Transportation Safety Board of Canada

Bureau de la sécurité des transports du Canada

AVIATION OCCURRENCE REPORT

TAILSTRIKE ON LANDING

CANADA 3000 AIRLINES LTD.
BOEING 757-28A, C-FXOO
ACAPULCO, MEXICO
14 DECEMBER 1994

REPORT NUMBER A94F0048

Canada

MANDATE OF THE TSB

The *Canadian Transportation Accident Investigation and Safety Board Act* provides the legal framework governing the TSB's activities.

The TSB has a mandate to advance safety in the marine, pipeline, rail, and aviation modes of transportation by:

- conducting independent investigations and, if necessary, public inquiries into transportation occurrences in order to make findings as to their causes and contributing factors;
- reporting publicly on its investigations and public inquiries and on the related findings;
- identifying safety deficiencies as evidenced by transportation occurrences;
- making recommendations designed to eliminate or reduce any such safety deficiencies; and
- conducting special studies and special investigations on transportation safety matters.

It is not the function of the Board to assign fault or determine civil or criminal liability.

INDEPENDENCE

To encourage public confidence in transportation accident investigation, the investigating agency must be, and be seen to be, objective, independent and free from any conflicts of interest. The key feature of the TSB is its independence. It reports to Parliament through the President of the Queen`s Privy Council for Canada and is separate from other government agencies and departments. Its independence enables it to be fully objective in arriving at its conclusions and recommendations. Its continuing independence rests on its competence, openness, and integrity, together with the fairness of its processes.

Transportation Safety Board of Canada

Bureau de la sécurité des transports du Canada

Aviation Occurrence Report

Tailstrike on Landing

Canada 3000 Airlines Ltd.
Boeing 757-28A, C-FXOO
Acapulco, Mexico
14 December 1994

Report Number A94F0048

Synopsis

The aircraft, with a crew of 9 and 167 passengers on board, was on an international charter from Toronto, Canada, to Acapulco, Mexico. Following a visual approach to runway 28 at Acapulco, a tailstrike occurred on landing. There were no injuries and only minor damage occurred to the aircraft.

The Board determined that the flight crew had not retracted the speed brakes prior to landing, which resulted in a tailstrike. Contributing to the occurrence were actions which deviated from company standard operating procedures and the aircraft flight manual, ineffective crew resource management, and incomplete check-list procedures.

Ce rapport est également disponible en français.

Table of Contents

List of Figures

1.0 Factual information

1.1 History of the Flight

The Canada 3000 international charter flight, number CMM 3507, on 14 December 1994, was 4 hours and 53 minutes en route from Toronto, Canada, to Acapulco, Mexico. The aircraft, C-FXOO, a Boeing 757, was flown by a flight crew of two with a cabin crew of seven. There were 167 passengers on board.

On arrival at Acapulco, the aircraft was cleared for a visual approach to runway 28. The captain, who was flying the aircraft, briefed the visual approach with a very high frequency omni-directional range (VOR)[1] as the back-up approach. There was some doubt as to the serviceability of the instrument landing system (ILS); however, the ILS appeared to be working. The aircraft approached the final approach fix correcting to the localizer from the left, in level flight at approximately 2,100 feet above mean sea level (asl), at 210 knots, with flaps selected to position 5, the landing gear up, and the autopilot engaged.

Just prior to ILS glide slope interception, the captain selected the approach mode on the flight director.

Figure 1 - Profile View ILS 28 Acapulco, Mexico

Shortly afterwards, the aircraft nose lowered quickly, which resulted in an initial rate of descent of approximately 2,000 feet per minute (fpm); the descent rate eventually decreased and stabilized around 1,200 fpm. The captain selected speed brakes out in order to keep the speed from increasing. Approximately 41 seconds after the descent was started, an engine indication and crew alerting system

1 See Glossary at Appendix B for all abbreviations and acronyms.

(EICAS) AUTOPILOT caution message appeared, and the master caution lights illuminated (indicating degraded autopilot operation); eleven seconds later, as the aircraft descended through 800 feet above ground level (agl), the CONFIG light on the centre panel illuminated along with the master warning lights (indicating that the landing gear was not down). Seven seconds later the ground proximity warning system (GPWS) emitted an aural "Glide Slope" warning, indicating deviation below the glide slope[2].

At this point, the landing gear was selected down, and the autopilot was disengaged. Six seconds after the first GPWS warning, the GPWS aural warning "Too Low Terrain" came on; the glide slope and terrain warnings continued until the landing gear was down and locked, which occurred at approximately 400 feet agl, with the aircraft 3.2 dots below the glide slope at a speed of 185 knots. The flaps were lowered 14 seconds later and reached position 30 when the aircraft was at about 250 feet agl.

The aircraft touched down at 1709 central standard time (CST)[3] with the speed brakes deployed and the auto-throttles engaged, at a pitch attitude of 11.5 degrees nose up, and the tail of the aircraft struck the runway.

There were no injuries and only minor damage to the aircraft.

1.2 *Injuries to Persons*

	Crew	Passengers	Others	Total
Fatal	-	-	-	-
Serious	-	-	-	-
Minor/None	9	167	-	176
Total	9	167	-	176

1.3 *Damage to Aircraft*

The damage to the tail section consisted of a four-foot strip of paint scrapes and minor damage to the drain mast. The skin was not punctured and no interior structure was damaged. The paint scrapes were in an area about 15 feet off the ground, and in an area where there were dark-coloured streaks

2 Although there was some doubt as to the serviceability of the ILS, localizer and glide slope deviation indications during the approach appear to be valid when compared to the aircraft's behaviour and position as determined from the derived flight path reconstruction.

3 All times are central standard time (Coordinated Universal Time [UTC] minus six hours) unless otherwise stated.

(stains) created by the airflow. The damage went undetected during the external inspection in Acapulco by both the first officer and the captain; it was dark and a flashlight was used during the inspections. The damage was not detected during the maintenance inspection after the aircraft returned from Acapulco nor during the pre-flight external inspection by another first officer the day after the occurrence flight; the damage was discovered by a technician during the push back.

1.4 *Other Damage*

None.

1.5 *Personnel Information*

	Captain	First Officer
Age	63	35
Pilot Licence	ATPL	ATPL
Medical Expiry Date	01 Jul 95	01 Apr 95
Total Flying Hours	20,000[4]	5,037
Hours on Type	275	37
Hours Last 90 Days	110	37
Hours on Type Last 90 Days	110	37
Hours on Duty Prior to Occurrence	6.5	6.5
Hours Off Duty Prior to Work Period	50	50

4 Estimated total flying hours.

1.5.1 Captain

The captain had been employed on the Boeing 757 with the company since 14 December 1990. He progressed from first officer to captain in July 1993, and then completed training and was appointed a company check pilot, type A & B approval, in October of 1993. His group 1 instrument rating was valid to 01 December 1996. The captain had a long career in the Canadian military where he accumulated several thousand hours on transport type aircraft. His company and Transport Canada (TC) records reflect a competent pilot who had no difficulty with the company training or company check pilot programs. He had received the company one-day crew resource management (CRM) training.

The captain indicated that he was in good spirits and not under any stress prior to or during the occurrence flight. He did have some back pain from time to time due to arthritis and had a muscle relaxant prescribed; however, he had not taken any on the day of the incident, and he indicated that, in any event, there were no side effects to the medication.

The captain had been the check captain on the first officer's line check two days prior to the occurrence flight.

1.5.2 First Officer

The first officer was a new hire with the company who had just left the Canadian military, where he had previously flown the Aurora, a multi-engine, turboprop aircraft. He had completed his pilot proficiency check (PPC) on 30 November 1994, and his line indoctrination check on 12 December 1994. His group 1 instrument rating was valid to 01 December 1996. His records reflect satisfactory performance during training. The only comment was that he had a tendency to plan and execute approaches which resulted in long slow finals. The first officer had received the company CRM training, and he had instructed CRM in the military.

The first officer indicated that he was not under any unusual stress on the day of the occurrence, apart from his newness to this type of operation. He indicated, however, that he was tired as a result of his last scheduled flight. He had flown previously with the captain and was at ease flying with him.

1.6 Aircraft Information

Manufacturer	Boeing
Type	757-28A
Year of Manufacture	1992
Serial Number	25621
Certificate of Airworthiness (Flight Permit)	Valid
Total Airframe Time	12,621 hr
Engine Type (number of)	RB 211-535-E4 (2)
Maximum Allowable Take-off Weight	250,000 lb
Recommended Fuel Type(s)	Jet A1
Fuel Type Used	Jet A1

1.7 Meteorological Information

Based on the recollection of the captain and first officer, the weather at Acapulco on arrival was clear with calm winds and six miles visibility in haze. The captain indicated that he had the airport visual at 10 miles.

1.8 Aids to Navigation

Mexico distributes its Notices to Airmen (NOTAMs) via the Aeronautical Fix Telecommunications Network (AFTN). The NOTAMs are then available throughout the world simultaneously. NOTAM A3818/94, concerning the ILS to runway 28 at Acapulco, was received by TC in Ottawa on 14 December 1994 at 2204. The NOTAM stated that the Acapulco runway 28 ILS would be unserviceable from 2205, 14 December 1994, until further notice.

Canada 3000 receives its NOTAMs for Mexico via American Airlines (AA). AA has a direct connection with the Federal Aviation Administration AFTN computer and downloads all international NOTAMs to the SABRE system as they arrive on the AFTN computer. Canada 3000 uses the SABRE connection to download NOTAMs for specific areas. At 1702, the company queried the system for en route weather and NOTAMS for Toronto to Acapulco.

The NOTAM had not been issued at that time, and consequently was not in the crew's pre-flight briefing package. The NOTAM was received while the aircraft was en route, and the flight crew was not made aware of this NOTAM.

Upon arrival, the flight was advised by Acapulco air traffic control (ATC) that the ILS was not being used. Repeated attempts by the crew to determine the facility's status were unsuccessful, and the flight crew commenced the approach unsure of the ILS status.

One of the conditions for triggering the AUTOPILOT caution is an unreliable ILS signal.

1.9 Communications

The incident was reported to the TSB; however, the initial evaluation of the incident did not indicate a likelihood of uncovering any significant safety deficiencies, and the TSB decided not to investigate. About two months after the occurrence, when the flight data recorder data had been analyzed and a video animation produced and reviewed, it was decided that the incident should be investigated. As a result of the delay, the ATC tape was not available to the investigation.

The flight crew indicated that they attempted to clarify the status of the ILS without success, stating that the language and terminology used by the Acapulco ATC were factors that caused the crew's uncertainty about the ILS. After the incident, the company issued an internal notice to flight crews of the ILS problem in Acapulco and advised Transport Canada as well.

1.10 Aerodrome Information

Runway 28 at Acapulco is 10,827 feet long and is served by ILS, VOR, VOR/DME (distance measuring equipment), and NDB (non-directional beacon) approaches. The ILS glide slope was 2.7 degrees. Other than the ILS, the aerodrome and facilities were not factors in the incident.

1.11 Flight Recorders

The aircraft was equipped with a flight data recorder (FDR) and a cockpit voice recorder (CVR). The FDR data relating to the occurrence flight were recovered. The CVR data was overplayed during the return flight to Toronto.

1.12 *Approach*

1.12.1 *Company Approach Standards*

Canada 3000 pilots are instructed to fly approaches in the B757 in accordance with Boeing recommended procedures, modified, as necessary, to conform with company procedures and ATC instructions. Airport authorities increasingly are requiring operators to conform to low power, low drag approaches flown at high approach speeds to maximize arrival capacity and minimize noise disturbance. The requirement for high speed usually ends at the final approach fix or outer marker. However, for all approaches, Canada 3000 SOPs require that, by 500 feet agl on approach, the aircraft be stabilized on the glide slope at a speed of V_{Ref} + 10 knots, with the landing gear down and locked, the flaps set to a landing position, and the speed brakes in and armed for auto deployment on landing. The auto-throttles should be disengaged prior to the flare for landing.

1.12.2 *Approach Flown on Occurrence Flight*

As the result of instructions from Acapulco ATC, the captain, who was the pilot flying the aircraft, briefed for a radar vector to visual approach, backed up by the VOR approach. At approximately 10 miles, the flight was cleared for the visual approach. As the aircraft approached the final approach fix, it was being flown using the autopilot, and the auto-throttles were engaged in the speed mode. Because the receivers in the aircraft appeared to be receiving good signals from the ILS, the captain decided to engage the ILS approach mode of the autopilot at 23:06:37 upon glide slope interception. This action is not unusual because company management encourages the use of automatics during visual approaches, and at this point there was no instrument indication that the ILS was unreliable.

Just prior to intercepting the glide slope, the aircraft was 2.9 dots left of the localizer, at approximately 210 knots calibrated airspeed, 2,000 feet radio altitude, 7.1 DME, on a heading of 290 degrees magnetic to intercept the localizer, with the speed brakes in, flaps position 5, and the landing gear up. The autopilot captured the glide slope, the aircraft nosed over, pronouncedly, and the autopilot initiated an initial rate of descent of approximately 2,000 fpm to adjust for the aircraft initial placement above the glide slope. Fourteen seconds later, the captain extended the speed brakes to reduce speed so that more flap could be selected. At this point the aircraft was 1.9 degrees left of the localizer, the airspeed had increased to 216 knots, and the aircraft was approximately 0.7 dots above the glide slope. The aircraft flight manual (AFM) limits the use of speed brakes to 800 feet agl and above.

At 23:07:26, the master caution lights illuminated and the AUTOPILOT caution was displayed on the EICAS, indicating degraded operation of the autopilot. The following indications would also have been presented: removal of the FD command bars; caution aural (four beeps in one second, then silent); AUTOPILOT light illuminated on centre panel; and a yellow bar through the G/S mode annunciation. At this point, the autopilot would have stopped using the ILS for vertical navigation and would have reverted to the inertial mode for pitch. The flight crew did not react to the indications of degraded autopilot operation, and the aircraft continued in a descent rate of approximately 1,300 fpm. Also, by this time, the aircraft had intercepted and was tracking the localizer, the airspeed was decreasing through 208 knots, flaps were still at position 5, radio altitude was 1,000 feet, and the aircraft was now approximately 1.4 dots below the glide slope. Canada 3000 procedures require that the pilot not flying (PNF) alert the pilot flying (PF) by calling "SINKRATE" when the rate of descent exceeds 1,000 fpm on final approach during any instrument approach using a fixed angle for final descent; this was not done.

At 23:07:35, the flap handle was selected to flap position 15 and was then reselected to flap position 5. Neither pilot could remember making this selection; nevertheless, the FDR data show that the flaps did travel to position 15 and then back to position 5. It is possible that a mis-selection occurred, that flap was selected as opposed to landing gear, and that this was corrected immediately. It was not possible to determine which pilot initiated the flap change; it is normally the PNF who selects flap.

Approximately two seconds later, as the aircraft descended through 800 feet radio altitude, the FDR recorded LDG-Config-Gear. Cockpit indications for this warning would be as follows: illumination of the master warning lights; an EICAS warning GEAR NOT DOWN; illumination of CONFIG on the centre panel; and the warning siren. At the same time, there would have been an EICAS caution SPEEDBRAKES EXT, illumination of the SPEED BRAKES light on the centre panel, and an aural caution. (The aural caution would have been overridden by the landing gear configuration warning--a steady siren.) Seven seconds later, the landing gear was selected down by the first officer, on the instructions of the captain. Almost simultaneously, the GPWS aural warning "Glide Slope" sounded, and shortly afterwards, the GPWS aural warning "Too Low Terrain" sounded. Between these alerts, the captain disengaged the autopilot in order to complete the visual approach. Conversation was difficult with all of the background noise caused by the warnings, and, at the first officer's request, the warnings were cancelled.

As the aircraft descended through 500 feet radio altitude, an altitude at which the PF is supposed to call and at which the aircraft approach is to be stabilized, the aircraft was at an airspeed of 194 knots, the landing gear was in transit, flaps were still at 5, the aircraft was approaching 3.4 dots below the glide slope, the speed brakes were at 85 per cent[5], and the auto-throttles were still engaged.

Both the captain and the first officer were aware that the aircraft was not stabilized at 500 feet agl. The captain continued with the visual approach even though company policy and procedures direct that a go-around be performed if the approach is not stabilized in the landing configuration by 500 feet agl. The first officer was also aware of company policy, but he chose not to remind the captain because he considered that the captain had the situation in hand. The captain indicated later that, had he been in instrument flight conditions, there would have been no question that he would have gone around, but he indicated that he did not consider the deviation significant during a visual approach.

[5] The speed brakes had been selected from 100% to 85% at 23:07:15, although the captain could not remember making this selection.

The flight crew continued the approach, and the landing gear reached the down-and-locked position as the aircraft passed through approximately 400 feet agl. The flap was then selected to position 30 for landing. According to FDR data, the landing gear was not locked down until approximately 5 to 10 seconds prior to touchdown, at which time the speed had been bled off to V_{Ref}. On touchdown, the pitch attitude increased to approximately 11.5 degrees. During the landing, with the speed brakes deployed and the auto-throttles engaged, the tail of the aircraft struck the runway.

According to the flight crew, the landing check was commenced late and was rushed. The aircraft landed with the speed brakes deployed; therefore, the landing check was not completed--the speed brakes had not been retracted and armed. Neither the first officer nor the captain noticed that the speed brakes remained deployed. According to the Flight Operations Manual, the first officer shall assist the pilot-in-command in the execution of cockpit procedures and check-lists. It further states that the pilot-in-command will verify each item of the Before Landing check-list, and that check-list items may not be passed until they are completed. The PNF is required to call each item in the landing check and monitor for the correct response. Interpretation of the above means that both pilots are to ensure that all challenge-and-response checks are properly completed. In this instance, the captain (PF) did not retract and arm the speed brakes, and neither pilot ensured that the landing check-list was completed.

The operations manual states that the PNF is expected to monitor aircraft pitch on landing and call "PITCH - PITCH" should the nose reach or exceed 7.5 degrees nose up. The PF will prevent any further nose pitch increase and lower the nose to below 7.5 degrees. Neither pilot was monitoring the pitch angle during landing, and the call was not made.

On this approach, there should have been two other verbal prompts by the PNF to alert the PF that corrections were required during the approach. According to the AFM and company SOPs, there should be calls if the speed is more than 10 knots above the desired level, or if the glide slope deviation is 1 dot or greater; no call was made in either case. The first officer indicated that he had not noticed some deviations, and that each time he felt the need to prompt the captain, the captain was already making a correction.

The captain did not conduct a debriefing of the approach anomalies after the flight, and neither pilot wrote up a report. Canada 3000 does not have a policy regarding the types of anomalies and unusual circumstances that flight crews must report after a flight.

1.13 Organizational and Management Information

The potential for a tailstrike to occur during a landing with the speed brakes deployed was known by the manufacturer, the regulator, and the company, and training and procedures were in place to prevent tailstrikes.

The management of the company had, in fact, taken action on the basis of a similar tailstrike incident involving another carrier's B757 aircraft in June 1994. Specifically, in reaction to that occurrence, the company's B757 chief pilot had issued a letter to all B757 pilots summarizing the main issues of the occurrence and instructing his pilots to leave one hand on the speed brake handle when the speed brakes are deployed, and to communicate with the other pilot when deploying speed brakes on approach to ensure that both pilots are aware of the configuration. In this incident, the captain did not keep his hand on the speed brake lever, but he did advise the first officer of the deployment of the speed brakes. According to the captain, the speed brake lever was masked by his arm, as his right hand was on the throttles throughout the approach.

Company policy is for pilots to cancel the master warning and master caution lights and audible signals when they activate (to reduce distractions and reset the warning systems), read and understand the EICAS and light panels, and then cancel them as appropriate. The flight crew in this instance did cancel the cautions and warnings, but neither pilot noticed the SPEEDBRAKES EXT warning on the EICAS or the SPEED BRAKES light on the centre panel illuminate. A subsequent test of the occurrence aircraft by the company showed that the aircraft's EICAS and warning systems gave the proper indications.

In a letter to all B757 pilots subsequent to this occurrence, the chief pilot reviewed the procedures regarding stabilized approaches: the need for the landing gear and flap to be selected no later than 1,000 feet agl if there is no outer marker or final approach fix in use or the aircraft has been positioned inside these fixes; standard calls; check-list requirements; warning switch overrides; and response to GPWS warnings. The chief pilot also drew attention to the need for the pilots to carry out their duties in a professional manner. In this approach, the outer marker/final approach fix (OM/FAF) coincided with the interception of the glide slope; therefore, the flaps should have been selected and the landing check performed at that time.

The B757 chief pilot and other company managers were surprised with the captain's performance on the occurrence flight; he had always been an above average performer, and the incident was totally unexpected.

1.14 Automated Systems and VFR Flight

Automated systems use data from various sensors to diagnose the aircraft's flight path and attitude, and control the aircraft safely and efficiently. Because different phases of flight impose different flight control requirements, automated flight control systems operate in different modes, depending, for the most part, on the phase of flight and immediate tasks to be performed. When an aircraft is being flown using automation, it is important that pilots know the current operating mode and adjust their aircraft-performance monitoring strategy accordingly in order to maintain their situational awareness.

If a pilot is unaware of the current mode, or adopts a monitoring strategy inappropriate to the mode, important information can escape detection or be misinterpreted. Awareness of the operational mode allows the pilot to accurately interpret or predict automated system control inputs, warnings, and alarms. Inaccurate situational assessment can lead to misinterpretation of information and events, confusion, or loss of valuable time in assessing the situation.

During this approach, the captain coupled the autopilot to the ILS system. However, while the automated system was attempting to control the aircraft according to the ILS, the captain devoted most of his attention to external lookout and relied heavily on external cues to assess the safety of the approach, as would be appropriate if he were manually flying the aircraft on a visual approach.

1.15 Flight Data Recorders and Accident Prevention

There are systems available, using data from aircraft flight data recorders, that allow users to routinely analyze trends and identify anomalies on completed flights. Such systems are not yet in use in Canada, but are being used extensively in Europe and becoming popular in the United States. The use of these types of systems as an effective means of accident prevention is being encouraged by the International Civil Aviation Organization (ICAO). As an added benefit, frequent data play-backs increase the likelihood that a recorder will be serviceable and the documentation in order in the event of an occurrence. However, the cost of such a system is significant, and there are flight crew union considerations regarding its implementation and use. The term now in use for this manner of using recorded information is Flight Operational Quality Assurance (FOQA).

Analysis of recorded data can provide to the operator information such as engine performance, fuel burn, aircrafts speeds, flight profiles, and equipment use and performance. The information can provide warning of pending equipment failure and insight toward the development of safer and more efficient procedures and practices. Training, in the aircraft and simulators, can then be tailored to focus on problem areas made apparent through analyses of the data. Individual pilots need not be identified in order for the operator to benefit from these programs; it is generally accepted that the program should be used to identify ways of improving the safety and efficiency of an airline, not to monitor individual pilot proficiency.

With a FOQA program the company may have been alerted to the possibility of an occurrence such as this one, and trained or briefed for its prevention. Although FOQA systems are available, the cost of implementation is high and they are not yet in use by other Canadian airlines. It is, therefore, not surprising that Canada 3000 does not have such a system in place. When the damage to the aircraft was discovered, the company was concerned, and the FDR data was used to determine the circumstances of the occurrence.

2.0 Analysis

2.1 Introduction

The flight crew did not fly this approach in accordance with SOPs, and the tail of the aircraft struck the runway on landing. The tail struck the runway because the speed brakes were still deployed, which resulted in a high angle of attack to maintain required lift and a consequent high aircraft pitch angle. The analysis will discuss flight crew attitudes and procedures, company standard operating procedures (SOPs), CRM, and aircraft warning systems.

2.2 Flight Crew Attitudes and Procedures

The incident might have been avoided if the captain or the first officer had complied with the Boeing 757 aircraft flight manual and company SOPs, which state that a missed approach must be initiated if the aircraft is not stabilized on the approach and in the landing configuration, at the latest, by 500 feet agl. The captain and first officer both acknowledged that they were aware of this rule, and were aware that at 500 feet agl, on this approach, the approach was not stabilized.

The captain's decision to continue the approach even though the approach was not stabilized at 500 feet agl was based on his evaluation that, despite the deviations, he could salvage the approach.

The first officer, although aware that the aircraft was not stabilized at 500 feet agl, was confident that the captain was in complete control and was taking effective action to complete the approach and landing. Given his limited experience in line operations and limited time in the company, he was reluctant to suggest to an experienced company check pilot that he execute a missed approach.

The result is that neither pilot initiated a missed approach. If the tailstrike had not occurred on landing, with the resultant aircraft damage, no one else would have been aware of the anomalies associated with the approach and landing since no report was required and neither pilot considered it necessary to write one. In addition, the sounding of a GPWS warning on approach is also an event requiring a go-around, according to SOPs. That a missed approach was not conducted is considered a lack of application of the procedures involved in the operation.

2.3 Occurrence Reporting

The company did not have a policy regarding the types of unusual circumstances that would prompt a flight crew to file a report; however, given the warnings, cautions, and GPWS activity during the final approach on this occurrence, the captain should have considered this flight to be somewhat unusual. The ILS and/or the aircraft autopilot's inability to properly fly the glide slope could have been reported to allow follow-up action to take place. The anomalies were eventually reported after the aircraft damage was discovered.

2.4 Standard Operating Procedures

The captain chose to deploy the speed brakes shortly after glide slope interception instead of following the approved Boeing AFM procedure and company SOP of lowering the landing gear and flaps to maintain the desired speed. On this approach, the glide slope interception was coincident with the OM/FAF, which is when the landing gear would normally be lowered.

The procedure of delaying extension of the landing gear until the outer marker or final approach fix, or approaching 1,000 feet agl if inside these positions, is included in the company SOPs, and is in accordance with national and international procedures. After the occurrence, the chief pilot sent a letter to all pilots reinforcing the procedure. A configuration warning will activate when the aircraft descends below 800 feet agl if the landing gear is not locked down. During an approach at normal rates of descent, if the landing gear were selected at 1,000 feet agl, it would be locked down by 800 feet. The landing gear was selected down at about 700 feet agl, and the warning activated. This warning undoubtedly added to the confusion of the flight crew caused by all of the other warnings and cautions.

Neither the manufacturer nor the company approves of using the speed brakes on final approach, whether in instrument or visual conditions, to keep the speed back. It is recognized that there is potential for forgetting the speed brakes in the deployed position, which greatly increases the possibility of a tailstrike on landing; hence, the rule that the speed brakes be retracted by 800 feet agl on descent.

The occurrence demonstrates that the deployment of the speed brakes, the delay in lowering the landing gear and flaps, and the incomplete landing check which allowed the continued deployment of the speed brakes contributed directly to the incident and the damage. There were, seemingly, adequate check-lists, check-list procedures, standard operating procedures, and aircraft system cautions and warnings in place to prevent this occurrence. However, the manner in which the captain flew the aircraft and completed his duties as the pilot-in-command circumvented all of the safeguards. The first officer, new and inexperienced with the aircraft and the company, did not adequately monitor that the captain was conducting the approach properly, and, when required, he did not effectively or aggressively convey his concerns to the captain.

2.5 Crew Resource Management (CRM)

CRM is interaction of the crew, especially the flight crew during flight, with the object of maintaining situational awareness and flying the aircraft in accordance with procedures and safe practices. Effective CRM is marked by good communication, assertiveness of crew members, leadership on the part of the captain, adherence to company procedures and policies, and good decision making.

Based on the information provided by the flight crew and the FDR data, effective CRM was absent in the late stages of this flight. In particular, the captain did not re-brief the approach when he decided to use the ILS; he did not keep the first officer updated on his intentions; he did not perform the landing check properly; his actions at the 500-foot agl stabilization point and in response to the GPWS warning were inappropriate; and his analysis of the situation was inconsistent with the warnings and input that he was receiving from the aircraft systems. By not involving the first officer more directly, the captain made it difficult for the first officer to provide effective feedback during the approach.

The first officer, as well, did not practise effective CRM. He did not make the mandatory calls on deviations which were occurring during the final approach, specifically the high rate of descent, high speed, excessive glide slope deviation, and excessive aircraft pitch attitude; he did not reinforce the 500-foot stabilization point by advising the captain that the approach was not stabilized; and he did not ensure that the landing check was completed properly. In summary, the first officer was ineffective in correcting the deficiencies during the approach. This situation could have been attributable to the first officer's inexperience with the company and on the aircraft, and perhaps he extended too much professional courtesy to the captain, given his status with the company. The first officer had instructed CRM during his military flying, had taken the company CRM course, and had over 5,000 hours flight time. One could expect him, with this background, to have been more active and assertive during the approach.

The captain got behind on this approach because he concentrated more on the visual approach than on the ILS approach that the autopilot was flying, and he did not re-brief the approach or advise the first officer when he changed his mind and coupled the autopilot to the ILS. From that point, the first officer was in a poor position to contribute to the approach because he was unsure of what would be required of him due to his inexperience on the line. The first officer's reluctance to prompt the captain throughout the approach probably contributed to the captain's sense that the situation was under control.

When the captain coupled the autopilot to the ILS, he did not adjust his monitoring technique to take into account how the autopilot was coping with the ILS approach. Instead, he continued to devote more attention to external cues, which would have been less precise than information displayed on aircraft instruments. This mixing of monitoring cues can lead to confusion and compound problems when difficulties arise during an approach. It should be understood by both members of the flight crew, before the approach is commenced, what procedures will be followed, thereby assisting in the maintenance of situational awareness.

When the ILS became unreliable and the aircraft increased its rate of descent, the captain's detection and interpretation of the events was probably slower than would have been the case if he had been devoting the majority of his attention to the automated system. The captain's situational awareness was degraded to the extent that, for the remainder of the approach, he was reacting to the situation rather than anticipating and controlling it. He eventually defaulted to the visual approach, by disengaging the autopilot, in order to salvage the approach and landing.

The first officer's appreciation of the situation differed from that of the captain's. In particular, he was unsure of the captain's intentions; the captain had briefed the approach and had then changed the plan without re-briefing. Also, the first officer's limited time on the line and limited exposure to this type of approach gave him few references for comparison; therefore, he was not able to assist the captain. The first officer was aware of some aspects of their situation, but, without effective communications with the captain, he was reluctant to act.

This interaction between the captain and the first officer resulted in confusion, breakdown in crew functions, rushed and incomplete procedures, and late, inappropriate decision making, all of which contributed to the tailstrike.

2.6 Aircraft Systems

The aircraft performed as it was designed to during this approach and gave the warnings, cautions, and messages required under the circumstances. It appears that the captain and first officer were confused by the many warnings that occurred in such a short period of time. They did not react to the EICAS AUTOPILOT caution and associated indications, and could not recall exactly what warnings and EICAS messages they received. Nevertheless, given the uncertainty of the status of the ILS, the captain could have discontinued its use when the aircraft started to descend below the glide slope and at an excessive rate.

Eventually, the captain disengaged the autopilot and attempted to salvage the approach and landing. Ironically, the systems in the aircraft that are there to assist the flight crew in maintaining situational awareness (e.g. EICAS, GPWS) became a hindrance to communication on the flight deck because of the volume and frequency of aural and visual signals being emitted during the approach. Both crew members probably knew that the aircraft systems logic will issue a configuration warning at 800 feet agl if the landing gear is not extended, that a speed brake caution will be issued if the speed brakes are extended below 800 feet agl, and that the GPWS will issue warnings regarding the glide slope and terrain for the conditions of the occurrence approach. However, the crew's responses to the warnings and the fact that they did not anticipate the warnings indicate either of the following: they did not have an adequate appreciation of the warning systems and their interactions in a dynamic situation; or they were so far behind the aircraft that they did not even think that the manner in which the approach was being flown would trigger the warnings and cautions. Whether it was inadequate appreciation or being behind the aircraft, or both, the situation was unusual, especially for a company check pilot and a recent graduate of the company's initial training program.

3.0 Conclusions

3.1 Findings

1. The flight crew was certified, trained, and qualified for the flight in accordance with existing regulations.

2. There was no evidence that physiological factors affected the flight crew's performance.

3. The aircraft was serviceable and provided the appropriate warnings and cautions to the flight crew during the approach.

4. The ILS at Acapulco was NOTAMed off the air; however, the flight crew did not receive this NOTAM.

5. The flight crew were unsure of the ILS status, and their attempts to confirm verbally its status were unsuccessful.

6. The AUTOPILOT caution was probably the result of the ILS glide-slope transmitter not functioning properly.

7. CRM principles were not in evidence during the final approach, despite both members of the flight crew having received CRM training.

8. In order to keep the speed back after glide slope interception, the captain deployed the speed brakes, instead of lowering the landing gear and flaps in accordance with the AFM and SOPs.

9. The flight was not stabilized by 500 feet agl, and the captain did not perform a go-around as required by company procedures.

10. The first officer did not make the mandatory deviation calls required by SOPs during the approach and landing.

11. The captain used an inappropriate monitoring technique during the visual approach with the autopilot coupled to the ILS, which resulted in confusion and delayed decision making.

12. The captain did not keep his hand on the speed brake lever as recommended by the manufacturer and the SOPs.

13. The flight crew completed the approach and landing with the speed brakes deployed, which resulted in the tailstrike; the crew did not monitor the pitch angle on landing.

14. The company did not have a policy regarding the types of unusual circumstances that would prompt a flight crew to file a report with regard to a flight.

3.2 Causes

The flight crew had not retracted the speed brakes prior to landing, which resulted in a tailstrike. Contributing to the occurrence were actions which deviated from company standard operating procedures and the aircraft flight manual, ineffective crew resource management, and incomplete check-list procedures.

4.0 Safety Action

4.1 Action Taken

4.1.1 Operator Action

Two days after the incident, the operator issued a letter to its Boeing 757 pilots highlighting the main issues arising from the company's analysis of the FDR data. Policies and procedures were reinforced for stabilized approaches by 500 feet agl, gear and flap extension in IMC and VMC, communications, use of ground proximity flap or configuration gear override, and GPWS. In January 1995, another letter was issued stressing the earlier letter and implementing an additional SOP concerning the cancellation of warnings or cautions in the cockpit.

The company has reportedly entered into discussions with a major airline to introduce Flight Operations Quality Assurance and is updating its training with respect to automation in the cockpit. The company is also refining its CRM training program.

4.1.2 Transport Canada Aviation Action

4.1.2.1 Managed Drag Approaches

As a result of this occurrence and feedback from Canada 3000 pilots, Transport Canada and Canada 3000 reviewed procedures for Boeing 757 managed drag approaches. These procedures were subsequently enhanced to ensure that crews have clear guidance on the technique required and on the need to conduct a go-around if the approach is not stabilized by the minimum altitude specified in the SOP. Company check pilots were briefed about the increased potential for unstabilized approaches that could result from over-emphasis on managed drag approaches.

4.1.2.2 Standard Operating Procedures (SOPs)

The new Canadian Aviation Regulations contain requirements pertaining to company SOPs. The SOPs must enable crew members to operate the aircraft within the limitations specified in the aircraft flight manual and must meet the commercial air service standards. Operators will be required not only to establish and maintain SOPs, but also to train and test their pilots in the application of SOPs.

4.1.3 International Civil Aviation Organization (ICAO) Action

Analysis of data from recording devices such as digital Flight Data Recorders (FDRs), Quick Access Recorders (QARs), and Health and Usage Monitoring Systems (HUMS) can result in the early detection of safety hazards and the initiation of appropriate corrective measures. Accordingly, in March 1995, ICAO reported its intention to include, as a recommended practice, a requirement that operators establish, in co-operation with their flight crews, a non-punitive performance monitoring programme.

This report concludes the Transportation Safety Board's investigation into this occurrence. Consequently, the Board, consisting of Chairperson Benoît Bouchard, and members Maurice Harquail and W.A. Tadros, authorized the release of this report on 20 August 1996.

Appendix A - List of Supporting Reports

The following TSB Engineering Branch Laboratory Report was completed:

LP 36/95 - FDR Report.

This report is available upon request from the Transportation Safety Board of Canada.

Appendix B - Glossary

AA	American Airlines
AFM	aircraft flight manual
AFTN	Aeronautical Fix Telecommunications Network
agl	above ground level
asl	above sea level
ATC	air traffic control
ATPL	air transport pilot licence
CRM	crew resource management
CST	central standard time
CVR	cockpit voice recorder
DME	distance measuring equipment
EICAS	engine indication and crew alerting system
FAF	final approach fix
FDR	flight data recorder
FOQA	flight operational quality assurance
fpm	feet per minute
GPWS	ground proximity warning system
hr	hour(s)
ICAO	International Civil Aviation Organization
ILS	instrument landing system
lb	pound(s)
NDB	non-directional beacon
NOTAM	Notice to Airmen
OM	outer marker
PF	pilot flying
PNF	pilot not flying
PPC	pilot proficiency check
SOP	standard operating procedure
TC	Transport Canada
UTC	Coordinated Universal Time
VFR	visual flight rules
VOR	very high frequency omni-directional range