NATIONAL TRANSPORTATION SAFETY BOARD
OFFICE OF AVIATION SAFETY
WASHINGTON, D.C. 20594

October 22, 2003

MAINTENANCE DEMONSTRATION AND INTERVIEW OF COLGAN AIR MECHANICS

NYC03MA183

A. ACCIDENT

Operator: Colgan Air Inc.
Aircraft: Raytheon Beechcraft 1900D
Location: Yarmouth, MA
Date: August 26, 2003
Time: 15:40 EDT

B. AIRWORTHINESS GROUP

Chairman — Steven Magladry
National Transportation Safety Board
Washington, DC

Member — Kevin Gonzalez
Colgan Air Inc.
Manassas, Virginia

Member — Robert L. Ramey
Raytheon Aircraft Company
Wichita, Kansas

Additional Group Participants:

Maintenance Records Group

Stephen Carbone
National Transportation Safety Board
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Eric West
Federal Aviation Administration (FAA)

Washington, DC

Robert Moorhead
Colgan Air Inc
Manassas, Virginia

System Safety Group

Dana Schulze (Recorder)
National Transportation Safety Board
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Other Participants:

William Bramble, PH.D.
National Transportation Safety Board
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National Transportation Safety Board
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C. SUMMARY

On August 26, 2003, at 15:40 eastern daylight time, a Beech 1900D, operated by Colgan Air as flight 9446, was substantially damaged when it impacted water near Yarmouth Massachusetts. The certificated airline transport pilot and certificated commercial pilot were fatally injured. Visual meteorological conditions prevailed for the flight that departed Barnstable Municipal Airport (HYA), Hyannis, Massachusetts; destined for Albany International Airport (ALB), Albany, New York. An instrument flight rules flight plan was filed for the repositioning flight conducted under 14 CFR Part 91.

The group convened at the Colgan Air Inc. maintenance hangar in Manassas, VA on October 22, 2003 to walk through the maintenance procedures performed on the accident aircraft with the two (2) mechanics who performed the elevator trim cable replacement, adjustment and tests on the accident airplane. The procedures discussed were those from the Beech 1900D Airliner Maintenance Manual (UE-1 and After), Revision 9, and

included: 27-30-04-201 Elevator Trim Tab Cable Removal and Elevator Trim Tab Cable Installation, 27-30-05-201 Elevator Trim Tab Rigging. Each mechanic was interviewed separately and the following is a summary or their statements.

D. DETAILS OF THE INVESTIGATION

During the interview, Colgan Air Inc mechanic Scott Servis stated the following information.

- When he arrived to begin his maintenance shift Monday night, August 25, 2003, the pitch trim items in the pedestal had already been disassembled. The trim tab actuators were already in-process.
- The trim cable drum, sprocket, lock pin, and other related parts were already out of the pedestal and bagged and tagged when he arrived to start his shift. The trim cable was off the drum and tied up in the cockpit area, cable was not marked.
- The trim cables in the center of the aircraft were in place
- He was not involved with the actuator.
- He was told that Perry had removed the cable drum over the weekend (before he arrived to start work on the system).
- He used the Maintenance Manual as printed off there in the hangar – confirmed it was Revision 9. Confirmed it was the one being shown him today during this exercise, Beech 1900D Airliner Maintenance Manual (UE-1 and After), Rev. 9, section 27-30-04-201.
- When he arrived, seats were already out (cockpit seat, partition wall behind captain, all seats on left side of aircraft except the last 3 seats across the back.
- Referring to step, "c.", in 27-30-04-201, he confirmed that he removed the cable retaining pins but not the pressure seals as they were only working the cable in the forward section
- He did have to remove a pulley just forward of the wing spar since the turnbuckle wouldn't roll over it. He said the other mechanic removed the pulley but he was there watching.
- He disconnected the turnbuckles; between he and the other mechanic, one held and one spun; turnbuckle ends were labeled, left-hand and maybe right-hand. The other mechanic visually saw the stamps – there was no need for magnification.
- Before pulling the cables off, he marked the pulleys starting with the 3rd pulley aft of the drum (as circled in figure 1 below), with a "T" for top. This was before the retaining pins were pulled.

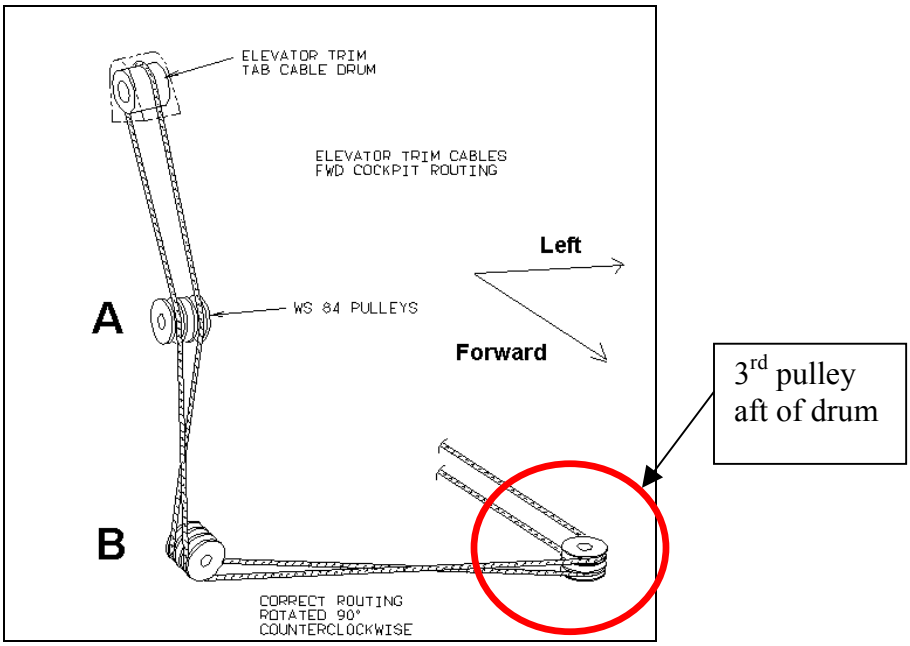

Figure 1 – Detail F from 27-30-04-201

- As they worked back towards spar, he would pull the cable and ask the other mechanic to verify which one was being pulled (for areas where turnbuckle was not visible).
- Every pulley starting with 3rd one from the drum in the cockpit pedestal back through the spar was marked with a "T".
- He went under the nose area to mark those pulley housings as well.
- He said no lead lines were put on the cables – he felt it was impossible to do it without kinking and was not necessary.
- Pulled both cables at the same time; but first marked cable (only the one attached to the FDR bridle) at the FDR sensor with nail polish on either side of the bridle then unbolted piece to get the cable out. He stated that the FDR clamped to one cable and he wanted to get the FDR reinstalled on the new cable as close to original position as possible. He couldn't remember if the fixed cable was the left or right one but he knew the cables ran side by side (as opposed to one on top of the other as the question was phrased).
- He did not mark the cable with a "T", just the pulley housings.
- He restated that the cable was not marked as they would be reinstalling it immediately after (within about 15 minutes) so there was no need.
- He did not find steps "n" through "r" of the procedure, which refer to steps affecting the aft cable, as confusing.
- Now the old cable was out of the aircraft. Laid on the floor next to the new cable which was taken out of its packaging and cleaned (wiped corrosion inhibitor grease and dirt off).
- They compared the turnbuckle ends on the old and new cables, left hand to right hand.
- Again he reconfirmed that only the pulleys were marked with a "T".

- The old cable had a kink (at about the center point of the cable where it wraps into the drum). It looked like the cable was starting to untwist (unravel). They had to pull forcefully to get cable to straighten out
- New cable was stamped with left hand and right hand markings too and they were more predominant than those on the old cable. He was also able to verify visually that the turnbuckle marked left was indeed a left hand thread.
- Marked the center point on the new cable first. He believes this was pretty exact with respect to the old cable.
- Marked where the FDR piece needed to attach on the new cable. He also stated that he tried to get as close as possible and that he knew they would have to MEL the sensor since they did not have a means to calibrate it there. He was just concerned that it be positioned such that it did not hit into anything.
- They then wrapped the drum using diagram 201 ("Elevator Tab Control Cable Winding") from maintenance manual, section 27-30-04-210, as a guide. See picture below (Figure 2) showing where they positioned the left hand threaded cable.

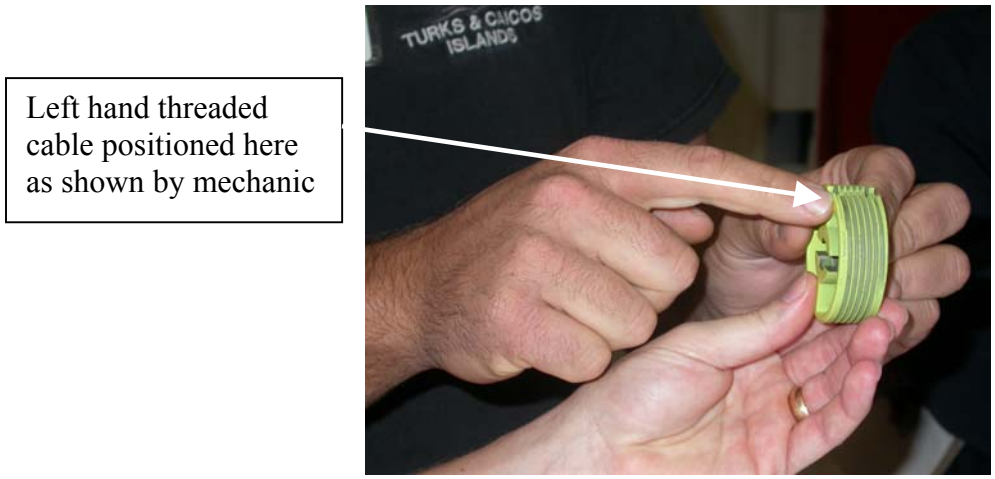

Figure 2 Elevator trim cables

- They taped over the cables, slid the shield over the drum, and wiped the cables clean once more using a rag.
- He threaded the cables down through the pedestal.
- The cables were loosely in place now from the pedestal to the spar.
- He felt the picture in the manual (figure 1, "Elevator Tab Control Cable Winding") was pretty obvious. He was not concerned that the keyway was shown incorrectly based on the orientation of the drum in the picture.
- He used figure 202 ("Elevator Trim Tab Control System") from the manual, 27-30-04-201, for running the cables. He indicated that in figure 202 you can see which cable is coming off of the front versus the rear of the drum. He also said he

could visually see this as installed in the pedestal too. He followed the cable routing exactly as shown in the picture. He believes that most of the cable installation can easily be seen in this area. He also said he looked up through the nose wheel area from under the aircraft and could see the drum and which cable came off of the front vs. the rear of the drum.

- He did not record that the left hand threaded cable went to the pulleys marked, "T" on the aluminum.
- He loosely laid the cables in place; put the shield/cover over the cables on the drum (both he and the other mechanic wound the drum together). They then assembled the sprocket .
- The cover was on the drum, he slid the shaft in place, sprocket slides on (there is keying so you cannot assemble this the wrong way). He put the assembly into the pedestal. He and the other mechanic each laid down on either side of the pedestal and held the wound drum in place while positioning the shims and the bolts.
- The chain was loose and he put it into position along with the tensioner. The routing of the chain was not ambiguous. He tensioned the chain.
- The drum was still taped.
- He asked for a few minutes so he could go down and position the cables under the nose area. He ran the cables over the pulleys from the nose area; put the retaining pins in place. He indicated that the pins showed no signs of damage ("looked good"). He worked from forward back through each pulley using Detail F in figure 202 of the MM as a guide. He put the phenolic blocks in place near the rear. During this time, the other mechanic was waiting inside the aircraft.
- Discussing the cables again, he reconfirmed that only one of the cables was marked with the fingernail polish.
- Because there was slack in the rear cables (the right actuator was not yet installed), he could connect the new cable turnbuckles to the rear cable turnbuckles.
- The other mechanic put the FDR sensor and bridle back onto the cable.
- He went back to the rear of the aircraft where the other team of mechanics was working on the actuators.
- He was tired, it was about 3 to 4 am, so he went home.
- He was not there to "Shore-up" the cables; that was done later.
- He did help the other mechanic install the cables though.
- He did not get involved in blocking the cables.
- Again he reconfirmed that when he originally arrived for this shift, the elevator trim cables were tied up with safety wire to keep them in position after the drum was removed from the pedestal. He was not there for this activity.
- More discussion on the drum installation: The cables were wrapped over the drum approximately 2 ¼ turns; the cables ran down each side of the drum.
- The drum was installed in the pedestal with the notch up.
- He indicated that it was pretty much at 0 (zero).
- As installed, he did not need to spin the drum to run the chain over the sprocket.
- The system was generally ready for rigging at that point.

- He confirmed that you cannot install the drum incorrectly, reversed, etc.
- When he was done, he asked the shift Inspector ("Jeff") to come over and take a look at the installation. He showed the Inspector the figure 201 & 202 diagrams and explained the "T" markings on the pulleys to indicate position of left hand threaded cable run.
- The Inspector reviewed the installation and concurred that it matched the diagrams. This was early Tuesday morning.
- Since the accident (8/26/03), he has received no additional training on performing this operation. He has reviewed all of the MM revisions released since then.
- He indicated that he had performed this cable replacement operation one time previously a number of years before on a Beech 1900 C –model while a mechanic at Bar Harbor Airlines.
- When asked by the NTSB Systems Group Chairman if he would do anything different now if he were to perform this maintenance operation again, he stated "no."
- He does not recall seeing the note, "Forward as Installed" on figure 201 ("Elevator Tab Control Cable Winding") of the MM, 27-30-04-201.
- He was not at work when the rigging check of the trim system was performed.

During the interview, Colgan Air Inc mechanic Dan Kinan stated the following information.

- He acknowledged working the cable replacement operation with the previously interviewed mechanic.
- He also acknowledged that he himself had been involved in the trim system rigging.
- He recounted the events on Monday night (8/25/03):
    - At some point he found that the cable was popped off of the drum; he got his supervisor to take a look.
    - His supervisor ("Perry") independently took the cables off of the drum, tied the cables up in the cockpit, and pulled the drum out and brought it off of the aircraft. He noted a kink in the cable.
    - The Supervisor thought the, "Z" form in the cable where it goes into the drum was a kink, but it wasn't really. The "Z" forms from how it rests in the drum.
    - Since the cable now showed signs of the strands unwinding ("separating"), they decided to order a new cable.
    - The Supervisor called Raytheon about the actuators on Sunday night. The Supervisor told him that the Raytheon phone operator made the statement, "Let me guess, the cable popped off of the drum," in reference to the actuator discussion. His Supervisor further told him that Raytheon said installation of the incorrect dash number actuator on the aircraft could cause this to occur because it moves the tab differently.
    - Early Monday morning, he pulled the right actuator back off of the aircraft to check its dimensions. They ordered the new cable and correct dash number actuator and both then arrived that Monday night.

- He checked the cable and actuator against what was ordered, and verified they were correct.
- He handed the actuator to the other team of mechanics ("Dominic" & "Scott").
- They started to remove the old cable at this point.
- They used the MM; they knew they would only be performing half of the operation (front cable only).
- At this point, the cables in the aft area were taped up inside the vertical stabilizer after the actuators were disconnected.
- Top was marked on the pulleys to indicate the routing of the old cable.
- The other mechanic he was working with marked the pulleys from the front to the back of the aircraft. At this point, the cable drum was still out but the pins were still in place so the cable positions on the pulleys were still good.
- He marked the (old cable) at the FDR position with respect to the cable using nail polish. He placed a dab on the cable at either side of the FDR bridle.
- The old cable was also marked at the "Z" position at the drum.
- They had to remove one of the pulleys because the turnbuckle would not be able to ride over the pulley.
- He assisted the other mechanic in identifying cable routing by yelling which cable the other mechanic was tugging on; he noted this was because some areas of the routing could not be easily seen.
- They removed the cable from the aircraft.
- They cleaned the new cable of the packaging grease; stretched the new cable out next to the old one; he could see that the cables marked as left hand threaded really did have left handed threads.
- They marked the new cable using the markings from the old one.
- The other mechanic wrapped the cable around the drum while he taped it in place.
- They discussed how the right hand threaded cable needed to go a particular direction on the drum.
- Using Figure 201 ("Elevator Tab Control Cable Winding") from the MM, 27-30-04-201, the cables were installed and came off of the drum as shown. He interpreted the cable drum illustration to be showing the open side of the drum, the other side is flat.
- They installed the wound drum into the aircraft; everything fell into place as shown. He, the other mechanic (Lead), and the Inspector ("Jeff") agreed that everything looked as shown on the MM figures 201 & 202.
- He stated that you cannot cross the cables in the back because of the conduits.
- When asked where the cross could have occurred, he stated that he knows the cables were not crossed because he checked them.
- He believes that the marking done on the pulleys took care of the cable placement.

  - He hooked the cables together after they were laid (preliminary adjustments made).
  - The drum had been installed before the cables were mated.
  - When asked if the drum could have spun in place, he answered, no. The drum can only sit with the slotted area up or down (180 degrees rotate) with the indicator at zero. But if in the slot down position, the cables would fall off so you would know it's wrong.
  - The sprocket and chain were assembled at the same time the drum was installed then the shims and bolts were put in place.
  - He paused to wait for the other team of mechanics to complete their installation of the trim actuators.
  - Once the other team indicated they were done, he hooked up and set tensions in the tail area near the actuators; the cables were clipped and it was pretty much done.
  - Everything was assembled at this point; the actuators had been replaced.
- Now moved into discussion on the rigging of the trim cable system, step, "u.," in the Elevator Trim Tab Cable Installation procedure, 27-30-04-201.
- Discussed step, "d." in the Elevator Trim Tab Rigging procedure, 27-30-05-201. He advised that the 3.07" dimension was already pre-set when the actuator was out of the aircraft.
- At step "c," of this same procedure, 27-30-05-201, the NTSB Systems Group Chairman asked if the indicator is set to zero as stated, could the 3.07" dimension noted in step "d" be met with the turnbuckles being even. He was not sure and so they went to the aircraft to check if this could be done.
  - The aircraft trim wheel was turned to set the indicator to zero position per step "c."
  - Going to the back of the aircraft and looking closely at the actuator and cable run in the tail section, the turnbuckles were now offset so the 3.07" dimension noted in Detail E of Figure 202 ("Elevator Trim Tab Control System") of 27-30-04-201, was no longer maintained. Further, the turnbuckles could not be adjusted far enough to bring this dimension back to 3.07".
  - He answered the Group Chairman by stating that what was important is to be sure that the tab is actually at zero degrees when the indicator reads zero degrees in the cockpit.
  - In closing this point of the discussion, the NTSB Group Chairman stated that there is no way that step "d." of this MM procedure, 27-30-05-201, could be accomplished without moving the turnbuckles 8" - 9"
  - He stated that he made sure that the indicator read zero degrees when the tab itself was at zero degrees.
  - He further stated that he then could not move the turnbuckles to get the 3.07" dimension and that he did not move the turnbuckles 8" – 9".
  - He did not recall adjusting the actuator at all.
  - He set the indicator to zero degrees and walked back himself to visually verify that the tab was positioned at zero degrees. He added that the

elevator had previously been pinned so he knew the elevator was at zero degrees and from there it was easy to tell the position of the tab as well.
    - He stated that the left side actuator had already been rigged the night before.
    - He used the digital protractor (instead of the travel board) held on top of the tab surface to measure tab deflections.
    - He moved the trim wheel in the cockpit from zero to full down; called back to the mechanic team in the tail area ("Dominic") to verify tab surface position; verified zero again. He checked all wheel travel against the tab position this way. He would actually step out onto the aircraft stairs and yell back to Dominic.
    - He stated that he checked full nose down travel and the numbers were good. Then checked zero degrees and full nose up travel and numbers Dominic gave him were good.
- He then went on to check the electric trim. Revision 9 of the MM does not specify an operational check of the electric trim system, but one is generally done.
- He stated that he checked the manual trim via the wheel 6 more times and 3-4 times to full travel with the electric trim.
- He did not remember pulling any circuit breakers; for a little portion of the activity they had ground power hooked up to use the lights inside the aircraft and to perform the electric pitch trim check.
- Near morning, he double-checked the trim system once again. He grabbed one of the other mechanics ("Harley") to do this functional check. Harley moved the trim wheel in the cockpit and he verified the tab surface motion. He would ask Harley for nose down and verify the tab moved correctly.
- He stated that he ran the electrical portion of the checks 4-5 times.
- He did not have to re-index the trim wheel indicator.
- He did not move the stops.
- He performed the operational checks with the floor boards up. Everything moved smoothly.
- No one else worked on the aircraft that he was aware.
- He was not aware of any changes or maintenance done on the electric trim system.
- He was not aware of any maintenance done on the control wheel electric trim switches, override switch, etc.
- When asked if there was a standard process to pull the FDR circuit breaker when the aircraft was on the ground, he said no.
- He did not know if any other circuit breakers had been pulled and he was not aware of a standard list of breakers that are typically pulled when maintenance is done on the aircraft.
- Answers to questions from Rob Ramey, Raytheon Systems Group Member, are summarized below:
    - He indicated that other than the panels and floorboards, no other items on the aircraft are taken apart during a typical Detail 6 inspection.
    - He was not fully aware however of what specifically had been done during the Detail 6 inspection because only the freeplay check was left when he

arrived at work on Sunday night. The freeplay check was run on Sunday night.
    - He was not made aware of any additional squawks on the aircraft the night it came in (believed it came in Saturday and sat all day Sunday). There was no documentation to indicate otherwise.
    - He confirmed earlier for Rob that he observed the indicator to move correctly over its full range of motion when he was doing his trim wheel indicator checks.
- Also noted by NTSB and Colgan Systems, Human Factors, and Maintenance Group Members, the mechanic acknowledged that there was approximately 17 degrees vs. 7 degrees of tab travel depending on the direction the tab is commanded so there was not way he would miss that during an ops check.

Additional Topics

- Further notes were made regarding electric power to the FDR
    - Ground power carts would supply DC power.
    - The inverters are typically turned off when the aircraft is on the ground.
    - It is also believed that the crew procedure involves shutting off the 2 AC bus switches when the aircraft is shut down.
    - It's possible that this is the reason the FDR was not powered during the maintenance activity. That is, no AC power was available to run the FDR.

- The trim wheel indicator on a sister 1900D aircraft in the hangar at the time of this activity was checked. It showed that starting at an indicator reading of zero degrees, full rotation of the wheel in the nose up direction results in a final indicator reading of 5.9 units. It was also noted that moving from 5 units to 6 units translated to about 5/8" wheel travel.

The above notes were transcribed from handwritten notes taken during the interviews. The following participated in a review of the notes after the interviews completed. Several members (Kevin Gonzalez, Robert Ramey, and Bob Moorhead) indicated that they did not hear all of the questions and answers during this interview of the mechanics.