

PNATIONAL TRANSPORTATION SAFETY BOARD

Office of Aviation Safety

Washington, D.C. 20594

Airworthiness Group Chairman's Factual Report

August 19, 2019

A. ACCIDENT ANC18LA031

Location: Atqasuk, Alaska
Date: April 11, 2018
Time: 0818 Local Time
Aircraft: Ravn Connect Flight 3370, a Textron Aviation 208B, N814GV

B. GROUP

Chairman: Tom Jacky
 National Transportation Safety Board
 Washington, D.C.

Member: Arno Boyle
 Federal Aviation Administration
 Kansas City, Missouri

Member: Greg Hess
 RavnAir Connect (Hageland Aviation)
 Anchorage, Alaska

Member: Ricardo Asensio
 Textron Aviation
 Wichita, Kansas

Member: Mike Foster
 Honeywell
 Olathe, Kansas

C. SUMMARY

On April 11, 2018, about 0818 Alaska daylight time, a single-engine, turbine-powered Cessna 208B airplane, N814GV, impacted snow-covered terrain about two miles north of the Edward Burnell Sr. Memorial Airport, Atqasuk, Alaska. The airline transport pilot, the only occupant onboard, sustained minor injuries, and the airplane sustained substantial damage. The airplane was being operated by Hageland Aviation Services, Inc., dba Ravn Connect Flight 3370, a visual flight rules (VFR) cross-country cargo/mail flight under 14 Code of Federal Regulations Part 135. Visual meteorological conditions (VMC) existed at the flight's point of departure, and company flight-

following procedures were in effect. The flight originated about 0758, from the Wiley Post–Will Rogers Memorial Airport, Utqiagvik, Alaska, and it was destined for Atkasuk, located about 58 miles south.

The group met at the Honeywell facility in Olathe, Kansas from May 22-23, 2018 to examine the following airplane components removed from the accident airplane:

1. Pitch Servo Actuator
Model: KS 270C
Part Number: 065-00178-2200
Serial Number: 11476
Mod Status: 1, 2, 3, 4, 5, 6, 8, 9 marked
2. Pitch Servo Mount
Model: KM 275
Part Number: 065-0030-00
Serial Number: 70551
Mod Status: None
3. Pitch Trim Autopilot Servo
Model: KS 272C
PN: 065-00180-0800
Serial Number: U3350
Mod Status: 6 marked
4. Pitch Trim Servo Mount
Model: KM 277
Part Number: 065-0041
Serial Number: 4086
Mod Status: None
5. Yaw Autopilot Servo
Model: KS 271C
PN: 065-00179-0600
Serial Number: 9717
Mod Status: 2, 3, 4, 6, 7, 9 marked
6. Yaw Servo Mount
Model: KM 275
Part Number: 065-0030-00
Serial Number: 59695
Mod Status: None
7. Roll Autopilot Servo
Model: KS 271C
Part Number: 065-00179-0100

- Serial Number: 12456
Mod Status: 1, 2, 4, 7, 8, 9 marked
8. Roll Servo Mount
Model: KM 275
Part Number: 065-0030
Serial Number: 36960
Mod Status: None
9. Rate Gyro
Model: KRG 331
Part Number: 060-0024-00
Serial Number: P1135
Mod Status: None
10. Directional Gyro
Model: KG 102A
Part Number: 060-0015-00
Serial Number: 22363
Mod Status: 1, 2, 3, 4, 5 marked
11. Flight Command Indicator (ADI)
Model: KI 256
Part Number: 060-0017-00
Serial Number: 25493
Mod Status: 1 through 11 marked
12. Pictorial NAV Indicator (HSI)
Model: KI 525A
Part Number: 066-3046-07
Serial Number: 89124
Mod Status: 7 through 11 marked
13. Remote Mode Annunciator
Model: KA 285A
Part Number: 065-00184-0100
Serial Number: 1617
Mod Status: None
14. Flight Control Computer
Model: KC 225
PN: 065-00183-2901
SN: 2229
Mod Status: 2, 3, 4, 5, 7 marked
15. Flight Control Computer Configuration Module

Model: KCM 100
Part Number: 071-00073-5000
Serial Number: 9377
Mod Status: 1 marked

In addition, the captain's control wheel and portion of the control column was removed from the airplane and provided to the group chairman. The control wheel and column did not have any visible identification noted.

Finally, the airplane's Terrain Awareness and Warning System (TAWS) unit was removed from the airplane and identified as follows:

Manufacturer: Honeywell
Part Name: KGP 560 General Aviation EGPWS Unit
Part Number: 965-1196-001
Serial Number: 0676
Mod Status: None (0)
Application Software Version: 001
Terrain Database Version: 466N

The examination and download of the TAWS unit were conducted on May 2, 2018 at the Honeywell facility at Redmond, WA.

For each of the testable units (except the remote mode annunciator), the final acceptance/return to service test was conducted. The testable units passed most elements of their individual final acceptance tests; some test elements were measured outside their respective tolerances but did not affect the unit's operation. Two of the servo mounts had torque measurements in excess of their tolerances. All resultant test sheets and photographs were provided to the group members at the end of the examinations.

D. DETAILS OF INVESTIGATION

The accident airplane was identified as follows:

Make/Model: Cessna Caravan 208B
Serial Number: 208B0958
Year of Manufacture: 2002
Total Time: 9,946.2 hours
Total Cycles: 16,675

The Cessna 208B Grand Caravan (C208B) is a fixed-gear, high-wing airplane powered by a 675 SHP Pratt and Whitney PT6A-140 turboprop engine.

The engine was identified as:

Make/Model: Pratt and Whitney Canada PT6A-114A

Serial Number: PCE-PC2121
Total Time: 3,950 hours

The airplane was ADS-B “In and Out” equipped¹. The ADS-B data from the airplane was recorded by the FAA and provided to the NTSB. The ADS-B and TAWS Event History data were the only sources of position data for the airplane.

1.0 Description of Pertinent Airplane Systems

Due to the circumstances of the accident, the airplane’s primary pitch control, pitch trim, and autopilot systems were investigated. Including the primary pitch control, the airplane’s primary flight control systems consisted of conventional aileron, elevator, and rudder control surfaces, along with a pair of spoilers mounted above the outboard ends of the wing flaps through a pushrod mounted to an arm on the aileron bell crank. The primary control surfaces were manually operated through mechanical linkages that connected the control wheel to the ailerons, control column to the elevators, and rudder/brake pedals to the rudder.

The airplane also provided manual trim systems for each of the aileron, elevator, and rudder systems.

1.1 Primary Pitch Control

The airplane’s two elevators, attached to the aft portion of the horizontal stabilizer, were the primary pitch control surfaces. The elevators were manually controlled by the control column, connected through mechanical linkages and cables that connected to the inboard side of each elevator.

1.2 Secondary Pitch Trim Control

The airplane’s pitch trim was accomplished via two trim tabs, one attached to the aft trailing edge of each elevator. Elevator trimming was accomplished through the elevator trim tabs by rotating the vertically mounted trim control wheel on the top left side of the control pedestal. Forward rotation of the control wheel provided nose-down trim; conversely, aft rotation provided nose-up trim.

There was also electric elevator trim controlled via the electric trim system switch on the control wheel.

1.3 Roll Trim Control

Roll (or aileron) trim control was accomplished via a trim tab attached to the aft, outboard section of the right aileron. The manual roll trim knob was located on the center pedestal and was mechanically connected to the aileron trim tab.

1.4 Autopilot System

The airplane was equipped with a Bendix/King (now Honeywell) KFC 225 Automatic Flight

¹ The airplane was equipped with a FreeFlight FDL-978-XVR ADS-B System.

Control system. The system provided pitch, roll, and yaw damper control using gyros, servos and the KFC 225 autopilot computer. See Figure 1. The KFC 225 provided pitch and roll guidance output commands to the pitch, roll, yaw, and trim servos.

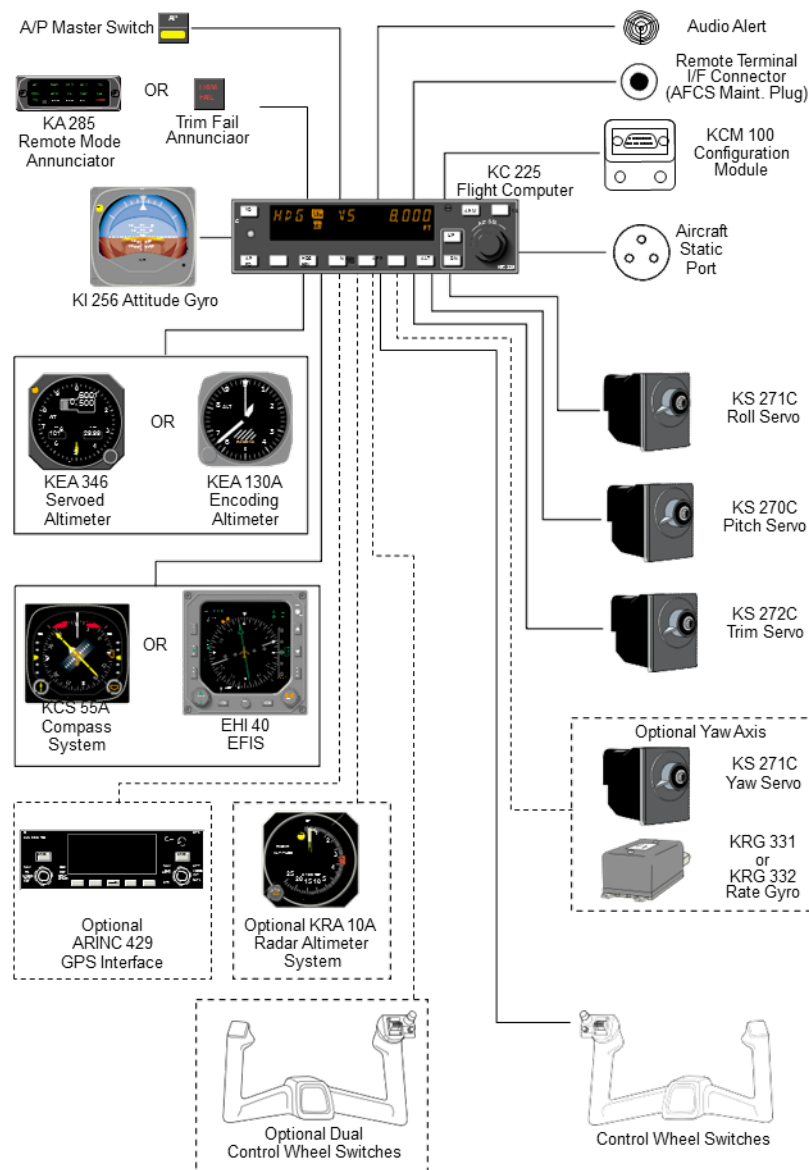


Figure 1 - KFC 225 System Diagram

The KFC 225 Flight Computer controlled the autoflight system with input from the flight crew. The KFC 225 was used for command inputs, mode selection, and flight plan following.

Many of the auto flight system components were removed from the accident airplane for further testing.

2.0 Examination of Airplane at Utqiagvik, April 19, 2018

On April 19, 2018, parties to the investigation met at the Wiley Post–Will Rogers Memorial Airport, Utqiagvik Alaska, for an initial examination of the airplane. The airplane had been recovered and moved the operator’s hangar at Utqiagvik.

In addition to documentation of the wreckage, the examination included the removal of the seventeen (17) components listed in the Summary (Section C) of this report.

All the removed components were sent to the NTSB office in Anchorage, Alaska for distribution. The EGPWS unit was then sent to the NTSB office in Federal Way, Washington, and the control wheel and column segment was sent to the Airworthiness Group chairman in Washington, DC. The remainder of the removed components (i.e. the pitch control system and flight instruments) were sent to the Honeywell facility in Phoenix, Arizona and then to the FAA flight standards district office (FSDO) in Kansas City, Missouri.

3.0 Examination of Terrain Awareness and Warnings System Unit

The download of the airplane’s TAWS unit was conducted on May 2, 2018 at the Honeywell facility in Redmond, WA. The KGP 560 EGPWS was hand-carried by an NTSB investigator from the Federal Way, WA office to the Honeywell facility. See Figure 2.



Figure 2 - The airplane's TAWS Unit, as removed.

The accident airplane was not equipped with a terrain display to provide a two-dimensional or visual alert relative to the general area; however, the TAWS unit provided a visual alert through the warning lamp, in addition to the audio alerts and warnings. For this installation, landing gear and flap data were not input to the EGPWS.

For the examination, the dust cover (outer) case was removed and the internal components examined to ensure that the download would be successful. The terrain data base cover was also removed; the terrain data base data card and ports appeared to be intact.

The terrain data base version at the time of the accident was 466N, released 9/18/2012, for TSO C151a Class B TAWS. On the date of the accident, the current version of the terrain data base

was 602N. Honeywell’s database group compared the 466N and 602N terrain databases and found there were no significant differences in the area around the accident flight path².

The Processor Circuit Card Assembly (PCCA) board was removed and appeared to be intact. A few white deposits were noted on the board and cleaned with isopropyl alcohol prior to testing. The PCCA board was then installed onto a surrogate KGP 560 unit for download. All connector pins to the interface unit appeared to be intact.

The download of data from the last operational use was successful. There were no current faults related to the operation of the EGPWS computer. Flight Leg 15890 was established as the last flight leg that was recorded. The recorded information indicated that “terrain inhibit” was not selected on flight leg 15890.

The download of the three terrain-proximity alerts captured in the warning history data were the following Table 1:

Table 1 - EGPWS Warnings Recorded in Final Flight Leg

#	Time (EGPWS Elapsed Time)	Alert Label	Alert Audio
1	12315:40:26	EGPWS MODE 1	PULL UP
2	12315:40:27	EGPWS TCF	TOO LOW TERRRAIN
3	12315:40:29	EGPWS TAD	TERRAIN PULL UP

The Mode 1 Pull Up Alert was annunciated at EGPWS Elapsed Time 12315:40:26 while the airplane was at an EGPWS-calculated Altitude Rate of -1955³ Feet Per Minute (FPM), a ground speed of 154.1 knots and a GPS altitude of 248 feet. Subsequently, at 12315:40:27 a Terrain Clearance Floor (TCF) Too Low Terrain Alert was annunciated. Finally, a Terrain Pull Up Warning was annunciated at 12315:40:29. The warning data history ended at elapsed time 12315:40:30.

For additional information about the three TAWS warnings generated by the EGPWS and comparison to the aircraft history of flight, please see the Aircraft Performance Study for the investigation.

In addition to the TAWS warnings, the unit provided the following information regarding the history of the unit’s performance, in Tables 2 and 3:

Table 2 - Number of Warning/Cautions Issued

EGPWS Category	# of Times Issued
Mode 1 Outer Curve	192
Mode 1 Inner Curve	95
Mode 2 Terrain	0

² For the flightpath, Honeywell used the latitude/longitude from the EGPWS warning history data.

³ The negative value indicates a descent.

Mode 2 Pull-Up	0
Mode 3 Don't Sink	372
Mode 4 Too Low Terrain	0
Mode 4 Too Low Gear	0
Mode 4 Too Low Flap	0
Mode 4 C Too Low Terrain	0
Mode 5 Glideslope	0
Mode 6 Bank Angle Alert	0
Terrain Clearance Floor	459
Terrain Awareness Caution	3504
Terrain Awareness Pull-Up	3348
Obstacle Caution	51
Obstacle Pull-Up	45
Mode 7 Windshear Warning	0
Mode 7 Windshear Caution	0

Table 3 - Table of Compiled EGPWS Activity

Activity	Count/Time
Number of Flights	17,272
GPWS INOP Time	1171:53:39
Windshear INOP Time	0:00:00
141:30:51 - TA&D INOP Time	141:30:51
TA&D Not Available Time	1171:14:45
Terrain Inhibit Time	5112:03:06
Flight Time	10329:41:05
Operating Time	12316:04:23

A listing of the relevant downloaded (warning) time history data is in Attachment 1.

4.0 Examination of Pitch Control System Components

The group met at the Honeywell facility in Olathe, Kansas from May 22-23, 2018. The group met to examine the components removed from the accident airplane.

The components had previously been shipped from the Honeywell facility in Phoenix, Arizona to the FAA's Kansas City, Missouri Flight Standards District Office. On the first day of the examination, the FAA group member hand carried the components to the Honeywell facility. For the remainder of the group's activities, the components were stored in Honeywell secured storage.

The shipping container was opened, and the contents removed. Photographs of each of the components were taken after removal of shipping materials.

4.1 KC225 Autopilot Computer

No visual physical damage to the unit was noted; however, the unit had areas of sticky substance on the exterior (Note: the airplane was carrying cases of Dr. Pepper soft drink)

The KC225 and the KCM 100 Configuration Module were connected to the Honeywell KC225 Test Bench for download and system level examination. The test bench includes test unit autopilot computer, servos, and configuration module. When power was first applied, the KC 225 indicated 2,500 feet. According to Honeywell, the Configuration Module will hold in memory the last programmed altitude selected. See Figure 3.



Figure 3 – KC 225 Autopilot Computer with 2,500 altitude value displayed after power was applied.

The segments of wire bundles were removed from the back of the Configuration Module and the module was then connected to the test bench.

The KC 225 was connected to the Honeywell KC225 Test Bench and the Final Acceptance/Return to Service test procedure was conducted on the unit. The unit passed all tests with no faults found. The resultant KC 225 Final Test Data Sheets were included in Attachment 2.

4.2 KCM 100 Configuration Module

No visible damage was noted to the module.

The KCM 100 Configuration Module was connected to the Honeywell KC225 Test Bench and the contents of memory downloaded and converted into a readable format.

A power cycle of 90 was generated by the engineering panel with error code 6 (“Inst strap mismatch”). The most-recently recorded error was noted on power cycle 63. No errors were recorded during the accident flight power cycle, which was determined to be power cycle 89.

The KCM 100 error code print out for power cycle 89 was included in Attachment 3.

4.3 Pitch Servo Actuator KS 270C

No visible damage was noted to the servo. See Figure 4.



Figure 4 - Pitch Servo, as Received.

The KS 270C Pitch Servo Actuator was attached to the Honeywell Servo Actuator Test Bench and the Final Acceptance/Return to Service test accomplished on the unit. No faults were found.

The resultant test data sheet(s) were included in Attachment 4.

4.4 KM 275 Pitch Servo Mount

During the visual examination the middle ball was noted as properly seated in its capstan. No visible damage was noted.

The KM 275 Pitch Servo Mount was tested on the Honeywell KSM-575, KLA-570, KSA-370, KSA371 Test Bench using a mount bracket and torque tester. The mount measured 50 in-lbs. in the clockwise (CW) and counter-clockwise (CCW) directions.

A torque notation of 43 +/- 4 in-lbs. (i.e. the specified torque limit) was noted on a tag on the servo mount base plate. The tag also indicated a date of “1-18”.

4.5 KS 272C Trim Servo

No visible physical damage was noted to the servo.

The KS 272C Trim Servo Actuator was attached to the Honeywell Servo Actuator Test Bench and the final acceptance/return to service test accomplished on the unit. No faults were found.

The resultant test data sheet(s) were included in Attachment 5.

4.6 KM 277 Pitch Trim Servo Mount

No visible physical damage was noted to the servo mount.

The KM 277 Pitch Trim Servo Mount was tested on the Honeywell KSM-575, KLA-570, KSA-370, KSA371 Servo Mount Test Bench using a mount bracket and torque tester. The mount measured 50 in-lbs. in the clockwise (CW) and counter-clockwise (CCW) directions.

A torque notation of 45 +/- 5 in-lbs. (i.e. the specified torque limit) was noted on a tag on the servo mount base plate. The tag also indicated a date of "1-18".

4.7 KS 271C Yaw Autopilot Servo

No visual physical damage was noted to the servo, but a sticky substance was noted on the servo exterior.

The KS 271C Yaw Autopilot Servo Actuator was attached to the Honeywell Servo Actuator Test Bench and the final acceptance/return to service test accomplished on the unit. No faults were found.

The resultant test data sheet(s) were included in Attachment 6.

4.8 KM 275 Yaw Servo Mount

During the visual examination the middle ball was noted as properly seated in its capstan. No visible physical damage was noted to the servo.

The KM 275 Yaw Servo Mount was tested on the Honeywell KSM-575, KLA-570, KSA-370, KSA371 Servo Mount Test Bench using a mount bracket and torque tester. The mount measured 50 in-lbs. in the clockwise (CW) and counter-clockwise (CCW) directions.

A torque notation of 50 +/- 5 in-lbs. (i.e. the specified torque limit) was noted on a tag on the servo mount base plate. The tag also indicated a date of "1-18".

4.9 KS 271C Roll Servo

No visual physical damage was noted to the servo.

The KS 271C Roll Servo actuator was attached to the Honeywell Servo Actuator Test Bench and the final acceptance/return to service test accomplished on the unit. No faults were found.

The resultant test data sheet(s) were included in Attachment 7.

4.10 KM 275 Roll Servo Mount

During the visual examination the middle ball was noted as properly seated in its capstan. No visible physical damage was noted to the servo mount.

The KM 275 Roll Servo Mount was tested on the Honeywell KSM-575, KLA-570, KSA-370, KSA371 Servo Mount Test Bench using a mount bracket and torque tester. The mount measured 46 in-lbs. in the clockwise (CW) direction and 45 in-lbs. in the counter-clockwise (CCW) direction.

A torque notation of 38 +/- 4 in-lbs. (i.e. the specified torque limit) was noted on a tag on the servo mount base plate. The tag also indicated a date of "1-18".

4.11 KRG 331 Yaw Rate Gyro

No visual physical damage was noted to the unit.

The KRG 331 Rate Gyro was connected to the Honeywell KRG 331/332 Test Bench and final acceptance/return to service test conducted. However, when power was applied, the gyro would not spin up. When the dust cover was removed to allow visual inspection, the rotor assembly and housing were noted offset from their normal, proper alignment, which restricted rotation. The gyro was considered untestable; no further testing was conducted.

4.12 KG 102A Directional Gyro

No visual physical damage was noted to the unit, but a sticky substance was noted on the unit's exterior.

The KG 102A directional gyro was connected to the Honeywell KG102A Test Bench with the gyro placed on the turn table and directed by test panel. The Final Test procedure was accomplished on the unit. For the tests the unit functioned correctly, but the drift test element was out of tolerance. The unit passed all other elements for the installed modifications.

The resultant Final Test Data Sheets were included in Attachment 8.

4.13 KI 256 Flight Command Indicator (ADI)

No visual physical damage was noted to the unit, but when the unit was rotated, a rattling noise was heard. See Figure 5.

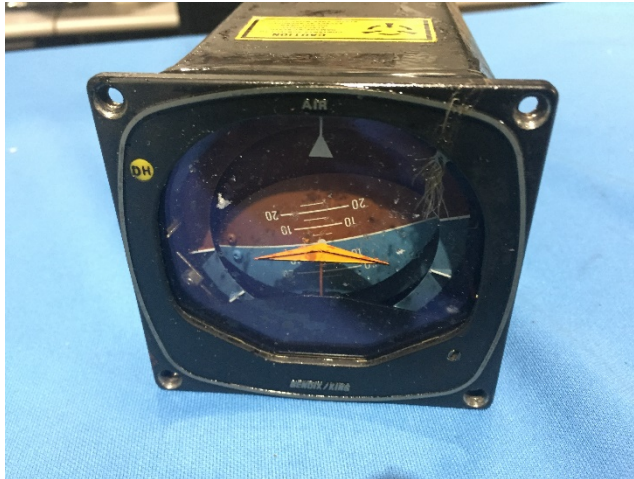


Figure 5 - The KI 256 Front View, as Received.

The dust cover was removed and one of the “fast erect vanes” was found dislodged and loose. The vane was re-installed.

The KI 256 was connected to the Honeywell KI 256 Test Bench and the final acceptance/return to service test was conducted. The unit functioned correctly, but the alignment nulls were slightly out of tolerance.

The resultant Final Test Data sheets were included in Attachment 9.

4.14 KI 525A Pictorial NAV Indicator (HSI)

No visual physical damage was noted to the unit, but a sticky substance was noted on the unit’s exterior.

The KI 525A was connected to a Honeywell Test Bench and the final acceptance/return to service test conducted. The unit functioned properly; however, several test elements were marginally out of tolerance.

The test results sheet was included in Attachment 10.

4.15 KA 285A Remote Mode Annunciator

No visual physical damage was noted to the unit, but a sticky substance was noted on the unit’s exterior.

The Honeywell facility did not have the test capability for the KA 285A Remote Mode Annunciator; therefore, no testing of the unit was accomplished.

No further examination of the RMA unit was accomplished.

4.16 Airplane Autopilot System Level Tests

The accident airplane autopilot components – KC 225 Flight Computer, KCM 100 Configuration Module, KS 270C Pitch Servo, KS 271C Roll Servo, and KS 272C Trim Servo – were connected to the KFC 225 Engineering Test Panel for a systems-level test.

With the Cessna 208B aircraft strap code (0C) set on the test panel and power applied, the autopilot system components passed the autopilot pre-flight test. The autopilot was engaged/disengaged without faults and the servo operation functioned properly. No error codes were generated.

With the engineering auto pilot computer attached to the Engineering Test Panel, the flight computer was rotated rapidly to trip the acceleration monitor limit. With the autopilot computer engaged, error codes were generated. With the autopilot computer not engaged, no error codes were generated.

At the end of the tests, the components were packaged back into the shipping box and held in Honeywell secured storage. On November 20, 2018, the components were returned to the operator.

5.0 Examination of the Control Wheel and Column

The captain's control wheel and segment of the control column were examined by the group chairman at NTSB Headquarters in Washington, DC.

The following observations were noted:

- The column and control wheel wiring were cut for removal from the airplane. See Figure 6.



Figure 6 - Control Wheel and Column

- The trim switch fixture was dislodged from the control wheel. See Figure 7.

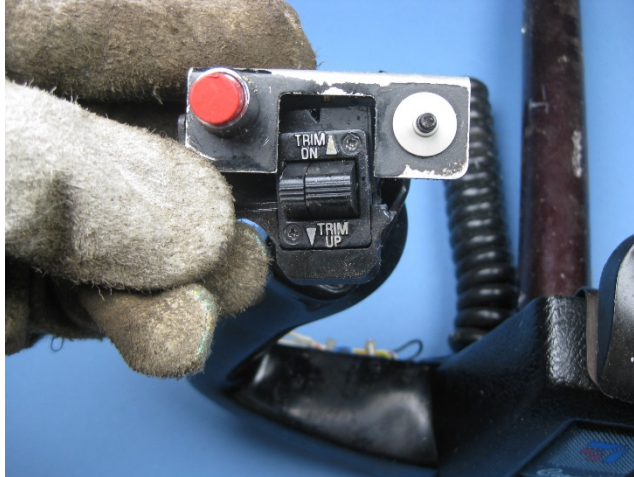


Figure 7 - Control Wheel Trim Switch

- The segment of external coiled wire was visually examined. No cuts, kinks, or deformations were noted on the segment. See Figure 8.



Figure 8 - Segment of External Control Wheel Wire

Tom Jacky
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