DATA SUMMARY

LOCATION

Date and time	**Thursday, 17 June 2004; 18:40 UTC[1]**
Site	**Valencia Airport**

AIRCRAFT

Registration	**EC-GXE**
Type and model	**FAIRCHILD SA227-AC, Swearingen METRO III**
Operator	**Swiftair**

Engines

Type and model	**GARRETT TPE331-11U-612G**
Number	**2**

CREW

	Pilot in command	Co-pilot
Age	**31 years old**	**33 years old**
Licence	**CPL(A)**	**CPL(A)**
Total flight hours	**3,664 h**	**800 h**
Flight hours on the type	**1,956 h**	**70 h**

INJURIES

INJURIES	Fatal	Serious	Minor/None
Crew			**2**
Passengers			
Third persons			

DAMAGE

Aircraft	**Minor damage to tyres and to a left propeller blade**
Third parties	**None**

FLIGHT DATA

Operation	**Commercial air transport – Non-scheduled domestic cargo**
Phase of flight	**Take-off run, before V1**

REPORT

Date of approval	**27 February 2008**

[1] All the times used in this report are UTC times. It is necessary to add two hours to get local time.

1. FACTUAL INFORMATION

1.1. History of the flight

Swiftair, flight number SWT-7025, a Metro Swearingen SA227-AC, was ready to initiate its takeoff run from Valencia airport to proceed to Madrid, on the evening of June 17th 2004, at 18:40 h UTC. It was in fact a cargo flight. On board the aircraft there were two crew members. The copilot, seated at the RH seat, was the pilot flying.

VMC conditions were prevailing and a light tail wind was blowing on runway 30. For this flight an IFR flight plan was filed.

The airplane entered the runway 30 threshold where it held its position for several minutes, advised by ATC. Previous traffic in the takeoff sequence was a B-757. A few minutes later, after being cleared by TWR-ATC, the airplane began its takeoff run under wet takeoff power, (making use of water/methanol injection). Half-way through its takeoff run, when reaching about 85 kt airspeed and after releasing the Nose Wheel Steering (NWS) button on the left side of the No 1 (i.e. left) power lever, the airplane started to veer to the right of the runway centre line. The captain took over the controls and initiated a rejected take-off procedure but he could not prevent the aircraft from exiting the runway at its right edge. The airplane ran approximately 350 m over flat terrain and at last, turned and skidded out of control until it came to a stop 1,000 m from the brake release point and 75 m from the runway centre line. The airplane's final magnetic heading was approximately 050°. The turning of the airplane occurred at low speed, according to a maintenance report, when a main landing gear got trapped in a ground hole.

After stopping the engines the crew checked to confirm that there was no fire and that the aircraft systems were shut down. They vacated the plane when the fire brigade and rescue personnel had already arrived.

The tyres did not come off. Both propellers were feathered.

1.2. Damage to aircraft

After the incident the only damage found was one of the left propeller blade tip bent and three wheels under-inflated, one on each landing gear. Also a fuel leak was detected in the left engine nacelle area.

1.3. Other damage

No other damage was noticed.

1.4. Personnel information

1.4.1. *Captain*

Age:	31 years old
Nationality:	Spanish
License:	CPL(A)
Latest license renewal:	21-01-2004
Total flight time:	3,664 h
Flight time on the type:	1,956 h
Current ratings:	Type rating in SA226/227(Metro), Multi-engine and Metro instructor

His latest duty period ended with a flight from Barcelona to Ibiza - where he arrived on June 16th at 03:26 UTC, as a third crew member in line training. From there he flew to Madrid where he enjoyed more than 24 hours of rest time. The next day, a new duty time was initiated when he flew from Madrid to Valencia in order to take command of the incident flight.

During the previous year he completed training courses on CRM, Rescue and Emergencies. His latest line check was flown on March, 2nd, 2004.

He had been fleet chief for three years.

1.4.2. *Copilot*

Age:	33 years old
Nationality:	Spanish
License:	CPL(A)
Date of first license issuance:	26-04-1993
Total flight time:	800 h
Flight time on the type:	70 h
Current ratings:	Type rating in Cessna SET, SA226/227(Metro) and IR(A)

His latest duty period had lasted 12:05 h with 04:00 flight time and a partial resting time in Madrid of 8:30 h.

Before he initiated the flight he had a resting period of 11:55 h at his Valencia base.

During the previous year he completed training courses on CRM, Rescue and Emergencies. His latest line check was flown on May, 12th 2004.

1.5. Aircraft information

SA227 Metro III is a pressurised twin turboprop aeroplane certified for public transport of passengers and cargo with accommodation for 19 passengers.

The type certificate holder is the company M7 Aerospace LP (Texas, USA).

1.5.1. *Aircraft*

Manufacturer:	Fairchild Swearingen Metro III
Model:	SA227-AC
Serial Number:	AC-694, year of production 1987
Registration Number:	EC-GXE
MTOW:	14,500 lb
Operator:	Swiftair
Airworthiness certificate:	No. 4398
Validity and expiry dates of airworthiness certificate:	From 3-02-2004 to 30-10-2004
Aircraft total time:	22,285 h

1.5.2. *Dimensions, Weight and Balance*

The Weight and Balance Sheet used for dispatch of flight SWT-7025 declared an actual TOW of 14,446 lb and a centre of gravity station 266.86, both of them within the limits established on the AFM (Aircraft Flight Manual).

1.5.3. *Landing Gear*

The landing gear is of a conventional tricycle configuration, with a nose landing gear strut equipped with a NWS (nose wheel steering system).

Main landing gear wheels have disk brakes.

1.5.4. *NWS system description*

The aircraft features a variable authority nose wheel steering system. Since this system is not included on the minimum equipment list, directional control while taxiing, taking off and landing when the NWS system is inoperative is achieved through differential braking of the main gear wheels and differential thrust.

The initial design of the NWS system has been modified through various Service Bulletins. A brief list of the relevant documents is provided below:

S.B. 227-32-006	Issued to increase NWS system reliability and provide a warning system to alert the pilot of failure while in caster mode. It incorporates a pressure switch.
S.B. 227-32-030	Issued to increase NWS system reliability. Improves the design of the NWS amplifier, replaces the pressure switch with a normally-open hydraulic valve vented to the return (relief valve), and changes out the potentiometer assemblies.
A.D. 93-08-09	Forbids the use of NWS during takeoffs and landings on post-S.B. 227-32-30 modified aircraft.
S.B. 227-32-034R	Issued to improve the NWS system. This bulletin rescinds the restrictions imposed by A.D. 93-08-09. Replaces the servo valve on the actuating assembly.
S.B. 227-32-040	Adds a new pushbutton on the RH power lever to provide independent control of the NWS to the pilot and copilot.

According to information supplied by the operator, S.B. 227-32-006 had been installed on the aircraft, but neither S.B. 227-32-030 nor S.B. 227-32-40 were installed.

What follows is a brief overview of the NWS system outfitted on the aircraft after being modified by SB 227-32-006 and prior to SB 227-32-030, SB 227-32-034R and SB 227-32-040.

Description of the NWS

The system features two hydraulic actuators that twist the inner cylinder on the nose strut through a rack and pinion mechanism. The system is electronically controlled and hydraulically actuated via servo valves. The cockpit controls include a control panel on the left console with ARM (arming) and TEST switches and a Park button.

The system normally provides the ability to steer the nose gear through ± 10°, its use during takeoff and landing being authorized.

Actuating the Park button increases the deflection to ± 63°. This feature is used during taxiing and ground movements.

Within reach of the crew, on the left side of the power lever, there is a “Power lever” pushbutton, which is easier for the pilot in the LH seat to access since it is designed to be actuated with the right thumb. This pushbutton activates the NWS system when the selector on the control panel is set to ARM. Inside the pedestal, out of the pilots’ reach, there is a microswitch that closes the circuit, in parallel with the button on the power lever, when the speed lever is in the LOW, or bottom, position.

When the NWS system is activated, with the system armed and the button on the power level depressed or the speed lever in LOW, the nose wheel is steered by means of the rudder pedals. A set of potentiometers mounted on the pedal hinges and on the top of the nose strut send electrical signals to an amplifier, or control box. Fault detection capability is provided by mounting two sets of potentiometers on two separate control and monitoring channels. The amplifier compares the control signal (pedal) with the slave signal (nose wheel) and sends driving signals to the hydraulic servo valve which powers the actuators in response to the commanded position. If, however, the system detects a fault or a mismatch of the electrical signals equivalent to 3° or more of deflection between the control and monitoring channels, then the system disengages.

The sole NWS hydraulic assembly incorporates actuators and hydraulic servos and is located on top of the nose strut and includes the actuating solenoids. The amplifier, or electrical control box, is mounted in the console to the left of the LH (chief pilot) seat. A power control relay located next to the circuit breaker panel actuates the solenoids on the servos when:

1.° The system is armed,
2.° Either the power lever pushbutton or the speed lever microswitch is actuated, and
3.° The landing gear is deployed. (See the NWS electrical diagram in Appendix B-4).

The NWS system includes a set of warning lights. A green one, located in the annunciator panel and labelled NWS, indicates when lit that the system is armed and that steering control is available. A second, amber, light, labelled NWS FAIL, flashes when the amplifier’s fault detection circuitry senses a malfunction.

Components of the NWS system hydraulic assembly (see diagram Appendix B-1)

The NWS hydraulic assembly, in addition to hydraulic liquid filters, restrictors and actuators, three main valves and two electromagnetically-actuated variable restrictors, includes:

- An arming valve for providing hydraulic pressure to the system or connecting the system to the hydraulic return header. It is electrically actuated.

- A mode selector valve with two positions: steering mode, in which hydraulic system pressure is directed to the actuators controlling the nose wheel; and caster mode, in which the hydraulic liquid is isolated from the hydraulic system but allowed to flow between actuators, which serves to dampen shimmy. In caster mode, the NWS system is deactivated and the nose wheel is self-aligning, and thus not controlled from the cockpit (see detail in Appendix B-2).
- variable servo valve with three positions: 1 - stops the flow of hydraulic fluid to the actuators (used when locking the wheels); 2 - turns the wheels left by exposing the liquid in the left actuator to supply header pressure, and the liquid in the right actuator to return header pressure; or, 3 - vice versa to turn the wheels right (see positions in figure, Appendix B-3). The different positions are obtained by opening or closing the variable restrictors.
- LH and RH variable restrictors, electrically actuated by the amplifier via the power control relay.
- A normally-open, electrically-actuated relief valve. It vents hydraulic system pressure when the NWS system is deactivated.
- A pressure micro switch, which switches on a light in the cockpit whenever hydraulic pressure is detected in the actuator.

1.5.5. *Propellers*

The aircraft is equipped with two constant-speed McCauley propellers measuring 2.69 m in diameter, with four variable-pitch blades with full feathering capability.

To facilitate engine start-up, the blade pitch control system features centrifugal mechanical locks which establish a negligible pitch angle so as to minimize aerodynamic drag when the propeller is turning.

1.5.6. *AWI - Alcohol-Water Injection*

An injection system of a mixture of water and methanol into the engines' combustion chambers is used in order to lower the turbines inlet gas flow temperature and to provide an increase in takeoff power. It is used on takeoff when weather and operational conditions require it.

Takeoff torque can reach 110% when water methanol injection is employed.

1.5.7. *Airplane flight Manual procedures*

The limits section in the AFM, on page 1-15, forbids using NWS when the arming valve fails its test or when there has been a fault in the hydraulic system.

The AFM section on normal procedures allows for operating the NWS system while carrying out the following procedures:

- Before taxi checklist. Step 8 arms the NWS system via the ARM switch.
- Taxi checklist. Step 4 performs a functional check of the NWS system by referencing the system checklist, which involves a series of steps that include placing the TEST switch in its different positions (L, R and OFF), actuating the pedals in both directions (left and right), moving the right speed lever and depressing the NWS activation pushbutton. With each step, proper operation of the warning lights is checked.
- Takeoff checklist. Step 7, after the brakes are released, states:

NWS Power lever Button AS DESIRED

The emergency procedures section of the AFM addresses two NWS system failure modes, namely, an electrical or hydraulic malfunction.

- In the event of electrical malfunction, as evidenced by a flashing green NWS light, by an undesired steering deflection, and/or by a lit parking light when the park button has not been pushed, the following actions are to be performed:

  1. release the 'NWS Power lever Button',
  2. push the right speed lever approximately 1/2 an inch above the LOW position
  3. use the rudder, brakes and/or throttle to steer
  4. disarm the system by placing the switch in OFF, and
  5. open the circuit breaker.

- In the event of hydraulic failure, as evidenced by the amber NWS FAIL light illuminating, press and hold the NWS Power Lever Button.

1.6. Meteorological information

The Valencia METAR report at 16:30 UTC advised of a 9 kt and 120° Wind. Visibility was over 10 km, there were few clouds at 4,000 ft, the temperature was 28 °C and pressure was standard.

Just before takeoff TWR reported to the Swiftair flight, a wind of 5 kt and 50°.

1.7. Communications

Radio contact was maintained between the airplane and TWR; a transcription of the communications that were held has been received and from it the following information is highlighted:

- At 18:41 the crew informed that they were ready to taxi out.
- At 18:46:57 the crew, after having changed the ground frequency, contacted TWR for the first time informing they were at the runway 30 holding point and ready.
- At 18:47:28 the airplane was cleared to enter the runway and hold position; one minute later it was cleared for takeoff. TWR informed the airplane that previous traffic was a B-757 in order to alert it of a possible wake turbulence.
- At 18:49:45 some communications between TWR-VLC and TRAFFIC shows that they had directly observed the Swiftair airplane going off the runway.
- The airplane transmission at 18:50:06 confirmed that it had rejected the takeoff and that its position was off the runway.
- After checking that the runway was unobstructed and that the distance from the runway edge to the airplane was over the minimum required, airport authority returned the runway into service at 19:07 approximately.

1.8. Aerodrome information

Valencia airport, at 225 ft of elevation, has a runway named 12-30. It is 2,700 m long by 45 m wide, within a strip of 2,920 × 300 m.

Another runway, 04-22, crosses the main runway west of the airport buildings.

In APENDIX A, an airport chart for ground movements is shown. In this chart the cargo apron, holding point H1 for runway 30 and the supposed trajectory of the airplane are depicted.

1.9. Flight recorders

1.9.1. *Flight Data Recorder*

The airplane was equipped with a flight data recorder (FDR), which was only able to record data of: pressure altitude, IAS, magnetic heading, vertical acceleration and discrete data as VHF communications. Parameters were recorded every second, although vertical acceleration was recorded twice per second during this interval.

The time span of the recording was 7 minutes and 46 seconds, encompassing the airplane's operation from the moment it exited the apron.

Altitude data was 565 ft throughout the recording.

IAS data was 85 kt during most of the recording; only in the final seconds it rose to 119.6 kt, then receding to 111.2 kt.

The magnetic heading showed values of about 150°, corresponding to the airplane's movement across the taxi ways. At the last minute the airplane's entered the runway and aligned with headings of 300°. In the final seconds the magnetic heading rose to 309.3° and in the last one it registered a value of 106.2°.

Vertical acceleration reached values of 3.56 and 3.88 g's but it has to be pointed out that many spurious values of 2.28 g's were recorded at times when the airplane was not running. Other parameters showed spurious data as well.

There were also recordings of 8 actuations of VHF equipment that can be precisely correlated to transmissions between TWR and the Swiftair plane, according to the transcription handed by ATC.

From brake release to the final stop 52 seconds elapsed.

APPENDIX C features a table with FDR parameter data, with comments added regarding the operation at each moment.

1.9.2. *Cockpit Voice Recorder CVR*

The airplane had a CVR, but, eight days later, when the incident was reported, the recorded information had not been preserved.

1.10. Tests and research

1.10.1. *Checks and line maintenance reports*

In the days after the incident took place a thorough inspection of the aircraft was made and the following results were recorded:

- No structural damage was found
- The right-hand tyre in the nose gear and three other tyres on the main gears were abnormally worn. All the wheels in the aircraft were replaced to return it into service.
- The wheel brakes were in good condition and only a clean up of the assemblies needed to be performed.
- The left propeller was replaced because of a bent blade tip.
- Full checks of the NWS were performed with a satisfactory result. However, the amplifier and the electro-hydraulic actuator assembly were dismounted for test bench.

1.10.2. *Tests in M7 Aerospace (Texas, USA)*

The amplifier or electronic control box P/N 35021-502 S/N 152 and the electro-hydraulic actuator assembly P/N 27-53043-075, S/N 113 were dismounted for test bench.

Regarding the actuator, the result of the test was that no fault was found and that it was in right condition according to the manufacturer specifications.

With respect to the amplifier, a small fault in a potentiometer, which required trimming and recalibration, was all that was found.

Initially this element was identified as a possible cause of the incident. However it was concluded that, from the operational point of view, although the out-of-trimming condition could have caused a little unbalance in the nose wheel deflection to one side and to the other, it could never have induced a sharp airplane yaw.

1.11. Additional information

1.11.1. *Pilots' statements*

From the pilots' statements the following information is highlighted:

- It was the first flight in their duty period.
- While taxiing a decision was made by the captain to use wet power under AWI because the airplane was at full load and the outside temperature was 28 °C.
- The pilot flying was the co-pilot. It was the first time that he had used AWI power.
- At takeoff position the brakes were engaged and power set until torque exceeded 40%. Then they released the brakes and adjusted power to 110% torque along the take-off run. The airplane accelerated, while trimming a small disagreement of –2% torque in the right engine.
- The co-pilot pressed the NWS activation button on the left-hand side of the left engine power lever.
- Reaching 60 kt, the captain called out this speed, and the co-pilot released the NWS button. In response to the investigators' query about the act of releasing the NWS button, their answer was that they did not exactly understand the origin of this widespread practice of releasing the button and deactivating the NWS when reaching this speed.
- After attaining 85 kt or 90 kt the airplane began to veer to the right and the co-pilot could not arrest the drift, despite applying full left pedal stroke.
- The captain took over the controls and commanded a rejected takeoff.
- The airplane departed the runway's paved surface and, lifting dust from the ground, and came to a stop after a sharp yaw to the right.
- The crew stopped the engines, pulling on the emergency handles.
- They remained inside the aircraft for about 30 seconds, checking that everything was shut down before vacating the plane.
- When they entered the runway, the B-757 which took off before the Metro III was not in their sight. The Metro III waited for several minutes at the brake release point before they were cleared to take off.

- There was no turbulence.
- After the incident the captain saw several tyre marks on the runway before the exiting tracks.

1.11.2. *Company fleet information*

During the investigation period the company stopped having in its AOC (Air Operator Certificate) aircrafts Fairchild SA 227-AC Metro III type, as the one involved in the incident.

1.11.3. *Company training information*

Flight simulators for this fleet were not available for crew training, therefore, the emergency procedures only could be performed during actual training flights.

1.11.4. *Previous incident*

In May 2004, an incident took place in which an aircraft SA-227-BC, same type and model, was involved. The Civil Aviation Aircraft Accident Investigation Commission (CIAIAC) carried out the investigation of this event and the report was approved in July 2007 (reference: Technical Report IN-026/2004)

At that incident, the aircraft was authorized by the TWR to take off on runway 06R of the Palma de Mallorca airport. Pilot flying was the copilot. The aircraft started its run by accelerating normally under takeoff power and using the Nose Wheel Steering (NWS) system, which the copilot engaged by pushing the system's activation button on the left side of the power lever for the No.1 engine. As the aircraft accelerated, the pilot called out going through 60 kt, meaning they had developed enough IAS for directional control. The copilot released the activation button for the steering system, shortly after the aircraft started veering toward the right edge of the runway without the crew noticing any power or system failure.

The investigation concluded, as a likely cause of the incident, an uncommanded turn of the nose wheels to the right and their subsequent locking in place.

As a result of the investigation, the following safety recommendations were issued:

REC 31/07. It is recommended that the operator, Top Fly, establish written operational procedures based on the contents of the AFM which define the actions to be carried out by each crewmember during the various phases of flight, and that the training given to crews be expanded to ensure the checklists that involve the NWS system are memorized.

REC 32/07. It is recommended that the manufacturer, M7 Aerospace:

1. Draft supporting information for operators of Fairchild SA227-BC aircraft on the effects of an NWS system malfunction during the takeoff run, and
2. Reassess Fairchild SA227-BC emergency procedures involving a failure of the NWS system so as to aid in more clearly identifying the cause of the malfunction, and that the actions to be taken specified in said procedures be adequate to ensure the safety of the aircraft.

2. ANALYSIS

2.1. Incident development

Factual information confirms that in the late afternoon of June 17th, 2004 at Valencia, the airplane Fairchild, Swearingen Metro III, registration number EC-GXE was making its first take-off on the crew's schedule. The two crew members were rested and ready. VMC were prevailing with a light tail wind for runway 30.

Flight dispatch was normal, reporting a takeoff weight near to maximum and balance within limits. The airplane departed the cargo apron and taxied to the runway 30 holding point and then to the 30 threshold, where it waited for a few minutes, required by TWR, in order to get separation from a possible wake turbulence of a B-757 that took off before them.

The takeoff run was initiated with AWI power, following the procedure for this kind of takeoff. It was the first time the copilot, who was the pilot flying, had used this system. The crew performed a static takeoff, increasing the propellers RPM and the engines torque while leaving the brakes on. The crew released the brakes when torque rose above 40% in both engines, and started the takeoff run, while the copilot was pressing the left power lever button of the NWS that was armed. During the acceleration they checked that torque increased to 110%, as is normal in wet takeoff, and they noticed a small difference of 2% that they tried to trim.

When a speed of 60 kt was attained the captain called out this speed, at which aerodynamic control begins to be effective, and the copilot released the NWS activation button, following a widespread procedure among the operators of this type of aircraft. When speed was above 85-90 kt the airplane began to veer to the right, but the copilot could not arrest the drift.

The captain took over the controls and initiated a rejected takeoff without being able to keep the plane from exiting the runway at its right edge. They ran about 350 m over flat, non-compacted ground within the runway strip. The airplane finally came to a stop between the runway and the North apron at 1,000 m distance from the brake release point and 75 m from the runway centre line. In the last part of the braking run the airplane yawed to the right when the right main gear got caught in the uneven terrain and stopped with a heading of approximately 050°.

The distance of 1,000 m covered in the acceleration-stop run implies a correct acceleration and a good braking action if they effectively reached 90 kt IAS. This run was made in about 52 seconds since brake release.

There were no injuries and the damage to the aircraft was restricted to the tires and a propeller blade which could have hit a runway light.

2.2. Possible incident causes

It could be argued that, aside from minor factors capable of inducing a yaw torque that could affect the steering of an aircraft while on its takeoff run, the following five factors could be considered significant enough to explain abrupt heading changes during the takeoff run:

a) A gust of wind
b) *Wake turbulence from other airplanes*
c) Large differential engine thrust
d) Locking the brakes on the MLG, or a tire blowout, and
e) NLG orientation.

Cause a) can be dismissed in this case due to the prevailing wind conditions during takeoff.

Likewise, cause b) can be ruled out given that there wasn't evidence of wake turbulence from the B-757. First of all, because the pilots did not notice it, also, because TWR ascertained meticulously that the prescribed time had elapsed before authorising the next take-off. In addition, in the take-off run the Metro moved only around the space where the B-757 had run before its rotation. Thus, the wing whirls from the B-757 would have been light ones and the prevailing tail wind would have displaced them forward away from the incident airplane.

As an AWI take-off procedure was followed by the crew, it seems improbable that cause c) was the origin of the incident. The idea of a possible failure in the propeller pitch system, because a fine pitch in one propeller could have cause differential propulsion or drag, is also discarded. Both engines showed an even rise in torque and the propellers then feathered correctly showing a normal functioning of the pitch change mechanism.

Cause d), namely that a brake, which is not normally used during takeoff, could have seized up can also be excluded, given the acceleration values obtained, which revealed nothing to this effect.

Inspection of the airplane after the incident revealed that braking assemblies were in perfect operating condition and that the tyres did not burst, showing only abnormal wear that was most likely a consequence of the hard braking during the rejected take-off and the running across uneven terrain in the runway strip.

Line Maintenance checks and the results of the bench tests in M7 Aerospace (of the amplifier, with only minor trim faults in the potentiometer, and actuator, which was in right condition) lead to discard, initially, cause e). Nevertheless a possible intermittent failure in the system must be considered.

In addition to the above evidence it should to be noted that the pilots were rested and fit for the operation, that they held the qualifications and experience required for the flight and the meteorological conditions were adequate for flying.

2.3. Possible NWS system failure modes and aircraft modification status

Considering the above, it must be assumed that in all likelihood the nose wheels turned to the right and stayed blocked in that position once the pushbutton on the throttle lever was released. At any rate, it has not been possible to reproduce the failure mode, nor has evidence of a malfunction been found in any of the components during functional tests made on the aircraft after the fact. Due to the system's architecture, the fault could have resulted from a clogged restrictor; for example, if the flow path between actuators is interrupted while in caster mode, the wheel's orientation would be blocked. The same thing would happen if a fault or a delay in the steering system's control relay kept the arming valve open. The troubleshooting process in the maintenance manual also considers other possible fault mechanisms which could have occurred, though as already stated, these could not be verified.

Even if these faults had been temporary or intermittent, it would have been difficult to recover from a loss of control following the release of the throttle lever pushbutton, since the resulting mismatch between more than 3° signals in the control and monitoring channels would have prevented the system from being reactivated without first positioning the pedals to reflect the blocked wheel's deflection.

As for the system warning lights, if they did turn on during the takeoff run, the incident crew failed to notice them. They could have illuminated or blinked on and off without the crew noticing them during an emergency.

NWS system operability on this type of aircraft is not relevant to the dispatching of flights. The aircraft may be operated, with or without using the NWS system, as specified by the Master Minimum Equipment List (MMEL).

The design of the NWS system has been the focus of several changes to this type of aircraft, effected through the issuance of successive service bulletins. According to information supplied by the manufacturer, the aim of these changes has been to improve its reliability in some cases, and the accessibility to the operating controls from both piloting positions in another. Yet, logically, despite these modifications, the possibility of faults in the system is still considered in the AFM's various operating procedures. Aside from faults detected during pre-flight checks while carrying out the taxi checklist, an emergency could arise from an electrical or hydraulic fault, as in this incident, while the aircraft is moving on the ground at considerable speed. Judging by the available data, the fault in this case could have been electrical, given the undesired steering deflection produced which, according to the manufacturer, seems to be related with this type of fault. But the fault could also have been of a hydraulic nature. In principle, then, there seems to be no easy way to differentiate between the two failure modes and thus apply the appropriate emergency procedure, especially considering that the procedures lead to opposite conditions, with the system disconnected in one and activated in the other. Moreover, if the fault is electrical, the applicable emergency procedure includes the execution of a series of steps that result in the system being disconnected and which must be carried out in very rapid succession if steering control of the aircraft is to be regained. The effectiveness of these actions in preventing an aircraft rolling near the decision velocity from going off the runway is doubtful.

It would be worthwhile, therefore, to reconsider changes to the applicable emergency procedures which might allow for a clearer identification of the problem affecting the system on the one hand, and a greater guarantee that the aircraft's safety will not be compromised on the other. It is considered that the recommendations **REC 32/07,** addressed to the manufacturer and **REC 31/07,** addressed to the operator of the aircraft involved in the incident reference as IN-026/2004, already identify the same necessities, therefore no further recommendations will be issued now on the subject. Furthermore, the operator of the aircraft involved in the incident studied here does not have anymore Fairchild SA227-AC, Swearingen METRO III aircraft type at its fleet, that's why it would not be convenient to formulate a similar recommendation to the above mentioned REC 31/07.

2.4. Operational factors

Two overriding challenges faced the crew during this emergency as they attempted to minimize the consequences of the aircraft's deviation: stopping the aircraft as quickly as possible and controlling its heading so as not to exit the runway.

It must be realized that the effectiveness of the brakes is reduced under high speed conditions, when the lift on the wings reduces the weight of the aircraft on the wheels. If the aircraft rolls off the runway, the vibrations and jolts could keep the pilot from applying full pressure to the brake pedals. As for reverse thrust, which is effective at high speeds, it has the drawback of the delay or time interval required by the engines and propellers to supply that thrust.

Regarding steering control on the ground, in theory, even with a NWS fault, the aircraft does have effective means for correcting an uncommanded steer on the ground. The emergency arising from such an uncontrolled deflection of the nose wheel, however, would catch the crew off guard and condition the pilot's response, making it very difficult to counteract the aircraft's tendency to go off the runway.

In addition to the wheel brakes, the aircraft is also capable of using differential thrust with one of the propellers in reverse, a possibility that was used in this case.

As a result of their training and in keeping with unwritten procedures, it may be inferred from the pilots' actions and statements that the NWS activation button was to be released upon reaching 60 kt, using aerodynamic surfaces instead to avoid possible unwanted deviations. This action is neither specifically considered in the AFM nor has it been possible to concrete which is the origin of its application.

The takeoff checklist in the AFM for normal operations specifies that the use of NWS by pushing its activation button on the thrust lever is left to the crew's discretion ("AS DESIRED"). There is no basis for questioning the practice of deactivating the NWS system at 60 kt, although if, as in this case, the decision is then made to abort the takeoff, having different crewmembers at the controls and on the throttle would result in valuable time lost in decelerating the aircraft.

Therefore, it is recommended that the manufacturer provide information to the operators on the effects of a malfunction in the NWS system while on the takeoff run, which would allow them to make a more informed decision regarding the proper use of this system. In this sense, it is formulated the above mentioned recommendation **REC 32/07** included in the report IN-026/2004 , which could be also applied to this report.

On the other hand, similar to the conclusions inferred from the IN-026/2004 report, it would be also advisable to recommend the operator to establish written operational procedures based on the AFM which define each crewmember's role in the different phases of flight, and also that it broaden the training provided to crews in a way that guarantees the memorization of checklists such as the one for a failure of NWS. It would be ideal if such a failure could be practiced on a simulator, though the lack of an available simulator precludes this possibility. In addition, the operator of the incident aircraft does not have Fairchild SA227-AC, Swearingen METRO III aircraft type at its fleet, therefore the possibility of issue a recommendation is not weighted up.

3. CONCLUSIONS

3.1. Findings

1. The airplane held a valid airworthiness certificate and was maintained according to regulations in force.

2. The aircraft configuration was previous to the S.B. 227-32-030
3. Actual airplane weight and balance were within limits
4. Both pilots held valid flying licenses.
5. Meteorological conditions were VMC.
6. The airplane began to deviate to the right when at high speed in the take-off run, after the flying pilot released the NWS ‘power lever button’.
7. Rejected take-off, distance covered in the acceleration-stop run, warrants the conclusion that the power plant and wheel brakes did perform correctly.
8. Possible factors in the incident’s development such as airplane turbulence, the operation of the wheels and brakes, and asymmetrical engine power and propellers have been discarded.
9. Maintenance checks and inspections and bench test of NWS components confirmed the sound condition of the NWS system.
10. It is suspected, although no direct evidence was found, that probably the nose wheels deflected to the right and jammed.
11. It is considered that the procedures in the Flight Manual are not completely clear in case of a sudden and uncommanded nose wheel deflection and regarding the activation button of the NWS system.

3.2. Cause

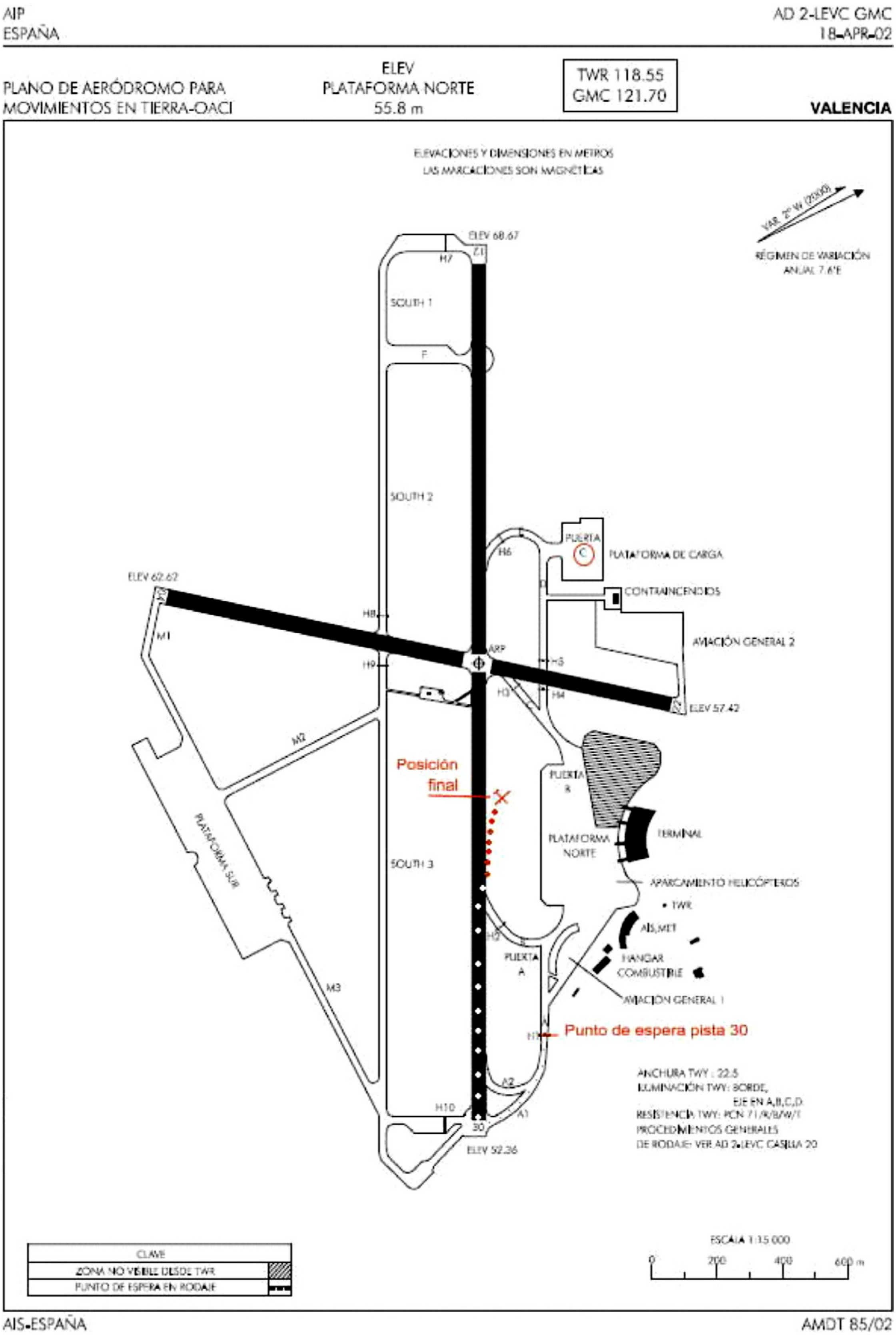
The airplane exited the runway probably due to the deflection to the right of the nose landing gear wheels, which was not commanded by the pilot flying.

It has not been identified the specific failure that could affect the Nose Wheel Steering System (NWS).

4. SAFETY RECOMMENDATIONS

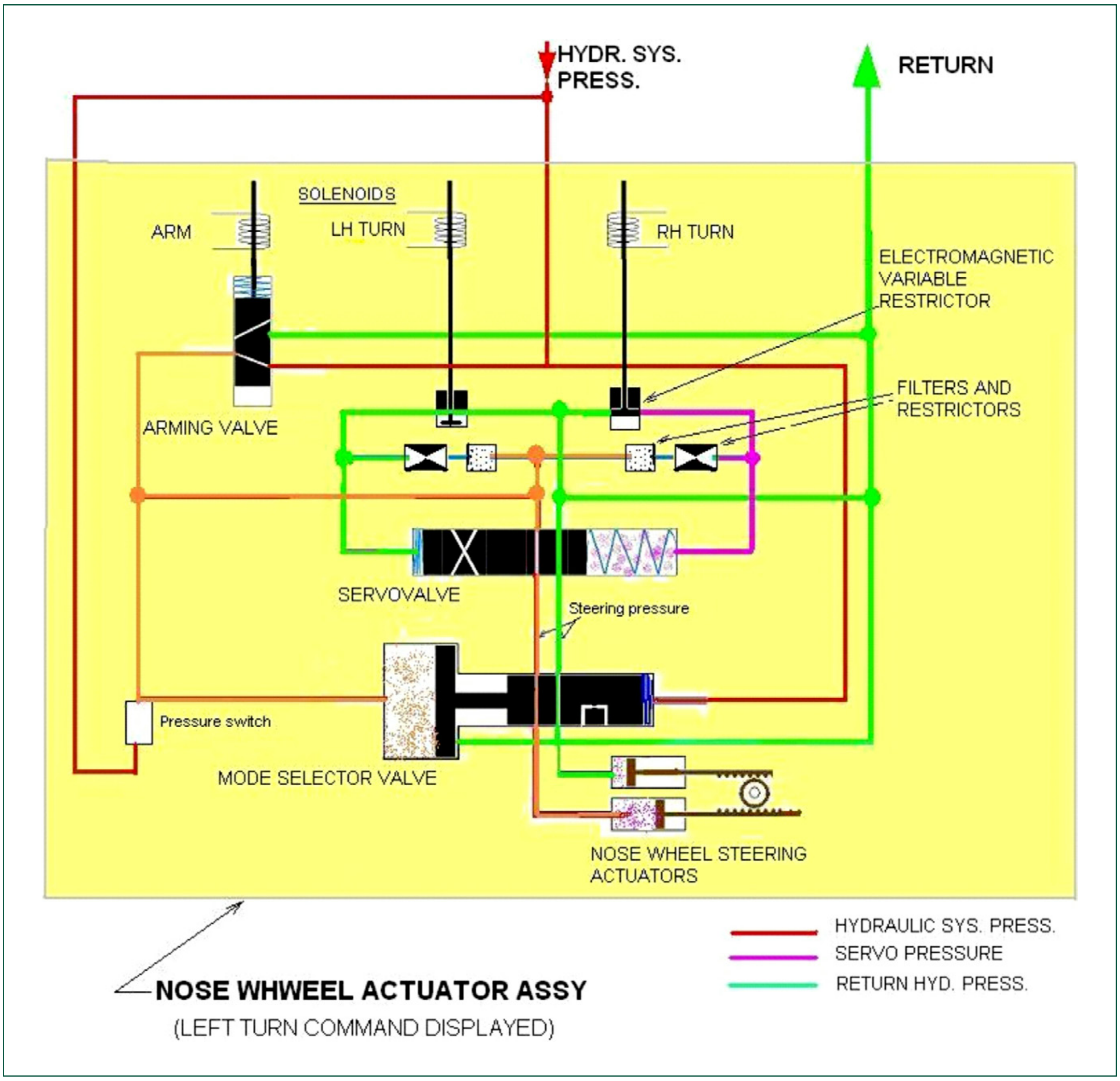
It is not considered appropriate to issue additional safety recommendations to the ones already included at the report under reference IN-026/2004.

APPENDIX A
Airport chart rejected take-off path

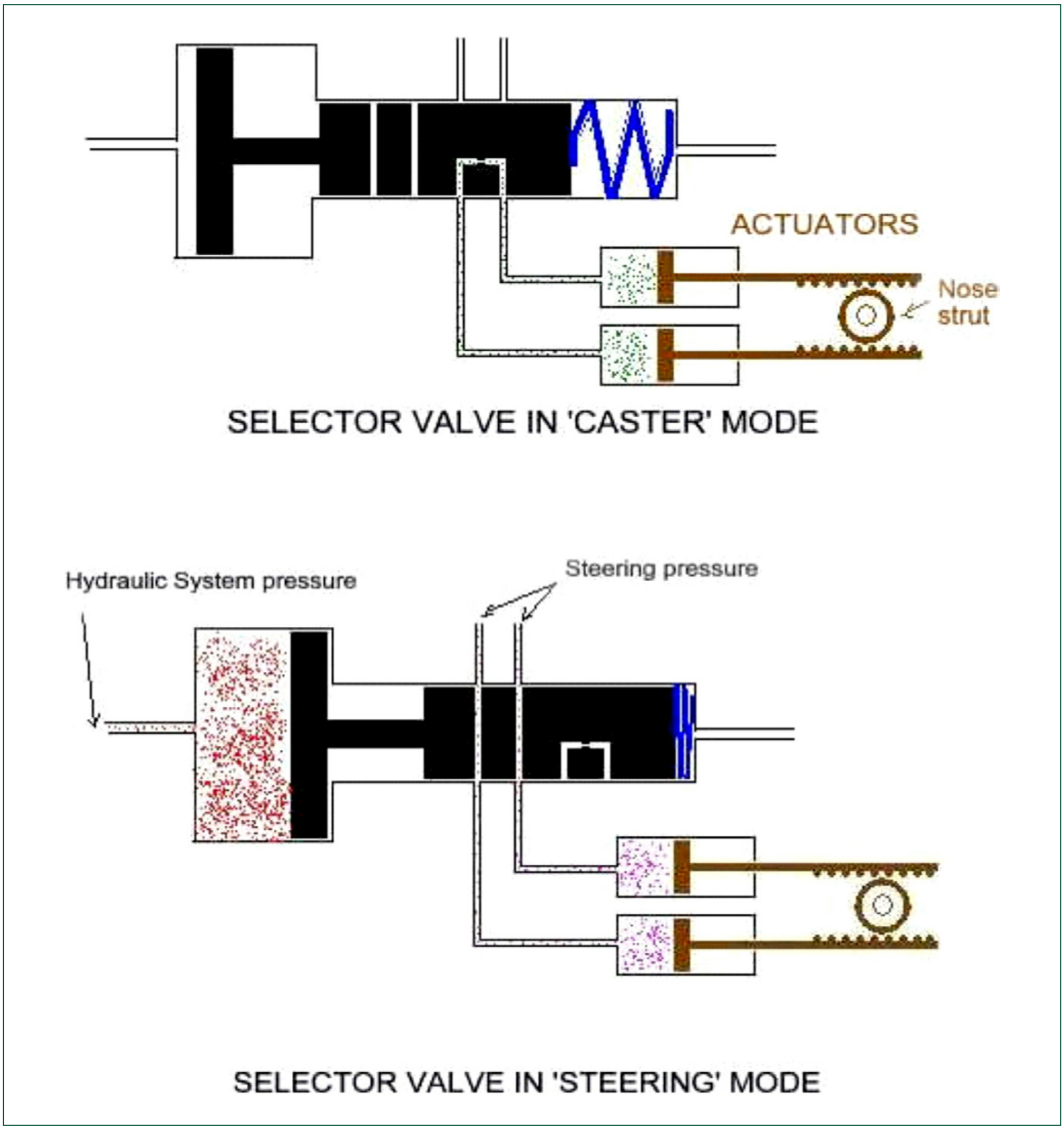


A-1. Airport chart and rejected take-off path

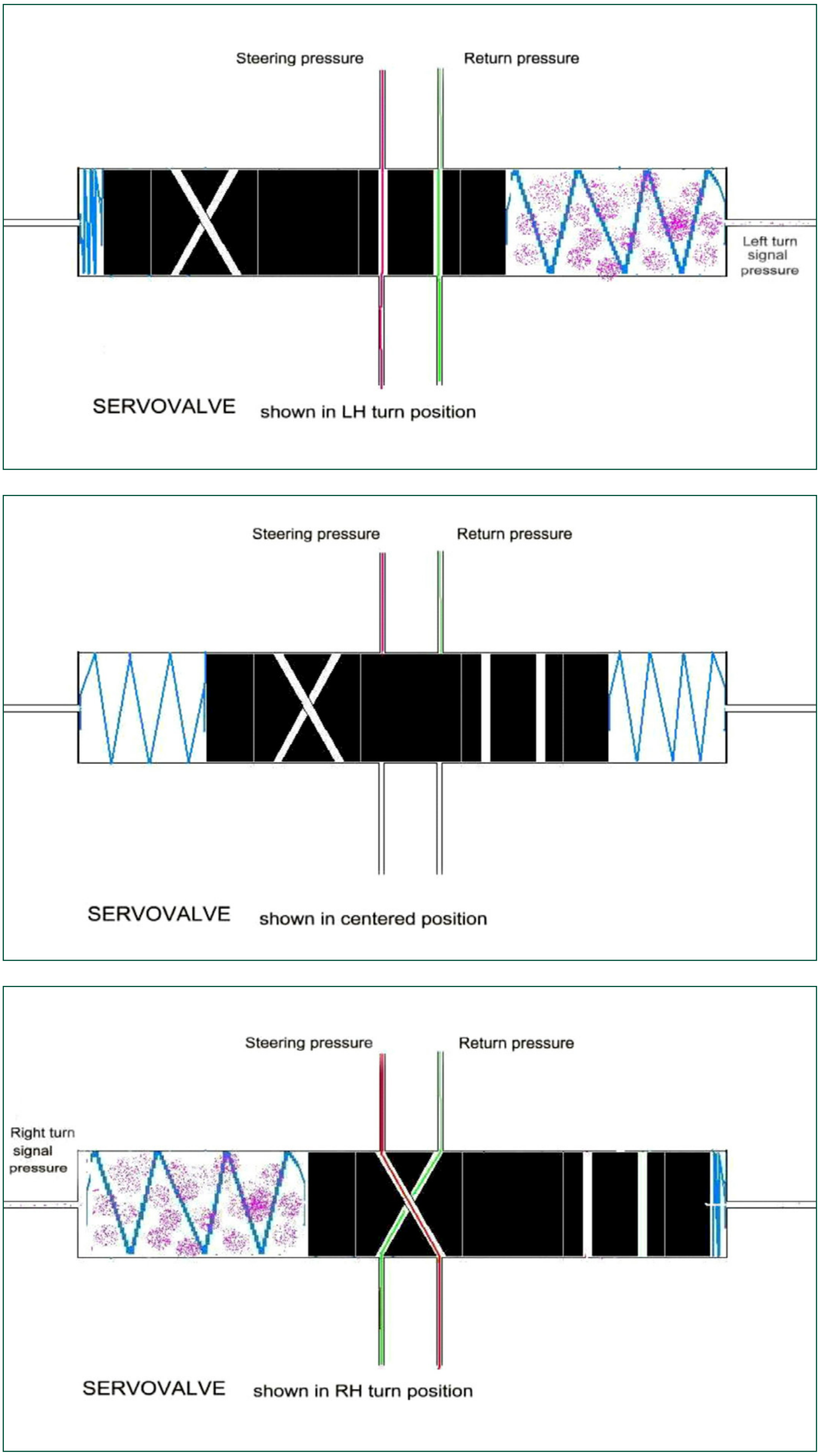
APPENDIX B
Hydraulic and electric schematic diagram



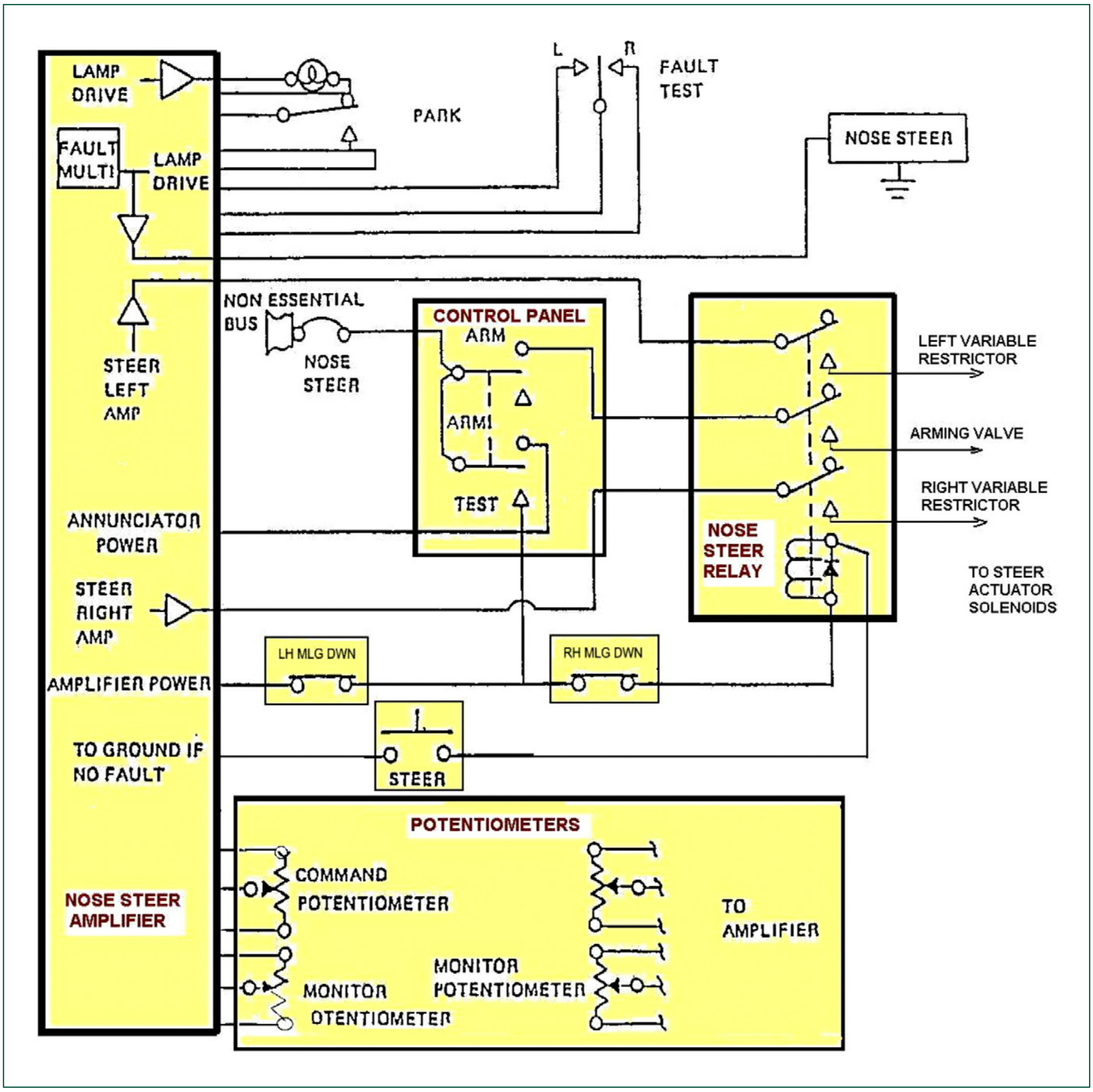
B-1. Hydraulic schematic diagram



B-2. Mode selector valve



B-3. Servovalve positions



B-4. Electrical schematic diagram

APPENDIX C
DFDR parameters

Time s	min	s	ALT	IAS	MHDG deg	VERG G	VERG G	VHF	Comments
			565	85,2	123,8	1	0	—	
			565	85,2	123,8	1	0	KEYED	Allowed to enter
–60	–1	0	565	85,2	123,8	1	0	KEYED	the runway and
–59	–1	1	565	85,2	123,8	2,28	1,28	KEYED	maintain
–58	–1	2	565	85,2	124	2,28	0	—	
–57	–1	3	565	85,2	125	1	0	—	
–56	–1	4	565	85,2	125,9	1	0	—	
–55	–1	5	565	85,2	127,2	1	1,28	—	
–54	–1	6	565	85,2	128,7	2,28	0,64	—	
–53	–1	7	565	85,2	130	2,28	0	—	
–52	–1	8	565	85,2	130,7	1	0	—	
–51	–1	9	565	85,2	131,5	1	1,28	—	
–50	–1	10	565	85,2	132,1	2,28	0	—	
–49	–1	11	565	85,2	132,5	2,28	1,28	—	
–48	–1	12	565	85,2	133	2,28	1,28	—	
–47	–1	13	565	85,2	133,7	2,28	1,28	—	
–46	–1	14	565	85,2	134,8	2,28	1,28	—	
–45	–1	15	565	85,2	135,6	2,28	1,28	—	
–44	–1	16	565	85,2	137,1	1	0	—	
–43	–1	17	565	85,2	138,4	1	0	—	
–42	–1	18	565	85,2	139,3	2,92	1,92	—	
–41	–1	19	565	85,2	140,9	2,92	0	—	
–40	–1	20	565	85,2	143,3	1	0	—	
–39	–1	21	565	85,2	145,5	2,28	1,28	—	
–38	–1	22	565	85,2	147,6	2,28	1,28	—	
–37	–1	23	565	85,2	149,2	2,28	0	—	
–36	–1	24	565	85,2	151,1	1	1,92	—	
–35	–1	25	565	85,2	153,2	2,28	1,28	—	
–34	–1	26	565	85,2	155	1	1,28	—	
–33	–1	27	565	85,2	156,9	1	0	—	
–32	–1	28	565	85,2	158,8	2,92	0	—	
–31	–1	29	565	85,2	161,6	1	1,28	—	
–30	–1	30	565	85,2	164,4	2,28	0	—	
–29	–1	31	565	85,2	168,1	2,28	0	—	

Time s	min	s	ALT	IAS	MHDG deg	VERG G	VERG G	VHF	Comments
–28	–1	32	565	85,2	171,8	2,28	1,28	—	
–27	–1	33	565	85,2	175,7	2,28	0	—	
–26	–1	34	565	85,2	179,7	1	1,28	—	
–25	–1	35	565	85,2	182,8	2,92	0	—	
–24	–1	36	565	85,2	186,9	1	0	—	
–23	–1	37	565	85,2	189,7	1	1,28	—	
–22	–1	38	565	85,2	192	1	1,28	—	
–21	–1	39	565	85,2	193,9	2,28	1,92	—	
–20	–1	40	565	85,2	195,4	1	1,28	—	
–19	–1	41	565	85,2	196,9	1	0	—	
–18	–1	42	565	85,2	198,2	2,28	1,28	—	
–17	–1	43	565	85,2	200,3	2,28	2,56	—	
–16	–1	44	565	85,2	205,1	2,92	2,24	—	
–15	–1	45	565	85,2	213,7	1	1,92	—	
–14	–1	46	565	85,2	222,5	1	1,92	—	
–13	–1	47	565	85,2	230,2	2,28	1,28	—	
–12	–1	48	565	85,2	240,5	2,28	0	—	
–11	–1	49	565	85,2	254,4	1	1,28	—	
–10	–1	50	565	85,2	263,2	1	0	—	
–9	–1	51	565	85,2	271,7	2,28	0	—	
–8	–1	52	565	85,2	278,7	1	1,28	—	
–7	–1	53	565	85,2	287,9	2,28	1,28	—	
–6	–1	54	565	85,2	293,1	2,28	0	—	
–5	–1	55	565	85,2	294,2	1	0	KEYED	Cleared to take off
–4	–1	56	565	85,2	297,3	2,28	1,28	KEYED	
–3	–1	57	565	85,2	299,4	2,92	1,28	KEYED	
–2	–1	58	565	85,2	300,5	1	0	KEYED	
–1	–1	59	565	85,2	300,8	2,28	0	—	
0	0	0	565	85,2	301	1	0	—	Take off starts
1	0	1	565	85,2	301	2,28	0	—	
2	0	2	565	85,2	301	1	0	—	
3	0	3	565	85,2	301	2,28	0	—	
4	0	4	565	85,2	301	2,28	0	—	
5	0	5	565	85,2	301	1	0	—	

Time s	min	s	ALT	IAS	MHDG deg	VERG G	VERG G	VHF	Comments
6	0	6	565	85,2	301	1	0	—	
7	0	7	565	85,2	301	1	0	—	Release brakes/AWI
8	0	8	565	85,2	300,9	2,28	0	—	
9	0	9	565	85,2	300,9	1	0	—	
10	0	10	565	85,2	300,8	1	1,28	—	
11	0	11	565	85,2	300,8	2,28	1,28	—	
12	0	12	565	85,2	300,8	1	0	—	
13	0	13	565	85,2	300,8	1	0	—	
14	0	14	565	85,2	300,8	1	1,28	—	
15	0	15	565	85,2	300,8	1	0	—	
16	0	16	565	85,2	300,6	1	1,28	—	
17	0	17	565	85,2	300,6	2,28	0	—	
18	0	18	565	85,2	300,3	1	0	—	
19	0	19	565	85,2	300,3	1	1,28	—	
20	0	20	561	85,2	300,2	1	1,28	—	
21	0	21	565	85,2	300,2	1	0,64	—	
22	0	22	565	85,2	300,2	1	0	—	
23	0	23	561	85,2	300,1	1	0	—	
24	0	24	565	85,2	300,1	2,28	1,28	—	
25	0	25	565	85,2	300,1	2,28	0	—	
26	0	26	561	85,2	299,8	2,28	1,28	—	
27	0	27	565	85,2	299,4	2,92	1,28	—	
28	0	28	561	85,2	299,4	2,28	1,92	—	
29	0	29	556	85,2	300,8	2,28	0	—	
30	0	30	561	85,2	303,1	2,28	1,28	—	Drift to the right
31	0	31	561	85,2	302,6	2,28	1,92	—	
32	0	32	565	85,2	302,3	2,28	1,28	—	
33	0	33	565	85,2	301,9	2,28	1,28	—	
34	0	34	565	99,7	301,7	2,28	1,92	—	
35	0	35	561	98,9	302,6	2,92	1,92	—	
36	0	36	565	100,5	303	2,28	1,28	—	
37	0	37	561	102	301,6	3,24	1,92	—	Vertical acceleration
38	0	38	565	104,3	300,9	2,28	1,28	—	
39	0	39	565	105,8	303,1	1	1,28	—	

Time s	min	s	ALT	IAS	MHDG deg	VERG G	VERG G	VHF	Comments
40	0	40	565	107,3	303,7	2,28	2,56	—	
41	0	41	565	110,4	303,7	2,28	1,28	—	
42	0	42	565	111,2	303,7	1	1,28	—	
43	0	43	565	114,2	302,6	2,28	1,28	—	
44	0	44	565	116,5	305,1	3,56	1,28	—	
45	0	45	565	118,8	309,3	3,56	1,28	—	Max drift
46	0	46	565	119,6	309,3	1	1,92	—	Maxima IAS
47	0	47	565	119,6	306,7	2,28	1,28	—	
48	0	48	561	118,8	305,4	2,92	1,92	—	
49	0	49	565	113,5	308,1	3,88	2,56	—	Max vertical acce
50	0	50	561	111,2	106,2	–75,48	33,36	—	Final orientation
51	0	51	248	177,7	306,8	1	0,64	KEYED	Out of the runway
52	0	52	253	178,5	306,8	2,28	0	KEYED	

Valores espurios