Transportation Safety Board of Canada
Bureau de la sécurité des transports du Canada

AVIATION INVESTIGATION REPORT
A06C0062

LOSS OF CONTROL ON GO-AROUND (REJECTED LANDING)

SASKATCHEWAN GOVERNMENT
NORTHERN AIR OPERATIONS
CONVAIR 580A AIR TANKER C-GSKJ
LA RONGE, SASKATCHEWAN
14 MAY 2006

Canada

The Transportation Safety Board of Canada (TSB) investigated this occurrence for the purpose of advancing transportation safety. It is not the function of the Board to assign fault or determine civil or criminal liability.

Aviation Investigation Report

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Summary

The Saskatchewan Government Northern Air Operations Convair 580A (registration C-GSKJ, serial number 202) was conducting stop-and-go landings on Runway 36 at the airport in La Ronge, Saskatchewan. On short final approach for the third landing, the aircraft developed a high sink rate, nearly striking the ground short of the runway. As the crew applied power to arrest the descent, the autofeather system feathered the left propeller and shut down the left engine.

On touchdown, the aircraft bounced, the landing was rejected, and a go-around was attempted, but the aircraft did not attain the airspeed required to climb or maintain directional control. The aircraft subsequently entered a descending left-hand turn and crashed into a wooded area approximately one mile northwest of the airport. The first officer was killed and two other crew members sustained serious injuries. The aircraft sustained substantial damage. The accident occurred during daylight hours at 1245 central standard time.

Ce rapport est également disponible en français.

Other Factual Information

The accident aircraft, a Convair 580A (CV-580A), was one of two aircraft that had recently been delivered to the Government of Saskatchewan's Northern Air Operations. CV-580As had been converted to aerial tankers (water bombers) for fighting forest fires. The accident flight was a training flight that consisted of stop-and-go circuits at the La Ronge Airport. The purpose of the training was to instruct and cross-qualify new CV-580A captains as first officers for future training requirements. The first two circuits were unremarkable; all altitudes, speeds, and aircraft performance were as expected for the exercises being carried out.

The final approach leg of the third circuit differed from the first two in that the aircraft's speed was lower. The airspeed was stabilized at 103 knots indicated airspeed (KIAS). The rate of descent and respective altitudes were unstable compared with those of the first two circuits. The captain had called for a power setting of 150 to 200 horsepower (hp) on both engines on short final approach, and the flaps, which had been set at 24°, were selected to 28°. The aircraft entered a high sink rate of approximately 1280 feet per minute (fpm).

In an effort to arrest the high sink rate, the captain, who was the pilot flying (PF), called for increased power, briefly increased pitch attitude, and then touched down on the runway, approximately 200 feet beyond the threshold. The first officer, the pilot not flying (PNF), responded to the captain's call for power by rapidly advancing both power levers to a point beyond the maximum power setting limit. When the power levers were advanced, the left propeller immediately autofeathered and the left engine shut down. The captain, noting the position of the power levers, quickly retarded them to a position he assumed would give maximum power.

During the final approach leg and on the go-around, the captain was not continuously setting or monitoring the engine power settings and consequently was unaware of the engine power or the nature of the emergency. The elapsed time between encountering the high sink rate and initiating the go-around was approximately seven seconds.

After touching down on the runway, the captain, believing that the aircraft was not aligned with the runway, initiated a go-around. The runway heading in La Ronge is 357° magnetic (M), and, at the point where the go-around was commenced, the aircraft's heading was 356°M. The autofeather was not called out or identified as an emergency. The decision to go around was not called out or communicated to the first officer. The actions taken to perform the go-around were sequentially as follows:

- the go-around was commenced at an airspeed of approximately 94 KIAS (V1 minus 2)[1]

- the gear was selected up during a momentary positive rate of climb; and

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1 V1 is the take-off decision speed (for a specified weight) below which the aircraft may be brought to a complete stop within the remaining runway length.

- the flaps were retracted at an airspeed of 95 KIAS, after the aircraft cleared the very high frequency omnidirectional radio range (VOR) transmitter located left of the departure end of Runway 36.

Shortly after the aircraft became airborne, its left wing dropped slightly and could not be righted. The airspeed fluctuated between 93 and 98 KIAS and would not increase with a positive pitch angle. Once the flaps were retracted at 95 KIAS, the angle of bank increased uncontrollably. The aircraft started to descend, and collided with trees and terrain in a wooded area on the airport property. There were indications that, sometime after the loss of control, the first officer pulled the left E handle.[2]

The Flight Crew

There were three pilots on board C-GSKJ. A contract training captain, who was employed by Conair Aviation (Conair),[3] was flying from the left seat. The captain was instructing the first officer in first officer duties. The first officer and the third pilot (occupying the centre observer's seat) were newly qualified Saskatchewan Government Northern Air Operations CV-580A captains. The pilot occupying the centre observer's seat was to take a turn at flying from the right seat later in the flight. All three pilots held valid Canadian airline transport pilot licences, the appropriate instrument ratings, and endorsements for the Convair 580. The captain had 9500 hours of total time and 750 hours on type. The first officer had 13 000 hours of total time and 25 hours on type. The pilots were adequately rested and fit in accordance with company and Transport Canada medical Category 1 requirements. All crew members appeared fit and capable of performing their duties on the day of the accident.

Weather

The weather observation for the La Ronge Airport at 1300 central standard time[4] was as follows: wind 040 at 10 knots, few clouds at 5000 feet, few clouds at 6000 feet, few clouds at 9000 feet, temperature 13°C, dew point 2°C, altimeter setting 30.42. The runway was bare and dry. Weather conditions of this type do not normally produce windshear.

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2 The E handle is a cockpit emergency control that, when pulled, shuts down the engine, and feathers the propeller, electrically and mechanically.

3 The aircraft were purchased from Conair, and the purchase agreement included two years of flight of instruction, to be provided by Conair.

4 All times are central standard time (Coordinated Universal Time minus six hours).

Company Standard Operating Procedures

The reference and training documents available to the crew that contained CV-580A standard operating procedures (SOPs) were as follows:

- a copied and non-current version of the Conair aircraft operating manual (AOM) — all Saskatchewan government pilots had been provided with a copy of this manual;
- a current and reformatted Conair AOM;
- Conair's SOP revision 06/03/25; and
- a quick reference handbook (QRH) on board the aircraft.

It could not be determined which SOPs were in use by the crew of C-GSKJ. The profile chart on page 4-19 of the current Conair AOM directs crews to approach at an airspeed of 120 knots, for the final approach fix (FAF) to runway threshold segment of the approach. However, the expanded description of "Stabilized Approach Factors" on page 4-15 suggests that the aircraft should be stabilized at Vref +10 by 500 to 800 feet above ground level (agl) for a straight-in approach or by 300 feet agl on a circling approach. [5]

Normal engine power to achieve a straight-in approach would be approximately 500 hp per side. The QRH did not contain any information concerning go-around procedures. Conair's current CV-580A AOM (Section 3.28.6, page 86) directs pilots to apply maximum except take-off (METO) power (971 TIT[6]) in the event a go-around is required. The Training & Flight Profile section of that manual (sections 4.13.2 and 4.13.4) directs pilots to apply maximum power (1071 TIT or 4000 hp per side).

The actions specified for a single engine go-around (after the power is increased) are as follows:

- rotate to overshoot climb attitude (approximately 8° to 10° nose up to achieve V2)[7]
- select flaps to 15°
- select landing gear up (upon achieving a positive rate of climb)

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[5] Vref is defined as the airspeed at which the aircraft should be stabilized as it passes over the runway threshold in zero wind conditions. Additional airspeed is required to be added for certain wind conditions (in this case an addition of 10 KIAS) Vref + 10 for C-GSJK at the time of the accident would have been 106 KIAS.

[6] TIT is defined as turbine inlet temperature

[7] V2 is defined as take-off safety speed, the airspeed above which a take-off with an engine failure will meet obstacle clearance requirements. It is usually 1.2 times the zero thrust V stall or 1.1 times the minimum airborne control speed (VMCA). At 40 000 pounds, V2 would have been 103 KIAS.

If there is a malfunction or emergency during the take-off that requires a rejection, a reject can be performed up to the V1 speed; at or above this speed, the take-off must be continued. The V1 speed for C-GSKJ at the time of the occurrence was 96 KIAS. The go-around was attempted from a speed of 94 KIAS.

There was no information available in any of the AOMs that provides direction or cautionary information with respect to

- executing a rejected landing,
- unwarranted autofeather activation, or
- undesired negative torque system activation.

Neither the normal or abnormal checklists have a section for training in the circuit. During circuit training, the crew's workload is increased substantially as the time available to carry out required cockpit duties is less than the time available during normal arrivals or take-offs.

The after-take-off checklist directs the crew to disarm the autofeather system. The approach and landing checklists did not specify any action with respect to autofeather status. Often, when simulating engine failures, at lighter take-off weights, training pilots will reduce power on the operating engine to avoid exceeding gear and flap limitation speeds and to simulate higher gross weights.

Aircraft Flight Data

C-GSKJ was equipped with a "Chelton Flight Logic" electronic flight information system (EFIS). Aircraft approach profile data retrieved from the aircraft's EFIS were correlated with radar information, which enabled the production of a video flight recreation. The resulting information indicated that the aircraft's airspeed on the final approach was substantially lower than it had been on the previous two final approaches. On this third approach, the aircraft's speed had been established at a speed of 103 KIAS for approximately five miles before the runway threshold.

The data for the last part of the third approach showed that the aircraft descended rapidly below the normal approach path to near ground level, and then lost airspeed at the time the crew arrested the rapid descent. The recovery was consistent with flight in a low-energy condition.

At an airspeed of 95 KIAS and landing weight of less than 40 000 pounds, the runway length required for C-GSKJ to land and stop was approximately 4100 feet.[8] At the point where the aircraft touched down, approximately 200 feet from the threshold, there was 4750 feet of runway remaining.

The horsepower gauge for the right engine was indicating large fluctuations shortly before the aircraft crashed.

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[8] Conair AOM, page 6-49

Wreckage Information

Inspection of the wreckage revealed the following relevant information:

- Left engine:
    - oil tank valve was found closed;
    - fuel valve was found closed;
    - left propeller was feathered;
    - left feathering button "In"; and
    - left E handle pulled.

- Right engine:
    - incurred greater damage than the left engine due to impact forces.
    - the four 10th stage bleed valves were found open, and the four 5th stage bleed valves were found in an intermediate position.

Both engines and propellers were removed and sent to an overhaul facility for complete teardown inspection. Apart from superficial impact damage, the left engine was in running condition and was later run in an engine test cell. The engine was found to be in serviceable condition with no pre-impact anomalies. The condition of the left engine was consistent with an engine that had been shut down either through activation of the autofeather system or by the manual selection of the E handle.

Teardown and inspection of the right-hand engine indicated the following:

- reverse blade bending of the first stage compressor;
- compressor displayed light ingestion of vegetation;
- re-solidified metal spatter on the 1st stage power turbine vanes, blades, and thermocouples;
- internal coordinator impact mark correlating to a 68° coordinator position;[9]
- all engine components were bench tested and no pre-impact anomalies were noted;
- teardown of the right engine did not reveal any pre-impact anomalies;
- teardown of the right propeller revealed blade angles at 53 to 54 degrees; and
- the damage to the right engine was indicative of an engine running at a low power setting or one that was in the process of shutting down.

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[9] A 68° coordinator position indicates that the power lever was set at approximately 2000 hp at the time of impact, indicating reduced power set on the right engine.

An examination of the aircraft flight controls indicated the following:

- all flight controls were inspected and no pre-impact anomalies were found;

- both flap gear boxes were found in a position that corresponded with an 8° flap setting at the time of impact;

- flap torque differential cutout switches were found centred and neither switch was made, indicating no flap asymmetry at the time of impact;

- all feather relays and associated wiring were tested for continuity and no anomalies were found; and

- the left E handle was pulled out.

Autofeather System

The CV-580A aircraft is equipped with an autofeather system that provides anti-drag protection in the event of an engine failure during critical flight phases. The system functions by detecting actual low propeller thrust. This autofeather system is a "committed" type in that it is committed to fully feathering the propeller and shutting down the engine when the following conditions are met:

- the pedestal-mounted autofeather switch is in the Arm position;
- the power lever is advanced beyond the 60° (65° coordinator) position; and
- the thrust sensitive switch detects less than 500 pounds of propeller thrust.

This committed type of autofeather system does not incorporate a timed delay; such a device would allow for transient propeller thrust during engine "spool-up." Testing of a similarly equipped aircraft revealed that it is possible to induce an unwarranted activation of the aircraft's autofeather system by rapidly advancing the power levers when the propellers are in a low-thrust condition.

When an operating engine is autofeathered and shut down, the aircraft initially yaws as the propeller blade angle increases toward feather, and then yaws in the other direction as the drag decreases. The resulting control forces are remarkably different from those felt from an actual engine failure, and could tend to confuse the crew as to the asymmetric nature of the emergency.

Negative Torque and Temperature Datum Systems

The CV-580A is equipped with a negative torque sensing (NTS) system to provide engine negative torque (engine overspeed) protection, during periods of temporary fuel interruption, air gust loads, or power loss. The system functions by measuring negative torque values in the engine reduction gearbox and increases propeller blade angle by overriding the propeller governor whenever a negative torque value of minus 230 hp to minus 320 hp is detected.

Engine turbine inlet temperature (TIT) is controlled by power lever position and through a fuel trimming system also known as the temperature datum (TD) system. The TD system has the capability to limit and control TIT.

The TD system limits TIT to values below 1077° whenever the power lever is beyond the 60° (66° coordinator) position and engine rpm is greater than 13 000 (94 per cent). The TD system limits TIT to values below 830° during engine start, acceleration up to 94 per cent, and operation in low-speed ground idle. The TD system controls TIT to a power lever-established value when engine speed exceeds 13 000 rpm and power lever position is greater than 66°. If the system is operating normally, it is not possible to exceed engine temperature limits.

Information provided by propeller system consultants and the Convair type certificate holder indicated that it is possible to induce undesired activation of the NTS system through a rapid advancement of the power lever followed by a quick retardation. This type of power lever movement could result in inertial propeller forces conflicting with the TD system mode in unusual flight regimes. An undesired NTS activation at low airspeed could cause the engine to under speed and flame out.

Flight Characteristics

Shortly after the occurrence, the Saskatchewan Government, in conjunction with TSB investigators, conducted a flight in a similarly equipped CV-580A. Several single engine go-around procedures were simulated in different aircraft configurations. In summary, the results were as follows:

- When a go-around was carried out from an airspeed greater than V2 and as directed in the AOM (maximum power, flaps 15°, positive rate, gear up), a successful go-around was achieved.

- When a go-around was attempted by retracting the landing gear first, with the right engine power set at the 28° coordinator position, and the flaps remaining at 24°, the aircraft would not accelerate to V2, and a steady positive rate of climb could not be achieved. Aircraft control was maintained.

- When a go-around was attempted with flaps 24°, airspeed at 94 KIAS, in a 5° bank in a left turn, a positive rate of climb could not be achieved. Directional control was barely manageable with the flaps at 24°, but was lost when the flaps were retracted; the angle of bank increased, and the aircraft eventually entered an incipient spin.

- With both engines operating and set to 100 hp per side, each time the power levers were rapidly advanced at a stabilized airspeed of 105 KIAS, an unwarranted autofeather was induced.

Analysis

The aircraft was at an unusually low airspeed on short final approach when the flaps were lowered from 24° to 28°. The resulting increased drag combined with the low power setting likely produced the rapid rate of descent. The weather at La Ronge at the time of the occurrence indicated that wind shear was unlikely.

Following the rapid rate of descent on short final approach, an unintentional shutdown of the left engine and propeller occurred when the first officer rapidly advanced the power levers. An inadvertent engine shutdown can normally be handled without losing control of the aircraft, given the performance capabilities of the aircraft and crew training for such emergencies. This analysis will focus on why the control loss was not avoided.

The crew's handling and perception of the engine power settings, the unexpected autofeather, and the crew members' inability to identify the emergency all contributed to a loss of situational awareness with respect to the aircraft's energy status and the nature of their emergency.

The autofeather system does not incorporate a delay between the time a low propeller thrust condition is detected and the time the autofeather occurs. Therefore, with the propellers in a low-thrust condition, parameters were met for an autofeather and engine shutdown when the first officer rapidly advanced the power levers beyond the 60° position.

Several abnormal events occurred in rapid succession during the last seven seconds of the final approach. Consequently, the captain was unaware of the cause of the high sink rate, and when he made the decision to go around, he was not aware that the left engine had shut down. Attempting a go-around at or below V1 with a malfunctioning aircraft is contrary to the SOPs for this type of aircraft. This crew was not in a normal or anticipated situation. Go-around procedures are developed with the expectation that the procedure will be initiated before landing, while the aircraft is still airborne. Rejected take-offs, and their associated safety speeds, assume an engine failure or malfunction during the take-off roll. The accident crew found themselves in a situation that fell somewhere between a go-around and a rejected take-off.

Attempting a go-around at a point where the crew had intended to land, deviating from the go-around SOP, and the captain's retarding the power levers all contributed to the crew losing situational awareness. The result was confusion in the cockpit and a breakdown of crew coordination, which impeded the crew's ability to recognize and deal with the engine autofeather and shutdown.

At the airspeed and landing weight at which the aircraft touched down, there was more than sufficient distance remaining to stop under normal conditions, and the aircraft's heading was closely aligned with the runway. However, inconsistencies between different sections of the AOMs, the lack of a checklist for training in the circuit, and the absence of information on rejected landings likely contributed to the confusion that the crew experienced, which affected the decision to initiate a go-around.

The impact marks on the right engine's coordinator cam indicate that the captain had reduced the right power lever to approximately the 60° position, where it likely remained until impact. The first officer did not provide engine power status to the captain. Consequently, the captain was not aware that the remaining (right) engine was not set to deliver maximum power. The aircraft's TD system provides engine over-temperature protection; therefore, there was no immediate requirement for the captain to retard the power levers. Reducing power on the operating engine decreased the aircraft's energy status and likely contributed to its inability to accelerate to an airspeed at which control could have been maintained.

Because the flaps were not retracted to 15° upon initiation of the go-around, the aircraft did not accelerate and climb as it was capable of doing. When the flaps were retracted, the aircraft was in a left bank flight attitude, and the aircraft's bank angle and rate of descent increased. The aircraft then descended uncontrollably into the wooded terrain.

The erratic power lever movement increased the risk of an undesired activation of the right engine's NTS system, which may have produced an engine underspeed, reducing available power, and possibly causing the right engine to flame out. This situation would be consistent with the reported horsepower fluctuations. Without normal power on the remaining right engine, it would have been impossible for the aircraft to accelerate to an airspeed at which the aircraft was controllable.

The following TSB Engineering Laboratory reports were completed:

- LP 070/2006 – Fuel Analysis
- LP 049/2006 – Instrument Panel Caution Light Analysis
- LP 050/2006 – Electronic Flight Display Analysis

These reports are available from the Transportation Safety Board of Canada upon request.

Findings as to Causes and Contributing Factors

1. The flight crew attempted a low-energy go-around after briefly touching down on the runway. The aircraft's low-energy state contributed to its inability to accelerate to the airspeed required to accomplish a successful go-around procedure.

2. The rapid power lever advancement caused an inadvertent shutdown of the left engine, which exacerbated the aircraft's low-energy status and contributed to the eventual loss of control.

3. The inadvertent activation of the autofeather system contributed to the crew's loss of situational awareness, which adversely influenced the decision to go around, at a time when it may have been possible for the aircraft to safely stop and remain on the runway.

4. The shortage and ambiguity of information available on rejected landings contributed to confusion between the pilots, which resulted in a delayed retraction of the flaps. This departure from procedure prevented the aircraft from accelerating adequately.

5. Retarding the power levers after the first officer had exceeded maximum power setting resulted in an inadequate power setting on the right engine and contributed to a breakdown of crew coordination. This prevented the crew from effectively identifying and responding to the emergencies they encountered.

Findings as to Risk

1. The design of the autofeather system is such that, when armed, the risk of an inadvertent engine shutdown is increased.

2. Rapid power movement may increase the risk of inadvertent activation of the negative torque sensing system during critical flight regimes.

Other Findings

1. There were inconsistencies between sections of the Conair aircraft operating manual (AOM), the standard operating procedures (SOPs), and the copied AOM that the operator possessed. These inconsistencies likely created confusion between the training captain and the operator's pilots.

2. The operator's CV-580A checklists do not contain a specified section for circuit training. The lack of such checklist information likely increased pilot workload.

Safety Action Taken

On 30 October 2006, the TSB sent a Safety Information Letter (A060037-1) addressing autofeather risks to Transport Canada.

Conair revised its procedures with respect to engine power management to achieve and maintain a stabilized approach.

The Saskatchewan Government Northern Air Operations hired experienced training personnel and is in the process of developing operating procedures specific to their operation.

This report concludes the Transportation Safety Board's investigation into this occurrence. Consequently, the Board authorized the release of this report on 21 August 2007.

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