COMANDO DA AERONÁUTICA

CENTRO DE INVESTIGAÇÃO E PREVENÇÃO DE ACIDENTES AERONÁUTICOS

FINAL REPORT
A - 149/CENIPA/2015

OCCURRENCE:	**ACCIDENT**
AIRCRAFT:	**PT-WQH**
MODEL:	**650**
DATE:	**10NOV2015**

NOTICE

According to the Law nº 7565, dated 19 December 1986, the Aeronautical Accident Investigation and Prevention System – SIPAER – is responsible for the planning, guidance, coordination and execution of the activities of investigation and prevention of aeronautical accidents.

The elaboration of this Final Report was conducted taking into account the contributing factors and hypotheses raised. The report is, therefore, a technical document which reflects the result obtained by SIPAER regarding the circumstances that contributed or may have contributed to triggering this occurrence.

The document does not focus on quantifying the degree of contribution of the different factors, including the individual, psychosocial or organizational variables that conditioned the human performance and interacted to create a scenario favorable to the accident.

The exclusive objective of this work is to recommend the study and the adoption of provisions of preventative nature, and the decision as to whether they should be applied belongs to the President, Director, Chief or the one corresponding to the highest level in the hierarchy of the organization to which they are being forwarded.

This Report does not resort to any proof production procedure for the determination of civil or criminal liability, and is in accordance with Appendix 2, Annex 13 to the 1944 Chicago Convention, which was incorporated in the Brazilian legal system by virtue of the Decree nº 21713, dated 27 August 1946.

Thus, it is worth highlighting the importance of protecting the persons who provide information regarding an aeronautical accident. The utilization of this report for punitive purposes maculates the principle of "non-self-incrimination" derived from the "right to remain silent" sheltered by the Federal Constitution.

Consequently, the use of this report for any purpose other than that of preventing future accidents, may induce to erroneous interpretations and conclusions.

N.B.: This English version of the report has been written and published by the CENIPA with the intention of making it easier to be read by English speaking people. Taking into account the nuances of a foreign language, no matter how accurate this translation may be, readers are advised that the original Portuguese version is the work of reference.

SYNOPSIS

This is the Final Report of the 10NOV2015 accident with the 650, Citation VII aircraft, registration PT-WQH. The accident was classified as “[SCF-NP] System/Component Failure or Malfunction Non-Powerplant”.

During the climbing phase, there was an inadvertent movement of the horizontal stabilizer. The aircraft had a sharp drop in altitude and crashed into the ground.

The two crewmembers and the two passengers perished at the site.

The aircraft was destroyed.

An Accredited Representative of the National Transportation Safety Board (NTSB) – USA, (State where the aircraft and the engines were designed) was designated for participation in the investigation.

CONTENTS

GLOSSARY OF TECHNICAL TERMS AND ABBREVIATIONS

AC	Advisory Circular
ACC-BS	Brasília Area Control Center
ACU	Actuator Control Unit
AD	Airworthiness Directive
AFM	Aircraft Flight Manual
AMOC	Alternate Means of Compliance
AMM	Aircraft Maintenance Manual
ANAC	Brazil's National Civil Aviation Agency
APU	Auxiliary Power Unit
ASL	Alert Service Letter
ATIS	Automatic Terminal Information Service
ATS	Air Traffic Services
CA	Airworthiness Certificate
CBA	Brazilian Code of Aeronautics
CENIPA	Aeronautical Accident Investigation and Prevention Center
CG	Center of Gravity
CSMU	Crash Survivable Memory Unit
CTAC	Civil Aviation Training Center
CVR	Cockpit Voice Recorder
DCTA	Department of Science and Airspace Technology
FAA	Federal Aviation Administration
FL	Flight Level
GPWS	Ground Proximity Warning System
HASP	São Paulo Aeronautics Hospital
HBV	Brazilian Daylight Saving Time
IAM	Annual Maintenance Inspection
IFR	Instrument Flight Rules
INSPSAU	Health Inspection
IPC	Illustrated Parts Catalog
IS	Supplementary Instruction
MDF	Dive Mach
MEL	Minimum Equipment List
MMEL	Master Minimum Equipment List
MMO	Maximum Operating Mach
NTSB	National Transportation Safety Board (USA)
OS	Service Order
PA	Automatic Pilot

PCM	Commercial Pilot License – Airplane
PLA	Airline Pilot License – Airplane
PN	Part Number
PPR	Private Pilot License – Airplane
RBAC	Brazilian Civil Aviation Regulation
RBHA	Brazilian Aeronautical Certification Regulation
SB	Service Bulletin
SBBR	ICAO Location Designator - Presidente Juscelino Kubitschek Aerodrome, Brasília - DF
SBSP	ICAO Location Designator – Congonhas Aerodrome, São Paulo - SP
SIPAER	Aeronautical Accident Investigation and Prevention System
SN	Serial Number
SOP	Standard Operational Procedures
TC	Temporary Change
TCDS	Type Certification Data Sheet
TPP	Registration Category of Private Aircraft Service
UTC	Universal Time Coordinated
VDF	Dive Speed
VMO	Maximum Operating Limit Speed

1. FACTUAL INFORMATION.

Aircraft	**Model:** 650 **Registration:** PT-WQH **Manufacturer:** Cessna Aircraft	**Operator:** *Banco* BRADESCO *S.A.*
Occurrence	**Date/time:** 10NOV2015 - 2104 UTC **Location:** Chapadão Farm **Lat.** 17°56'05"S **Long.** 047°18'34"W **Municipality – State:** Guarda-Mor – MG	**Type(s):** [SCF-NP] System/Component Failure or Malfunction Non-Powerplant **Subtype(s):** NIL

1.1 History of the flight.

The aircraft took off from the Presidente Juscelino Kubitschek (SBBR) Aerodrome, Brasília - DF, to the Congonhas Aerodrome (SBSP), São Paulo - SP, at 2039 (UTC), to carry out a personnel transportation flight with two crewmembers and two passengers on board.

During the cockpit preparation procedure, the crew members commented about the operation of the Pitch Trim System.

The first flight of the day, that occurred in the morning, was from São Paulo to Brasilia and with no abnormalities.

About thirty minutes after take-off from Brasília, still during the climb, near the FL370, the cabin voice recorder recorded a characteristic sound of the aircraft's horizontal stabilizer moving.

Then, the aircraft made a downward trajectory with high speed and a big rate of descent until the impact against the ground.

The aircraft was destroyed.

All occupants perished at the site.

1.2 Injuries to persons.

Injuries	Crew	Passengers	Others
Fatal	2	2	-
Serious	-	-	-
Minor	-	-	-
None	-	-	-

1.3 Damage to the aircraft.

The aircraft was destroyed.

1.4 Other damage.

None.

1.5 Personnel information.

1.5.1 Crew's flight experience.

Hours Flown		
	Pilot	Copilot
Total	13.143:48	2.527:00
Total in the last 30 days	52:00	03:10
Total in the last 24 hours	01:30	01:30
In this type of aircraft	Unknown	1.633:30
In this type in the last 30 days	52:00	03:10
In this type in the last 24 hours	01:30	01:30

N.B.: The Data related to the flown hours were provided by the aircraft's operator.

1.5.2 Personnel training.

The pilot took the PPR course at the Bauru Aeroclube, in 1976.

The copilot took the PPR course at the Araras Aeroclube, in 2010.

1.5.3 Category of licenses and validity of certificates.

The pilot had the PLA License and valid C650 airplane and IFRA Ratings.

The copilot had the PCM License and valid C650 airplane and IFRA Ratings.

1.5.4 Qualification and flight experience.

The pilots were qualified and had experience in that kind of flight.

1.5.5 Validity of medical certificate.

The pilots had valid Aeronautical Medical Certificates (CMA).

1.6 Aircraft information.

The aircraft, serial number 650-7083, was manufactured by the Cessna Aircraft Company, in 1998, and it was registered in the TPP category.

The aircraft had valid Certificate of Airworthiness (CA).

The airframe and engines logbook records were updated.

The aircraft had the capacity to take up to eight passengers and was certified for operation with two crewmembers.

The maximum takeoff weight (PMD) of the aircraft was 10,433kg and at the take-off moment, it was within the limits of weight and balancing.

The aircraft was equipped with two turbofan engines, manufactured by Honeywell model TFE731-4R-2S model engines.

The left engine, Part Number (PN) 3073640-2 and Serial Number (SN) P-102269, was with approximately 5,175 flight hours and 4,630 cycles at the date of the accident.

The right engine, Part Number (PN) 3073640-2 and Serial Number (SN) P-102278, was with approximately 5,400 flight hours and 4,810 cycles at the date of the accident.

Pitch Trim System: Description

The pitch trim system had the function of balancing the aircraft in the longitudinal plan, in various stages and flight conditions, weight configurations and center of gravity

(CG). The pitch trim of this model was made through the aerodynamic surface action called horizontal stabilizer.

The horizontal stabilizer had an operating range from -13° to +2°, according to the Type Certification Data Sheet (TCDS) No. EA-8502. The -13° value represented maximum deflection at the nose-up direction and the + 2° value represented maximum deflection at the nose down direction.

The pitch trim system consisted of two independent modes of operation, called the primary pitch trim system and the secondary pitch trim system**.**

The surface of the horizontal stabilizer could be controlled manually through the pilots' actuation or automatically by means of the autopilot (PA).

Figure 1, taken from the Aircraft Maintenance Manual (AMM), provides an overview of the major components location in the aircraft.

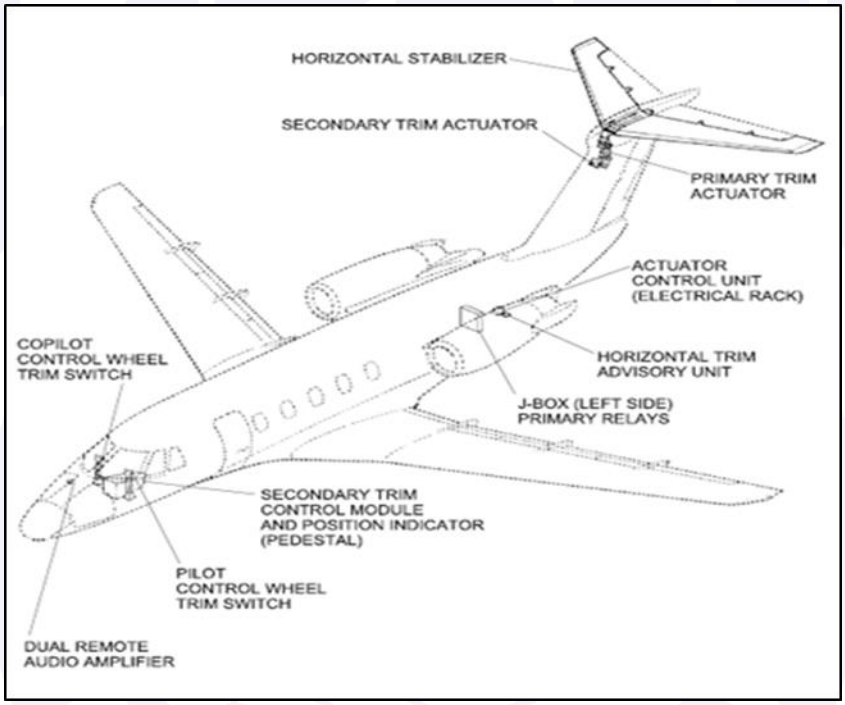


Figure 1 - Components of the horizontal stabilizer system of the Cessna 650 aircraft. Taken from the AMM of the model.

Pitch Trim System: Operation

The movement of the horizontal stabilizer was carried out electro-mechanically through the primary trim system or the secondary trim system. The cockpit instruments of the pitch trim system are shown in Figure 2.

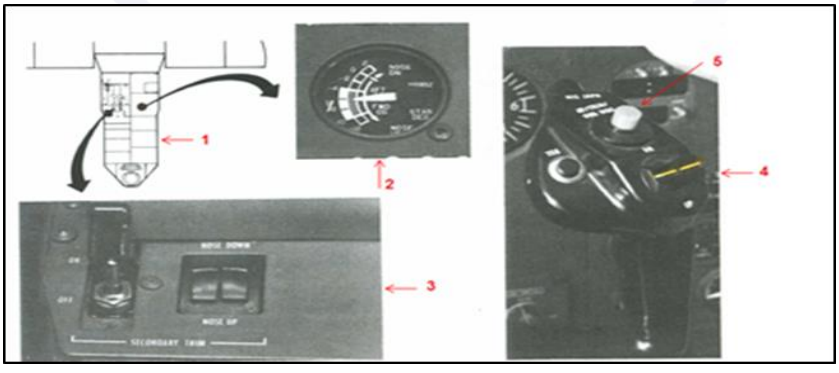


Figure 2 - Primary and Secondary Compensation Commands for aircraft model 650. (1) Central Pedestal; (2) Horizontal stabilizer position indicator; (3) SECONDARY TRIM ON /

OFF switch and secondary mode drive switches; (4) Split Trim Switches; (5) AP / TRIM / NWS DISCONNECT SWITCH button. Taken from the Flight Safety® Training Manual, Revision 01SEPT1994.

The operation of the aircraft pitch trim system could be carried out in the following ways:

(1) Automatic mode: the position of the horizontal stabilizer was controlled by the autopilot, which sent signals to move the surface. In order to engage the autopilot, the primary pitch trim system must be active and operational.

(2) Primary Manual: main manual mode of operation of the aircraft pitch trim system. The surface movement was manually controlled by pressing the two switches called Split Trim Switches, located on both, the pilot's control wheel and the copilot's control wheel, Figure 2 (4). The primary system was composed by the Actuator Control Unit (ACU), the relay box, the primary engine, the actuator and its components.

The primary system had a Clacker sound, audible after 1.2 seconds of continuous movement, according to AMM Revision 35 of 01AUG2014.

According to the AMM Revision 35 Horizontal Stabilizer Control System Functional Check maintenance task, the total surface movement time between stroke limits was 44 ± 4 seconds.

There were two Circuit Breakers related to the primary pitch trim system: Pitch Power (Pitch PWR) and Pitch Control (Pitch CTRL).

The primary system could be disconnected in three ways:

1) by pressing the AP/TRIM/NWS DISCONNECT SWITCH button, located on both control wheels, as shown in Figure 2 (5);

2) removing the power source from the system; and

3) by activating the secondary mode.

(3) Secondary Manual: emergency operating mode of the aircraft trim system. Switching between the primary and secondary modes was performed by the Switch SECONDARY TRIM ON-OFF (covered by safety guard), Figure 2 (3), located in the center console according to Figure 2 (1).

The selection of the operating mode of the system occurred as follows:

OFF Position	Primary Mode active (with the guard low, the Switch must be in the OFF position).
ON Position	Active Secondary Mode (The Switch in the ON position must have the guard raised). The Split Trim Switches, Figure 2 (4), become inactive in this condition and the switches, located in the center console Figure 2 (3), control the movement of the horizontal stabilizer.

The secondary system had the same audible warning of Clacker, audible after a continuous movement of 1.0 to 1.2 seconds according to the AMM.

The total movement time of the stabilizer in the secondary mode between stroke limits was approximately 84 ± 8 seconds, according to the AMM Revision 35 Horizontal Stabilizer Control System Functional Check task.

The light SEC TRIM FAULT illuminated when the operating mode was changed and it remained illuminated until the movement of the stabilizer using the secondary mode occurred or in case of failure of the secondary system.

The Circuit Breaker SEC PITCH TRIM was related to the secondary pitch trim system.

Additionally, located in the center console, there was a position indicator of the horizontal stabilizer, as shown in Figure 2 (2).

The red AP / TRIM / NWS DISCONNECT SWITCH button, located on both control wheels, Figure 2 (5), had the function of disengaging the autopilot, de-energizing the primary pitch trim system, and disabling nose-landing gear steering.

In the aircraft alarm and warning panel, there was a failure indication light for the primary pitch trim system, called PRI TRIM FAIL, and a failure indication light for the secondary pitch trim mode, called the SEC TRIM FAULT. Figure 3 shows the position of these warning lights.

Figure 3 - PRI TRIM FAIL and SEC TRIM FAULT lights on the warning and alarm panel.

Pitch Trim System: Components

The Part Numbers of the main components of the pitch trim system installed on the aircraft were: Actuator Control Unit (ACU) - PN 9914197-8, Primary Trim Actuator - PN 9914056-4, Secondary Trim Motor - PN 9914257-2 and Horizontal Trim Advisory Unit - PN 9914287-1.

Below, there is a brief description of the function of the listed components of the pitch trim system. Component images have been taken from the aircraft's Illustrated Parts Catalog (IPC).

Actuator Control Unit

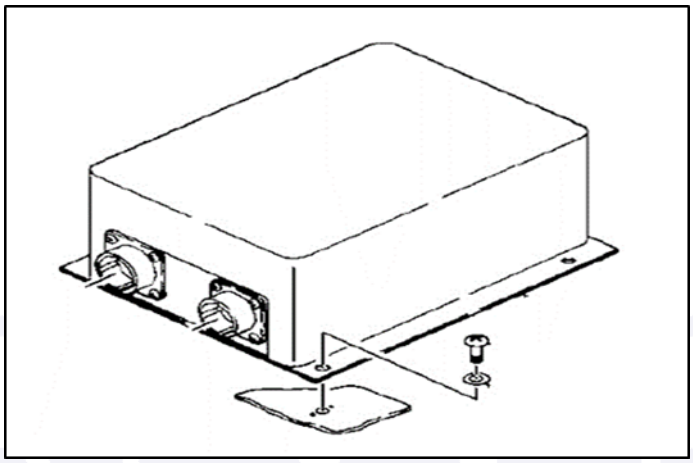


Figure 4 - Actuator Control Unit (ACU). Image taken from the aircraft's IPC.

The Actuator Control Unit (ACU) had the function of providing actuation voltage for the primary engine to move the surface of the horizontal stabilizer.

This component was related to the primary mode of operation and to the autopilot, that is, in the secondary mode the ACU had no active function.

Signals of the actuator position sensors and the autopilot modified the frequency of the actuation voltage supplied by the ACU, in order to change the movement speed of the actuator.

To check the status of the monitoring circuit, one should perform the procedure in the Rotary Test Switch, TRIM/FLAP position.

Primary Trim Actuator

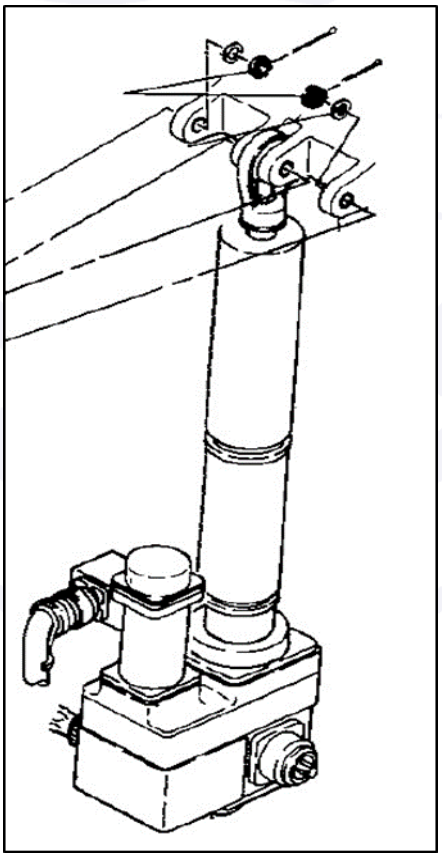


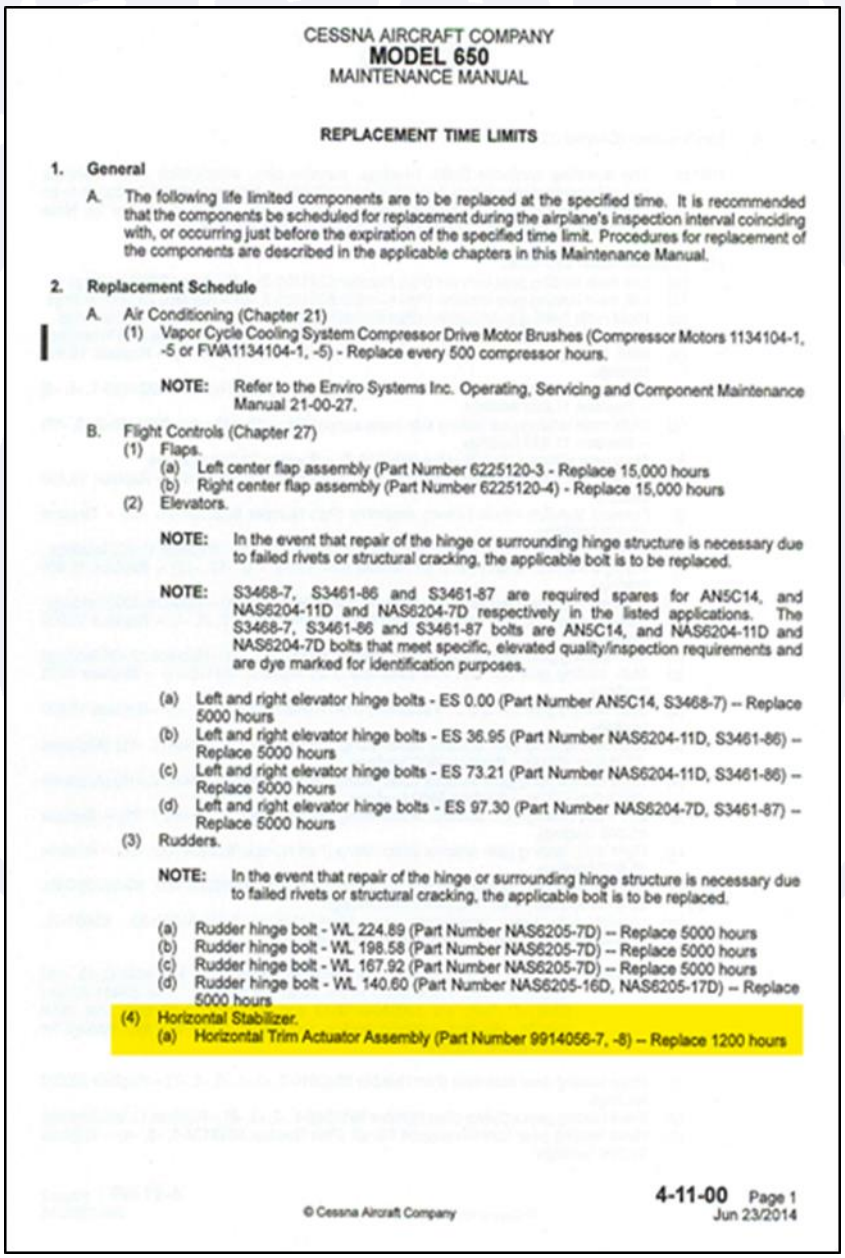
Figure 5 - Primary Trim Actuator. Image taken from the IPC.

The Primary Trim Actuator received ACU actuation voltage and transmitted mechanical movement to the horizontal stabilizer.

It consisted of a mechanical shaft, engine, brake, clutch, gear reducers, course limit switches and transmitters of position and rate of change.

The mechanical axis for moving the horizontal stabilizer was the same, both in the primary and in the secondary mode. However, there were two independent engines for each mode of operation. The primary engine was powered by alternating current, while the secondary engine by direct current.

According to the aircraft maintenance program, approved on 05JAN1983, according to Chapter 04 - Replacement Time Limits of AMM, Revision 32, of 23JUN2014 (Figure 6), the Horizontal Trim Actuator should be replaced every 1,200 flight hours, if Part Number 9914056-7 or 9914056-8 is installed.



CESSNA AIRCRAFT COMPANY
MODEL 650
MAINTENANCE MANUAL

REPLACEMENT TIME LIMITS

1. General

A. The following life limited components are to be replaced at the specified time. It is recommended that the components be scheduled for replacement during the airplane's inspection interval coinciding with, or occurring just before the expiration of the specified time limit. Procedures for replacement of the components are described in the applicable chapters in this Maintenance Manual.

2. Replacement Schedule

A. Air Conditioning (Chapter 21)
(1) Vapor Cycle Cooling System Compressor Drive Motor Brushes (Compressor Motors 1134104-1, -5 or FWA1134104-1, -5) - Replace every 500 compressor hours.

NOTE: Refer to the Enviro Systems Inc. Operating, Servicing and Component Maintenance Manual 21-00-27.

B. Flight Controls (Chapter 27)
(1) Flaps.
(a) Left center flap assembly (Part Number 6225120-3 - Replace 15,000 hours
(b) Right center flap assembly (Part Number 6225120-4) - Replace 15,000 hours
(2) Elevators.

NOTE: In the event that repair of the hinge or surrounding hinge structure is necessary due to failed rivets or structural cracking, the applicable bolt is to be replaced.

NOTE: S3468-7, S3461-86 and S3461-87 are required spares for AN5C14, and NAS6204-11D and NAS6204-7D respectively in the listed applications. The S3468-7, S3461-86 and S3461-87 bolts are AN5C14, and NAS6204-11D and NAS6204-7D bolts that meet specific, elevated quality/inspection requirements and are dye marked for identification purposes.

(a) Left and right elevator hinge bolts - ES 0.00 (Part Number AN5C14, S3468-7) -- Replace 5000 hours
(b) Left and right elevator hinge bolts - ES 36.95 (Part Number NAS6204-11D, S3461-86) -- Replace 5000 hours
(c) Left and right elevator hinge bolts - ES 73.21 (Part Number NAS6204-11D, S3461-86) -- Replace 5000 hours
(d) Left and right elevator hinge bolts - ES 97.30 (Part Number NAS6204-7D, S3461-87) -- Replace 5000 hours
(3) Rudders.

NOTE: In the event that repair of the hinge or surrounding hinge structure is necessary due to failed rivets or structural cracking, the applicable bolt is to be replaced.

(a) Rudder hinge bolt - WL 224.89 (Part Number NAS6205-7D) -- Replace 5000 hours
(b) Rudder hinge bolt - WL 198.58 (Part Number NAS6205-7D) -- Replace 5000 hours
(c) Rudder hinge bolt - WL 167.92 (Part Number NAS6205-7D) -- Replace 5000 hours
(d) Rudder hinge bolt - WL 140.60 (Part Number NAS6205-16D, NAS6205-17D) -- Replace 5000 hours
(4) Horizontal Stabilizer.
(a) Horizontal Trim Actuator Assembly (Part Number 9914056-7, -8) -- Replace 1200 hours

Figure 6 - AMM Chapter 04 Page, Revision 32, from 23JUN2014. The replacement range of the Horizontal Trim Actuator Assembly is highlighted.

Secondary Trim Motor

The Secondary Trim Motor consisted of a reversible direct current engine whose function was to move the mechanical axis of the Primary Trim Actuator through a mechanical chain. The secondary system was used in case of malfunction of the primary trim system.

Horizontal Trim Advisory Unit

The Horizontal Trim Advisory Unit had the function of indicating the position of the stabilizer for the Horizontal Stab Indicator in the cockpit, Figure 2 (2) and to provide a Clacker sound, when the horizontal stabilizer surface moved for more than one second.

Pitch Trim System: Test

The model 650, Citation VII, had a test panel incorporated in the upper right corner of the Switches panel in the cockpit of the aircraft, consisting of a selector button containing nine positions to test various aircraft systems. This selector button was called the Rotary Test Switch (Figure 7).

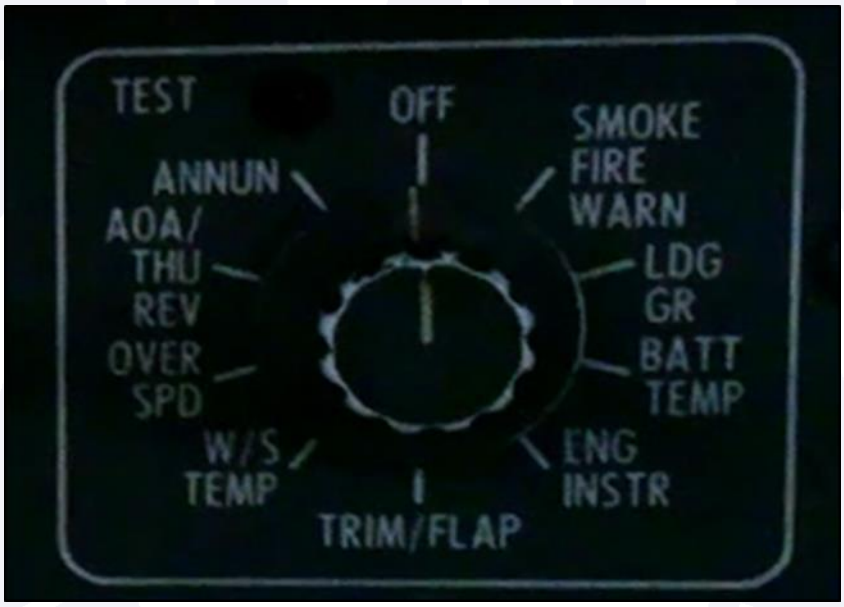


Figure 7 - Rotary Test Switch.

The function of the Rotary Test Switch was to conduct functional tests of various aircraft systems. Here are the functions of each position of the Rotary Test Switch:

(1) SMOKE FIRE WARN - Test of fire detection and warning system in the engines and smoke in the cabin.

(2) LDG GR - Test of the landing gear audible warning system.

(3) BATT TEMP - Test of indication and alert of over temperature in the batteries.

(4) ENG INSTR - Test of indication and alert of temperature parameters of the engines and rotation of the turbines.

(5) TRIM/FLAP - Test of the pitch trim system and flaps of the aircraft.

(6) W/S TEMP – Test of the Windscreen heating system.

(7) OVER SPD - Test of aircraft overspeed warning system.

(8) AOA/THU REV - Test of stall alert systems and thrust reversers.

(9) ANNUN - Test of the aircraft alarm panel system and warning of Alt Sel (Altitude Selector).

The systems tests, through the Rotary Test Switch, were previsedin both operational procedures and maintenance actions.

TRIM/FLAP position of the Rotary Test Switch

According to the AMM, Revision 31, of 01JAN2009, the TRIM/FLAP test consisted of the following procedures:

a) momentarily, start the horizontal stabilizer trim in the primary mode;

b) make sure the PRI TRIM FAIL annunciator comes on;

c) do a check of the horizontal stabilizer primary trim actuator if the PRI TRIM FAIL does not come on. Refer to Horizontal Stabilizer Trim Control - Troubleshooting;

d) make sure that the MASTER WARNING RESET light comes on;

e) make sure that the FLAP O'SPD light comes on;

f) make sure that the FLAP INOP light comes on;

g) if installed, make sure the O'HEAT light comes on and goes off after approximately 3 seconds; and

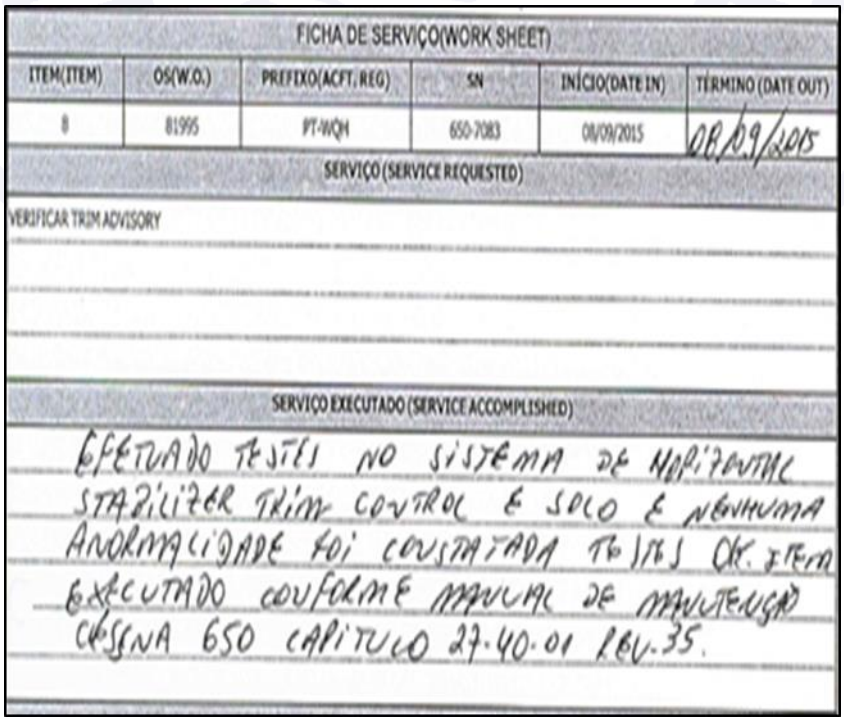
h) make sure the NO TAKEOFF horn is heard in the cockpit speakers.

Maintenance History

The last inspection of the aircraft, the "Annual Maintenance Inspection (IAM)" type, was carried out on 05DEC2014, by TAM Executive Aviation and Air Taxi S.A, in Jundiaí - SP, having flown 250 hours and 40 minutes after the inspection.

On 08SEPT2015, 63 days before the accident, the aircraft had a series of scheduled inspections performed, called Inspection Document 20, Inspection Document 50, Inspection Document MA and Inspection Document 28. The performed inspections had no direct relationship with the aircraft's pitch trim system.

In addition, at the request of the operator, a non-scheduled service was performed in the pitch trim system, related to the Horizontal Trim Advisory Unit. The Service Order (OS) n° 81.995 details the work done (Figure 8).



FICHA DE SERVIÇO(WORK SHEET)

ITEM(ITEM)	OS(W.O.)	PREFIXO(ACFT. REG)	SN	INÍCIO(DATE IN)	TÉRMINO (DATE OUT)
8	81995	PT-WQH	650-7083	08/09/2015	08/09/2015

SERVIÇO (SERVICE REQUESTED)

VERIFICAR TRIM ADVISORY

SERVIÇO EXECUTADO (SERVICE ACCOMPLISHED)

EFETUADO TESTES NO SISTEMA DE HORIZONTAL STABILIZER TRIM CONTROL E SOLO E NENHUMA ANORMALIDADE FOI CONSTATADA TESTES OK. ITEM EXECUTADO CONFORME MANUAL DE MANUTENÇÃO CESSNA 650 CAPITULO 27-40-01 REV.35.

Figure 8 - Service Order nº 81.995 from 08SEPT2015.

In Service Order No. 81.995, in the description of the executed service, it was informed that functional tests were performed on the ground in the pitch trim system of the aircraft, according to the Maintenance Manual and no abnormality was found.

On 21SEPT2015, 13 days after the accomplishment of OS 81.995 and 50 days before the accident, the aircraft returned to the same shop, in order to perform another maintenance service, at the request of the operator.

This OS included the accomplishment of three tasks: the first related to the aural warning of the pitch trim system of the aircraft, the second referred to the oil analysis of the engines and the third dealt with the replacement of the starter-generator of the left engine.

The description of the first task contained in OS No. 82.071 was "alarm of the trim with constant audible warning - necessary to replace (referring item 08 from OS nº 81.995)", (Figure 9).

FICHA DE SERVIÇO(WORK SHEET)

ITEM(ITEM)	OS(W.O.)	PREFIXO(ACFT. REG)	SN	INÍCIO(DATE IN)	TÉRMINO (DATE OUT)
1	82071	PT-WQH	650-7083	21/09/2015	21/09/15

SERVIÇO (SERVICE REQUESTED)

ALARME DO TRIM COM AVISO SONORO CONSTANTE - NECESSÁRIO SUBSTITUIR (REFERENTE ITEM 08 DA OS 81995)

SERVIÇO EXECUTADO (SERVICE ACCOMPLISHED)

EFETUADA SUBSTITUIÇÃO DO CONTROL TRIM HORIZONTAL STABILIZER TESTES EM SOLO OK. ITEM EXECUTADO CONFORME MANUAL DE MANUTENÇÃO ISSUE 650 CAPITULO 27-40-01 REV-35

MATERIAIS (MATERIALS)

DESCRIÇÃO (DESCRIPTION)	PN REMOVIDO (REMOVED)	QTD	SN REMOVIDO (REMOVED)
CONTROL TRIM HORIZONTAL STABILIZER	9914287-1	01	469

DESCRIÇÃO (DESCRIPTION)	PN INST. (INSTALLED)	QTD	SN INSTALADO (INSTALLED)
CONTROL - TRIM ADVISORY HORIZONTAL STABILIZER	9914287-1EX	1.00	9924069

Figure 9 - Service Order nº 82.071 from 21SEPT2015.

In Service Order No. 82.071, in the description of the executed service, there was mistakenly the substitution of the "Control Trim Horizontal Stabilizer" (sic), PN 9914287-1. In fact, the service performed referred to the Horizontal Trim Advisory Unit (Figure 9).

There was no record of any malfunction related to the aircraft's pitch trim system in the aircraft flight logbook.

The Horizontal Trim Advisory Unit, PN 9914287-1, Serial Number (SN) 469, was sent for repair at Symetrics Industries LLC, where the component malfunction was confirmed and a repaired unit 9914287-1EX Serial Number 9924069 was installed.

On 26OCT2015, the aircraft had the inspection related to the fire protection system of the engines performed, called Inspection Document ME. Simultaneously with this inspection, a replacement of the left engine starter-generator was performed.

On 04NOV2015, the starter-generator of the Auxiliary Power Unit (APU) and hydraulic oil of the left landing gear were replaced.

Continued Airworthiness Documentation Related to the Aircraft Pitch Trim System

Service Bulletin SB650-27-53

On 11MAR2004, the aircraft manufacturer issued the Service Bulletin (SB), SB650-27-53. The Federal Aviation Administration (FAA) issued the Airworthiness Directive (AD) number 2005-13-21 on 14JUN2005 with the effective date of 09JUL2005, making compliance with SB650-27-53 mandatory.

Briefly, SB650-27-53 directed the exchange of ACU PN 9914197-3 or 9914197-4 by ACU PN 9914197-7 (Figures 10 to 13).

Citation **SERVICE BULLETIN** Cessna

SB650-27-53

TITLE

FLIGHT CONTROLS - HORIZONTAL STABILIZER TRIM ACTUATOR CONTROLLER IMPROVEMENT

EFFECTIVITY

MODEL	SERIAL NUMBERS
650	-0001 thru -0241, -7001 thru -7119

REASON

To upgrade the pitch trim system by installing an improved controller which has an uncommanded motion monitor.

DESCRIPTION

This service bulletin provides parts and instructions to remove and replace the horizontal stabilizer trim actuator controller.

COMPLIANCE

MANDATORY. This service bulletin must be accomplished at the next phase 2 inspection or within 18 months of the release date of this service bulletin, whichever occurs first.

A service bulletin published by Cessna Aircraft Company may be recorded as "completed" in an aircraft log only when the following requirements are satisfied:

1) The mechanic must complete all of the instructions in the service bulletin, including the intent therein.
2) The mechanic must correctly use and install all applicable parts supplied with the service bulletin kit. Only with written authorization from Cessna Aircraft Company can substitute parts or rebuilt parts be used to replace new parts.
3) The mechanic or airplane owner must use the technical data in the service bulletin only as approved and published.
4) The mechanic or airplane owner must apply the information in the service bulletin only to aircraft serial numbers identified in the "Effectivity" section of the bulletin.
5) The mechanic or airplane owner must use maintenance practices that are identified as acceptable standard practices in the aviation industry and governmental regulations.

No individual or corporate organization other than Cessna Aircraft Company is authorized to make or apply any changes to a Cessna-issued service bulletin, service letter, or flight manual supplement without prior written consent from Cessna Aircraft Company.

Cessna Aircraft Company is not responsible for the quality of maintenance performed to comply with this document, unless the maintenance is accomplished at a Cessna-owned Citation Service Center.

FLIGHT CREW OPERATIONS

No Change.

Mar 11/2004 650-27-53
Page 1 of 4

Cessna Aircraft Company, Citation Marketing Division, P.O. Box 7706, Wichita, KS 67277, U.S.A. 1-316-517-6000, Fax 1-316-517-8500

Figure 10 - SB650-27-53 page 1 of 4.

Citation **SERVICE BULLETIN** Cessna A Textron Company

SB650-27-53

APPROVAL

FAA approval has been obtained on technical data in this publication that affects airplane type design.

This information shall be considered an amendment to the Cessna Manufacturer's Maintenance Manual or Instructions for Continued Airworthiness, and must be accomplished for ongoing airworthiness compliance as required per 14 CFR Part 43.13.

MANPOWER

WORK PHASE	MAN-HOURS
Modification	*

MATERIAL - Cost and Availability

PART NUMBER	AVAILABILITY	COST
SB650-27-53	*	*

* Refer to the attached Service Bulletin Supplemental Data sheet for man-hours, material cost and availability, and warranty information.

TOOLING

None

CHANGE IN WEIGHT AND BALANCE

Negligible

REFERENCES

Cessna Model 650 Citation III, VI, and VII Maintenance Manual

PUBLICATIONS AFFECTED

Cessna Model 650 Citation III, VI, and VII Maintenance Manual

Cessna Model 650 Citation III, VI, and VII Illustrated Parts Catalog

ACCOMPLISHMENT INSTRUCTIONS

1. Prepare the airplane for maintenance.
   - A. Make sure that all switches are in the OFF/NORM position.
   - B. Disconnect electrical power from the airplane.
     - (1) Disconnect the airplane battery.
     - (2) Disconnect external electrical power.
   - C. Attach maintenance warning tags to the battery and external power receptacle that have **"DO NOT CONNECT ELECTRICAL POWER - MAINTENANCE IN PROGRESS"** written on them.
2. Make sure that the existing actuator control unit is not a 9914197-7 Actuator Control Unit.
   - A. If the 9914197-7 Actuator Control Unit is installed on the airplane, remove the maintenance warning tags, connect the airplane battery, and continue to Step 16.
   - B. If the 9914197-7 Actuator Control Unit is not already installed on the airplane, continue to Step 3.
3. Disengage the PITCH CONTROL and PITCH PWR circuit breakers located on the left circuit breaker panel.

Mar 11/2004 650-27-53 Page 2

Figure 11 - SB650-27-53 page 2 of 4.

4. Remove the existing actuator control unit from the airplane. Keep the attaching hardware. (Refer to the Maintenance Manual, Chapter 27, Horizontal Stabilizer Trim Control - Maintenance Practices.)
5. Return the existing actuator control unit to Cessna Aircraft Company, Citation Parts Distribution, 7121 Southwest Boulevard, Wichita, KS 67215, for exchange.

   NOTE: The existing actuator control unit is to be returned to Cessna Aircraft Company, Citation Parts Distribution, 7121 Southwest Boulevard, Wichita, KS 67215, USA, and exchanged for a 9914197-7 Actuator Control Unit. This option will require advance scheduling with Citation Parts Distribution, telephone number 1-800-835-4000 (Domestic) or 1-316-517-7542 (International) or telefax 1-316-517-7711.
6. Install the 9914197-7 Actuator Control Unit to the airplane with the attaching hardware that you kept. (Refer to the Maintenance Manual, Chapter 27, Horizontal Stabilizer Trim Control - Maintenance Practices.)
7. Engage the PITCH CONTROL and PITCH PWR circuit breakers located on the left circuit breaker panel.
8. Remove maintenance warning tags and connect external electrical power to the airplane.
9. Put the battery switch in the on position.
10. Push the RESET button on the actuator control unit.

    NOTE: This will clear any faults that may have been set during acceptance testing at the manufacturer or during initial power up.
11. Do a functional test of the system. (Refer to the Maintenance Manual, Chapter 27, Horizontal Stabilizer Trim Control - Adjustment/Test.)
    A. (For airplanes with the 9914056-3 Trim Actuator only.) Do the Trim System Operational Test.
    B. (For airplanes with the 9914056-4 Trim Actuator only.) Do the Primary/Secondary Split Trim Switches Operational Test.
    C. (For airplanes with the 9914056-4 Trim Actuator only.) Do the Pitch Trim System Electrical Test.
12. Remove external electrical power and connect the airplane battery.
13. Do an operational check flight.
    A. One take-off and landing within the airport pattern will be sufficient. The altitude and airspeed during the flight are not critical.
    B. Actuate the primary trim system in both the nose up and nose down directions during the flight.
14. After landing, but before power is removed from the airplane, put the rotary test switch in the TRIM/FLAP position.
    A. If the master warning and the primary trim fail lights come on, continue to Step 16.
    B. If the master warning and the primary trim fail lights do not come on, continue to Step 15.

       NOTE: This is an indication of a potential backdrive condition.
15. Remove and replace the horizontal stabilizer trim actuator prior to the next flight. (Refer to the Maintenance Manual, Chapter 27, Horizontal Stabilizer Trim Control - Maintenance Practices.)
16. Record that this service bulletin has been completed.
    A. Complete a Maintenance Transaction Report.
    B. Put a copy of the completed Maintenance Transaction Report in the airplane logbook.
    C. Send a copy of the completed Maintenance Transaction Report to: CESCOM, P.O. Box 7706, Wichita, KS 67277.

Figure 12 - SB650-27-53 page 3 of 4.

MATERIAL INFORMATION

NOTE: The parts included in this service bulletin cover installation for one airplane.

NEW P/N	QUAN-TITY	KEY WORD	OLD P/N	INSTRUCTIONS/ DISPOSITION
SB650-27-53	1	**Kit,** consisting of the following parts:		
SB650-27-53	1	Instructions		

In addition to the parts in the SB650-27-53 Kit, the following will be required for accomplishment of this service bulletin.

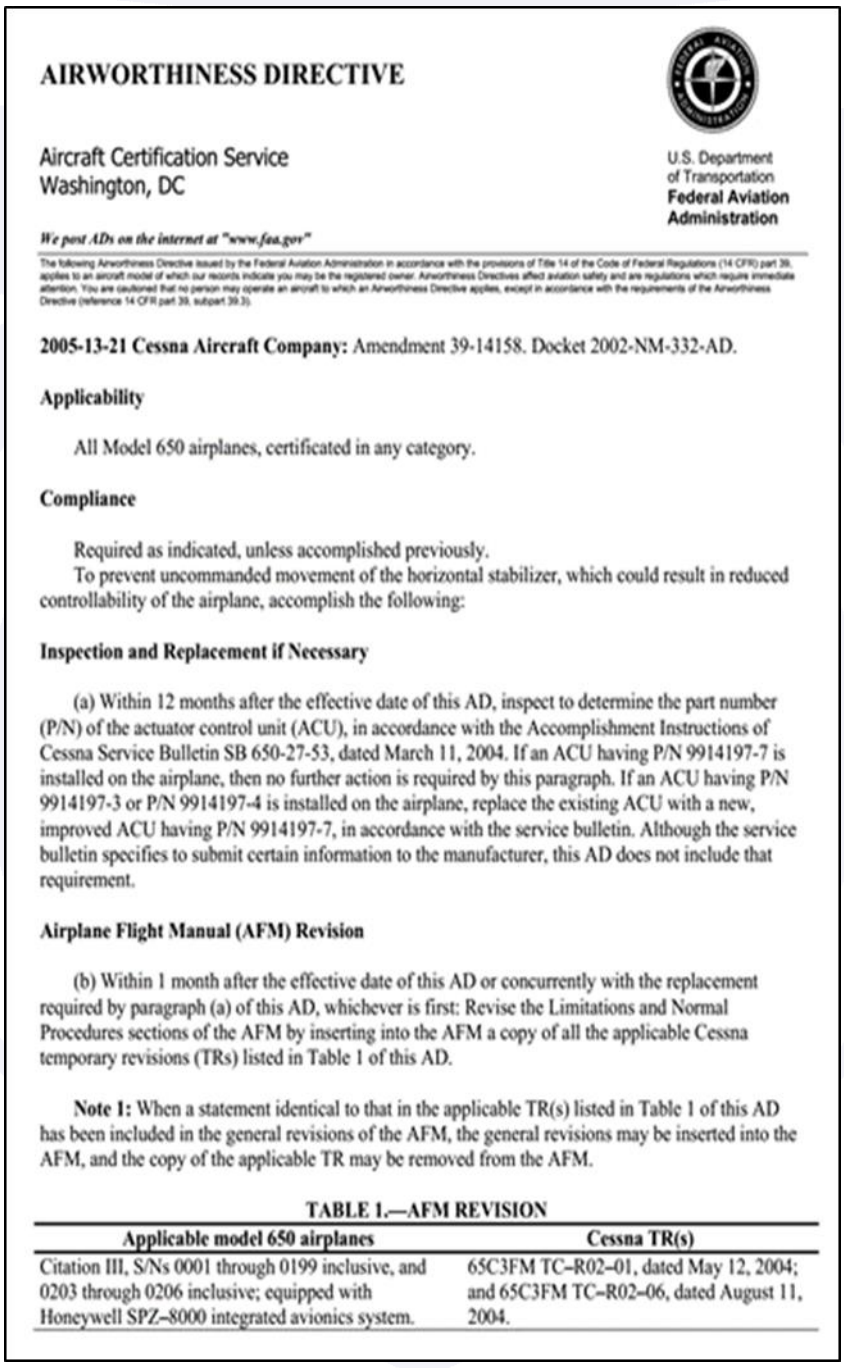
NEW P/N	QUANTITY	KEY WORD	OLD P/N	INSTRUCTIONS/ DISPOSITION
9914197-7 (EX)	1	Actuator Control Unit	9914197-3 or 9914197-4	Return to Cessna for exchange

NOTE: The existing actuator control unit is to be returned to Cessna Aircraft Company, Citation Parts Distribution, 7121 Southwest Boulevard, Wichita, KS 67215, USA, and exchanged for a 9914197-7 Actuator Control Unit. This option will require advance scheduling with Citation Parts Distribution, telephone number 1-800-835-4000 (Domestic) or 1-316-517-7542 (International) or telefax 1-316-517-7711.

Figure 13 - SB650-27-53 page 4 of 4.

The AD No. 2005-13-21 guided, in general, to perform an ACU Part Number check. If the PN were 9914197-7, no action would be required. If the PN were 9914197-3 or 9914197-4, the replacement should be performed according to the ACU PN, as directed in SB650-27-53 of 11MAR2004.

In addition, AD No. 2005-13-21 guided the incorporation of Temporary Changes (TC) into the Airplane Flight Manual (AFM). In the case of the PT-WQH aircraft, Serial Number 650-7083, it should be incorporated the Temporary Change 65C7FM TC-R10-07, from 11AUG2004 (Figures 14 to 16).



AIRWORTHINESS DIRECTIVE

Aircraft Certification Service
Washington, DC

U.S. Department of Transportation
Federal Aviation Administration

We post ADs on the internet at "www.faa.gov"

The following Airworthiness Directive issued by the Federal Aviation Administration in accordance with the provisions of Title 14 of the Code of Federal Regulations (14 CFR) part 39, applies to an aircraft model of which our records indicate you may be the registered owner. Airworthiness Directives affect aviation safety and are regulations which require immediate attention. You are cautioned that no person may operate an aircraft to which an Airworthiness Directive applies, except in accordance with the requirements of the Airworthiness Directive (reference 14 CFR part 39, subpart 39.3).

2005-13-21 Cessna Aircraft Company: Amendment 39-14158. Docket 2002-NM-332-AD.

Applicability

All Model 650 airplanes, certificated in any category.

Compliance

Required as indicated, unless accomplished previously.
To prevent uncommanded movement of the horizontal stabilizer, which could result in reduced controllability of the airplane, accomplish the following:

Inspection and Replacement if Necessary

(a) Within 12 months after the effective date of this AD, inspect to determine the part number (P/N) of the actuator control unit (ACU), in accordance with the Accomplishment Instructions of Cessna Service Bulletin SB 650-27-53, dated March 11, 2004. If an ACU having P/N 9914197-7 is installed on the airplane, then no further action is required by this paragraph. If an ACU having P/N 9914197-3 or P/N 9914197-4 is installed on the airplane, replace the existing ACU with a new, improved ACU having P/N 9914197-7, in accordance with the service bulletin. Although the service bulletin specifies to submit certain information to the manufacturer, this AD does not include that requirement.

Airplane Flight Manual (AFM) Revision

(b) Within 1 month after the effective date of this AD or concurrently with the replacement required by paragraph (a) of this AD, whichever is first: Revise the Limitations and Normal Procedures sections of the AFM by inserting into the AFM a copy of all the applicable Cessna temporary revisions (TRs) listed in Table 1 of this AD.

Note 1: When a statement identical to that in the applicable TR(s) listed in Table 1 of this AD has been included in the general revisions of the AFM, the general revisions may be inserted into the AFM, and the copy of the applicable TR may be removed from the AFM.

TABLE 1.—AFM REVISION

Applicable model 650 airplanes	Cessna TR(s)
Citation III, S/Ns 0001 through 0199 inclusive, and 0203 through 0206 inclusive; equipped with Honeywell SPZ–8000 integrated avionics system.	65C3FM TC–R02–01, dated May 12, 2004; and 65C3FM TC–R02–06, dated August 11, 2004.

Figure 14 - AD nº 2005-13-21 page 1 of 3.

Citation III, S/Ns 0001 through 0199 inclusive, and 0203 through 0206 inclusive; not equipped with Honeywell SPZ–8000 integrated avionics system.	65C3FM TC–R02–01, dated May 12, 2004; and 65C3FM TC–R02–07, dated August 11, 2004.
Citation VI, S/Ns 0200 through 0202 inclusive, and 0207 and subsequent	65C6FM TC–R04–01, dated May 12, 2004; and 65C6FM TC–R04–06, dated August 11, 2004.
Citation VII, S/Ns 7001 and subsequent	65C7FM TC–R10–01, dated May 12, 2004.
Citation VII, S/Ns 7001 and subsequent, equipped with Honeywell SPZ–8000 integrated avionics system.	65C7FM TC–R10–07, dated August 11, 2004.

Parts Installation

(c) As of the effective date of this AD, no person may install an ACU having P/N 9914197-3 or -4, on any airplane.

Alternative Methods of Compliance

(d) In accordance with 14 CFR 39.19, the Manager, Wichita Aircraft Certification Office, FAA, is authorized to approve alternative methods of compliance for this AD.

Incorporation by Reference

(e) Unless otherwise specified in this AD, the actions must be done in accordance with the service information listed in Table 2 of this AD. This incorporation by reference was approved by the Director of the Federal Register in accordance with 5 U.S.C. 552(a) and 1 CFR part 51. To get copies of this service information, contact Cessna Aircraft Co., P.O. Box 7706, Wichita, Kansas 67277. To inspect copies of this service information, go to the FAA, Transport Airplane Directorate, 1601 Lind Avenue, SW., Renton, Washington; or to the FAA, Wichita Aircraft Certification Office, 1801 Airport Road, Room 100, Mid-Continent Airport, Wichita, Kansas; or to the National Archives and Records Administration (NARA). For information on the availability of this material at the NARA, call (202) 741-6030, or go to *http://www.archives.gov/federal_register/code_of_federal_regulations/ibr_locations.html*.

TABLE 2.—MATERIAL INCORPORATED BY REFERENCE

Cessna Service Information	Date
Service Bulletin SB 650–27–53	March 11, 2004.
Temporary Revision 65C3FM TC–R02–01	May 12, 2004.
Temporary Revision 65C3FM TC–R02–06	August 11, 2004.
Temporary Revision 65C3FM TC–R02–07	August 11, 2004.
Temporary Revision 65C6FM TC–R04–01	May 12, 2004.
Temporary Revision 65C6FM TC–R04–06	August 11, 2004.
Temporary Revision 65C7FM TC–R10–01	May 12, 2004.
Temporary Revision 65C7FM TC–R10–07	August 11, 2004.

Figure 15 - AD nº 2005-13-21 page 2 of 3.

Effective Date

(f) This amendment becomes effective on July 29, 2005.

Issued in Renton, Washington, on June 14, 2005.
Kevin M. Mullin,
Acting Manager, Transport Airplane Directorate, Aircraft Certification Service.
[FR Doc. 05-12306 Filed 6-23-05; 8:45 am]
BILLING CODE 4910-13-P

Figure 16 - AD nº 2005-13-21 page 3 of 3.

According to maintenance records, SB650-27-53 and AD No. 2005-13-21 were completed on 28JUL2006. Item 13 of SB650-27-53 prevised an operational check flight of the system.

In the records of the aircraft's flight logbook, no test flight was identified, in order to comply with item 13 of SB650-27-53.

Alert Service Letter ASL650-55-04

On 02NOV2007, the aircraft's manufacturer issued the first version of the *Alert Service Letter* (ASL) - ASL650-55-04 (Figures 17 to 19). This document has passed through 2 revisions, as described below.

The first revision was from 01OCT2008 and had small changes in the actuators assembly set, in case there was the need of a replacement.

The second revision was from 23APR2009 and altered the accomplishment deadline from 18 to 36 months.

Citation **ALERT SERVICE LETTER** Cessna A Textron Company

ASL650-55-04

TITLE

STABILIZERS - HORIZONTAL-STABILIZER ACTUATOR-CONTROLLER

EFFECTIVITY

MODEL	SERIAL NUMBERS
650 (Citation III)	-0001 thru -0199, -0203 thru -0206
650 (Citation VI)	-0200 thru -0202, -0207 thru -0241
650 (Citation VII)	-7001 thru -7119

REASON

The horizontal-stabilizer actuator-controller can cause the PRI TRIM FAIL annunciator light to not illuminate during the Warning System-CHECK of the pre-flight and post-flight rotary test.

DESCRIPTION

This service letter provides the part number information for an improved horizontal-stabilizer actuator-controller.

COMPLIANCE

MANDATORY. This service letter must be accomplished within 36 months from the original date of receipt.

MANPOWER

WORK PHASE	MAN-HOURS
Modification	3.0 man-hours for replacement of the 9914197-8 Actuator Controller, and associated paper work.

MATERIAL - Cost and Availability

NOTE: The following parts may be required to complete this service letter.

PART NUMBER	QUANTITY	KEY WORD	COST
9914056-7	1	Actuator Assembly	*
9914056-8	1	Actuator Assembly	*
9914197-8	1	Actuator Controller	*

* Please contact Citation Parts Distribution for current cost and availability of parts listed in this service letter. Phone at 1-800-835-4000 (Domestic) or 1-316-517-7542 (International). Send Email to: citationparts@cessna.textron.com or telefax at 1-316-517-7711.

NOTE: The 9914056-7 and 9914056-8 Actuator Assemblies have a 1200 hour replacement time limit. This replacement time limit will be incorporated into chapter 4 of the Model 650 Maintenance Manual.

Nov 2/2007
Revision 2 - Apr 23/2009

650-55-04
Page 1 of 3

Figure 17 - ASL650-55-04 page 1 of 3.

Citation **ALERT SERVICE LETTER** Cessna A Textron Company

ASL650-55-04

WARRANTY

Eligibility: Aircraft superseding from the 9914197-7 actuator controller to the 9914197-8 actuator controller, that are within the effectivity of this alert service letter (ASL650-55-04), will be eligible for warranty consideration. Warranty eligibility is limited to the superseding of the actuator controller and does not cover replacement of the actuator assembly(s).

Parts: Authorized Citation Service Facilities, individual operators, or other maintenance facilities may submit a Credit Claim Form for the parts kit(s) required for accomplishment of this service letter, provided the work is completed and the claim submitted by the expiration date shown below.

Labor: Authorized Citation Service Facilities may submit a Credit Claim Form for accomplishment of this service letter, on eligible airplanes, provided the work is completed and the claim submitted by the expiration date shown below.

Expiration: Mar 31/2011

REFERENCES

Cessna Citation Model 650 Maintenance Manual

Cessna Citation Model 650 Illustrated Parts Catalog

PUBLICATIONS AFFECTED

Cessna Citation Model 650 Illustrated Parts Catalog

ACCOMPLISHMENT INSTRUCTIONS

1. Prepare the airplane for maintenance.
   - A. Make sure that all switches are in the OFF/NORM position.
   - B. Disconnect electrical power from the airplane.
     - (1) Disconnect the airplane battery.
     - (2) Disconnect external electrical power.
   - C. Attach maintenance warning tags to the battery and external power receptacle that have **"DO NOT CONNECT ELECTRICAL POWER - MAINTENANCE IN PROGRESS"** on them.
2. Remove the 9914197-7 Actuator Controller. (Refer to the Model 650 Maintenance Manual, Chapter 27, Horizontal Stabilizer Trim Control - Maintenance Practices.)
3. Install the 9914197-8 Actuator Controller. (Refer to the Model 650 Maintenance Manual, Chapter 27, Horizontal Stabilizer Trim Control - Maintenance Practices.)
4. Do a flight at 40,000 feet or higher for one hour.

   NOTE: The flight must be accomplished in less than 4 weeks.
5. Do the post-flight Warning System-CHECK.
   - A. If the PRI TRIM FAIL annunciator light does not illuminate, do Step 6.

     NOTE: The horizontal actuator assembly must be replaced in 15 flight hours or less.
   - B. If the PRI TRIM FAIL annunciator light does illuminate, do Step 7.

Figure 18 - ASL650-55-04 page 2 of 3.

Citation **ALERT SERVICE LETTER** Cessna A Textron Company

ASL650-55-04

6. Replace the actuator assembly.
   - A. (Airplanes with the 9914056-3 Actuator Assembly installed.) Remove the 9914056-3 Actuator Assembly. (Refer to the Model 650 Maintenance Manual, Chapter 27, Horizontal Stabilizer Trim Control - Maintenance Practices.)
     - (1) Install the 9914056-7 Actuator Assembly. (Refer to the Model 650 Maintenance Manual, Chapter 27, Horizontal Stabilizer Trim Control - Maintenance Practices.)

       NOTE: The 9914056-7 Actuator Assembly has a 1200 hour replacement time limit. This replacement time limit will be incorporated into chapter 4 of the Model 650 Maintenance Manual.

       NOTE: A 9914056-3 Actuator Assembly may be used if a 9914056-7 Actuator Assembly is not available.
   - B. (Airplanes with the 9914056-4 Actuator Assembly installed.) Remove the 9914056-4 Actuator Assembly. (Refer to the Model 650 Maintenance Manual, Chapter 27, Horizontal Stabilizer Trim Control - Maintenance Practices.)
     - (1) Install the 9914056-8 Actuator Assembly. (Refer to the Model 650 Maintenance Manual, Chapter 27, Horizontal Stabilizer Trim Control - Maintenance Practices.)

       NOTE: The 9914056-8 Actuator Assembly has a 1200 hour replacement time limit. This replacement time limit will be incorporated into chapter 4 of the Model 650 Maintenance Manual.

       NOTE: A 9914056-4 Actuator Assembly may be used if a 9914056-8 Actuator Assembly is not available.
7. Complete the Horizontal Stabilizer Trim Information form (Attached).
   - A. Fax the Horizontal Stabilizer Trim Information form to Citation Customer Service at 1-316-206-6460.
8. Record that you completed this service letter as follows:
   - A. Complete a Maintenance Transaction Report.
   - B. Put a copy of the completed Maintenance Transaction Report in the airplane logbook.
   - C. Send a copy of the completed Maintenance Transaction Report to: CESCOM, P.O. Box 7706, Wichita, KS 67277.

Figure 19 - ASL650-55-04 page 3 of 3.

In general, the procedures previsted in the ASL650-55-04 were:

- remove ACU PN 9914197-7 and install ACU PN 9914197-8;
- perform an operational check flight on FL400 or above, for at least 1h; and
- perform a Warning System - CHECK.

If the PRI TRIM FAIL light does not turn on, the actuator must be replaced, as follows:

- if the installed actuator was the PN 9914056-3, replace it by the PN 9914056-7; and
- if the installed actuator was the PN 9914056-4, replace it by the PN 9914056-8.

The FAA has considered ASL650-55-04 an alternative method of compliance, or Alternate Means of Compliance (AMOC), of AD No. 2005-13-21, through the response letter issued under the heading "Alternate Means of Compliance to AD 2005 -13-21" from 06NOV2007.

The OS 68.496, opened on 03SEPT2010 and closed on 17SEPT2010, in the maintenance organization TAM Executive Aviation and Air Taxi S.A, contained information regarding compliance with ASL650-55-04 (Figure 20).

FICHA DE SERVIÇO(WORK SHEET)

ITEM(ITEM)	OS(W.O.)	PREFIXO(ACFT. REG)	SN	INÍCIO(DATE IN)	TÉRMINO (DATE OUT)
2	68496	PT-WQH	650-7083	03/09/2010	17/09/2010

SERVIÇO (SERVICE REQUESTED)

ASL650-55-04

SERVIÇO EXECUTADO (SERVICE ACCOMPLISHED)

EFETUADO A ASL650-55-04 CONFORME AS INSTRUÇÕES EM ANEXO. FOI NECESSARIO EFETUAR A SUBSTITUIÇÃO DO CONTROLE DO ATUADOR REMOVIDO 9914197-7 S/N 2045 INSTALADO P/N 9914197-8 S/N 3292. FOI USADO O M.M CESSNA 650 CAP27-40-01 REV 32., NÃO FOI NECESSARIO EFETUAR A SUBSTITUIÇÃO DO ATUADOR CONFORME INSTRUÇÕES EM ANEXO DA ASL650-55-04 PONTO 5B .OK.

Figure 20 - Service Order nº 68.496, from 03SEPT2010.

The OS nº 68.496 had the following description of the service performed.

> "(...) IT WAS NOT NECESSARY TO PERFORM THE REPLACEMENT OF THE ACTUATOR ACCORDING TO THE INSTRUCTIONS IN ANNEX OF ASL650-55-04 POINT 5B. OK."

Point 5B of ASL650-55-04 referred to the WARNING SYSTEM - CHECK, after the test flight.

In the records of the flight logbook there were some flights during the period in which the Service Order was open, from 03SEP2010 to 19SEPT2010, including transporting passengers.

None of the flights performed during that time were for the specific purpose of flight check. Nor was there any description of the conditions observed in flight and the result of the WARNING SYSTEM - CHECK test.

1.7 Meteorological information.

En route weather conditions were favorable for the flight, as shown by the satellite image at 2100 (UTC), close to the time of the accident (Figure 21).

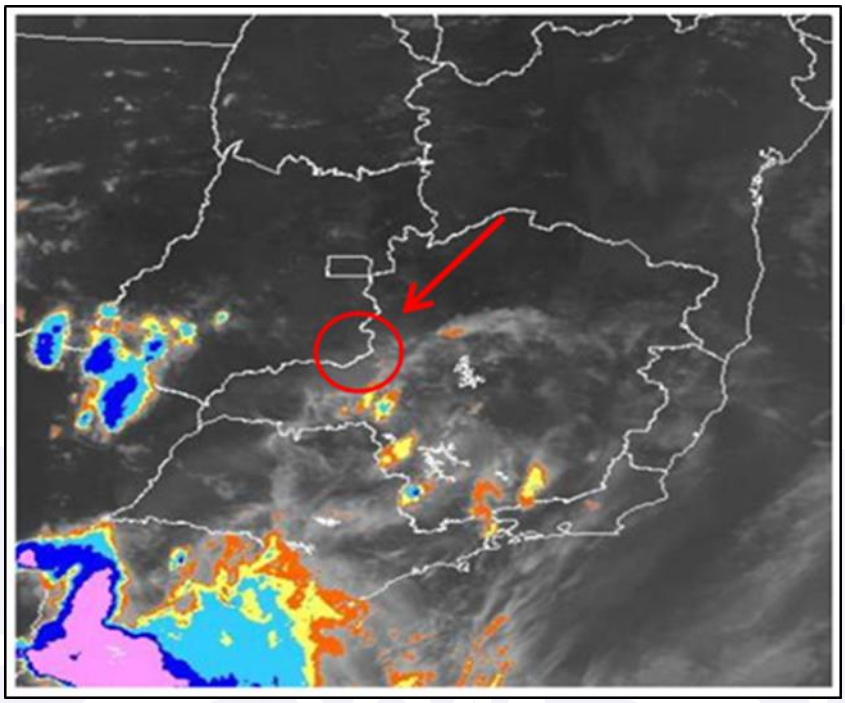


Figure 21 - Satellite image consulted at 2100 (UTC), close to the time of the accident.
The red circle shows the approximate impact place of the aircraft against the ground.

1.8 Aids to navigation.

Nil.

1.9 Communications.

All communications were made with the air traffic services without intercurrences.

1.10 Aerodrome information.

The occurrence took place outside the Aerodrome.

1.11 Flight recorders.

The aircraft was equipped with a digital voice recorder, Cockpit Voice Recorder (CVR). The data recorder was not required for the PT-WQH operation category and it was not installed. The CVR installed had the following specifications:

Manufacturer: L-3 Aviation Recorders

Model: A200S

Part Number: S200-0012-00

This CVR had the capability to store data on two audio channels. One of standard quality, lasting approximately two hours, coming from two audio sources (cabin area microphone and pilot's headset). The other high quality audio channel, which lasted approximately thirty minutes, had four sources (cabin area microphone, pilot's headset, copilot's headset, and cabin intercom).

The recording of the audio was initiated when the aircraft was energized and stopped when the power supply was interrupted or even when the CVR was subjected to high "G" load factors.

Data from this voice recorder model was stored in a unit called Crash Survivable Memory Unit (CSMU). The CSMU was found at the accident site with significant damage due to impact and fire (Figure 22).

Figure 22 - CSMU at the accident site.

Due to the extensive damage to the CSMU, data extraction from the memory was performed at the National Transportation Safety Board (NTSB) facility in Washington - United States of America, accompanied by technicians from the (CENIPA).

The standard quality audio was fully extracted, totaling two hours, four minutes and fifteen seconds of recording. The records were related to the final descent, landing and taxi phase of the previous flight. In addition, the recordings contained conversations carried out on the ground with the aircraft powered and throughout the flight of the accident.

With regard to high quality audio, a total of 31 minutes and 26 seconds of recording was extracted. However, it was identified that a memory chip was irrecoverably damaged.

Due to the CVR's recording logic, the memory chip's failure generated small spot gaps in the high-quality audio section relating to the area microphone capture. The high quality recording period comprised the end of the taxi phase and the entire flight of the accident.

In the recordings related to the previous flight (SBSP-SBBR), after the landing during the shutdown procedure, the TRIM / FLAP test of the Rotary Test Switch was not identified.

The aircraft was re-energized about 45 minutes prior to takeoff for the flight of the occurrence, and at that time the CVR started recording the cabin sounds again.

During the preparation for the flight, it was possible to identify several subjects, such as: flight plan, navigation and information of Automatic Terminal Information Service (ATIS). At that time, some actions of the Cockpit Preparation Checklist were not identified.

About thirty minutes before the takeoff, there was the following dialogue between the crew:

> - "I did not even touched it… this time it happened again. This morning it did not happen, but I did not even touch it here. "
>
> - "Ah, take it out ... just take it out a little bit there."
>
> - "Pitch Control. Pitch Power. "

Moments after the last speech of this dialogue, it was possible to identify two low-intensity sounds in the crew's audio channel, characterized by two low-pitched clicks, spaced for approximately one second.

After about fifteen seconds, two other click sounds similar to the previous ones were identified, spaced again for a second.

Approximately one minute and twenty seconds after the speech "*Pitch Control. Pitch power*" other two clicks were recorded.

The first one was characterized as the click sound of low to medium intensity and slightly low tone. After 1.5 seconds, another sound was characterized as a click of medium intensity and moderately acute tone.

Then it was possible to hear the clacker sound twice.

About five seconds after the last clacker sound, a single sound characterized by a click of medium intensity and slightly acute was recorded on the audio channel of the cabin microphone.

About 30 seconds after the end of the clacker sound, approximately 25 minutes before take-off, the following conversation took place between the crew:

"Nothing, right?"

"It did not even light on."

"Uh ... Try it ... Red Button."

"Do you want to pull it a little bit again and leave it for a couple of minutes?"

Soon after this dialogue, it was possible to identify again, in the audio channel of the crew, a sound of low intensity characterized by two clicks of low tone, spaced by approximately 0.7 seconds.

About 24 minutes before take-off, one of the crewmembers made a phone call requesting the passengers to board. The following is an excerpt from the phone call:

- "Not to cause too much stress there, ask the passengers to come in."

The following conversation between the crew was recorded approximately 23 minutes before take-off:

- "Come back?"
- "Come back."

Thereafter, two low-pitched and low toned sounds were recorded on the crew's audio channel with two clicks, spaced approximately one second apart.

In the sequence, the crew comment on the switching on of a light, however, without specifying it. Other comments were made about turning off the Auxiliary Power Unit (APU) and battery, but without establishing a direct relationship with any aircraft system.

The boarding of the passengers occurred approximately 21 minutes before take-off. The crew reported that the aircraft was set and ready for the taxi about 13 minutes before takeoff.

A couple of minutes after the crew informed ready for taxi, it was possible to identify a single sound of low intensity for medium and slightly low tone. Then there was the following comment from one of the crewmembers:

"Did you switch it? Isn't it working too? "

During this speech, it was possible to identify, in the audio channel of the cabin microphone, a single sound of medium intensity and moderately acute tone. About four seconds later, there were two clacker sounds.

Around five seconds after the end of the movement, it was possible to identify in the audio channel of the cabin microphone a single medium intensity sound with a slightly acute tone.

About four minutes before the start of the take-off run, the crew had the following dialogue before lining-up runway 11R:

- "There's no aircraft."
- "Let's do this ... shutdown APU."
- "APU off. OK. Do you want to try the inverter as well? "
- "Um, no, not the inverter."
- “It will have to be manually.”
- “Huh?”
- “It will have to be manually.”

The aircraft was then authorized to takeoff. The run-off took place without intercurrences. During the initial climb, less than one minute after takeoff, it was possible to identify two sounds in the audio channel of the cabin microphone.

The first sound was characterized as a click of low to moderate intensity and a slightly low tone. The second sound was characterized as a click of medium intensity and moderately acute tone. These clicks were spaced approximately 1.5 seconds apart.

At about three seconds after these two beeps, it was possible to hear the clacker sound beep at 4 different times, totaling 16.8 seconds of audible warning in a time interval of approximately two minutes.

During the take-off and climb procedures, the crew made some After-Takeoff Checklist actions.

About three minutes after the takeoff, there was the following dialogue between the crew:

- "Here you have to put in your head that you are an autopilot."
- "Uhum."

After four minutes and thirty seconds of flight, three distinct sounds were identified in the audio channel of the cabin microphone. The first one was characterized as a click of medium intensity and slightly acute tone. After 2.1 seconds, a second click of low to moderate intensity and a slightly low tone was heard. Lastly, there was a third click spaced 2.3 seconds from the second click with medium intensity and slightly acute tone. Soon after, there was the following dialogue between the crew:

- "Leave it, right?"
- "Yes."
- "Do you want to keep it there?"
- "OK."

After this dialogue, one of the crew provided guidance on more comfortable piloting positions and about keeping the aircraft on the desired route.

About twelve minutes of flight, one of the crewmembers commented on the position of the horizontal stabilizer being approximately -2 ° in straight and leveled flight.

About 14 minutes into the flight, there was the following dialogue between the crew:

- "Let's see if the AP is working?"
- "Let's go."

Less than a second after this dialogue, it was possible to hear a sound in the audio channel of the cabin microphone, characterized by a click of medium intensity and a slightly acute pitch. About five seconds after this sound, there was the following dialogue between the crew:

- "Nothing, right?"

- "Nothing."

About seven seconds after the last dialogue, it was possible to identify two different sounds again in the cabin area microphone. The first one characterized by a click of medium intensity for low and slightly low tone. The second one characterized by a click of medium intensity and moderately acute tone spaced from approximately 1 second of the first sound.

Less than two minutes after the previous dialogue, that is, after approximately 16 minutes of flight, there was the following dialogue between the crew:

- "Do you believe that once I and [name of person] took the [nickname] to [city name] like this?"

- "Gosh!"

- "It's been an hour each like this."

After this dialogue, the crew commented on some weather formations and about making small detours on the route. With approximately 21 minutes of flight, the crew requested the FL410 as the final level of flight. This request was authorized by the Air Traffic Services (ATS).

After about 23 minutes and thirty seconds of flight, there was the following dialogue between the crew:

- "If you want me to try something, you tell me. If you want me to go trying something"

- "No, not now ... I've just ... It's back to normal. Let's see if it turns on"

Immediately after the end of the second speech of the previous dialogue, there was the following sequence of events recorded on the audio channel of the cabin microphone:

- Event 01 (00m00,0s): sound of a click with medium intensity and slightly high tone;

- Event 02 (00m02,2s): beginning of a clacker sound ;

- Event 03 (00m03,6s): speaks of one of the crew: "Gosh!";

-Event 04(00m03,8s): end of the clacker sound;

- Event 05 (00m03,9s): aural warning of approximately 2,700hz of frequency;

- Event 06 (00m05,9s): low intensity sound for medium and slightly low tone;

- Event 07 (00m06,3s): sound of medium intensity and moderately acute tone;

- Event 08 (00m12,5s): speech of one of the crewmember: "Reduce?";

- Event 09 (00m13,4s): speech of the other crewmember: "Uhum.";

- Event 10 (00m18,3s): sound of physical effort of one of the crewmembers - there were about 10 similar manifestations during the fall of the aircraft;

- Event 11 (00m21,3s): Overspeed characteristic alarm - this alarm remained until the interruption of the recording;

- Event 12 (00m56.0s): Ground Proximity Warning System (GPWS) alarms - Caution Terrain and Pull Up warnings - these alarms were emitted spaced out until the recording was interrupted; and

- Event 13 (01m13,3s): interruption of the recording of the aircraft's CVR.

_____

1 Name of people and cities intentionally omitted.

1.12 Wreckage and impact information.

The aircraft crashed into the ground with high energy, in a farm located in the municipality of Guarda Mor - MG. The elevation of the terrain was of approximately 2,200ft.

The impact on the ground produced high fragmentation of the aircraft and a crater of approximately ten meters in diameter and seven meters deep.

Figure 23 - Place of impact of the aircraft against the ground.

1.13 Medical and pathological information.

1.13.1 Medical aspects.

According to data from the Health Inspections (INSPSAU), the crewmembers were considered physically and mentally healthy.

The pilot performed his last Health Inspection on 09JUN2015, at the health board of the São Paulo Aeronautics Hospital (HASP), receiving the opinion "able for the intended purpose." INSPSAU was valid until 09JUN2016.

The copilot performed his last Health Inspection on 26FEB2015, at the health board of the São Paulo Aeronautics Hospital (HASP), receiving the opinion "able for the intended purpose." INSPSAU was valid until 26FEB2016.

1.13.2 Ergonomic information.

Nil.

1.13.3 Psychological aspects.

At the time of the accident, the pilot worked for the operating company for more than 30 years.

According to reports, he was professionally respected among co-workers and maintained a good interpersonal relationship with everyone, generally assuming a calm, discreet, methodical and relieving behavioral profile.

Despite his more introspective and reserved posture, he was open to communication and dialogue among the pilots with whom he worked, a fact that facilitated the team's dynamics and the management of technical and human resources during the flights.

People close to the pilot reported that in the period before the accident, he was physically and emotionally stable. He maintained healthy eating and sleeping routines and had no complaints about work that might negatively reflect his performance.

His disposition was complete to the flight, even on weekends. However, according to family members, the pilot did not report discomfort due to social absences caused by his work.

Among the crew of the operating company, the pilot involved in the accident was the one who used to be the commander of all flights scheduled to the PT-WQH aircraft.

According to reports by his colleagues, his technical mastery of this aircraft model was remarkable, with emphasis on self-confidence and the level of situational awareness presented during the flights.

Relatives and co-workers stated that it was common for the pilot to keep a close watch on the operating conditions of the aircraft. They were not aware of any reports of abnormalities in the PT-WQH operation.

The copilot, according to his family, was physically and psychologically healthy before the accident. They stated that, despite being sedentary and slightly overweight, he did not present complaints of fatigue or tiredness during the performance of his activities.

The copilot was described as a focused professional who was still in the process of acquiring operational experience. He had no employment relationship with the operator, but he was asked to take part in the scheduled composition because of the absence of another crewmember.

Whenever necessary, the pilot used to prioritize flights with this copilot. The copilot’s relatives reported that this condition pleased him because of the opportunity, albeit informal, to be instructed and operationally trained by the pilot during the flights.

With regard to the psychosocial aspects present in the working relationship of the pilots with the operators' managers and other users of their air service, there were no reports of pressure on rigid scheduling or flight plan compliance.

According to the operating company’s pilots, the passengers did not have the habit of interfering in the conduct of the flights or in the actions in cabin, being comprehensive with possible route deviations, when the flight safety demanded.

Regarding the maintenance services performed, although some reports from members of the maintenance company deny the existence of pressures by the operator for the execution and completion of services, it was reported that sometimes there was pressure from the operator's chief pilot.

The very close monitoring of the activities inside the maintenance hangar itself, on some occasions, embarrassed the mechanics during the execution of the services.

They also reported that this posture reflected in a self-imposed pressure by the mechanic to finish the work, in addition to a stress load that was added to the demands of the maintenance activity itself.

1.14 Fire.

There was no evidence of fire in flight. All signs found were consistent with fire after impact. Flames damaged documentations aboard the aircraft.

1.15 Survival aspects.

There were no survivors.

1.16 Tests and research.

The wreckage was analyzed between 23FEB2016 and 26FEB2016, with the participation of representatives of the CENIPA, the DCTA, the aircraft manufacturer and the engine manufacturer, at the CENIPA's facilities in Brasilia - DF.

Due to the extent of the damage, it was not possible to carry out detailed examinations on several systems of the aircraft.

From the analysis of the wreckage, it was possible to affirm that:

a) the measurement of the actuators of the flaps, spoilers and speed brakes indicated that they were retracted; and

b) the measurement of the landing gear actuators indicated that they were in the retracted position.

Regarding the pitch trim system, the actuator attachment assembly on the horizontal stabilizer surface, the horizontal stabilizer electric engine, and a section of approximately five inches of the jackscrew actuation (Figure 24) were recovered.

Figure 24 – Horizontal stabilizer electric engine and jackscrew section.

It was not possible to estimate the position of the horizontal stabilizer at the moment of impact.

The left engine, model TFE731-4, PN 3073640-2, SN P-102269, presented damages with friction characteristics in the turbine disks. These damages indicated that the engine was rotating and was operating at the time of impact.

Figure 25 - Damaged blades of the left engine low-pressure turbine.

The right engine, model TFE731-4, PN 3073640-2, SN P-102278, presented damages with friction characteristics in turbine disks. These damages indicated that the engine was rotating and was operating at the time of impact.

Figure 26 - Damaged blades of the right low-engine turbine.

No preexisting conditions were observed indicating abnormal engine operating conditions.

1.17 Organizational and management information.

The operator used private transport air services to fulfill its schedule of activities for almost forty years, in order to meet the demands of the company's managers.

The operator used the aircraft model 650 since 1998. At the time of the accident, the operator had, in addition to the model 650, a model Gulfstream 200. The operation team of these aircraft was composed of four pilots, the pilot involved in the accident operated the PT-WQH, predominantly.

The copilot that flew the 650 on the day of the accident had no employment relationship with the operator. He made flights on demand, which lasted approximately three years.

According to the copilot’s relatives, there was an expectation, although not yet officialized, of a formal hiring by the operator for 2016.

The operator's chief pilot coordinated the operator’s airline activities. The flights were carried out on demand, with no pre-defined operating routine.

Usually flights were requested with an average advance from ten to fifteen days, which allowed them to be planned in an organized way.

At around thirty flights a month were performed, equivalent to twenty monthly flight hours, on average, which could also involve working nights or weekends.

According to reports, the abnormal conditions (failures) observed in the operation of the aircraft were usually reported verbally and were not registered in the flight logbook.

Maintenance services were usually performed at the base shop. Eventually, however, maintenance interventions could be carried out outside the local base, where the aircraft was located.

Most of the maintenance interventions performed on the PT-WQH were accompanied by the operator's chief pilot and, when possible, also by the pilot involved in the crash.

According to the maintenance organization, due to the transparency policy it sought to maintain with its customers, it did not limit or prevent the operator from following the progress and types of services that were performed by the mechanics inside the maintenance hangar itself.

Regarding the organizational processes related to the opening of service orders by the maintenance organization, it was verified that a Customer Support team, whose composition did not previse the presence of a professional with technical maintenance knowledge, made them.

About this, some maintenance professionals mentioned that it was common to receive OS with poorly detailed or confusing descriptions of the service to be performed, which often led to a rework of having to get in contact with the operator and/or the Customer Support team again, in order to better clarify the nature and the characteristic of the registered condition.

As mentioned in section 1.6, there were two maintenance interventions related to the pitch trim system in September 2015, OS nº 81.995, 08SEPT2015 and OS nº 82.071, from 21SEPT2015.

According to the information obtained from the maintenance organization, it was informed that in the case of the first OS, it was apparently an intermittent electrical fault, since it was not possible to reproduce it more than once during the tests.

In addition, the service description at the OS did not address a more complex problem, that required a more detailed verification at the whole pitch trim system of the aircraft.

The interpretation of the first OS description induced the maintenance team to perform checks on the electrical system associated with the Horizontal Trim Advisory.

It was observed that the maintenance inspector responsible for the service conference did not have a deep knowledge in electrical systems, despite having the course related to the subject. The inspector was not also enabled in avionics, being his specialty related to the systems of flight commands.

The execution of the service relating to this first OS was signed by the maintenance supervisor of the company and not by the mechanic responsible for performing the service. According to interviews, this was not a common practice in the company.

After the completion of OS service 81.995, a second OS, nº 82.071, was requested by the operator, with the following description:

> "TRIM ALARM WITH CONSTANT SOUND WARNING - NECESSARY TO REPLACE (REFERENCE ITEM 08 OF OS 81.995)."

The description of the service was restricted to sound only. A new system test was not carried out, only the component was replaced. Therefore, according to reports, the detailed verification of the system was not performed.

1.18 Operational information.

The aircraft took off from the Congonhas Aerodrome (SBSP) to the Brasília Aerodrome (SBBR), in the morning of 10NOV2015, scheduled to return at the end of the same day.

This flight was intended to transport executives from the company that owned the aircraft.

The aircraft was supplied with 1.400 liters of JET A1 fuel, in Brasília - DF.

The aircraft was within the weight and balance limits specified by the manufacturer.

The take-off occurred at 2039 (UTC). The cruise level in the flight plan was the FL390.

The first detection of one of the air traffic control radars occurred with less than one minute of flight, around 4.000ft. This detection occurred in the radar secondary mode, in which the aircraft gives altitude information and transponder code.

In the primary mode, the altitude information is obtained through the radar detection itself and has less precision.

With about 21 minutes of flying, the aircraft was on the FL340. At that time, as described in section 1.11, the crew requested the final flight level FL410.

The ACC-BS authorized the requested level.

With 24 minutes of flying, the air traffic radars detected, through the radar secondary mode that the aircraft was at an altitude of 36.800ft.

After reaching this altitude, the radar detections showed that it described a marked downward trajectory.

After the altitude of 35.800ft, the radar detection logic considered the information provided by the aircraft to be invalid, and the detections were performed in the primary mode.

Figure 27, below, summarizes the downward trajectory of the aircraft.

The first column shows the detection time, the second shows the altitude values, and the third shows the detection mode (primary or secondary).

Hora (UTC)	Altitude (ft)	Modo
21:03:24	36800	Secundário
21:03:28	36600	Secundário
21:03:29	36400	Secundário
21:03:32	36100	Primário
21:03:34	35800	Secundário
21:03:36	35500	Primário
21:03:35	35600	Primário
21:03:39	34800	Primário
21:03:40	34600	Primário
21:03:44	33700	Primário
21:03:46	33000	Primário
21:03:48	32400	Primário
21:03:49	32000	Primário
21:03:50	31300	Primário
21:03:51	30800	Primário
21:03:54	29500	Primário
21:03:55	28800	Primário
21:03:58	27200	Primário
21:04:03	23700	Primário
21:04:06	21400	Primário
21:04:10	18700	Primário

Figure 27 - Radar detections during the fall of the PT-WQH aircraft.

The last detection occurred in primary mode at 21h:04min:10s (UTC) at an altitude of 18.700ft.

The coordinates recorded by radar at that point were 17°55'55"S and 047°20'57"W.

Considering the last radar detection and the point of impact (17°56'05"S and 047° 18'34"W), it was concluded that the aircraft traveled a horizontal distance of 2.3 NM (4.260m) between these two points.

With regard to flight manuals, the Airplane Flight Manual (AFM) contained procedures to be performed on checklists according to the aircraft's flight situation.

In general, checklists are divided into three broad areas: Normal Procedures, Abnormal Procedures and Emergency Procedures.

The checklists in the Normal Procedures are those actions that must be adopted in the routine operation of the aircraft.

Figure 28 shows the Normal Procedures of the aircraft model 650, according to AFM Revision 10, from 13AUG2001.

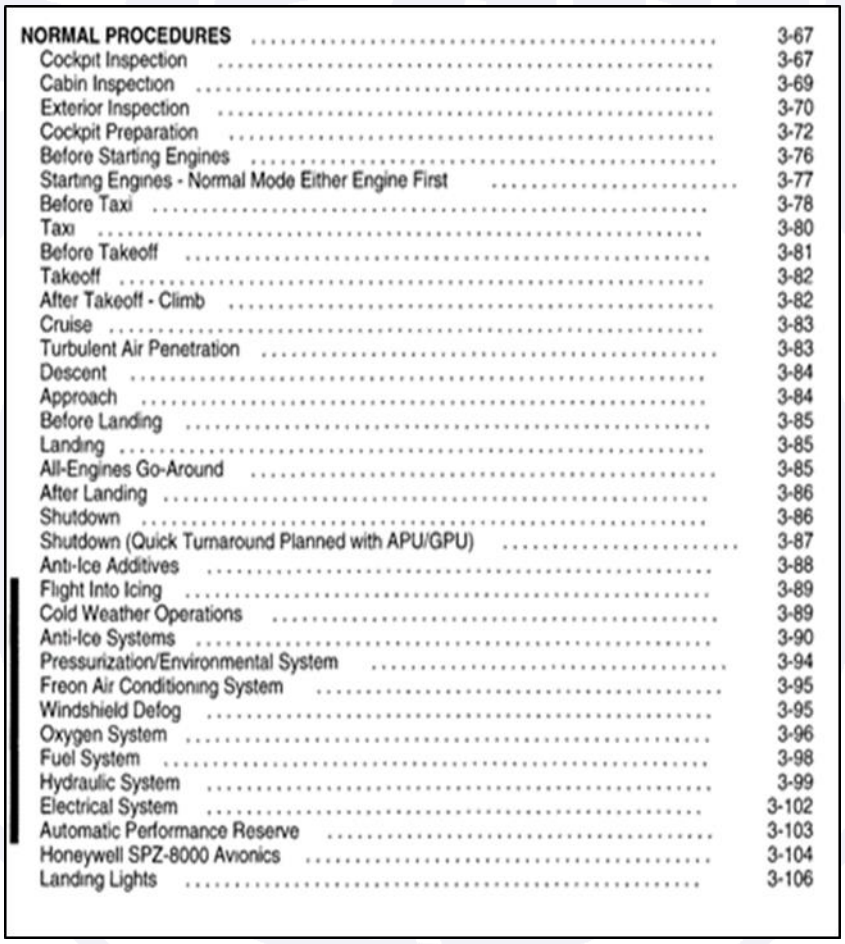


Figure 28 - Normal procedures of the aircraft model 650.

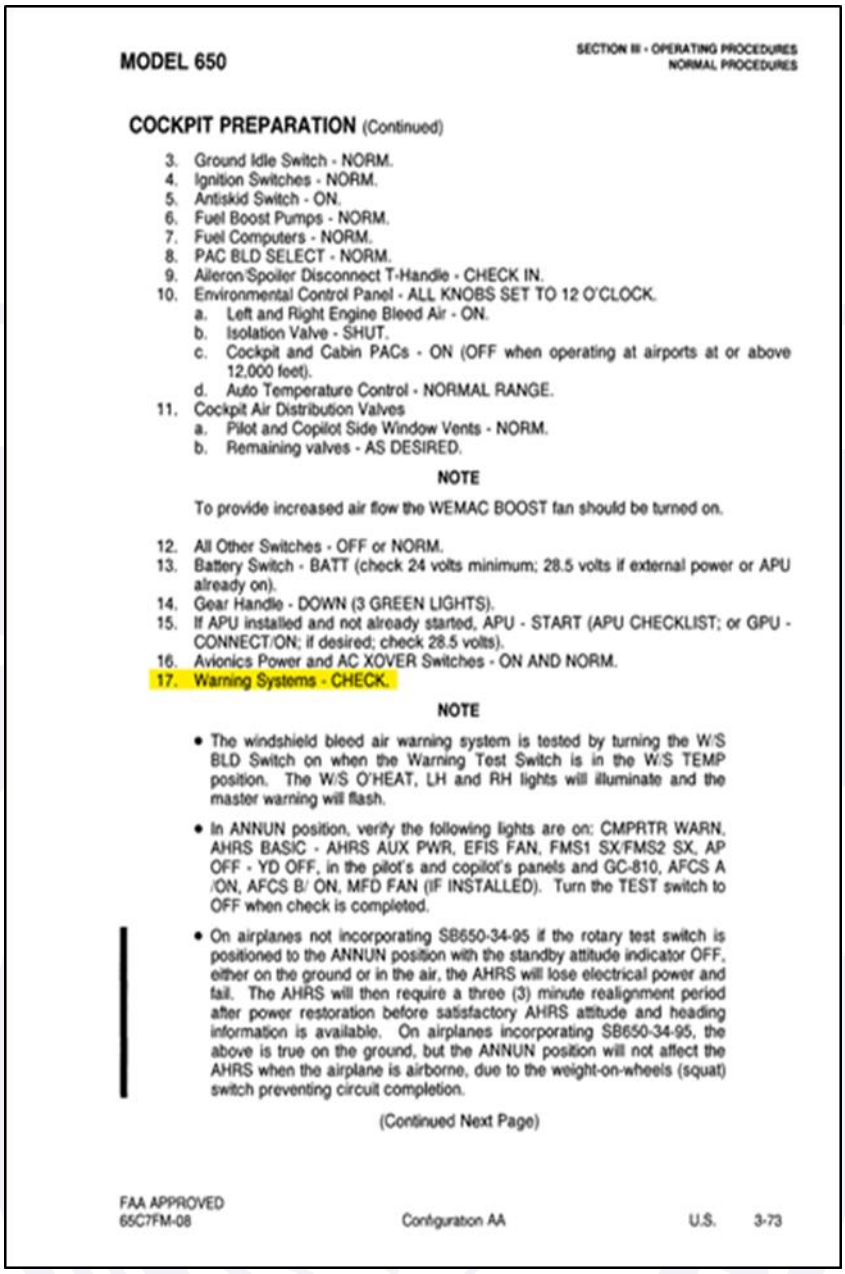
Among the topics shown in Figure 28, those who predicted a check in the pitch trim system of the aircraft were the Cockpit Preparation and the Shutdown Checklist.

The Cockpit Preparation Checklist contemplated actions to be performed after internal/external inspections and prior to the start of the engines.

Overall, its purpose was to set up the aircraft for flight and test its various systems.

According to AFM Revision 10, dated 13AUG2001, the Cockpit Preparation Checklist included thirty items.

Figure 29 shows the item 17, Warning Systems - CHECK, of the Cockpit Preparation Checklist.



MODEL 650

SECTION III - OPERATING PROCEDURES
NORMAL PROCEDURES

COCKPIT PREPARATION (Continued)

3. Ground Idle Switch - NORM.
4. Ignition Switches - NORM.
5. Antiskid Switch - ON.
6. Fuel Boost Pumps - NORM.
7. Fuel Computers - NORM.
8. PAC BLD SELECT - NORM.
9. Aileron/Spoiler Disconnect T-Handle - CHECK IN.
10. Environmental Control Panel - ALL KNOBS SET TO 12 O'CLOCK.
    a. Left and Right Engine Bleed Air - ON.
    b. Isolation Valve - SHUT.
    c. Cockpit and Cabin PACs - ON (OFF when operating at airports at or above 12,000 feet).
    d. Auto Temperature Control - NORMAL RANGE.
11. Cockpit Air Distribution Valves
    a. Pilot and Copilot Side Window Vents - NORM.
    b. Remaining valves - AS DESIRED.

NOTE

To provide increased air flow the WEMAC BOOST fan should be turned on.

12. All Other Switches - OFF or NORM.
13. Battery Switch - BATT (check 24 volts minimum; 28.5 volts if external power or APU already on).
14. Gear Handle - DOWN (3 GREEN LIGHTS).
15. If APU installed and not already started, APU - START (APU CHECKLIST; or GPU - CONNECT/ON; if desired; check 28.5 volts).
16. Avionics Power and AC XOVER Switches - ON AND NORM.
17. Warning Systems - CHECK.

NOTE

- The windshield bleed air warning system is tested by turning the W/S BLD Switch on when the Warning Test Switch is in the W/S TEMP position. The W/S O'HEAT, LH and RH lights will illuminate and the master warning will flash.
- In ANNUN position, verify the following lights are on: CMPRTR WARN, AHRS BASIC - AHRS AUX PWR, EFIS FAN, FMS1 SX/FMS2 SX, AP OFF - YD OFF, in the pilot's and copilot's panels and GC-810, AFCS A /ON, AFCS B/ ON, MFD FAN (IF INSTALLED). Turn the TEST switch to OFF when check is completed.
- On airplanes not incorporating SB650-34-95 if the rotary test switch is positioned to the ANNUN position with the standby attitude indicator OFF, either on the ground or in the air, the AHRS will lose electrical power and fail. The AHRS will then require a three (3) minute realignment period after power restoration before satisfactory AHRS attitude and heading information is available. On airplanes incorporating SB650-34-95, the above is true on the ground, but the ANNUN position will not affect the AHRS when the airplane is airborne, due to the weight-on-wheels (squat) switch preventing circuit completion.

(Continued Next Page)

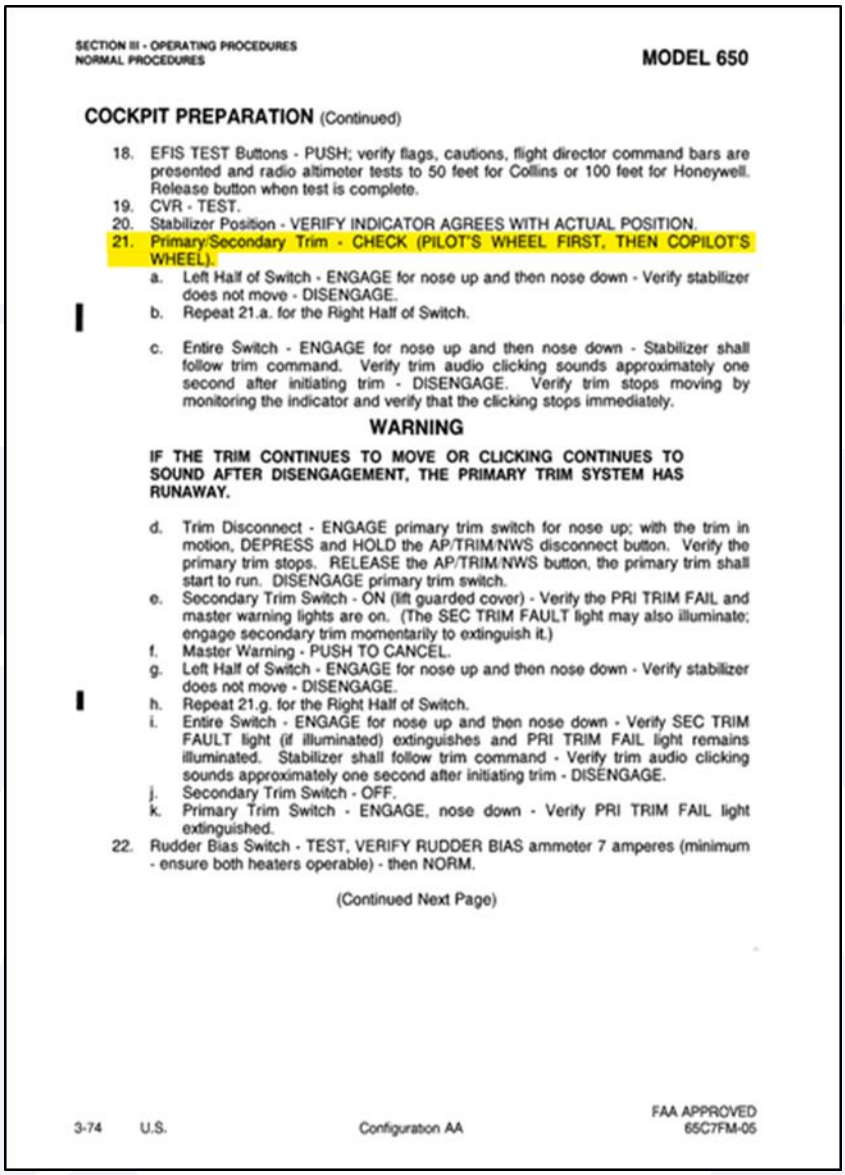
Figure 29 - Cockpit Preparation Checklist, Page 3-73, showing items 3 to 17, according to AFM Revision 10, from 13AUG2001 (our emphasis).

The Warning Systems - CHECK procedure, contained in AFM Revision 10, from 13AUG2001, did not describe in detail the actions to be performed in this procedure.

The notes in item 17 referred to the W/S positions TEMP and ANNUN of the Rotary Test Switch selector key.

In Section 2 (Airplane and Systems - Warning and Test), in the Operating Manual Revision 3, from 19FEB1999, there was the description of several systems of alerts to the crew, as well as the detail of each position of the Rotary Test Switch.

Figure 30 shows the item 21, Primary/Secondary Trim - CHECK, of the Cockpit Preparation Checklist.



SECTION III - OPERATING PROCEDURES
NORMAL PROCEDURES

MODEL 650

COCKPIT PREPARATION (Continued)

18. EFIS TEST Buttons - PUSH; verify flags, cautions, flight director command bars are presented and radio altimeter tests to 50 feet for Collins or 100 feet for Honeywell. Release button when test is complete.
19. CVR - TEST.
20. Stabilizer Position - VERIFY INDICATOR AGREES WITH ACTUAL POSITION.
21. Primary/Secondary Trim - CHECK (PILOT'S WHEEL FIRST, THEN COPILOT'S WHEEL).
    a. Left Half of Switch - ENGAGE for nose up and then nose down - Verify stabilizer does not move - DISENGAGE.
    b. Repeat 21.a. for the Right Half of Switch.
    c. Entire Switch - ENGAGE for nose up and then nose down - Stabilizer shall follow trim command. Verify trim audio clicking sounds approximately one second after initiating trim - DISENGAGE. Verify trim stops moving by monitoring the indicator and verify that the clicking stops immediately.

WARNING

IF THE TRIM CONTINUES TO MOVE OR CLICKING CONTINUES TO SOUND AFTER DISENGAGEMENT, THE PRIMARY TRIM SYSTEM HAS RUNAWAY.

    d. Trim Disconnect - ENGAGE primary trim switch for nose up; with the trim in motion, DEPRESS and HOLD the AP/TRIM/NWS disconnect button. Verify the primary trim stops. RELEASE the AP/TRIM/NWS button, the primary trim shall start to run. DISENGAGE primary trim switch.
    e. Secondary Trim Switch - ON (lift guarded cover) - Verify the PRI TRIM FAIL and master warning lights are on. (The SEC TRIM FAULT light may also illuminate; engage secondary trim momentarily to extinguish it.)
    f. Master Warning - PUSH TO CANCEL.
    g. Left Half of Switch - ENGAGE for nose up and then nose down - Verify stabilizer does not move - DISENGAGE.
    h. Repeat 21.g. for the Right Half of Switch.
    i. Entire Switch - ENGAGE for nose up and then nose down - Verify SEC TRIM FAULT light (if illuminated) extinguishes and PRI TRIM FAIL light remains illuminated. Stabilizer shall follow trim command - Verify trim audio clicking sounds approximately one second after initiating trim - DISENGAGE.
    j. Secondary Trim Switch - OFF.
    k. Primary Trim Switch - ENGAGE, nose down - Verify PRI TRIM FAIL light extinguished.
22. Rudder Bias Switch - TEST, VERIFY RUDDER BIAS ammeter 7 amperes (minimum - ensure both heaters operable) - then NORM.

(Continued Next Page)

Figure 30 - Cockpit Preparation Checklist, Page 3-74, showing items 18 to 22, according to AFM Revision 10, from 13AUG2001 (our emphasis).

This item prevised an extensive verification of the functionality of the aircraft pitch trim system, both in the primary mode and in the secondary mode.

On 16MAY2008, the FAA approved the Temporary Change 65C7FM TC-R10-18, which brought three modifications to the Cockpit Preparation Checklist contained in AFM Revision 10, from 13AUG2001.

The Temporary Change 65C7FM TC-R10-18 modified the sequence of the Cockpit Preparation Checklist. By modification, item 17, Warning System - CHECK, should be performed immediately after item 21.

In addition, the TC 65C7FM TC-R10-18 modified the third point of item 17, Warning System - CHECK, for a warning (Caution). It also included a new warning, saying that if there was a failure in the primary trim system test, this condition would be impeding the flight until it is corrected.

Figures 31 and 32 show the contents of the Temporary Change 65C7FM TC-R10-18.

TEMPORARY FAA APPROVED AIRPLANE FLIGHT MANUAL CHANGE

Publication Affected:	Model 650 Citation VII (Airplanes 650-7001 and On) basic FAA Approved Airplane Flight Manual Revision 10, dated 13 August 2001.
Airplane Serial Numbers Affected:	Airplanes 650-7001 thru -7119 equipped with the SPZ-8000, incorporating SB650-27-53 or ASL650-55-04.
Description of Change:	Section III, Normal Procedures, COCKPIT PREPARATION, page 3-74, move a step, change a note, and add a warning.
Filing Instructions:	Insert this temporary change in the Model 650 Citation VII (Airplanes 650-7001 and On) basic FAA Approved Airplane Flight Manual adjacent to page 3-74, airplanes equipped with SPZ-8000, incorporating SB650-27-53 or ASL650-55-04. This temporary change replaces 65C7FM TC-R10-07 in its entirety.
Removal Instructions:	Remove and discard 65C7FM TC-R10-07. This temporary change must be removed and discarded when Revision 11 has been collated into the basic FAA Approved Airplane Flight Manual.

In Section III, Normal Procedures, COCKPIT PREPARATION, move step 17 from page 3-73 to immediately after step 21 on page 3-74, change the third bullet in the note to a caution, and add warning as follows:

COCKPIT PREPARATION

I. Warning Systems - CHECK

NOTE

- The windshield bleed air warning system is tested by turning the W/S BLD Switch on when the Warning Test Switch is in the W/S TEMP position. The W/S O'HEAT, LH and RH lights will illuminate and the master warning will flash.
- In ANNUN position, verify the following lights are on: CMPRTR WARN, AHRS BASIC - AHRS AUX PWR, EFIS FAN, FMS1 SX/FMS2 SX, AP OFF - YD OFF, in the pilot's and copilot's panels and GC- 810, AFCS A /ON, AFCS B/ ON, MFD FAN (IF INSTALLED). Turn the TEST switch to OFF when check is completed.

CAUTION

ON AIRPLANES NOT INCORPORATING SB650-34-95 IF THE ROTARY TEST SWITCH IS POSITIONED TO THE ANNUN POSITION WITH THE STANDBY ATTITUDE INDICATOR OFF, EITHER ON THE GROUND OR IN THE AIR, THE AHRS WILL LOSE ELECTRICAL POWER AND FAIL. THE AHRS WILL THEN REQUIRE A THREE (3) MINUTE REALIGNMENT PERIOD AFTER POWER RESTORATION BEFORE SATISFACTORY AHRS ATTITUDE AND HEADING INFORMATION IS AVAILABLE. ON AIRPLANES INCORPORATING SB650-34-95, THE ABOVE IS TRUE ON THE GROUND, BUT THE ANNUN POSITION WILL NOT AFFECT THE AHRS WHEN THE AIRPLANE IS AIRBORNE, DUE TO THE WEIGHT-ON-WHEELS (SQUAT) SWITCH PREVENTING CIRCUIT COMPLETION.

(Continued Next Page)

Figure 31 - Page 1 of 2 of the Temporary Change 65C7FM TC-R10-18, 16MAY2008.

TEMPORARY FAA APPROVED AIRPLANE FLIGHT MANUAL CHANGE

WARNING

THE PRIMARY TRIM FAIL ANNUNCIATOR LIGHT MUST ILLUMINATE DURING THE WARNING SYSTEM TEST. FAILURE TO ILLUMINATE INDICATES A FAULT IN THE PRIMARY TRIM CONTROL SYSTEM THEREBY PREVENTING ANY CONTINUED FLIGHT UNTIL THE CONDITION IS CORRECTED.

APPROVED BY _____
for Margaret Kline, Manager
Aircraft Certification Office
Federal Aviation Administration
Wichita, Kansas
DATE OF APPROVAL 5/16/08

Figure 32 - Page 2 of 2 of the Temporary Change 65C7FM TC-R10-18, 16MAY2008.

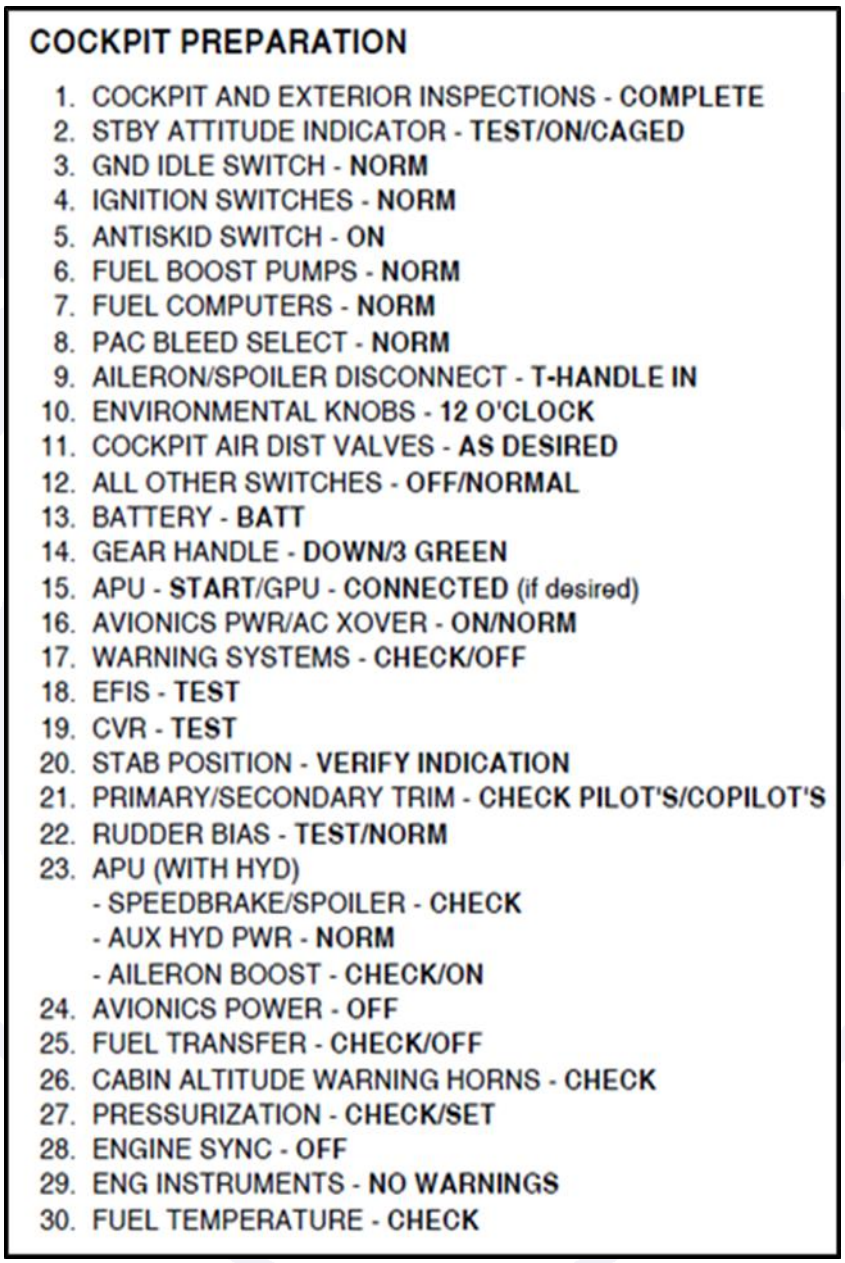
The aircraft manufacturer also provided a condensed checklist, called Pilots' Abbreviated Checklist - NORMAL PROCEDURES, Revision 5, 30SEPT2001.

In a research conducted during the investigation, it was verified that this manual was in the same version and made available for sale through the manufacturer's purchasing channel.

The Pilots' Abbreviated Checklist should be used when the crew was already familiar with the aircraft and its systems.

It should be noted that in the event of conflicting information between the Checklist of the Airplane Flight Manual latest version and its amendments approved by the FAA and the Pilots' Abbreviated Checklist, the AFM Checklist information should be considered valid.

Figure 33 shows the items provided in the Cockpit Preparation Pilots' Abbreviated Checklist - NORMAL PROCEDURES, Revision 5, 30SEPT2001.



COCKPIT PREPARATION

1. COCKPIT AND EXTERIOR INSPECTIONS - **COMPLETE**
2. STBY ATTITUDE INDICATOR - **TEST/ON/CAGED**
3. GND IDLE SWITCH - **NORM**
4. IGNITION SWITCHES - **NORM**
5. ANTISKID SWITCH - **ON**
6. FUEL BOOST PUMPS - **NORM**
7. FUEL COMPUTERS - **NORM**
8. PAC BLEED SELECT - **NORM**
9. AILERON/SPOILER DISCONNECT - **T-HANDLE IN**
10. ENVIRONMENTAL KNOBS - **12 O'CLOCK**
11. COCKPIT AIR DIST VALVES - **AS DESIRED**
12. ALL OTHER SWITCHES - **OFF/NORMAL**
13. BATTERY - **BATT**
14. GEAR HANDLE - **DOWN/3 GREEN**
15. APU - **START**/GPU - **CONNECTED** (if desired)
16. AVIONICS PWR/AC XOVER - **ON/NORM**
17. WARNING SYSTEMS - **CHECK/OFF**
18. EFIS - **TEST**
19. CVR - **TEST**
20. STAB POSITION - **VERIFY INDICATION**
21. PRIMARY/SECONDARY TRIM - **CHECK PILOT'S/COPILOT'S**
22. RUDDER BIAS - **TEST/NORM**
23. APU (WITH HYD)
    - SPEEDBRAKE/SPOILER - **CHECK**
    - AUX HYD PWR - **NORM**
    - AILERON BOOST - **CHECK/ON**
24. AVIONICS POWER - **OFF**
25. FUEL TRANSFER - **CHECK/OFF**
26. CABIN ALTITUDE WARNING HORNS - **CHECK**
27. PRESSURIZATION - **CHECK/SET**
28. ENGINE SYNC - **OFF**
29. ENG INSTRUMENTS - **NO WARNINGS**
30. FUEL TEMPERATURE - **CHECK**

Figure 33 - Cockpit Preparation Checklist extracted from the Pilots' Abbreviated Checklist - NORMAL PROCEDURES, Revision 5, 30SEPT2001.

Another procedure that received modifications, through Temporary Changes, was the Shutdown Checklist, which prevised procedures for engine cut-off and de-energization of the aircraft.

The Shutdown Checklist contained fifteen items, which did not previse verifications of the aircraft's pitch trim system (Figures 34 and 35).

SHUTDOWN

1. Parking Brake - SET.

NOTE

If the brakes are hot, do not set parking brake.

2. Auxiliary Hydraulic Power - OFF.
3. Defog Fan - OFF.
4. All Anti-Ice Switches and Valves - OFF.
5. Air Conditioning (if installed) - OFF.
6. Throttles - CUTOFF - After two minutes below 38 percent fan RPM (N_1).
7. Passenger Advisory Lights - OFF.
8. Standby Attitude Indicator - OFF and CAGED.
9. Avionics Power Switch - OFF.
10. Emergency Lights - OFF.
11. APU (if installed) - SHUT DOWN.
12. Exterior Lights - OFF.

(Continued Next Page)

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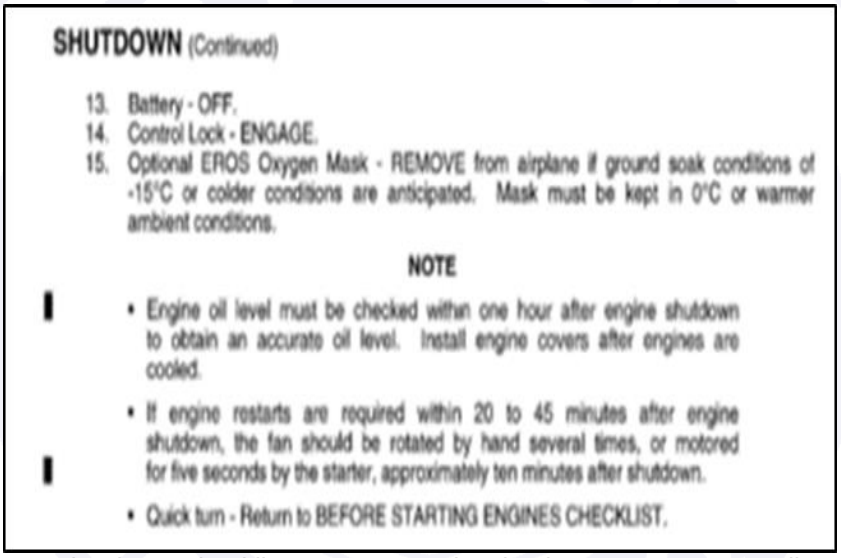
Figure 34 - Shutdown Checklist. Page 3-86, showing items 1 to 12, according to AFM Revision 10, from 13AUG2001.



SHUTDOWN (Continued)

13. Battery - OFF.
14. Control Lock - ENGAGE.
15. Optional EROS Oxygen Mask - REMOVE from airplane if ground soak conditions of -15°C or colder conditions are anticipated. Mask must be kept in 0°C or warmer ambient conditions.

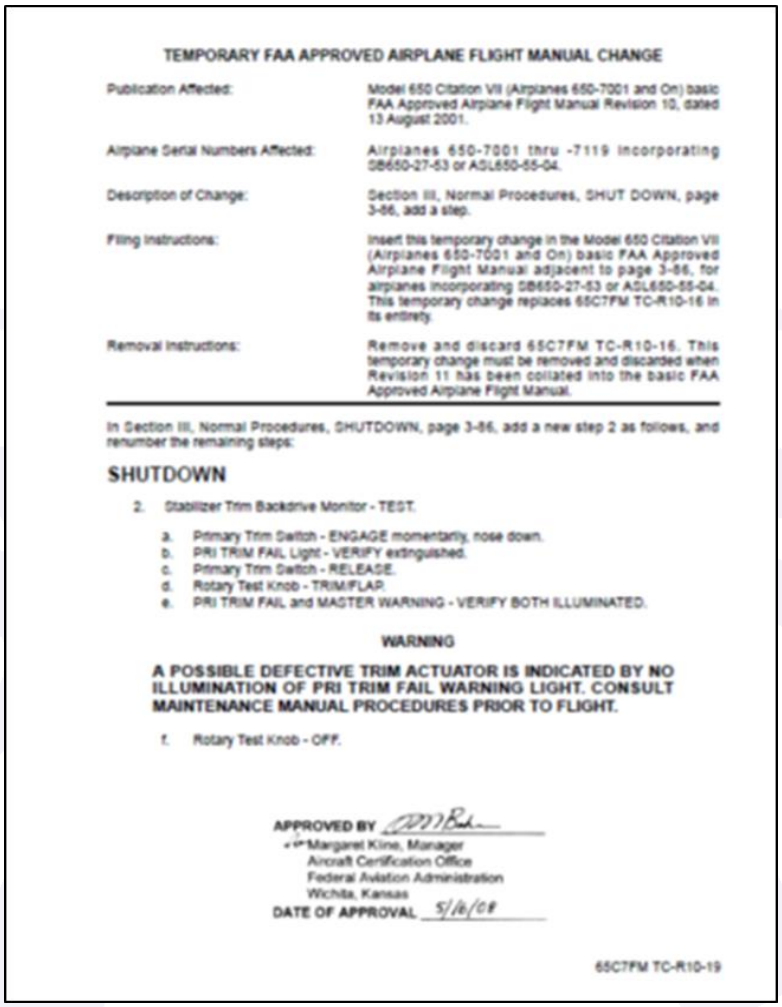
NOTE

- Engine oil level must be checked within one hour after engine shutdown to obtain an accurate oil level. Install engine covers after engines are cooled.
- If engine restarts are required within 20 to 45 minutes after engine shutdown, the fan should be rotated by hand several times, or motored for five seconds by the starter, approximately ten minutes after shutdown.
- Quick turn - Return to BEFORE STARTING ENGINES CHECKLIST.

Figure 35 - Shutdown Checklist. Page 3-87, showing item 13 to 15, according to AFM Revision 10, from 13AUG2001.

On 16MAY2008, the FAA approved the Temporary Change 65C7FM TC-R10-19, which guided the addition of a new item at position 2 of the AFM Shutdown Checklist, Revision 10, from 13AUG2001 and the renumbering of the remaining items.

The new item 2, called Stabilizer Trim Backdrive Monitor - TEST, had six sub items and a Warning, according to Figure 36.



TEMPORARY FAA APPROVED AIRPLANE FLIGHT MANUAL CHANGE

Publication Affected:	Model 650 Citation VII (Airplanes 650-7001 and On) basic FAA Approved Airplane Flight Manual Revision 10, dated 13 August 2001.
Airplane Serial Numbers Affected:	Airplanes 650-7001 thru -7119 incorporating SB650-27-53 or ASL650-55-04.
Description of Change:	Section III, Normal Procedures, SHUT DOWN, page 3-86, add a step.
Filing Instructions:	Insert this temporary change in the Model 650 Citation VII (Airplanes 650-7001 and On) basic FAA Approved Airplane Flight Manual adjacent to page 3-86, for airplanes incorporating SB650-27-53 or ASL650-55-04. This temporary change replaces 65C7FM TC-R10-16 in its entirety.
Removal Instructions:	Remove and discard 65C7FM TC-R10-16. This temporary change must be removed and discarded when Revision 11 has been collated into the basic FAA Approved Airplane Flight Manual.

In Section III, Normal Procedures, SHUTDOWN, page 3-86, add a new step 2 as follows, and renumber the remaining steps:

SHUTDOWN

2. Stabilizer Trim Backdrive Monitor - TEST.
   a. Primary Trim Switch - ENGAGE momentarily, nose down.
   b. PRI TRIM FAIL Light - VERIFY extinguished.
   c. Primary Trim Switch - RELEASE.
   d. Rotary Test Knob - TRIM/FLAP.
   e. PRI TRIM FAIL and MASTER WARNING - VERIFY BOTH ILLUMINATED.

WARNING

A POSSIBLE DEFECTIVE TRIM ACTUATOR IS INDICATED BY NO ILLUMINATION OF PRI TRIM FAIL WARNING LIGHT. CONSULT MAINTENANCE MANUAL PROCEDURES PRIOR TO FLIGHT.

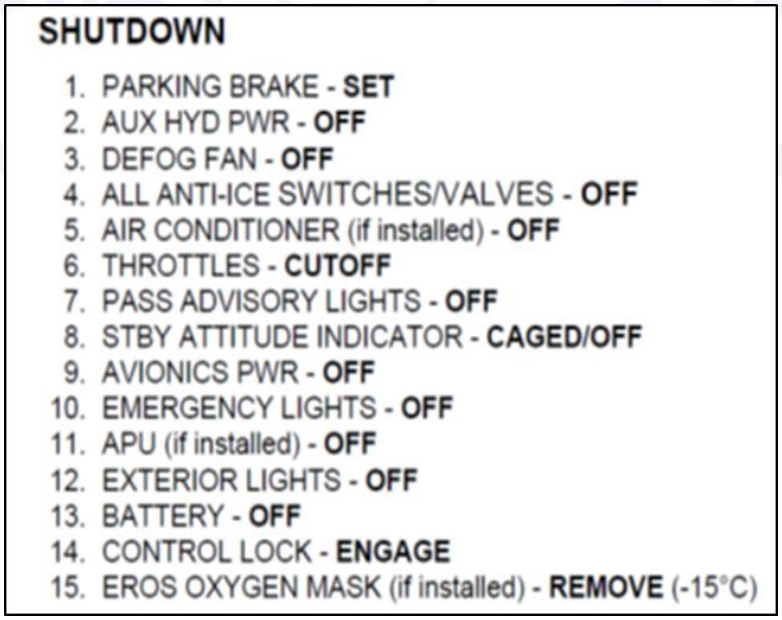
f. Rotary Test Knob - OFF.

APPROVED BY
Margaret Kline, Manager
Aircraft Certification Office
Federal Aviation Administration
Wichita, Kansas
DATE OF APPROVAL 5/16/08

65C7FM TC-R10-19

Figure 36 - Single page of the Temporary Change 65C7FM TC-R10-19, from 16MAY2008.

Similarly, the Pilots' Abbreviated Checklist (NORMAL PROCEDURES, Revision 5, 30SEPT2001) contained the procedures in accordance with AFM Revision 10, 13AUG2001, without contemplating the changes of Temporary Change 65C7FM TC-R10-19, from 16MAY2008 (Figure 37).



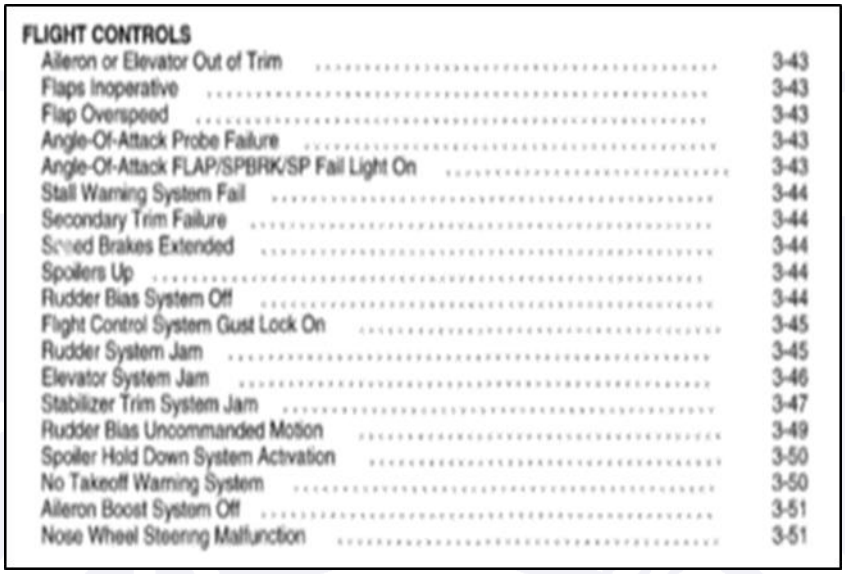
SHUTDOWN

1. PARKING BRAKE - **SET**
2. AUX HYD PWR - **OFF**
3. DEFOG FAN - **OFF**
4. ALL ANTI-ICE SWITCHES/VALVES - **OFF**
5. AIR CONDITIONER (if installed) - **OFF**
6. THROTTLES - **CUTOFF**
7. PASS ADVISORY LIGHTS - **OFF**
8. STBY ATTITUDE INDICATOR - **CAGED/OFF**
9. AVIONICS PWR - **OFF**
10. EMERGENCY LIGHTS - **OFF**
11. APU (if installed) - **OFF**
12. EXTERIOR LIGHTS - **OFF**
13. BATTERY - **OFF**
14. CONTROL LOCK - **ENGAGE**
15. EROS OXYGEN MASK (if installed) - **REMOVE** (-15°C)

Figure 37 - Shutdown Checklist extracted from the Pilots' Abbreviated Checklist - NORMAL PROCEDURES, Revision 5, from 30SEPT2001.

Abnormal Procedures checklists are those procedures that require the use of alternative systems or special use of normal systems, in order to maintain an acceptable level of safety.

AFM Revision 10, from 13AUG2001, contained the following checklists related to Abnormal Procedures with flight commands (Figure 38).

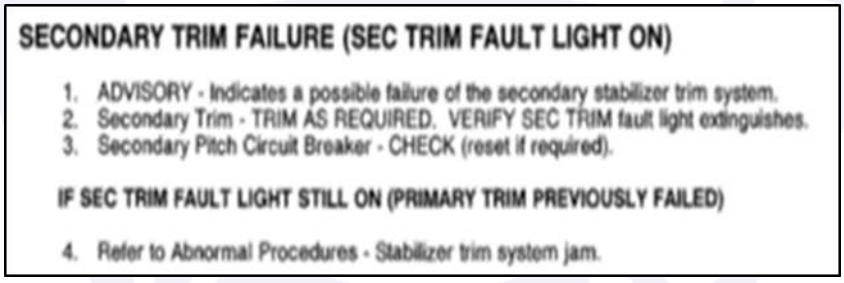


FLIGHT CONTROLS

Figure 38 - Abnormal procedures related to flight commands, according to AFM Revision 10, from 13AUG2001.

The Secondary Trim Failure Checklist contained information related to the SEC TRIM FAULT annunciator in flight.

The actions to be taken are shown in Figure 39, according to AFM Revision 10, from 13AUG2001.



SECONDARY TRIM FAILURE (SEC TRIM FAULT LIGHT ON)

1. ADVISORY - Indicates a possible failure of the secondary stabilizer trim system.
2. Secondary Trim - TRIM AS REQUIRED. VERIFY SEC TRIM fault light extinguishes.
3. Secondary Pitch Circuit Breaker - CHECK (reset if required).

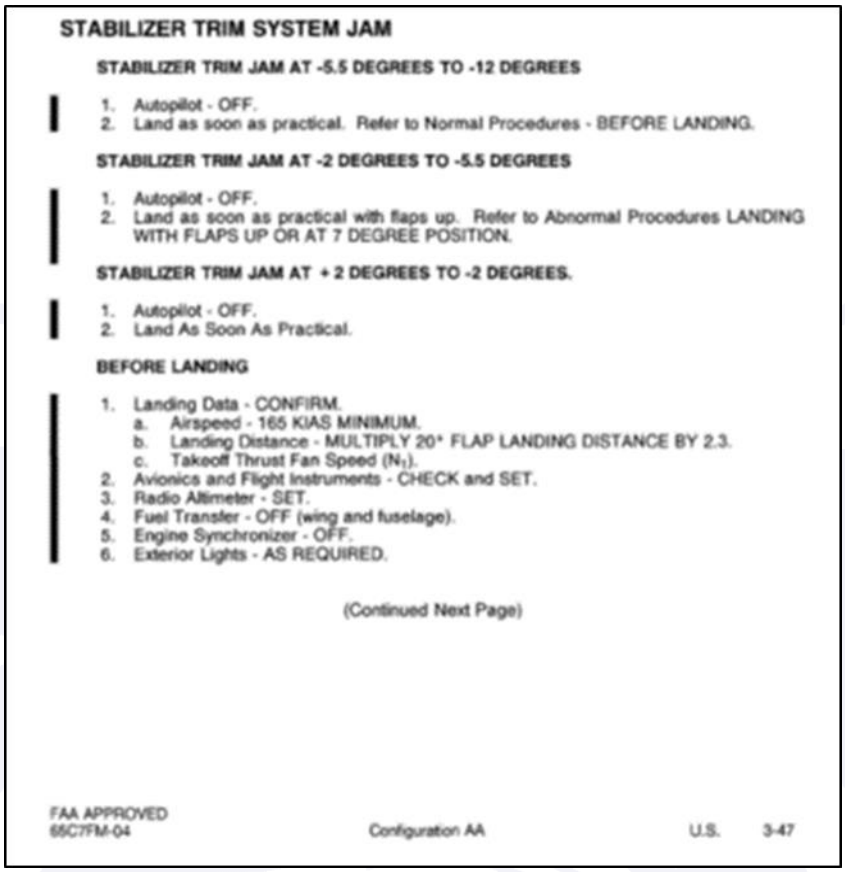
IF SEC TRIM FAULT LIGHT STILL ON (PRIMARY TRIM PREVIOUSLY FAILED)

4. Refer to Abnormal Procedures - Stabilizer trim system jam.

Figure 39 - Secondary Trim Failure Checklist, according to the AFM Revision 10, from 13AUG2001.

The Stabilizer Trim System Jam Checklist contained information on procedures to be followed in the case of locking the horizontal stabilizer and how to perform the landing, according to the position where the surface remained locked.

The Stabilizer Trim System Jam Checklist, according to AFM Revision 10, of 13AUG2001, is shown in Figures 40 to 42.



STABILIZER TRIM SYSTEM JAM

STABILIZER TRIM JAM AT -5.5 DEGREES TO -12 DEGREES

1. Autopilot - OFF.
2. Land as soon as practical. Refer to Normal Procedures - BEFORE LANDING.

STABILIZER TRIM JAM AT -2 DEGREES TO -5.5 DEGREES

1. Autopilot - OFF.
2. Land as soon as practical with flaps up. Refer to Abnormal Procedures LANDING WITH FLAPS UP OR AT 7 DEGREE POSITION.

STABILIZER TRIM JAM AT + 2 DEGREES TO -2 DEGREES.

1. Autopilot - OFF.
2. Land As Soon As Practical.

BEFORE LANDING

1. Landing Data - CONFIRM.
   a. Airspeed - 165 KIAS MINIMUM.
   b. Landing Distance - MULTIPLY 20° FLAP LANDING DISTANCE BY 2.3.
   c. Takeoff Thrust Fan Speed (N_1).
2. Avionics and Flight Instruments - CHECK and SET.
3. Radio Altimeter - SET.
4. Fuel Transfer - OFF (wing and fuselage).
5. Engine Synchronizer - OFF.
6. Exterior Lights - AS REQUIRED.

(Continued Next Page)

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Figure 40 - Page 1 of 3 Checklist Stabilizer Trim System Jam, according to AFM Revision 10, from 13AUG2001.

SECTION III - OPERATING PROCEDURES
ABNORMAL PROCEDURES

MODEL 650

STABILIZER TRIM SYSTEM JAM (Continued)

7. Flaps - UP.
8. Ignition - ON.
9. Passenger - BRIEF.
10. Seats, Seat Belts and Shoulder Harnesses - SECURE.
11. Passenger Advisory Lights - PASS SAFE.
12. Spoiler Hold Down - ON. Verify Spoiler Hold Down Light Is On.
13. Auxiliary Hydraulic Power - ON. Verify AUX-HYD Pump On Or AUX-HYD PRESS Light On.
14. Spoiler Lever - UP.

NOTE

- The left and right roll control spoilers will be UP causing a nose up trim change.
- Lateral control is provided by the ailerons only. Lateral control is sufficient for a maximum sideslip of one-half ball without the roll control spoilers.
- Limiting crosswind component is 10 knots.

15. Landing Gear - DOWN and LOCKED.
16. Nose Wheel Steering Switch - PUSH; VERIFY ARMED LIGHT IS ON.
17. Annunciator Panel - CHECK.
18. Yaw Damper - OFF.

WARNING

- **LANDING WITH A TAILWIND OR NEGATIVE RUNWAY GRADIENT IS PROHIBITED.**
- **DO NOT ATTEMPT TO RESTOW REVERSERS AND TAKE OFF ONCE THE REVERSERS HAVE STARTED TO DEPLOY. THROTTLE LINKAGE DAMAGE MAY OCCUR.**

NOTE

- A power approach to landing is recommended to maintain positive control of sink rate.
- Do not fly steep approach path angle.

LANDING

1. Flare Attitude - MINIMUM ANGLE.
2. Throttles - IDLE.
3. Spoiler Hold Down - OFF, after main wheel ground contact.

(Continued Next Page)

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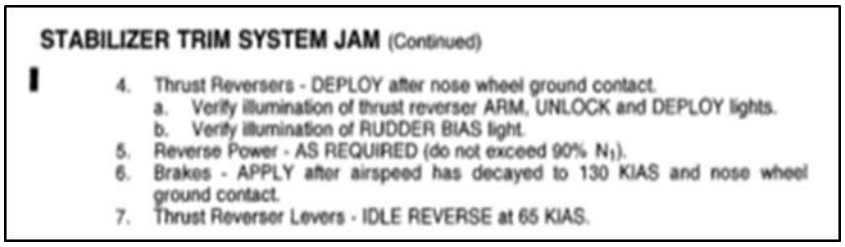
Figure 41 - Page 2 of 3 of the Checklist Stabilizer Trim System Jam, according to AFM Revision 10, from 13AUG2001.



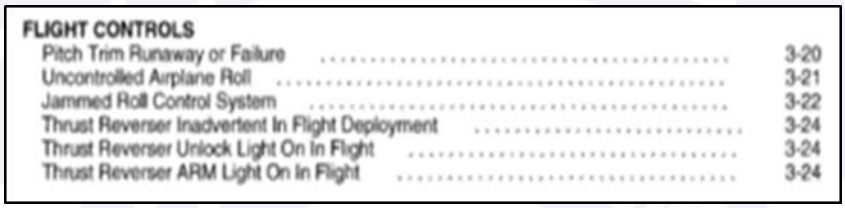
STABILIZER TRIM SYSTEM JAM (Continued)

4. Thrust Reversers - DEPLOY after nose wheel ground contact.
   a. Verify illumination of thrust reverser ARM, UNLOCK and DEPLOY lights.
   b. Verify illumination of RUDDER BIAS light.
5. Reverse Power - AS REQUIRED (do not exceed 90% N_1).
6. Brakes - APPLY after airspeed has decayed to 130 KIAS and nose wheel ground contact.
7. Thrust Reverser Levers - IDLE REVERSE at 65 KIAS.

Figure 42 - Page 3 of 3 of the Checklist Stabilizer Trim System Jam, according to AFM Revision 10, from 13AUG2001.

Checklists contained within the scope of the Emergency Procedures are those procedures that require immediate action to protect occupants and aircraft from critical situations. The Emergency Procedures also require the use of alternative systems or the special use of normal systems.

The AFM Revision 10, from 13AUG2001, contained the following procedures related to emergency situations with flight commands (Figure 43):

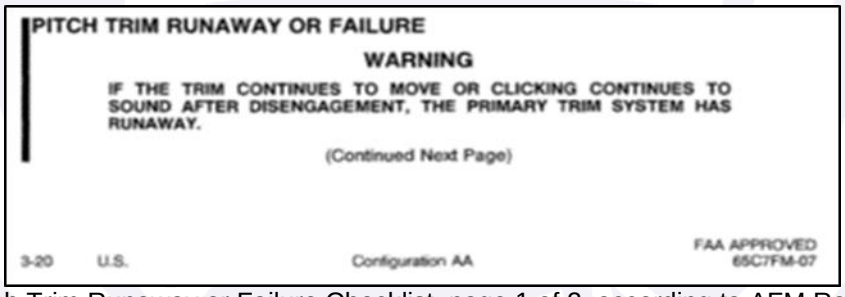


FLIGHT CONTROLS

Figure 43 - Emergency Procedures Checklists related to flight commands, according to AFM Revision 10, from 13AUG2001.

The Pitch Trim Runaway or Failure Checklist contained information on actions to be taken in connection with Pitch Trim Runaway or Failure.

The Pitch Trim Runaway or Failure procedure, according to AFM Revision 10, of 13AUG2001, is shown in Figures 44 and 45.



PITCH TRIM RUNAWAY OR FAILURE

WARNING

IF THE TRIM CONTINUES TO MOVE OR CLICKING CONTINUES TO SOUND AFTER DISENGAGEMENT, THE PRIMARY TRIM SYSTEM HAS RUNAWAY.

(Continued Next Page)

Figure 44 - Pitch Trim Runaway or Failure Checklist, page 1 of 2, according to AFM Revision 10, from 13AUG2001.

Steps 1 to 3, highlighted by a rectangle in Figure 45, were known as memory items, that is, actions that should be taken immediately after the identification of the failure, without consulting any manual.

MODEL 650

SECTION III - OPERATING PROCEDURES
EMERGENCY PROCEDURES

PITCH TRIM RUNAWAY OR FAILURE (Continued)

PRIMARY TRIM RUNAWAY

1. AP/TRIM/NWS Disengage Switch - PRESS AND HOLD.
2. Secondary Trim Switch - ON (lift guarded cover).
3. Trim - AS REQUIRED. (SEC TRIM FAULT Light May Be Illuminated Until the Secondary Trim is Actuated.)
4. AP/TRIM/NWS Disengage Switch - RELEASE.
5. PITCH PWR Circuit Breaker (LH Panel) - PULL.

IF SECONDARY TRIM FUNCTIONS NORMALLY

6. Land as soon as practical.

IF SECONDARY TRIM ALSO RUNAWAY

6. Secondary Trim Switch - OFF (close guard).
7. SEC PITCH TRIM Circuit Breaker - PULL.
8. Land as soon as practical - Refer to Abnormal Procedures, STABILIZER TRIM SYSTEM JAM.

FAILURE

1. PITCH PWR and PITCH CONTROL Circuit Breakers (LH Panel) - CHECK IN.

IF TRIM STILL FAILED

2. Secondary Trim Switch - ON (Lift Guarded Cover).
3. Trim - AS REQUIRED (SEC TRIM FAULT Light May Be Illuminated Until the Secondary Trim is Actuated).
4. Land As Soon as Practical

Figure 45 - Pitch Trim Runaway or Failure Checklist, page 2 of 2, according to AFM Revision 10, from 13AUG2001.

The Pilots' Abbreviated Checklist EMERGENCY/ABNORMAL PROCEDURES contained the same information as the Pitch Trim Runaway or Failure Checklist of the AFM Revision 10, of 13AUG2001.

The pilots' training was carried out according to the criteria of the legislation in force at the time of the accident.

The operator did not have a formal and periodic simulator-training program for pilots, since its operation complied with the criteria of the Brazilian Aeronautical Certification Regulation (RBHA) number 91, amendment 91-12, of 30DEC2005.

Regarding periodicity, the Brazilian Civil Aviation Regulation (RBAC) number 61 Amendment 05, dated 11NOV2014, previsted the following criteria:

> "61.19 Validity of pilot Ratings
>
> (a) The validity of the Ratings registered in the pilot's licenses or certificates shall comply with the following terms, counted from the pilot's approval month in the proficiency examination, except as provided in paragraph 61.33 (a) of this Regulation:
>
> (...)
>
> (2) type rating: 12 (twelve) months;
>
> (...) "

Section 61.215 of that regulation previsted the training conditions that the crewmember had to fulfill, in order to renew his Rating:

> "61.215 Revalidation of type rating
>
> (a) In order to revalidate a type rating, the applicant shall:
>
> (1) has successfully completed the six (6) months prior to proficiency, ground and flight training for the revalidation of rating related to the type of aircraft required; and
>
> (2) be approved in a proficiency examination conducted in accordance with paragraph 61.213 (a) (4) of this Regulation;

(b) ground and flight training for revalidation shall be conducted:

(1) in CTAC, for airplanes, helicopters with two or more engines, airships and power-sustaining aircraft; or

(2) in CTAC, civil aviation schools or Aeroclubs, for single-engine helicopters;

(c) -I if it does not exist, up to the date on which the candidate initiates re-validation training, CTAC, civil aviation school or Aeroclubs certified or validated by the ANAC to administer it, this training may be given by a PC or PLA rated and qualified in the aircraft. The training shall, in such case, include at least 20% (twenty percent) of the flight hours provided in paragraphs 61.213 (a) (3) (iii) (A) or 61.213 (a) (3) (iii) (B), as applicable. For candidates who started flight training until 12NOV2015, revalidation may be made with the training provided in paragraph 61.215 (c), even if there is a CTAC, civil aviation school or Aeroclub certified or validated for the type. (Included by Resolution No. 347 of 10NOV2014)

(d) For pilots employed in Airlines, ground and flight training for the granting and revalidation of type rating shall be made in accordance with RBAC 121 or 135, as applicable. "

Supplementary Instruction (IS) number 61-005 Revision A, of 31DEC2014, provided training criteria, both in ground and in flight that should be performed. According to this IS, the ground training consisted of:

"(A) Technical knowledge of the aircraft:

I. general characteristics and limitations of the electrical, hydraulic, fuel, pressurizing and other systems of the aircraft;

II. principles of functioning, operation and operational limitations of aircraft engines; influence of atmospheric conditions on engine performance; operational information contained in the flight manual;

III. normal, abnormal and emergency operating procedures;

IV. limitations of the aircraft; influence of the atmospheric conditions on the performance of the aircraft, in accordance with the information in the flight manual;

V. operation of aircraft instruments and procedures in case of malfunction;

VI. use of the autopilot and other automation systems;

VII. procedures for maintaining the airworthiness of the aircraft, such as pre-flight checks, periodic inspections, verification of maintenance records, service bulletins and current airworthiness directives;

(...)

(d) Flight theory: flight principles relating to the aircraft for which rating is requested; flight at high speeds and recovery from abnormal attitudes; "

After ground training, both for concession and for revalidation, the pilot, if considered able, proceeded to the in-flight training, which was divided in local and en route flights. In the programmatic content of IS 61-005 local flight training, it was stated:

(a) pre-flight procedures, including flight planning, fuel calculation, fueling, weight and balance calculation, aircraft airworthiness inspections and verification;

b) normal and high performance takeoffs;

c) operations at Aerodromes and in traffic circuits; precautions and procedures to prevent collisions;

d) use of checklists during all phases of the flight;

e) control of the airplane using external references and instrument references;

f) low-speed flight, pre-stall and stall recognition and recovery;

g) abnormal and emergency procedures in simulated failures of equipment, engines, systems and structure; and

> h) procedures for incapacitation of a flight crew member and crew coordination, allocation of flight duties and crew co-operation, as applicable.

The programmatic content of en-route training addressed issues related to fuel calculation, navigation, approach, landing procedures, and so on.

After successfully completing the flight training, the pilot was considered able for the check.

In the flight simulator, the last record provided by the pilot involved in the accident was dated 03NOV2005.

This was a recurrent type training. The ground training included twenty hours, in which several issues of aircraft systems were addressed. The flight training included six hours in the pilot flying function and six hours in the pilot not flying function.

The copilot did not have an employment relationship with the operator and performed flights on demand. No training records were found in the flight simulator, in the model of the occurrence, by the crewmember.

1.19 Additional information.

On 18FEV2008, there was an accident, in Venezuela, with apparently similar characteristics.

This incident involved the aircraft model 650, version Citation III, registration N385EM.

The difference between the Citation III version and the Citation VII basically consisted of the motorization, influencing more significantly performance-related issues. The flight command system of the two versions of the model was quite similar.

According to the Interim Report of the Venezuelan authority, the copilot probably gave his place on board to a passenger without any qualification to operate the aircraft, moments after takeoff.

Also according to the item Analysis of the Interim Report, during the en-route flight phase, a failure of the primary pitch trim system was simulated by the activation of the secondary system, which would have resulted in an abnormal operation of the system, followed by violent loss of altitude and over speed condition.

As of the date of this report publication, the final report concerning the accident with the aircraft registration N385EM, dated 18FEV2008, had not been issued.

The TCDS No. EA 8502-02, issued by the Brazilian civil aviation authority, approved on 15SEPT1994, described the conditions and limitations of airworthiness under which the type certificate was issued.

According to the TCDS, the aircraft was certified according to section 25.255 Out-of-Trim characteristics, amendment number 25-42, 16JAN1978, of the Title 14 Code of Federal Regulations Part 25. This section dealt with the flight characteristics of the out-of-trim flight.

> “§ 25.255 Out-of-trim characteristics.
>
> (a) From an initial condition with the airplane trimmed at cruise speeds up to VMO/MMO, the airplane must have satisfactory maneuvering stability and controllability with the degree of out-of trim in both the airplane nose-up and nose down directions, which results from the greater of -
>
> (1) A three-second movement of the longitudinal trim system at its normal rate for the particular flight condition with no aerodynamic load (or an equivalent degree of trim for airplanes that do not have a power-operated trim system), except as limited

by stops in the trim system, including those required by §25.655(b) for adjustable stabilizers; or

(…)

(c) Except as provided in paragraphs (d) and (e) of this section, compliance with the provisions of paragraph (a) of this section must be demonstrated in flight over the acceleration range

(1) -1 g to +2.5 g; or

(2) 0 g to 2.0 g, and extrapolating by an acceptable method to -1 g and +2.5 g.

(…)

(f) In the out-of-trim condition specified in paragraph (a) of this section, it must be possible from an over speed condition at VDF/MDF to produce at least 1.5 g for recovery by applying not more than 125 pounds of longitudinal control force using either the primary longitudinal control alone or the primary longitudinal control and the longitudinal trim system. If the longitudinal trim is used to assist in producing the required load factor, it must be shown at VDF/MDF that the longitudinal trim can be actuated in the airplane nose-up direction with the primary surface loaded to correspond to the least of the following airplane nose-up control forces:

(1) The maximum control forces expected in service as specified in §§25.301 and 25.397.

(2) The control force required to produce 1.5 g.

(3) The control force corresponding to buffeting or other phenomena of such intensity that it is a strong deterrent to further application of primary longitudinal control force."

In the Report FT650-7 Vibration, Buffet & High Speed Characteristics of 01JUL1982, owned by Textron Aviation®, used to demonstrate compliance with this requirement, there was the horizontal stabilizer angle plot by the time performed on the ground without the presence of aerodynamic loads, as shown in Figure 46.

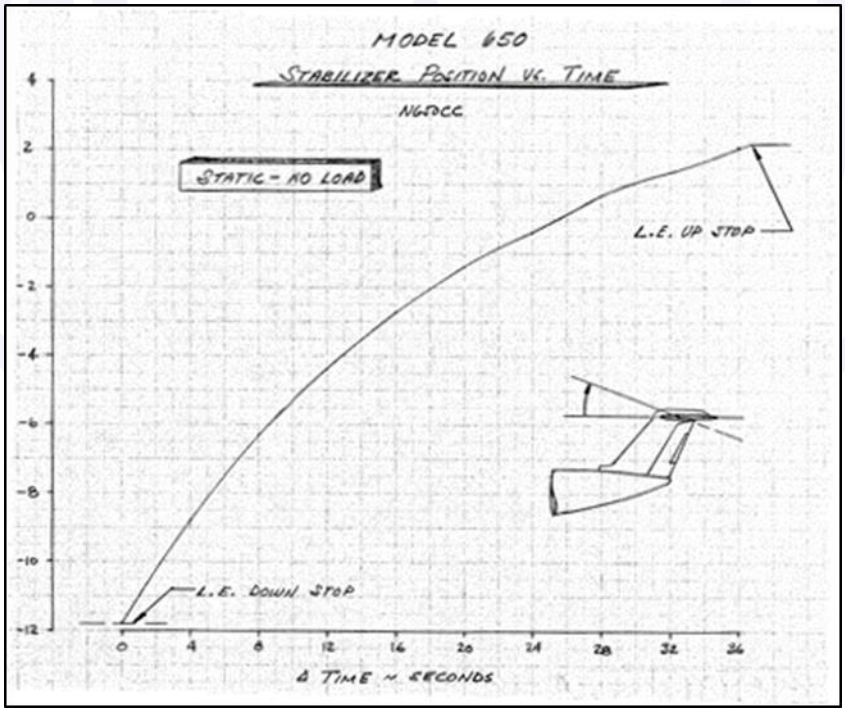


Figure 46 - Horizontal stabilizer angle plot by time. Property information of Textron Aviation®.

The demonstration of compliance with section 25.255 was performed through a flight test campaign and was intended to demonstrate satisfactory maneuverability and controllability of the aircraft model 650 both nose-up and nose-down.

A total of six flights were performed to demonstrate compliance with this requirement, varying several parameters, such as altitude, aircraft weight, CG position, movement of the stabilizer direction (nose up or nose down) and the obtention of several G load values through the maneuvers performed.

Section 25.255 did not specify the Trim system that should be used to meet this requirement. It was verified that only the primary pitch trim system was used for demonstration of section 25.255.

To conduct an assessment of flight characteristics on aircraft using stability augmentation systems, automatic or motorized, the sections of Title 14 Code of Federal Regulations Part 25 related to this subject were 25.21, 25.671 and 25.672.

For the verification of these sections, it was provided an extract of the Report FT650-13 Mechanical and Electrical System Equipment and Furnishings of 19JUL1982, owned by Textron Aviation®, which was related to automatic or motorized stability augmentation systems for flight.

These sections provided information on evidence of compliance with requirements for stability, automatic and motorized control systems.

The FT650-13 report includes the flight test campaign for compliance with these sections, performed with the monitoring of the country's design and manufacturing certification authority.

In this report, several system failure conditions were considered, namely:

- Rudder Jam and loss of rudder bias;
- Rudder Bias Hardover;
- Adverse Trim, Nose Down;
- Adverse Trim, Nose Up;
- Aileron Jam;
- Elevator Jam;
- Nosewheel Steering;
- Spoiler Failure; and
- Trim Runaway - Horizontal Stabilizer.

For each fault condition, at least one test flight was performed. The Adverse Trim Nose Down, Adverse Trim Nose Up and Trim Runaway - Horizontal Stabilizer conditions will be described below.

The Adverse Trim Nose Down failure assessment was performed on a single flight. In that flight, the stabilizer was compensated in the nose position all the way down. The approximation was performed with 0° of flaps.

Due to air traffic conflicts, a missed approach maneuver was performed without the compensation of the aircraft and the landing was performed on the next attempt. According to the test reports, a speed of 160kt and 0° flap configuration provided adequate pitch control authority. The procedures observed in this test were included in the AFM.

The Adverse Trim Nose Up failure assessment was performed on another test flight. In that flight, the stabilizer was compensated in the nose position all the way up with the flaps fully extended. The approach and maneuver of the go-around procedure was performed, including retraction of the flaps to the 20° position. Subsequently, the landing was performed with fully extended flaps. The forces to control the aircraft were considered

acceptable and their controllability good. No procedures were included in the AFM for this condition.

The evaluation of the Trim Runaway - Horizontal Stabilizer fault was performed on four test flights by varying weight and CG configurations. On these flights, maneuvers were performed in various phases of operation (takeoff, climb, cruise, descent and landing), using both the primary longitudinal and secondary Trim systems. Horizontal stabilizer movements were performed in both directions, nose down and nose up.

The tests were conducted considering the following aspects:

- time recognition of emergency by the pilot (three seconds during the cruise phase and one second in the other phases of flight);

- "G" load factor imposed not to be so high as to prevent operation at the primary controls, while pressing the interrupt button (AP / TRIM / NWS);

- the loads resulting from the malfunction cannot exceed the envelope of 0 to 2 G's. (the positive G load limit may be exceeded provided that structural analysis shows that neither the malfunction nor the subsequent correction exceeds the G load limit of the aircraft); and

- pilots should not be unduly burdened with tasks while temporarily maintaining control forces, pressing the interrupt button, and locating the secondary compensating system switch to relieve control forces or to disable the secondary system as necessary.

In addition to the aspects mentioned above, it was also evaluated questions related to the design of this aircraft system, such as the illumination of the light of the secondary system (when making the change of the active system), evaluation of the warning sound intensity and overtaking of the pilot's drive switches in relation to the copilot in the primary mode.

Figure 47 shows the flight tests performed regarding the horizontal stabilizer triggering test condition. The test conditions that will be shown in more detail in this report are highlighted.

TEST DATA

Test Conditions: Horizontal Stab Trim Runaway

	Time	Condition	Altitude	Speed KCAS/ Mach	Fwd CG	System Flight	Nose 771	'G' (No. of sec)		'G'(Max)	Time to 'G'(Max)
1	16:22:50	Cruise	14000 ft	352/.68		Secondary	UP	1.4(3)		1.5	4 sec.
2	16:24:25	Cruise	14000 ft	352/.68		Secondary	Down	.35(3)		.25	4 sec.
3	16:26:28	Cruise	14000 ft	352/.68		Secondary	Down	.35(3)		.3	3.7 sec.
			AFT	CG		Flights	765	766	767		
A	11:14:02	Cruise	34000 ft	285/.82		Primary	Down	.47(3)		.24	4.5 sec
B	11:15:43	Cruise	34200 ft	283/.816		Primary	Up	1.5(3)		1.68	4.5 sec
C	11:21:58	Cruise	32200 ft	292/.805		Secondary	Up	1.6(3)		1.75	4.2 sec
D	11:24:23	Cruise	32200 ft	295/.815		Secondary	Down	.3(3)		-.1	5.5 sec
E	11:31:56	Descent	14000 ft	335/.65		Primary	Down	.74(1)		.1	4.7 sec
F	11:33:06	Descent	11500 ft	337/.625		Primary	Up	1.38(1)		1.8	3.6 sec
G	11:33:53	Descent	10000 ft	342/.615		Secondary	Down	.47(1)		.06	3.4 sec
H	11:36:40	Descent	12500 ft	350/.655		Secondary	Up	1.48 (1)		1.9	3.7 sec
I	11:38:38	Cruise	11300 ft	350/.66		Primary	Down	.3(3)		.02	3.5 sec
J	11:40:30	Cruise	11500 ft	348/.66		Primary	Up	1.72(3)		1.85	3.6 sec
K	11:41:36	Cruise	11700 ft	350/.67		Secondary	Down	.07(3)		-.1	3.8 sec
L	11:42:22	Cruise	11700 ft	350/.67		Secondary	Up	1.74(3)		1.90	4.2 sec
M	13:03:51	Takeoff	4500 ft	132/.22		Primary	Down	1.0(1)		.85	2.5sec
N	13:07:55	Takeoff	4500 ft	140/.23		Primary	Up	1.39(1)		1.39	1 sec
O	13:11:54	Climb	14600 ft	247/.49		Primary	Up	1.24(1)		1.26	1.3 sec
P	13:12:22	Climb	16000 ft	250/.52		Secondary	Up	1.18(1)		1.25	2.0 sec
Q	13:14:19	Climb	13000 ft	248/.474		Secondary	Down	.56(1)		.52	2.0 sec
R	13:17:15	Landing	16000 ft	111/.23		Primary	Down	.87(1)		.83	2.0 sec
S	13:17:45	Landing	15000 ft	113/.23		Primary	Up	1.14(1)		1.20	2.0 sec
T	13:18:26	Landing	14000 ft	110/.22		Secondary	Up	1.07(1)		1.09	2.5 sec
U	13:18:56	Landing	13000 ft	110/.21		Secondary	Down	.96(1)		.93	2.4 sec
V	14:26:15	Cruise	32000 ft	293/.81		Secondary	Up	1.75(3)		1.90	4.5 sec
W		NO PILOT RECOGNITION									
X	14:29:05	Cruise	32000 ft	290/.806		Secondary	Down	.35(3)		.20	4.2 sec

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Figure 47 - Tests for the horizontal stabilizer trim runaway condition. Property information of Textron Aviation®.

Below, it will be presented data from the flight tests carried out for the certification of the aircraft model. The parameters of these test flights were:

- CALT: Calibrated Altitude, in feet. Chart values multiplied by 10^4;

- MACH: Mach number, dimensionless. Chart values divided by 10;

- STPOS: Stabilizer Position, in degrees. Chart values divided by 10;

- KCAS: Calibrated Airspeed, in knots. Chart values multiplied by 10;

- ELFOR: Elevator Force, in pounds. Chart values multiplied by 100;

- ELPOS: Elevator Position, in degrees. Chart values multiplied by 10;

- AOA: Attack of Angle, in degrees. Chart values multiplied by 10;

- AOP: Pitch Angle, in degrees;

- NACG: Vertical Acceleration measured in CG, number of G; and

- EVENT: Marking of events relevant to the test, such as horizontal stabilizer movement and the pilot recognition (beginning of the aural warning).

In the in-flight test data presented there was no information on engine parameters.

Figure 48 shows the in-flight certification test called Test "A" for the condition of horizontal stabilizer trim runaway.

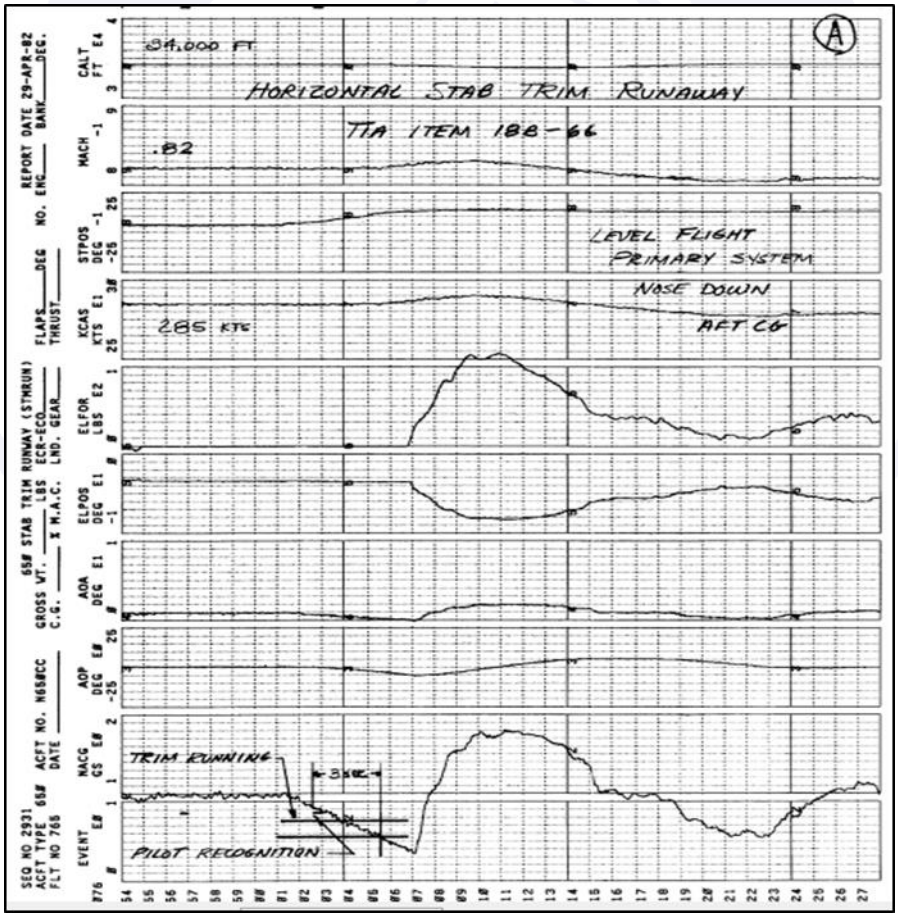


Figure 48 - In-flight test: Test "A" for the horizontal stabilizer trim runaway failure condition. Property information of Textron Aviation®.

In Test "A", it was possible to observe that the stabilizer moved for about 6 seconds, approximately 1.5 seconds without warning, 3 seconds with audible warning where the pilot already had indications for the recognition of the emergency situation and 1,5 additional seconds, where there would still be indication of movement for the pilots.

The initial position of the horizontal stabilizer was + 0.5 ° and the final position, after moving, was + 1.4 ° (nose-down). After this movement, the maneuver was performed without trimming the surface for the initial flight condition.

In this test flight, started at 34,000 feet, it was possible to observe that the altitude variation was less than 1,000 feet and that the maximum speed reached was approximately 0.83 Mach or 290 knots (speed calibrated).

The force on the stick has reached values around 120 pounds, consistent with the elevator deflection values. The vertical acceleration reached values of approximately 0.2 G during the horizontal stabilizer movement and about 1.8 G during the recovery maneuver. The parameters of pitch angle and angle of attack were compatible with the maneuver executed.

Figure 49 shows the in-flight certification test called the "D-Test" for the horizontal stabilizer trim runaway condition.

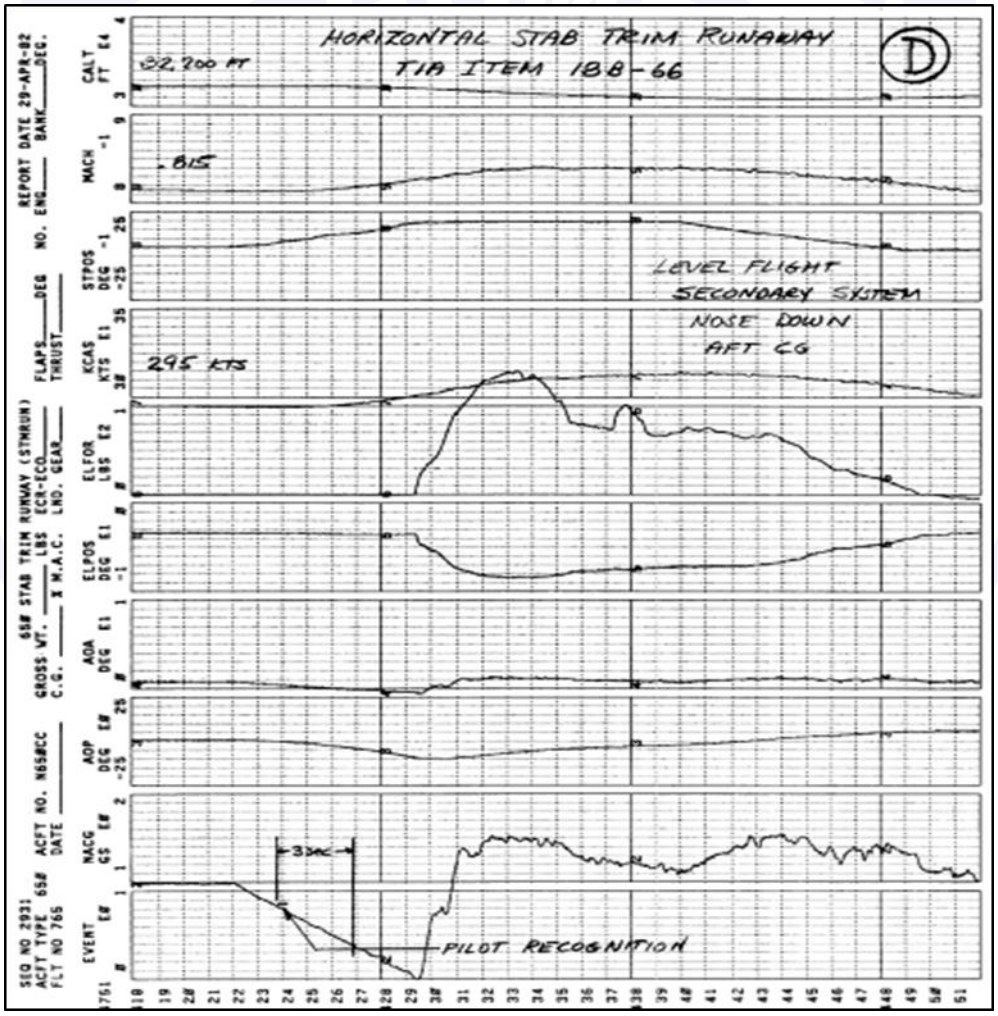


Figure 49 - In-flight test: "D" test for horizontal stabilizer trim runaway condition. Property information of Textron Aviation®.

In the "D" test, it was possible to observe that the stabilizer first moved for about 8 seconds (at about times 22 and 30), being approximately 2 seconds without aural warning, 3 seconds with aural warning, where the pilot already had indications for the recognition of

the emergency situation and an additional 4 seconds, where there would still be the indication of movement for the pilots.

The initial position of the horizontal stabilizer was + 0.5° and the final position, after moving, was + 2.0° (nose-down).

The aircraft flew for approximately 10 seconds with the stabilizer in the + 2.0° position and in 9 seconds (between times 40 and 49) the horizontal stabilizer was moved back to a position close to the initial one, at about + 0.4°.

In this test flight, it was possible to observe that the altitude variation was of approximately 1,200 feet and that the maximum speed reached was of approximately 0.84 Mach, near 310 knots (calibrated speed).

The force on the stick reached values around 140 pounds, consistent with the elevator deflection values. The vertical acceleration reached values of approximately 0 G during the movement of the horizontal stabilizer and about 1.5 G during the recovery maneuver. The pitch angle and angle of attack parameters are compatible with the maneuver performed.

Figures 50 and 51 show the in-flight tests called the "I" Test and the "K" Test, respectively. The horizontal stabilizer trim runaway condition was tested in a straight and leveled flight situation at low altitude (approximately 11,000 feet) and the horizontal stabilizer was moved using both, the primary and the secondary pitch trim systems.

In these two test conditions, only the test data will be shown, without the description of the parameters obtained.

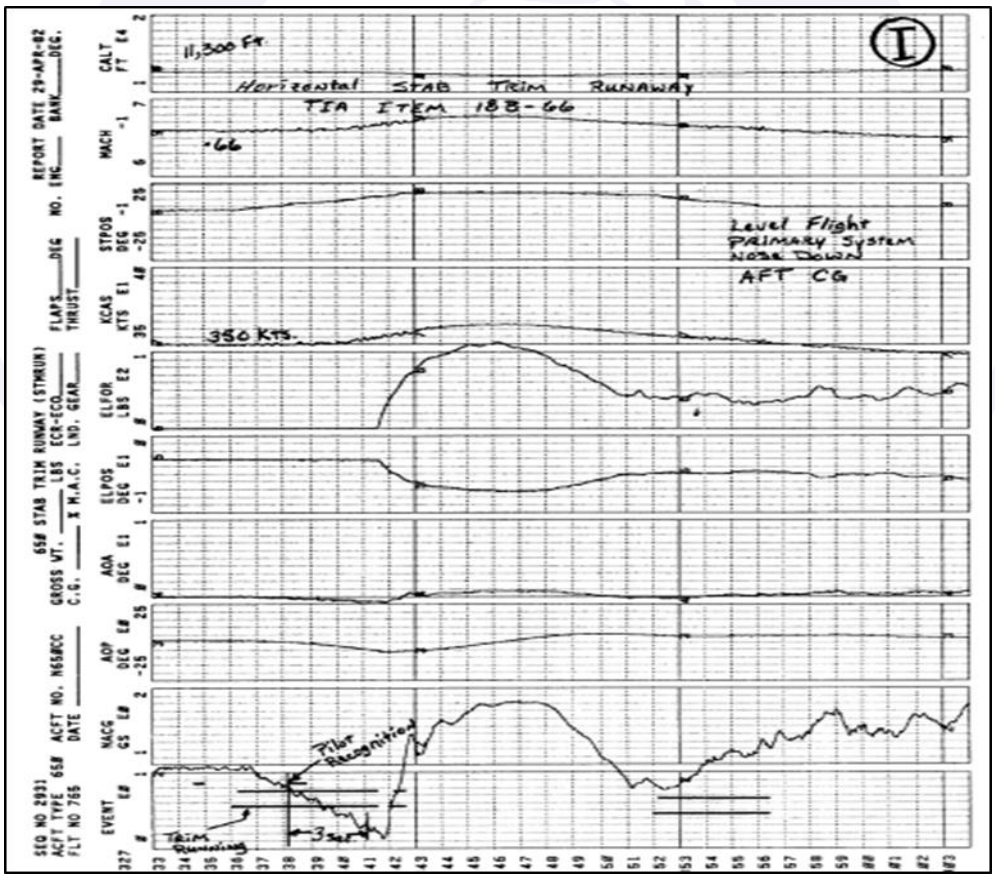


Figure 50 - In-flight test: "I" Test for horizontal stabilizer trim runaway condition. Property information of Textron Aviation®.

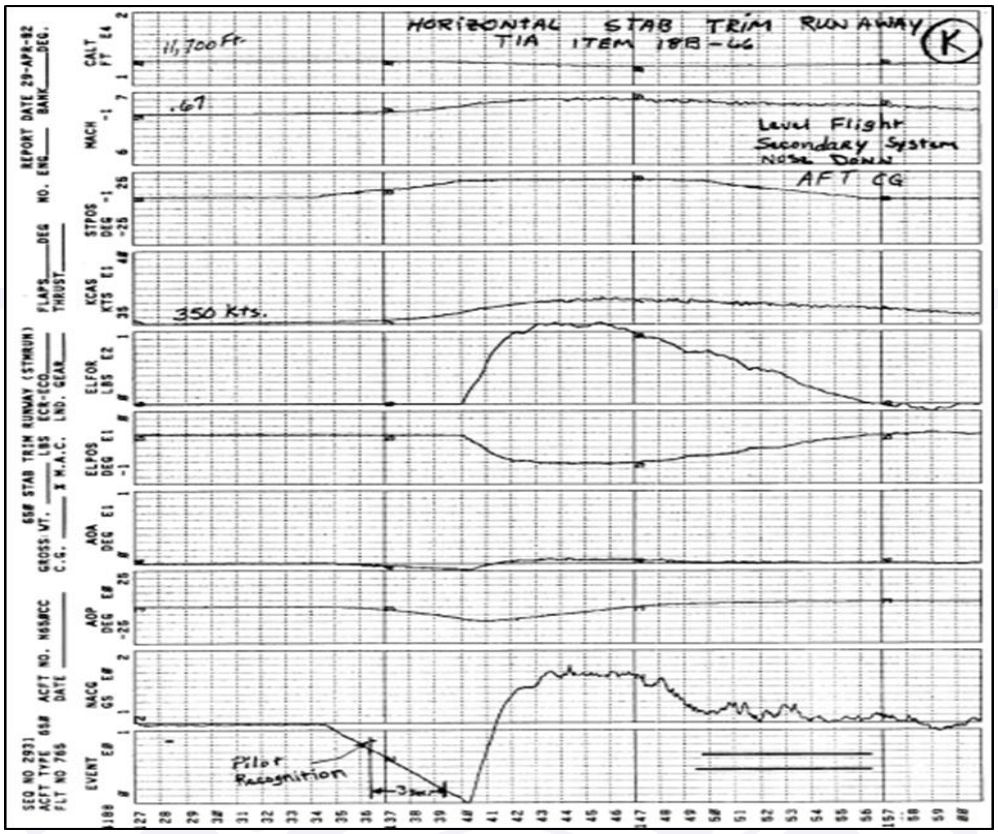


Figure 51 - In-flight test: "K" Test for horizontal stabilizer trim runaway condition. Property information of Textron Aviation®.

The certification test campaign was followed and validated by a member of the primary certifier (FAA). In the report with the data from the test campaign, there were some remarks about the failure conditions tested. In relation to the simulated horizontal stabilizer trim runaway, there were the following remarks:

> "*a(1) & b(1). The critical trim runaway condition found during malfunction testing at aft c.g. was repeated at fwd c.g. (secondary trim – 15,000' PA high speed cruise).*
>
> *a(2) & b(2). The force/gradient test results were satisfactory. (18 lbs/sec).*
>
> *c. Selecting secondary trim caused the PRI TRIM Fail and Master Warning light to illuminate also, depending upon the clutch engagement status at the time the secondary trim was selected. The secondary trim must be momentarily engaged to clear the SEC TRIM FAULT light. This procedure explanation will be included in the AFM.*
>
> *d. The aural trim-in-motion warning system was used for the recognition of a trim runaway during these tests. The minimum trim-in-motion aural magnitude will be established on the first completed production airplane.*
>
> *e. The primary trim system will stop when opposing commands are given by the pilot's and the copilot's primary trim switches. The primary trim system will stop if either the pilot's or copilot's master disconnect is held down. This command van be obtained by switching the secondary trim system ON and using the secondary trim switch".*

At the time of the accident, RBHA nº 91, amendment 91-12, of 30DEC2005 was in force. This regulation established general operating rules for civil aircraft.

In relation to airworthiness criteria and inoperative equipment, the following was highlighted:

> "91.7 - Civil aircraft Airworthiness
>
> (a) No person may operate a civil aircraft unless it is in an airworthy condition.

(b) The pilot-in-command of a civil aircraft is responsible for checking the aircraft conditions for flight safety. It must discontinue the flight when maintenance or structural problems occur that degrade the aircraft's airworthiness.

(...)

91.213 - Inoperative equipment and instruments

(a) Except as provided in paragraph (d) of this section, no person may take off with a civil aircraft with installed inoperative equipment or instruments, unless the following conditions are met:

(1) there is a minimum equipment list (MEL) developed by the aircraft operator. "

The Minimum Equipment List (MEL), established criteria for equipment that might be inoperative prior to the take-off of the aircraft.

Faults in flight were not related to this publication and specific documentation should be used for this purpose.

The MEL was developed by the operator from the Master Minimum Equipment List (MMEL) and then submitted for approval by the National Civil Aviation Agency (ANAC), in the case of Brazilian registered aircraft.

The MEL, however, was not mandatory according to the rules of RBHA 91, and its elaboration is optional to the operator.

It was verified that there was no minimum equipment list developed by the operator for this aircraft.

In this way, no system or equipment installed in the aircraft could be inoperative before takeoff.

Also according to RBHA 91, amendment 91-12, 30DEC2005, there were the following criteria for documentation on board the aircraft:

"91.203 - Civil aircraft. Required documents

(a) Except as provided in 91.715 and paragraphs (b), (c) and (d) of this section, no person may operate a Brazilian civil aircraft unless it has on board the following documents:

(1) valid certificate of registration and certificate of airworthiness, issued by the Brazilian Aeronautical Registry (RAB);

(2) flight manual and checklist;

(...)

91.503 - Flight equipment and operational information

(a) The pilot-in-command of an airplane shall ensure that the following flight equipment, aeronautical charts and operational information in up-to-date and appropriate format versions shall be available in the airplane's cockpit on each flight:

(...)

(2) a cabin checklist containing the procedures listed in paragraph (b) of this section.

(b) Each cabin checklist shall contain the following procedures and shall be used by the flight crew when operating the airplane:

(1) before starting the engines;

(2) before take-off;

(3) on a cruise;

(4) before landing;

(5) after landing;

(6) in the cutting off the engines; and

(7) in emergencies.

(...) "

1.20 Useful or effective investigation techniques.

Nil.

2. ANALYSIS.

The PT-WQH aircraft, manufactured by the Cessna Aircraft Company, model 650 (Citation VII), took off on 10NOV2015 from the Brasilia Aerodrome (SBBR) at 2039 (UTC), 1839 (local time), to the Congonhas Aerodrome (SBSP), São Paulo - SP, with the purpose of making an executive transport flight.

In order to reconstruct the sequence of events that resulted in this accident, the sounds registered in the voice recorder were associated with possible aircraft sounds, such as audible alarms, clacker movement warnings, switches and circuit breakers, among others.

During the climb, at approximately 36.800ft altitude, the characteristic sound of the horizontal stabilizer (Clacker) was recorded in the CVR recordings, with a duration of 1.6 seconds.

Considering the time interval of 1.2 seconds of performance without the audible warning, the total estimated movement time was 2.8 seconds. An operation in the pitch trim system with this duration, during this flight phase, was considered unusual.

Thereafter, the air traffic radars recorded a marked downward trajectory until the impact of the aircraft against the ground. The estimated time was approximately one minute and thirteen seconds.

No evidence was found in CVR recordings and interviews that the movement that resulted in the downward trajectory would have been performed voluntarily by the crew.

Thus, an inadvertent movement of the horizontal stabilizer is likely to have caused the sequence of events that resulted in this accident.

In this context, a historical survey was made of the pitch trim system of the 650 aircraft model and, specifically, of the aircraft involved in this occurrence, in order to identify factors that may have contributed to this accident.

On 14JUN2005, the FAA issued AD No. 2005-13-21 related to the guidance contained in SB650-27-53, issued by the aircraft manufacturer on 11MAR2004. This Service Bulletin contained information for the replacement of ACU, PN 9914197-3 or 9914197-4, by ACU PN 9914197-7.

According to the maintenance records, SB650-27-53 and AD No. 2005-13-21 were issued as completed on 28JUL2006. Item 13 of SB650-27-53 provided for an operational check flight of the system.

After the operational check flight, the Service Bulletin established a verification of the pitch trim system through the Rotary Test Switch at the TRIM/FLAP position. If the test indicated failure, the SB650-27-53 provided for replacement of the Horizontal Stabilizer Trim Actuator.

However, the flight log corresponding to item 13 of SB650-27-53 (operational flight of check) was not identified in the aircraft flight logbook.

This flight should be performed solely for this purpose, describing the observed conditions and the result of the verification of the pitch trim system through the Rotary Test Switch in position TRIM/FLAP, according to item 14 of SB650-27-53.

From these actions, the Service Bulletin could be considered as fully complied with.

Although the experience flight was not formally identified and recorded, there were no indications that the aircraft had malfunctioned in the pitch trim system on flights subsequent to the date of registration of compliance with SB650-27- 53, on 28JUL2006, that required the replacement of actuator PN 9914056-4.

On 02NOV2007, the manufacturer published the first version of ASL650-55-04. The first and second revisions of this document, with minor modifications, were issued on 01JAN2008 and December 23, In general, ASL650-55-04 directed the replacement of ACU PN 9914197-7 by PN 9914197-8.

Since ACU PN 9914197-7 could cause the PRI TRIM FAIL light to fail, during the completion of the Warning System - CHECK, in the pre-flight and in the Rotary Test of the post-flight, the manufacturer issued the ASL650-55 -04.

Failure to turn on the PRI TRIM FAIL light during the pre-flight and post-flight tests could represent a false indication of failure, resulting in possible unnecessary maintenance actions in the unnecessary pitch trim system.

Therefore, in this context, the issuance of ASL650-55-04 would not be directly related to operational safety issues.

The AD No. 2005-13-21, issued by the FAA, prevised the installation of ACU PN 9914197-7. However, the ASL650-55-04 prevised the replacement of ACU PN 9914197-7 by ACU PN 9914197-8.

Thus, the FAA issued on 06NOV2007, an alternative method of compliance, or Alternate Means of Compliance (AMOC), which considered ASL650-55-04 an acceptable form of compliance with AD No. 2005-13-21.

Thus, aircraft equipped with both ACU PN 9914197-7 and ACU PN 9914197-8 would be in accordance with FAA-approved airworthiness criteria.

The OS 68.496, related to compliance with ASL650-55-04, was opened at 03SEPT2010 and closed at 17SEPT2010. During the period in which this service order was opened, the aircraft made some flights, including transporting passengers.

None of these flights occurred for the specific purpose of flight test, nor was there a description in the flight logbook of the conditions observed and the result of the post-flight tests, as prevised in item 05 of ASL650-55-04.

Thus, it was observed that the records and control of the flight of experience (operational verification flights) were not performed in an adequate manner, both by the maintainer (registration in the service orders and release of the aircraft) and by the operator (registration in the flight logbook).

In the service description, in OS 68.496, the ASL650-55-04 item referring to the system check, after the operational check flight, contained the inscription "ok" and described that it was not necessary to replace the actuator .

This condition signaled the existence of informality in the organizational processes of both companies, which compromised the maintenance of the adequate history of the operational conditions of the aircraft and hampered its monitoring at the level of the management supervision.

Despite the observed conditions for compliance with continued airworthiness documents (in particular ASL650-55-04), no relationship was found between differences in compliance with these documents and the failures observed in the accident flight, in view of the number of hours flown by the aircraft between the date of execution of the services, 17SEPT2010, and the one of the occurrence, 10NOV2015.

If the tests envisaged in ASL650-55-04, after the operational check flight indicated failure (item 5A of Figure 18), the Primary Trim Actuator should be exchanged for PN 9914056-8 (item 6B of Figure 19). If the actuator PN 9914056-8 was not available, an actuator PN 9914056-4 could be installed.

The shop that performed the ASL650-55-04 did not identify the need to change the actuator, as described at OS 68.496 (Figure 20). Therefore, the aircraft remained with the same actuator, PN 9914056-4.

In relation to the history of accidents related to the model 650, an event with apparently similar characteristics occurred in Venezuela, on 18FEB2008. This incident involved the aircraft model 650, version Citation III, registration N385EM.

According to the item Analysis of the Interim Report, issued by the Venezuelan investigation authority during the en-route flight phase, a failure of the primary pitch trim system was simulated by the activation of the secondary system, which would have resulted in an abnormal operation of the system, followed by violent altitude loss and over speed condition.

In this Interim Report, the abnormal operation, with characteristics of a horizontal stabilizer runaway of the secondary pitch trim system, was pointed out as one of the possible causes.

In this sense, it was verified that both occurrences have apparently similar characteristics, as for the descending trajectory, impact against the ground and possibility of malfunctioning of the pitch trim system of the aircraft.

In the case of the N385EM aircraft, the Venezuelan investigation authority related the runaway to the abnormal operation of the secondary pitch trim system. In this occurrence involving the PT-WQH aircraft, the evidence pointed to a possible abnormal functioning of the primary pitch trim system, as will be described in the course of this analysis.

During the investigation of the occurrence with the PT-WQH, the final report regarding the accident with the aircraft N385EM had not yet been published. Thus, it was not possible to perform a more detailed comparative analysis between the two occurrences.

With regard to maintenance services performed close to the date of the accident, there were two service orders related to the sound warning of the pitch trim system of the aircraft.

The maintenance tasks performed were in accordance with the conditions reported by the operator in the service orders.

However, it was observed that the writing of the service requested in the OS was carried out by professionals without deep technical knowledge in the area of maintenance, which could favor descriptions that were not detailed or inadequate for the service required.

This possible inadequacy in the description of the OS could favor interpretation errors by the mechanic in relation to the content or even the complexity of the service to be executed.

It cannot be ruled out that a more complete failure survey throughout the aircraft pitch trim system has not been performed because of the poor detail in which OS Nos. 81995, of 08SEPT15 and OS No. 82071, of 21SEPT15 have been described.

The OS No. 82.071, for example, only requested the replacement of the "Horizontal Trim Advisory Unit", action on which the mechanic was restricted to execute.

The Horizontal Trim Advisory Unit's repair report confirmed the failure of the item that led to its removal.

In the two subsequent maintenance actions, registered on 26OCT2015 and 04NOV2015, there was no execution of tasks related to the pitch trim system of the aircraft, indicating that the aircraft did not present again the discrepancies that led to the opening of the service orders executed in September 2015.

As a result, it was not possible to establish a link between the maintenance services performed on the aircraft in September 2015 and the events that resulted in the accident occurring on 10NOV2015.

It should be noted, however, that the discrepancies that led to the opening of service orders were not recorded in the flight logbook, characterizing informality in the organizational processes related to the history of the operational conditions of the aircraft.

On the date of the occurrence, the aircraft performed an earlier passenger flight from the Congonhas Aerodrome (SBSP) to the Brasilia Aerodrome (SBBR).

As described in section 1.11, the CVR's two-hour audio track recorded the descent, landing, and taxi phases of the flight prior to the accident. According to the audio recordings, no condition or comment was identified for the crew that could indicate an abnormal condition during the flight prior to the accident.

After the landing in Brasilia, in the phase of operation of the aircraft on the ground, related to the cut off the engines, the execution of the Shutdown Checklist was prevised. This procedure was updated on 16May2008, through the Temporary Change 65C7FM TC-R10-19.

The Temporary Change 65C7FM TC-R10-19 brought a new item (called Stabilizer Trim Backdrive Monitor - TEST) to the Shutdown Checklist, which, in general, prevised a verification of the aircraft's pitch trim system, as shown in Figure 39.

The Pilots' Abbreviated Checklist - NORMAL PROCEDURES, Revision 5 of 30SEPT2001 brought the Shutdown Checklist without the Stabilizer Trim Backdrive Monitor - TEST item. In a research conducted during the investigation, it was verified that this manual was available for sale, through the manufacturer's purchasing channel, in this version.

According to the legislation in force at the time of the accident, the checklist was a required document on board the aircraft and should be updated in accordance with the latest amendments of the AFM. In addition, it is up to the pilot of the aircraft to check that the mandatory publications on board the aircraft are up to date.

The checklists shall be drawn up in accordance with the latest approved version of the AFM by the civil aviation authority. Thus, the Pilots' Abbreviated Checklist - NORMAL PROCEDURES, Revision 5, of 30SEPT2001, would not contemplate the temporary revisions incorporated after the date of approval of the last AFM revision, 13AUG2001.

It should be noted that the aircraft manuals and all the publications related to the operation of the aircraft are tools that constitute a support system for the crew, fundamental to the performance of their duties. The inadequacy of any of these tools, in

this case a possible outdating of the checklist, can directly affect the crewmember's performance, leading to planning, operational or emergency errors.

The use of the Pilots' Abbreviated Checklist was only recommended when the crew was already familiar with the aircraft and its systems, as this document presented the information in a summary form.

It should be noted that the information contained in the Airplane Flight Manual should prevail in case of conflict with the data contained in the Pilots' Abbreviated Checklist.

Due to the post-impact fire, the manuals that were on board the aircraft were not retrieved, so it was not possible to determine if they incorporated the modifications envisaged in the Temporary Change 65C7FM TC-R10-18 and 65C7FM TC-R10-19.

A checklist with the same structure as the Pilots' Abbreviated Checklist (NORMAL PROCEDURES, Revision 5, containing the modifications of the Temporary Change 65C7FM TC-R10-19 (Figure 52) was developed for research assistance purposes).

SHUTDOWN

1. PARKING BRAKE - **SET**
2. AUX HYD PWR - **OFF**
3. DEFOG FAN - **OFF**
4. ALL ANTI-ICE SWITCHES/VALVES - **OFF**
5. AIR CONDITIONER (if installed) - **OFF**
6. THROTTLES - **CUTOFF**
7. PASS ADVISORY LIGHTS - **OFF**
8. STBY ATTITUDE INDICATOR - **CAGED/OFF**
9. AVIONICS PWR - **OFF**
10. EMERGENCY LIGHTS - **OFF**
11. APU (if installed) - **OFF**
12. EXTERIOR LIGHTS - **OFF**
13. BATTERY - **OFF**
14. CONTROL LOCK - **ENGAGE**
15. EROS OXYGEN MASK (if installed) - **REMOVE** (-15°C)

SHUTDOWN

1. PARKING BRAKE - **SET**
2. STABILIZER TRIM BACKDRIVE MONITOR - **TEST**
3. AUX HYD PWR - **OFF**
4. DEFOG FAN - **OFF**
5. ALL ANTI-ICE SWITCHES/VALVES - **OFF**
6. AIR CONDITIONER (if installed) - **OFF**
7. THROTTLES - **CUTOFF**
8. PASS ADVISORY LIGHTS - **OFF**
9. STBY ATTITUDE INDICATOR - **CAGED/OFF**
10. AVIONICS PWR - **OFF**
11. EMERGENCY LIGHTS - **OFF**
12. APU (if installed) - **OFF**
13. EXTERIOR LIGHTS - **OFF**
14. BATTERY - **OFF**
15. CONTROL LOCK - **ENGAGE**
16. EROS OXYGEN MASK (if installed) - **REMOVE** (-15°C)

Figure 52 - Comparison between the Shutdown Checklist contained in the Pilots' Abbreviated Checklist - NORMAL PROCEDURES, Revision 5, of 30SEPT2001 and a possible update according to Temporary Change 65C7FM TC-R10-19 (our emphasis).

Regarding the Temporary Change 65C7FM TC-R10-19, which referred to the Shutdown Checklist, since CVR recordings did not include statements regarding the actions of this procedure, it was possible to elaborate two hypotheses for the events that occurred at the time of the cut off engines.

The first hypothesis was that the Shutdown Checklist was not fully completed, since it was not possible to identify in CVR recordings the performance of these procedure actions.

In this case, it would be possible to consider a lack of adhesion to the operational procedures of the aircraft by the crew, possibly associated with a greater self-confidence of the pilot on the routine of the aircraft's operation, whose experience might have given him the habit of ignoring certain procedures judged less important in the completion phase of the flight.

The second hypothesis was the realization of the outdated Shutdown Checklist, that is, according to the Pilots' Abbreviated Checklist - NORMAL PROCEDURES, Revision 5, of 30SEPT2001, without the changes inserted in the AFM by the Temporary Change 65C7FM TC-R10-19, once that the characteristic sound of the positions of the Rotary Test Switch (item D of the new procedure) was not recorded in the CVR recordings.

In this scenario, the Shutdown Checklist would have been performed without the communication between the crewmembers, with the conference between the aircraft configuration and the checklist items being held in silence.

In an aircraft operated by two pilots, verbalization of compliance with the checklists is a good practice, since it allows a cross-checking of the actions foreseen in the cabin procedures, avoiding forgetting of items related to the operation of the equipment.

Considering the legislation in force at the time of the accident, with each year revalidation of the type rating, from 2009 on, the new procedures should have been given and therefore crewmembers should be familiar with the changes introduced by the Temporary Changes, if the trainings were performed according to IS 61-005.

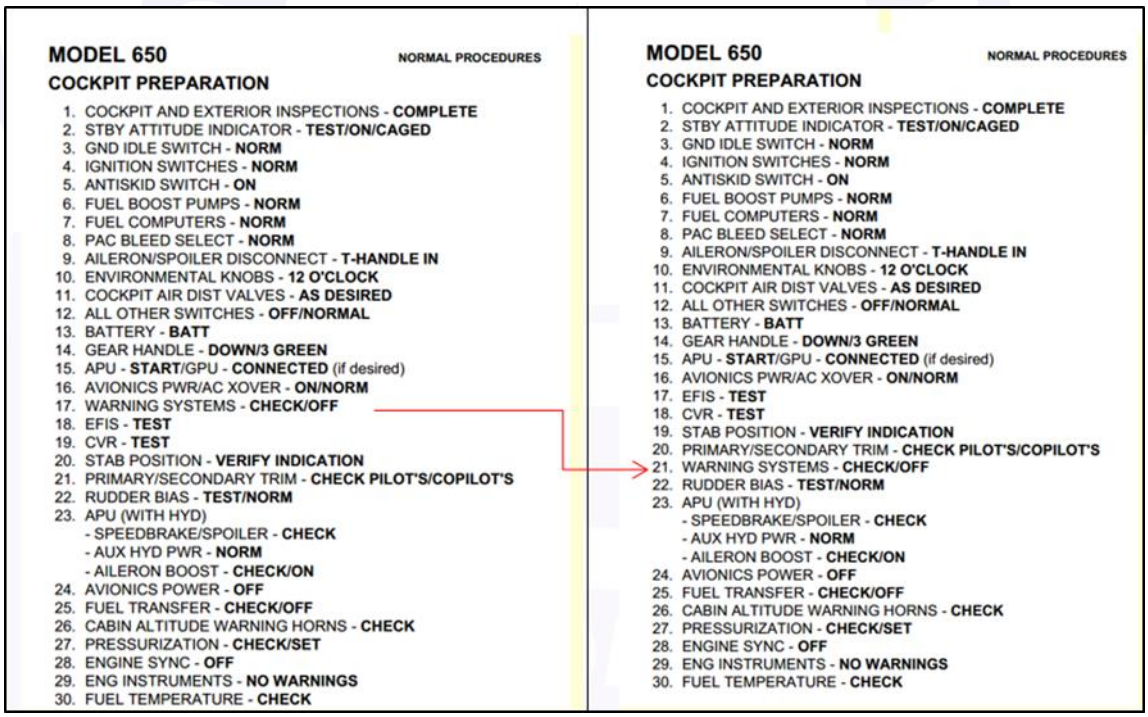
It is possible that the aircraft has been de-energized after the flight prior to the accident without proper verification of a failure condition in the pitch trim system (Stabilizer Trim Backdrive Monitor - TEST) procedure as set forth in the updated technical documentation of the aircraft.

Considering the hypothesis that the Stabilizer Trim Backdrive Monitor - TEST was not performed, failure to comply with this procedure may have represented a latent risk condition, since possible failures in the pitch trim system may have remained hidden.

During the preparation for the flight where the accident occurred, it was not possible to identify, in the CVR recordings, some actions related to the Cockpit Preparation Checklist, in particular the accomplishment of all the steps of the item Primary/Secondary Trim - Check.

The Cockpit Preparation Checklist was changed by the Temporary Change 65C7FM TC-R10-18, of 16MAY2008.

A checklist with the same structure as the Pilots' Abbreviated Checklist (NORMAL PROCEDURES, Revision 5), containing the modifications of the Temporary Change 65C7FM TC-R10-18 (Figure 53) was developed for the purposes of Investigation assistance.



MODEL 650 NORMAL PROCEDURES

COCKPIT PREPARATION

1. COCKPIT AND EXTERIOR INSPECTIONS - **COMPLETE**
2. STBY ATTITUDE INDICATOR - **TEST/ON/CAGED**
3. GND IDLE SWITCH - **NORM**
4. IGNITION SWITCHES - **NORM**
5. ANTISKID SWITCH - **ON**
6. FUEL BOOST PUMPS - **NORM**
7. FUEL COMPUTERS - **NORM**
8. PAC BLEED SELECT - **NORM**
9. AILERON/SPOILER DISCONNECT - **T-HANDLE IN**
10. ENVIRONMENTAL KNOBS - **12 O'CLOCK**
11. COCKPIT AIR DIST VALVES - **AS DESIRED**
12. ALL OTHER SWITCHES - **OFF/NORMAL**
13. BATTERY - **BATT**
14. GEAR HANDLE - **DOWN/3 GREEN**
15. APU - **START**/GPU - **CONNECTED** (if desired)
16. AVIONICS PWR/AC XOVER - **ON/NORM**
17. WARNING SYSTEMS - **CHECK/OFF**
18. EFIS - **TEST**
19. CVR - **TEST**
20. STAB POSITION - **VERIFY INDICATION**
21. PRIMARY/SECONDARY TRIM - **CHECK PILOT'S/COPILOT'S**
22. RUDDER BIAS - **TEST/NORM**
23. APU (WITH HYD)
    - SPEEDBRAKE/SPOILER - **CHECK**
    - AUX HYD PWR - **NORM**
    - AILERON BOOST - **CHECK/ON**
24. AVIONICS POWER - **OFF**
25. FUEL TRANSFER - **CHECK/OFF**
26. CABIN ALTITUDE WARNING HORNS - **CHECK**
27. PRESSURIZATION - **CHECK/SET**
28. ENGINE SYNC - **OFF**
29. ENG INSTRUMENTS - **NO WARNINGS**
30. FUEL TEMPERATURE - **CHECK**

MODEL 650 NORMAL PROCEDURES

COCKPIT PREPARATION

1. COCKPIT AND EXTERIOR INSPECTIONS - **COMPLETE**
2. STBY ATTITUDE INDICATOR - **TEST/ON/CAGED**
3. GND IDLE SWITCH - **NORM**
4. IGNITION SWITCHES - **NORM**
5. ANTISKID SWITCH - **ON**
6. FUEL BOOST PUMPS - **NORM**
7. FUEL COMPUTERS - **NORM**
8. PAC BLEED SELECT - **NORM**
9. AILERON/SPOILER DISCONNECT - **T-HANDLE IN**
10. ENVIRONMENTAL KNOBS - **12 O'CLOCK**
11. COCKPIT AIR DIST VALVES - **AS DESIRED**
12. ALL OTHER SWITCHES - **OFF/NORMAL**
13. BATTERY - **BATT**
14. GEAR HANDLE - **DOWN/3 GREEN**
15. APU - **START**/GPU - **CONNECTED** (if desired)
16. AVIONICS PWR/AC XOVER - **ON/NORM**
17. EFIS - **TEST**
18. CVR - **TEST**
19. STAB POSITION - **VERIFY INDICATION**
20. PRIMARY/SECONDARY TRIM - **CHECK PILOT'S/COPILOT'S**
21. WARNING SYSTEMS - **CHECK/OFF**
22. RUDDER BIAS - **TEST/NORM**
23. APU (WITH HYD)
    - SPEEDBRAKE/SPOILER - **CHECK**
    - AUX HYD PWR - **NORM**
    - AILERON BOOST - **CHECK/ON**
24. AVIONICS POWER - **OFF**
25. FUEL TRANSFER - **CHECK/OFF**
26. CABIN ALTITUDE WARNING HORNS - **CHECK**
27. PRESSURIZATION - **CHECK/SET**
28. ENGINE SYNC - **OFF**
29. ENG INSTRUMENTS - **NO WARNINGS**
30. FUEL TEMPERATURE - **CHECK**

Figure 53 - Comparison between the Cockpit Preparation Checklist contained in the Pilots' Abbreviated Checklist - NORMAL PROCEDURES, Revision 5, from 30SEPT2001 (left) and a possible update (right), according to Temporary Change 65C7FM TC-R10-18 (our emphasis) .

Primary/Secondary Trim - Check Pilot's/Copilot's, according to AFM Revision 10, from 13AUG2001, prevised extensive verification of the aircraft's pitch trim system in both primary and secondary mode.

Considering the recordings of the CVR, the accomplishment of all the steps of the item Primary/Secondary Trim - Check Pilot's/Copilot's of the Cockpit Preparation Checklist was not identified.

Likewise, the characteristic alarm sounds of each system, relative to the test positions of the Rotary Test Switch, were not recorded in the CVR recording. Therefore, it was verified that the Warning Systems - Check item of the Cockpit Preparation Checklist was not performed.

Still during the preparation on the ground, approximately thirty minutes before the take-off, there was the following dialogue between the crew:

> - "I did not even touched it… this time it happened again. This morning it did not happen, but I did not even touch it here. "
>
> - "Ah, take it out ... just take it out a little bit there."
>
> - "Pitch Control. Pitch Power. "

Moments after the last speech of this dialogue, it was possible to identify two low intensity sounds characterized by two spaced clicks of approximately 1.0 second. These sounds were associated with pulling Circuit Breakers, Pitch Control and Pitch Power, given the context of the previous speech.

After about 15 seconds, it was possible to identify two other clicks similar to the previous ones, spaced of 1.0 second again. These clicks were associated with pressing the same Circuit Breakers.

The action of pulling the Circuit Breakers was not anticipated in the normal procedures of the aircraft. It is possible that the crew, on their own, performed this action, in order to reset the primary pitch trim system, after a possible PRI TRIM FAIL light.

It should be noted that, in order to perform a correct verification of the pitch trim system, all items of the Cockpit Preparation Checklist should be followed.

The Primary/Secondary Trim - Check Pilot's/Copilot's item would show results regarding movement and operability of both primary and secondary modes.

The Warning Systems - Check, TRIM / FLAP position of the Rotary Test Switch, would show a complete diagnosis of a possible failure of the primary pitch trim system.

In case of failure or inoperativeness of the system is proved, flight preparation should be interrupted and maintenance services should be performed on the aircraft until it is properly released for return to flight.

In turn, sounds recorded approximately one minute and twenty seconds after the "Pitch Control. Pitch Power" were associated with the actions of raising the safety guard and modifying the SECONDARY TRIM ON/OFF Switch to the ON position, making the secondary mode of operation of the pitch trim system active.

Then, it was possible to hear the sound movement of the horizontal stabilizer (Clacker) twice. In this context, this movement would be associated to the performance of one of the crewmembers on the switches of the secondary pitch trim system, located in the central console of the aircraft.

Likewise, the sound recorded about five seconds after the last warning sound (Clacker) was associated with the lowering of the security guard, which would automatically change the position of the SECONDARY TRIM ON/OFF Switch to the OFF position.

About 30 seconds after the end of the warning sound (Clacker), approximately 25 minutes before take-off, the following conversation took place between the crew:

"Nothing, right?"

"It did not even light on."

"Uh ... Try it ... Red Button."

"Do you want to pull it a little bit again and leave it for a couple of minutes?"

The PRI TRIM FAIL and SEC FAULT indication lights should be switched on in systems changing situations. These lights should remain lit until the surface is moved through one of the modes of operation (primary or secondary).

It is also possible that the horizontal stabilizer was not moving when the pilots were actuating the pitch trim system through the primary mode. Thus, the "red button" speech could be associated with the AP / TRIM / NWS Disconnect Switch, which, among others, had the function of de-energizing the primary pitch trim system.

The last speech of this dialogue could be associated to the intention to pull again the Circuit Breakers.

In the sequence, it was possible to identify in the audio channel of the crew two low intensity clicks spaced of approximately 0.7 second. These sounds were associated with the possible pulling action of CB Pitch Control and Pitch Power.

Approximately one minute after the last dialogue, there was a telephone call from one of the crew requesting the passengers to board.

At that time, according to the sequence of events exposed, the aircraft would possibly be with Circuit Breakers Pitch Control and Pitch Power disarmed, so the primary pitch trim system would be inoperative.

This scenario suggested that there was some pressure for take-off to occur, even with the aircraft's pitch trim system showing inadequate operation.

It was not possible to determine if this behavior would have occurred by passengers' demand or the pilot's himself, which could be demonstrating a kind of self-imposed pressure for takeoff, in view of the possible desire to avoid conflicts, either with passengers or with the operations sector of the operating company.

As far as the copilot was concerned, it was found that he did not have an employment relationship with the operator and was still in the process of acquiring experience. Therefore, it is possible that the copilot did not feel comfortable to interfere more assertively in the way the pilot conducted the aircraft preparation actions for the flight.

In this way, interpersonal relationships may have contributed to the decision to make the flight with the aircraft in a possible condition of inoperativeness of the primary pitch trim system, disregarding technical aspects of the operation of the aircraft.

About one minute after the passenger-boarding request, there was the following dialogue between the crew:

- "Come back?"

- "Come back."

Thereafter, two low-intensity and low-toned sounds were recorded on the crew's audio channel, each consisting of two spaced-apart clicks of approximately 1.0 second. These sounds were associated with the action of pressing Circuit Breakers, Pitch Control and Pitch Power again.

Just over two minutes after the crew declared the aircraft was set and ready for the taxi, it was possible to identify a single sound, probably associated with the SECONDARY TRIM ON/OFF security guard survey, followed by a dialogue suggesting that the secondary pitch trim system would not yet be active.

At the end of this dialogue, it was possible to identify a single sound associated with the possible change from the Switch SECONDARY TRIM ON/OFF to the ON position, making the secondary pitch trim system active.

After about four seconds, there were two horizontal stabilizer (Clacker) movement sounds.

At about five seconds after the end of the movement, it was possible to identify, in the audio channel of the cabin microphone, a single sound possibly associated with the lowering of the SECONDARY TRIM ON/OFF safety guard, and consequently the modification of the switch position to the OFF one, which would automatically activate the primary pitch trim system.

About four minutes before the start of the take-off run, the crew had a dialogue that could be related to a possible last attempt to make the primary pitch trim system active. The speech showed below could be related to a possible flight without autopilot.

- "It will have to be manually."
- "Huh?"
- "It will have to be manually."

It should be noted that the operation of the autopilot depended on the operation of the primary pitch trim system. A possible failure or inoperativeness of this system would consequently lead to the failure of the autopilot.

In view of the sequence of events described up to this point, it was possible to establish the hypothesis that the aircraft was operating with the primary pitch trim system in failure.

Therefore, according to RBHA 91, amendment 91-12, of 30DEC2005, sections 91.7 and 91.213, the aircraft could not have continued on the flight under these conditions.

It was therefore considered that the risks of flying without the correct operation of the autopilot and the primary pitch trim system of the aircraft were not properly analyzed and considered.

During the initial climb, less than one minute after take-off, it was possible to identify two sounds characterized by two 1.5-second spaced clicks.

These sounds could be associated with the actions of raising the SECONDARY TRIM ON/OFF switch and changing its position to ON, making the secondary pitch trim system active.

Around three seconds after these two sounds, it was possible to hear the clacker of horizontal stabilizer movement in four different moments, totaling 16.8 seconds of sound, in a time interval of approximately two minutes.

Considering the sequence of events previously described, it is possible that the movement of the horizontal stabilizer has been controlled by the pilots through the secondary pitch trim system.

The subsequent dialogue corroborates the condition that the aircraft is flying without the autopilot connected:

- "Here you have to put in your head that you are an autopilot."
- "Uhum."

After four minutes and thirty seconds of flight, three distinct sounds were identified in the audio channel of the cabin microphone.

The first click was associated with the possible lowering of the SECONDARY TRIM ON/OFF Switch, thus making the primary pitch trim system active.

In the time interval between the action associated with lowering the security guard and the next action, it is possible that the crew attempted to move the surface in the primary mode or to engage the autopilot without success.

The second and third sounds were associated with the possible actions of raising the guard cover and changing the Switch SECONDARY TRIM ON/OFF to the ON position, respectively, again making the secondary pitch trim system active.

The subsequent dialogue suggested that the pilots agreed to keep the secondary system active:

- "Leave it alone, right?"

- "Yes."

With about fourteen minutes of flight, that is, approximately ten minutes after the dialogue presented previously, one of the crewmembers was questioned about the possibility of verifying the operation of the autopilot, as shown below:

- "Let's see if the AP is working?"

- "Let's go."

Less than a second after this dialogue, it was possible to hear in the audio channel of the cabin microphone a sound associated with the action of lowering the security guard of the SECONDARY TRIM ON / OFF Switch making the primary pitch trim system active.

The following dialogue between the crew as described in section 1.11 indicated that it was not possible to engage the autopilot.

Approximately seven seconds after the previous dialogue, it was possible to identify again two distinct sounds in the cabin area microphone associated with the actions of raising the Switch SECONDARY TRIM ON/OFF and changing its position to ON, respectively.

Then, after about sixteen minutes of flight, one of the crewmembers commented that he had already had a similar situation on a previous flight with an approximate duration of two hours.

This dialogue suggested an operation under similar conditions. The successful completion of that flight reinforces a natural tendency of the human element to rely on the success of previous experiences to substantiate attitudes, which it judges to be similar to those that have been successful.

In this case, the success obtained in carrying out an earlier flight without the aid of the autopilot may have been a reinforcing element for the reproduction of this same behavior.

After this dialogue, the crew commented on some weather formations and about making small detours on the route. With approximately 21 minutes of flight, the crew requested the FL410 as the final level of flight. This request was authorized by the air traffic service (ATS).

After approximately 23min30s of flight, there was the following dialogue between the crew:

- "If you want me to try something, you tell me. If you want me to go trying something"

- "No, not now ... I've just ... It's back to normal. Let's see if it turns on"

Immediately after the end of this conversation, the following sequence of events occurred, taking as a time reference the first identified event of this sequence:

- Event 01 (00m00,0s): Sound associated with the action of lowering the security guard of the Switch SECONDARY TRIM ON/OFF making the primary pitch trim system active;

- Event 02 (00m02,2s): beginning of the sound warning of horizontal stabilizer (Clacker);

- Event 03 (00m03,6s): speech of one of the crewmembers: "Eita". This speech, associated with the Clacker warning sound, would indicate an uncontrolled horizontal stabilizer movement;

- Event 04 (00m03,8s): end of the horizontal stabilizer movement warning (Clacker).

The total warning sound time was 1.6 seconds. Therefore, considering the surface movement time without the Clacker warning sound (1.2 seconds in the primary mode), the total horizontal stabilizer movement time could be estimated in 2.8 seconds.

The interruption of the horizontal stabilizer movement may have occurred because the surface has reached its travel limit, the action of one of the crewmembers pressing the AP / TRIM / NWS DISCONNECT SWITCH button or an interruption without any command.

- Event 05 (00m03,9s): warning sound associated with Altitude Alert, related to the loss of altitude of the aircraft;

The horizontal stabilizer movement warning sound (Clacker), the Altitude Alert warning and altitude loss recorded by the air traffic radars are indicative that the aircraft has had a horizontal stabilizer trim runaway.

- Event 06 (00m05,9s): sound associated with the action of raising the security guard;

- Event 07 (00m06,3s): Sound associated with the action of changing the position of the Switch SECONDARY TRIM ON/OFF to ON.

The time interval between Event 07 and the next two events associated with the reduction of the engines was of 6.2 seconds.

- Event 08 (00m12,5s): speech of one of the crewmembers: "Reduce?";

- Event 09 (00m13,4s): speech of the other crewmember: "Aham."

Events 08 and 09 were associated with a brief dialogue on engine reduction.

Considering the occurrence of the horizontal stabilizer- pitch trim runaway event, there was a Pitch Trim Runaway or Failure procedure concerning this condition that should be performed as soon as the crew identified the emergency situation.

The Pitch Trim Runaway or Failure procedure contained three memory items that should be executed immediately after the failure recognition. The memory items are shown below:

1. *AP/TRIM/NWS* Disengage Switch – PRESS and HOLD;

2. *Secondary Trim Switch - ON* (lift guarded cover);

3. Trim – AS REQUIRED (SEC TRIM FAULT Light May Be Illuminated Until the Secondary Trim is Actuated).

It was not possible to verify if item 1 of the Emergency Pitch Trim Runaway or Failure procedure was performed.

Events 06 and 07 were associated with the actions of raising the security guard and changing the position of the Switch SECONDARY TRIM ON / OFF to ON, making the secondary pitch trim system active.

After these events, the Clacker warning sound corresponding to the movement of the horizontal stabilizer (item 3 of the emergency procedure) was not registered in the CVR.

The action of exchange the active aircraft system and did not trim back the aircraft could be considered unnatural, since the secondary system trim switches were located very close to the Switch SECONDARY TRIM ON / OFF.

It was considered that the absence of a warning sound (Clacker) would be related to the non-movement of the horizontal stabilizer. There were no signs of horizontal stabilizer movement without a sound system indication.

Thus, the following hypotheses were elaborated for the absence of a warning sound of the horizontal stabilizer (Clacker) movement, after the exchange of the active system of the aircraft pitch trim and in the initial moments of the downward trajectory described by the aircraft.

The first hypothesis for not moving the horizontal stabilizer, after the change of the active system of the aircraft, consisted of a failure of the secondary pitch trim system or the horizontal stabilizer jammed, after the occurrence of the emergency condition.

In the CVR recordings, no speech or sounds were identified that suggested the occurrence of these possible failures.

The level of damage to the wreckage prevented the verification of the operating conditions of the secondary pitch trim system, as well as the horizontal stabilizer for possible locking.

Thus, the hypothesis for not moving the horizontal stabilizer related to a failure of the secondary pitch trim system or horizontal stabilizer jamming system could not be confirmed.

However, considering the data from the FT650-13 Report, Test "A", performed during the certification campaign of the aircraft (Figure 48), demonstrated that it is possible to recover the aircraft without performing new trimming, after a movement of approximately 6 seconds, at an altitude of 34,000 feet and a speed of 0.82 Mach.

In addition, the analysis of the Adverse Trim Nose Down condition demonstrated that it is possible to perform approach, go-around and landing maneuvers under these conditions following the procedures set in the Abnormal Procedures Stabilizer System Jam Checklist.

Thus, even if there had been a failure of the secondary pitch trim system or horizontal stabilizer jamming, it was demonstrated that the aircraft provided, at certain conditions, ways to return to a normal flight situation and proceed to landing safely.

The second hypothesis for not moving the horizontal stabilizer, after the change of the aircraft active system, would be related to the non-effectiveness of the secondary pitch trim system in returning the aircraft to a safe condition of straight and leveled flight.

In this way, the certification documents of the model of this aircraft were analyzed, in order to evaluate the use of the secondary pitch trim system under horizontal stabilizer pitch trim runaway conditions.

Firstly, section 25.255 (Out-of-Trim characteristics) was analyzed. In general, this requirement was intended to demonstrate satisfactory stability and controllability of the aircraft under out-of-trim conditions.

Section 25.255 did not previse an evaluation of the aircraft's pitch trim systems, and for demonstration of this requirement, only the primary pitch trim system was used. The flight test data presented, demonstrated that the 650 model complied with the conditions of section 25.255.

In addition, data related to the verification of system requirements for flight commands, in particular the fault condition named Trim Runaway - Horizontal Stabilizer, as reported in Report FT650-13, were analyzed.

The "D" test of the FT650-13 Report consisted in performing a horizontal stabilizer movement and then a recovery maneuver using the secondary pitch trim system.

In this test, there was no detailed description of the time when the system was changed. Thus, a comparison of the movement times recorded in this test was performed with the graph of the horizontal stabilizer movement by time (Figure 46), performed on the ground, that is, without the presence of aerodynamic loads.

The total time of the horizontal stabilizer movement shown in Figure 46 (36 seconds) was consistent with the movement in the primary system, according to the AMM Revision 35, Horizontal Stabilizer Control System Functional Check task, which previse a total time of 44 seconds for the entire stroke of the horizontal stabilizer in the primary system and 84 seconds in the secondary.

In the "D" Test of Report FT650-13 (Figure 49), the first movement of the horizontal stabilizer lasted about 8 seconds from the initial position close to +0.5° to the near end position of +2.0°.

This first movement observed on the test flight was consistent with the graph of the horizontal stabilizer movement by time associated with the primary system. In the graph of Figure 46, the +0.5° position was obtained at the time of 28 seconds and the position +2.0° in the time of 36 seconds, resulting, therefore, in a time interval of 8 seconds between the two positions.

The second movement performed in the “D” test took the horizontal stabilizer from an approximate position of +2.0° to about +0.4°, in a time of approximately 9 seconds (Figure 49).

According to Figure 46, the time to move the horizontal stabilizer from the approximate positions of +2.0° to +0.4° would be about 9 seconds, this movement would be associated to the primary system, without aerodynamic loads.

Figure 54 summarizes the observations described above illustrating the comparison of the horizontal stabilizer movements observed in the flight test “D” and the movement of that surface on the ground without aerodynamic loads, as shown in Figure 46.

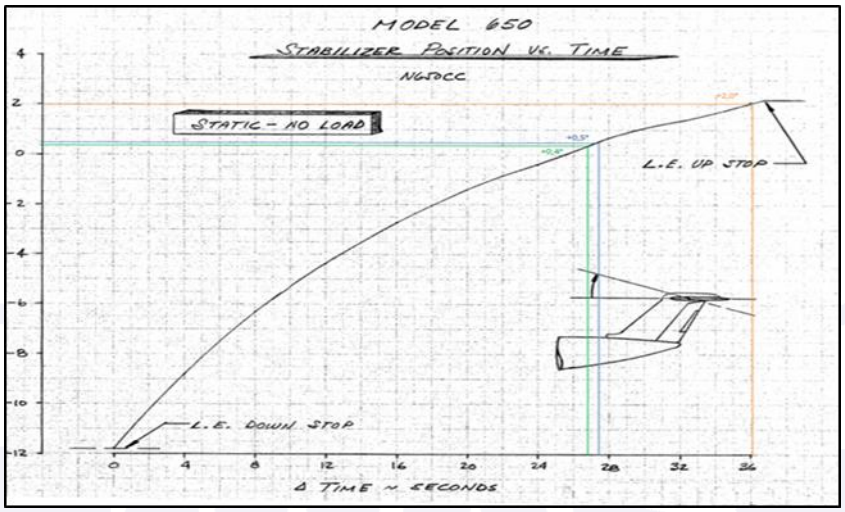


Figure 54 - Positions observed in flight test "D". Adapted from reports belonging to Textron Aviation®.

Blue Line. Initial position of stabilizer in the “D” test (around +0.5°).

Orange Line. Position of the stabilizer after the first movement performed in the “D” test (around +2.0°).

Green Line. Final position of the stabilizer after the second movement performed in the “D” test (around +0.4°).

Considering the time of 84 seconds for the movement of the horizontal stabilizer, on ground, in its entire stroke, using the secondary pitch trim system (according to the maintenance task Horizontal Stabilizer Control System Functional Check, from AMM Revision 35), the movement observed in the “D” test flight of the FT650-13 Report would be closer to the characteristics of the primary system than the secondary system.

The data analyses of the certification tests were limited to the available documents, and it is not possible to estimate the influence of the aerodynamic loads on the surface movement.

The tests were followed and validated by a representative of the primary certifier (FAA), and remarks were made regarding the tests.

The remarks identified the malfunction test of the pitch trim system at 15,000 feet as the most critical condition, and brought the need to repeat the test in different CG configurations.

In addition, there were comments regarding the lighting of the PRI TRIM FAIL and SEC TRIM FAULT and secondary system switches, demonstrating the use of this system during the aircraft certification tests.

Therefore, the secondary pitch trim system was considered used during the certification tests for the horizontal stabilizer runaway.

However, it was considered necessary to review the data from the test campaign to ensure that the secondary system provides an adequate level of safety for a runaway condition of the primary pitch trim system.

Therefore, the second hypothesis for the non-movement of the horizontal stabilizer, after the change of the active system of the aircraft, related to the non-effectiveness of the secondary pitch trim system in returning the aircraft to a safe condition of straight and leveled flight, was considered unlikely.

The third hypothesis for not moving the horizontal stabilizer, after the change of the aircraft active system, consisted in the non-actuation, in an assertive way, in the switches of the secondary pitch trim system.

The Pitch Trim Runaway, connected with a possible abrupt change in the attitude of the aircraft, could have surprised the crew and inhibited some immediate actions foreseen in the Pitch Trim Runaway or Failure Checklist.

In this context, it was possible to consider that the exchange of the active system of the pitch trim (from primary to secondary) was an automatic response of the crew to the inadvertent movement of the surface, without the action of trimming the aircraft through the secondary system.

The failure to activate the secondary system switches could also be related to the absence of periodic training of the emergency Pitch Trim Runway or Failure in simulator.

This lack of training would imply difficulties in quickly and correctly identifying the abnormal condition, which would enable immediate psychomotor reactions to be corrected.

Furthermore, even if the crew recognized the emergency situation, they might not have performed all the planned actions, since their technical proficiency probably lacked massed cognitive and psychomotor reactions for better emergency management.

Simulator training can be considered an important tool to improve crew response in an emergency situation that could only be reproduced on this equipment.

Regarding the qualification and training of the pilots, because there is no specific requirement corresponding to their flight simulator temporality by the RBHA 91, the operating company did not have an internal procedure for the systematic accomplishment of this type of training.

Although the other crew of the company consider the pilot a professional with remarkable technical mastery in the aircraft model, it is possible that the absence of training in emergency situations in flight simulators has impaired the cognitive and psychomotor response of the crew in a real emergency situation.

After the exchange of the active pitch trim system, no statements were identified regarding the actions required to manage the Pitch Trim Runaway or Failure between the crew.

In addition, there were no dialogues indicating that the crew occupying the left seat had taken over the aircraft's controls at the time of the emergency, since the crewmember occupying the right seat was possibly conducting the flight.

These factors indicated inadequate cabin coordination in light of the events of this occurrence, reinforced by a possible misunderstanding of the reasons that would have led the aircraft to that flight situation.

About 6.2 seconds after the action associated with the exchange of the active pitch trim system of the aircraft, there was a talk of the crew associated with the reduction of engine power.

The management of engine power and aircraft speed in this scenario is essential for a successful recovery maneuver.

It was also considered that the performance of the crew could have been restricted only to the command of the elevator in the control wheels of the aircraft. However, using this command alone, without adequate management of engine power and aircraft speed, it might not be sufficient for a successful recovery maneuver (as observed in the flight test

named “A” from the FT650-13 Report) without commanding the horizontal stabilizer movement.

The flight test data did not allow an assessment of how the engine power management was performed during the flight test.

As well was not possible to estimate the final position of the horizontal stabilizer, due to the high fragmentation of the aircraft wreckage.

Therefore, the hypothesis of a non-actuation, in an assertive way, in the switches of the secondary pitch trim system was considered possible for not moving the horizontal stabilizer, after the change of the active system of the aircraft.

About 18 seconds after the first event, there was the first audible manifestation of physical exertion of one of the crew. About 10 similar events were recorded throughout the descent, up to moments before impact. This manifestation of physical exertion was consistent with the action of pulling the stick in order to lift the nose of the aircraft.

The overspeed alarm has been registered for the first time approximately 21 seconds after the end of the horizontal stabilizer movement warning (clacker).

The aircraft's latest radar detection occurred at an altitude of 18,700ft. Below that altitude, the aircraft would not be in the air traffic radars coverage area.

The last two radar detections in the primary mode indicated that the aircraft would have a descent rate of approximately 40,500 ft. / min.

Ground proximity alarms began to be heard 56 seconds after the first event (seventeen seconds before the recording had stopped).

At that point, due to the overspeed condition and the altitude in relation to the ground, there was no longer any possibility of regaining control of the aircraft.

The interruption of the CVR recording occurred as a consequence of the impact against the ground, about one minute and 9.5 seconds after the horizontal stabilizer movement had stopped.

Considering the total downward trajectory (one minute and thirteen seconds), the altitude of the aircraft and the altitude of the terrain at the site of the accident, the calculated mean descent rate was approximately 30,000ft / min.

The crater resulting from the impact indicated that the aircraft collided with the ground at a high pitch and high speed.

The aircraft was destroyed. Tests indicated that the landing gear, flaps, spoilers, and speed brakes were retracted. It was not possible to estimate the position of the horizontal stabilizer at the moment of impact.

All occupants died as a result of the impact.

3. CONCLUSIONS.

3.1 Facts.

a) the pilots had valid Aeronautical Medical Certificates (CMA);

b) the pilots had valid C650 aircraft and IFRA Ratings;

c) the pilots were qualified and had experience in that kind of flight;

d) the aircraft had valid Airworthiness Certificate (CA);

e) the aircraft was within the limits of weight and balance;

f) the airframe and engine logbook records were updated;

g) the weather conditions were favorable for the flight;

h) on 11MAR2004, the aircraft manufacturer issued the SB650-27-53 service bulletin that instructed the ACU exchange, with the prediction of an operational check flight;

i) on 14JUN2005, the FAA issued the Airworthiness Directive AD No. 2005-13-21 related to SB650-27-53;

j) the maintenance shop registered compliance with AD No. 2005-13-21 and SB650-27-53 on 28JUL2006;

k) in the logbook records, no operational check flight was identified after compliance with SB650-27-53;

l) on 23APR2009, the aircraft manufacturer issued the second revision of ASL650-55-04, which provided for a new ACU exchange, with the prediction of an operational check flight;

m) the FAA issued a response letter, considering ASL650-55-04 as an alternative compliance method (AMOC) of AD No. 2005-13-21;

n) OS 68.496 related to the compliance with ASL650-55-04 was opened on 03SEPT2010 and closed on 17SEPT2010;

o) at the time the OS 68.496 was open, some flights were recorded in the logbook, none of which contained the specific operational flight check purpose;

p) on 03SEPT2015, it was opened the OS 81.995, requesting verification in the Horizontal Trim Advisory Unit, in addition to other planned maintenance inspections;

q) on 21SEPT2015, the replacement of the Horizontal Trim Advisory Unit item was performed, as described in OS 82.071;

r) on the date of the occurrence, 10NOV2015, the aircraft performed a flight between SBSP and SBBR;

s) in the CVR recordings, after the first flight on 10NOV2015, the realization of the Stabilizer Trim Backdrive Monitor – Test, incorporated in the Shutdown Checklist through the Temporary Change 65C7FM TC-R10-19, was not identified;

t) in the CVR recordings, before the performance of the flight that resulted in the accident, the realization of the item Warning Systems - Check was not identified;

u) during the climb phase, approximately on the FL370, there was an audible warning of the movement of the horizontal stabilizer of the aircraft recorded in the CVR recordings;

v) the air traffic radars detected a significant downward trajectory;

w) during the downward trajectory, a dialogue was identified among the crew related to the reduction of engine power;

x) during the downward trajectory, there were about ten manifestations of physical effort by one of the crewmembers initiated after the horizontal stabilizer movement (Clacker);

y) the CVR did not record the sound of Clacker (related to the movement of the horizontal stabilizer of the aircraft), after the Pitch Trim Runway or Failure;

z) approximately seventeen seconds after the end of the horizontal stabilizer movement, the characteristic over speed alarm was recorded, which remained until the interruption of the recording;

aa) the aircraft's latest radar detection occurred at an altitude of 18,700ft;

bb) the time elapsed between the end of the horizontal stabilizer movement and the interruption of the CVR recording was of one minute and 9.5 seconds;

cc) the calculated mean descent rate was approximately 30,000 ft. / min;

dd) examinations in the wreckage of the aircraft indicated that the landing gear, flaps, spoilers and speed brakes were retracted;

ee) it was not possible to estimate the position of the horizontal stabilizer at the time of impact;

ff) the aircraft was destroyed; and

gg) all occupants perished.

3.2 Contributing factors.

- **Control skills – undetermined.**

It is possible that, after inadvertent movement of the horizontal stabilizer, the crewmembers did not operate on the control switches of the secondary pitch trim system, since no other warning sound (Clacker) was recorded on the CVR recordings.

The action previsted in the emergency procedures Pitch Trim Runaway or Failure, item 3, regarding trimming of the aircraft through the secondary system, possibly, was not performed.

The performance of the crew may have been restricted only to the elevator control on the aircraft controls or to the control of the stabilizer associated with the primary trimming mode.

- **Attitude – undetermined.**

The decision to make the flight without the proper functioning of the primary pitch trim and autopilot system may have been the result of the pilot's self-confidence because of the successful previous flight under similar operating conditions.

Considering the hypothesis that the updated Shutdown Checklist, which should incorporate the Stabilizer Trim Backdrive Monitor - TEST, was not performed after the pre-crash flight, one could consider that there was a lack of adhesion to the aircraft operating procedures.

Such an attitude could be associated with the pilot's self-confidence about the aircraft's operating routine, whose acquired experience could have given him the habit of ignoring some of the procedures deemed less important during the flight completion phase.

- **Crew Resource Management – a contributor**

Throughout the flight, there was an absence of verbalization and communication of the actions on the checklist.

Similarly, in the face of the emergency situation of the horizontal stabilizer (Pitch Trim Runaway or Failure), no statements were identified regarding the actions required to manage this situation among the crew.

These characteristics denote inefficiency in the use of human resources available for the aircraft operation.

- **Training – undetermined.**

It is possible that the absence of a periodic training in simulator, especially the emergency Pitch Trim Runway or Failure, has affected the performance of the crew, as far as the CVR did not record statements related to the actions required by the abnormal condition experienced.

- **Organizational culture – undetermined.**

The operator did not usually properly fill out the PT-WQH flight logbook. This condition evidenced the existence of informal rules regarding the monitoring of the operational conditions of the aircraft. In this context, it is possible that the history of failures related to the pitch trim system has not been registered.

- **Piloting judgment – undetermined.**

Moments prior to takeoff, it was recorded in the CVR speeches related to the flight without the autopilot, possibly related to a failure or inoperativeness of the primary pitch trim system.

The takeoff with a possible failure in the pitch trim system of the aircraft, showed an inadequate assessment of the risks involved in the operation under those conditions.

- **Aircraft maintenance – undetermined.**

It was not possible to establish a link between the maintenance services performed on the aircraft in September 2015 and the events that resulted in the accident occurred on 10NOV2015.

However, it was not ruled out that an incomplete crash survey was carried out in the pitch trim system of the aircraft, due to the lack of detail of the service orders.

- **Decision-making process – a contributor.**

The sounds related to the test positions of the Rotary Test Switch have not been recorded in the CVR recording, so it is possible to conclude that the Warning Systems - Check item of the Cockpit Preparation Checklist has not been performed.

The decision to perform the flight without the complete execution of all items of the Cockpit Preparation Checklist, prevented the correct verification of the primary longitudinal Trim system of the aircraft and reflected an inadequate judgment about the risks involved in that operation.

- **Interpersonal relationship – undetermined.**

According to the CVR data, there was a possible rush of the crew to take-off, even though it was verified that the aircraft's pitch trim system did not work properly.

It was not possible to determine if this rush was motivated by passengers' pressure or self-imposed by the pilot.

- **Support systems – undetermined.**

It is possible that the Pilots' Abbreviated Checklist - NORMAL PROCEDURES, aboard the aircraft, was outdated, without the incorporation of the Stabilizer Trim Backdrive Monitor - TEST procedure in the Shutdown Checklist.

The possible completion of Shutdown Checklist with outdated procedures would have hampered the manufacturer's suggested verification for identification of abnormalities in the aircraft's pitch trim system.

- **Managerial oversight – undetermined.**

The records and control of the operational check flights, both by the maintenance shop and by the operator, prevised in documentation issued by the manufacturer (SB650-27-53 and ASL650-55-04) were not performed in an adequate manner, indicating possible weaknesses in the supervision of the maintenance activities.

4. SAFETY RECOMMENDATION.

A proposal of an accident investigation authority based on information derived from an investigation, made with the intention of preventing accidents or incidents and which in no case has the purpose of creating a presumption of blame or liability for an accident or incident. In addition to safety recommendations arising from accident and incident investigations, safety recommendations may result from diverse sources, including safety studies.

In consonance with the Law n°7565/1986, recommendations are made solely for the benefit of the air activity operational safety, and shall be treated as established in the NSCA 3-13 "Protocols for the Investigation of Civil Aviation Aeronautical Occurrences conducted by the Brazilian State".

Recommendations issued at the publication of this report:

To the Brazil's National Civil Aviation Agency (ANAC):

A-149/CENIPA/2015 - 01 **Issued on 04/08/2019**

Act with TAM Executive Aviation and Air Taxi S.A, so that the maintenance organization implements improvements in the control processes and test flight records (operational verification flights) required after the maintenance actions.

A-149/CENIPA/2015 - 02 **Issued on 04/08/2019**

Act with Banco Bradesco S.A, so that the operator improves the processes related to the logbook records, especially regarding the execution of test flights (operational verification flights).

A-149/CENIPA/2015 - 03 **Issued on 04/08/2019**

Act with the Cessna Aircraft Company to revise the AFM of aircraft model 650, so that changes in operational procedures introduced through Temporary Changes can also be incorporated into their condensed checklists (Pilots' Abbreviated Checklist).

A-149/CENIPA/2015 - 04 **Issued on 04/08/2019**

Verify with the primary certifier of the aircraft, the Federal Aviation Administration (FAA), the need to revise the aircraft model 650-certification documents, regarding the use of the secondary pitch trim system under the horizontal stabilizer trim runaway conditions.

5. CORRECTIVE OR PREVENTATIVE ACTION ALREADY TAKEN.

The operator has implemented these actions: an annual simulator training program, a minimum equipment list (MEL) approved by ANAC for another aircraft in its fleet, a risk assessment program and a Standard Operational Procedures Manual (SOP).

ANAC revised RBAC nº 61, through amendment no. 07, of 21DEC2017, providing that the revalidation of the type rating should be performed at a Civil Aviation Training Center (CTAC) approved by that Agency.

On April 08th, 2019.

ANNEX A

COMMENTS BY THE NTSB ON DRAFT FINAL REPORT

Below, there is a list of all the comments forwarded by the National Transportation Safety Board (NTSB) on PT-WQH Draft Final Report.

Comment	Chapter	Page	Text to be corrected (first ... last word)	Text Proposed by NTSB / Argumentation	CENIPA´s comment
1.	1.1	7	The… Site. (Line 12)	Missing history for the previous flight in the morning of the accident as well conversation in the cockpit for the flight before the horizontal stabilizer movement.	A text was added.
2.	1.6	8	6507063	Serial number of the aircraft is 650-7083	The serial number was correct.
3.	1.6	8	TFE731-4	TFE731-4R-2S model engines	Accepted
4.	1.6	8	The…Accident	Please verify the engine serial numbers for the left and right engine. According to the last maintenance performed, the left and right engine serial numbers do not match the engine logbook information.	The engine serial numbers are in accordance with the documentation.
5.	1.6	8	Model was made	Replace was with is. model is made	In CENIPA´S reports, the using of verb tense in simple past is a standard. CENIPA believes that this doesn´t cause any misunderstand.
6.	1.6	8	consisted	Replace to consist	
7.	1.6	9	Stabilizer was carried	Replace to stabilizer is carried	
8.	1.6	9	Instruments of the pitch	Instruments for the pitch	Accepted
9.	1.6	9	Stabilizer was controlled	Stabilizer is control	In CENIPA´S reports, the using of verb tense in simple past is a standard. CENIPA believes that this doesn´t cause any misunderstand.
10.	1.6	9	Movement was manually	Movement is manually	
11.	1.6	10	System was composed	System is composed	
12.	1.6	10	Limits was	Limits is	
13.	1.6	10	There were	There are	
14.	1.6	10	Modes was performed	Modes is performed	
15.	1.6	10	System had the same	System have the same	

Comment	Chapter	Page	Text to be corrected (first ... last word)	Text Proposed by NTSB / Argumentation	CENIPA´s comment
16.	1.6	10	Was approximately	Is approximately	In CENIPA´S reports, the using of verb tense in simple past is a standard. CENIPA believes that this doesn´t cause any misunderstand.
17.	1.6	10	TRIM was related	TRIM is related	
18.	1.6	10	There was a	There is a	
19.	1.6	10	Had the function	Have the function	
20.	1.6	10	There was a failure	There is a failure	
21.	1.6	10	And a failure indication	And a fault indication	Accepted
22.	1.6	10	SEC TRIM FAIL	SEC TRIM FAULT	Accepted
23.	1.6	10		You may want to explain the meaning of the fault annunciation for clarification.	A text was added, explaining the fault annunciation.
24.	1.6	11	SEC TRIM FAIL	SEC TRIM FAULT	Accepted
25.	1.6	12	Actuator Assembly…	Remove everything after Actuator	Accepted
26.	1.6	12	…, depending on the…	Replace with …, if Part Number (PN 9914056-7 or 9914056-8 is installed.	Accepted
27.	1.6	13	Trim Engine	Trim Motor	Accepted
28.	1.6	13	… Trim Engine…	Trim Motor	Accepted
29.	1.6	13	Compensation	Trim	Accepted
30.	1.6	16	Was confirmed.	Add … and a repaired unit 9914287-1EX serial number 9924069 was installed.	Accepted