



**National  
Transportation  
Safety Board**

# Maintenance-Related Airplane Investigations

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# About the NTSB

- Small federal agency
- About 400 people total, 100 in Aviation
- Various modes
  - Aviation
  - Highway
  - Marine
  - Rail/Pipeline/Hazmat



# About the NTSB

- About 1,500 accidents per year
- 95%+ investigated by 45+ regional investigators
- Congress mandates that all aviation accidents are investigated while other modes are selective



# NTSB Investigation Purpose

- To determine the facts, conditions, and circumstances relating to an accident or incident and the probable cause(s)
- These results are then used to ascertain measures that would best tend to prevent similar accidents or incidents in the future
- No enforcement or regulatory powers



# What is an Accident?



# What is an Accident?

## Definition of an Aircraft Accident?

An occurrence associated with the operation of an aircraft which:

- takes place between the time any person boards the aircraft with the intention of flight and all such persons have disembarked, and in which
- any person suffers death or serious injury, or in which
- the aircraft receives substantial damage



# What is an Accident?

## Serious Injury

Any injury which:

- Requires hospitalization for more than **48 hours**, commencing within **7 days** of the date that the injury was received;
- Results in a **fracture** of any bone (except simple fractures of fingers, toes, or nose);
- Causes severe hemorrhages, nerve, muscle, or tendon damage;
- Involves any **internal organ** or;
- Involves **2<sup>nd</sup> or 3<sup>rd</sup> degree burns**, or burns affecting more than 5% of the body surface



# What is an Accident?

## Substantial Damage

Substantial Damage is...

Damage or failure which:

- Adversely affects the structural **strength, performance, or flight characteristics** of the aircraft, and which
- Would normally require **major repair or replacement** of the affected component

Substantial Damage is **not**...

- Engine failure or damage limited to an engine if only one engine fails or is damaged,
- Bent fairings or cowling, dented skin
- Small puncture holes in the skin or fabric
- Ground damage to rotor or propeller blades
- Damage to landing gear, wheels, tires, flaps, engine accessories, brakes, or wingtips are not considered “substantial damage”



# What is an Incident?

“An occurrence other than an accident associated with the operation of an aircraft, which affects or could affect the safety of operations.”

- 49 Code Federal Regulations 830.2



# Accident or Incident?



NTSB

# Accident or Incident?



# Accident or Incident?



# Accident or Incident?



NTSB

# Accident or Incident?



# Accident or Incident?



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# Accident or Incident?



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# Accident or Incident?



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# Accident or Incident?



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# Accident or Incident?



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# Accident or Incident?



NTSB

# Case Studies

# Human Factors in Maintenance

## THE DIRTY DOZEN

Twelve human factors for aircraft maintenance proficiency

Lack of Communication

Lack of Teamwork

Lack of Assertiveness

Complacency

Fatigue

Stress

Lack of Knowledge

Lack of Resources

Lack of Awareness

Distraction

Pressure

Norms

FAA AMT Handbook 8083-30

# Cessna 310Q

Tupelo, MS



# Overview

- Crashed during takeoff
- Airplane had just undergone an annual inspection
- Number 2 cylinder replaced on left engine
- Witnesses reported airplane turning to the left and descending until impact with trees and terrain
- Witnesses further reported hearing a loss of engine power





Photo 3) View of the wreckage. Photo Provided by Cessna Aircraft Company

# Examination

- Neither propeller was feathered
- Left engine exam showed B-nut on fuel supply hose to the fuel manifold valve on top of the engine had backed off  $\frac{1}{4}$  turn
- Torque seal was broken

# Post Accident Testing

- Both engines ran successfully
- Left engine test run showed at finger tight torque, B-nut would loosen

# Mechanic Interview

- Reported that the fuel supply hose B-nut was removed to facilitate cylinder replacement
- Stated that B-nut was torqued, but he did not have torque seal available
- Pilot and mechanic did post maintenance test run

TELEDYNE  
CONTINENTAL MOTORS  
Aircraft Products Division

PN 631351-10A8

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MOD  
FIRING ORDER

How could this accident have been prevented?

# Complacency

THE DIRTY DOZEN Twelve human factors for aircraft maintenance proficiency		
Lack of Communication	Lack of Teamwork	Lack of Assertiveness
<b>Complacency</b>	Fatigue	Stress
Lack of Knowledge	Lack of Resources	Lack of Awareness
Distraction	Pressure	Norms

MITIGATING THE RISK		
Always expect to find something wrong.	Never sign off on something that you did not fully check.	Always double check your work.

Piper PA12  
Anchorage, AK  
July 2, 2014



# Overview

- Crashed during takeoff
- Witnesses reported very steep climb then stall at apex
- On-scene: heavy aft crush damage, nose of airplane, leading edge of wings

# Examination

- Elevator control cable continuity to rear stick
- Stick aft = elevator down
- Control cables misrigged, opposite locations on elevator control horn, resulting in a reversal of elevator control inputs

# Examination

- Determined “what” (misrigging)
- It’s not often we find the “what” so quickly
- Also concerned about pilot issues
  - Preflight: controls free and *correct*
  - Unprepared to abort takeoff







# Overview

- First flight after maintenance and modification over several years
- Maintenance logs showed no entries more recent than 2007
- Pilot often performed maintenance, but no one knew who performed maintenance on elevator controls

How could this accident have been prevented?

# Lack of Knowledge

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Complacency	Fatigue	Stress
<b>Lack of Knowledge</b>	Lack of Resources	Lack of Awareness
Distraction	Pressure	Norms

MITIGATING THE RISK		
Only fix parts that you are trained to fix.	Ensure that the maintenance manual you are using is up to date.	If you do not know how to fix something, ask for help from someone who does.

Cessna T182T  
Cohokia, IL  
December 12, 2014



# Overview

- Commercial pilot and pilot-certificated passenger
- Post maintenance check flight
- Just after takeoff, airplane nose began to pitch steeply toward the ground
- Pilot held back pressure on yoke and passenger declared an emergency

# Overview

- On base leg, the pilot applied nose down trim
- Nose down control forces decreased and pilot realized that there was a control reversal
- Landed uneventfully



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NOSE  
DOWN

NOSE  
LEFT

NOSE  
RIGHT

NOSE  
UP

OPEN

POWER  
OFF

# Findings

- Elevator trim actuator replaced, cables reattached
- Mechanic checked travel
- Experienced mechanic checked work
- Briefed check pilot on work accomplished



How could this incident have been prevented?

# Complacency

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# Diamond, DA-40

## San Carlos, CA



# Incident Details

- Run up uneventful, pilot noted that the RPMs dropped lower than normal when he cycled the propeller
- During climb out, engine RPMs climbed to 2,800 so pilot leveled climb and pulled the propeller control back, with no reduction in engine RPM
- Pilot pulled the power back and reduced the RPMs below 2,700. He attempted to cycled the propeller twice but noticed no change in RPMs



# Incident Details

- At this time, the pilot decided to return to the departure airport
- During the return flight, he heard and felt a thump forward of the cockpit
- Engine continued to run smoothly while developing adequate power, pilot landed uneventfully



# Post Incident Examination

- Maintenance facility said they had found a blister in the engine casing and fragments of metal in the oil
- Engine then disassembled and ball bearings from the propeller governor were located in the engine
- Propeller governor was removed for further examination

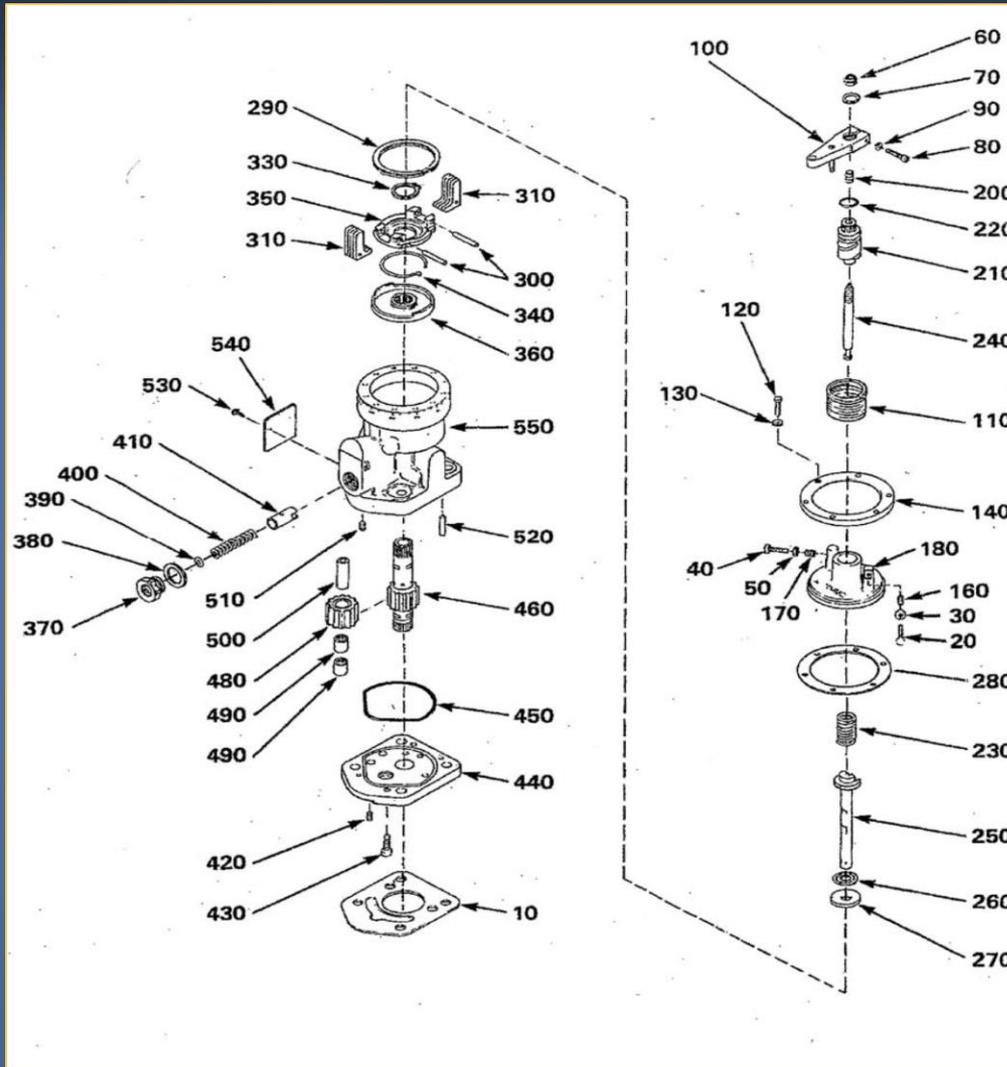


# Post Incident Examination

- Further disassembly identified one ball bearing within the oil sump, as well as damage to the case and two camshaft lifters
- Examination showed that governor ball bearings were able to pass through the oil drain hole of the governor



# Assembly

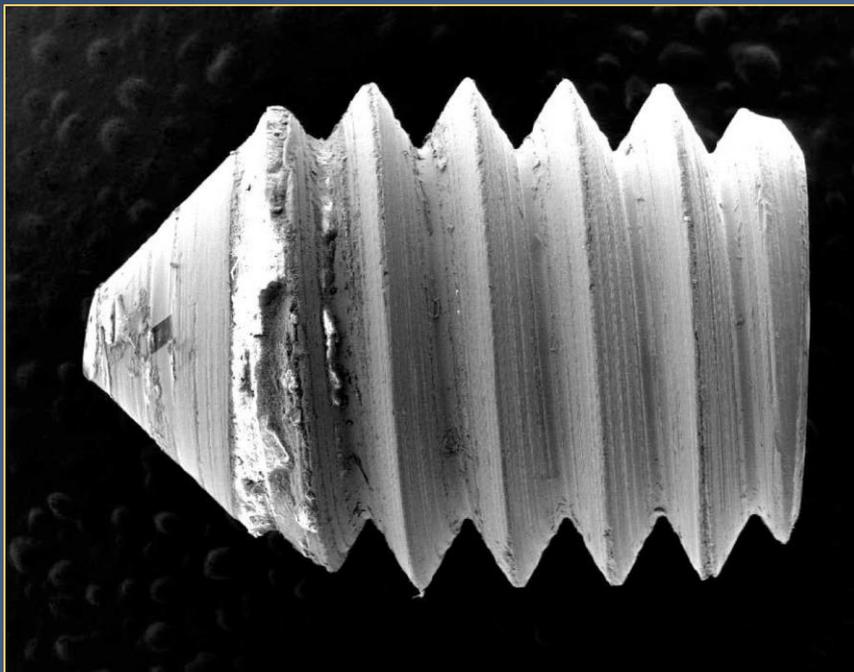


# Governor Examination

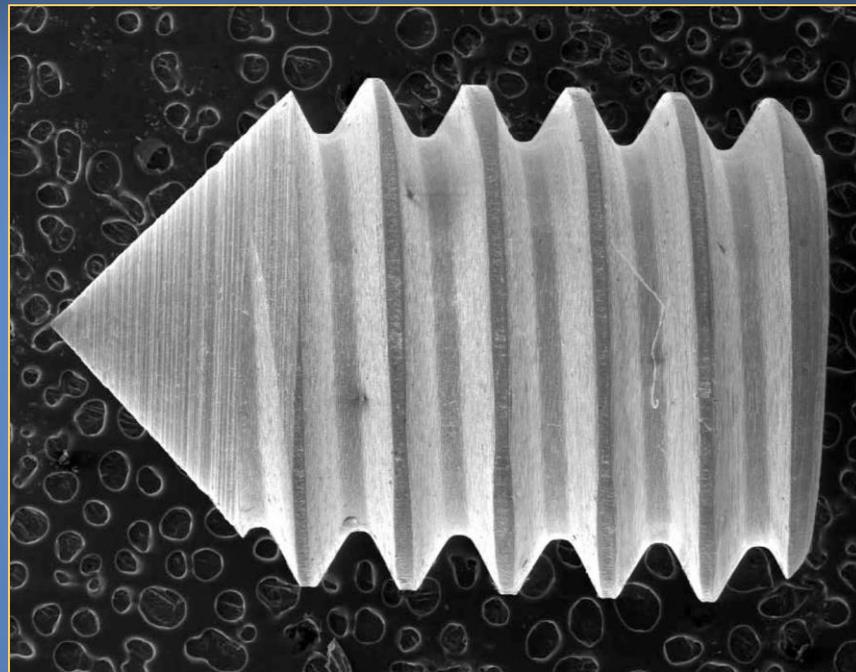
- Governor bearing race and plunger were assembled with the bearing race set screw and plunger hole misaligned
- When the bearing race set screw was torqued down, the set screw tip flattened against the harder plunger surface
- During operation, the set screw/plunger race separated



# Set Screw



SEM MAG: 21 x View field: 5.35 mm  
SEM HV: 20.00 kV Date(m/d/y): 12/11/08 1 mm  
Name: Pilot Valve Bearing Race Set Screw 001.jpg  
VEGA\\ TESCAN  
SEAL Laboratories



SEM MAG: 22 x View field: 5.33 mm  
SEM HV: 20.00 kV Date(m/d/y): 12/11/08 1 mm  
Name: Exemplar Set Screw 001.jpg  
VEGA\\ TESCAN  
SEAL Laboratories



# Why SDRs are important!

- Review of the governor manufacturer's reports showed two service difficulty reports (SDRs) had been reported for similar events
- The two events, as well as the governor assembly from the accident, were from a single batch of 74 assemblies



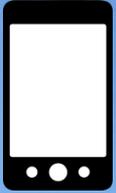
# Manufacturer and FAA Actions

- Mandatory service bulletin (SB) DES-353 issued on December 18, 2008, for the affected assemblies
  - SB required that the units be returned to Ontic for inspection and, if necessary, repair.
- FAA issued an AD requiring examination of the assemblies



How was an accident prevented?

# Contact information



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[www.ntsb.gov/air](http://www.ntsb.gov/air)





# National Transportation Safety Board