IT'S NOT ALL BAD NEWS

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GOOD SAFETY VS BAD SAFETY

A CASE STUDY OF SUCCESS

- AFTER-MARKET MAJOR EXTERNAL MODIFICATIONS ON A PROVEN PLEATFORM
- 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

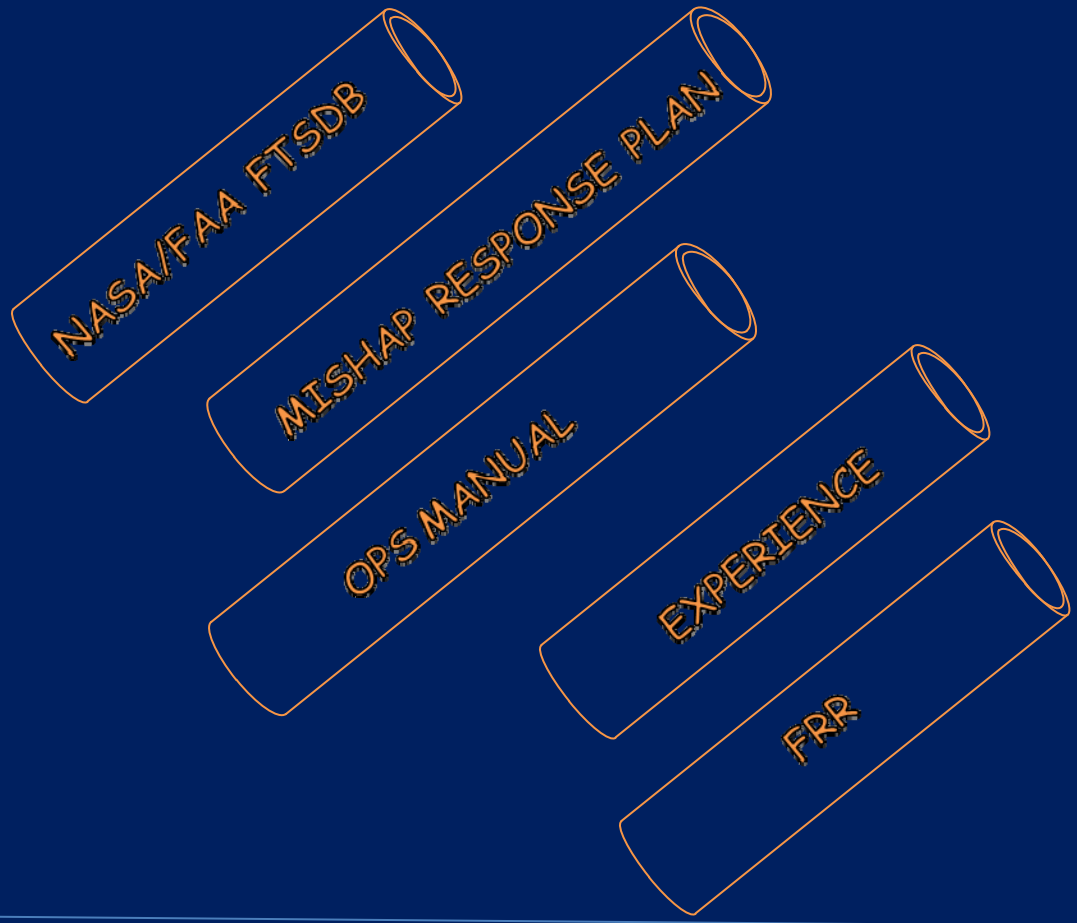
MORE……

A CASE STUDY OF SUCCESS

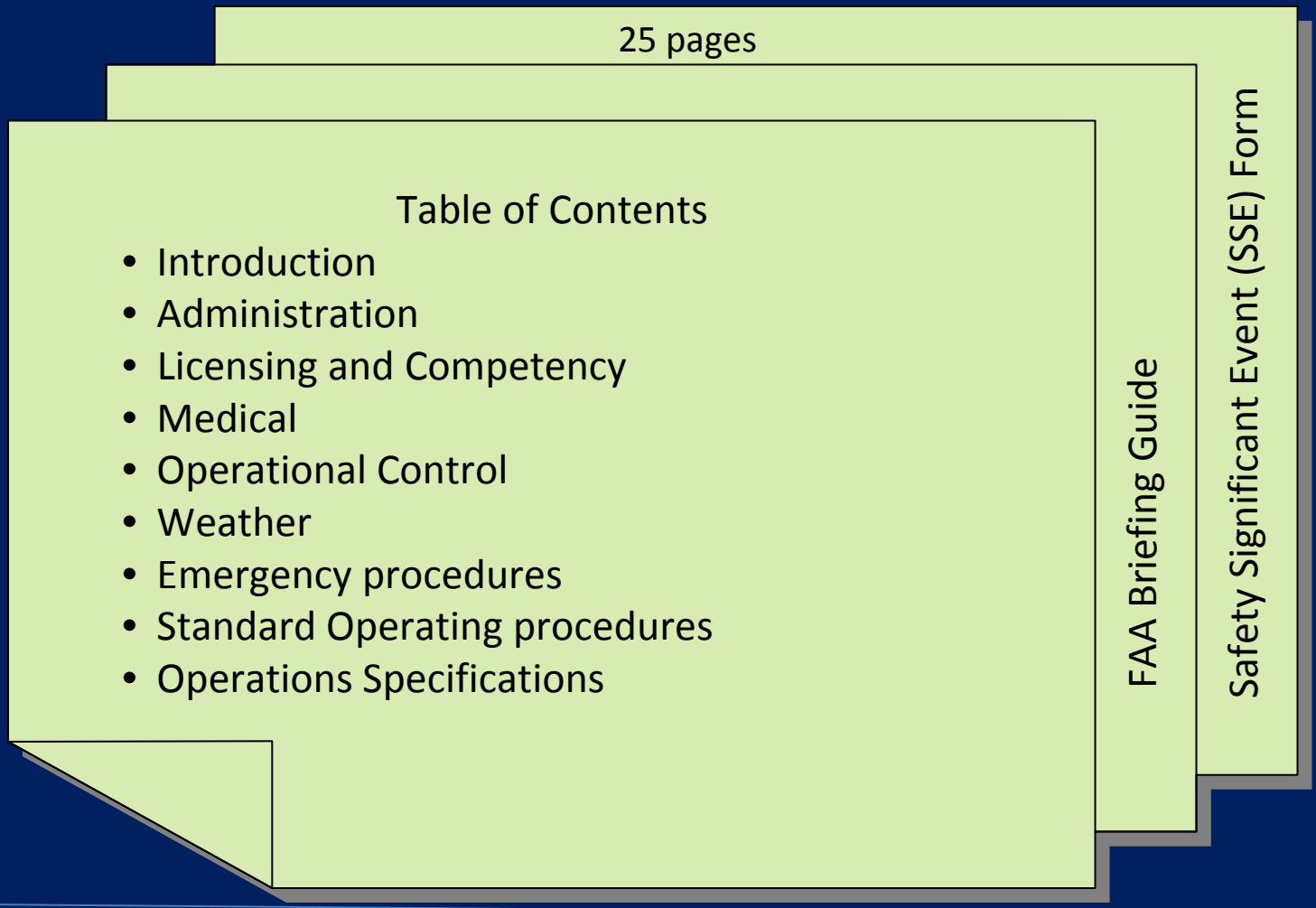
- CHALLENGES (CONT'):
  - WEATHER
  - TEST SITE
  - FLIGHT FOLLOWING
  - MANAGEMENT PRESSURE
  - CONFIGURATION CONTROL/CONFORMITY
  - ENVELOPE EXPANSION

CHALLENGES

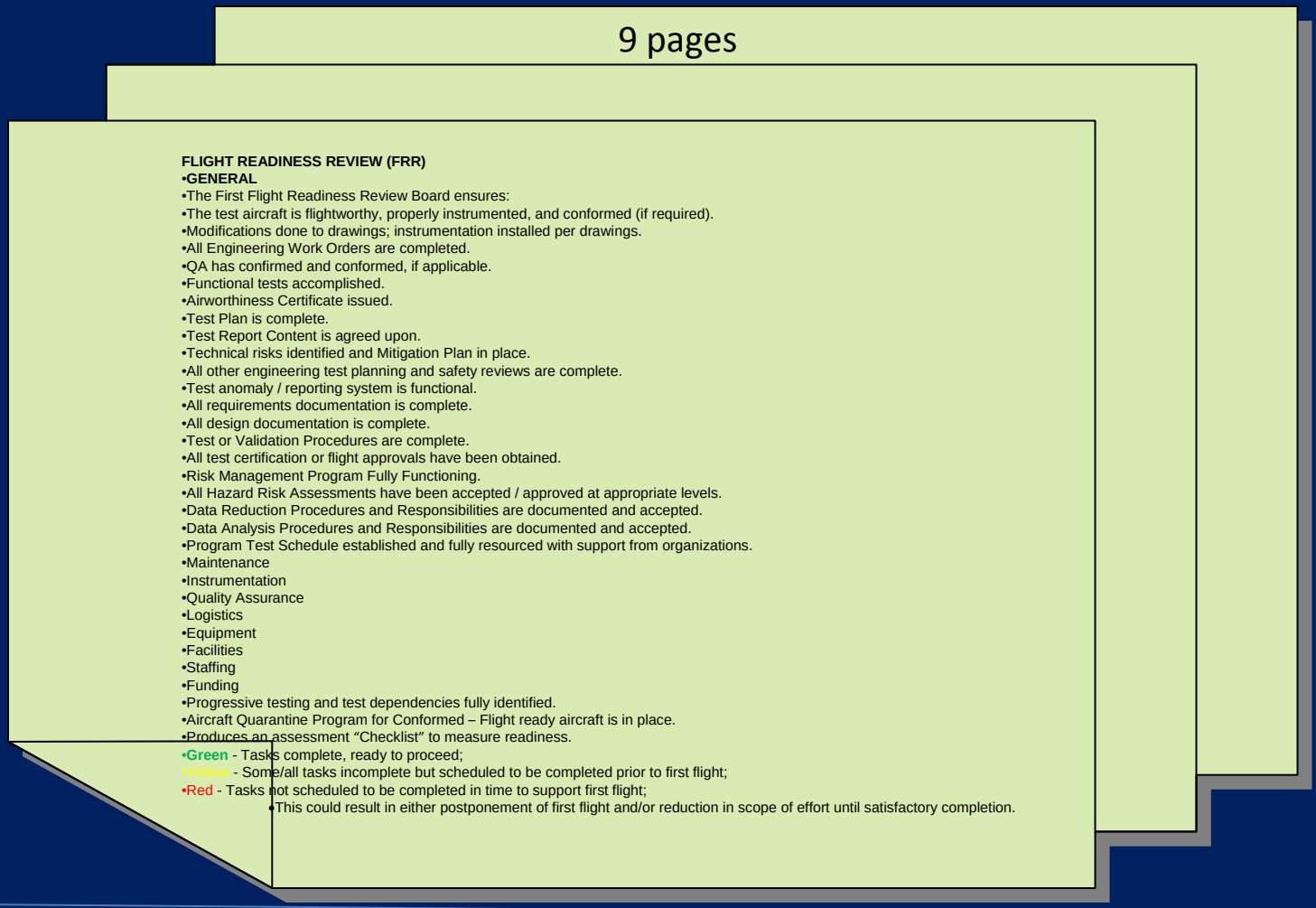
Operator with no flight test organization
Flight test contracted out



TRICK: FLIGHT TEST OPERATIONS MANUAL



TRICK: FLIGHT READINESS REVIEW (FRR)



TRICK: NASA/FAA FTSDB

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 complete 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.

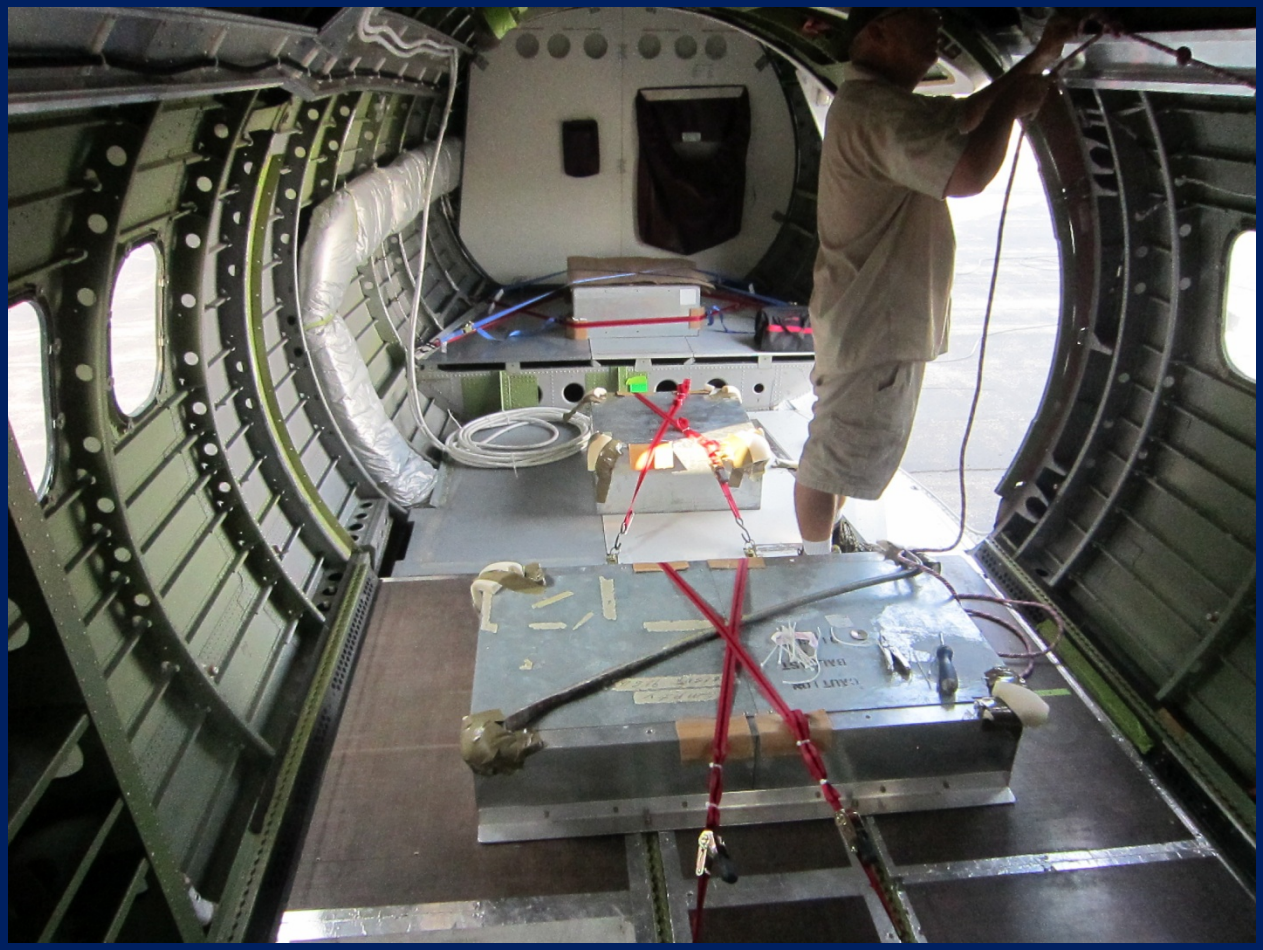
High Risk (Aft CG Stalls)

•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 $1.2Vs_1$.
•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



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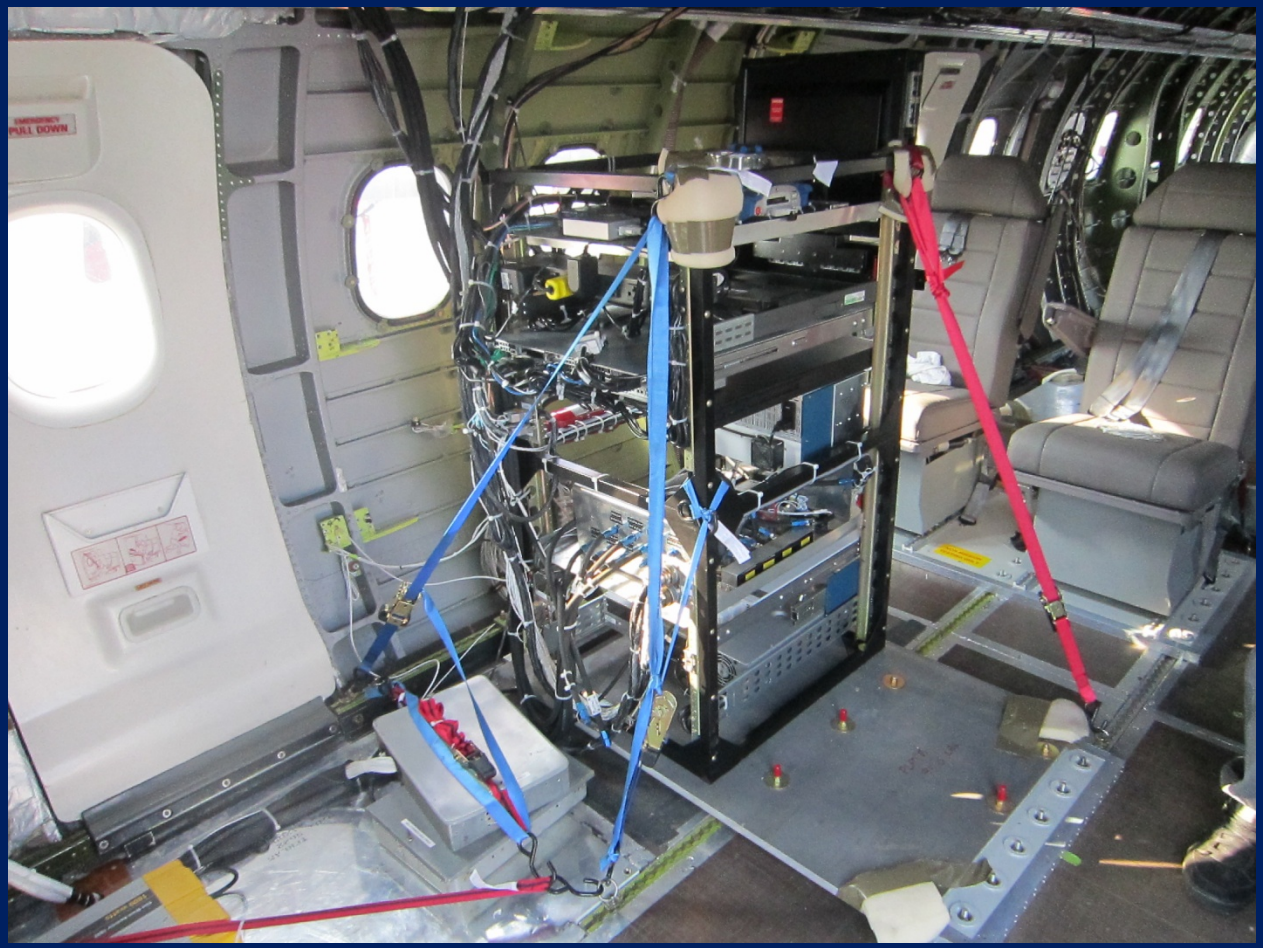


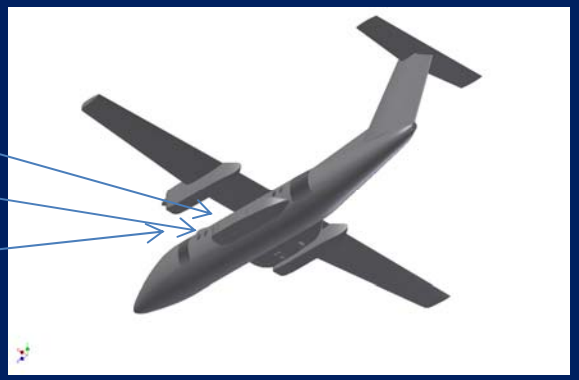
TRICK: EXPERIENCE – SAFETY EQUIPMENT

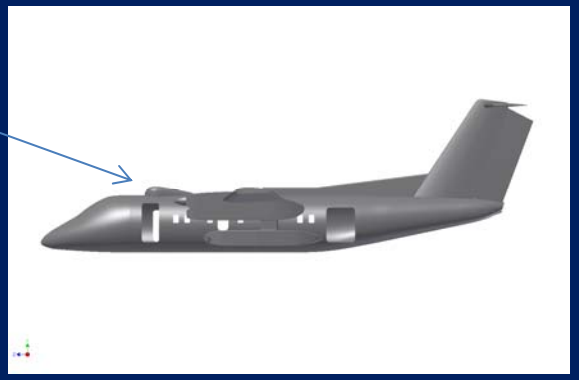
BASELINE AIRPLANE

CONCEPTUAL DESIGN

EXPECTED ISSUES

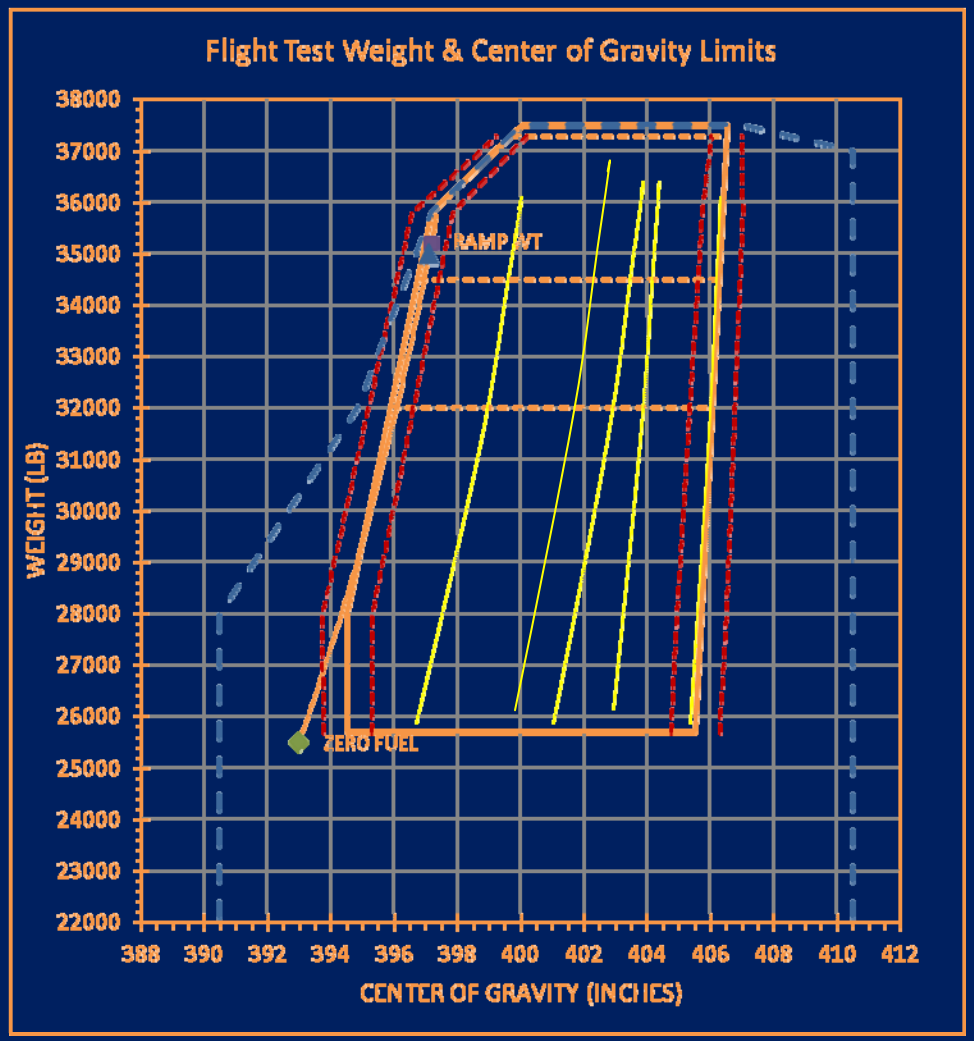
- LONG – STAB
- MAN – STAB
- STALLS
- DIR





MODIFIED AIRPLANE

ENVELOPE EXPANSION

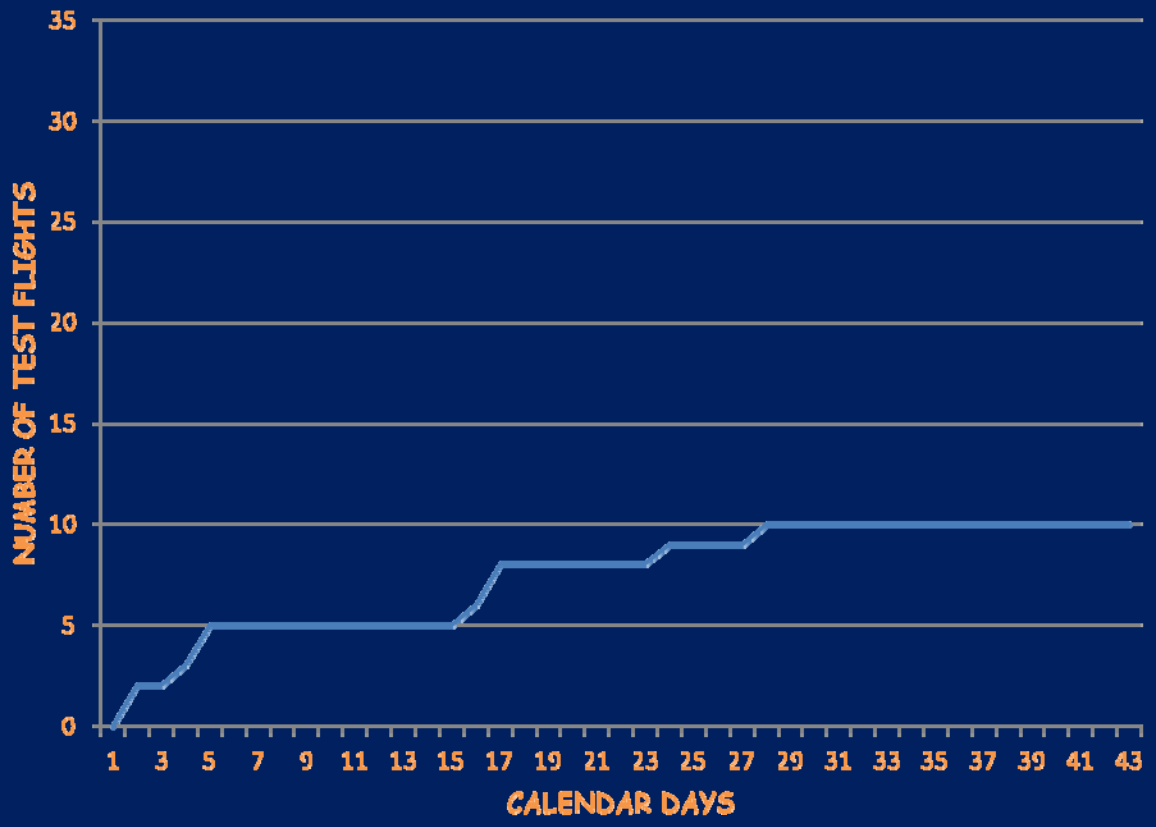


CHALLENGE – TEST SITE

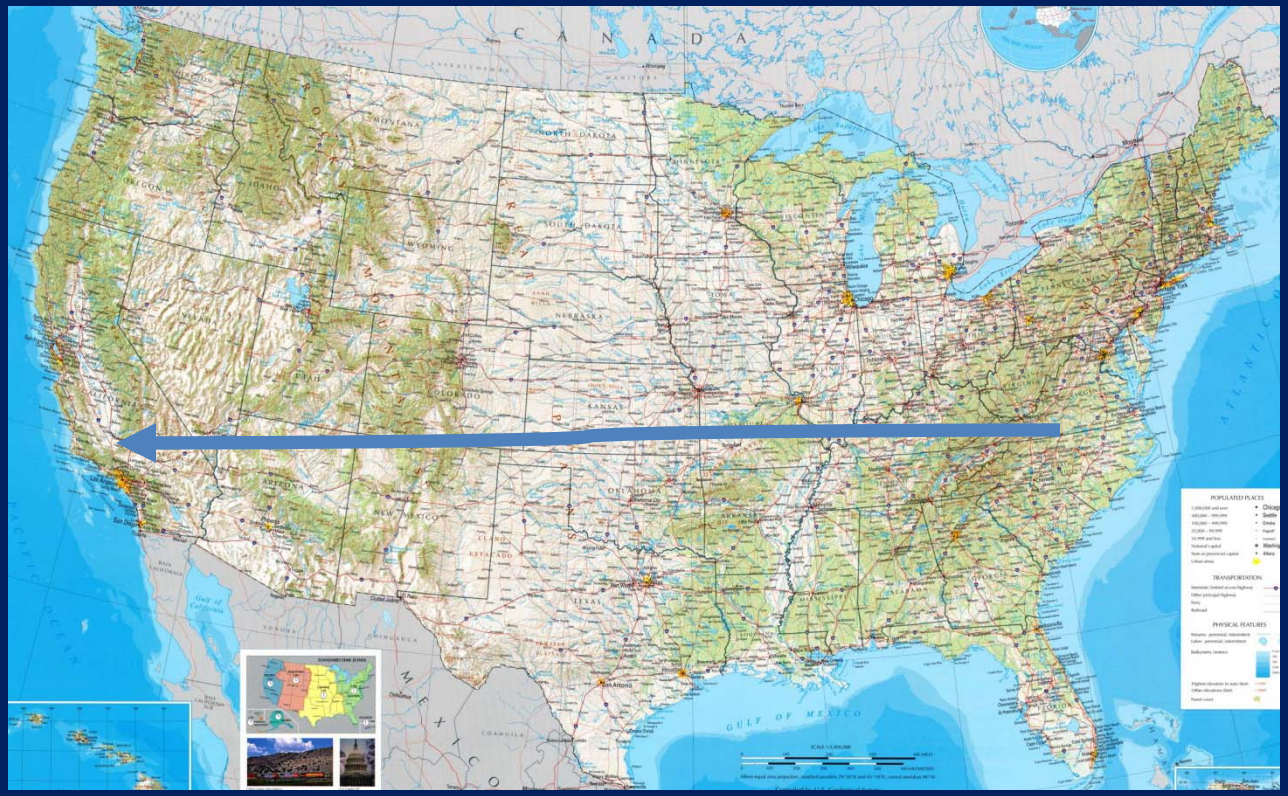
CHALLENGE – TEST SITE

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

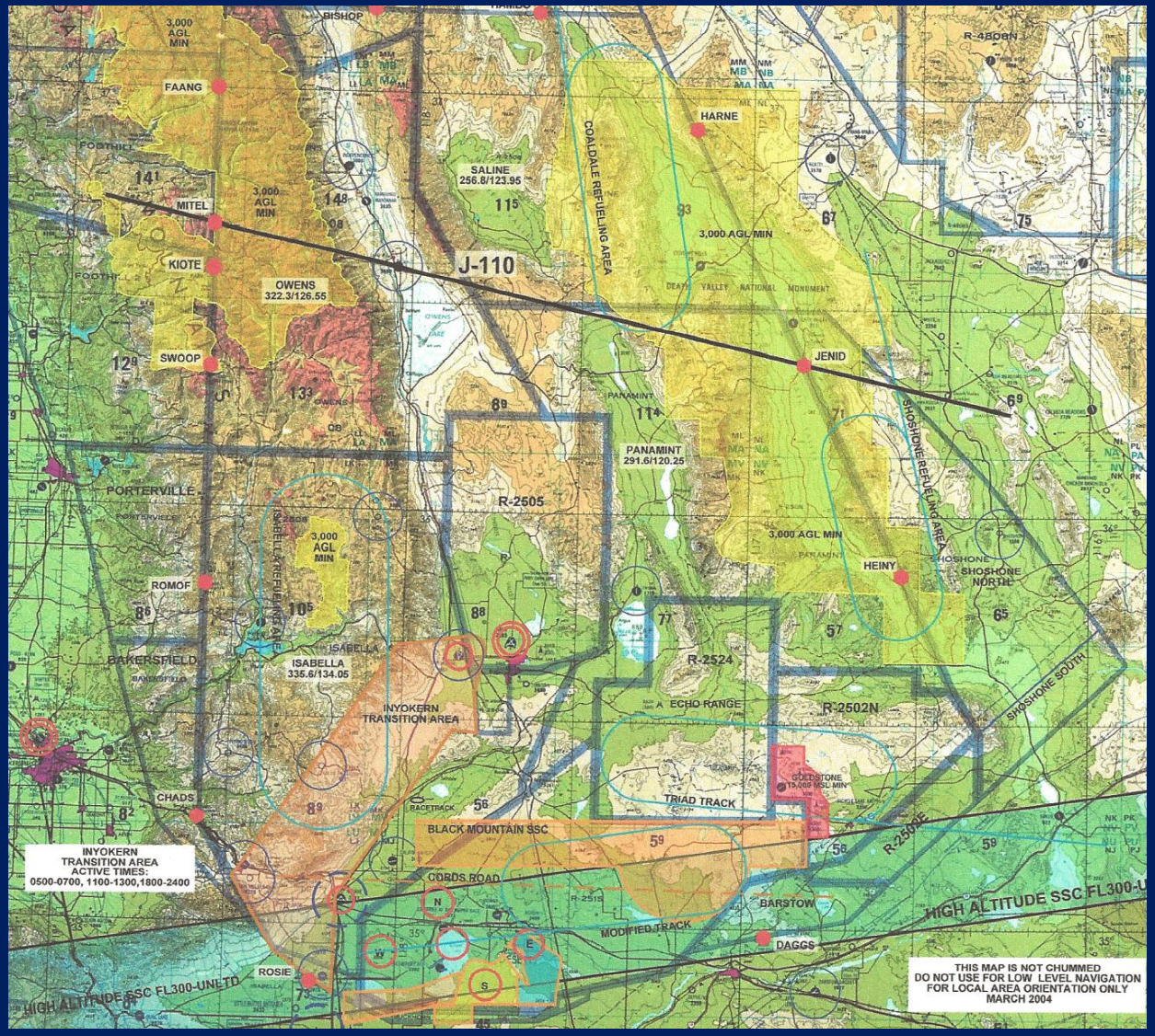
FLIGHT TEST PROGRESS - ORIGINAL TEST SITE



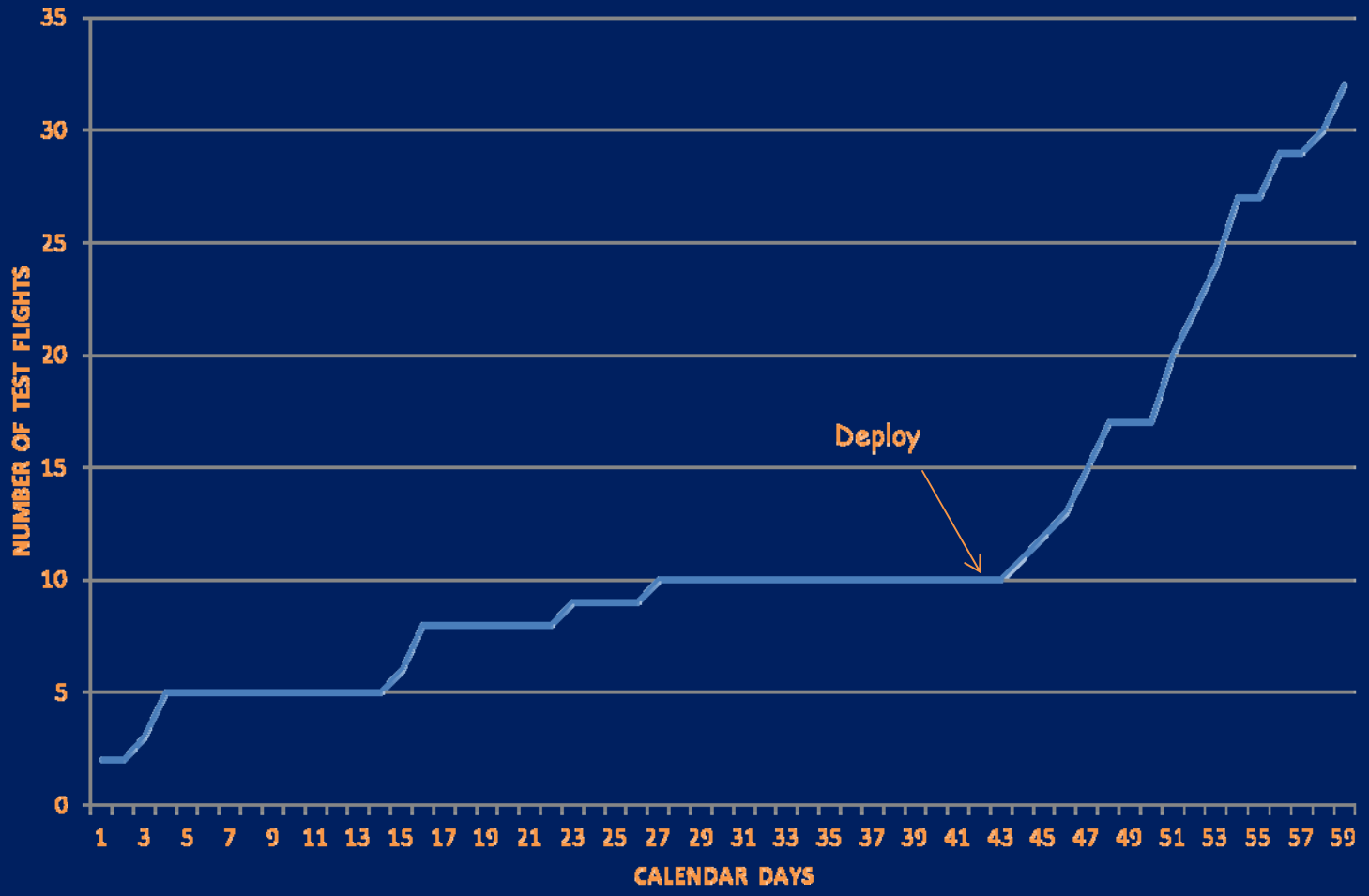
DEPLOY !!!



BETTER TEST SITE



FLIGHT PROGRESS



LONG – STAB IN THEORY

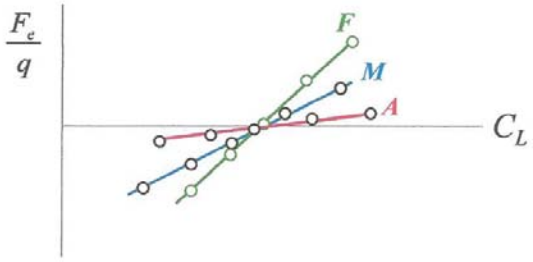
Measuring Stick Free Stability

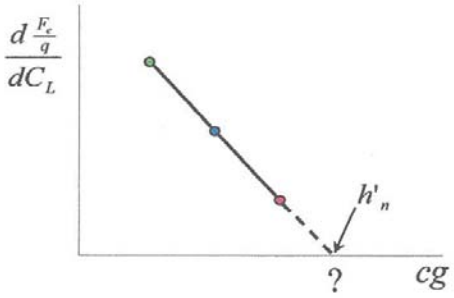
Dividing eqn 3.34 by q gives

$$\frac{F_e}{q} = A\left(B + C_{h_{\delta_t}}\delta_t\right) - \frac{AC_LC_{h_\delta}}{C_{M_{\delta_e}}}\left[\frac{dC_M}{dC_L}\right]_{free}$$

$$\frac{d\frac{F_e}{q}}{dC_L} = -\frac{AC_{h_\delta}}{C_{M_{\delta_e}}}\left.\frac{dC_M}{dC_L}\right|_{free} \qquad (3.39)$$

$$\frac{d\frac{F_S}{q}}{dC_L} = f\left[\frac{dC_M}{dC_L}\right]_{free} \qquad h'_n = cg \text{ position where } \left.\frac{dC_M}{dC_L}\right|_{stick\ free} = 0$$





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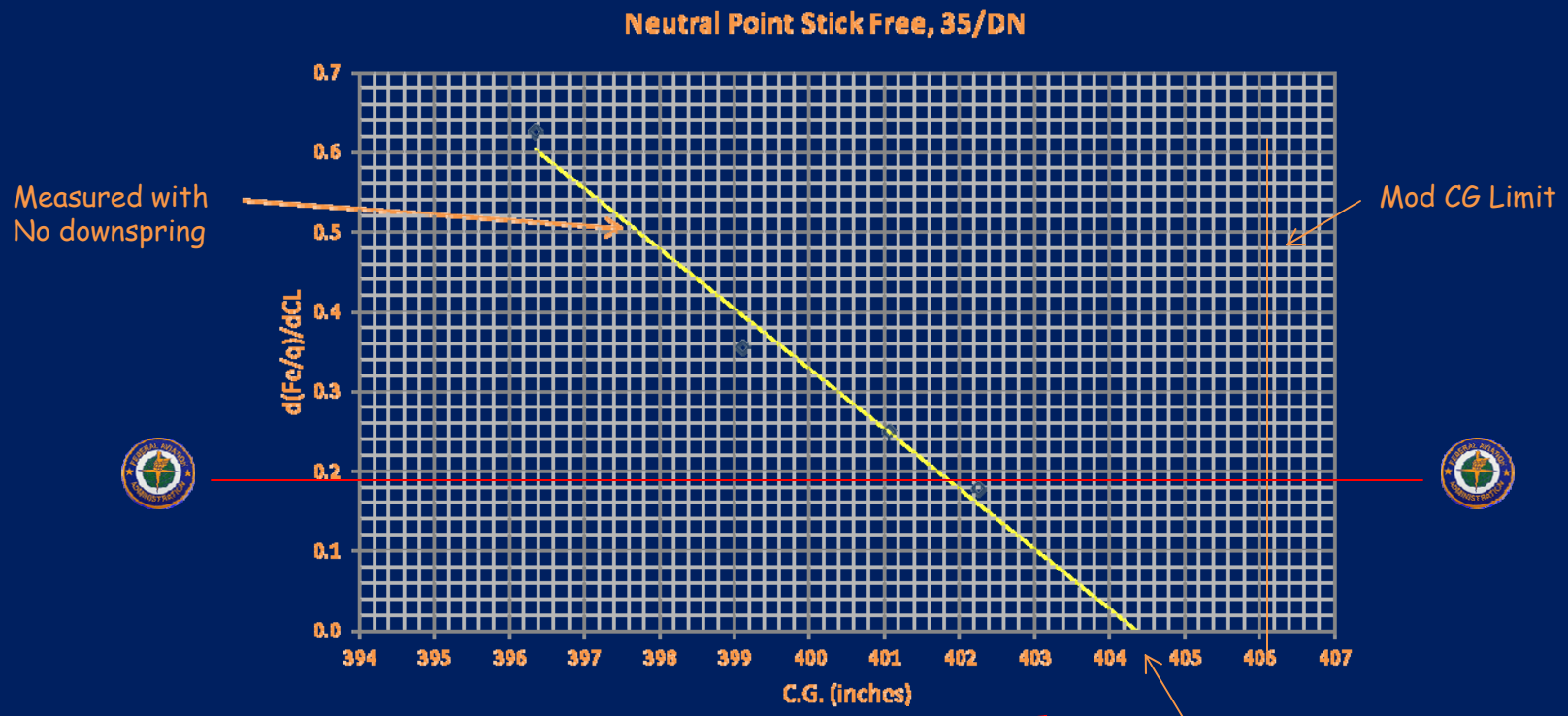
LONG – STAB IN PRACTICE



We're in trouble……

STRAKES ?

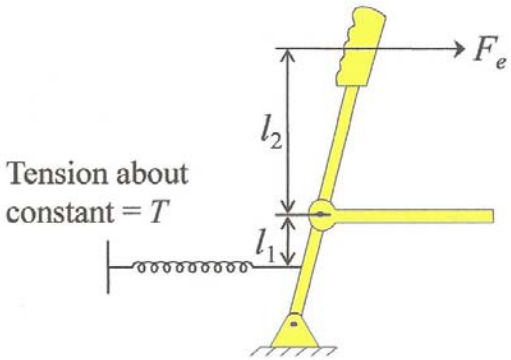
WHAT WAS THE REAL ISSUE ?

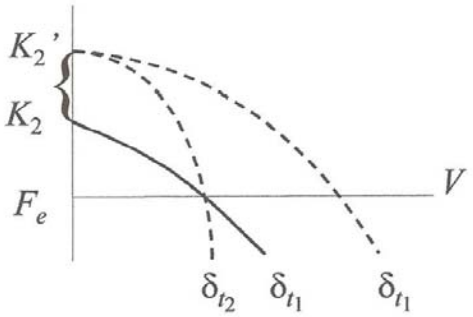
- LAT – DIR MEETING ALL REQUIREMENTS
- STALLS MEETING ALL REQUIREMENTS
- MAN – STAB MEETING ALL REQUIREMENTS
- ONLY ISSUE LEFT WAS LONG – STAB
  - DOWNSPRING (relatively easy)
  - BOB WEIGHT (relatively hard)

DOWNSPRING – IN THEORY

Altering Speed Stability using a Downspring

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





$$F_e = T\frac{l_1}{l_2} = K_3 \qquad F_e = K_1 V_e^2 + K_2 + K_3$$

- Extra tab required to offset K_3 which increases apparent stability

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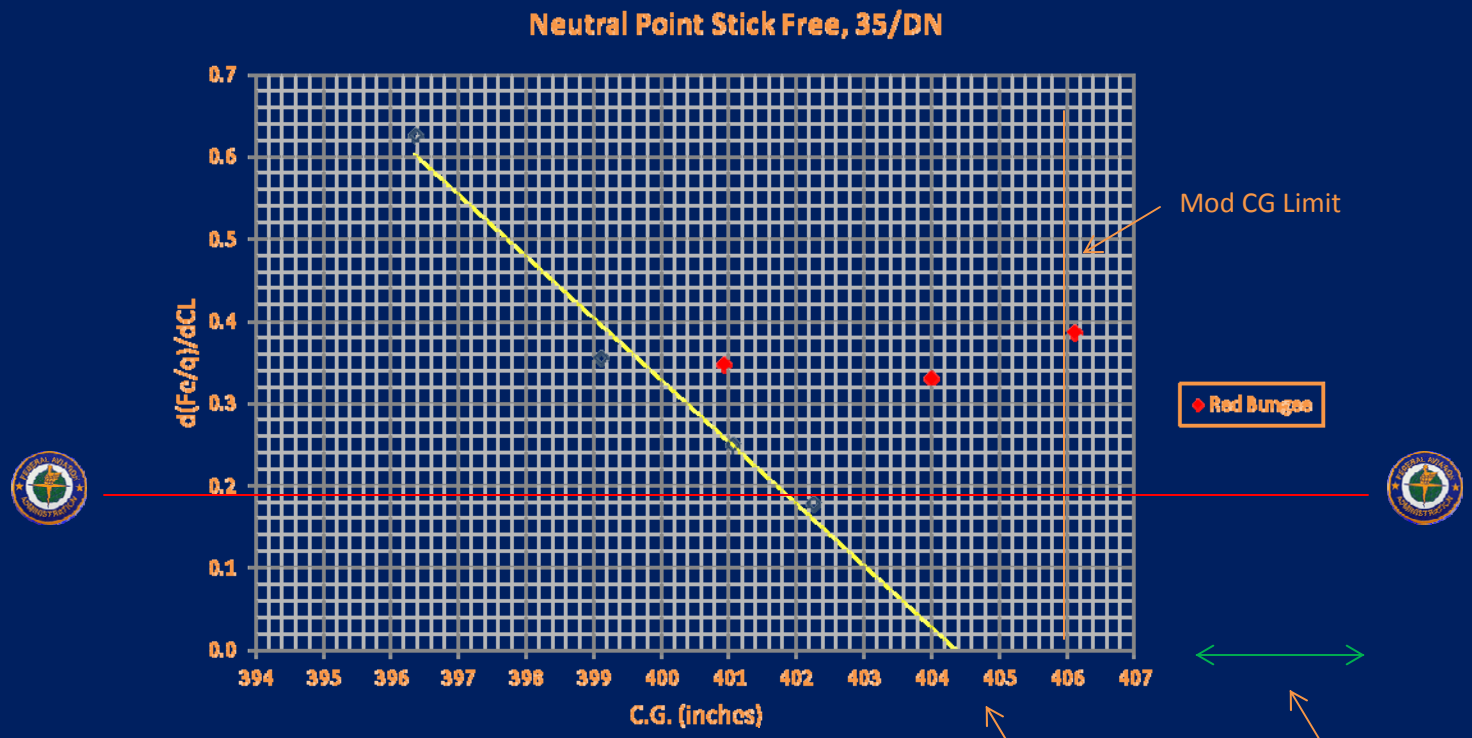
THE BUNGEE CHORD EXPERIENCE

DOWNSPRING – IN PRACTICE

BUNGEE CHORD EFFECT



Predicted
Neutral Point
No downspring

Neutral Point
Bungee = SAFE

DOWNSPRING – FINAL INSTALLATION

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 SCEDULING COMMITMENTS REQUIRE APPROPRIATE AIRWORTHINESS TEST SITE*
- *CONFIGURATION CONTROL / CONFORMITY PROCESS IS CRITICAL*
- *TESTING CRUNCH AT THE END*
- *Vmca TESTING SHOULD BE DEDICATED FLIGHTS*

QUESTIONS ?