THE DUTCH SAFETY BOARD

PRECAUTIONARY LANDING AFTER CONTROL PROBLEMS

The aim in the Netherlands is to reduce the risk of accidents and incidents as much as possible. If accidents or near-accidents nevertheless occur, a thorough investigation into the causes of the problem, irrespective of who is to blame for it, may help to prevent similar problems from occurring in the future. It is important to ensure that that the investigation is carried out independently from the parties involved. This is why the Dutch Safety Boars itself selects the issues it wishes to investigate, mindful of citizens' position of dependence with respect to public authorities and business.[1]

GENERAL INFORMATION

Incident number:	2011057
Classification:	Serious incident
Date, time[2] incident:	15 July 2011, 17.11 hours
Place of the incident:	Near Lelystad Airport
Registration:	PH-FLD
Aircraft type:	Diamond DA 40 D
Aircraft category:	Single engine propeller airplane
Flight type:	Private flight
Flight phase:	Take-off
Aircraft damage:	None
Number of crew:	One
Number of passengers:	One
Personal injury:	None
Other damage:	None
Light conditions:	Daylight

SUMMARY

Just after takeoff the pilot experienced elevator control problems. It was difficult to control the attitude of the aircraft and consequently the pilot decided to make a precautionary landing in a field of standing crops. There was no damage to the aircraft and the occupants were able to leave the aircraft unharmed.

[1] The Dutch Safety Board's work is not to establish the blame, responsibility or liability attaching to any party. Information gathered during the course of an investigation – including statements given to the Board, information that the Board has compiled, results of technical research and analyses and drafted documents (including the published report) – cannot be used as evidence in criminal, disciplinary or civil law proceedings.

[2] All times mentioned in this report are local unless otherwise specified.

FACTUAL INFORMATION

The flight

On July 15th 2011, at approximately 17.00 hours, a Diamond DA 40 D, registration PH-FLD operated as a private flight from Lelystad Airport (EHLE). On board were one pilot and one passenger who was also a pilot. The pilot performed the checklist items and taxied to the runway. The takeoff was from Runway 23 in south-westerly direction (230 degrees).

According to the pilot, during the takeoff roll, at a speed of around 30 knots, the nose of the aircraft started to pitch up and lift from the ground. The pilot pushed forward on the controls to move the nose down and checked the trim position. The takeoff was continued and the aircraft became airborne at approximately 60 knots.

The pilot stated that during the climb it became more difficult to move the elevator. In order to change the attitude of the aircraft, greater force was required. The pilot stated that he checked the trim position again. No problems were noted on the roll and direction controls.

The second pilot took control and also experienced control difficulties, it was decided to make a precautionary landing. After making a right-hand turn at approximately 250 feet, a precautionary landing was made in a field of standing crops. There was no damage to the aircraft and the occupants were able to exit the aircraft unharmed (Figure 1).

Figure 1: the PH-FLD after the precautionary landing in a standing crop field (source: KLPD – Aviation Police)

The pilot

The pilot was a 62 year old male, in possession of a valid Private Pilot's Licence (PPL) and authorised to conduct the flight. His medical certificate was valid until June 23rd 2011.

Type of certificate	Private Pilot's Licence (PPL)
Qualifications	RT/LPE
Flying hours total	Approximately 480
Hours on type	67
Hours past three months	3

Table 1: pilot experience

Trim and elevator control system DA40

The DA40 is equipped with an elevator with a mechanically operated trim tab. The trim tab allows the aircraft to be trimmed[3] at different speeds and centre of gravity positions and can be controlled in two ways. The normal way is to control the trim tab is by turning the trim wheel located in the centre console, forwards or aft, which trims the nose of the DA40 up or down. The second way to control the trim tab is by using the switch on the left control stick. This switch has a left and right part. The left part arms (ARM) the trim system (electrical part becomes active) and the right part of the switch controls the direction of trim movement (TRIM) by the trim cable. When both parts of the switch are moved forward, the nose of the aircraft will be trimmed down ("TRIM DOWN"). When both parts are moved aft, the nose of the aircraft will be trimmed up ("TRIM UP"). A black line on the centre console indicates the current trim setting.

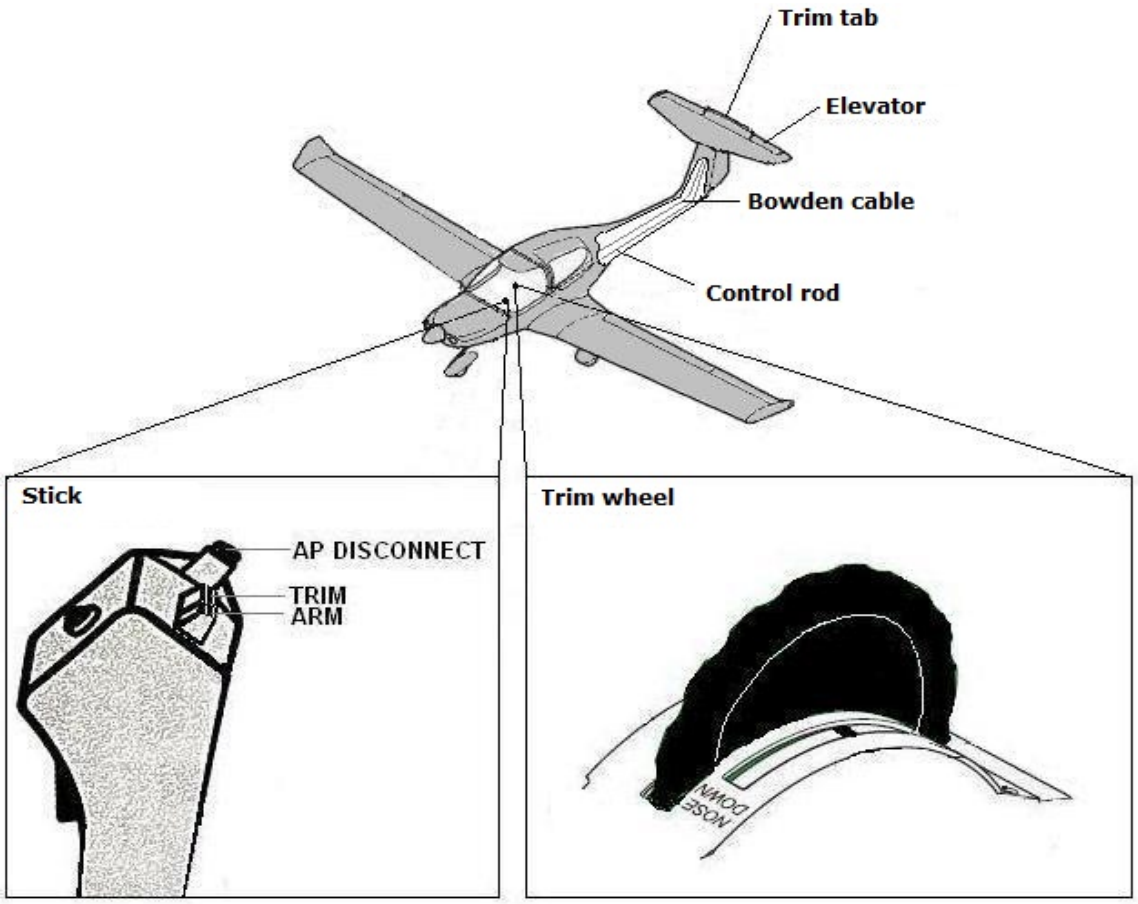

Figure 2: three-dimensional overview of the DA40 control system including a cutaway tail showing the elevator control system (source: DA40 Airplane Maintenance Manual – Diamond Aircraft Industries. Adapted by the Dutch Safety Board)

[3] By trimming the aircraft the control forces on the stick can be cancelled (balanced).

A Bowden cable[4] connects the trim wheel to the trim tab at the tail. The Bowden cable is separate from the elevator control which is controlled by a control rod. The elevator control rod is moved by the two control sticks located in the cockpit. By moving the stick forward or aft, the pitch (nose up or down) of the aircraft is controlled.

Systems PH-FLD
A digital flight control system, hereafter referred to as the autopilot, is installed in the PH-FLD. The autopilot system provides roll, pitch and trim control. The DA40 autopilot should not be used for takeoff and landing. The autopilot can be switched on by pressing the AP button of the flight control computer (autopilot) on the main panel. The AP is switched off by pressing the AP button on the left or right control stick or by switching the Avionics Master OFF.

Both the autopilot and trim should be checked prior to each flight. The autopilot performs a self-check when power is applied to the aircraft (AVIONIC MASTER ON). The pilot should check the trim mechanism as described in the checklist.

Checklist
A checklist is a structured procedure to be followed in order to accomplish a safe flight. It is used, in part, to check and verify the operational condition systems which are essential for flight. When a checklist is accomplished correctly, it confirms that the aircraft is configured for a particular phase of flight. In Appendix A, the PH-FLD “Before Starting engine”, “Before Take-off” and “Take-off” checklists are shown.

In two PH-FLD checklists the trim configuration is referred to. The first time is the Before Starting Engine checklist in which it is stated the trim wheel should be set in T/O position. In the Before Take-off checklist the trim is referred to for a second time and the position (Trim T/O) should be verified. The checklist is almost identical to the one prescribed by the manufacturer. There are only minor differences, none which in respect to the trim setting. According to the manufacturer experience, mistakes or skipping of checklists items have not occurred using these checklists.

[4] A Bowden cable is a type of flexible cable used to transmit mechanical force or energy by the movement of an inner cable (most commonly of steel or stainless steel) relative to a hollow outer cable housing.

INVESTIGATION AND ANALYSIS

Digital data

The aircraft is equipped with an engine and propeller which are electronically controlled and regulated by a digital Full Authority Digital Engine Control[5] (FADEC) unit. The FADEC includes a failure and data recording system which may be utilised for engine troubleshooting. The data also may be downloaded after a flight, for analysis purposes. At the request of the Dutch Safety Board the FADEC data was downloaded after the event but it could not be used to explain the high control forces. Analysis of the data did show, however, that the aircraft took off with 83% selected power (LOAD[6]) (Appendix B). In the Take-off checklist it is stated that maximum power should be selected, and during takeoff roll the indicated LOAD indication should be between 90 - 100%.

Technical examination

After the event, the aircraft was taken to a hanger for detailed technical examination. The control system was inspected for evidence of failure or obstruction. This examination did not reveal any system failures, obstruction or anything which may have interfered with the control system.

During the technical examination, several scenarios were considered which could explain the control problems. Among these were the 'folding of the stick boot' or 'the pilot trying to steer against an active autopilot'. No evidence could be found to support these scenarios. A third scenario, where the aircraft took off with an incorrect trim condition, could explain the high control forces. When the speed of the aircraft increased, the control force would also increase.

Manufacturer's test flight

At the request of the Dutch Safety Board a test flight was performed in a DA 40 D. The flight was conducted using the same weight and performance conditions as those in the incident flight. For the test flight the trim was set in the full nose-up position and 80% power was selected.

From the test flight it was noticed that during the takeoff roll, at approximately 40 knots, the nose started to rise. The force required to control the attitude of the aircraft was higher than normal but not so high that the aircraft became uncontrollable. The control force required increased when the airspeed of the aircraft increased. The forces required to control yaw and roll were unaffected.

The nose-up condition and heavy controls of the event flight were simulated during the test flight and corresponded with pilot testimony. From the test flight it was concluded that the aircraft control problems were the result of incorrect trim condition.

Checklist usage

The use of a checklist is an essential pre-condition to conduct a safe flight. Following an aircraft checklist, especially items related to aircraft configuration, is of the utmost importance for aircraft safety. From this and other events which the Dutch Safety Board has investigated in the past, it can be concluded that checklists are not always followed and completed. As in this case, a partial completion of a checklist will be detrimental to aircraft safety.

[5] Full Authority Digital Engine Control is a system utilising a digital computer, engine control units (ECU's) and accessory components for a complete aircraft power plant control.
[6] The LOAD is an indication of the selected power.

CONCLUSIONS

The following points are derived from this investigation:

- No technical anomalies were found on the aircrafts elevator control system.
- Following a test flight, performed by the manufacturer, a nose-up trim position was found to increase the control force necessary to steer the aircraft.

The investigation concludes that the control problems were probably the result of a mis-trimmed aircraft. Consequently the aircraft reacted differently, needing more control force to steer the aircraft. This in turn led the pilot to feel compelled to make a precautionary landing.

Note: This report has been published in English and Dutch language. If there are differences in interpretation the Dutch text prevails.

APPENDIX A: DA40 PH-FLD CHECKLISTS

BEFORE STARTING ENGINE

- Pre-flight inspection..... Completed
- Rudder pedals..... Adjust
- Passengers..... Instructed
- Safety harnesses..... Closed & fastened
- Rear door..... Closed & Locked
- Front Canopy..... Closed
- Parking brake..... Lock
- Flight controls..... Free movement
- Trim wheel..... T/O
- Power lever..... Check IDLE
- Friction device power lever..... Adjusted
- Alternate air..... Check CLOSED
- Alternate static valve..... Check CLOSED
- AVIONIC MASTER SWITCH..... Check OFF
- ELECTRIC MASTER KEY..... ON
- Display panel / engine instruments..... Check
- Acknowledge button..... PRESS
- WATER LEVEL caution light..... Check OFF

BEFORE TAKE-OFF

- Position airplane in the wind if possible..... SET
- Parking brake..... Lock
- Safety harnesses..... Fastened
- Rear door..... Closed & Locked
- Front Canopy..... Closed & Locked
- Door warning light (DOOR)..... OFF
- Engine instruments..... GREEN range
- Circuit breakers..... Check
- Flaps..... T/O
- Trim..... T/O
- Flight controls..... FREE
- Power lever ..... IDLE
- **ECU TEST switch**..... Press & HOLD
  - * Caution lights (ECU A, ECU B, CAUTION)..... Blinking
  - * Caution lights (ECU B, CAUTION)..... Blinking
  - * Propeller RPM..... Cycling
  - * Caution lights..... OFF
  - * ECU BACKUP UNSAFE-light..... OFF
- **ECU TEST switch**..... RELEASE
- ECU SWAP, set switch to..... ECU B
  - * Engine running without change..... Check
- ECU SWAP, set switch back to..... AUTOMATIC
- Pitot heating..... ON, if required
- Taxi light..... OFF
- Landing light..... ON, if required
- Suction..... GREEN range
- Fuel transfer pump..... Test
- Parking brake..... Release
- Time..... Copy

TAKE-OFF

- Power lever..... MAX
- Elevator..... NEUTRAL
- Rudder..... Maintain direction
- <u>During Start Run:</u>
  - * Oil pressure..... GREEN range
  - * Airspeed indicator..... Alive
  - * RPM..... 2240 - 2300 RPM
  - * LOAD indication..... 90 - 100%
- <u>Rotate (Vr):</u>
  - * 1150 kg..... 60 KIAS
  - * 1000 kg..... 55 KIAS
  - * 850 kg..... 50 KIAS
- Initial climb speed..... 66 KIAS
- Above save height, landings light..... OFF

CLIMB (Best Rate of Climb)

- Flaps..... T/O
- Airspeed..... 66 KIAS
- Power lever..... MAX
- Engine instruments..... GREEN
- Trim..... As required

APPENDIX B: PH-FLD FADEC-DATA GRAPHS

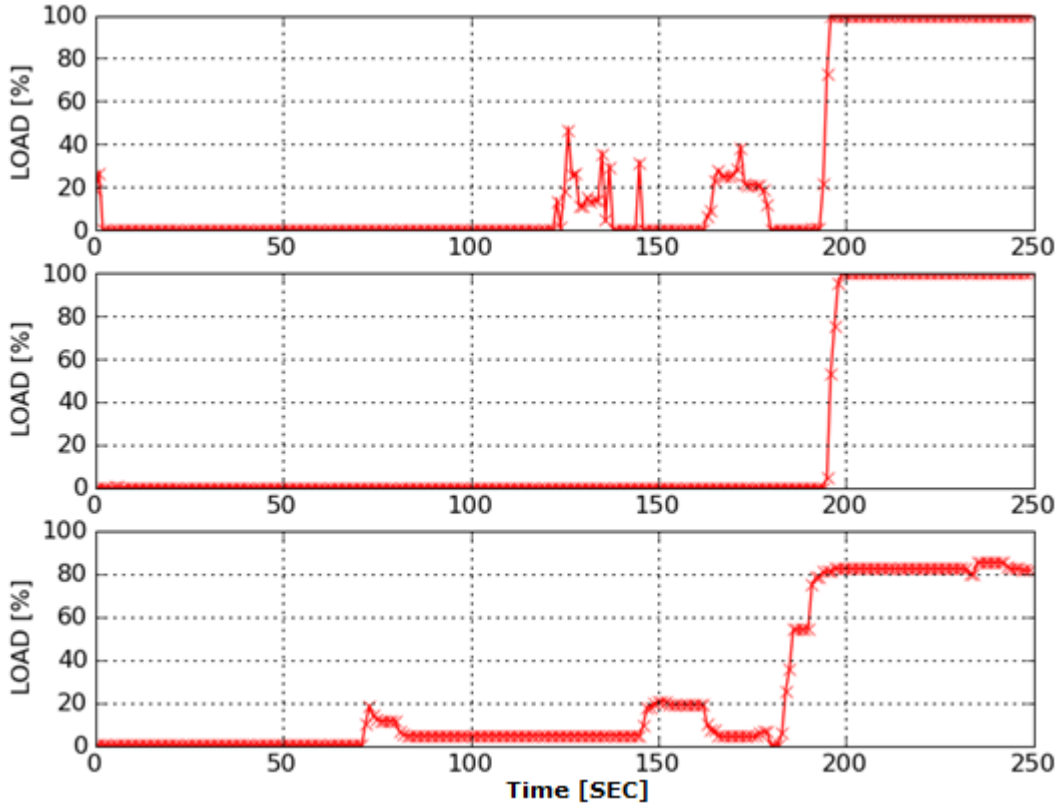

Figure 3: overview of the LOAD selection of three PH-FLD takeoffs. The first two takeoffs a load of 100% is selected, the third takeoff (event flight) a LOAD of 83% is selected.