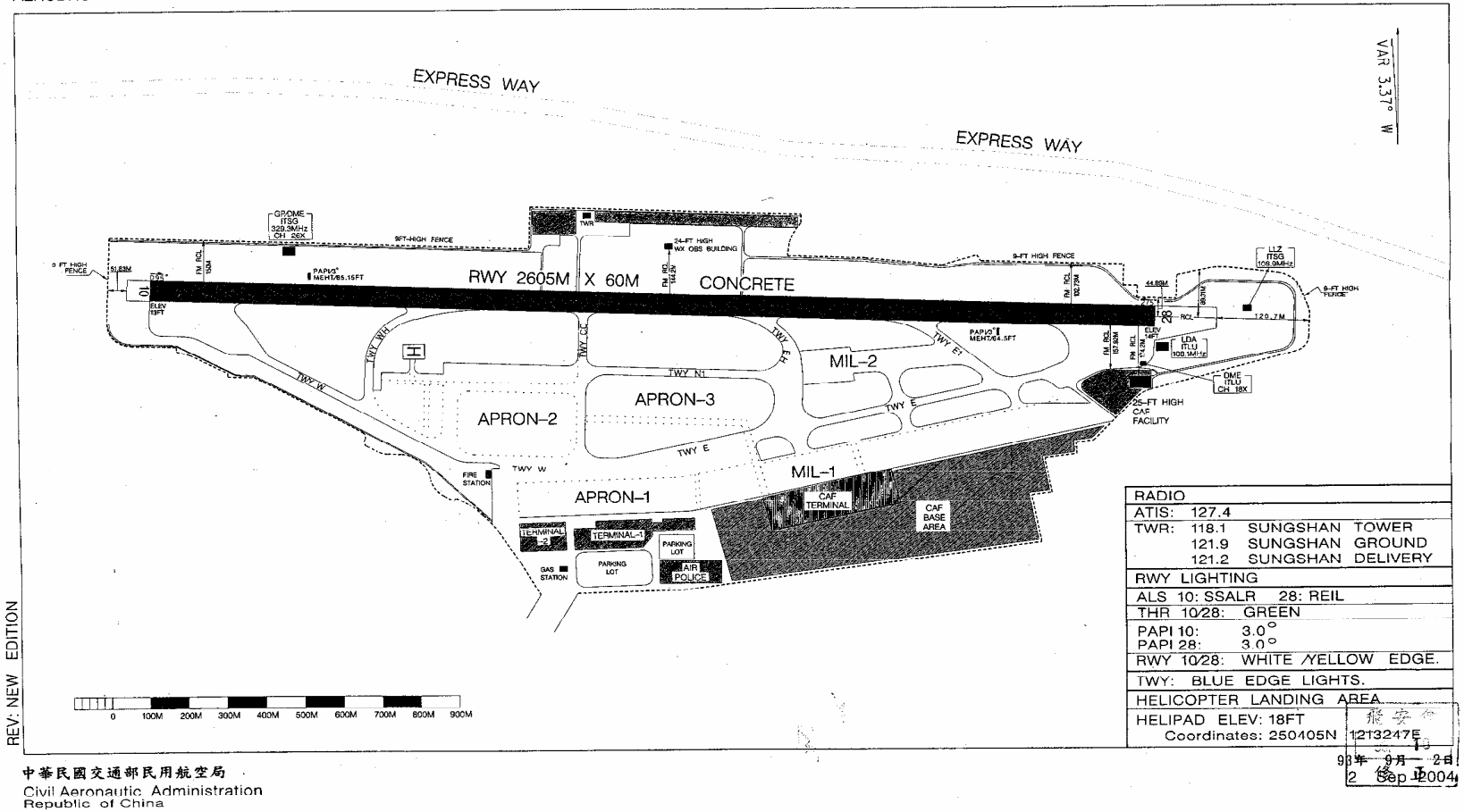
---

[11] 4(Aerodrome reference code number): The highest value of the aeroplane reference field length of the aeroplanes for which the runway is intended is 1800m and over； D(Aerodrome reference code letter)：The greatest wing span whichever gives the more demanding code letter of the aeroplanes for which the facility is intended is 36m up to but not including 52m, or the greatest outer main gear wheel span is 9m up to but not including 14m.

機場圖
AERODROME CHART

ELEV 18 FT
ARP: 250410N 1213306E

TAIPEI/SUNGSHAN AD



中華民國交通部民用航空局
Civil Aeronautic Administration
Republic of China

Figure 1.10-1Layout of Sungshan Airport

1.10.3 Regulations regaring Runway Safety Area

According to 「Civil Aerodrome Design and Operation Standard」（v1.1, July 2004）, paragraph 3.3.2：

"A strip shall extend before the threshold and beyond the end of the runway or stopway for a distance of at least：

- 60m where the code number is 2,3,4…."

Paragraph 3.3.3：

"A strip including a precision approach runway shall extend laterally to a distance of at least：

- 150 m where the code number is 3 or 4."

Paragraph 3.3.8：

"That portion of a strip of an instrument runway within a distance of at least：

- 75m where the code number is 3 or 4…

from the centre line of the runway and its extended centre line shall provide a graded area for aeroplanes which the runway extended to serve in the event of an aeroplane running off the runway.

Note. – Guidance on the grading of a great area of a strip including a precision approach runway where the code number 3 or 4 is given in Attachment A, section8. " (See Figure1.10-2)

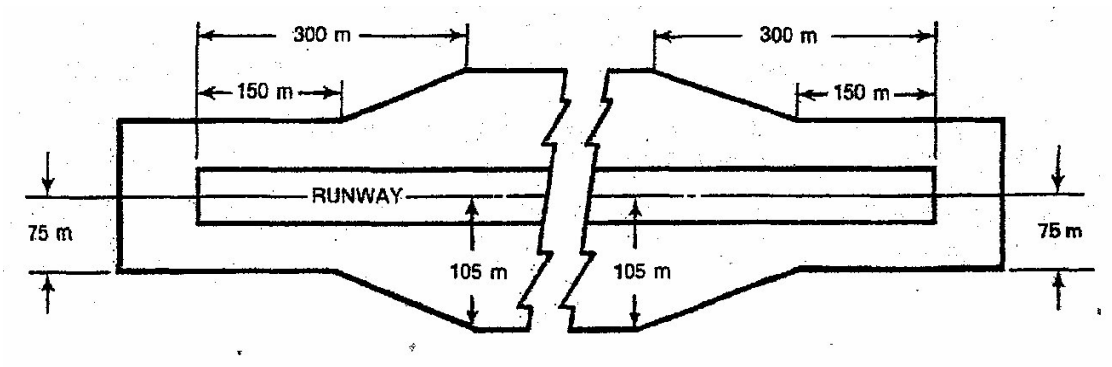


Figure 1.10-2Graded portion of a strip including a precision approach runway where the code number is 3 or 4

Paragraph 3.4.1：

“A runway end safety area shall be provided at each end of a runway strip where the code number is 3 or 4.”

Paragraph 3.4.2：

“A runway end safety area shall extend from the end of a runway strip to a distance of at least 90m.”

Paragraph 3.4.4：

“The width of a runway end safety area shall be at least twice that of the associated runway.”

1.10.4 Transverse Slope

According to the Sungshan Airport Elevation Diagram, which was measured and plotted by a CAA’s contractor, the transverse slope （from runway centerline to runway edge, 30m for each side）of runway is shown in Table 1.10-1.

Table 1.10-1 the transverse slope of runway 10/28

Location	**Runway 10 threshold**	**100**[12]	**200**	**300**	**400**	**500**	**600**	**700**	**800**	**900**	**1000**	**1100**	**1200**	**1300**
Transverse slope of north side（% ）	1.63[13]	1.69	1.72	1.66	1.54	1.60	1.36	1.42	1.36	1.28	1.46	1.59	1.66	1.81
Transverse slope of south side（% ）	1.37	1.43	1.83	1.60	1.43	1.77	1.90	2.00	1.73	1.97	1.80	1.80	2.17	1.83
Location	**1400**	**1500**	**1600**	**1700**	**1800**	**1900**	**2000**	**2100**	**2200**	**2300**	**2400**	**2500**	**Runway 28 threshold**	
Transverse slope of north side（% ）	1.63	1.69	1.72	1.66	1.54	1.60	1.36	1.42	1.36	1.28	1.46	1.59	1.66	
Transverse slope of south side（% ）	1.37	1.43	1.83	1.60	1.43	1.77	1.90	2.00	1.73	1.97	1.80	1.80	2.17	

[12] meter

[13] %

1.10.5 Regulations regarding transverse slope

According to 「Civil Aerodrome Design and Operation Standard」（v1.1, July 2004）, paragraph 3.1.18：

> *“To promte the most rapid drainage of water, the runway surface shall be cambered except where a single crossfall from high to low in the direction of the wind most frequently associated with rain whould ensure rapid drainage. The transverse slope shall ideally be：*
>
> *-1.5 per cent where the code letter is C, D, E or F; and*
>
> *-2 percent where the code letter is A or B;*
>
> *but in any event shall not exceed 1.5 per cent or 2 per cent, as practical, nor be less than 1 percent except at runway or taxiway intersections where flatter slopes may be necessary….*”

1.10.6 Maintenance Runway Skid Resistance

According to the interview records of the airport operators as follows：

1. CAA contracted periodical runway surface friction measurement to a consulting company. The measuring frequency at present is once per month based on the landing frequency of jet aircraft in Sungshan Airport.
2. Based on the monthly measurement report, the consulting company will provide recommendations for improvement. If the runway friction is lower than “minimun friction level”, another company will clean up the accumulated rubber deposites, and then will measure the runway friction value again to ensure the quality of the corrective work. The runway friction value is based on the average friction value of the one third of the runway length or 100 meter.
3. The lastest time to overlay runway pavement was on June 2002. The runway friction value was ever lower than the minimun friction level before this occurrence.
4. There are no NOTAM regarding “*runway may be slippery when wet*”. And airport flight operation division does not have any records regarding runway water patches for three months period before the occurrence.

According to the monthly friction measurement report, the measurement of the runway friction value was from 3 meter of the runway centerline marking on both sides. It was ICAO certified test equipment “Grip Tester”. There were two measuring routes, one was from north of Runway 10 threshold to Runway 28

threshold and then turned to south of Runway 10 threshold, and then reverse its route to complete another measurement. The measuring speed was 65 km/hr, and the water depth was 1.00 mm.

The Sungshan Airport conducted monthly friction measurement on September 29th and Octorber 22th..

According to the runway friction monthly measurement report, a measurement was conducted on September 29th, the lowest mean friction value was sited on the first section of one-third of runway from Runway 10 threshold. And the mean friction values between 400 and 700 meter from Runway 10 threshold were lower. This area was the touch down zone and the main area to accumulate rubber deposites. There were recommendations for Sungshan Airport in this report：

1. *Immediately to take corrective action in area between 210 and 810 meter from Runway 10 threshold. The runway friction value in this area was lower than FAA's "the minimum friction level".*
2. *To remove rubber deposites and groove runway pavement to promote the skid resistance performance on runway.*

According to the runway friction monthly measurement report, another measurement was conducted on Octorber 22th, the lowest mean friction value was sited on the first section of the one-third of runway from Runway 10 threshold. Comparing with the previous measurement conducted in September, the friction values in the second and the third section of the one-third of runway from Runway 10 threshold were deteriorating. The mean value friction value between 400 and 600 meter from Runway 10 threshold was lower. This area was touch down zone and the main area to accumulate rubber deposites. There were recommendations for Sungshan Airport in this report：

1. *Immediately to take corrective actions between 210 and 750 meter from Runway 10 threshold. The runway friction value in this area was lower than FAA's "the minimum friction level".*
2. *Comparing with the previous measurement conducted in September, the mean friction values between 900 meter from Runway 10 threshold and Runway 28 threshold were deteriorating due to high frequency of aircraft operating. It should be continuously monitored.*
3. *To remove rubber deposites and groove runway pavement for promote the skid resistance performance on runway.*

There were two rubber deposites removal actions conducted and the measurements were taken on October 7th and14th. On October 14th, this runway conducted three tests including "GripTester friction measurement", "DF-Tester friction measurement" and "Pavement texture depth measurement". The measurement reports stated that the accumulated rubber deposites has severely covered on pavement surface and compacted

into runway texture on the Runway 10 touch down zone. This report also recommended using other rubber removal methods or groove runway to promote the skid resistance performance.

1.10.7 Regulations regarding Runway Friction Resistance

Accoring to「Sungshan Airport runway friction measurement and maintenance action regulations」drawed up by Sungshan Airport operater, paragraph 6.1：

> *"…When runway friction value is lower than the minimum friction level, airport operator shall immediately ask the contractor to conduct corrective action.*
>
> *If the duty officers of the flight operation division find standing water or flooded on runway or portion thereof, which may cause risk to aircrafts, they shall ask the maintenance division to inspect.*
>
> *If runway friction value is lower than the minimum friction level, the maintenance division shall ask the flight operation division to report " runway may be slippery when wet" in NOTAM."*

Paragraph 7.1：

> *"The maintenance division shall ask contractor to remove precipitant either the measured friction value lower than the maintenance level or the contaminant covering on runway marking which may cause runway slipperiness when wet."*

According to 「Civil Aerodrome Design and Operation Standard」（v1.1, July 2004）, paragraph 9.4.5：

> *"Measurements of the friction characteristics of a runway surface shall be made periodically with a continuous friction measuring device using self-wetting features."*

Paragraph 9.4.6：

> *"Corrective maintenance action shall be taken when the friction characterictics for either the entire runway or a portion thereof are below a minimum friction level specified by CAA.*
>
> *Note. – A portion of runway in the order of 100m long may be considered significant for maintenance or reporting action."*

Paragraph 9.4.8：

> *"Where there is reason to believe that the drainage characteristics*

of a runway, or portions thereof, are poor due to slopes or depressions, then the runway friction characteristics shall be assessed under natural or simulated conditions that are representative of local rain and corrective maintenance actions shall be taken as neseccary."

Attachment A Guidance Material Supplementary

Paragraph 5.1：

"…The finished surface wearing course is to be of such regularity that, when tested with a 3m straight-edge placed anywhere in any direction on the surface, there is no deviation greater than 3mm between the bottom of the straight-edge and the surface of the pavement anywhere along the straight edge."

Paragraph 5.4：

"Deformation of the runway with time may aloso increase the possibility of the formation of water pools. Pools as shallow as approximately 3mm in depth, particularly if they are located where they are likely to be countered at high speed by landing aeroplanes, can induced aquaplaning…."

Paragraph 7.3：

"Friction tests of existing surface conditions shall be taken periodically in order to identify runways with low friction when wet. CAA shall define what minimum friction level it considers acceptable before a runway is classified as slippery when wet and publish this value in the State's aeronautical information publication (AIP). When the friction of runway is found to be below this reported value, then such information shall be promulgated by NOTAM. CAA shall also establish a maintenance planning level, below which, appropriate corrective maintenance action shall be initiated to improve the friction. However, when the friction characteristics for either the entire runway or a portion thereof are below the minimum friction level, corrective maintenance action must be taken without delay…."

Paragraph 7.5：

"When it is suspected that the friction characteristics of a runway may be reduced because of poor drainage, owing to inadequate slopes or depressions, then an additional test shall be made, but this time under natural conditions representative of a local rain. This test differs from the previous one in that water depths in the poorly cleared areas are normally greater in a local rain condition. The test results are thus more apt to identify problem areas having low friction values that could induce aquaplaning than the previous test.

If circumstances do not permit tests to be conducted during natural conditions representative of a rain, then this condition may be simulated."

Paragraph 7.9：

"Civil Aerodrome Design and Operation Standard requires to specify two friction levels as follows:

a）a maintenance friction level below which corrective maintence action should be initiated;and

b）a minimum friction level below which information that a runway may be slippery when wet shall be made available.

Furthermore, CAA shall establish criteria for the friction characteristics of new or resurfaced runway surfaces. Table A-1 provides guidance on establishing the design objective for new runway surfaces and maintenance planning and minimum friction levels for runway surfaces in use."

Table A-1.

Test equipment	Test tire		Test speed (km/h)	Test water depth (mm)	Design objective for new surface	Maintenance planning level	Minimum friction level
	Type	Pressure (kPa)					
(1)	(2)		(3)	(4)	(5)	(6)	(7)
Mu-meter Trailer	A	70	65	1.0	0.72	0.52	0.42
	A	70	95	1.0	0.66	0.38	0.26
Skiddometer Trailer	B	210	65	1.0	0.82	0.60	0.50
	B	210	95	1.0	0.74	0.47	0.34
Surface Friction	B	210	65	1.0	0.82	0.60	0.50
Tester Vehicle	B	210	95	1.0	0.74	0.47	0.34
Runway Friction	B	210	65	1.0	0.82	0.60	0.50
Tester Vehicle	B	210	95	1.0	0.74	0.54	0.41
TATRA Friction	B	210	65	1.0	0.76	0.57	0.48
Tester Vehicle	B	210	95	1.0	0.67	0.52	0.42
GRIPTESTER	C	140	65	1.0	0.74	0.53	0.43
Trailer	C	140	95	1.0	0.64	0.36	0.24

1.11 Flight Recorders

1.11.1 Cockpit Voice Recorder

This aircraft was equipped with a Solid State Cockpit Voice Recorder (CVR), model Fairchild A200S, part number S200-0012-00, serial number 01471. The recording of 120-minute duration was downloaded properly. Quality of the recording was good.

The last 30 minutes of the recording was transcribed as in Appendix 1. The transcript was synchronized with the Digital Flight Data Recorder (FDR) data based on the FDR time parameter[14]. The transcript contained the GE 536 climbing to the cruising level, cruising, descending, landing, landing rolling, skidding off the runway and the flight crew asking for ground support. After the aircraft skidding off the runway, the CVR was temporarily stopped resulting from shutdown of the engine by the flight crew and resume power after the Auxiliary Power Unit (APU) activated. The CVR finally stopped as the flight crew pulled the Circuit Brake (CB).

1.11.2 Flight Data Recorder

This aircraft was equipped with a Flight Data Recorder (FDR), manufacturer L3 Communication Inc, part number S800-3000-00, serial number 00703, and have the ability to record 50 hours of data.

According to the converting algorithms[15], totally 179 parameters were recorded in theFDR. All the recorded parameters were listed in Appendix 2. Detail results are plot in Figure 1.11-1 ~ Figure 1.11-2. Summary of the FDR Readout as follows:

1. The Flight Data Recorder complies with Civil Aviation Law- “07-02A Aircraft Flight Operation Management Regulations,” and ICAO Annex 6 “Type 1” Flight Data Recorder, satisfactory to record the 32 mandatory parameters.
2. The GE 536 flight started recording at 1930.

---

[14] The CVR and FDR recordings were synchronized by VHF keying before the recorders stopped. The time format for the transcript has been transferred to Taipei local time while the DFDR data were described in UTC format.

[15] Source BEA Flight Recorders Lab, A/C:A320/200 Engine: IAE V2527-A5；FDIU SAGEM P/N ED43A1D5；ARINCE 573/717 128 Word/s

3. According to earlier CVR recording, at 1917:21. The first officer said: “brake test” and the captain replied: “check”. After comparing with the FDR data, the brake pedal position and brake pressure quantity varied during 1917:21 to 1917:23 due to the execution of this check item.

4. During final approach, GE536 engaged autopilot and autothrottle. The deceleration rate of Auto Brake armed at “Medium[16],” before landing; “Anti-skid selector” set at “ON”; Three Hydraulic pressures of “Hydraulic pressure Yellow/Green/Blue” are “Normal”; “Normal brake fault” is “no fault”; “Alternate braking” didn’t activate; “Antiskid fault” is “no fault”.

5. At 1940:29, GE536 started descent, airspeed 319 knots.

6. At 1956:45, ground spoiler armed, airspeed 158 knots, radio altitude 1576 feet, magnetic heading 081 deg, wind 001 deg at 43 knots.

7. Configuration of Slat/flap lever position- at 1957:11 flap configured at “3”, flap position 20 deg, with airspeed 151.9 knots, radio altitude 1751 feet, magnetic heading 079 deg, wind 001 deg at 43 knots.

8. At 1959:04, autopilot was disengaged, airspeed 144 knots, radio altitude 282 feet, magnetic heading 094 deg, wind 009 deg at 42 knots. Both Thrust Lever angle (TLA) were 22.5 deg.

9. At 1959:14, radio altitude 100 ft, airspeed 137.6 knots, magnetic heading 092 deg, and wind 340 deg at 7 knots. Both TLAs were22.5 deg.

10. At 1959:21, radio altitude 50 feet, airspeed 135.8 knots, magnetic heading 093 deg, and wind 338 deg at 5 knots. Both TLAs were 22.5 deg.

11. At 1959:23, radio altitude 23 feet, airspeed 141.6 knots, magnetic heading 094 deg, and wind 305 deg at 8 knots. Both TLAs were 22.5 deg.

12. 1 second (1959:26) prior to main landing gear touched ground, airspeed 133.8 knots, radio altitude -1 feet, magnet heading 094 deg, wind 297 deg at 11 knots. Left- and right- TLA were19.7 deg, and 22.5 deg, respectively.

13. At 1959:27, main landing gear touched ground, maximum vertical acceleration 1.38 G, the parameter of “Compressed shock absorber” switched from “Air” to “Ground”, with airspeed 137.6 knots, radio altitude -2 feet, magnetic heading 093 deg, wind 297 deg at 11 knots. Left- and right- TLA were 19.7 deg, and 22.5 deg, respectively,

14. 3 seconds posterior to main landing gear touched ground (1959:30), nose gear touched ground, airspeed 140 knots, magnetic heading 095 deg, wind 269 deg at 4 knots. Left- and right- TLA were -22.5 deg, and 22.5 deg, respectively.

15. At 1959:32, auto-throttle disengaged (posterior 5 seconds to main landing touched ground), airspeed 139.6 knots, magnetic heading 095 deg, Left- and right- TLA were -22.5 deg, and 22.5 deg, respectively.

---

[16] Medium deceleration: its deceleration rate is set at 3.0 meter/s^2

16. Since main landing touched ground (1959:27) until GE536 stopped (2000:47), the ground spoilers have not been deployed.

17. From 1959:32 to 2000:35, Left- Thrust Reverser was full deployed, and right- Thrust Reverser was retracted. The relevant parameters of magnetic heading, TLA and EPR listing in Table 1.11-1:

Table 1.11-1 The relevant parameters of magnetic heading, TLA and EPR

Time	Left-TLA (deg) Left- EPR (%)	Right -TLA (deg) Right - EPR (%)
1959:32 | 1959:38	-22 ~ -22 0.99 ↑ 1.03	22.5 ~ 22.5 1.08 ~ 1.08
	Magnetic heading: 95.3 → 94.6 →96.3	
1959:39 | 1200:00	-8 ~ -8 1.03 ↓ 0.99	22.5 ~ 22.5 1.08 ~1.08
	Magnetic heading: 97.0 → 94.0 →98.4	
1200:01 | 1200:12	-20 ~ -20 0.99 ↑ 1.06	22.5 ~ 22.5 1.08 ~1.08
	Magnetic heading: 97.0 → 95.3 →51.0	
1200:13 | 1200:35	--8 ~ -8 1.05 ↓ 1.00	22.5 ~ 22.5 1.08 ~1.08
	Magnetic heading: 39.4 → 13 →1.4	
Note: ↑ Increase；↓Decrease		

18. During landing roll operation, the relevant parameters of brake pedal position (BPP), normal brake pressure(NBP) and ground speed are listing in Table 1.11-2:

Table 1.11-2 The relevant parameters of BPP, NBP and ground speed

Time	Left-BPP(deg)/ Left-NBP(psi)	Right-BPP(deg)/ Right-NBP (psi)	Ground speed (GS) Deceleration Rate (DR)
1959:30 | 1959:39	0 ~ 0 0 ~ 0	2 ~ 10 0 ~ 64	GS146 knots ~ 131 knots average DR 1.0 m/s2
1959:40 | 1959:44	28 ~ 16 192 ~ 256	46 ~ 78 192 ~ 320	GS128 knots ~ 124 knots average DR 1.3 m/s2
1959:45 | 1959:48	54 ~ 72 256 ~ 512	78 ~ 80 192 ~ 384	GS121 knots ~ 115 knots average DR 1.6 m/s2

Time	Left-BPP(deg)/ Left-NBP(psi)	Right-BPP(deg)/ Right-NBP (psi)	Ground speed (GS) Deceleration Rate (DR)
1959:49 | 2000:00	78 ~ 80 860 ~ 1536	78 ~ 80 384 ~ 1088	GS111 knots ~ 75 knots average DR 1.9 m/s2
2000:01 | 2000:15	78 ~ 80 1280 ~ 192	78 ~ 80 640 ~ 256	GS69 knots ~ 12 knots average DR 2.0 m/s2
2000:16 | 2000:47	78 ~ 72 2496 ~ 64	70 ~ 74 1792 ~ 64	GS12 knots ~ 0 knots average DR 1.0m/s2
Note: Brake pedal position Resolution = 2 deg Normal brake pressure Resolution = 64 Psi			

19. After touched ground, between 2000:08 and 2000:48, rudder position is recorded at right 25 deg; between 2000:10 and 2000:13, the roll operating of F/O's side stick reached maximum right roll of 20 deg.

20. At 2000:05, GE536 started drifted to left-side. (after main landing gear touched ground 39 seconds), airspeed 56.6 knots, ground speed 55 knots, heading 93.5 deg.

21. Between 2000:15.75 to 2000:17, GE536 stopped rolling, airspeed 0 knots, ground speed decreased from 12 knots to 1 knots, magnetic heading left drafted from 13 deg to 01.4 deg. During this period, the parameter "Compressed shock absorber" transit from "Ground" to "Air".

22. Between 2000:37 to 2000:40, right-TLA retracted to IDLE position (22.5 deg retracted to -3 deg).

23. At 2000:4, FDR stopped recording, airspeed 0 knots, ground speed 0 knots, and magnetic heading 002 deg.

The touched ground position and timing is determined by parameters of "Landing Gear RH/LH Compressed Shock Absorber" and maximum vertical acceleration, as shown in Figure 1.11-3. At 1959:27, main landing gear touched ground at 1,750 feet beyond the threshold of runway 10. At 1959:37, Captain called out "No brake", the GE536 located at 4,000 ft beyond the threshold of Runway 10.

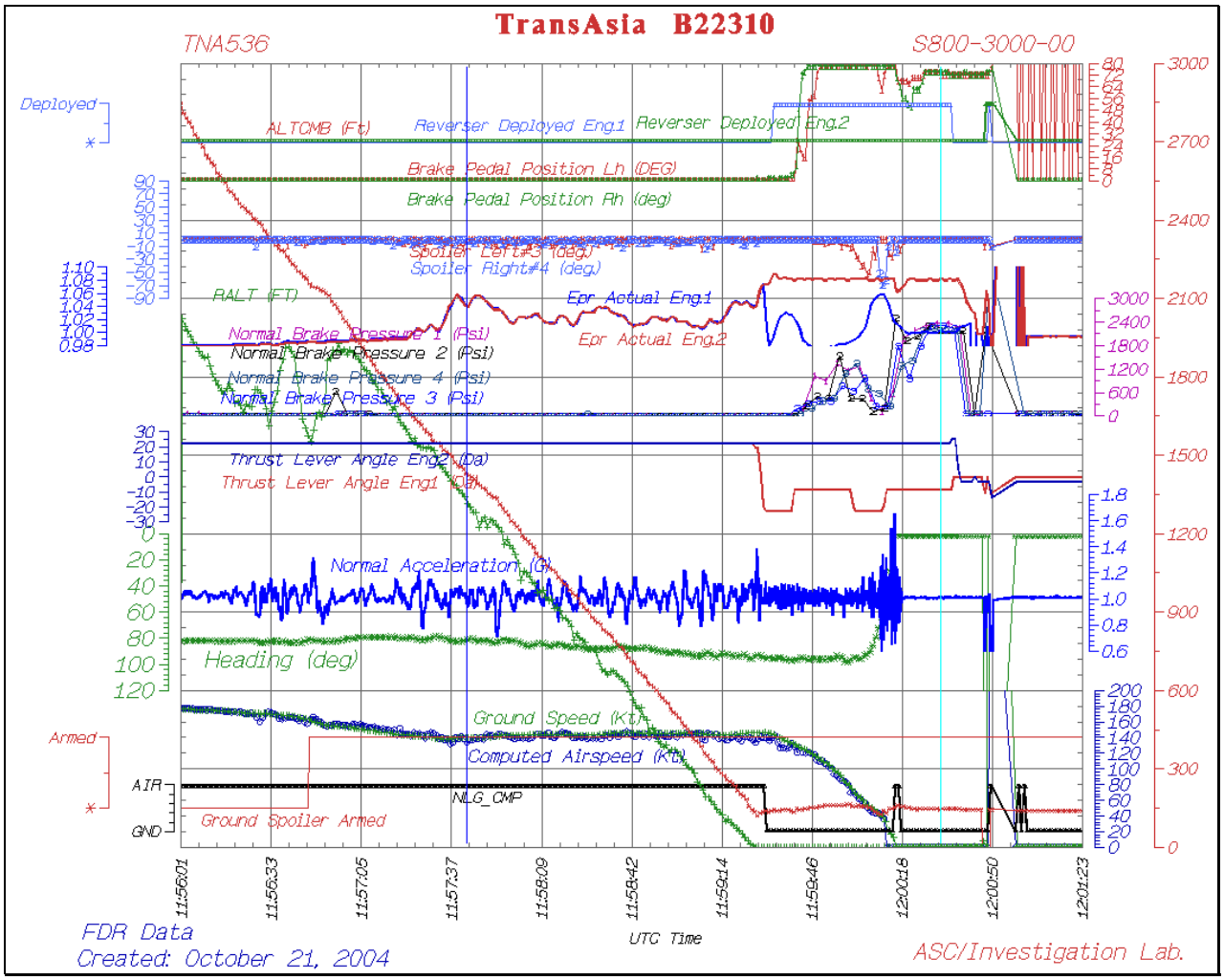


Figure 1.11-1 Flight Data Plot[17] (Final Approach, Landing and Deceleration)

[17] The flight data were all plotted in UTC time format.

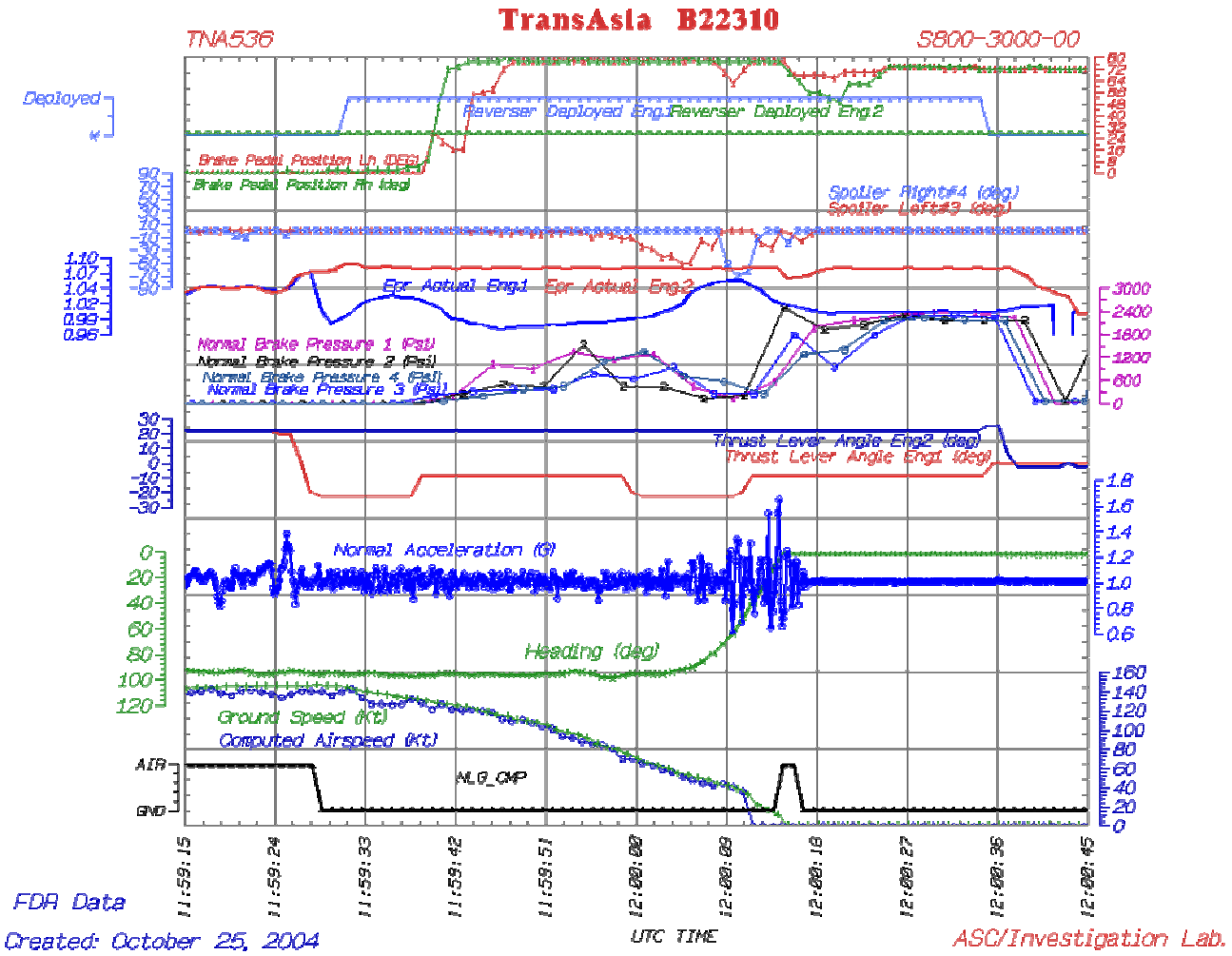
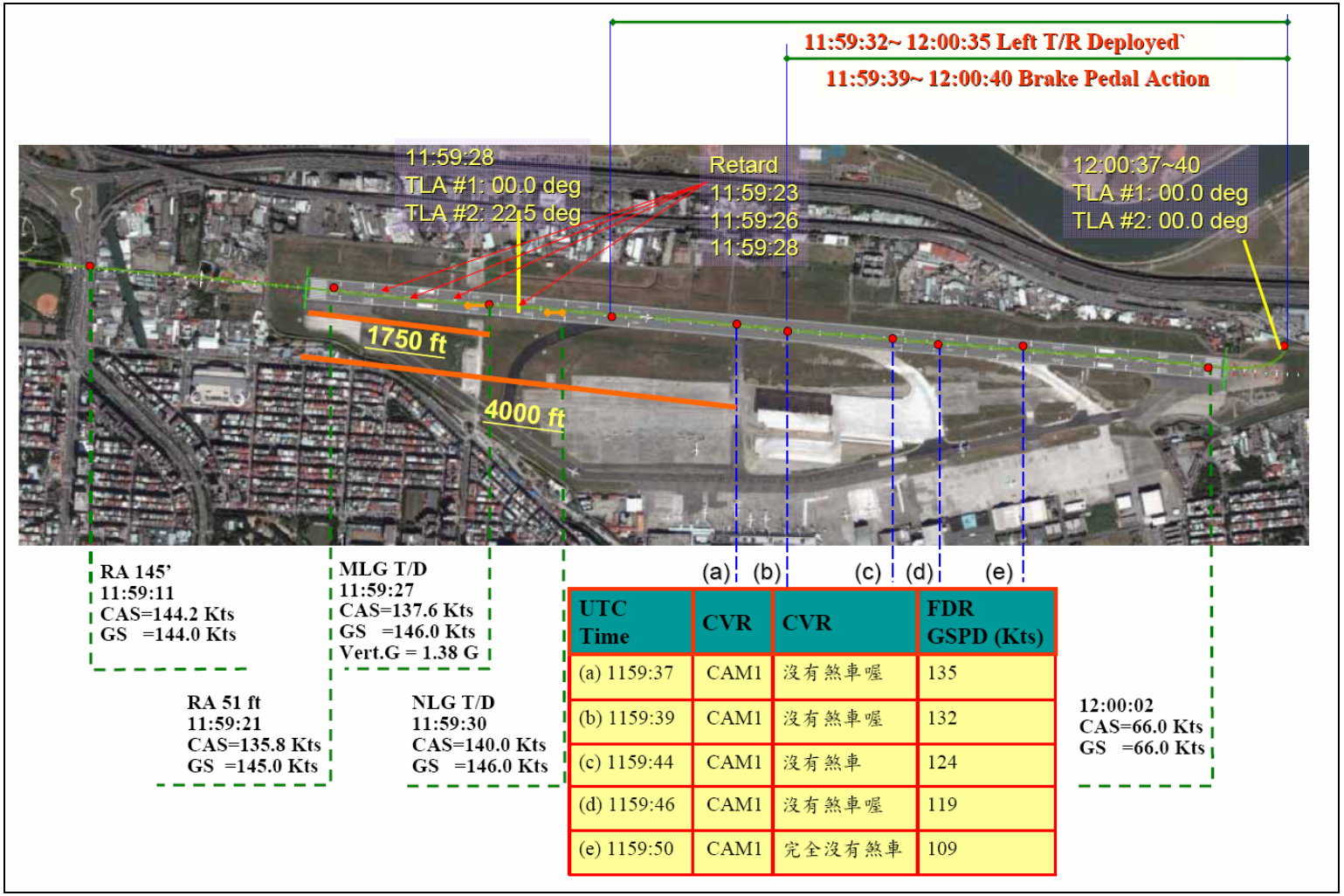


Figure 1.11-2　Flight Data Plot（Landing and Deceleration）



UTC Time	CVR	CVR	FDR GSPD (Kts)
(a) 1159:37	CAM1	沒有煞車喔	135
(b) 1159:39	CAM1	沒有煞車喔	132
(c) 1159:44	CAM1	沒有煞車	124
(d) 1159:46	CAM1	沒有煞車喔	119
(e) 1159:50	CAM1	完全沒有煞車	109

Figure 1.11-3 Superpose of Flight Path and Satellite Image（Time, Flight Path, FDR Parameters, and CVR Transcripts）

1.12 Wreckage and Impact Information

The following damage assessment is based upon A320 AMM task 05-51-24 as a basis.

1.12.1 Damaged and Contaminated Areas

The damaged（red point） and contaminated area （blue point）of the aircraft are shown in Figure 1.12-1.

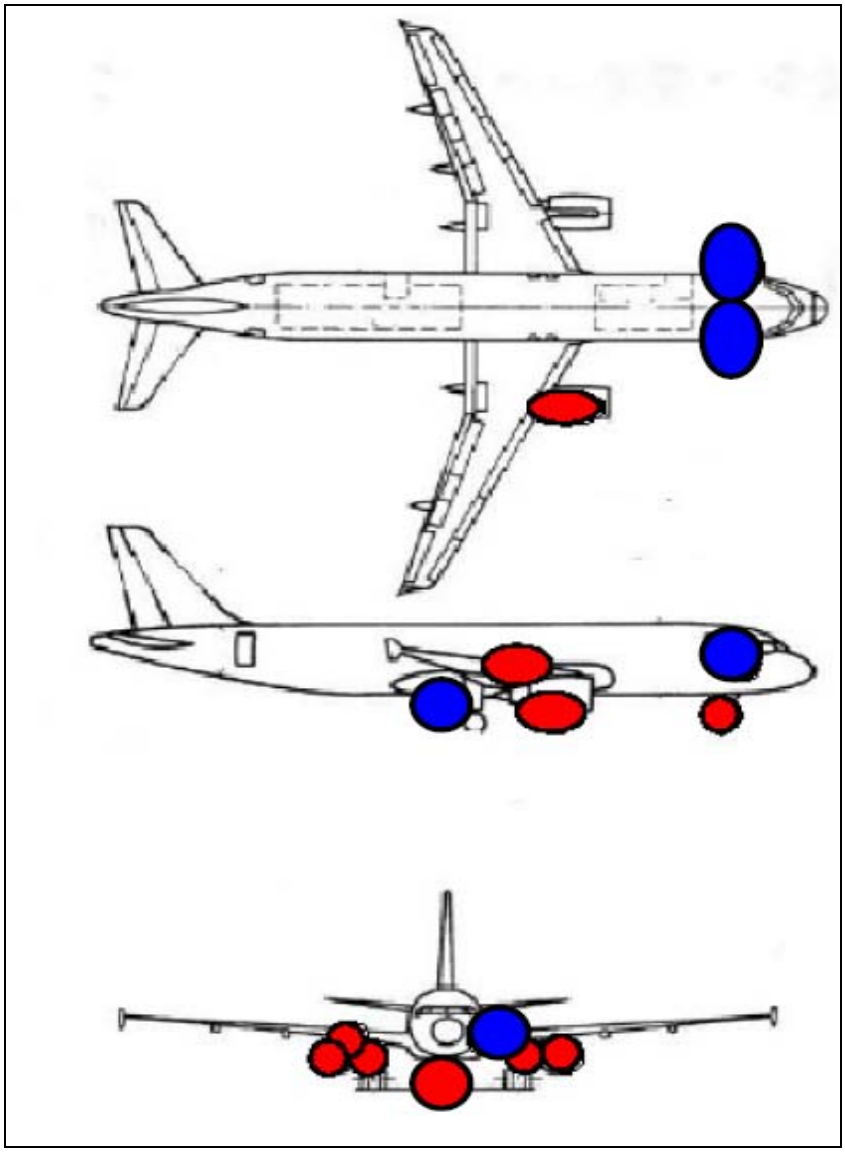


Figure 1.12-1The damaged and contaminated area of the aircraft

Fuselage Area

- No fuselage impacts noted.
- Contamination observed at the pitot/ static ports and air conditioning pack intakes.
- Anti collision light lens chipped.

Nose Landing Gear Area

- No visual damage noted at the NLG attachment or to the bay structure.
- Sliding tube broken and associated harnesses destroyed（Figure 1.12-2,3）.
- NLG Aft door (LH and RH) damaged during recovery（Figure 1.12-4）.

Figure 1.12-2NLG Sliding tube broken and associated harnesses destroyed

Figure 1.12-3NLG without broken sliding tube

Figure 1.12-4Deformation and dent to NLG Aft doors

Main Landing Gear Area

- No visual damage noted at the MLG attachments or to the bay structure.
- Damage noted to LH tire due to contact with runway object.
- LH and RH MLG experienced damage to the electrical and hydraulic systems on the casing during recovery. Compression of the systems against casing has scratches to the surface of both assemblies（Figure 1.12-5, 6）
- LH MLG door minor seal detachment noted. Not considered occurrence related.

Figure 1.12-5LH MLG electrical and hydraulic systems damage

Figure 1.12-6LH MLG Scratches – max depth 0.5mm

LH Engine

- Three fan blades and cone damage（Figure 1.12-7, 8）;
- 5 damage locations noted on the LH Nose cowl (four on the inner surface and one external)（Figure 1.12-9, 10）.

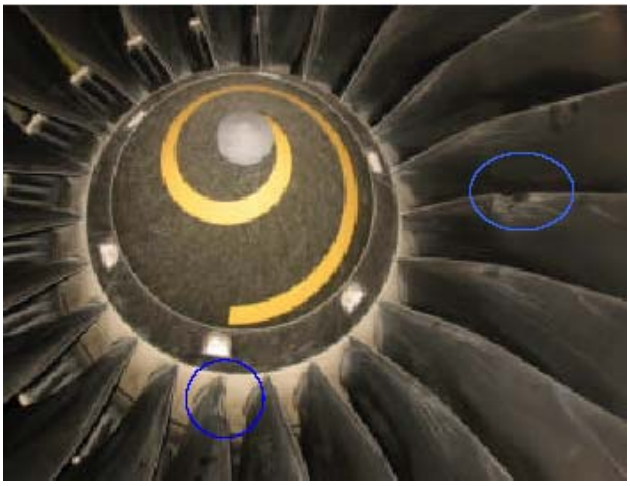


Figure 1.12-7Fan damage

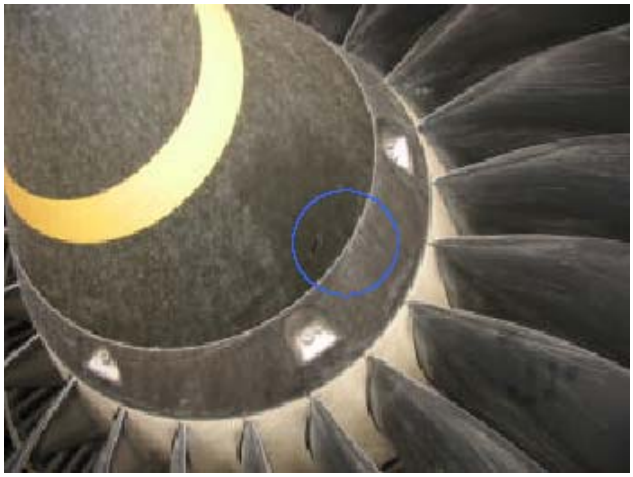


Figure 1.12-8Cone scratch

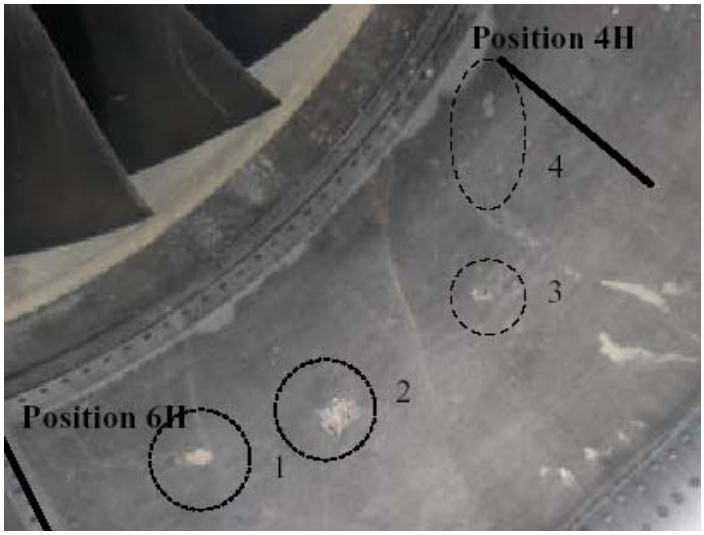


Figure 1.12-9Inner Surface damage

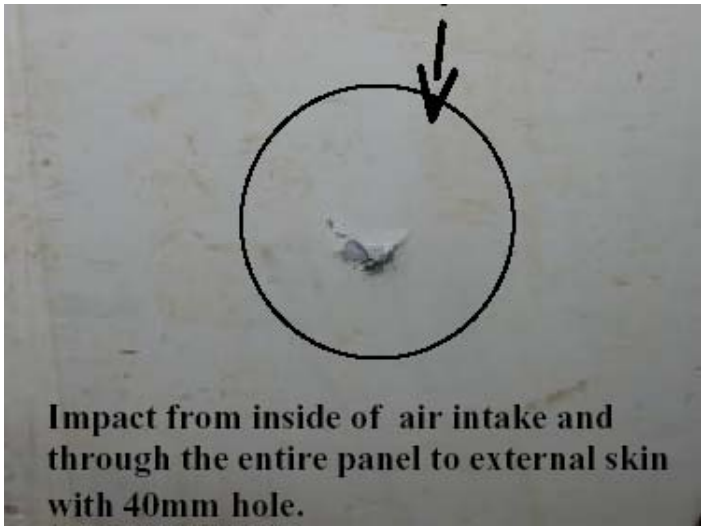


Figure 1.12-10 External Damage

LH Nacelle Area

- No visual damage noted to the pylon structure.

LH Wing

- Landing light damaged（Figure 1.12-11）

Figure 1.12-11　Landing light damaged

RH Engine

- Two fan blades noted damaged（Figure 1.12-12）.
- Piping bent, lower drain missing（Figure 1.12-13）.
- Lateral cooler damaged（Figure 1.12-14）.
- Extensive damage noted on the nose cowl, fan cowl and thrust reverser（Figure 1.12-15）.

Figure 1.12-12　Fan damage

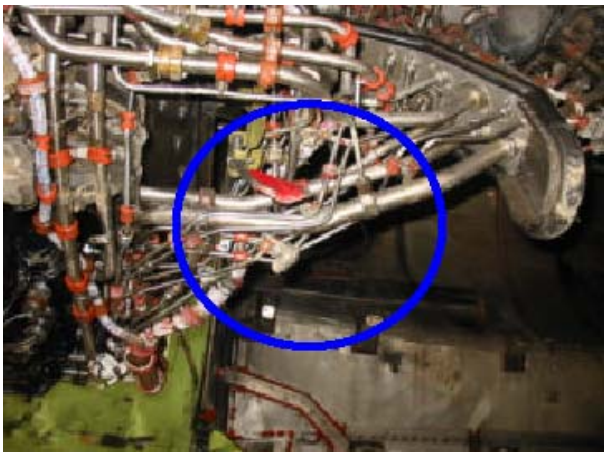


Figure 1.12-13 Bent Pipes, lower drain missing

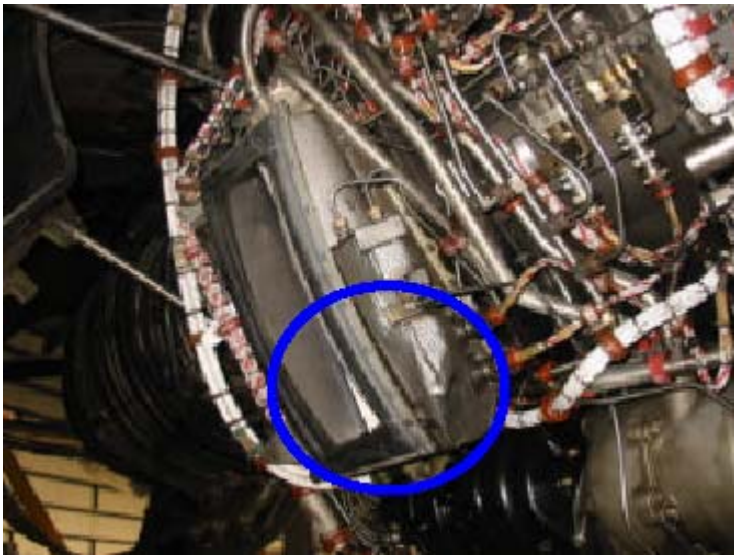


Figure 1.12-14 Lateral cooler damaged

Figure 1.12-15 Nacelle Overview

RH Pylon

- No visible damage to the attachment points.
- Lateral panel deformation and fastener pulling（Figure 1.12-16）.
- Upper panel deformation/ fastener pulling（Figure 1.12-17~20）
- Closing panel and fairing damage（Figure 1.12-21）.
- Cantilever deformation（Figure 1.12-22）

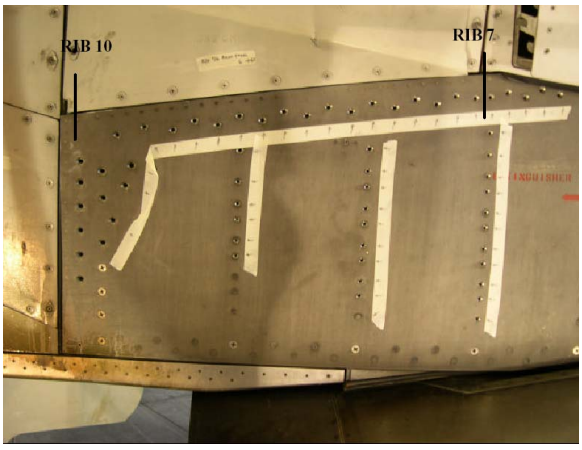


Figure 1.12-16 Lateral Panel Pulled fasteners

Figure 1.12-17 Upper Panel Pulled fasteners

Figure 1.12-18 Internal profile deformed.

Figure 1.12-19 Twisting of the lower profile

Figure 1.12-20 Vertical Profiles deformed

Figure 1.12-21 Fairings deformed

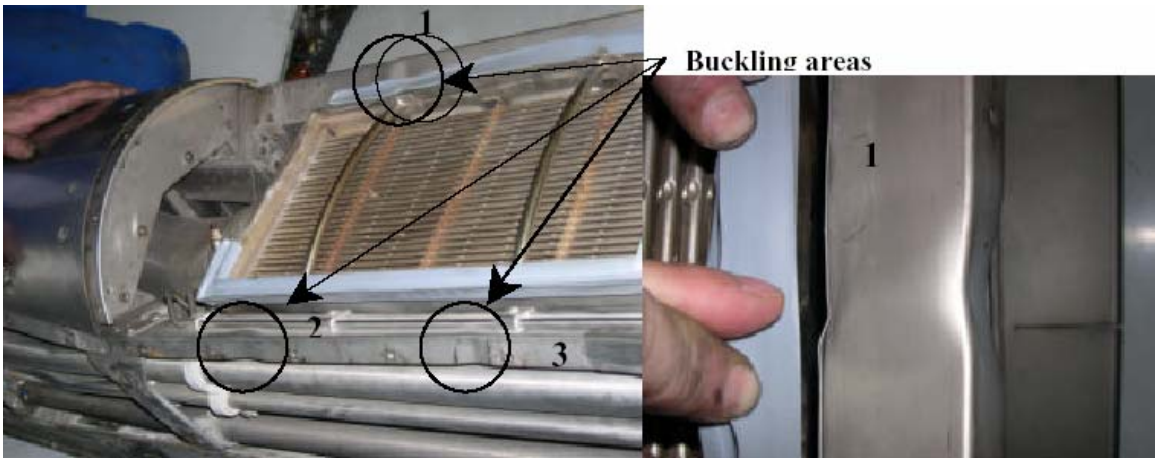


Figure 1.12-22 Upper cantilever angle buckling

RH Wing

- Damage noted to No. 1 Slat near pylon, leading edge lower skin exhibited a 25mm ×75mm dent（Figure 1.12-23）, leading edge upper skin exhibited a 25mm ×90mm dent（Figure 1.12-24）.

Figure 1.12-23 leading edge lower skin exhibited a 25mm ×75mm dent

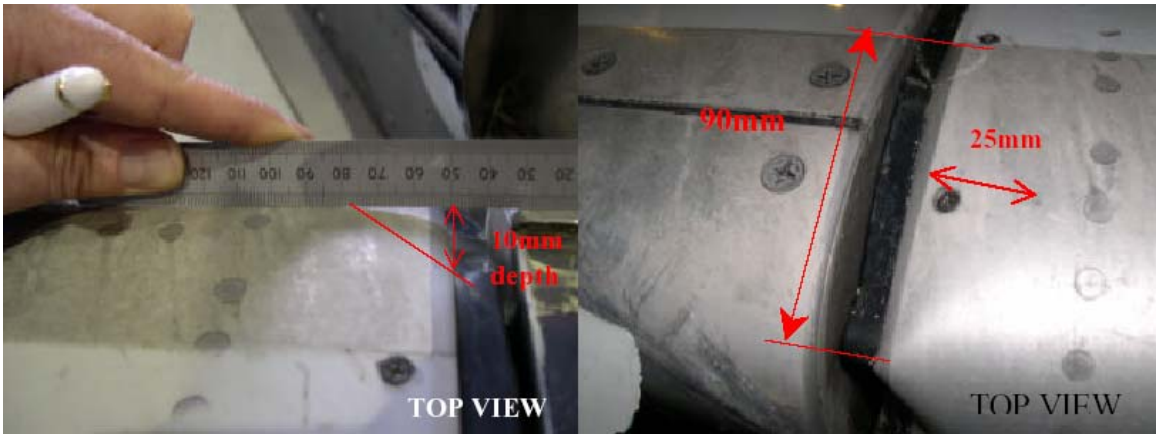


Figure 1.12-24 leading edge upper skin exhibited a 25mm ×90mm dent

1.13 Medical and Pathology

The CM-1 and CM-2 got an alcohol test at 2135 on the accident date. The results of the test showed the their alcohol levels were normal. .

1.14 Fire

There was no fire in this occurrence.

1.15 Survival Factors

Based on the tower control transcript, CVR transcript, and pilot interview records, it is noted that the CM-1 informed tower for help after the aircraft veer-off the runway. The CM-1 used the PA to announce “attention crew at station”. The pilots then shut down the engines and started APU to supply power. CM-1 told the purser to prepare to evacuate the passengers.

Based on the CVR transcript and the purser’s interview record, she sensed the aircraft speed was not reduced as usual during the landing roll. She sensed more severed vibration and noise than routing flight. The aircraft stopped approximately 20 second after touch down. There was no loud bang during the final impact. She heard the announcement of “attention crew at station” from cockpit via PA. The cabin crew judged that the situation was a “forced landing without preparation”. The purser stated that four cabin crews stayed at their designated positions and judged whether their exits were safe for evacuation. The purser used interphone to verify the exit conditions after the visual check with the other cabin crews. The responses from the cabin crews indicated no fire and smoke at the exterior of exits. The purser comforted the passengers and ask them to stay in the seat for further instruction. The CM-1 called the purser to the cockpit and told her that the ground support would arrive very soon. The CM-1 suggested the purser to evacuate passengers from the rear exits via the airport service stairs.

After leaving the cockpit, the purser opened 1L exit and talked to firemen who were on the ground. The firemen and the purser exchanged information to confirm that the aircraft did not catch fire and cabin was safe.

Although the purser was told to evacuate passengers from the rear exit via the airport service stairs, she considered that the height of the rear exit was not suitable to use the airport service stairs. After discussion with the ground handling personnel and other cabin crews, the purser decided to evacuate passengers by 1L door slide, then informed CM-1 and announced it to the passengers.

The purser briefed the passengers of the way to jump slide and asked to

remove all sharp stuffs before stepping on the slide. The purser stated that the situation was not in emergency, and allowed passengers to take their personal belongings, except the big and heavy ones, to jump onto the slide. After all passengers evacuated, the cabin crew gathered the passengers and examined them for injury. No passenger reported injury during the evacuation. The purser stated that there did not use flashlight or megaphone because the electric power supply was normal and the cabin PA system was normal during evacuation.

1.16 Test and Research

1.16.1 Ground Spoilers Test

To test the automatic extension function of ground spoilers, on November 3, 2004, the investigation team performed tests at Transasia Airlines Hangar. There is no dedicated ground test procedure in A320 Aircraft Maintenance Manual for ground spoilers automatic extension function. Instead, the manufacturer provided a procedure of this test（refer to Appendix 3）. The methodology of this test is to drive the tachometers on each wheel with special tools. It simulated the wheel speed higher than 72 knots. When all wheel speed are higher than 72 knots and both throttle control levers are at idle positions, then all ground spoilers would automatically extend. When all wheel speed are higher than 72 knots and both throttle control levers are at climb position, all ground spoilers should stay at neutral position.

First test: Following is the initial conditions of automatic function test,

- Aircraft on ground;
- Speedbrake control lever at ARM position;
- Both throttle control levers at MCT T.O.（engines not running）; and
- Driving all four tachometers about 1,000RPM（589RPM is about ground speed 72 knots）.

While aircraft is at the above mentioned conditions, the test engineer moved both throttle control levers from MCT T.O. to idle position. While both throttle control levers at idle position, all ground spoiler automatically extended.

Second test: Following is the initial conditions of automatic function test,

- Aircraft on ground;
- Speedbrake control lever at ARM position;
- Both throttle control levers at MCT T.O.（engines not running）; and
- Driving all four tachometers about 1,000RPM.

While aircraft was at the above mentioned conditions, no.1 throttle control lever was moved from MCT T.O. to idle position. All ground spoilers stayed at neutral position. No.2 throttle control lever was moved to 22.5 degrees all ground spoilers stayed at neutral position. Continued to move no.1 throttle control lever to REV MAX position, all ground spoilers stayed at neutral position. The next step was to move no.2 throttle control lever toward idle position slowly. While no.2 throttle control levers passed 14.9 degrees, all ground spoiler automatically extended.

Under same initial conditions, the test engineer moved no.2 throttle control lever to idle position. All ground spoilers stayed at neutral position. No.1 throttle control lever was moved toward idle position. When no.1 throttle control lever passed 15 degrees, all ground spoilers automatic extended.

This test successfully demonstrated the relationships between throttle control lever position and automatic function of ground spoiler extension. One throttle control lever at 22.5 degrees and the other one throttle control lever stays at idle position or reverse thrust range, all ground spoilers stay at neutral position. When aircraft conditions are met and both throttle control levers position are less than 15 degrees, all ground spoiler extend automatically.

1.16.2 Condition Checks of Wheel & Brake and Thrust Reverse System

To verify the conditions and functions of wheel & brake and thrust reverse systems. Investigation team performed associated tests at Transasia Airlines Hangar from October 19, 2004 to October 27, 2004.

1.16.2.1 Wheel & Brake System

Main tires inspection

All four tires had deep cut damage (depth up to tread reinforcing ply) and diagonal scratch marks, as shown in Figure 1.16-1. There is no tread rubber reversion present.

Figure 1.16-1Deep cut damage and diagonal scratch marks

Tires pressure check

Main tires: tire1 175 psi, tire2 185 psi, tire3 185 psi and tire4 185 psi

Nose tires: L/H tire 160 psi, R/H tire165 psi

Brake hydraulic pressure

The test engineers pressurized the 3 hydraulic systems by using AC Motor Pump and Power Transfer Unit and then measured hydraulic pressure form brake pressure line as following:

No.1：Yellow system 2,600 psi, Green system2,500~2,600 psi

No.2：Yellow system 2,600 psi, Green system2,500~2,600 psi

No.3：Yellow system 2,600 psi, Green system2,500~2,600 psi

No.4：Yellow system 2,600 psi, Green system2,500~2,600 psi

Brake assemblies

The Council conducted brake assembly inspections in accordance with TNA brake shop task card. There was no abnormal finding.

BSCU

A malfunction signal[18] was logged, when reviewed the BSCU fault history. The result of BSCU self test was passed.

The Council conducted the following 2 operation tests in accordance with Aircraft Maintenance Manual. There was no abnormal finding.

- Lost of Normal Braking Without Warning Indication;
- Operational Test of Alternate Braking System with Anti-skid.

1.16.2.2 Engine Thrust Reverse Operation Test

Operational test of Engine 1 thrust reverse was conducted in order to verify its function. Test result was in compliance with AMM 78-31-00.

1.16.3 Throttle Control Lever Position and Indication

To obtain an accurate reading of the throttle lever angle, TLA, for ground spoilers test as indicated in paragraph 1.16.1, on October 26, 2004, the investigation team performed the throttle control lever position and indication test at Transasia Airlines Hangar. The TLA value was read from Multi-purpose Control and Display Unit, MCDU, via Aircraft Integrated Data System, AIDS.

[18] The fault was logged by BSCU after the occurrence.

However the AIDS recognized the alpha “TRA” rather than “TLA”. According to Aircraft Maintenance Manual, AMM, 76.11-00 the relationship between TLA and TRA is linear, as indicated in Figure 1.16-2.

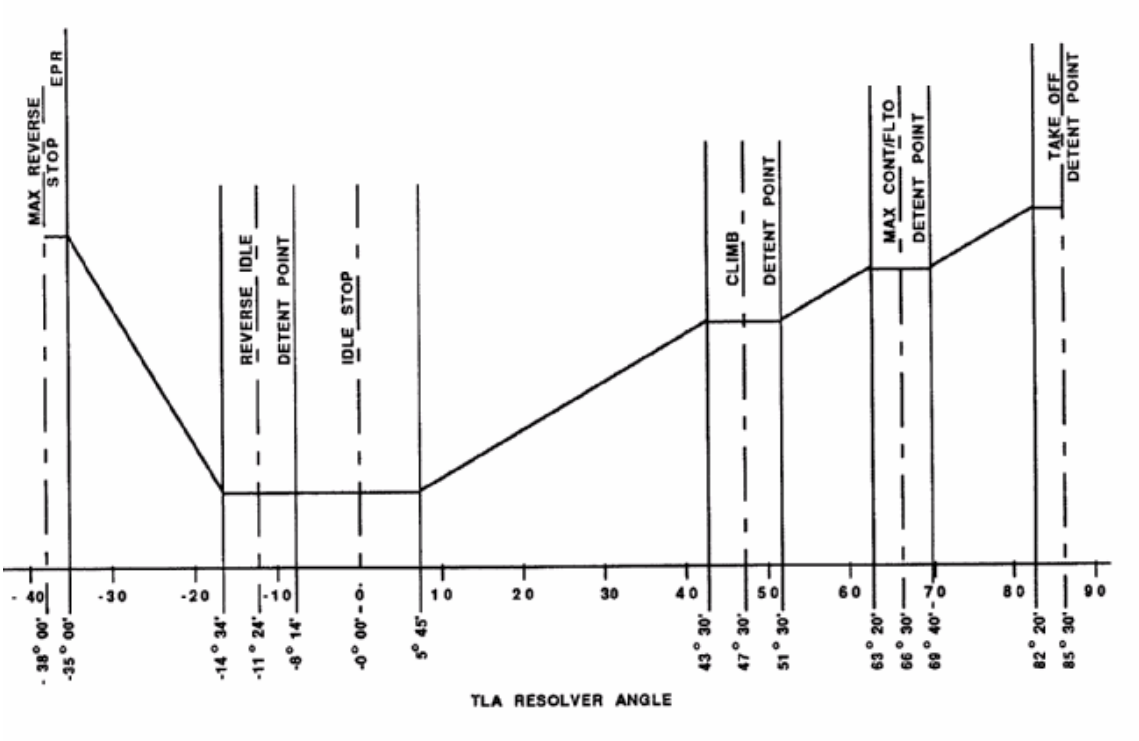


Figure 1.16-2Relationship between TLA and TRA

To understand the relationship between physical position of throttle control lever and the TRA display on MCDU, investigation team performed a test by moving the throttle control lever at full travel and recorded the TRA value. The physical positions and associated TRA reading is recorded in Table 1.16-1. This test indicated the physical positions from REV MAX to TO GA and associated TRA reading from -20 degrees to +45 degrees. The recorded range of TRA conforms the range of TLA. Therefore the indication of TRA on MCDU is TLA.

Table 1.16-1 Physical positions of throttle control lever and reading on MCDU

Physical positions of throttle control lever	MCDU data parameter	Data source	Indication
REV MAX	TRA	EEC1 EEC2	-20.1 -20.2
REV IDLE	TRA	EEC1 EEC2	-6.0 -6.0
IDLE	TRA	EEC1 EEC2	0.0 -0.1
CLIMB	TRA	EEC1 EEC2	25.0 25.0
FLX MCT	TRA	EEC1 EEC2	34.9 34.9

Physical positions of throttle control lever	MCDU data parameter	Data source	Indication
TO GA	TRA	EEC1 EEC2	44.7 44.8

1.16.4 Runway Friction Coefficient of Fixed Locations Test

The purpose of this test was to assess the possible effects of the runway friction as the aircraft overran the end of runway and veered towards left.

1.16.4.1 Test Method

The Safety Council appointed “Yen Tjing Ling Industrial Research Institute” to conduct the runway friction test[19] in the vicinity of the runway 28 threshold and the runway 10 stopway on December, 2004. The equipment of this test was a Dynamic Friction Tester（DF Tester）[20] made by Japan.

There were three test areas as follows:

(1) Threshold marking of runway 28

This area included 16 threshold marking lines. Totally 8 groups of test points were chosen, and there was a marking between one group to another. Each group included two test points, one was on the marking and the other was on the pavement between two lines. The location of the test points and number are showed in Figure 1.16-3.

[19] The test process is to put the test equipment at the certain test point, and then connect the water-providing machine with the test equipment. When test beginning, at first make the tire out of ground, and accelerate the rotating speed of tire. When the rotating speed reaches to the scheduled speed（90 km/hr）, make the tire touch ground. The friction will make the tire decelerate to totally stop, so the data about the relationship between speed and friction can be got through the recorder.

[20] The results measuring by DF tester should not be compared with the results measuring by continuous friction measuring devices. The DF tester is not certified by ICAO.

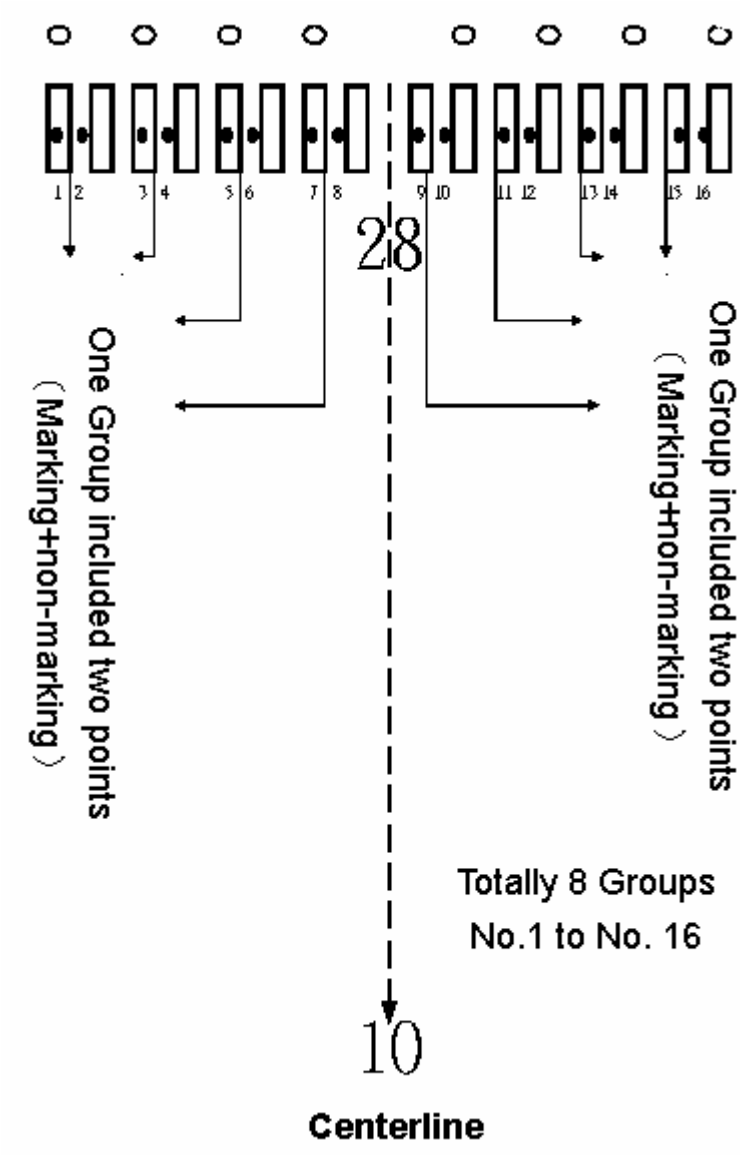


Figure 1.16-3 The distribution chart of test points on the threshold marking of runway 28

(2) The 100 meters long area after threshold marking of runway 28

The test in this area was conducted from 3 meter to both sides of the runway centerline. Two test points separated by the runway centerline comprised one group, 10 meter long between one group to another. Totally 10 groups, 20 test points were chosen. The distribution chart of the test points is showed in Figure 1.16-4.

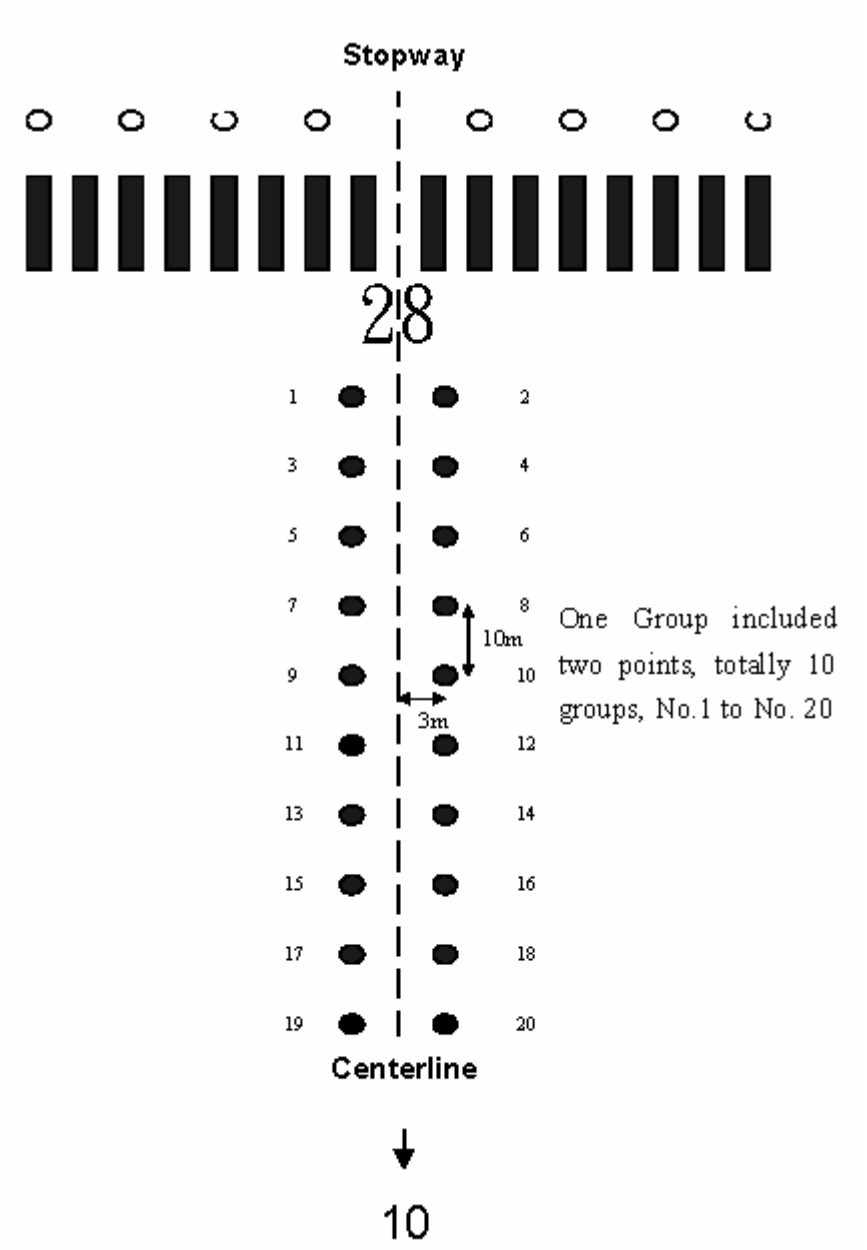


Figure 1.16-4The distribution chart of test points on the 100 meters long area after threshold marking of runway 28

(3) Stopway of runway 10

The test in this area was conducted after the runway end lights, from 0 to 100 meter on the stopway, and 3 meter to both side of extended line of runway centerline. Two test points separated by extended centerline comprised one group, 10 meter long between on group to another. Totally 10 groups, 20 test points were chosen. The distribution chart of the test points is showed in Figure 1.16-5.

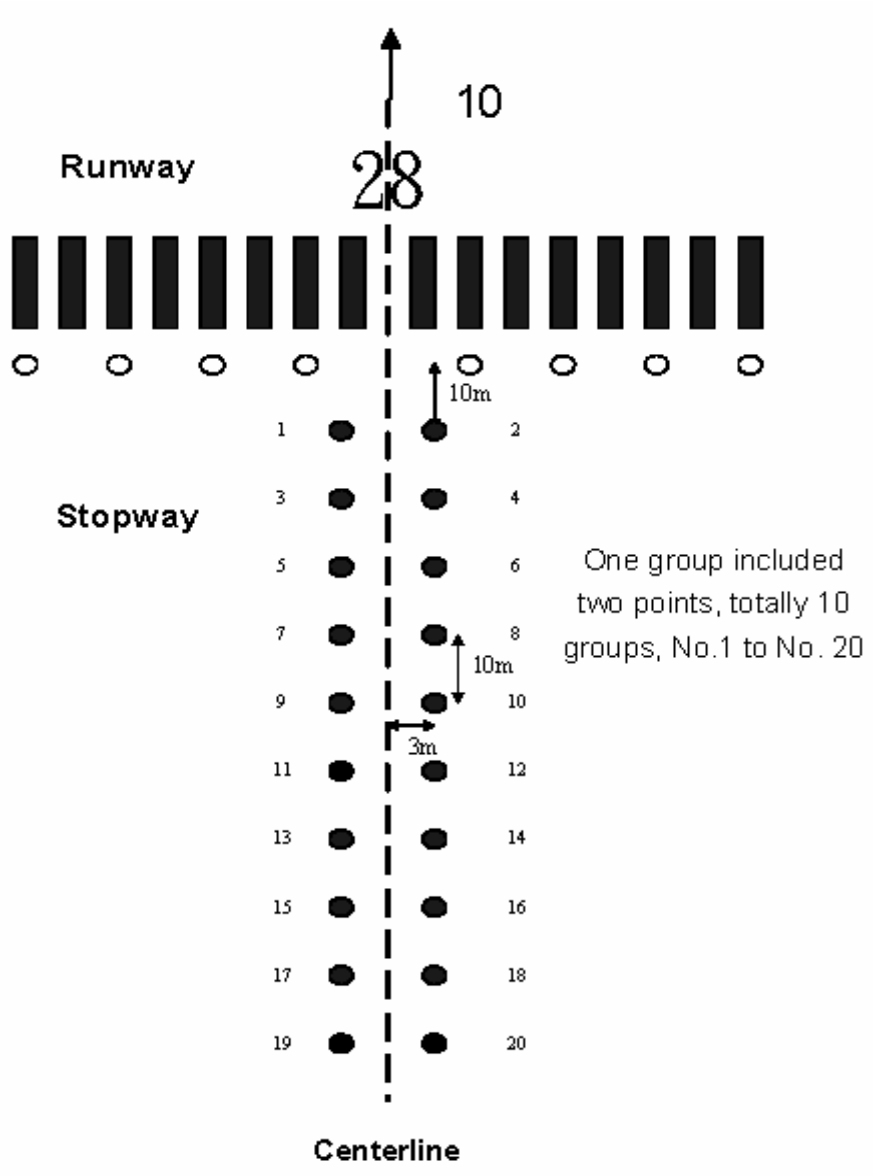


Figure 1.16-5 The distribution chart of test points on the stopway of runway 10 from 0 to 100 meter

1.16.4.2 Test Results

The test results are showed with the friction coefficient at the speed of 20, 40, 60 and 80 km/hr, listed from Table 1.16-2 to 1.16-4 according to the test areas.

Table 1.16-2 The test result of threshold marking of runway 28

Marking area					Non-marking area				
No.	**20**	**40**	**60**	**80**	**No.**	**20**	**40**	**60**	**80**
1	0.57	0.47	0.40	0.35	2	1.03	0.96	0.86	0.62
3	0.50	0.38	0.33	0.28	4	1.06	1.01	0.92	0.63
5	0.46	0.38	0.34	0.27	6	1.06	0.99	0.89	0.60
7	0.48	0.41	0.37	0.31	8	1.03	0.94	0.84	0.62
9	0.68	0.59	0.54	0.41	10	1.00	0.92	0.82	0.58

11	0.56	0.51	0.45	0.38	12	1.04	0.98	0.87	0.61
13	0.50	0.42	0.37	0.34	14	1.02	0.94	0.83	0.55
15	0.63	0.55	0.49	0.40	16	1.05	0.98	0.90	0.61
Average of marking area	0.55	0.46	0.41	0.34	Average of non-marking area	1.04	0.97	0.87	0.60

Table 1.16-3 The test result of 100 meter long area after threshold marking of runway 28

No.	20	40	60	80	No.	20	40	60	80
1	0.38	0.33	0.28	0.25	**2**	0.96	0.88	0.77	0.52
3	0.45	0.37	0.33	0.27	**4**	0.38	0.33	0.30	0.25
5	1.00	0.90	0.83	0.51	**6**	0.96	0.93	0.78	0.54
7	0.94	0.90	0.80	0.51	**8**	0.96	0.87	0.80	0.55
9	0.99	0.92	0.80	0.53	**10**	0.99	0.93	0.80	0.56
11	0.99	0.93	0.83	0.57	**12**	0.96	0.92	0.76	0.52
13	1.01	0.95	0.83	0.54	**14**	1.03	0.94	0.85	0.57
15	1.00	0.92	0.82	0.53	**16**	1.03	0.93	0.82	0.58
17	1.02	0.95	0.84	0.54	**18**	0.99	0.93	0.83	0.60
19	1.02	0.98	0.85	0.55	**20**	0.92	0.83	0.76	0.54

Table 1.16-4 The test result of the runway 10 stopway

No.	20	40	60	80	No.	20	40	60	80
1	1.00	0.94	0.82	0.54	2	1.17	0.97	0.88	0.60
3	0.95	0.93	0.83	0.53	4	1.02	0.97	0.89	0.59
5	0.94	0.89	0.84	0.57	6	0.94	0.93	0.89	0.65
7	0.87	0.84	0.77	0.55	8	0.96	0.93	0.84	0.55
9	0.94	0.92	0.85	0.59	10	0.97	0.94	0.87	0.58
11	0.97	0.93	0.87	0.57	12	0.97	0.94	0.88	0.62
13	0.98	0.96	0.90	0.57	14	0.93	0.90	0.84	0.57
15	0.94	0.92	0.85	0.58	16	0.95	0.94	0.84	0.57
17	0.96	0.93	0.86	0.56	18	0.97	0.94	0.86	0.56
19	0.99	0.95	0.87	0.55	20	0.93	0.88	0.80	0.50

Speed	20	40	60	80
Average	0.97	0.93	0.85	0.57

1.16.5 Runway Surface Texture Depth Measurements

The purpose of this test is to assess the runway drainage effectiveness through measuring of the runway surface texture depth.

1.16.5.1 Test Method

The Safety Council appointed “Yen Tjing Ling Industrial Research Institute” to perform the average texture depth measurements in the vicinity of the runway 28 threshold and the runway 10 stopway in December, 2004. The test method used is Sand Patch Method. The computations involved in determining texture depths were conducted according to AC 150/5320-12C by the Federal Aviation Administration（FAA）. The texture depths standards and recommended improvements described in that AC are listed in Table 1.16-5.

Table 1.16-5 Texture depths standards and recommended improvements

Texture Depths Standards	Recommended Improvements
<1.14mm	Conduct texture depth measurements each time a runway friction survey is conducted
0.76mm~0.40mm	Initiate plans to correct the pavement texture deficiency within a year
<0.25mm	Correct the pavement texture deficiency within 2 months

The distribution chart of test points is showed in Figure 1.16-6. There were three test areas as follows: The first area was located at the threshold marking of runway 28. There were 8 test points chosen in this area, four of them were on the marking line, and the others were on the non-marking pavement for making the comparison of the texture depth of marking area to non-marking; The second was located at the stopway of runway 10. The range of length for measuring the texture depth was from 0 to 100 meter in the stopway. The test points were uniformly distributed like a oblique line, the longitudinal space was 10 meters and the transverse space was 6 meter; The third was located within 100 meter after the threshold marking of runway 28. Two test points, comprising one group, were respectively located at 3 meter to both sides of runway centerline. The longitudinal space was 20 meter. These three test areas have 28 test points total.

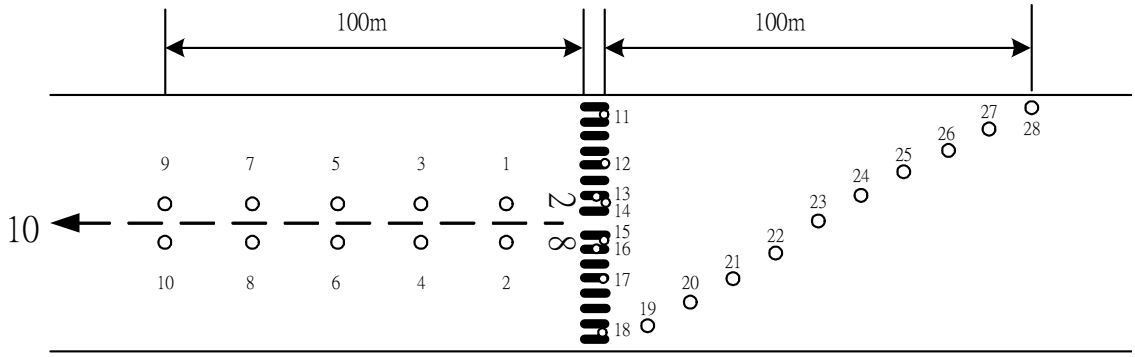


Figure 1.16-6The distribution chart of test points for runway surface texture depth measurement

1.16.5.2 Test Rusults

The test results are listed from Table 1.16-6 to 1.16-8.

Table 1.16-6 The test results of sand patch method within 100 meters after the threshold marking of runway 28

	No.	Volume of Sand (ml)	Average Texture Depth (mm)	No.	Volume of Sand (ml)	Average Texture Depth (mm)	Average per 100 meter
Within 100 meter after the Threshold Marking of Runway 28	1[21]	5.0	0.250	2	9.0	0.450	
	3	6.0	0.300	4	8.0	0.400	
	5	10.0	0.500	6	9.0	0.450	
	7	9.0	0.450	8	8.0	0.400	
	9	9.0	0.450	10	8.0	0.400	
Average	0.390			0.420			0.405
Average after deleting the point on making line	0.425			0.420			0.422

[21] This point was located at the marking line.

Table 1.16-7 The test results of sand patch method within the threshold marking of runway 28

No.	Volume of Sand （ml）	Average Texture Depth （mm）	No.	Volume of Sand （ml）	Average Texture Depth （mm）
Non-marking area			**Marking area**		
11	9.0	0.450	12	7.0	0.350
13	11.0	0.550	14	9.5	0.475
16	11.0	0.550	15	7.5	0.375
18	9.0	0.450	17	8.5	0.425
Average	-	0.500	Average	-	0.406

Table 1.16-8 The test results of sand patch method within the stopway of runway 10

No.	Volume of Sand （ml）	Average Texture Depth （mm）	No.	Volume of Sand （ml）	Average Texture Depth （mm）
19	5.0	0.250	24	4.0	0.200
20	5.0	0.250	25	5.0	0.250
21	6.0	0.300	26	4.0	0.200
22	4.0	0.200	27	5.0	0.250
23	5.0	0.250	28	5.0	0.250
Average	0.240				

1.17 Organizational and Management Information

1.17.1 Organization and Management pertaining to TNA

TNA is composed of Security & Safety Office, System Operation Center, and Flight Operations Department among other units. See Figure 1.17-1 for details.

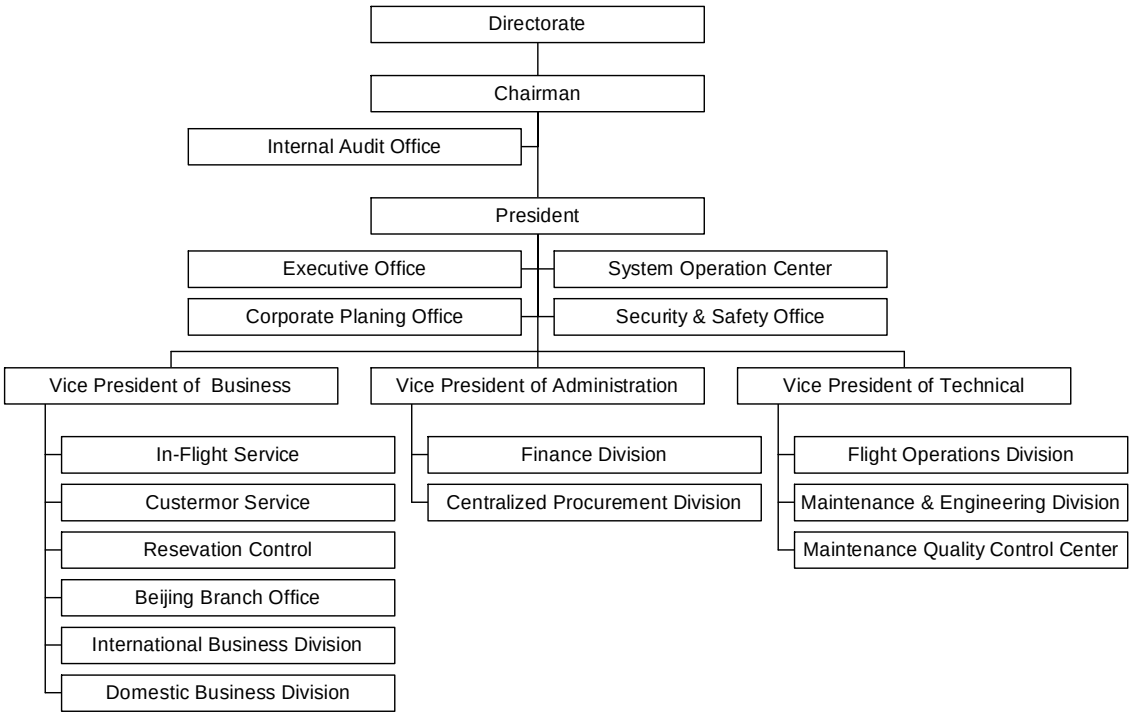


Figure 1.17-1 TNA Organizational Chart

1.17.1.1 Security & Safety Office（SSO）

The Flight Safety Office was under TNA's Flight Operations Department in the past. It was separated and transferred to under the Executive Office in May 1995. The functions of security protection and labors safety were incorporated into the Safety Control Office to become Security & Safety Office (SSO) on January 1, 2002, which are manned with 6 persons: 1 Director, 2 Officers, 2 Engineers and 1 Staff Member.

The functions of Safety Control Office involve units of flight operation, engineering and maintenance operation, QC, and ground services. Its main tasks include:

1. Carry out the analysis of the Line Operations Monitor System (LOMS) of the Flight Operations Quality Assurance (FOQA) and dealing with general

business regarding flight safety;

2. The LOMS operation is divided into two parts: the SCO is responsible for operation management and analysis of overall trend, and the Flight Operations Department designating pilots to provide assistance in confirming incidents and handling the follow-on work;
3. Participating daily maintenance meeting to have an awareness of operating conditions;
4. Directing each of the related department to conducting self-inspection operations, and collect the records submitted to Executive Office on a regular time schedule;
5. Implementing hazardous material education to all employees of TNA;
6. Organizing a mobile education team to instill the concept of “all-employees flight safety” in which each unit is responsible for flight safety of its own; and
7. Flight Operations Department is responsible for handling “flight crew reports” while units involving flight safety are providing assistances together with SCO.

1.17.1.2 Flight Operations Department（FOD）

The Flight Operations Department（FOD）is subordinated to Deputy General Manager for Flight/Maintenance. According to Operations Manual of TNA FOD, its functions include:

1. Promoting Flight Operation policy;
2. Assuring flight safety;
3. Developing and implementing relevant operating manuals and procedures;
4. Implementing manpower planning, training, employment, evaluation and management of flight pilots; and
5. Assigning and implementing flight missions.

The establishment of FOD includes Fleet Management Department (FMD) and Standard & Training Department (STD). The FMD is composed of AIRBUS fleet, ATR fleet and Crew Scheduling Management Section. Under the STD department, there are three sections: Academic Courses Planning, Standard & Training, and Planning & Development.

The (deputy) assistant vice president of FOD acts as the leader of FOD whose responsibilities include:

1. Overseeing internal affairs and communicating with other units;

2. Supervising and developing policies and procedures of TNA flight operations;
3. Supervising the implementation of flight operations;
4. Supervising training of flight crew members;
5. Supervising and planning policies to ensure flight safety; and
6. Supervising, evaluating and managing subordinates.

1.17.1.2.1 Fleet Management Department

AIRBUS fleet contains 8 AIRBUS 320/321 aircrafts with 28 captains (of which 2 CAA designated examiners, 3 check pilots and 3 instructor pilots) and 26 first officers with 54 in total. ATR fleet has 10 ATR72 passenger aircraft.

According to Operations Manual of TNA Flight Operations Department, the responsibilities of chief pilot include:

1. Implementing test and evaluation of pilots;
2. Conducting selection review of new pilots, pilots for advanced training and pilots for transfer training, and manpower planning;
3. Attending and supervising required study classes;
4. Management of fleet personnel including pilot flight skills, disciplines and habits in daily life;
5. Conducting checks on various skills and evaluation of annual individual pilot performance; and
6. Handling “Flight Crew Member Report”

1.17.1.2.2 Standard & Training Department（STD）

Standard & Training Section (STS)

STS is staffed with Director, one Staff Member, and a task-based team composed of check pilots and instructor pilots.

According to Operations Manual of TNA Flight Operations Department, the functions of STS include:

1. Revising and enlarging various standard flight operation doctrines such as Standard Operations Procedures, Flight Operations Manual, Flight Training Management Manual, Flight Training Manual and Route Manual;
2. Collecting and compiling teaching material and questions pool regarding ground academic training, simulator training and flight training of each

type of aircraft;

3. Supervising the instructor pilots in conducting training, qualifying techniques and skills, evaluating training results and tracking shortcomings, as well as conducting checks on lag of training progress and events of poor grade examination and raising suggestions;

4. Taking part in the process of selecting and evaluating new pilots and pilots for advanced and transferring training, and attending the fleet manpower appraisal meeting; and

5. Holding meetings to check pilots' flight competence and skills.

According to Operations Manual of TNA Flight Operations Department, the responsibilities of Check pilots and Instructor Pilots of the task-based team include:

1. Conducting checks and tests on various pilot techniques and skills;

2. Implementing various flight trainings (including flight-related ground academic subjects and civil aviation regulations and laws);

3. Reflecting training problems and improving training or operational procedures;

4. Appraising and checking the qualifications of pilots; and

5. Participating regular instructor pilot meetings as well as personnel techniques and skills appraisal meetings.

Academic Courses Planning Section

Academic Courses Planning Section (ACPS) is staffed with Director, Deputy Director and one Staff Member.

According to Operations Manual of TNA Flight Operations Department, the functions of ACPS include:

1. Developing training programs and tracking the implementation of them.

2. Coordinating with Dispatch Center to arrange the recurrent training of pilots;

3. Safekeeping, sorting out and replenishing training material, books and training equipment;

4. In charge of various flight and ground academic trainings, and collecting and assessing the opinions from instructors and trainees.

5. Arranging trainees for simulator recurrent training and handling information; and

6. Tracking trainees' stage trainings and their examination records.

1.18 Additional Information

1.18.1 Site Survey

The result of site survey was presented on the airport satellite image as shown in Figure 1.18-1. The ground tracks of left main landing gear, right main landing gear and nose gear were represented with green, orange and red lines respectively.

According to the site-survey result, the nose gear of the occurrence aircraft skipped off the pavement of the stopway at 321 feet outward the threshold of Runway 28. The nose gear stopped in the uncovered ditch at about 130 feet in the north of the stopway (Figure 1.18-2). The aircraft stopped with heading 002 and nose downward slightly.

The tire marks of the aircraft could be tracked from the grass area, via the pavement of the stopway, continuously to the runway threshold markings of Runway 28 (Figure 1.18-3). No apparent tire marks of the occurrence aircraft could be found on the runway.

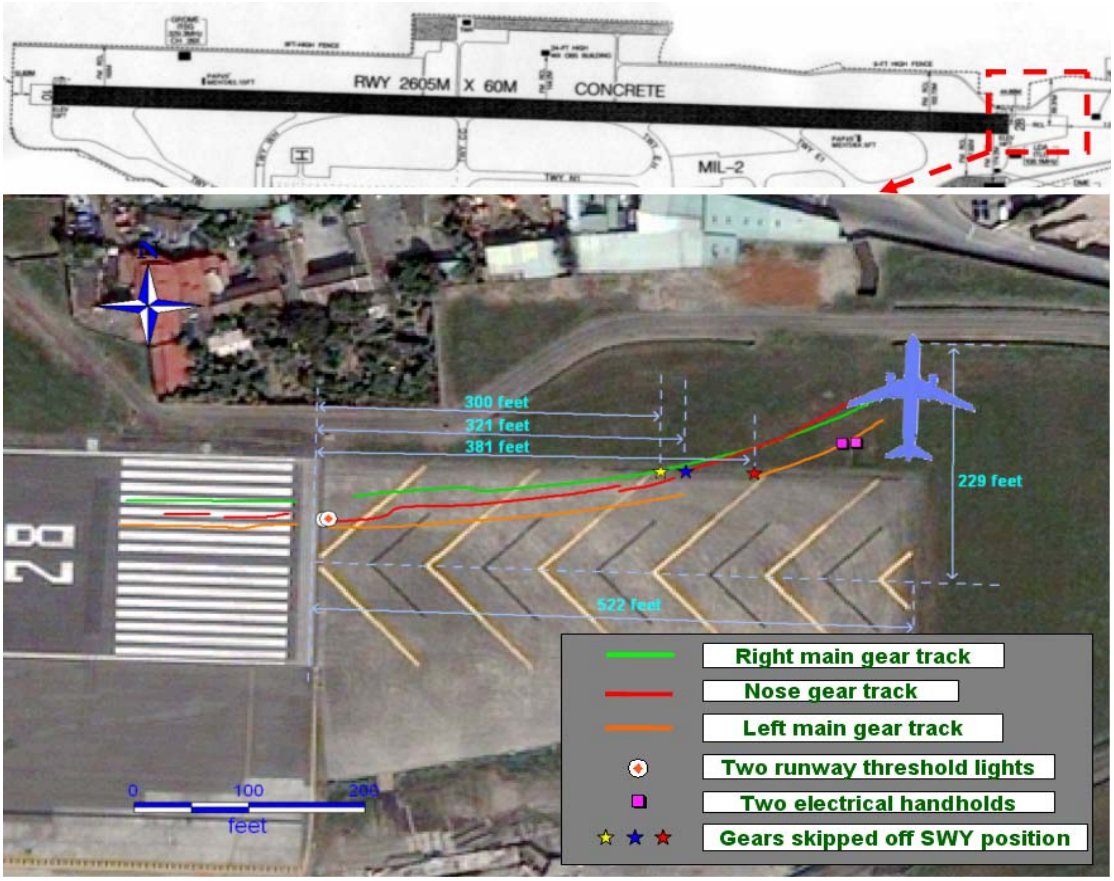


Figure 1.18-1Sungshan airport chart and site-survey results with the satellite image

Figure 1.18-2The nose gear stopped in the ditch

Figure 1.18-3Ground tracks from the stopway pavement to the grass area

1.18.2 Aircraft Recovery

Recovery of the aircraft was performed by TNA. An airbag was placed at the RH wing root but did not have sufficient height to enable recovery. The lifting of

the fuselage was carried out with slings at Frame 15, 21 and 62（Figure 1.18-4）. With the damaged NLG resting on a trolley and slings around the two main landing gear the aircraft was pulled directly backwards with a vehicle to a solid surface（Figure 1.18-5）.

Figure 1.18-4　Aircraft with slings at Frame 15, 21 and 62

Figure 1.18-5　Aircraft towing with straps around both MLG casings

1.18.3　Summary of Interview with Pilots

1.18.3.1　CM-1

He stated that he was told the number two engine thrust reverser of B-22310 was deactivated while he reported to the System Operations Center, so he briefed to the CM-2 that the thrust reverser fault meet the dispatch standard but should pay attention to the deceleration and direction control at landing roll.

He stated the ATIS reported the visibility at Sungshan Airport was 5 miles, ceiling at 1,800 ft and their existed low level windshear and moderate turbulence on final. Then he agreed with CM-2's selections of flaps 3 and autobrake medium.

They received landing clearance at around 1,000 ft, on final approach had turbulence, and the visibility was good. He stated the aircraft's touch down was normal, he called out "Spoiler, one reversal green" once and "no brake" several times after landing, but the deceleration were not enough, so he applied the brake pedal also. He stated that CM-2 did advance the number one throttle lever and then pull it full back.

The aircraft rolled off from the left side of stopway into grass, the speed decreased rapidly and came into a full stop while the nose gear collapsed into a ditch. He shut down both engines and broadcasted "Cabin crew at station" for three times by Public Address (PA) system. Then he started the Auxiliary Power Unit (APU) after checked there was no fire warning, and then contacted tower to request the ground support.

He talked to purser regarding the situation and released the passenger via slide out from the left passenger front door because the ladder at the rear exit could not be linked to the aircraft.

1.18.3.2 CM-2

He stated the ATIS reported the visibility at Sungshan Airport was 5 miles, ceiling at 1,800 ft, wind speed varies at 3 knots and windshear existed on Runway 10. The approach briefing was conducted following the card; the approach speed was computed as 137 knots, set flaps 3 and select autobrake at medium. Auto-pilot was engaged.

On final approach, at about 400 feet, the auto-pilot was disengaged due to unstable wind. CM-1 call out "reverse one green" after the number 1 thrust reverser was applied at landing. He applied the brake immediately after CM-1 call out "no brake", but even with more brake pedal actions, the aircraft did not effectively deceleration. He could felt that the CM-1 was applied the brake simultaneously.

He decreased the thrust of number one thrust reverser to try to control the aircraft's direction, and then, advanced the thrust to the maximum.

The aircraft decelerated rapidly after rolling toward the left side stopway. From the aircraft landed till full stop, the CM-1 did not announce that he took over the control.

1.18.4 Summary of Flight Crew Operating Manual

A/THR ACTIVATION

The A/THR is active when it controls thrust or speed. The position of the thrust lever determines the maximum thrust that the A/THR system can command (except in α-floor condition).

R The A/THR being armed, is activated :

– when the pilot sets both thrust levers between the CL and IDLE detents (two engines operative)

R – when the pilot sets one thrust lever between the MCT and IDLE detents (one engine
R inoperative).

R The A/THR being disconnected, is activated when the pilot pushes the FCU pushbutton
R while the thrust levers are within the active range, including IDLE position.

R

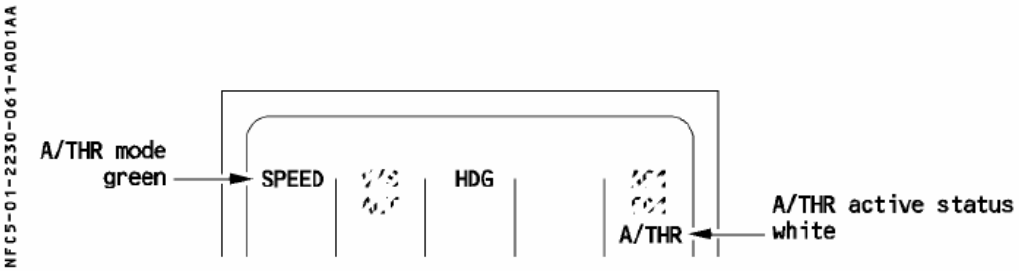
R *Note : When the pilot sets both thrust levers to IDLE position, the A/THR disconnects but,*
R *if the pilot pushes the A/THR pushbutton of the FCU, he will simultaneously arm and*
R *activate the autothrust. Due to the thrust levers position, IDLE thrust will be*
R *maintained.*

– when ALPHA FLOOR is activated, regardless of the initial status of A/THR and the position of the thrust levers.

When A/THR is active :

– The A/THR pushbutton on the FCU lights up.

R – The FMA displays A/THR mode in green in the first column and A/THR in white in the
R fifth column.



EFFECTS OF THRUST LEVER MOVEMENT WHILE A/THR IS ACTIVE

- When both thrust levers are set above the CL detent (both engines operative) or one thrust lever is set above MCT (one engine operative) the A/THR reverts from active to armed. "A/THR" turns to blue on the FMA and the thrust levers control the thrust directly. The FMA displays "MAN THR" white in its first column.
  The thrust levers provide the crew with an immediate increase of thrust when both thrust levers are pushed above the CL detent (2 engines) or the active thrust lever above the MCT detent (one engine operative).
- When both thrust levers are set below the CL detent (both engines operative) or one thrust lever is set below MCT (one engine operative), a repeating warning (amber caution, single chime, ECAM message "A/THR LIMITED") is activated every 5 seconds until the pilot moves the lever back into the detent. "THR LVR" green is displayed on the FMA
  "LVR CLB" (both engines operative) or "LVR MCT" (one engine operative) flashes white in the first column of the FMA.
  This device reminds the crew that the normal operating position of the thrust levers, when A/THR is active, is the CL detent (2 engines) or the MCT detent (one engine operative).
- When one thrust lever is in the CL detent and the other one out of the detent, the "LVR ASYM" amber message comes up until both levers are set in the CL detent (only with both engines operative).

A/THR DISCONNECT

When the A/THR is disconnected, it is neither armed nor active.
The A/THR can be disconnected in two ways :

* Standard disconnection
  - The pilot pushes the instinctive disconnect pushbutton on the thrust levers (which immediately sets the thrust corresponding to the lever positions) or
  - The pilot sets both thrust levers to IDLE detent.
* Non-standard disconnection
  - The pilot pushes the A/THR pushbutton on the FCU while A/THR is armed/active, or
  - The system loses one of the arming conditions.

R **Below 100 feet radio altitude**

R When the radio altitude is below 100 feet and the pilot sets both thrust levers above the
R CL detent or one above the MCT detent, the autothrust will disconnect. It will rearm
R automatically when at least one of the thrust levers is set to TOGA.
R If the PF sets the thrust levers slightly above CL detent but below TOGA and come back
R to CL detent, the A/THR will disconnect and remain disconnected. As a result, the thrust
R will increase up to CLIMB thrust. The crew has to manually set the appropriate thrust for
R landing (or go around).

CAUTION

If the pilot pushes and holds one instinctive disconnect pushbutton for more than 15 seconds, the A/THR system is disconnected for the remainder of the flight. All A/THR functions including ALPHA FLOOR are lost, and they can be recovered only at the next FMGC power-up (on ground).

THRUST LOCK FUNCTION

The THRUST LOCK function is activated when the thrust levers are in the CL detent (or the MCT detent with one engine out) and the pilot pushes the A/THR pushbutton on the FCU or the A/THR disconnects due to a failure.

- "THR LK" flashes amber on the FMA.
- ECAM "ENG THRUST LOCKED" flashes every five seconds.
- ECAM displays "THR LEVERS..... MOVE"
- A single chime sounds and the Master Caution Light flashes every five seconds.

The thrust is locked at its level prior to disconnection. Moving the thrust levers out of CL or MCT suppresses the thrust lock and gives the pilot manual control with the thrust levers. All warnings cease when the pilot moves the thrust levers out of the detent.

A/THR DISCONNECT CAUTION

		A/THR DISCONNECTION	
		BY INSTINCTIVE DISCONNECT OR SETTING TWO LEVERS TO IDLE (if above 50 ft RA)	**BY OTHER MEANS**
CONSEQUENCE	MASTER CAUTION	illuminated-3 sec max	illuminated
	ECAM MESSAGE	amber A/THR OFF message 9 sec maximum	Flashing "ENG THRUST LOCKED" (amber AUTO FLT A/THR OFF THR LEVERS..... MOVE (blue)
	AUDIO	single chime	single chime
	CLR pushbutton on ECAM CONTROL PANEL	extinguished	illuminated
ACTION	MASTER CAUTION pushbutton	extinguishes MASTER CAUTION light erases ECAM message	extinguishes MASTER CAUTION light
	CLR puhbutton on ECAM CONTROL PANEL	No effect	extinguishes MC light and CLR pushbutton, erases ECAM message calls status
	INSTINCTIVE DISCONNECT pushbutton	extinguishes MASTER CAUTION light erases ECAM message	extinguishes MASTER CAUTION light
ECAM STATUS MESSAGE		NO	YES

R – Standard disconnection triggers temporary ECAM message and caution light. Single
R chime sounds.
R – Non standard disconnection triggers caution light and ECAM message removed only by
R a pilot action. Single chime sounds.

A/THR MODES

Except in takeoff and go around situations, normal operation of the A/THR system requires the thrust levers to be :

- In the CL detent for the two-engine configuration. If they are not set in the CL detent, "LVR CLB" flashes white on the FMA.
- In MCT detent when in the one-engine-out configuration. If the appropriate lever is not set in the MCT detent, "LVR MCT" flashes white on the FMA.

The A/THR modes are selected automatically in conjunction with the AP/FD modes (except for ALPHA FLOOR).

A/THR in THRUST mode	AP/FD pitch mode maintains the speed : OP CLB - OP DES - CLB - EXP CLB◁ - EXP DES◁ - SRS - FLARE and DES (IDLE path)
A/THR in SPEED/MACH mode	If neither AP nor FD is engaged
	If AP/FD controls a vertical path V/S-FPA-ALT*- ALT CST*-ALT-ALT CRZ-G/S* -G/S-FINAL and DES (geometric path)
A/THR in RETARD mode	Automatic landing (AP engaged in LAND mode).

THRUST mode

- In THRUST mode, autothrust commands a specific thrust level in conjunction with the AP/FD pitch mode. This thrust level is limited by thrust lever position.

FMA display	Meaning
THR MCT	Single engine thrust in climb. The live engine is at maximum continuous thrust (thrust lever in MCT detent)
THR CLB	Climb thrust two engine configuration (at least one thrust lever in the CL detent, the other one below CL)
THR LVR	Undetermined thrust (neither CLB or MCT thrust)
THR IDLE	Minimum thrust (both engines at IDLE thrust)

Note : When the A/THR is armed for takeoff or go around, the FMA displays "MAN TOGA" (or "MAN FLX") in white to remind the crew that the thrust levers have been positioned properly.

RETARD MODE

The RETARD mode is only available during automatic landing (AP engaged in LAND mode). At approximately 40 feet RA, the RETARD mode engages and remains engaged after touchdown. The A/THR commands IDLE thrust during the flare, and the FMA and engine warning display "IDLE". If the autopilot is disengaged during the flare before touchdown, the SPEED mode replaces the RETARD mode, and the pilot has to manually reduce thrust.

Note : In an automatic landing, the system generates a "RETARD" callout at 10 feet radioaltitude (RA), which prompts the pilot to move the thrust levers to IDLE in order to confirm thrust reduction. In manual landing conditions, the system generates this callout at 20 feet RA, as a reminder.

ALPHA FLOOR

ALPHA FLOOR is a protection that commands TOGA thrust, regardless of the thrust levers' positions. This protection is available from lift-off to 100 feet RA on approach.
ALPHA FLOOR calls up the following indications :
- "A FLOOR" in green, surrounded by a flashing amber box on the FMA, and in amber on the engine warning display, (as long as α-floor conditions are met).
- "TOGA LK" in green, surrounded by a flashing amber box on the FMA, when the aircraft leaves the α-floor conditions. TOGA thrust is frozen.

To cancel ALPHA FLOOR or TOGA LK thrust, the pilot must disconnect the autothrust.

SPEED/MACH mode

In SPEED/MACH mode, the A/THR adjusts the thrust in order to acquire and hold a speed or Mach target.
The speed or Mach target may be :
- Selected on the FCU by the pilot.
- Managed by the FMGC.

When in SPD/MACH mode, the A/THR does not allow speed excursions beyond the following limits, regardless of the target speed or Mach number :
- For a selected speed target, the limits are VLS and VMAX (VMO-MMO, VFE-VLE, whichever applies).
- For a managed speed target, the limits are maneuvering speed (Green Dot, S, F, whichever applies) and maximum speed (340/.80-VFE-VLE, whichever applies).

The changeover from SPEED to MACH mode is either automatic, performed by the FMGC, or manual, with the pilot pushing the SPD/MACH changeover pushbutton.
The FMA displays "SPEED" or "MACH".

Approach autothrust :

R Below 3200 feet radioaltitude, with at least CONF 1, the A/THR logic is modified to be more responsive to speed variation. This is referred to as approach autothrust.

GROUND SPOILER CONTROL

Spoilers 1 to 5 act as ground spoilers.
When a ground spoiler surface on one wing fails, the symmetric one on the other wing is inhibited.

Arming

The pilot arms the ground spoilers by pulling the speedbrake control lever up into the armed position.

Full extension

The ground spoilers automatically extend during rejected takeoff, at a speed greater than 72 knots, or at landing when both main landing gears have touched down, when :

R · Ground spoilers are armed and all thrust levers are at or near idle, or
· Reverse is selected on at least one engine (other thrust lever at or near idle), if ground
R spoilers were not armed.

Note : · In autoland, the ground spoilers fully extend at half speed one second after both main landing gear touch down.

R *· The spoiler roll function is inhibited when spoilers are used for the ground spoiler*
R *function.*

Partial extension

The ground spoilers partially extend (10°) when reverse is selected on at least one engine (other engine at idle), and one main landing gear strut is compressed. This partial extension, by decreasing the lift, eases the compression of the second main landing gear strut, and consequently leads to full ground spoiler extension.

Retraction

The ground spoilers retract :
· After landing, or after a rejected takeoff, when the ground spoilers are disarmed.

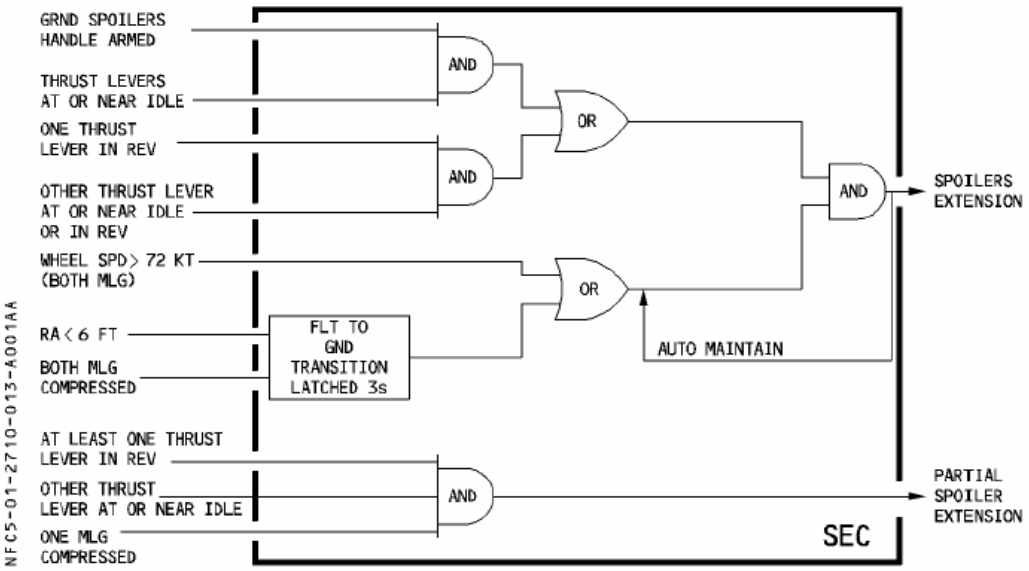
Note : If ground spoilers are not armed, they extend at the reverse selection and retract when idle is selected.

· During a touch and go, when at least one thrust lever is advanced above 20°.

Note : After an aircraft bounce, the ground spoilers remain extended with the thrust levers at idle.

FOR INFO

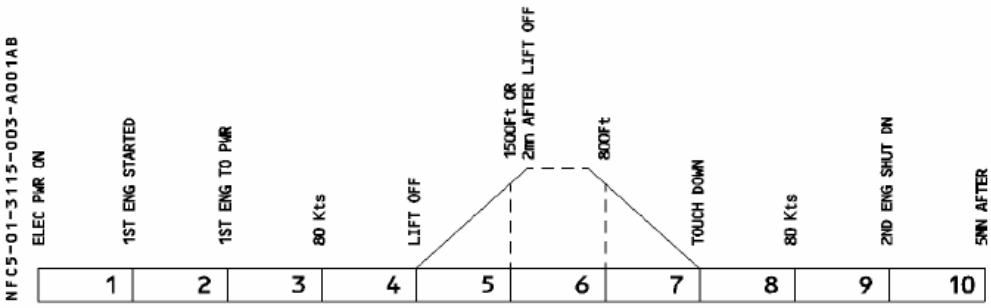
R *The landing gear touchdown condition is triggered for both main landing gear, either when*
R *their wheel speed is greater than 72 knots, or when their landing gear struts are*
R *compressed and the radio altitude is very low (RA < 6 feet).*
R *For the ground spoiler logic, idle signifies :*
R *Thrust lever position < 4° or < 15° when below 10 ft*
R



FLIGHT PHASES

GENERAL

The FWC divides its functions according to these ten flight phases :

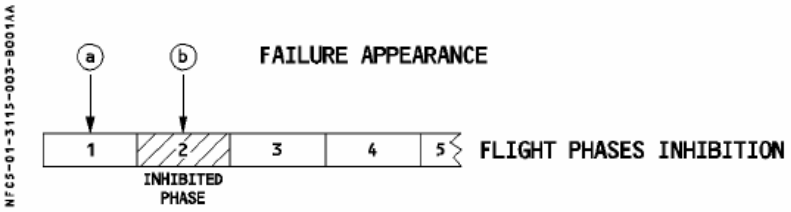


To improve its operational efficacy, the computer inhibits some warnings and cautions for certain flight phases. It does so to avoid alerting the pilots unnecessarily at times when they have high workloads, such as during takeoff or landing. In these two phases, the DU displays magenta memos : "T.O. INHIBIT" (flight phases 3, 4, and 5), and "LDG INHIBIT" (flight phases 7 and 8).

Note : These flight phases are different from and independent of the ones that the FMGC uses.

FLIGHT PHASE INHIBITION

Two cases are possible (for instance) :



Effect on E/WD :

(a) The failure occurs during phase 1. The E/WD displays the warning immediately and continues to display it as long as the failure is present, even in phase 2.

(b) The failure occurs during phase 2. The E/WD displays the warning only when the aircraft has entered phase 3, where it is not inhibited. Then the warning remains displayed as long as the failure is present.

AUTO BRAKE

The purposes of this system are :
- to reduce the braking distance in case of an aborted takeoff
- to establish and maintain a selected deceleration rate during landing, thereby improving passenger comfort and reducing crew workload.

R SYSTEM ARMING

The system arms when the crew presses the LO, MED, or MAX pushbutton switch if :
- Green pressure is available.
- The anti-skid system has electric power.
- There is no failure in the braking system.
- At least one ADIRS is functioning.

Note : Auto brake may be armed with the parking brake on.

R SYSTEM ACTIVATION

R Automatic braking activates when the ground spoilers extend (Refer to 1.27.10 SPEED BRAKES AND GROUND SPOILERS). Therefore, if the aircraft makes an acceleration stop and begins to decelerate when its speed is under 72 knots, the automatic braking will not
R activate because the ground spoilers will not extend.
For autobrake to activate, at least two SEC's must be operative.

R SYSTEM DEACTIVATION

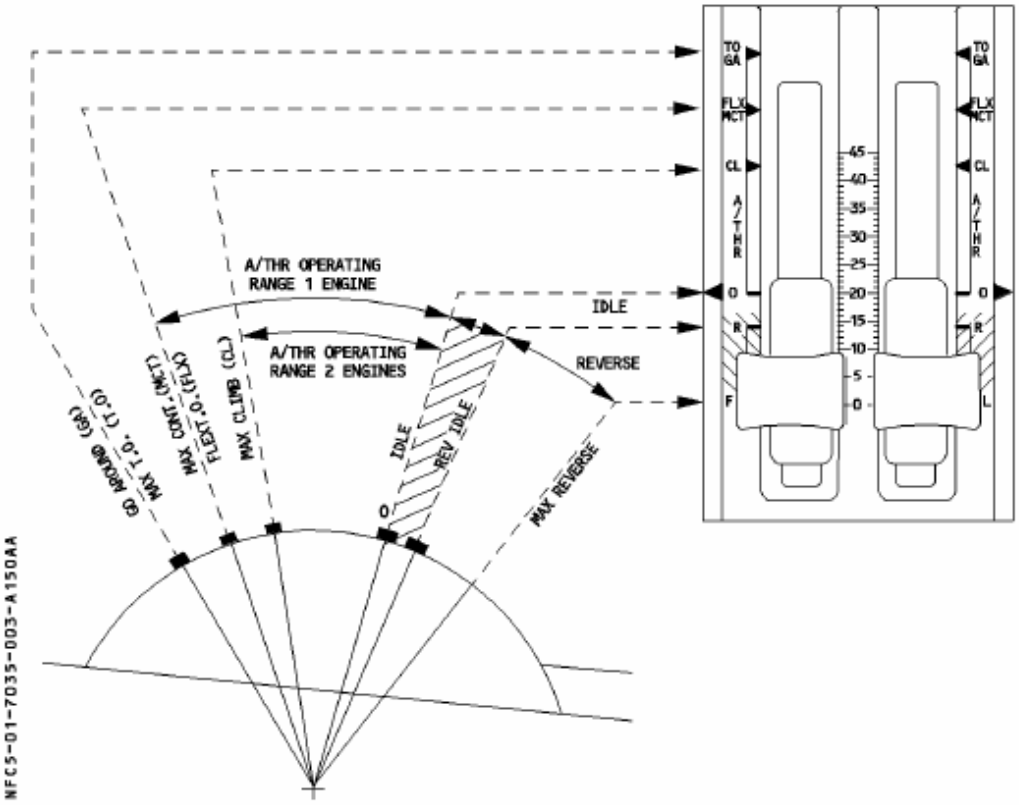
R The system deactivates :
R – When it is disarmed (see below).
R – When the ground spoilers retract. In this case it remains armed.

R SYSTEM DISARMING

The system disarms when :
- Flight crew presses the pushbutton switch or,
- One or more arming conditions is lost or,

R – Flight crew applies enough deflection to at least one brake pedal when autobrake is active in MAX, MED or LO mode.
R – After take-off/touch and go.

THRUST LEVERS



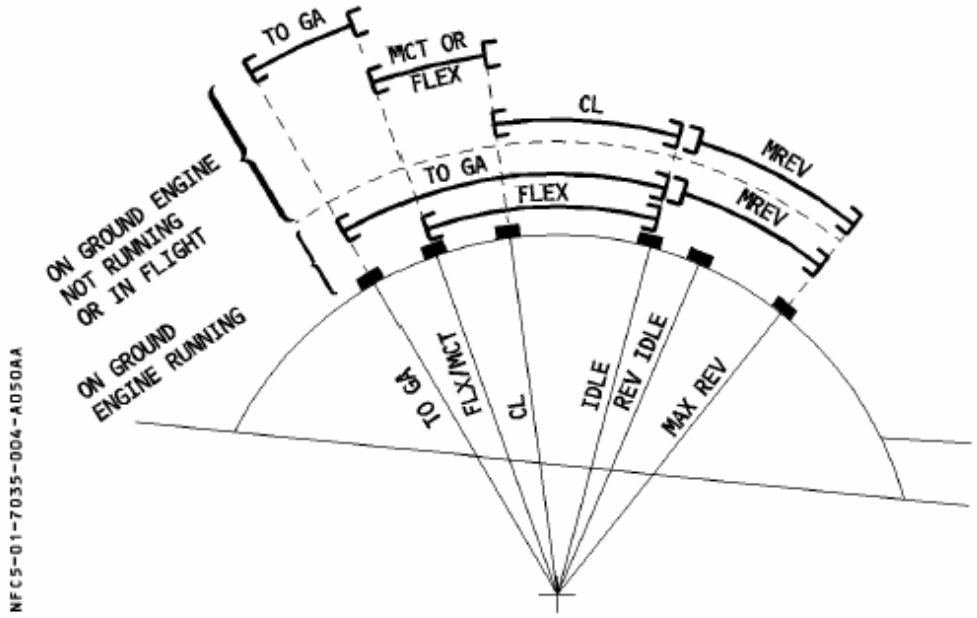
The thrust levers can only be moved manually.
They move over a sector that is divided into four operating segments.
The sector has five positions defined by detents or stops.
Thrust lever position is transmitted to the FADEC, which computes and displays the thrust rating limit and the N1 for that Thrust Lever Angle (TLA).

Note : There is no reverse idle detent. When the pilot moves the lever out of the idle stop by pulling up the reverse lever on the front of the thrust lever, he selects reverse idle.

THRUST RATING LIMIT

The FADEC computes the thrust rating limit for each thrust lever position, as shown below.
If the thrust lever is set in a detent, the FADEC selects the rating limit corresponding to this detent.
If the thrust lever is set between two detents, the FADEC selects the rating limit corresponding to the higher detent.

RATING LIMITS :



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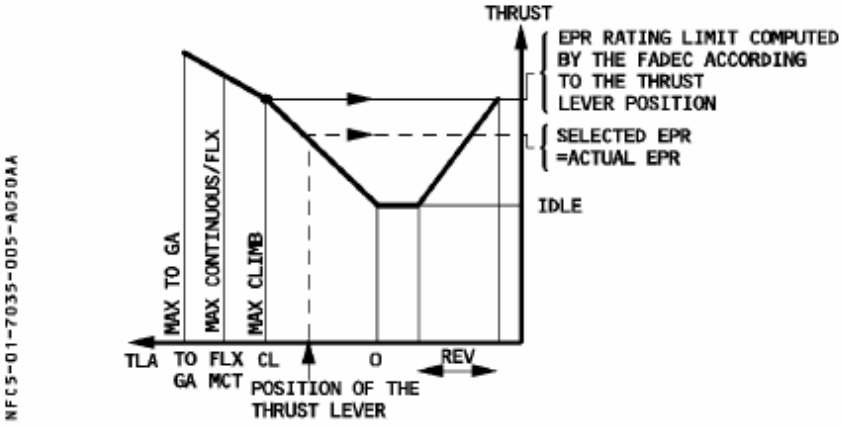
THRUST CONTROL

MANUAL MODE

The engines are in the manual mode provided the A/THR function is :
– not armed or
– armed and not active (thrust lever not in the A/THR operating range and no alpha floor).
In these conditions, each engine is controlled by the position of its thrust lever.
The pilot controls thrust by moving the thrust lever between IDLE and TOGA positions. Each position of the thrust lever within these limits corresponds to an EPR.
When the thrust lever is in a detent, the corresponding EPR is equal to the EPR rating limit computed by the FADEC for that engine.



When the thrust lever is in the FLX/MCT detent :

– **On the ground**
The engine runs at the flex takeoff thrust rating if the crew has selected a flex takeoff temperature on the MCDU that is higher than the current Total Air Temperature (TAT). Otherwise the engine produces Maximum Continuous Thrust (MCT).

Note : A change in FLEX TEMP during the takeoff has no effect on the thrust.

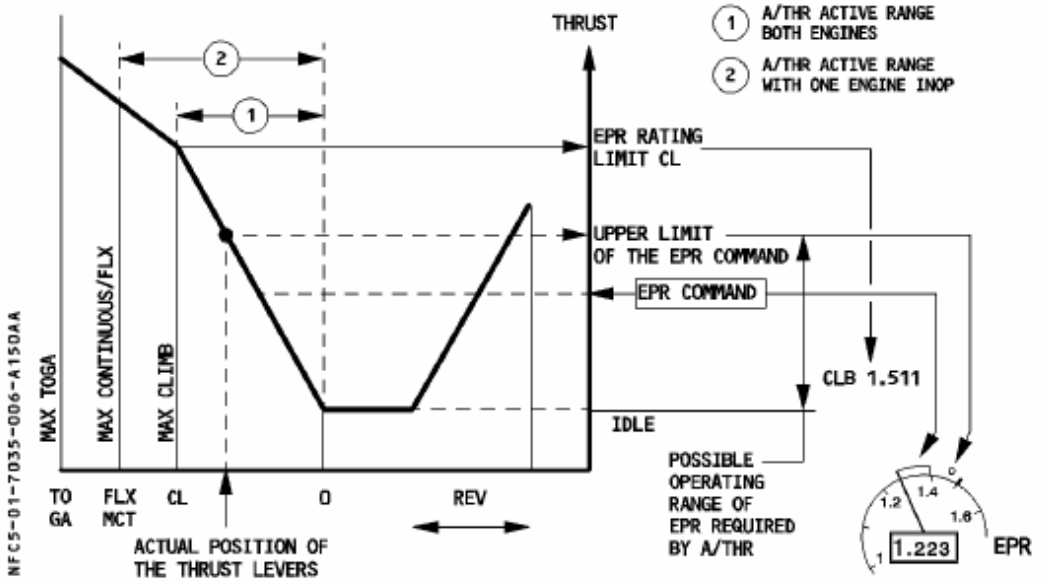
– **After takeoff**
The pilot can change from FLX to MCT by moving the thrust lever to TOGA or CL, then back to MCT. After that, he cannot use the FLX rating.

R *Note : Setting the thrust lever out of FLX/MCT detent without reaching TOGA or CL*
R *detent has no effect.*

The pilot can always get MAX TO thrust by pushing the thrust lever all the way forward.

AUTOMATIC MODE

In the autothrust mode (A/THR function active), the FMGC computes the thrust, which is limited to the value corresponding to the thrust lever position (unless the alpha-floor mode is activated).



INDICATIONS ON FMA

The FADECs monitor the positions of the thrust levers, and trigger appropriate indications on the FMA.

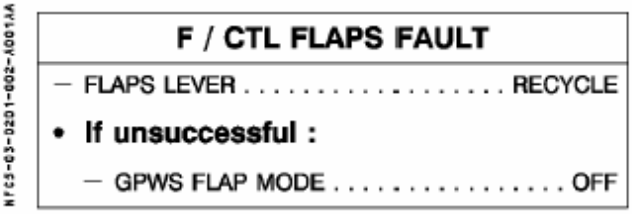
LVR ASYM : appears in amber (3rd line on the FMA) if, with A/THR active and both engines running, one thrust lever is set out of the CLB detent.

LVR CLB : flashes white (3rd line on the FMA) if the thrust levers are not in CL position while the aircraft is above the altitude of thrust reduction with both engines running.

LVR MCT : flashes white (3rd line on the FMA) if the thrust levers are not in MCT position after an engine failure (with speed above green dot).

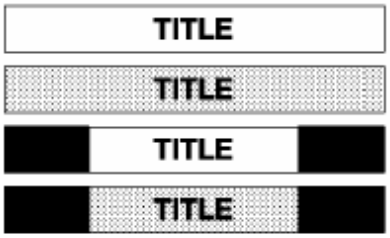
The ECAM does not display black squares.

· If an action depends on a precondition, a black dot identifies the precondition. If the precondition appears on ECAM, it appears in large letters. If not, it appears in small letters.
For example :



"If unsuccessful" does not appear on ECAM

· Titles of the procedures appear in the following ways :



Abnormal procedure displayed on ECAM

Abnormal procedure not displayed on ECAM

Emergency procedure displayed on ECAM

Emergency procedure not displayed on ECAM

TASK SHARING

The general task sharing shown below applies to all procedures.
The pilot flying remains pilot flying throughout the procedure.
PF, the pilot flying, is responsible for :
– thrust levers
– control of flight path and airspeed
– aircraft configuration (request configuration change)
– navigation
– communications.
PNF, the pilot not flying, is responsible for :
– reading aloud the ECAM and checklists
– executing required actions or actions requested by the PF, if applicable
– operating the engine master switch and ENG FIRE pushbutton (monitored by the PF).

R MEMORY ITEMS

R The following procedures are to be applied without referring to paper : Windshear ◁ ,
R windshear ahead ◁ , TCAS ◁ , EGPWS ◁ , loss of braking, beginning of EMER DESCENT,
R beginning of UNRELIABLE SPEED INDICATION.

F/CTL GND SPLR / 1 + 2 / 3 + 4 / FAULT

Crew awareness.

● **GND SPLR FAULT :**

Loss of ground spoiler function in SEC 1 + 3, or 1 + 2, or 2 + 3, or 1 + 2 + 3.

● **GND SPLR 1 + 2 (3 + 4) FAULT :**

Loss of ground spoiler function in SEC 3 (or 1).

	STATUS
– LDG DIST PROC . . . . . APPLY	INOP SYS
R *Refer to the QRH Part 2, or to the FCOM 3.02.80.*	GND SPLR (affected)

F/CTL SPD BRK DISAGREE

■ **Surfaces 3 + 4 affected**

Surfaces' position not in agreement with the handle position.

– SPD BRK LEVER . . . . . RETRACT
– SPD BRK . . . . . DO NOT USE

	STATUS
– SPD BRK . . . . . DO NOT USE	INOP SYS
	SPD BRK 3 + 4

■ **Surfaces 2 + 3 + 4 affected :**

After automatic retraction (due to activation of alpha protection or slats/flaps in configuration FULL), surface position is not in agreement with the handle position.

– SPD BRK LEVER . . . . . RETRACT

LOSS OF BRAKING

- **IF AUTOBRAKE IS SELECTED :**
  - BRAKE PEDALS ..... PRESS
    This will override the autobrake.
- **IF NO BRAKING AVAILABLE :**
  - REV ..... MAX
  - BRAKE PEDALS ..... RELEASE
    Brake pedals should be released when the A/SKID & N/W STRG selector is switched OFF, since the pedal force or displacement produces more braking action in alternate mode than in normal mode.
  - A/SKID & N/W STRG ..... OFF
    Braking system reverts to alternate mode.
  - BRAKE PEDALS ..... PRESS
    Apply brake with care, since initial pedal force or displacement produces more braking action in alternate mode than in normal mode.
  - MAX BRK PR ..... 1000 PSI
    Monitor brake pressure or BRAKES PRESS indicator. Limit brake pressure to approximately 1000 psi and, at low ground speed, adjust brake pressure as required.
  - **If STILL NO BRAKING :**
    - PARKING BRAKE ..... USE
      Use short successive parking brake applications to stop the aircraft. Brake onset asymmetry may be felt at each parking brake application. If possible, delay the use of the parking brake until low speed, to reduce the risk of tire burst and lateral control difficulties.

WHEEL HYD SEL FAULT

R *Failure of normal brake selector valve, or the steering selector valve, in the open position.*
R – *If the normal brake selector valve is failed open, full green hydraulic pressure is present*
R *at normal servovalves' entry.*
R *Nosewheel steering remains available.*
R – *On ground, do not tow the aircraft with the green hydraulic system pressurized :*
R *Nosewheel steering remains pressurized, and so towing may either break the towbar*
R *shear pin, or the nose gear (if towbarless towing).*
R – *Selecting A/SKID & N/W STRG OFF, or resetting the BSCU, will cause the nosewheel to*
R *go to maximum deflection.*
– A/SKID & N/W STRG ..... KEEP ON
As long as antiskid is operative, brake pressure is regulated by normal servovalves.

1.18.5 Summary of A320 SOP

● **At touchdown:**

– **REV** ..... **MAX**

- Select MAX REV immediately after the main landing gear touches down.
  If the airport regulations restrict the use of reversers, select and maintain reverse idle until taxi speed is reached.
  A slight pitch-up, easily controlled by the crew, may appeared when the thrust reversers are deployed before the nose landing gear touches down.
  Lower the nosewheel without undue delay if MED is selected.
- In case of engine failure, the use of the remaining reverser is recommended.
- Braking may be commenced before nosewheel is down, if required for performance reasons, but when comfort is the priority it should be delayed until the nose wheel has touched down.
  During roll out, sidestick inputs (either lateral or longitudinal) should be avoided.
  If directional control problems are encountered, reduce thrust to reverse idle until directional control is satisfactory.
- After reverse thrust is initiated, a full stop landing must be made.

– **GROUND SPOILERS** ..... **CHECK**

Check that the ECAM WHEEL page shows the ground spoilers fully deployed after touchdown. Announce "Ground spoilers" then "reverse green"

– **DIRECTIONAL CONTROL** ..... **ENSURE**

- Use rudder pedals for directional control.
- Do not use the nose wheel steering control handle before reaching taxi speed.

– **BRAKES** ..... **AS RQRD**

- Monitor the autobrake, if it is on. When required, brake with the pedals.
- Although the green hydraulic system supplies the braking system, if pedals are pressed quickly a brief brake pressure indication appears on the BRAKE PRESS indicator.

● **At 80 knots:**

– **THRUST levers** ..... **REV IDLE**

70 knots is the minimum recommended speed with full reverse thrust.

CAUTION
Avoid using high levels of reverse thrust at low airspeed, because gases re-entering the compressor can cause engine stalls that may result in excessive EGT.

1.18.6 Summary of Quick Reference Hand Book

A319 A320 A321	EMERGENCY PROCEDURES	REV 36 SEQ 001	1.13

LOSS OF BRAKING

- **IF AUTOBRAKE IS SELECTED :**
  - BRAKE PEDALS ..... PRESS
- **IF NO BRAKING AVAILABLE :**
- REV ..... MAX
- BRAKE PEDALS ..... RELEASE
- A/SKID & N/W STRG ..... OFF
- BRAKE PEDALS ..... PRESS
- MAX BRK PR ..... 1000 PSI
  - **If STILL NO BRAKING :**
  - PARKING BRAKE ..... SHORT AND SUCCESSIVE APPLICATIONS

LANDING	
PF	PNF
At 20 feet :	
FLARE . . . . . PERFORM	ATTITUDE . . . . . MONITOR
THRUST LEVERS . . . . . IDLE	
At touchdown :	
REV . . . . . MAX	ANNOUNCE . . . . . "GRND SPLRS"
BRAKES . . . . . AS REQD	ANNOUNCE . . . . . "REVERSE GREEN"
At 70 knots :	
REV . . . . . IDLE	ANNOUNCE . . . . . "70 KT"
At taxi speed :	
REV . . . . . STOW	
Before 20 knots :	
AUTOBRK . . . . . DISENGAGE	

GO AROUND (WITH FD ON)	
PF	PNF
THRUST LEVERS . . . . . TOGA	
ANNOUNCE . . . . . "GO AROUND-FLAPS"	
ROTATION . . . . . PERFORM	FLAPS . . . . . RETRACT ONE STEP
ANNOUNCE . . . . . FMA	ANNOUNCE . . . . . "POSITIVE CLIMB"
ORDER . . . . . "GEAR UP"	L/G . . . . . UP
	ANNOUNCE . . . . . "GEAR UP-FLAPS"
	NAV or HDG . . . . . SELECT
At GA thrust red. altitude :	
THRUST LEVERS CL	
At GA accel altitude :	
SPEED . . . . . MONITOR	FLAPS . . . . . RETRACT ON SCHEDULE

GO AROUND (WITH FD OFF)	
PF	PNF
THRUST LEVERS . . . . . TOGA	
ANNOUNCE . . . . . "GO AROUND-FLAPS"	
ROTATION . . . . . 15° OF PITCH	FLAPS . . . . . RETRACT ONE STEP
	ANNOUNCE . . . . . "POSITIVE CLIMB"
ORDER . . . . . "GEAR UP"	L/G . . . . . UP
	ANNOUNCE . . . . . "GEAR UP-FLAPS"
At GA thrust red. altitude :	
THRUST LEVERS . . . . . KEEP TOGA	
At GA accel altitude :	
SPEED . . . . . SELECT	
PITCH . . . . . + 10°/12°	
THRUST LEVERS CL	
A/THR (if GA alt < 100 feet) . . . . . ENGAGE	FDs . . . . . ON
	NAV or HDG . . . . . SELECT
	OPEN CLIMB . . . . . ENGAGE
	FLAPS . . . . . RETRACT ON SCHEDULE
ANNOUNCE . . . . . FMA	

1.18.7 Summary of A320 Minimum Equipment List

78 EXHAUST

1. SYSTEM & SEQUENCE NUMBER ITEM	2. RECTIFICATION INTERVAL	3. NUMBER INSTALLED	4. NUMBER REQUIRED FOR DISPATCH	5. REMARKS OR EXCEPTIONS
78-30 THRUST REVERSER				
30-01 Thrust Reverser	C	2	0	* **(m) (o)** One or both may be inoperative provided: 1) The inoperative reverser is deactivated and secured in the stowed position, and no operation or procedure is predicated on thrust reversers use, and 2) No REV PRESSURIZED warning is displayed on ECAM.
OPERATING PROCEDURES ***AT LANDING:*** ***Note:*** *It is recommended not to select reverse thrust on the affected engine.*				
30-02 Reverser Inhibition Relay Switch	C	4	0	One or more may be inoperative provided the associated reverser is deactivated. Refer to **78-30-01.**
30-03 Reverser Indication	C	2	0	One or both may be inoperative provided the associated reverser is deactivated. Refer to **78-30-01**
30-04 Thrust Reverser Shut Off Valve *(Applicable to **B22310, B22311, B22606** and **B22607** only)*	C	2	0	One or both may be inoperative in open position.

ALL

Appendix 1 GE536 CVR Transcript

Legend:

CM1: radio communication from captain (pilot not flying)

CM2: radio communication from first officer (pilot flying)

CAM: sounds from cockpit area microphone

CAM1: captain voice from CAM

CAM2: first officer voice from CAM

PA: recording of public address

KHH：Kaohsiung approach

TCH：Taichung approach

ACC: Taipei area control center

APP: Taipei approach

TWR: Sungshan tower

---: source unknown

…: content unintelligible

*: communication not related to operation

() : remarks

~: communication interrupted

CAL616、CAL678、CAL688、CPA401、EVA228、FEA082、FEA137、MDA280、MDA732、MDA747、TNA242、TNA374、TNA535、UNI615、UNI829、UNI830、UNI831、UNI93 stand for other flights appeared in the recording

Time	Source	Content	Translation
1931:32	PA	各位貴賓現在扣緊安全帶的警示燈已經熄滅了 但是為了要預防突然間不穩定的氣流所以請您在座位上將安全帶扣好 在機艙內請不要使用行動電話及相關電子用品 謝謝您的合作(以台語複述)ladies and gentlemen please fasten your seat belt whenever seated according to last CAA regulation may we remind you cell phone radio transmitter remote control for any other electronic devices must not be used please kindly switch it off thank you for your cooperation 各位貴賓在本段的航程中我們將提供您選擇的飲料有熱咖啡熱烏龍茶柳橙汁以及熱的蜂蜜菊花茶希望您對我們的服務感到滿意謝謝	(public address in Chinese, Taiwanese and English)
1931:34	KHH	（KHH 與 UNI829 間對話）	(communication between KHH and UNI829)
1931:37	UNI829	（KHH 與 UNI829 間對話）	(communication between KHH and UNI829)
1931:40	KHH	transasia five tree six climb and maintain flight level one niner zero	
1931:43	CM1	climb and maintain flight level one niner zero transasia five tree six	
1931:47	KHH	（KHH 與 AR55 間對話）	(communication between KHH and AR55)
1932:02	CAM	（不明聲響）	(unknown sound)
1932:13	CAM2	它在我們後面一點	It's just behind us
1933:12	CAM2	*	
1933:15	KHH	（KHH 與 UNI829 間對話）	(communication between KHH and UNI829)
1933:17	CAM1	*	
1933:19	CAM2	*	
1933:21	UNI829	（KHH 與 UNI829 間對話）	(communication between KHH and UNI829)
1933:24	KHH	（KHH 與 UNI829 間對話）	(communication between KHH and UNI829)

Time	Source	Content	Translation
1933:31	UNI829	（KHH 與 UNI829 間對話）	(communication between KHH and UNI829)
1933:33	CAM1	*	
1933:34	CAM2	*	
1933:36	CAM1	*	
1933:38	KHH	transasia five tree six contact taichung approach one two niner point six	
1933:42	CM1	嗯 taichung approach one two niner point six good day ma'am transasia five tree six	Uh taichung approach one two niner point six good day ma'am transasia five tree six
1933:48	KHH	（KHH 與 MDA280 間對話）	(communication between KHH and MDA829)
1933:49	CAM1	*	
1933:54	CAM2	*	
1933:59	CAM1	*	
1934:09	CM1	taichung approach good evening transasia five tree six climbing to flight level one niner zero	
1934:14	TCH	transasia five tree six taichung approach roger	
1934:18	CAM1	*	
1934:22	CAM2	*	
1934:23	CAM1	*	
1934:25	UNI615	（TCH 與 UNI615 間對話）	(communication between TCH and UNI615)
1934:30	TCH	（TCH 與 UNI615 間對話）	(communication between TCH and UNI615)
1934:33	UNI615	（TCH 與 UNI615 間對話）	(communication between TCH and UNI615)
1934:42	CAM2	*	
1934:59	CAM1	*	
1935:04	TCH	（TCH 與它機間對話）	(communication between TCH and an unknown aircraft)
1935:25	CAM2	*	
1935:29	CAM1	*	
1935:30	TCH	（TCH 與 UNI615 間對話）	(communication between TCH and UNI615)
1935:33	UNI615	（TCH 與 UNI615 間對話）	(communication between TCH and UNI615)
1935:46	CAM1	*	
1936:33	TCH	（TCH 與 UNI9631 間對話）	(communication between TCH and UNI615)
1936:50	CAM1	*	
1936:56	CAM2	*	
1936:58	CAM1	*	

Time	Source	Content	Translation
1937:18	CAM1	你先用那個天氣吧 我這個還收不到 喔 來了 那我來收	You use that weather report first I haven't received the ATIS yet uh it's coming I'll take it
1937:21	CAM2	…	
1937:21	ATIS	three thousand five hundred feet temperature two three QNH one zero zero eight hacto pascal low level wind shear advisory in effect moderate to sever ~mation zulu sungshan airport information zulu one one two eight zulu expect ILS approach runway one zero in use wind variable at three ~five hundred meter light rain cloud scatter ~ one thousand eight hundred feet overcast three thousand ~ temperature two three dew point two two QNH one zero zero eight hacto pascal wind shear on runway one zero low level wind shear advisory in effect moderate to severe inform taipei approach or sungshan tower~	
1937:26	CAM	（機械聲）	(mechanical sound)
1937:27	CAM1	you have radio please	
1937:27	TCH	transasia five tree six contact taipei control one two six point seven good day	
1937:32	CM2	five tree six good day	
1937:39	CM2	taipei control good evening transasia five tree six flight level one niner zero four nine dme to houlung identing	
1937:46	ACC	transasia five tree six taipei control roger	
1937:54	ACC	（ACC 與 CAL616 間對話）	(communication between ACC and CAL616)
1938:00	CAL616	（ACC 與 CAL616 間對話）	(communication between ACC and CAL616)
1938:06	ACC	（ACC 與 CAL616 間對話）	(communication between ACC and CAL616)
1938:25	ACC	（ACC 與 TNA374 間對話）	(communication between ACC and TNA374)

Time	Source	Content	Translation
1938:29	TNA374	（ACC 與 TNA374 間對話）	(communication between ACC and TNA374)
1938:31	CAM1	還是一樣 low level wind shear moderate turbulence	Still the same low level wind shear moderate turbulence
1938:37	CAM2	sir moderate turbulence	
1938:37	ACC	（ACC 與 CAL688 間對話）	(communication between ACC and CAL688)
1938:38	CAM	（機械聲）	(mechanical sound)
1938:41	CAL688	（ACC 與 CAL688 間對話）	(communication between ACC and CAL688)
1938:42	CAM1	I have radio sir	
1938:47	CAM1	現在台北 control 好	Now at taipei control okay
1938:49	CAM2	對	Right
1939:04	ACC	（ACC 與 CAL688 間對話）	(communication between ACC and CAL688)
1939:08	PA	晚安各位先生各位女士這是副機師報告 歡迎各位搭乘復興航空第五三六班次由台南飛往台北松山 我們現在飛行的高度是一萬九千英呎 Average 的地速大約每小時八百公里 目前松山天氣嗯多雲下雨地面氣溫二十三度 C 預計抵達的時間大約在晚間的八點鐘左右 感謝各位的搭乘 全體組員敬祝各位身體健康旅途愉快謝謝 good evening ladies and gentlemen this is the first officer speaking welcome board transasia airways flight number five thee six from tainan to sungshan and now we are flying at nineteen thousand feet average ground speed is about eight hundred kilometer per hour with forecast at sungshan is raining now ground temperature about twenty three degrees and estimate arrival at eight o’clock PM thanks for flying with us have nice trip thank you	(public address in Chinese and English)
1939:09	CAL688	（ACC 與 CAL688 間對話）	(communication between ACC and CAL688)

Time	Source	Content	Translation
1939:41	ACC	（ACC 與 CPA401 間對話）	(communication between ACC and CPA401)
1939:47	CPA401	（ACC 與 CPA401 間對話）	(communication between ACC and CPA401)
1940:03	ACC	transasia five tree six descend and maintain flight level one five zero descend now	
1940:08	CM1	descend to one five zero we are leaving transasia five tree six	
1940:17	CAM1	VS descend flight level one five zero	
1940:18	ACC	(communication between ACC and TNA374)	
1940:21	CAM2	sir cruise checklist complete…	
1940:26	CAM2	weather at sungshan wind shear VMC …approach speed... radio nav houlung zero five two anpu lima kilo oscar progress... MDA two six three... approach chart... ITSG... outer marker position two thousand… houlung one zulu after houlung via zero five two radial zonli four thousand cross zonli descend three thousand five hundred feet until tazan inbound course zero niner five go around procedure oscar lima uniform ...oscar lima uniform four thousand hold at lima uniform or radar vector... cleared for approach flight director autopilot autothrust decelerate approach one thousand stable in case go around I will call out ...	
1940:26	TNA374	(communication between ACC and TNA374)	
1940:31	ACC	(communication between ACC and CAL688)	
1940:36	CAL688	(communication between ACC and CAL688)	
1940:58	ACC	(communication between ACC and EVA228)	

Time	Source	Content	Translation
1941:03	EVA228	(communication between ACC and EVA228)	
1941:06	ACC	(communication between ACC and EVA228)	
1941:09	ACC	(communication between ACC and TNA374)	
1941:13	TNA374	(communication between ACC and TNA374)	
1941:22	CAL678	(communication between ACC and CAL678)	
1941:26	ACC	(communication between ACC and CAL678)	
1941:31	CAL678	(communication between ACC and CAL678)	
1941:37	ACC	(communication between ACC and MDA280)	
1941:39	PA	各位貴賓我們正經過不穩定的氣流請務必留在座位上扣好安全帶謝謝 (同時以國語、台語及客語複述) ladies and gentlemen we are now passing through turbulence please fasten your seat belt thank you	(public address in Chinese, Taiwanese, Hakka and English)
1941:41	MDA280	(communication between ACC and MDA280)	
1941:55	ACC	transasia five tree six contact taipei approach one one niner point seven	
1942:00	CM1	one niner point seven good night sir five tree six	
1942:04	ACC	Right	
1942:04	APP	(communication between APP and FEA082)	
1942:06	FEA082	(communication between APP and FEA082)	
1942:07	CAM1	you have control	
1942:09	CAM2	yes I have control	
1942:10	CAM1	VS descend to one five zero	
1942:11	CAM2	check	
1942:11	APP	(communication between APP and FEA137)	
1942:12	CAM1	我把速度減到…	I reduce the speed to…
1942:14	FEA137	(communication between APP and FEA137)	
1942:21	APP	(communication between APP and FEA137)	

Time	Source	Content	Translation
1942:24	FEA137	(communication between APP and FEA137)	
1942:29	CM1	taipei approach good evening transasia five tree six descend flight level one five zero	
1942:34	APP	transasia five tree six taipei approach ident taipei QNH one zero zero niner	
1942:39	CM1	one zero zero niner transasia five tree six	
1942:45	TNA535	(communication between APP and TNA535)	
1942:56	APP	(communication between APP and TNA535)	
1942:58	TNA535	(communication between APP and TNA535)	
1943:02	APP	(communication between APP and TNA535)	
1943:05	TNA535	(communication between APP and TNA535)	
1943:08	APP	(communication between APP and MDA747)	
1943:11	MDA747	(communication between APP and MDA747)	
1943:13	APP	(communication between APP and MDA747)	
1943:14	MDA732	(communication between APP and MDA732)	
1943:17	APP	(communication between APP and MDA732)	
1943:19	MDA732	(communication between APP and MDA732)	
1943:20	APP	(communication between APP and TNA242)	
1943:24	TNA242	(communication between APP and TNA242)	
1943:28	CM1	taipei approach transasia five tree six approaching flight level one five zero	
1943:32	APP	transasia five tree six descend and maintain five thousand	
1943:36	CM1	descend five thousand five tree six	
1943:39	APP	(communication between APP and TNA242)	
1943:42	CAM2	idle descend five thousand	

Time	Source	Content	Translation
1943:42	TNA242	(communication between APP and TNA242)	
1943:43	CAM1	check	
1943:44	APP	(communication between APP and TNA242)	
1943:48	TNA242	(communication between APP and TNA242)	
1943:52	APP	(communication between APP and TNA242)	
1943:53	APP	transasia five tree six proceeding ATR over putin speed two one zero	
1943:57	CM1	TCAS contact we are adjust our speed transasia five tree six	
1944:11	APP	(communication between APP and FEA082)	
1944:17	FEA082	(communication between APP and FEA082)	
1944:26	MDA280	(communication between APP and MDA280)	
1944:30	CAM2	idle descend	
1944:31	CAM1	check	
1944:31	APP	(communication between APP and MDA280)	
1944:38	MDA280	(communication between APP and MDA280)	
1944:42	CAM2	one zero zero niner…	
1944:43	APP	transasia five tree six cleared ILS runway one zero approach	
1944:46	CAM1	check	
1944:48	CAM2	教官 我們許可 ILS	Sir we are cleared for ILS
1944:51	CM1	cleared ILS runway one zero approach transasia five tree six	
1945:20	APP	(communication between APP and FEA082)	
1945:24	FEA082	(communication between APP and FEA082)	
1945:44	APP	(communication between APP and FEA137)	
1945:48	FEA137	(communication between APP and FEA137)	
1945:49	APP	(communication between APP and FEA137)	
1945:51	APP	(communication between APP and MDA280)	

Time	Source	Content	Translation
1945:54	MDA280	(communication between APP and MDA280)	
1945:57	APP	(communication between APP and MDA280)	
1946:03	PA	各位貴賓 我們已經開始航機的下降了 受到天氣的影響下降的氣流不穩定 請您務必扣好安全帶 靠椅扶正 面前的餐桌歸回原處 (同時以國語及台語複述) ladies and gentlemen we are now descending due to turbulence please fasten your seat belt kindly put your seat upright and lock your tray table in place thank you	(public address in Chinese, Taiwanese and English)
1946:03	MDA280	(communication between APP and MDA280)	
1946:09	APP	(communication between APP and MDA280)	
1946:13	MDA280	(communication between APP and MDA280)	
1946:14	CAM1	with ATR speed	
1946:14	APP	(communication between APP and MDA280)	
1946:17	MDA280	(communication between APP and MDA280)	
1946:25	CAM	(unknown sound)	
1946:25	CAM2	approach checklist please sir	
1946:26	CAM1	yes sir	
1946:28	APP	(communication between APP and FEA082)	
1946:28	CAM1	briefing	
1946:29	CAM2	confirmed	
1946:30	CAM1	status	
1946:31	CAM2	no status	
1946:33	CAM1	v bugs	
1946:34	CAM2	set	
1946:35	CAM1	seat belt	
1946:36	CAM2	on	
1946:36	CAM1	QNH MDA	
1946:37	FEA082	(communication between APP and FEA082)	
1946:38	CAM2	one zero zero niner MDA two six three	
1946:41	CAM1	TAD on ND	
1946:42	CAM2	…	

Time	Source	Content	Translation
1946:43	CAM1	engine mode select	
1946:44	CAM2	normal	
1946:45	CAM1	checklist completed	
1946:56	CAM1	*	
1947:37	CAM2	*	
1947:38	CAM1	*	
1947:39	APP	transasia five tree six say airspeed	
1947:42	CM1	speed two five zero	
1947:45	APP	roger	
1947:46	APP	(communication between APP and FEA082)	
1947:50	FEA082	(communication between APP and FEA082)	
1947:54	APP	(communication between APP and FEA082)	
1947:57	FEA082	(communication between APP and FEA082)	
1948:09	CAM1	*	
1948:19	FEA082	(communication between APP and FEA082)	
1948:20	CAM1	*	
1948:22	APP	(communication between APP and FEA082)	
1948:26	CAM	(unknown sound)	
1948:26	FEA082	(communication between APP and FEA082)	
1948:29	APP	(communication between APP and FEA082)	
1948:30	CAM1	*	
1948:57	APP	(communication between APP and MDA280)	
1949:01	MDA280	(communication between APP and MDA280)	
1949:10	FEA678	(communication between APP and FEA678)	
1949:18	CAM2	*	
1949:21	CAM1	*	
1949:23	APP	(communication between APP and FEA678)	
1949:26	FEA678	(communication between APP and FEA678)	
1949:36	CAM1	*	
1951:32	APP	(communication between APP and MDA280)	
1951:35	MDA280	(communication between APP and MDA280)	
1951:38	APP	(communication between	

Time	Source	Content	Translation
		APP and MDA280)	
1951:49	CAM	(unknown sound)	
1951:53	TNA242	(communication between APP and TNA242)	
1951:56	APP	(communication between APP and TNA242)	
1951:59	TNA242	(communication between APP and TNA242)	
1952:00	APP	(communication between APP and TNA242)	
1952:14	CAM2	zonli three thousand five	
1952:15	CAM1	check	
1952:16	CAM2	activate approach phase	
1952:21	CAM1	嗯奇怪你為什麼不再等一下呢 等 automatically activate approach phase	Uh why don't you keep waiting until it automatically activates approach phase
1952:28	CAM2	看他已經進去了 速度又減	Yeah the preceding traffic is established and the speed is reducing
1952:28	CAM1	對呀 你看你現在也到啦	See we reach the point (automatically activates approach phase)
1953:06	UNI830	(communication between APP and UNI830)	
1953:14	APP	(communication between APP and UNI830)	
1953:16	CAM2	heading	
1953:17	CAM1	check	
1953:18	CAM2	glide slope loc blue cat three dual	
1953:21	CAM1	check	
1953:21	CAM2	cat three dual autopilot one and two	
1953:22	CAM1	check	
1953:22	UNI830	(communication between APP and UNI830)	
1953:45	APP	(communication between APP and MDA280)	
1953:50	MDA280	(communication between APP and MDA280)	
1953:52	CAM2	flap one sir	
1953:53	CAM1	speed check flap one	
1954:50	CAM2	loc alive	
1954:51	CAM1	check	
1954:52	CAM2	loc star	
1954:53	CAM1	check	
1954:58	UNI93	(communication between APP and UNI93)	

Time	Source	Content	Translation
1955:04	CAM2	glide slope star four thousand set	
1955:05	APP	(communication between APP and UNI93)	
1955:05	CAM1	check	
1955:10	UNI93	(communication between APP and UNI93)	
1955:15	CM1	taipei approach transasia five tree six establish	
1955:23	CAM2	flap two	
1955:24	APP	transasia five tree six contact tower one one eight point one	
1955:27	CM1	contact tower good night mam five tree six	
1955:34	CM1	sungshan tower good evening transasia five tree six ILS approach and ten mile on final	
1955:40	TWR	good evening transasia five three six sungshan tower runway one zero wind zero one zero at four QNH one zero zero eight continue approach	
1955:49	CM1	one zero zero eight runway one zero continue approach five three six	
1955:56	CAM2	么洞洞八	One zero zero eight
1955:57	CAM1	check	
1955:59	CAM1	RA alive	
1956:00	CAM2	check	
1956:26	CAM	(unknown sound)	
1956:34	CAM	(mose code sound - outer marker signal)	
1956:38	CAM2	outer marker	
1956:39	CAM1	check two thousand	
1956:40	CAM2	gear down	
1956:41	CAM1	gear down	
1956:42	CAM	(sound similar to landing gears down)	
1956:47	PA	各位貴賓我們即將降落 請扣緊安全帶豎直椅背收回桌子謝謝 組員請就座 (同時以國語及台語複述) ladies and gentlemen we are about to land please fasten your seat belt kindly put your seat	(public address in Chinese, Taiwanese and English)

Time	Source	Content	Translation
		upright and lock your tray table in place thank you	
1957:05	CAM2	flap three	
1957:05	CAM1	three	
1957:09	CAM1	final set	
1957:11	CAM2	landing checklist	
1957:12	CAM1	before landing cabin crew	
1957:13	CAM2	advised	
1957:14	CAM1	auto thrust	
1957:15	CAM2	speed	
1957:15	CAM1	go around altitude	
1957:17	CAM2	four thousand set	
1957:17	CAM1	landing memo	
1957:18	CAM2	no blue	
1957:19	CAM1	correct runway	
1957:20	CAM2	runway one zero	
1957:21	CAM1	standby landing clearance	
1957:21	TWR	(communication between TWR and TNA242)	
1957:25	TNA242	(communication between TWR and TNA242)	
1957:28	TWR	(communication between TWR and TNA242)	
1957:30	TNA242	(communication between TWR and TNA242)	
1958:03	CAM2	one thousand	
1958:03	CAM1	stable	
1958:11	---	…	
1958:12	TWR	transasia five tree six the wind calm cleared to land	
1958:15	CM1	wind calm cleared to land five tree six	
1958:18	CAM2	wind calm cleared to land	
1958:19	CAM1	yah	
1958:51	CAM	four hundred (altitude alert)	
1958:51	MDA280	(communication between TWR and MDA280)	
1958:53	CAM1	hundred above minimum	
1958:55	TWR	(communication between TWR and MDA280)	
1958:56	CAM2	land green	
1958:58	CAM1	check	
1959:01	MDA280	(communication between TWR and MDA280)	
1959:02	CAM	three hundred (altitude alert)	
1959:02	CAM2	insight landing	
1959:03	CAM1	cleared to land	
1959:04	CAM	cricket cricket cricket (sound	

Time	Source	Content	Translation
		of autopilot disengaged)	
1959:05	CAM	(morse code sound - middle marker signal)	
1959:05	UNI831	(communication between TWR and UNI831)	
1959:06	CAM	two hundred (altitude alert)	
1959:08	TWR	(communication between TWR and UNI831)	
1959:10	UNI831	(communication between TWR and UNI831)	
1959:15	CAM	one hundred (altitude alert)	
1959:21	CAM	fifty (altitude alert)	
1959:23	CAM	twenty (altitude alert)	
1959:23	CAM	retard retard	
1959:26	CAM	(sound similar to landing gears touching down)	
1959:26	CAM	retard	
1959:27	CAM	(mechanical sound)	
1959:28	CAM	retard	
1959:29	CAM1	spoiler one reverse green and	
1959:37	CAM1	沒有煞車喔	No brake
1959:37	TWR	(communication between TWR and UNI831)	
1959:39	CAM1	沒有煞車喔	No brake
1959:40	UNI831	(communication between TWR and UNI831)	
1959:43	TWR	(communication between TWR and UNI831)	
1959:44	CAM1	沒有煞車	No brake
1959:46	CAM1	沒有煞車喔	No brake
1959:47	UNI831	(communication between TWR and UNI831)	
1959:50	CAM1	完全沒有煞車	No brake at all
1959:50	TWR	(communication between TWR and UNI831)	
1959:53	CAM1	煞車	Brake
1959:54	CAM2	怎麼回事兒教官	What's going on sir
1959:55	CAM1	我不知道	I have no idea
1959:57	CAM1	哇噻	Wow
1959:57	CAM	(sound similar to impact)	
1959:58	CAM	(sound similar to impact)	
1959:59	CAM	chime (single chime)	
2000:01	CAM2	嗯	Uh
2000:03	CAM1	哇噻	Wow
2000:03	CAM	(sound similar to impact)	

Time	Source	Content	Translation
2000:04	CAM1	哇噻	Wow
2000:05	CAM	(sound similar to impact)	
2000:06	TWR	transasia five three six ground	
2000:08	CM1	我們沒有煞失效煞車	We have no brake brake failed
2000:10	CAM	(sound similar to impact)	
2000:11	CAM	(sound similar to impact)	
2000:15	CAM	(sound similar to impact)	
2000:15	TWR	教官請問你們出跑道了嗎	Sir are you off the runway
2000:17	CAM	chime (single chime)	
2000:18	CM1	我們需要地面支援	We need ground support
2000:19	TWR	roger	
2000:20	CAM	chime (single chime)	
2000:21	CM1	attention crew at station attention crew at station	
2000:22	CAM	chime (single chime)	
2000:24	CM1	attention crew at station	
2000:31	CAM1	唉	Sigh
2000:34	CAM	(mechanical sound)	
2000:34	MDA280	(communication between TWR and MDA280)	
2000:36	PA	組員請就位	Crew at station
2000:37	CAM	(mechanical sound)	
2000:37	CAM	chime (single chime)	
2000:38	TWR	(communication between TWR and MDA280)	
2000:40	CAM2	關車嗎	Shall we shutdown
2000:41	CAM1	關車	Shutdown
2000:42	CAM	(sound of switch)	
2000:43	CAM	(sound of switch)	
2000:46	MDA280	(communication between TWR and MDA280)	
2000:48		(recording stopped)	
2002:15[22]		(recording restarted)	
2002:15	CM1	需要這個在目前的地點疏散旅客	We need to evacuate passengers right here
2002:20	TWR	復興五三六 roger 我們會請相關人員支援	Transasia five three six roger we will send the ground support
2002:20	PA	各位貴賓我們現在已經看過外界的狀況 目前我們是在跑道頭這邊停下來了 很抱歉造	Ladies and gentlemen we have checked the situation outside we stopped at the

[22] Time reference of restarting recording is according to the ATC time.

Time	Source	Content	Translation
		成各位讓各位受驚 那麼外界目前的狀況看嗯是 看起來目前看起來是安全正常的 那麼各位先保持在您的座位上 我們機長已經在跟相關單位做一個聯絡~	end of the runway sorry for the frightening the situation seems safe and normal so far please stay on your seat our captain is contacting with related agencies right now~
2002:41	TWR	(communication between TWR and TNA280)	
2002:42		(recording ended)	

Appendix 2 B-22310 Flight Parameters List

A/C:A320/200 Engine: IAE V2527-A5

FDIU SAGEM P/N ED43A1D5 ARINCE 573/717 128 Word/s

	Ident	Bus	Label/SDI	Description
1	A01a01	Clock	260/00	Day of Date
2	A02a01	FWC	126/01	Flight Phase
3	A03a01	DMC	233/01	Flight Number
4	A05a01	DMC	230/01	Data Base Update
5	A06a01	DMC	075/01	Gross Weight
6	A07a01			Fleet Identification
7	A07c01			A/C Type
8	A07d01			A/C Tail Number
9	A07f01			Result Parameter Check
10	A07g01			FDIU BITE
11	A08a01	DMC	046/01	Engine 1 Ident
12	A08a02	DMC	046/01	Engine 2 Ident
13	M01a01	Clock	125/00	UTC Hours
14	M01a04	Clock	150/00	Clock Synchronized by GPS
15	M01b01			Frame Counter
16	M02a01	DMC	203/XX	Altitude standard fine
17	M02a02	DMC	203/XX	Altitude standard coarse
18	M03a01	DMC	206/XX	Indicated Airspeed
19	M04a01	DMC	320/XX	True Heading
20	M04b02	FWC	126/10	Warning HDG Discrepancy
21	M05a01	SDAC	333/01	normal acceleration
22	M06a01	DMC	324/01	Pitch attitude
23	M06a02	FWC	124/01	Warning Pitch discrepancy
24	M07a01	DMC	325/XX	Rall attitude
25	M07a02	FWC	124/01	Warning Roll discrepancy
26	M08a01	SDAC	002/01	VHF Keying
27	M08a02	SDAC	002/01	HF Keying
28	M09a01	DMC	346/01	N1/EPR Actual Eng 1
29	M09a02	DMC	346/10	N1/EPR Actual Eng 2
30	M09tl01	DMC	133/01	Throttle Lever Angel Eng 1
31	M10a01	FWC	137/00	Flaps Position
32	M11a01	FWC	127/00	Slats Position
33	M11tl01	SDAC	046/01	Lever Position (Matrix 1)
34	M12a01	DMC	270/01	Reverser Unlock Eng 1
35	M12a02	DMC	270/01	Reverser Unlock Eng 2
36	M12a05	DMC	270/01	Rev Deployed Eng 1
37	M12a06	DMC	270/01	Rev Deployed Eng 2
38	M13a03	FCDC	043/01	Left Spoiler 1 Out
39	M13a04	FCDC	043/01	Right Spoiler 1 Out
40	M14a01	DMC	211/XX	True Air Temperature (TAT)
41	M15a01	DMC	276/01	A/P 1 Engaged
42	M15a02	DMC	276/01	A/P 2 Engaged
43	M15a09	DMC	271/01	ATS Thrust N1 Mode
44	M15a0l	DMC	271/01	ATS Speed Mach Mode Activated
45	M15a10	DMC	271/01	Thrust EPR Mode
46	M15a35	DMC	301/01	H/Path submode NAV engaged

	Ident	Bus	Label/SDI	Description
47	M15a36	DMC	301/01	HDG submode NAV engaged
48	M15a38	DMC	301/01	VOR submode NAV engaged
49	M15a39	DMC	301/01	Loc submode Runway engaged
50	M15a3l	DMC	301/01	Track submode NAV engaged
51	M15a40	DMC	301/01	Track submode Runway engaged
52	M15a41	DMC	300/01	Roll out submode LAND TRACK engaged
53	M15a42	DMC	300/01	Align submode LAND TRACK engaged
54	M15a43	DMC 3	02/01	Altitude Capture Mode
55	M15a44	DMC 3	02/01	Altitude Track Mode
56	M 18a0	FCDC	314/0	Left Elevator Position
57	M 19a0	FCDC	315/01	Stabilizer Position
58	M15a45	DMC	302/01	G/S Track Mode
59	M15a46	DMC	302/01	G/S Capture Mode
60	M15a48	DMC	302/01	Expedite Climb Mode
61	M15a49	DMC	302/01	Immediate Climb Mode
62	M15a4l	DMC	302/01	Open Climb Mode
63	M15a50	DMC	302/01	Open Descent Mode
64	M15a51	DMC	302/01	Expedite Descent Mode
65	M15a52	DMC	302 /01	Immediate Mode
66	M16a01	SDAC	331/01	Longitudinall Acceleration
67	M17a01	SDAC	332/01	Lateral Acceleration
68	M18a02	FCDC	334/01	Left Elevator Position
69	M18a05	FCDC	041/01	Right Elevator Position
70	M18c01	SDAC	312/00	Rudder Position
71	M18c02	FWC	126/00	Yaw Damper 1 fault
72	M18c03	FWC	126/00	Yaw Damper 2 fault
73	M18c04	FCDC	304/01	Rudder pedal Position
74	M18c05	FWC	313/01	Rudder trim Position
75	M18tl03	FCDC	310/01	Left Aileron Position
76	M18tl04	FCDC	330/01	Right Aileron Position
77	M18tl20	FCDC	363/01	Left Spoiler 3 Position
78	M18tl21	FCDC	374/01	Right Spoiler 4 Position
79	M20a01	DMC	164/01	Radio Altitude 1
80	M21a01	DMC	174/01	Glide Slope Deviation 1
81	M22a01	DMC	173/01	Localizer Deviation 1
82	M23a01	DMC	274/01	Marker Beacon Passage
83	M24a02	FWC	126/00	APU Fire
84	M24a03	FWC	126/00	Engine 1 Fire
85	M24a04	FWC	126/00	Engine 2 Fire
86	M24a05	FWC	126/00	Cabin Press Warning
87	M24a06	FWC	126/00	Avionic Smoke Warning
88	M24a18	FWC	126/00	Red Warning
89	M24a19	FWC	126/10	A/P oft Warning
90	M24a20	FWC	126 /11	Sidestick not in T.O. configuration
91	M24a21	FWC	126/11	L+R elevator fault
92	M24a22	FWC	126/11	Gear not downlocked
93	M24a23	SDA	002/00	Parking brake oft
94	M24a24	FCDC	044/01	Left sidestick fault
95	M24a25	FCDC	044/01	Right sidestick fault
96	M28a01	FWC	016/01	GPWS Warning
97	M28tl01	DMC	307/01	Capt EGPWS valid

	Ident	Bus	Label/SDI	Description
98	M28tl02	DMC	307/10	F/O EGPWS valid
99	M28tl03	DMC	307/01	Capt WXR valid
100	M28tl04	DMC	307/10	F/O WXR valid
101	M28tl05	DMC	307/01	Capt EGPWS installed
102	M28tl06	DMC	307/10	F/O EGPWS installed
103	M28tlol	SDAC	002/00	EGPWS TERR ON ND switch
104	M29a01	DMC	221/XX	Angle of Attack LH
105	M2la03	FWC	021/01	LDG Squat Switch LH
106	M30a01	FWC	126/00	Hyd Low Press Yellow
107	M30a02	FWC	126/00	Hyd Low Press Green
108	M30a03	FWC	126/00	Hyd Low Press Blue
109	M31a01	DMC	312/XX	Ground Speed
110	M32b01	FWC	022/01	Gear Up locked
111	M32b02	FWC	020/01	Gear down locked
112	R01d01	DMC	310/DD	Present Pos Latitude Fine
113	R01d02	DMC	310/DD	Present Pos Latitude Coarse
114	R01d03	DMC	311/DD	Present Pos Long Fine
115	R01d04	DMC	311/DD	Present Pos Long Coarse
116	R01e01	DMC	307/01	GPS Primary Capt
117	R01e02	DMC	307/10	GPS Primary F/O
118	R02a02	BSCU	331/01	Left brake pedal angle
119	R02b06	SDAC	026/01	Alternate braking
120	R02b08	SDAC	002/00	Antiskid Selector ON
121	R02b09	FWC	126/11	Normal brake fault
122	R02bOl	FWC	126/11	Antiskid fault
123	R02c01	BSCU	300/01	Normal brake pressure 1
124	R02c02	BSCU	301/01	Normal brake pressure 2
125	R02c03	BSCU	302/01	Normal brake pressure 3
126	R02c04	BSCU	303/01	Normal brake pressure 4
127	R02c05	BSCU	304/01	Normal brake pressure 5
128	R02c06	BSCU	305/01	Normal brake pressure 6
129	R02c08	BSCU	307/01	Normal brake pressure 8
130	R02cOl	BSCU	306/01	Normal brake pressure l
131	R03b01	DMC	345/01	EGT Eng 1 (1 495)
132	R03c01	DMC	244/01	Fuel flow Eng 1
133	R05b01	DMC	350/01	Pred W/S internal failure
134	R05b02	DMC	350/01	Pred W/S external failure
135	R05b03	DMC	350/01	Pred W/S alert/terrain Caution Capt
136	R05b04	DMC	350/10	Pred W/S alert/terrain Caution F/O
137	R05b05	DMC	350/01	Pred W/S warning/terrain warning Capt
138	R05b05	DMC	350/01	Pred W/S warning/terrain warning Capt
139	R05b06	DMC	350/10	Pred W/S warning/terrain warning F/O
140	R05b08	DMC	350/01	Pred W/S oft
141	R05bOl	FWC	16/00	Pred W/S pinprog
142	R06a04	DMC	276/10	Altitude STDQHNQFE F/O
143	R09b05	DMC	271/01	Mach Selection
144	R12c01	DMC	276/01	Heading0rack Selection
145	R14a34	DMC	307/01	Radar/EGPWS operating Mode Capt
146	R14a35	DMC	307/01	Radar/EGPWS operating Mode F/O
147	R15a19	DMC	275/01	System page origin
148	R17a02	SDAC	002/01	AC 1 bus ON

	Ident	Bus	Label/SDI	Description
149	R17a03	SDAC	002/00	AC ess bus ON
150	R18a03	SDAC	004/11	DC ess bus ON
151	R19a05	SDAC	067/01	Eng 1 HPV not fully closed
152	R19a06	SDAC	066/01	Eng 2 HPV not fully closed
153	R19a08	SDAC	066/01	Eng 2 PRV not fully closed
154	R19a11	SDAC	055/01	Cross Feed Valve Eng 1l2 not fully closed
155	R19a12	SDAC	003/01	Pack 1 flow control valve not fully closed
156	R19a13	SDAC	003/10	Pack 2 flow control valve not fully closed
157	R19a14	SDAC	003/01	Eng 1 anti ice P/B On
158	R19a15	SDAC	003/10	Eng 2 anti ice P/B On
159	R19a16	SDAC	003/11	wing anti ice P/B off
160	R19a18	SDAC	001/00	Eng 2 AntiIce valve not fault
161	R19al7	SDAC	001/11	Eng 1 AntiIce valve not fault
162	R19aOl	SDAC	067/01	Eng 1 PRV not fully closed
163	R21b01	FWC	126/00	Slats Fault
164	R21b02	FWC	126/00	Flaps Fault
165	ROlb02			Constraint Altitude (SSM)
166	R21c01	FWC	126/11	Engine 1 FADEC fault
167	R21c02	FWC	126/11	Engine 2 FADEC fault
168	R21d01	SDAC	006/01	GPWS terrain det. Fault
169	R28d01	DMC	033/01	ILS1 Frequency I MMR 1 frequency I channel modes(coarse)
170	R28d02	DMC	033/01	ILS1 Frequency I MMR 1 frequency I channel modes (fine)
171	R28d03	DMC	033/01	MMR 1 modes
172	R28d04	DMC	033/10	ILS2 Frequency I MMR 2 frequency I channel modes(coarse)
173	R28d05	DMC	033/10	ILS2 Frequency I MMR 2 frequency I channel modes (fine)
174	R28d06	DMC	033/10	MMR 2 modes
175	R28e01	DMC	032/01	ADF 1 Frequency 100khz, 10khz, 1khz
176	R28e02	DMC	032/01	ADF 1 Frequency 1000khz, 0.5khz
177	R28e03	DMC	032/10	ADF 2 Frequency 100khz, 10khz, 1khz
178	R28e04	DMC	032/10	ADF 2 Frequency 1000khz, 0.5khz
179	R30a01			Event Marker

Appendix 3 AIRBUS Ground Spoilers Test Procedure

Subject: TNATPE/60/05 TNA A320 MSN 791 Runway Excursion - Ground Spoiler Extension Procedure

Please find following a Ground Spoiler Extension procedure, as requested by the ASC, which has been verified on a production aircraft here in Toulouse.

This procedure requires the use of a Main Landing Gear Wheel Tachometer Driving Tool part number 355M03190000.

Procedure:

1) Aircraft configuration:

> > 1.1 Energize the aircraft electrical circuits.

> > 1.2 Do the IR alignment procedure.

> > 1.3 On the panel 23 VU verify that the SEC1 SEC3, ELAC1 P/B are engaged.

> > 1.4 On the panel 24VU verify that the SEC2, ELAC 2 P/B are engaged.

> >

> > 2) Test :

> > 2.1 Install the MLG WHEEL TACHYMETER DRIVING TOOL (355M03190000) on the wheel 1 and wheel 4

> > 2.2 Pressurize the 3 hydraulic systems (elec. pump and power transfer unit)

> > 2.3 on the cockpit put the throttle control levers to the idle position and pre-select the speed brake control lever

> > 2.4 on the driving tool set a wheel speed around 1000 rpm and verify that the spoilers 1, 2 and 5 are extended;

> > 2.5 in case of problem perform a ground scanning and record the maintenance message

> > 2.6 on the cockpit put the throttle control levers to climb position and verify that the spoilers 1,2 and 5 reach the neutral position.

> > 2.7 depressurize the 3 hydraulic systems.

> > 2.8 remove the MLG WHEEL TACHYMETER DRIVING TOOL to the

wheels 1 and 4 and install it on the wheels 2 and 3

> > 2.9 repeat the test cited in ?2.2 to ?2.6 the spoilers 3 and 4 must move.

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