



# National Transportation Safety Board Aviation Accident Final Report

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<b>Location:</b>	Yarmouth, MA	<b>Accident Number:</b>	NYC03MA183
<b>Date &amp; Time:</b>	08/26/2003, 1540 EDT	<b>Registration:</b>	N240CJ
<b>Aircraft:</b>	Beech 1900D	<b>Aircraft Damage:</b>	Destroyed
<b>Defining Event:</b>		<b>Injuries:</b>	2 Fatal
<b>Flight Conducted Under:</b>	Part 91: General Aviation - Positioning		

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## Analysis

The accident flight was the first flight after maintenance personnel replaced the forward elevator trim cable. When the flightcrew received the airplane, the captain did not address the recent cable change noted on his maintenance release. The captain also did not perform a first flight of the day checklist, which included an elevator trim check. Shortly after takeoff, the flightcrew reported a runaway trim, and manually selected nose-up trim. However, the elevator trim then traveled to the full nose-down position. The control column forces subsequently increased to 250 pounds, and the flightcrew was unable to maintain control of the airplane. During the replacement of the cable, the maintenance personnel skipped a step in the manufacturer's airliner maintenance manual (AMM). They did not use a lead wire to assist with cable orientation. In addition, the AMM incorrectly depicted the elevator trim drum, and the depiction of the orientation of the cable around the drum was ambiguous. The maintenance personnel stated that they had completed an operational check of the airplane after maintenance. The Safety Board performed a mis-rigging demonstration on an exemplar airplane, which reversed the elevator trim system. An operational check on that airplane revealed that when the electric trim motor was activated in one direction, the elevator trim tabs moved in the correct direction, but the trim wheel moved opposite of the corresponding correct direction. When the manual trim wheel was moved in one direction, the elevator trim tabs moved opposite of the corresponding correct direction.

## Probable Cause and Findings

The National Transportation Safety Board determines the probable cause(s) of this accident to be: The improper replacement of the forward elevator trim cable, and subsequent inadequate functional check of the maintenance performed, which resulted in a reversal of the elevator trim system and a loss of control in-flight. Factors were the flightcrew's failure to follow the checklist procedures, and the aircraft manufacturer's erroneous depiction of the elevator trim drum in the maintenance manual.

## Findings

Occurrence #1: LOSS OF CONTROL - IN FLIGHT

Phase of Operation: EMERGENCY LANDING AFTER TAKEOFF

### Findings

1. FLT CONTROL SYST,ELEVATOR TRIM/TAB CONTROL - REVERSED
2. (C) MAINTENANCE,REPLACEMENT - IMPROPER - COMPANY MAINTENANCE PERSONNEL
3. (F) CONDITION(S)/STEP(S) IN ERROR - MANUFACTURER
4. (C) MAINTENANCE,INSPECTION - INADEQUATE - COMPANY MAINTENANCE PERSONNEL
5. (F) CHECKLIST - NOT FOLLOWED - FLIGHTCREW

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Occurrence #2: IN FLIGHT COLLISION WITH TERRAIN/WATER

Phase of Operation: DESCENT - UNCONTROLLED

### Findings

6. TERRAIN CONDITION - WATER

## Factual Information

### HISTORY OF FLIGHT

On August 26, 2003, at 1540 eastern daylight time, a Beech 1900D, N240CJ, operated by Colgan Air Inc. as flight 9446 (d.b.a. US Airways Express), was destroyed 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.

According to data from Federal Aviation Administration (FAA) air traffic control (ATC), the flight departed runway 24 at Hyannis about 1538. Shortly after takeoff, the flightcrew declared an emergency and reported a "runaway trim." The airplane flew a left turn and reached an altitude of approximately 1,100 feet. The flightcrew subsequently requested to land on runway 33, and the air traffic control tower (ATCT) controller cleared the flight to land on any runway. No further transmissions were received from the flightcrew.

Witnesses observed the airplane in a left turn, with a nose-up attitude. The airplane then pitched nose-down, and impacted the water "nose first."

According to the cockpit voice recorder (CVR), the flightcrew completed the Before Start checklist between 1523 and 1530; however, there was no record of the First Flight Of The Day checklist being completed after engine start.

At 1523:30, the captain called for the Before Start checklist.

At 1523:43, the first officer stated, "preflight's complete. cockpit scan complete." The captain replied, "complete."

At 1523:58, the first officer stated, "maintenance log, release, checked the aircraft." The captain replied, "uhhhh. maintenance and release on aircraft. The captain subsequently identified that the DFDR was inoperative, and confirmed that the minimum equipment list (MEL) was still open.

At 1525:11, the captain began to start the right engine, before being interrupted. Approximately 1 minute later, after a conversation with maintenance personnel over the radio, the captain resumed the starting of the right engine.

At 1529:29, as the captain was starting the left engine, the flightcrew began non-pertinent conversation, which lasted about 30 seconds.

At 1530:04, the captain called for the After Start checklist. After completing the After Start checklist items, the first officer announced the checklist "complete."

At 1530:21, the captain continued the previous non-pertinent conversation, followed 10 seconds later with, "all right we're ready to taxi with HOTEL."

At 1530:50, the flightcrew began a conversation about the flight plan to ALB, taxiing the airplane, and which pilot would fly the airplane. The conversation lasted for about 4 minutes.

At 1535:14, during the Taxi checklist, the first officer stated, "...three trims are set." The first officer then called the Taxi checklist "complete."

At 1535:26, the flight crew began a non-pertinent discussion about a landing airplane. The discussion lasted about 1 minute and 27 seconds.

At 1537:00, the airplane was holding short of runway 24.

At 1537:17, the captain stated, "all right. forty six is ready." The flightcrew then began to announce several items, which were identified as being on the Before Takeoff checklist; however, the checklist was not called for.

At 1538:07, the controller cleared Colgan flight 9446 for takeoff on runway 24.

At 1538:08, the flightcrew initiated a takeoff on runway 24.

At 1538:40, the first officer stated "V1...rotate."

At 1538:46, the captain stated, "...we got a hot trim..." At that time, according to the digital flight data recorder (DFDR), the elevator trim moved from approximately -1.5 degrees (nose down) to -3 degrees at a speed consistent with the electric trim motor.

At 1538:48, the captain stated, "kill the trim kill the trim kill the trim."

At 1538:50, the captain stated, "roll back...roll back roll back roll back roll back." According to the DFDR, the elevator trim then moved from approximately -3 degrees to -7 degrees at a speed greater than the capacity of the electric trim motor.

At 1538:56, the captain stated, "roll it back roll my trim..."

At 1539:00, the captain stated, "do the electric trim disconnect..."

At 1539:04, the captain instructed the first officer to, "go on the controls" with him.

At 1539:14, the captain instructed the first officer to retract the landing gear.

At 1539:18, the captain instructed the first officer to retract the flaps. The first officer responded that they were "up."

At 1539:21, the captain declared an emergency regarding a runaway trim and requested to return to the airport. The controller acknowledged the emergency and offered the option of the left or right downwind for runway 24.

At 1539:33, the captain instructed the first officer to reduce the engine power.

From 1539:49 to 1540:03, the captain instructed the first officer to "pull the breaker." The first officer queried the captain as to its location.

At 1540:30, the captain requested to land on runway 33. The controller acknowledged the transmission and cleared the flight to land on runway 33.

The recording ended at 1540:47.

The accident occurred during the hours of daylight; located approximately 41 degrees, 37 minutes north longitude, and 70 degrees, 15 minutes west latitude.

## PERSONNEL INFORMATION

### Captain

The captain held an airline transport pilot certificate, with a rating for airplane multiengine land, and was type rated in the Beech 1900D. His most recent FAA first class medical

certificate was issued on March 18, 2003. The captain was hired by Colgan Air on July 16, 2001, and initially flew as a first officer on the Beech 1900D. He received a Beech 1900D type rating on January 8, 2003. The captain's most recent proficiency check was completed on June 5, 2003. The captain had accumulated a total flight time of 2,891 hours; of which, 451 hours were as pilot in command of a Beech 1900D, and 913 hours were as second in command of a Beech 1900D.

#### First Officer

The first officer held a commercial pilot certificate with ratings for airplane single engine land, airplane multiengine land, and instrument airplane. His most recent FAA first class medical certificate was issued on August 22, 2003. The first officer was hired by Colgan Air on October 22, 2002, and assigned to the Beech 1900D. His most recent proficiency check was completed on November 3, 2002. The first officer had accumulated a total flight time of 2,489 hours; of which, 689 hours were in a Beech 1900D.

#### Quality Assurance Inspector

The quality assurance inspector received an airframe and powerplant certificate in 1986. He worked for several companies within the aviation industry and was hired by Colgan Air in June, 2002. The quality assurance inspector had no prior experience on the Beech 1900 before his employment at Colgan Air. He received 40 hours of formal training for the Beech 1900, and on the job (OJT) training as well.

#### Lead Maintenance Technician

The lead maintenance technician that replaced the elevator trim tab cable received his airframe and powerplant certificate in September, 2001. He was hired by Colgan Air on October 2, 2001. He received approximately 94.5 hours of formal training on the Beech 1900, and OJT. The lead maintenance technician had previously replaced a forward elevator trim tab cable on a Beech 1900C with a former employer.

#### Lead Maintenance Technician

The second lead maintenance technician that assisted in replacing the elevator trim tab cable received his airframe and powerplant certificate in September, 2001. He was hired by Colgan Air on October 2, 2001. He received approximately 72 hours of formal training on the Beech 1900, and OJT.

#### AIRCRAFT INFORMATION

The airplane was manufactured in 1993, and equipped with two Pratt & Whitney PT6A engines. On January 3, 2003, Colgan Air leased the airplane from Raytheon Aircraft Credit Corporation, and it entered service on January 4, 2003.

At the time of the accident, the airplane had accumulated 16,503.5 hours of operation; of which, 1,219.1 hours were generated by Colgan Air. The airplane had accumulated a total of 24,637 cycles; of which, 1,765 cycles were generated by Colgan Air. The left engine had accumulated 15,245 total hours of operation, and 3,120 hours since the last overhaul. The right engine had accumulated 16,180 total hours of operation, and 3,120 hours since the last overhaul.

The accident flight was the first flight after maintenance had been performed on the airplane, which included replacement of the forward elevator pitch trim tab cable.

## METEOROLOGICAL INFORMATION

At 1556, the reported weather at HYA was: winds variable at 6 knots; visibility 10 miles; sky clear; temperature 78 degrees Fahrenheit; dew point 68 degrees Fahrenheit; altimeter 29.86 inches of mercury.

## FLIGHT RECORDERS

### Cockpit Voice Recorder

The airplane was equipped with a Fairchild model A-100A CVR. The CVR was transported to the NTSB, Office of Research and Engineering, on August 27, 2003. A CVR group convened on August 28, 2003, and a transcript was prepared of 17 minutes 17 seconds of the approximate 34-minute recording. Recordings prior to the flightcrew entering the cockpit were not transcribed.

According to the CVR Group Chairman's report, the exterior of the CVR showed evidence of structural damage. The interior of the recorder and the tape were found intact and in good condition. The recording consisted of four channels of "poor to good" quality audio information.

### Flight Data Recorder

The airplane was equipped with a L3COM (Fairchild) Model F1000 (S/N 00505) DFDR. The DFDR was transported to the NTSB Office of Research and Engineering on August 27, 2003. A DFDR readout was then performed.

The DFDR recorded data in a digital format using solid-state Flash Memory as the recording medium. Although the recorder was damaged by impact forces, the memory module was not damaged. The timing of the DFDR data was correlated to air traffic control and CVR timing.

A total of 96.7 hours of data on the DFDR was referenced to compare previous flights to the accident flight. As a result of the recent maintenance performed on the airplane, the pitch trim values and elevator position values for the DFDR were out of calibration, and the DFDR was noted as inoperative on the maintenance records. However, the DFDR recorded data for the accident flight. Although the exact pitch trim and elevator position values were not known, the data provided trend information.

There was no DFDR data recovered that indicated an operational check of the elevator trim system was performed after maintenance. However, the DFDR required 115 volts of AC current to operate. The electric trim system could operate using the 28-volt DC bus, without having the 115-volt AC bus powered.

The DFDR values recorded for the pitch trim control position, at the beginning of the flight, were approximately 2 degrees negative. Shortly after takeoff, the pitch trim control values changed to approximately 3 degrees negative, where they remained for a period of about 10 seconds. The pitch trim control values then moved to approximately 7 degrees negative, where they remained for the duration of the flight. The data also revealed that after takeoff, the airspeed continued to increase to approximately 210 knots, and then to 250 knots during the descent.

The digital flight data recorded (DFDR) indicated that shortly after declaring an emergency, the airplane began a left turn while climbing to 1,100 feet. Engine torque was reduced, and the airplane remained at 1,100 feet while maintaining an airspeed of approximately 207 knots and

30 degrees of left bank for 15 seconds. The airplane then pitched down to 8 degrees negative (nose down) and the airspeed increased to 218 knots. The airplane rolled right and left due to control inputs, and the pitch attitude decreased to 30 degrees negative.

#### AIRCRAFT PERFORMANCE

A performance study was completed to evaluate radar and DFDR data. For the purpose of the study, the un-calibrated DFDR values were corrected to known values during ground operations, and assumed values during the accident flight.

Specifically, the elevator pitch trim was shifted 2.07 degrees nose-up based on a maximum nose down value of approximately -5 degrees, rather than -7 degrees.

The performance study was completed in conjunction with a DFDR study. They revealed that during the takeoff roll, the elevator did not leave the trailing edge down stop as soon, and did not move in the trailing edge up direction as rapidly, as during previous takeoffs. A kinematics extraction revealed that approximately 60 pounds of control column pull force was required immediately after rotation, which was greater than previous flights.

Once airborne, the airplane performance was consistent with the elevator pitch trim moving to the full nose down position. The airplane climbed to approximately 1,100 feet msl, before descending into the water. As the airspeed exceeded 200 knots during the flight, and approached 250 knots during the descent, the control column forces increased to approximately 250 pounds.

#### WRECKAGE INFORMATION

The investigative team arrived near the accident scene on August 26 and 27, 2003. The airplane came to rest in approximately 18 feet of water, about 300 feet from the Yarmouth shore. The majority of the wreckage, including both engines, was recovered on August 28. The team examined wreckage, operational records, maintenance records, and DFDR data on-scene from August 27 through August 31.

The left engine exhibited impact and salt-water immersion damage. The engine was recovered stripped of the cowling, right engine mount, and right exhaust stub. The shroud and guide vane inner and outer drums were circumferentially scored at the second stage power turbine. The first stage compressor blades were bent forward and opposite the direction of rotation, and the shroud exhibited circumferential scoring.

The right engine exhibited impact and salt-water immersion damage. The engine was recovered with some portions of the cowling attached. The shroud and guide vane inner and outer drums were circumferentially scored at the second stage power turbine. The first stage compressor blades were bent forward and opposite the direction of rotation, and the shroud exhibited circumferential scoring.

Portions of both wings, the cockpit, and fuselage were recovered, and exhibited impact damage. The empennage was recovered partially intact. Approximately all of the right elevator was recovered, except for the outboard edge. The inboard portion of the right elevator remained attached to the horizontal stabilizer at the two inboard hinge locations. About 5 feet of the left elevator was recovered, and attached at one inboard hinge. Both elevator balance weights were recovered. An approximate 7-foot section of left horizontal stabilizer was found intact, and an approximate 5-foot section of right stabilizer spar was visible. The rudder remained attached to the vertical stabilizer.

The right and left elevator trim tabs were found attached to the elevator. The right and left elevator trim actuators were found near the full nose-down elevator trim position. The electric elevator trim servo was found attached to the base of the horizontal stabilizer. The left and right trim tab cables remained wrapped around their respective trim actuator drums. Elevator trim continuity was confirmed from the elevator trim tabs to the cargo door area. Due to fragmentation forward of the cargo door area, trim cable continuity could not be confirmed from the elevator to the cockpit pedestal. However, the cockpit pedestal with elevator trim drum and manual trim wheel was recovered. Further examination of the manual trim wheel revealed that it was found near the 6.5 units of nose-up trim position.

## MAINTENANCE

Colgan Air employed its own maintenance technicians that performed all of the necessary scheduled and phase maintenance on its fleet. The fleet was maintained under a continuous airworthiness maintenance program (CAMP), which was developed by Colgan Air and approved by the FAA. The CAMP was a series of checks and inspections, which incorporated guidance from the Beech 1900D airliner maintenance manual (AMM). The various inspections included in the CAMP were: Preflight Inspections, Routine Inspections, Detail Inspections, and Structural Inspections. The Preflight Inspections were due every 4 flight-days, and the Routine Inspections were due every 8 flight-days. The Detail Inspections were divided into six phases, and each phase was performed every 220 flight-hours, which resulted in a completed Detail Inspection after every 1,320 flight hours. The Structural Inspections were set forth by the manufacturer.

Each Detail Inspection focused specifically on a certain part of the airplane. They were: Wings, Powerplant and Nacelles, Flight Compartment/Cabin, Environmental Systems, Landing Gear, and Aft Fuselage/Empennage.

On August 23, 2003, the accident airplane underwent a Detail Six phase check (Aft Fuselage/Empennage). The phase check was interrupted, and the remaining work was deferred on the morning of August 24, per the general maintenance manual (GMM). Ten revenue flight legs were completed that day, and the Detail Six phase check resumed on the evening of August 24, and concluded on August 26.

A maintenance technician conducted a free play check of the left and right elevator trim actuators as part of the Detail Six phase check. Both actuators failed the check, and the failure required replacement of the actuators. During the replacement of the actuators, the technician did not remove the elevators as required by the CAMP and AMM. Additionally, the technician did not maintain pressure on (block) the elevator trim tab cables, nor did the AMM require that the cables be blocked. Subsequently, the cable unwound off the forward drum. On August 25, during the operational check of the system, the forward elevator trim tab cable "fell off" the forward drum, seized, and kinked.

A new forward elevator trim tab cable was ordered. Due to an incorrect right elevator trim actuator part number, a new right elevator trim actuator was also ordered. That evening, two lead maintenance technicians replaced the forward elevator trim tab cable, and two other maintenance technicians replaced the right elevator trim actuator. The forward elevator trim tab cable drum had already been removed by personnel on the dayshift, but no turnover notes were forwarded. The AMM and Colgan Air policies did not require turnover notes from one shift to another.



The two lead maintenance technicians that replaced the forward elevator trim tab cable did not use a lead wire as instructed by the AMM. They marked the topmost cable pulleys with a "T" instead. A lead maintenance technician and the quality assurance inspector stated that following the maintenance; a successful operational check of the system was completed. They added that the operational check included running the manual and electric elevator trim several times, with the quality assurance inspector at the cockpit and tailbone during different phases of the operational check.

The two lead maintenance technicians that installed the new cable stated that they referred to the AMM, and were not confused handling the drum or interpreting the drum illustration.

The airplane was returned to service on August 26.

Review of the Beech AMM Chapter 27-30-04, "Elevator Trim Tab Cables - Maintenance Practices," revealed that the trim drum was depicted backwards. Although the drum could not be installed backwards, it was possible to mis-route the cable around the drum, and reverse the trim system. The depiction in the maintenance manual showed the nose-up trim tab cable emanating from the aft end of the drum, rather than the forward end. It also showed the nose-down cable emanating from the forward end of the drum, rather than the aft. However, the "FORWARD AS INSTALLED" arrow included in the depiction would have to be ignored, and the cables would have to be crossed once along the cable run, to reverse the system and secure the cable ends into the turnbuckles.

Further review of the Beech AMM revealed that there was no procedure for an operational check contained in Chapter 27-30-04. Nor was there a referral to Chapter 27-30-09, "Elevator Trim - Maintenance Practices...Elevator Trim Operational Check;" which did contain a procedure for an operational check of the elevator trim system.

#### MEDICAL AND PATHOLOGICAL INFORMATION

An autopsy was performed on the pilots by The Commonwealth of Massachusetts, Department of Health, Office of the Chief Medical Examiner, Boston, Massachusetts.

Toxicological testing was conducted on the pilots at the FAA Toxicology Accident Research Laboratory, Oklahoma City, Oklahoma.

#### TESTS AND RESEARCH

##### Elevator Trim System

The cockpit controls consisted of a manual trim wheel; and two switches on each yoke, which activated an electric elevator trim motor. When moved in the nose up direction, and using "O" as a point of origin, the manual wheel was indexed "O, AFT, 3, FWD, 6, -, UP, -, -, 10, -, UP," and terminated at a white box. When moved in the nose down direction, using "O" as a point of origin, the manual wheel was indexed "O, -, DN, -, 3," and terminated at a white box. The trim wheel connected to a sprocket, driving a chain to a second sprocket, connected to the elevator trim cable drum. The sprockets, chain, and trim drum were located inside the cockpit pedestal. One side of the drum had a slotted side or key way, which connected to the sprocket, and prevented the drum from being installed backwards. The approximate 55-foot long forward elevator trim cable was wrapped around the drum and secured with a cable lock pin.

According to a representative from Raytheon Aircraft, the electric trim system could be disconnected in any of four ways: depressing the trim disconnect switch located on each

control wheel, moving the ELEV TRIM switch located on the pedestal to the OFF position, pulling the ELEV TRIM circuit breaker, or positioning the BAT, L GEN, R GEN switches to OFF. Additionally, the representative added that the electric trim could be overridden by manually rolling the trim wheel.

When the 55-foot cable was routed correctly and wrapped around the drum, it resulted in two approximate equal portions of cable emanating from the trim drum. Both portions of cable proceeded downward below the floor of the cockpit. The nose-up cable portion was the forward cable originating from the drum, and approximately 27 feet 5 inches long. It traveled through sets of pulleys as it proceeded downward, and became the right cable traveling aft underneath the floor of the airplane cabin. The nose-up cable then crossed over a final pulley, becoming the left cable, before mating with the left turnbuckle. The end of the nose-up cable had left hand threads, which screwed into the left hand threads of the left turnbuckle. The left hand threads could not be screwed into the right turnbuckle, as it had right hand threads. The turnbuckles were located near the mid-point of the airplane.

The nose-down cable was the aft cable originating from the drum, and approximately 27 feet 2 inches long. It traveled through sets of pulleys as it proceeded downward, and became the left cable traveling aft underneath the floor of the airplane cabin. The nose-down cable then crossed over a final pulley, becoming the right cable, before mating with the right turnbuckle. The end of the nose-down cable had right hand threads, which screwed into the right hand threads of the right turnbuckle. The right hand threads could not be screwed into the left turnbuckle, as it had left hand threads.

From the turnbuckles, additional cables continued to travel aft and upward, terminating at the elevator trim actuators, which were attached via pushrods to the elevator trim tabs located at the inboard portion of the right and left elevator. The electric trim motor was installed at the base of the vertical stabilizer, beyond the first set of turnbuckles.

On the accident airplane, although the approximate 55-foot elevator trim cable was fragmented due to impact forces, five sections were recovered (assuming that the forward and aft cable emanating from the drum are counted as two sections). Three sections corresponded to the nose-up cable portion, and two sections corresponded to the nose-down cable portion. Cable marks made by the cable lock pin and digital flight data recorder bridle were used for orientation points, as was the intact elevator trim cable removed and replaced before the accident flight. Using those points and the intact elevator trim cable as a reference, the three sections of the nose-up portion of the accident cable measured to within 1.2 inches of the intact cable. However, the three sections resulted in the forward cable emanating from the trim drum terminating in the right turnbuckle, rather than the left turnbuckle (see Airworthiness Group Chairman's Factual Report for more detail and depictions).

An approximate 7-foot section of cable, which corresponded to the middle section of the nose-down portion of cable, was not recovered.

A mis-rigging demonstration was conducted at Raytheon Aircraft, Wichita, Kansas, on October 14 and 15, 2003. During the demonstration, the manual trim wheel was indexed to "0" when the elevator trim tabs were placed in the neutral position. Although the system was purposely mis-rigged, an operational check of the elevator trim system revealed the error. When the cockpit trim wheel was positioned nose down, the elevator trim tabs moved in a nose-up direction. When the cockpit trim wheel was positioned nose-up, the elevator trim tabs moved

in a nose-down direction. When the electric trim motor was activated in one direction, the elevator tabs moved in the corresponding correct direction, but the trim wheel moved opposite of the commanded electric trim direction.

The mis-rigging demonstration also revealed that when the manual trim wheel was in the nose-down direction, the trim indicator in the cockpit moved well past the nose down limit, and the trim tabs were in the full nose up position. When the manual trim wheel was moved in the nose-up direction, the trim indicator did not reach the nose up limit. Rather, the indicator stopped near positive "3" units, and the trim tabs were in the full nose down position.

#### Flight Simulator

The Operations Group convened at Flight Safety International, Flushing, New York, on November 25, 2003. Using an FAA certified Level "D" Beech 1900 full motion simulator, the group attempted six simulations of the accident flight. The chief pilot of Colgan Air and an FAA inspector manipulated the controls during the flight simulations.

During all simulations, the elevator trim was positioned full nose-down shortly after takeoff. The simulator pilot attempted to maintain aircraft control using different power settings to obtain different airspeeds. Five of the six simulations resulted in an uncontrolled descent into terrain. On the sixth test, the simulator pilot was able to partially maintain control of the airplane by gradually reducing engine power and maintaining an airspeed of approximately 170 knots. However, he had to return to the airport area at 170 knots, and touchdown at 180 knots. The airplane did not land on a runway, and subsequently impacted terrain.

#### ADDITIONAL INFORMATION

##### Sterile Cockpit Concept

Review of the Colgan Air flight operations policy and procedures manual (FOPP), revealed that during the periods of taxiing, takeoff, and altitudes below 10,000 feet indicated, the "flight crewmembers will not participate in any activity which could distract any flight crewmember from the performance of their duties or which could interfere in any way with the proper conduct of those duties." Examples given by the manual, of activities that were to be avoided, included "engaging in non-essential conversations."

##### Aircraft Maintenance and Flight Log

The FOPP also detailed the captain's responsibilities for determining the airworthiness of the airplane. It stated:

"Review/Verify the Aircraft Maintenance & Flight Log back to the latest valid Airworthiness Release and ensure that all discrepancies between that Airworthiness Release and the current log page are corrected or properly deferred. If the Captain determines that the aircraft status is other than listed on the release, the Captain will inform System Control and correct the inconsistency."

Review of the Aircraft Maintenance and Flight Log form for the accident flight revealed a discrepancy, which stated, "Flt. Data Recorder needs downloading due to mx. Replacement of Elevator trim cable (Fwd. Most)." The discrepancy was signed by a maintenance technician. The discrepancy was released and signed by the same maintenance technician, in accordance with an approved minimum equipment list, and supporting control number.

The captain noted to the first officer that the DFDR was an open item on the MEL; however,

there is no record of the captain mentioning the replacement of the forward elevator trim cable.

### Checklists

Review of Colgan Air's Beech 1900 Company Flight Manual revealed that it was FAA approved and contained the expanded normal checklist procedures, as well as abnormal and emergency procedures, and policies; all of which applied to Colgan Air flight operations.

The manual had specific guidance on the use of normal checklists and procedures, and was to be used to "ensure all safety items are accomplished." All of the checklists were to be accomplished using a challenge and response method (except for the climb and after landing checklists). The manual also gave guidance in the event that the checklist flow was interrupted. It stated;

"Interruptions to checklists increase the possibility of items being missed, which in turn may create hazards to flight operations. When interruptions occur, the crew must give consideration to restarting the checklist from the beginning, taking into consideration such factors as the length and type of interruption."

The following checklist excerpts were to have been accomplished by the accident flightcrew. The details of the checklists are focused on the elevator trim system and its related components and systems.

### Preflight Checklist

The Preflight Checklist included, "Elevator, Elevator Tab, Static Wicks (4 each side) - Check & Verify Tabs are in Neutral Position."

### Before Start Checklist

The Before Start Checklist required that the captain review the dispatch release and sign it. He was also required to review the maintenance release and the dispatch release with the first officer.

### First Flight of the Day Checklist

After the engines had been started the checklist required that a "First Flight of the Day" check be performed by the flightcrew. The expanded items of the "Electric Pitch Trim" check included;

ELEV TRIM Switch.....ON

### Pilot's and Copilot's Trim

Switches.....CHECKED

- 1) Pilot's trim will override copilot's trim.
- 2) Movement of only half switch will not activate trim.

Trim Disconnect Switch.....PRESS TO 2ND LEVEL AND RELEASE

- 1) PITCH TRIM OFF Annunciator - ILLUMINATED
- 2) Electric Pitch Trim - DEACTIVATED

ELEV TRIM Switch.....OFF then ON

PITCH TRIM OFF Annunciator - EXTINGUISHED

Electric Pitch Trim.....SET FOR TAKEOFF

Taxi Checklist

The expanded items of the Taxi Checklist included;

Trims.....SET

Verify proper trim indicator positions (UP 2 Units UC & 3 Units UE, ROLL o, YAW o) and state "SET."

Weight and Balance

Review of all available data revealed that the airplane was within the center of gravity envelope for the flight.

Safety Results

As a result of the Colgan Air flight 9446 investigation, and the investigation into Air Midwest flight 5481 (DCA03MA022), the Safety Board issued fourteen recommendations to the FAA pertaining to FAR Part 121 air carrier maintenance. One of the recommendations was specific to maintenance procedures for the Beech 1900.

During the course of the Colgan Air investigation, Raytheon Aircraft released Temporary Revision 27-9 of the AMM on September 12, 2003, titled "Manual Elevator Trip Operational Check." Raytheon then released Safety Communiqué 234 on September 24, 2003, and Temporary Revision 27-10 on October 22, 2003, which revised AMM 27-30-04 and updated the depiction of the forward trim drum. The FAA issued Airworthiness Directive (AD2003-20-10), which instructed operators to incorporate TR-27-9, and provided a change to the maintenance illustration depicting the forward trim drum.

Following the accident, Colgan Air issued an alert to its employees regarding possible trim problems. Colgan Air also expanded the trim check procedure on the First Flight of the Day and the Taxi checklists.

Wreckage Release

The wreckage was released to a representative of the owner's insurance company on August 31, 2003.

## Pilot Information

<b>Certificate:</b>	Airline Transport; Commercial	<b>Age:</b>	39, Male
<b>Airplane Rating(s):</b>	Multi-engine Land; Single-engine Land; Single-engine Sea	<b>Seat Occupied:</b>	Front
<b>Other Aircraft Rating(s):</b>	None	<b>Restraint Used:</b>	Seatbelt, Shoulder harness
<b>Instrument Rating(s):</b>	Airplane	<b>Second Pilot Present:</b>	Yes
<b>Instructor Rating(s):</b>	None	<b>Toxicology Performed:</b>	Yes
<b>Medical Certification:</b>	Class 1 Valid Medical--w/ waivers/lim.	<b>Last Medical Exam:</b>	03/18/2003
<b>Occupational Pilot:</b>		<b>Last Flight Review or Equivalent:</b>	06/05/2003
<b>Flight Time:</b>	2891 hours (Total, all aircraft), 1364 hours (Total, this make and model), 211 hours (Last 90 days, all aircraft), 76 hours (Last 30 days, all aircraft), 7 hours (Last 24 hours, all aircraft)		

## Pilot Information

<b>Certificate:</b>	Commercial	<b>Age:</b>	38, Male
<b>Airplane Rating(s):</b>	Multi-engine Land; Single-engine Land	<b>Seat Occupied:</b>	Right
<b>Other Aircraft Rating(s):</b>	None	<b>Restraint Used:</b>	Seatbelt, Shoulder harness
<b>Instrument Rating(s):</b>	Airplane	<b>Second Pilot Present:</b>	Yes
<b>Instructor Rating(s):</b>	None	<b>Toxicology Performed:</b>	Yes
<b>Medical Certification:</b>	Class 1 Valid Medical--w/ waivers/lim.	<b>Last Medical Exam:</b>	08/30/2002
<b>Occupational Pilot:</b>		<b>Last Flight Review or Equivalent:</b>	11/03/2002
<b>Flight Time:</b>	2489 hours (Total, all aircraft), 689 hours (Total, this make and model), 1667 hours (Pilot In Command, all aircraft), 222 hours (Last 90 days, all aircraft), 52 hours (Last 30 days, all aircraft), 9 hours (Last 24 hours, all aircraft)		

## Aircraft and Owner/Operator Information

<b>Aircraft Manufacturer:</b>	Beech	<b>Registration:</b>	N240CJ
<b>Model/Series:</b>	1900D	<b>Aircraft Category:</b>	Airplane
<b>Year of Manufacture:</b>		<b>Amateur Built:</b>	No
<b>Airworthiness Certificate:</b>	Transport	<b>Serial Number:</b>	UE-40
<b>Landing Gear Type:</b>	Retractable - Tricycle	<b>Seats:</b>	21
<b>Date/Type of Last Inspection:</b>	08/26/2003, Continuous Airworthiness	<b>Certified Max Gross Wt.:</b>	17060 lbs
<b>Time Since Last Inspection:</b>	0 Hours	<b>Engines:</b>	2 Turbo Prop
<b>Airframe Total Time:</b>	16503 Hours	<b>Engine Manufacturer:</b>	Pratt & Whitney
<b>ELT:</b>	Installed, not activated	<b>Engine Model/Series:</b>	PT6A-67D
<b>Registered Owner:</b>	Raytheon Aircraft Credit Corporation	<b>Rated Power:</b>	1214 hp
<b>Operator:</b>	Colgan Air Inc.	<b>Air Carrier Operating Certificate:</b>	Flag carrier (121)
<b>Operator Does Business As:</b>	US Airways Express	<b>Operator Designator Code:</b>	NSVA

## Meteorological Information and Flight Plan

<b>Conditions at Accident Site:</b>	Visual Conditions	<b>Condition of Light:</b>	Day
<b>Observation Facility, Elevation:</b>	HYA, 55 ft msl	<b>Observation Time:</b>	1556 EDT
<b>Distance from Accident Site:</b>	4 Nautical Miles	<b>Direction from Accident Site:</b>	180°
<b>Lowest Cloud Condition:</b>	Clear	<b>Temperature/Dew Point:</b>	23° C / 20° C
<b>Lowest Ceiling:</b>	None	<b>Visibility</b>	10 Miles
<b>Wind Speed/Gusts, Direction:</b>	6 knots, Variable	<b>Visibility (RVR):</b>	
<b>Altimeter Setting:</b>	29.86 inches Hg	<b>Visibility (RVV):</b>	
<b>Precipitation and Obscuration:</b>			
<b>Departure Point:</b>	Hyannis, MA (HYA)	<b>Type of Flight Plan Filed:</b>	IFR
<b>Destination:</b>	Albany, NY (ALB)	<b>Type of Clearance:</b>	IFR
<b>Departure Time:</b>	1538 EDT	<b>Type of Airspace:</b>	Class D

## Airport Information

<b>Airport:</b>	Barnstable Municipal Airport (HYA)	<b>Runway Surface Type:</b>	Asphalt
<b>Airport Elevation:</b>	55 ft	<b>Runway Surface Condition:</b>	Dry
<b>Runway Used:</b>	33	<b>IFR Approach:</b>	None
<b>Runway Length/Width:</b>	5252 ft / 150 ft	<b>VFR Approach/Landing:</b>	None

## Wreckage and Impact Information

<b>Crew Injuries:</b>	2 Fatal	<b>Aircraft Damage:</b>	Destroyed
<b>Passenger Injuries:</b>	N/A	<b>Aircraft Fire:</b>	None
<b>Ground Injuries:</b>	N/A	<b>Aircraft Explosion:</b>	None
<b>Total Injuries:</b>	2 Fatal	<b>Latitude, Longitude:</b>	41.609722, -70.255556

## Administrative Information

<b>Investigator In Charge (IIC):</b>	Robert J Gretz	<b>Adopted Date:</b>	08/31/2004
<b>Additional Participating Persons:</b>	Floyd A James; FAA AAI-100; Washington, DC Robert Ramey; Raytheon Aircraft Company; Wichita, KS Dave Vance; Colgan Air Inc.; Manassas, VA Richard Bunker; MA Aeronautics Commission; Boston, MA Thomas Berthe; Pratt & Whitney Canada; South Burlington, VT		
<b>Publish Date:</b>			
<b>Investigation Docket:</b>	NTSB accident and incident dockets serve as permanent archival information for the NTSB's investigations. Dockets released prior to June 1, 2009 are publicly available from the NTSB's Record Management Division at <a href="mailto:pubinq@ntsb.gov">pubinq@ntsb.gov</a> , or at 800-877-6799. Dockets released after this date are available at <a href="http://dms.nts.gov/pubdms/">http://dms.nts.gov/pubdms/</a> .		

The National Transportation Safety Board (NTSB), established in 1967, is an independent federal agency mandated by Congress through the Independent Safety Board Act of 1974 to investigate transportation accidents, determine the probable causes of the accidents, issue safety recommendations, study transportation safety issues, and evaluate the safety effectiveness of government agencies involved in transportation. The NTSB makes public its actions and decisions through accident reports, safety studies, special investigation reports, safety recommendations, and statistical reviews.

The Independent Safety Board Act, as codified at 49 U.S.C. Section 1154(b), precludes the admission into evidence or use of any part of an NTSB report related to an incident or accident in a civil action for damages resulting from a matter mentioned in the report.