1956
CESSNA REPORT 2124
T-37 BACKGROUND

Described in Cessna Report 2124, 2 Aug 1956

This result led to wind tunnel and flight tests which are
indicated spin characteristics quite different than predicted
X-T-37 AF 54-716 prototype aircraft. Test results
initial flight test spins attempted 8 March 1955

Two turns or less

Would produce recovery from steady state spins
indicated that normal spin recovery techniques
WADC T-37 TUNNEL TESTS MAY-DEC, 1954

Cessna Report 2119, 4 Jan 1954

Prediction of spin and recovery mode
46 RPS TO 4 AND TURNS FOR RECOVERY FROM 4-1/2 TO 2
WITH VERTICAL FIN ADDED (5' FULL SCALE) MODEL WENT FROM

NEEDED TO GET SAME AS AIRCRAFT RESULTS
A PITCH VANE ON THE BOTTOM OF FORWARD FUSELAGE OF MODEL

FURTHER MODEL TESTS CONDUCTED IN WADC TUNNEL IN APRIL 1955

SPIN FLATTER AND FASTER THAN WADC SPIN TESTS INDICATED
IN AT 25,000 FT; OUT AT 11,500 FT
NEXT, ONE TURN SPIN TO LEFT UNCONTROLLABLE-CHUTE DEPLOYED.
ONE-HALF TURN TO LEFT, 1-1/2 TURN RECOVERY

FIRST SPIN FLIGHT:

FIRST XT-37 PROTOTYPE SPIN TEST
RECOVERIES (FROM 2 TURN SPINS)
- AIRCRAFT TEST IN "FLAMED OUT" GAVE ONE TURN
  MODEL TESTS DID NOT SIMULATE POWER
  FROM TWO TURN SPINS - TWO TURN RECOVERIES

FLIGHT TESTS CONTINUED:
- ADDED VENTRAL FIN
  STICK FORCE ADJUSTMENT
  SLIGHT REDUCTION IN ELEVATOR CHORD (MANEUVERING)

AIRCRAFT MODS BEFORE FLIGHT TESTS:
Forward shift of aircraft CG

Extension and canting of engine exhaust tailpipes

Stabilizer inboard L.E. fillets installed

Ventral fin removed from lower aft fuselage longer units

Ventral fin, rudder, and dorsal replaced with vertical fin valve added to fuel system

Change in elevator travel aft fuselage "strakes"

Other fixes that were evaluated included
In mid 1966, it became apparent that acceptable spins were unattainable with the fix.

Pilot abandoned airplane, went uncontrolled, spin chute attachment failed.

On last flight to evaluate last item (CG) spin.

Spin and recovery characteristics were both poor and inconsistent.

Four required spin chute.

More than 5 spin conducted.

First Prototype Aircraft (AF 54-716)
Most were 2 turns or less
- No recoveries required more than three (3) turns.

Pilots (Oct. 6, 1956 - Nov. 1, 1956)
One hundred (100) spins were then made by Cessna Test

Turns for recovery
- None of the spins required more than 2-1/2

Included 5-turn erect spins

Fifteen (15) spins were conducted

Horizontal tail height increased 6 in.
Tail arm length increased 25 in.

Major modifications made on AF-54-717
MINOR CHANGES

EVALUATED TECHNIQUES, CONTROL TRAVELS,

Aileron Effectiveness on Recovery

Various Amounts of Rudder-Lead for Recovery

Elevator Down Travel of 10°

Dihedral Wing Tips

Ventral Fin

After Fuselage Stakes

Elevator Up Travel Extended to 26.5°

Thrust Attenuator Effects
But not necessary
Then neutral controls. Airborne against helpful
One-half turn rudder lead, full down elevator.

- Standard recovery technique
- Dihedral wing tips were retained
- Ventral fin was retained
- Elevator travel -26.5° to 10°

Based on these tests, following changes made:
WE ARE SATISFIED
THE SAME TEST AIRPLANE AF-54-717. ALL CONCERNED
ALL REQUIRED SPINS WERE PERFORMED AND SPECIFICATIONS MET IN

• 141 SPINS COMPLETED IN THIS PHASE

October 1966 END OF PROTOTYPE TESTING

WE ARE SUCCESSFUL
5 MORE COMPANY SPINS SUCCESSFUL AND 8 MORE A.F. SPINS

• THE STOP CORRECTED THEN

MACHINICAL STOP PREVENTED FULL DOWN ELEVATOR

• ONE RECOVERY REQUIRED A CHUTE

AIR FORCE EVALUATION
NO EFFECT
- REMOVAL OF DORSAL FIN
- AFT FUSELAGE STRAKES
- WING LE STRIPES
ELIMINATE INCONSISTENCIES
29 MORE SPINS TO EVALUATE FIXES TO

AFTER 56 SPINS - CHUTE NEEDED

ONE FLIGHT TO NEXT

RIGHT TO LEFT
SPINS WERE INCONSISTENT

PRODUCTION AIRCRAFT AT 56-2972
CONFIRM RELIABILITY OF PROTOTYPE DATA WITH

PRODUCTION AIRPLANE TESTS
- NEXT FLIGHT UNCONTROLLABLE - CHUTE
  STRAKES REMOVED
- REDUCE TURN TURNS FOR RECOVERY
- REDUCE SPIN RATE
  VERY EFFECTIVE TO (6 FLIGHTS)
  4 IN. WIDE 6 FT. LONG
  AT THIS POINT NOSE STRAKES WERE INSTALLED

NOSE STRAKES
DECREASED LONG STABILITY - INCREASED DRAG

SLOW SPIN RATE - FASTER RECOVERIES

- 2 IN. WIDE, 6 FT, LONG STRAKE COMPROMISE
- VENTRAL AND DORSAL FINS RETAINED
- CLOSE CHECK ON FUEL UNBALANCE

• NOSE STRAKE REPLACED, TAILORRED-37 MORE SPINS MADE

• CAN BE ASYMMETRICALLY LOADED DURING GROUND REFUELING

• THAN PROTOTYPE AIRPLANE

• FUEL SYSTEM OF PRODUCTION AIRPLANE DIFFERENT

• POST FLIGHT SHOWED 27,000 IN. LBS FUEL UNBALANCE

FUEL UNBALANCE
Turns for Recovery: 1-1/4 Turns

Angle of Attack: 45°

Turn Rate: 180°/sec or 3 Sec/Turn

Results

Without Spin Chute on Aircraft, AF 54-2730

Final Check Spins Made Another Production Airplane

206 Spins Completed with Production Airplane

15,000 Lbs Maximum Fuel Unbalance Permitted

Parachute Installed on Standard Production Airplane with

All Specification Spins Satisfactorily Demonstrated

Final Check on Production Airplane
Another flight test program was started and non-recoverable - faster rate - steeper attitude. Characterized by:

Aggravated spin showed up - resulted in loss of aircraft.

23 Oct. 1983
Cessna Report 318A-6303-046
Fleet Experience
"Single Recovery Procedure" Flight Test Conducted at Edwards To Develop
- Confused As to Direction And Type Of Spin
- Recovery Problems Caused By Disorientation Of The Pilot
  - Elevator "Slowly" Moved To Down
  - Rudder "Not" Full Against
- Caused By Not Applying Full Recovery Controls And Timing

The Aggravated Spin
OF "ZERO" LOADING
TO MINOR AIRFRAME MODIFICATIONS (A CHARACTERISTIC
TO RECOVERY CONTROL TECHNIQUE AND RATHER INSENSITIVE
THE SPIN RECOVERY CHARACTERISTICS ARE VERY SENSITIVE

• RECOVERY TECHNIQUES
  • AIRCRAFT WERE STILL BEING LOST DUE TO IMPROPER
• RECOVERY PROCEDURE NOT CURE-ALL
• SINGLE RECOVERY PROCEDURE DEVELOPED

CONDITIONS AFTER EDWARDS TESTS
Airflow

Nose up

Moment

Pitching inertia

Spin Axis

W

W

W

Nose down

Moment

Pitching aerodynamic

Spin Axis

W

W

W

Moments in a spin

Balance of aerodynamic and inertia

Inertial moments = Aerodynamic moments
\[
\frac{m_b^2}{x - 1_y} \times 10^{-4}
\]

0 \approx \frac{1}{100}

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<thead>
<tr>
<th>Primary Recovery Controls</th>
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<td><strong>Fuselage Heavy Loading</strong></td>
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Loading IS Primary Factor in Recovery
ENSURING DIVE

6. After spinning stops, neutralize controls and recover from
    is effected allow the stick to move aft of neutral until recovery
    while continuing to hold rudder until spinning stops. Do not
    then, as the nose pitches down, relax forward pressure
    after one turn, abruptly move the stick full forward,
    and hold

3. Abruptly apply full rudder opposite to the spin direction

If spinning continues, determine direction of rotation

b) If the spinning continues from the ensuing dive

Recovery will be effected within one-half turn

a) If the spin is inverted, a rapid and positive

2. Neutralize rudder and move the stick full aft

1. Check throttles at idle position

SINGLE RECOVERY PROCEDURE
The spin characteristics of the T-37 of items that could change or improve. Air force requested spin tunnel to make study.
Cessna Report 318A-6303-046

OCT 1963

Of The T-37 Airplane and Recovery Characteristics Study To Improve The Spinning
Spin during recovery attempts

Eliminate the ability to inadvertently transition from an erect to an inverted

Application of recovery controls

Provide for recoveries without precise

decrease the spin rotation rate

Eliminate the accelerated spin

Objectives of study were to:
Items investigated in study

• Mass distribution
• Increased rubber size
• Increased tail arm
• Increased wing dihedral
• Fuselage nose shape
• Increased horizontal tail area
• Increased horizontal tail height
No accelerated spin/good recoveries

\( \frac{\text{mb}^2}{\sqrt{I_x - I_y}} = 161 \times 10^{-4} \) (20 gal in each tip tank)

Recommended changing loading to wing heavy loading

Accelerated spin be eliminated

Only with mass distribution change can the results of mass distribution only modification

Which would assure results

Results of study
ONE ACCIDENT IN 1981


ONE ACCIDENT IN 1976

NO ACCIDENTS 1973, 1974, 1975

32 ACCIDENTS THRU DEC. 1972

JAN. 1977 - FIRST T-37 SPIN ACCIDENT

RECOVERIES STILL SENSITIVE TO CONTROL TECHNIQUE

NO MASS CHANGES WERE MADE TO AIRCRAFT

SUMMARY