IT'S NOT ALL BAD NEWS

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Rodrigo (Rod) Huete
President
Flight Test & Safety Consultants, LLC
GOOD SAFETY VS BAD SAFETY
A CASE STUDY OF SUCCESS

• AFTER-MARKET MAJOR EXTERNAL MODIFICATIONS ON A PROVEN PLATFORM

• CHALLENGES:
  • OPERATOR WITH NO FLIGHT TEST ORGANIZATION
  • FLIGHT TEST CONTRACTED OUT
  • RAPID DEPLOYMENT NEED FOR END-USER
  • AIRWORTHINESS CRITICAL TO SYSTEMS TESTING
  • CRITICAL SCHEDULING MILESTONES

MORE......
A CASE STUDY OF SUCCESS

• CHALLENGES (CONT’):

  • WEATHER
  • TEST SITE
  • FLIGHT FOLLOWING
  • MANAGEMENT PRESSURE
  • CONFIGURATION CONTROL/CONFORMITY
  • ENVELOPE EXPANSION
CHALLENGES

Operator with no flight test organization
Flight test contracted out
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• Administration
• Licensing and Competency
• Medical
• Operational Control
• Weather
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FLIGHT READINESS REVIEW (FRR)

- GENERAL
  - The First Flight Readiness Review Board ensures:
  - The test aircraft is flightworthy, properly instrumented, and conformed (if required).
  - Modifications done to drawings; instrumentation installed per drawings.
  - All Engineering Work Orders are completed.
  - QA has confirmed and conformed, if applicable.
  - Functional tests accomplished.
  - Airworthiness Certificate issued.
  - Test Plan is complete.
  - Test Report Content is agreed upon.
  - Technical risks identified and Mitigation Plan in place.
  - All other engineering test planning and safety reviews are complete.
  - Test anomaly / reporting system is functional.
  - All requirements documentation is complete.
  - All design documentation is complete.
  - Test or Validation Procedures are complete.
  - All test certification or flight approvals have been obtained.
  - Risk Management Program Fully Functioning.
  - All Hazard Risk Assessments have been accepted / approved at appropriate levels.
  - Data Reduction Procedures and Responsibilities are documented and accepted.
  - Data Analysis Procedures and Responsibilities are documented and accepted.
  - Program Test Schedule established and fully resourced with support from organizations.
  - Maintenance
  - Instrumentation
  - Quality Assurance
  - Logistics
  - Equipment
  - Facilities
  - Staffing
  - Funding
  - Progressive testing and test dependencies fully identified.
  - Aircraft Quarantine Program for Conformed – Flight ready aircraft is in place.
  - Produces an assessment “Checklist” to measure readiness.

- **Green** - Tasks complete, ready to proceed;
- **Yellow** - Some/all tasks incomplete but scheduled to be completed prior to first flight;
- **Red** - Tasks not scheduled to be completed in time to support first flight;
  - This could result in either postponement of first flight and/or reduction in scope of effort until satisfactory completion.
Test Prerequisites:

- Current weight and balance by weighing or calculation.
- Fuel quantity gauging system calibrated if indicated fuel quantity is used to determine weight.
- Swivel-head air data boom installed. Boom airspeed indication available in the cockpit.
- Calibrated airspeed indicating system (instrument and position errors quantified).
- Test and ship pitot-static system leak check satisfactorily completed.
- Flight control rigging check satisfactorily completed. All flight control travels verified to be within the limits specified by the AMM.
- Elevator nose-up travel set to the maximum allowable deflection if any test condition is found to be limiting that would warrant further investigation with critical, worst-case flight control rigging.
- Propeller flight idle stops verified to be within the limits specified by the AMM.
- Stable atmospheric conditions are required for this test. Smooth atmospheric conditions are preferred.
- Forward C.G. stall performance tests and data analysis completed prior to aft C.G. stall testing in the same flap/gear configuration.
- Pilot to be familiar with aerobatic maneuvers and unusual attitude / upset recovery techniques, including the recovery from spins.

High Risk (Aft C.G. Stalls)

- Hazard Identification:
  - Departure from controlled flight.
  - Inability to pitch the aircraft nose down from high angle-of-attack.
  - Elevator control force reversal / elevator overbalance.
  - Loss of operating engine(s).
- Risk Reduction:
  - Day VMC conditions only.
  - Do stall testing using a build-up approach (least risk to highest risk).
  - Establish minimum altitudes. Recovery from stall to be completed before 5,000 feet above ground level.
  - Perform pre-flight checks of stall warning system and verify adjusted within AMM tolerance.
  - Use aileron to control roll and rudder to control yaw. DO NOT USE RUDDER TO “LIFT A WING”.
  - For power-off stalls, do not add power during stall recovery until speed has increased to 1.2Vs.
  - For power-on stalls, do not reduce power during the initial recovery.
  - Flight crew with sufficient flight time to feel comfortable with the aircraft.
  - Monitor angle of attack and rate of change of angle of attack during approaches to stalls.
  - Do not exceed angle-of-attack or pitch attitude limits established for the test.
  - Monitor entry rate during approach to the stall. Do not exceed entry rate limits established for the testing.
  - If the stall is defined by the elevator on the aft stop, do not exceed 1 second with the stick on the aft stop.
  - Crew fully briefed and practised on emergency procedures, including the use of parachutes.
  - Establish minimum bail out altitude.
  - Flight crew to wear helmets and parachutes.
  - Minimum crew on board (essential flight crew only).
  - Surface winds to be less than 20kt (parachute limit).
  - Complete pre-flight briefing, including clear definition of test procedures, potential problems, and appropriate resolution.
- Pilot to be familiar with aerobatic maneuvers and unusual attitude / upset recovery techniques, including the recovery from spins.

Emergency Procedures:

- If an uncommanded pitch or roll occurs, use normal controls to return to controlled flight.
- If a spin develops, apply AFM recovery procedure. If no AFM procedure, apply standard recovery procedure:
  1. Maintain ailerons neutral;
  2. Apply full rudder in the direction opposite to the spin rotation;
  3. Briskly apply nose down elevator;
  4. HOLD these control positions until rotation stops;
  5. After spin rotation stops, neutralize the rudder and apply elevator back-pressure as required to smoothly raise the nose to level flight.
TRICK: EXPERIENCE
TRICK: EXPERIENCE
TRICK: EXPERIENCE - SAFETY EQUIPMENT
BASELINE AIRPLANE
CONCEPTUAL DESIGN
EXPECTED ISSUES

- LONG - STAB
- MAN - STAB
- STALLS
- DIR
MODIFIED AIRPLANE
ENVELOPE EXPANSION

Flight Test Weight & Center of Gravity Limits

Weight (lb) vs. Center of Gravity (inches)
CHALLENGE - TEST SITE
CHALLENGE - TEST SITE

• VERY SLOW PROGRESS
• INITIAL CONFIGURATION / CONFORMITY ISSUES
• BOGGED DOWN BY WEATHER PATTERNS
• MANAGEMENT SCHEDULING PRESSURES
• FLIGHT TEST TEAM WANTED TO DEPLOY
DEPLOY !!!
FLIGHT PROGRESS

NUMBER OF TEST FLIGHTS

CALENDAR DAYS

Deploy

Flight Test & Safety Consultants, LLC

22
Measuring Stick Free Stability

Dividing eqn 3.34 by \( q \) gives

\[
\frac{F_e}{q} = A \left( B + C_{h_h} \delta_t \right) \frac{A C_L C_{h_k}}{C_{M_{Mz}}} \left[ \frac{dC_M}{dC_L} \right]_{\text{free}}
\]

\[
\frac{d \frac{F_e}{q}}{dC_L} = \frac{AC_{h_k} dC_M}{C_{M_{Mz}} dC_L} \left[ \frac{dC_M}{dC_L} \right]_{\text{free}}
\]

\[
\frac{d F_e}{dC_L} = f \left[ \frac{dC_M}{dC_L} \right]_{\text{free}}
\]

\[
h'_n = \text{cg position where } \frac{dC_M}{dC_L} \bigg|_{\text{stick free}} = 0
\]
LONG - STAB IN PRACTICE

Neutral Point Stick Free, 35/DN

Measured with No downspring

Mod CG Limit

Predicted Neutral Point

We're in trouble........
WHAT WAS THE REAL ISSUE?

• LAT - DIR MEETING ALL REQUIREMENTS
• STALLS MEETING ALL REQUIREMENTS
• MAN - STAB MEETING ALL REQUIREMENTS
• ONLY ISSUE LEFT WAS LONG - STAB
  • DOWNSPRING (relatively easy)
  • BOB WEIGHT (relatively hard)
Altering Speed Stability using a Downspring

- Improves stick-free longitudinal stability by producing a constant force on the stick (pull), independent of speed

\[ F_e = T \frac{l_1}{l_2} = K_3 \]

- Extra tab required to offset \( K_3 \) which increases apparent stability

\[ F_e = K_1 V_e^2 + K_2 + K_3 \]
THE BUNGEE CHORD EXPERIENCE
BUNGEE CHORD EFFECT

Neutral Point Stick Free, 35/DN

- Mod CG Limit
- Predicted Neutral Point No downspring
- Neutral Point Bungee = SAFE

Flight Test & Safety Consultants, LLC
SUMMARY

• 32 FLIGHTS COMPLETED
• OVER 80 HOURS FLOWN
• ZERO INCIDENTS
• NO MAINTENANCE CANCELS
• ONLY ONE WEATHER CANCEL AT KMHV - WINDS
• SYSTEMS TESTING SCHEDULE MET
• ENVELOPE CLEARED TO
  • ESTABLISHED CG LIMITS
  • FULL Vmo
  • SAME TAKEOFF SPEEDS
  • 30,000 ft (BASELINE ONLY 25,000 FT)
KEY TO SUCCESS

• TEST / ENGINEERING TEAMWORK
• DISCIPLINE
• PROFESSIONALISM / EXPERIENCE
• ASSERTIVENESS WITH RESPECT
• BAG OF TRICKS
• MANAGEMENT COOPERATION / UNDERSTANDING
• EXCELLENT MAINTENANCE PERSONNEL
KEY TO SUCCESS (Cont’)

- EXPERIENCED COMPANY PIC
- GOOD CRM
- TEST PILOT EXPLAIN FTTs to PIC
LESSONS LEARNED (RE-LEARNED)

- **TIGHT SCHEDULING COMMITMENTS REQUIRE APPROPRIATE AIRWORTHINESS TEST SITE**

- **CONFIGURATION CONTROL / CONFORMITY PROCESS IS CRITICAL**

- **TESTING CRUNCH AT THE END**

- **Vmca TESTING SHOULD BE DEDICATED FLIGHTS**
QUESTIONS?