AVIATION INVESTIGATION REPORT
A97O0077

REVERSED ELEVATOR TRIM TAB CONTROL

KELOWNA FLIGHTCRAFT LTD.
CONVAIR 340/580 C-GKFO
HAMILTON, ONTARIO
14 MAY 1997

Aviation Investigation Report

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Summary

The Convair 340/580 aircraft, serial number 78, was being utilized on a regularly scheduled courier flight carrying freight between Hamilton, Ontario, and Mirabel Airport, Quebec. The flight was being conducted at night, on an instrument flight rules (IFR) flight plan departing at 0029 eastern daylight saving time (EDT). During the take-off roll, as the aircraft was approaching lift-off speed, it pitched nose-up to a climb attitude and became airborne with very little input from the captain. The aircraft continued to increase its nose-up attitude despite the captain's efforts to control it. Even with full nose-down trim and the pilots' considerable force on the controls, the nose of the aircraft continued to rise. Both pilots had to use their feet to push the control column forward; they were able to maintain pitch control of the aircraft. After some experimentation with various power and flap settings they found that they could put the aircraft in a descent by entering a moderate turn. After having notified Hamilton air traffic control (ATC) that they were having control difficulties, they returned to Hamilton for landing. They requested that the emergency response vehicles be called out for the landing. The crew safely landed the aircraft on runway 24 at 0043 before the arrival of the emergency response vehicles. There was no damage and no injuries.

Ce rapport est également disponible en français.

Other Factual Information

On the evening of 13 May 1997, the flight crew arrived at the Ontario Flightcraft facility at the Hamilton Airport to prepare for a scheduled courier flight from Hamilton to Halifax,
Nova Scotia, via Montreal, Quebec. The aircraft had been loaded, and documentation, including weight and balance, maintenance records, and flight plan, was checked by the flight crew prior to boarding the aircraft. It was noted by the flight crew that considerable maintenance work had been done to the aircraft and that some of the work had involved the elevator and elevator trim.

The Convair has been described by flight crews as being very heavy on the controls. On this flight, the first abnormal symptom occurred during the take-off roll when the aircraft reached
Vr (rotation speed); it almost lifted off the runway by itself. The captain (the pilot flying) immediately began trimming the aircraft nose-down. As the aircraft became airborne, picking up speed, the nose pitch-up force became stronger, requiring significant counter-pressure on the control column to keep the nose in a normal climb attitude. The pilot continued to increase the nose-down trim and he noted that, as the aircraft was accelerating, the pitch-up force was increasing. He asked for assistance from his first officer as he reached full nose-down trim. Both crew members came to the conclusion that they had a centre of gravity (C of G) problem, either from incorrect loading or due to the load shifting on take-off.

The first officer (a qualified training captain) immediately unfastened his seat belt and brought both feet up to the control column so that he could exert greater forward pressure on the control column. The captain also placed his feet on the control column. The aircraft reached an altitude of approximately 6 700 feet above sea level (6 000 feet above ground level). The captain was able to make turns by controlling with his feet. The flight crew tried varying engine power settings, cycling the landing gear and flaps, but none of the configurations had a significant effect on the aircraft pitch attitude. The landing gear was left extended and the flaps were left at 10 degrees.

Because the flight was not following the standard instrument departure route (SID), ATC began to query the intentions of the flight crew. The flight crew were slow to respond but did indicate that they had a flight control problem and were returning to land on runway 30R. When the controller asked the nature of the control problem, the first officer replied that they were too busy to explain. As the aircraft circled the airport, the captain looked and did not see the rotating beacons of any of the emergency response services (ERS) equipment; the controller informed him that 911 had been called and the ERS equipment was on the way.

As they brought the aircraft around, the flight crew noted that, during the turns, when the bank angle exceeded 10 degrees, the nose would drop and the aircraft would descend. Using this technique, the crew was able to bring the aircraft around and line up for a landing on runway 24. When the aircraft was on short final, about to cross the runway threshold, the captain removed his feet from the control column so that he could have control with his hands for the landing. This action reduced the counter-pressure on the control column and resulted in the aircraft flaring for the landing. The aircraft touched down firmly on runway 24 and the crew was able to bring it to a complete stop on the runway. ERS had not yet arrived at the airport. Following the landing the aircraft taxied normally to the Ontario Flightcraft hangar.

At the hangar, the aircraft load was inspected, the C of G was recalculated, and the load was re-weighed. All indications were that the aircraft weight and balance were within limits. When the aircraft was inspected in

detail, it was discovered that the elevator trim tab was in the full nose-up position and moved in the opposite direction to the trim control wheel and to the trim indicator in the cockpit. There was no damage to the aircraft structure or any of its components.

The captain had worked for the company for about two years. He had approximately 8 000 hours flying time, of which 25 hours were on the Convair aircraft, models 580 and 5800. Most of his experience was as a first or second officer on the Boeing 727 aircraft. He had recently been upgraded to captain status on the Convair. This flight was part of the captain's line check.

The first officer was a qualified training captain on the Convair aircraft. He had accumulated a total flying time of 16 500 hours, of which 5 500 hours were on Convair aircraft.

Kelowna Flightcraft Ltd. had operated a maintenance base at Hamilton for three years. The base had expanded recently because of the company's work with Greyhound Air, and because of continued growth in the courier air freight industry. The expansion required new staff but the company found that there were few licensed aircraft maintenance engineers (AME) available, so they hired apprentices. There are no regulations regarding the ratio of licensed engineers to apprentices in a company. Over half of the employees at the Hamilton base were apprentice engineers. At the time of the occurrence, there were approximately 110 maintenance personnel at the Hamilton base. Of these, there were 36 who were directly involved in aircraft line maintenance. The line maintenance personnel were divided into 4 crews of 9 and were required to maintain 24-hour coverage. To do this, the crews worked rotating 10-hour shifts. The maintenance work, involved in this occurrence, took place on the second and third nights of a four-night work cycle. The crew had been working the night shift for a period of five weeks. They were on days off from May 6 to May 8 and started back on the night shift schedule on May 9; it was their last night shift cycle before returning to the day shift cycle.

The occurrence aircraft was a Convair 440 which had been converted by supplemental-type certificate to a Convair 580. This was an older generation aircraft for which the company had not yet developed a complete set of work or task cards. The aircraft had 70 883.3 hours (110 707 cycles) total time as of 10 May 1997. The aircraft was brought into the Hamilton maintenance base five days prior to the occurrence flight for the completion of numerous maintenance tasks. Included in those tasks were a number of non-destructive tests (NDT) for corrosion and crack inspection. These NDT were part of an on-going aging-aircraft inspection program. Part of this inspection included an ultrasonic and an X-ray inspection of the horizontal stabilizer attachment fittings. Although the X-ray inspection was negative, the ultrasonic inspection produced a positive indication on one of the horizontal stabilizer attachment fittings. The right horizontal stabilizer and elevator were removed to gain access to the fitting for a visual inspection. The elevator and stabilizer were removed as a single unit, which meant that only the elevator connection bolts, the stabilizer connection bolts, and the elevator trim cables needed to be disconnected. The elevator trim cables were not marked when they were disassembled; it is not a procedure specified in the maintenance manual, but is one that is considered good practice in the industry. When the stabilizer was removed, it was determined that there was a small amount of corrosion on the fitting lug. The fitting was repaired, and the horizontal stabilizer and elevator were reinstalled.

The maintenance crew that removed the stabilizer assembly was not available when it was time to reinstall the stabilizer. The crew that was present to finish the job normally consisted of a crew chief, two lead AMEs, and six apprentices. When the reinstallation of the stabilizer assembly began, one of the lead engineers was absent because he had requested a day off, and the other lead engineer had phoned in to say he would not be available because of illness; therefore, the crew consisted of the crew chief and six apprentices. The crew chief had an

energetic, hands-on, supervisory style, and he provided close supervision. He took two of his apprentices and showed them how to install the stabilizer and elevator. He then took one of the apprentices inside the tail of the aircraft to hook up the elevator trim cables. The crew chief selected the cables and the apprentice installed the turnbuckles. The crew chief then provided the apprentices with the appropriate information on bolt torque and cable tension and left them to complete the job. It was the view of the crew chief that he was helping the apprentices with the routine but important task of installing and inspecting the stabilizer, elevator, and elevator trim systems. The apprentices, on the other hand, viewed their task as lending a hand to the crew chief who was responsible for the work. All of the work related to the reinstallation of the elevator and stabilizer was completed on the Sunday, 11 May 1997, on the night shift. The following night, both lead AMEs were available so the crew was at full staff. On this shift, the crew chief instructed one of the AMEs to complete an "independent inspection" of the work. After inspecting the work, the AME pointed out to the apprentices several items which had not been properly completed, including missing cotter pins and locking clips, a nut which was not fully installed on its bolt, and lock wire which was not of adequate thickness. The apprentices then redid the work and presented it for reinspection. Because of concurrent tasks, the AME did not reinspect the work until the end of the shift, and he did not have any assistance while accomplishing the inspection. Since the details had been completed satisfactorily, he checked that the system was free from binding by running the trim system from full nose-down to full nose-up trim. He then checked that the elevator trim tab was at full deflection when the trim control was moved to full nose-down and full nose-up selections, and that the tab was in neutral when the trim indicator indicated neutral. Since the elevator trim tab is not visible from the cockpit, this involved setting the trim in the cockpit, exiting the aircraft, and walking around to the aircraft tail to check the trim tab position.

The elevator trim tab control cables run side-by-side, under the floor along the belly of the fuselage into the tail section where they angle upwards to the rear bulkhead. At the bulkhead, the cable direction changes to the right and the cables run one on top of the other (the inside cable becomes the top cable) along the spar out into the right horizontal stabilizer. This change of orientation (side-by-side to one on top of the other) means that the cables are not parallel as they angle up to the rear bulkhead. This change of orientation is represented on the aircraft maintenance manual diagrams as the cables coming together to a point at the rear bulkhead pulleys. Two turnbuckles are located midway along the rising span of the cable run in the tail section and allow the trim cables to be separated when the removal of the trim control is necessary. The turnbuckles are only slightly staggered when the control is in the neutral position. Looking at the two-dimensional drawing of the cable installation in the aircraft maintenance manual does not immediately indicate that the cables do not cross each other when correctly installed.

At the end of the shift, the lead engineer assisted the crew chief in filling out the aircraft logbooks. According to the maintenance logbook entry, the horizontal stabilizer and elevator were reinstalled and the rigging was checked as per the maintenance manual, although no one actually completed the task of checking the rigging. The crew chief had asked an apprentice to follow the rigging procedure as detailed in the maintenance manual, and he had highlighted two of the important tasks of the rigging by telling him to pay special attention to the cable tension and to a particular dimensional check. The apprentice understood the instruction as a request to check the cable tension and dimension, which he did; the rigging was not performed properly.

The maintenance entry was signed as having been completed by the AME who had actually completed the "independent inspection", while the "independent inspection" was signed off by the crew chief who supervised the task. This occurred at the end of the shift when logbooks from several aircraft were being completed and signed by the two AMEs. Both AMEs felt confident in the other's work, and they simply signed off the work

completed by the crew, regardless of their personal involvement. The previous concept, as outlined in *Airworthiness Manual* (AWM) 571.209, was that the inspection would be completed by a person who was completely independent from the persons who accomplished the work.

This incident occurred as the Hamilton base was undergoing a managerial change. The nature and complexity of the Hamilton operation had changed and Kelowna Flightcraft Ltd. felt that a new manager was necessary. One of the first initiatives of the new manager was a change in shift schedule. However, the old shift schedule, which was generally disliked by the employees, was still in use at the time of the occurrence. The old shift schedule was a complex cycle that repeated every eight weeks. It involved working between four and seven consecutive days, followed by three to six days off. Each shift was 10 hours long. In this occurrence, the elevator trim tab had been installed by a crew that was working their last set of nights, after having been on night shifts for five weeks. (The actual control cable attachment was accomplished between the hours of 0300 and 0500. These times coincide with the low point in a person's normal circadian rhythm.

Kelowna Flightcraft Ltd. has numerous bases throughout Canada, with line maintenance at each base. The company has adopted a centralized system of maintenance control with maintenance planning being accomplished at the company's head office in Kelowna, British Columbia. An index sheet detailing the work to be done on a particular aircraft was faxed to the base where the aircraft was located. At the end of the shift, the base would fax details of the work that had been performed back to the maintenance control office. Task cards were used to detail the work required for the regularly scheduled inspections. Non-scheduled maintenance was done by reference to the company's maintenance control manual (MCM). The removal and re-installation of the horizontal stabilizer on this night was done by reference to the MCM.

Initial training for new apprentices was limited to self-study of the company's policy and procedures manual. The crew chief and lead hand were responsible for on-the-job training to ensure that the apprentices learned how to do the various tasks required of them. Licensed engineers received aircraft type training leading to type endorsements for the various aircraft that the company operated. No additional training was given to help the crew chief to carry out the supervisory and training aspects of the job.

The "independent inspection" is required by the *Canadian Aviation Regulations* (CARs) as a recognition of the possible serious consequences when flight controls or power plant controls are worked on. CARs Standards 571.10 specifies that work that disturbs engine or flight controls be inspected for "correct assembly, locking and sense of operation, by at least two persons, and the technical record contains the signatures of both persons. Information Note: *One of the signatures required by this section may be that of the person who has signed the maintenance release*."

Part of the "independent inspection" is the requirement to inspect for correct sense of operation (i.e. that the trim tab moves in the desired direction); there is no requirement to check for correct range of travel. On this aircraft, it is not possible to observe the motion of the trim tab from the cockpit. To accomplish the "independent inspection", the AME moved the control fully through the entire range of motion and checked the actual position of the trim tab three times by going to the back of the aircraft and observing the tab in the full-up, full-down, and the neutral position. The elevator trim tab moves in a direction opposite to the elevator. Moving the cockpit trim control towards the nose-down position causes the trim tab to move trailing edge up,

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[1] All times are EDT (coordinated universal time minus four hours) unless otherwise noted.

while moving the control towards nose-up causes the tab to move trailing edge down. No one who worked on the system checked the elevator trim for correct rigging.

The flight crew was aware that the elevator and elevator trim had been affected by the maintenance work performed; however, because the flight was a cargo flight, the nose-up tendency of the aircraft was quickly assumed to be caused by a load shift problem, rather than a flight control problem.

ERS presence was not immediately available because there are no emergency rescue personnel at the airport at night. Hamilton Airport has on-site ERS from 0700 to 2330, after which the airport is serviced by the Glanford Fire Department.

The aircraft was equipped with an intercom system which incorporated a hot mike to facilitate crew communication. To transmit via very high frequency (VHF) radio, the pilot must depress and hold a push-to-talk (PTT) button. In a typical installation, the PTT button is located on the pilot's control wheel, but on this aircraft the button is located on an intercom box that is mounted on the cockpit wall beside the pilot seats. In order for the crew to use the PTT button, they must remove one hand from the control column, left hand for the captain or right hand for the first officer.

Analysis

Aviation maintenance professionals require an extremely broad range of skills, and they are subjected to the pressures of keeping all aircraft in revenue service, working during evening hours under severe time constraints, maintaining an ageing fleet, and dealing with other factors that affect human performance. The ultimate fear of any maintenance professional (supervisor, AME, apprentice, or inspector) is that an error, once committed, will remain undiscovered and ultimately lead to an accident. The serious consequences of an error in the installation/rigging of flight or engine controls is recognized by both the industry and Transport Canada, thus engine or flight control maintenance is treated differently than other maintenance tasks. The requirement for a second person to formally inspect this work is intended to prevent the aircraft from being dispatched with control problems. In this occurrence, five people had a hand in the installation/rigging/inspection of the elevator trim tab control system of this aircraft, and it was still released with the elevator trim control operating in reverse.

The task of hooking up the control cables is, in itself, very basic. There are only two cables and it does not require training to expert levels to understand the system and to recognize that the consequences of hooking the cables up backwards can be disastrous. This analysis will focus on how five aircraft maintenance professionals (with different levels of experience) worked on this system and allowed the aircraft to be dispatched with the elevator trim operating backwards.

The job performed by the maintenance crew when they set out to reinstall the horizontal stabilizer and elevator was not technically complex. It involved positioning and bolting the stabilizer and elevator in place and reconnecting and tensioning the elevator trim tab cables. The job was straightforward enough that the crew chief could allow two apprentices to complete it without direct continuous supervision. However, there are a number of seemingly insignificant factors which compounded to make the task more error-prone.

First, the crew had been working the night shift for a number of weeks and, since the individuals would revert

to a regular daytime schedule on their days off, they had experienced five changes in sleep patterns in the past five weeks, from daytime to nighttime. The control attachment was done at the low point in the circadian rhythm, when each of the individuals involved would be at their lowest level of alertness, suggesting that fatigue may have been a factor in the occurrence. No one on the crew was aware of the degrading effects that shift work has on human performance. The crew chief was simultaneously responsible for assigning and supervising the work of six apprentices that night, a task that would require maximum alertness and awareness on his part. The apprentices, despite low levels of experience, were task oriented. Fatigue would make it more difficult for them to view the project as a whole, compared to the relative ease of viewing and completing a single task. Even during the completion of the individual tasks, fatigue and/or complacency contributed to a number of relatively minor errors in installation, which the lead hand identified during his first inspection.

This was an older generation aircraft for which the company had not yet developed a complete set of work or task cards. All maintenance work was performed with reference to the aircraft maintenance manual. The maintenance manual contains detailed instructions on how to remove and install the elevator and how to remove and install the stabilizer, but does not provide instruction for the task of removing and installing the stabilizer with the elevator attached. Thus, a significant amount of interpretation is required. When he connected the control cables, the crew chief had no objective cues to help him decide which cable ends should be attached together. The cables were identical, the turnbuckle locations were not significantly staggered to prevent incorrect installation, and the cables had not been marked when they were disassembled. The crew chief relied on the subjective appearance of the installation, and he believed that they were correctly connected. Comparison with the two-dimensional drawing of the cable installation in the aircraft maintenance manual would not immediately indicate to him that the cables did not cross each other when correctly installed. In fact, after the occurrence, the cable arrangement was described as looking wrong when correctly hooked up and looking right when hooked up backwards. Adding to his false sense of security, he knew that when the controls were rigged, an "independent inspection" would be carried out. In fact, he had the system double-checked, first by the AME and later by another apprentice.

The crew chief's hands-on supervisory style may have been more efficient in getting the job completed, but it prevented the apprentices who were working on the installation from gaining an overall picture of the work being carried out. Although they were in a learning position, there was no formal and little informal technical training for the apprentices. In this instance, there was no explanation of how to choose which of the cable ends were to be connected together, nor was there an explanation of how to ensure that the job was completed correctly. The job was initiated by the crew chief, then turned over to the apprentices to complete. The two apprentices completed the tasks as they thought they had been assigned; they did not feel responsible for the overall installation. This lack of communication was also a factor with the third apprentice who was later assigned to check the rigging. He did not fully understand what he was being asked to do, nor did he appreciate the significance of rigging the controls. His focus was on two of the installation tasks that formed only a small part of the overall rigging procedure.

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[2] M. Moore-Ede, *The Twenty-Four-Hour-Society*. (New York: Addison-Wesley Publishing Company, 1993).

R.M. Coleman, *Wide Awake at 3:00 a.m., By Choice or by Chance?* (New York: W.H. Freeman & Company, 1986).

Another significant factor in this occurrence is the quality and quantity of training that the personnel received. The apprentices who carried out much of the work in the installation had never accomplished this task before, a fact that the crew chief was not aware of. Since the continuous and progressive training of the apprentices is not a formal process, he would have been aware only if the apprentices had informed him. The crew chief, who was required to supervise and train the apprentices, had himself never received supervisory training. Training on soft issues, such as supervisory skills and interpersonal communication, is still quite rare in the aircraft maintenance industry.

The CARs require that two individuals inspect the control system for correct assembly, locking, and sense of operation, and that both individuals record their signatures in the technical record. There is no requirement that either individual be independent of the work being done. The AME who accomplished the "independent inspection" did not notice that the controls were incorrectly connected. There are two separate issues relating to this check: the independence of the check, and the contents of the check. The former concept, as outlined in AWM 571.209, was that the inspection would be completed by a person who was completely independent from the persons who accomplished the work. This person would approach the inspection with fresh eyes, and therefore he would see errors overlooked by the person who actually performed the work. He would also have an interest in ensuring that the work was correct since his signature indicates that he is taking on responsibility for work which he did not complete. In practice, the work accomplished is often signed off by one of the AMEs who performed the work, and the "independent inspection" is signed off by another person working on the same job. This casual attitude toward the signature for the "independent inspection" is evident in this occurrence. The two AMEs were concerned only that both their signatures were recorded in the logbook, not what their individual signatures represented. Each AME simply signed one of the two blanks on the logbook, regardless of who had done the work and who had inspected the work. The content of the check is also at issue. The intention of the check was to examine for correct assembly, locking, and sense of operation. The AME did check for correct assembly and locking and did find some discrepancies, which he rectified. These are areas he knew the apprentice had completed. He then performed a very cursory inspection of the system, visually checking for full movement of the tab and ensuring that the turnbuckles were not interfering with the pulleys. However, without a second person to assist him, on this aircraft, it was more difficult to adequately check either the range of travel or the sense of operation.

Although the captain was licensed and qualified for the flight, his experience on Convair aircraft was extremely limited. When checking the maintenance records prior to the flight, he did note the amount of maintenance work that had been completed on the aircraft, but rather than suspecting potential problem areas, he viewed this as an indication that the aircraft was being kept in great shape. When the aircraft began to pitch nose-up during the take-off run, the crew misdiagnosed the problem as one associated with the aircraft C of G rather than the trim setting.

Findings

1. There were four maintenance crews maintaining 24-hour coverage via a complicated shift rotation. The crew had been working the night shift for five weeks and were on the second and third nights of a four-night block.

2. The maintenance crew consisted of three licensed AMEs and six apprentices. On the night the cables were connected, two of the licensed AMEs were not at work.

3. The maintenance crew that removed the stabilizer and elevator assembly was not the same crew that reinstalled the assembly.

4. When disconnected, the elevator trim cables were not marked so there were no easy references when they were reconnected.

5. The elevator trim cables were crossed during the installation because the crew chief did not identify the elevator trim cables.

6. When the AME was conducting the final inspection of the installation, he was working alone. Therefore, he relied on operating the trim and checking the movements of the surfaces. He did not notice that the trim tab was moving in the opposite direction to the input in the cockpit.

7. The AME who inspected the installation signed in the maintenance log as having accomplished the work, and the crew chief signed as having inspected the work.

8. The maintenance entry indicated that the elevator trim system had been rigged when it had only been reconnected.

9. The company did not have a complete set of maintenance task cards available for all spontaneous maintenance tasks. To complete this task, the crew were relying on the aircraft maintenance manual.

10. The elevator trim control cable diagram in the aircraft maintenance manual is ambiguous and could be interpreted as having the trim cables crossing each other.

11. Although the company provided adequate technical training for licensed AMEs, there was no training for the apprentices and no human factor or supervisory training for the crew chiefs, nor is there a regulatory requirement for this training.

12. CAR 571.10 requires that two persons inspect any engine or flight controls which have been disturbed (commonly known as the independent or dual inspection). There are no criteria as to who those persons may or may not be.

13. CAR 571.10 does not specifically require that controls be checked for range of travel.

14. Airport ERS were not available for the landing because, after midnight, the airport relies on the municipal fire department for crash fire rescue.

15. To transmit via two-way VHF radio, the crew members had to remove one hand from the control column to depress the PTT button.

16. The captain's inexperience on type, combined with the crew's predisposition toward a C of G problem related to a load shift, led to the crew incorrectly diagnosing the trim problem.

Causes and Contributing Factors

The aircraft was dispatched with the elevator trim operating in reverse due to a series of maintenance errors. Contributing to this occurrence were that the crew chief connected the elevator trim control cables in reverse, and that the AME who was tasked subsequently with inspecting the work did not properly assess the sense of operation and trim direction.

Safety Action

Following the occurrence, Kelowna Flightcraft Ltd. proceeded with the change of shift work scheduling to a more workable two week shift schedule.

Kelowna Flightcraft Ltd. has amended the maintenance training program to include supervisory training for crew chiefs and plans human factors training for all AMEs in the future.

Kelowna Flightcraft Ltd. has amended the independent inspection of flight controls to include the inspection and sign-off by a qualified flight crew member.

Following the occurrence, Kelowna Flightcraft Ltd. modified the aircraft so that the PTT button was located on the control column.

Kelowna Flightcraft Ltd. has recognized the potential for hooking the trim cables in reverse, and future developments of the model 5800 will be designed with the intent of ensuring that the trim cables are significantly staggered to make it difficult to connect the cables in reverse.

Kelowna Flightcraft Ltd. is in the process of writing task cards for the removal of assemblies. These task cards will contain a caution note about trim cable connections.

Transport Canada issued Airworthiness Notice No. C010 Edition 1, dated 10 October 1997, entitled *Inspections of Control Systems,* which explains the regulations applicable to the maintenance of engine and flight controls and outlines the applicable standards for control systems maintenance. The document emphasizes the requirement that the person performing the dual inspection be independent of the original work and that the inspection include a verification of the range of operation of the control system.

In the 4/97 issue of Transport Canada's *Aviation Safety Maintainer*, the article "Exploring the Problem of Misconnected Controls" uses the circumstances of another crossed flight control accident (TSB Report No. A97C0089) to raise the question as to why so many people would miss such an important item as the integrity of flight controls. It concludes with a challenge to the reader to develop a methodology that uses all the tools available to avoid lapses that result in mis-rigged controls.

This report concludes the Transportation Safety Board's investigation into this occurrence. Consequently, the Board, consisting of Chairperson Benoît Bouchard, and members Jonathan Seymour, Charles Simpson, W.A. Tadros and Henry Wright authorized the release of this report on 13 January 2000.