

# 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 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.....



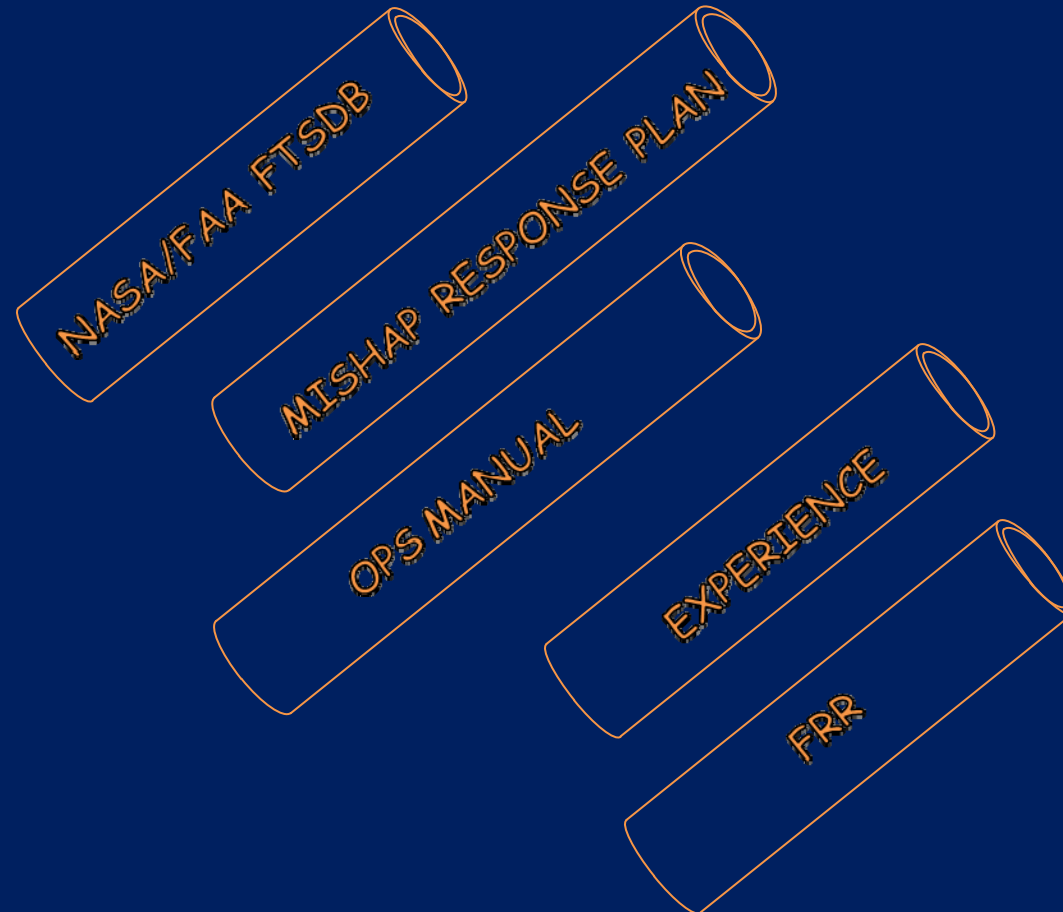
# A CASE STUDY OF SUCCESS

- 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



# TRICK: FLIGHT TEST OPERATIONS MANUAL

25 pages

## Table of Contents

- Introduction
- Administration
- Licensing and Competency
- Medical
- Operational Control
- Weather
- Emergency procedures
- Standard Operating procedures
- Operations Specifications

FAA Briefing Guide

Safety Significant Event (SSE) Form



# TRICK: FLIGHT READINESS REVIEW (FRR)

9 pages

## 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.



# TRICK: NASA/FAA FTSDDB

## 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  $1.2V_{s1}$ .
- 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.

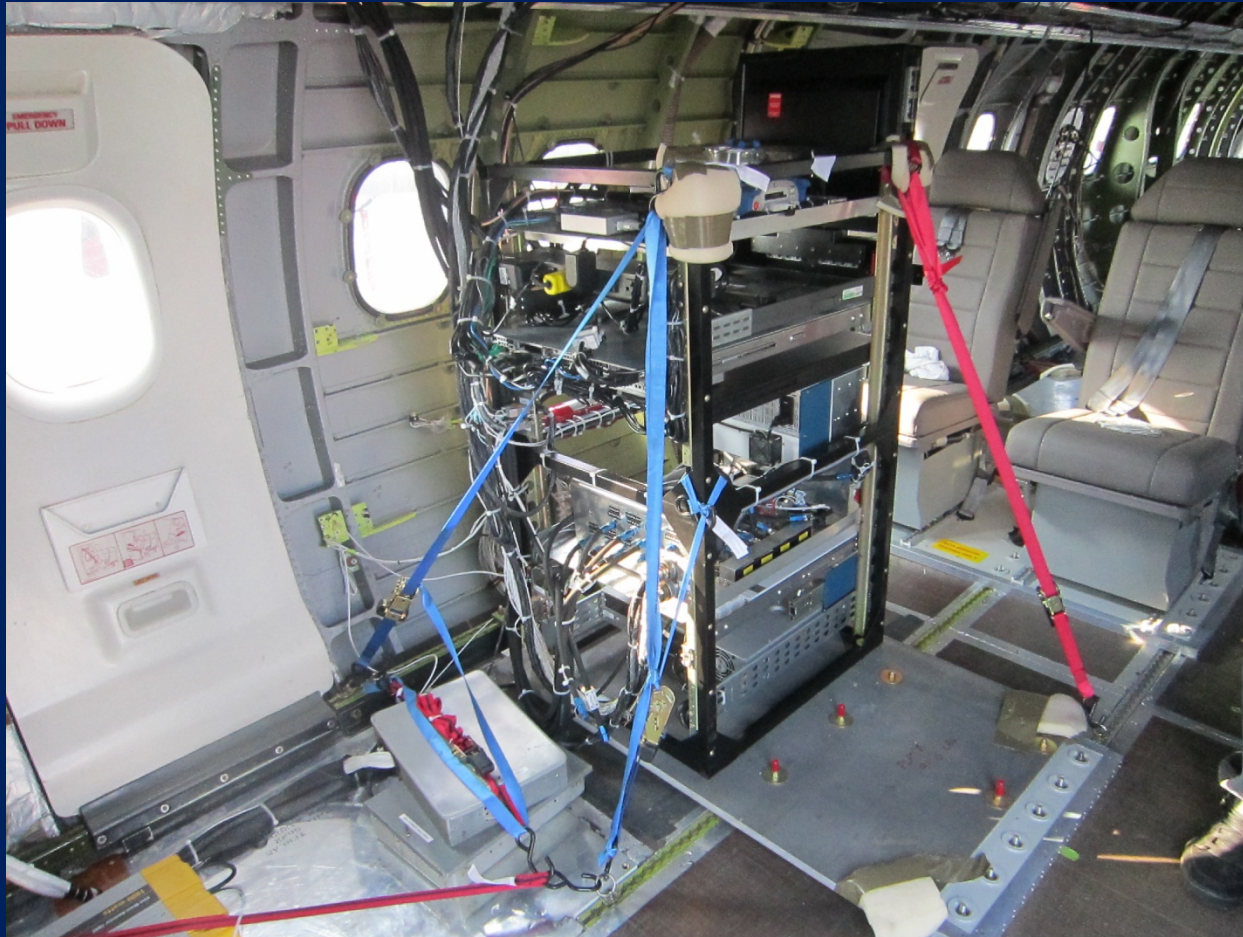




# TRICK: EXPERIENCE



# TRICK: EXPERIENCE





# TRICK: EXPERIENCE - SAFETY EQUIPMENT



# BASELINE AIRPLANE

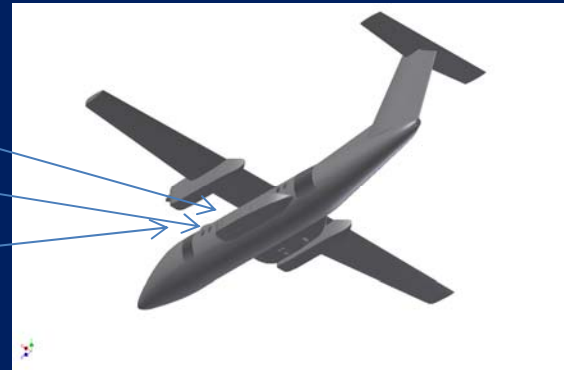


# CONCEPTUAL DESIGN



# EXPECTED ISSUES

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

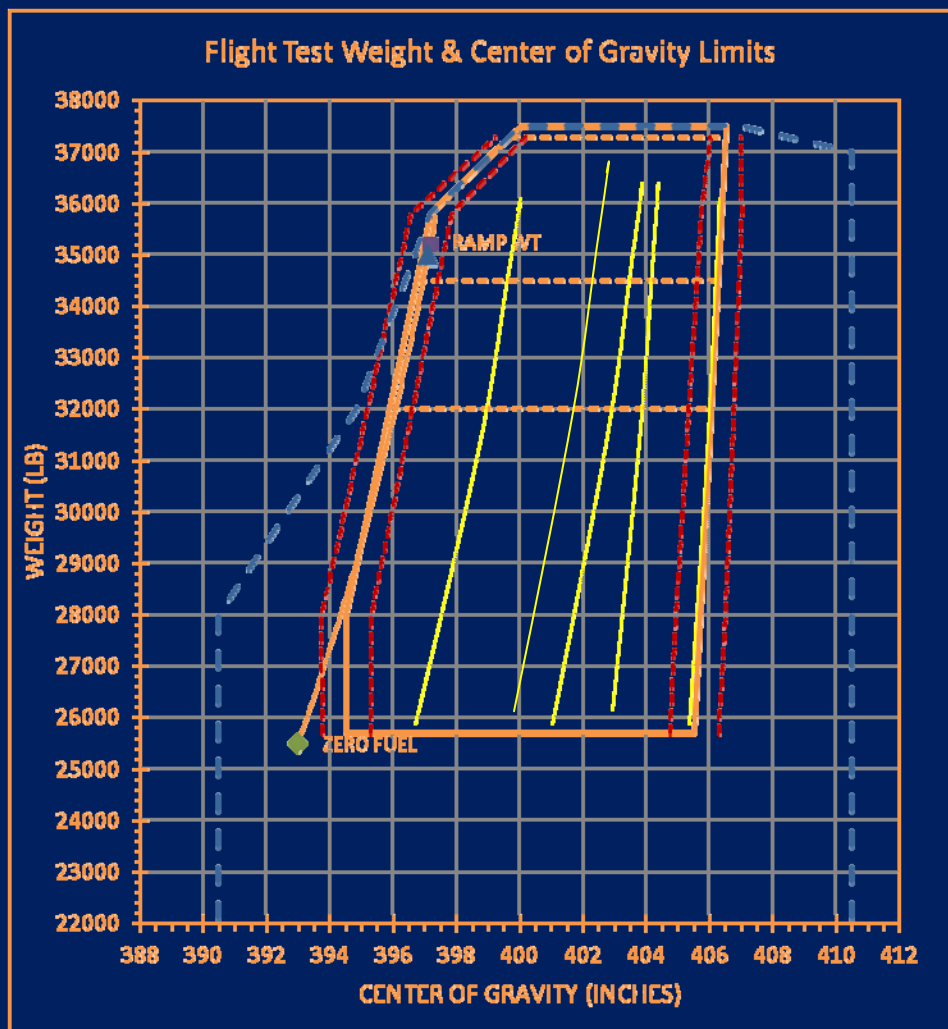




# MODIFIED AIRPLANE

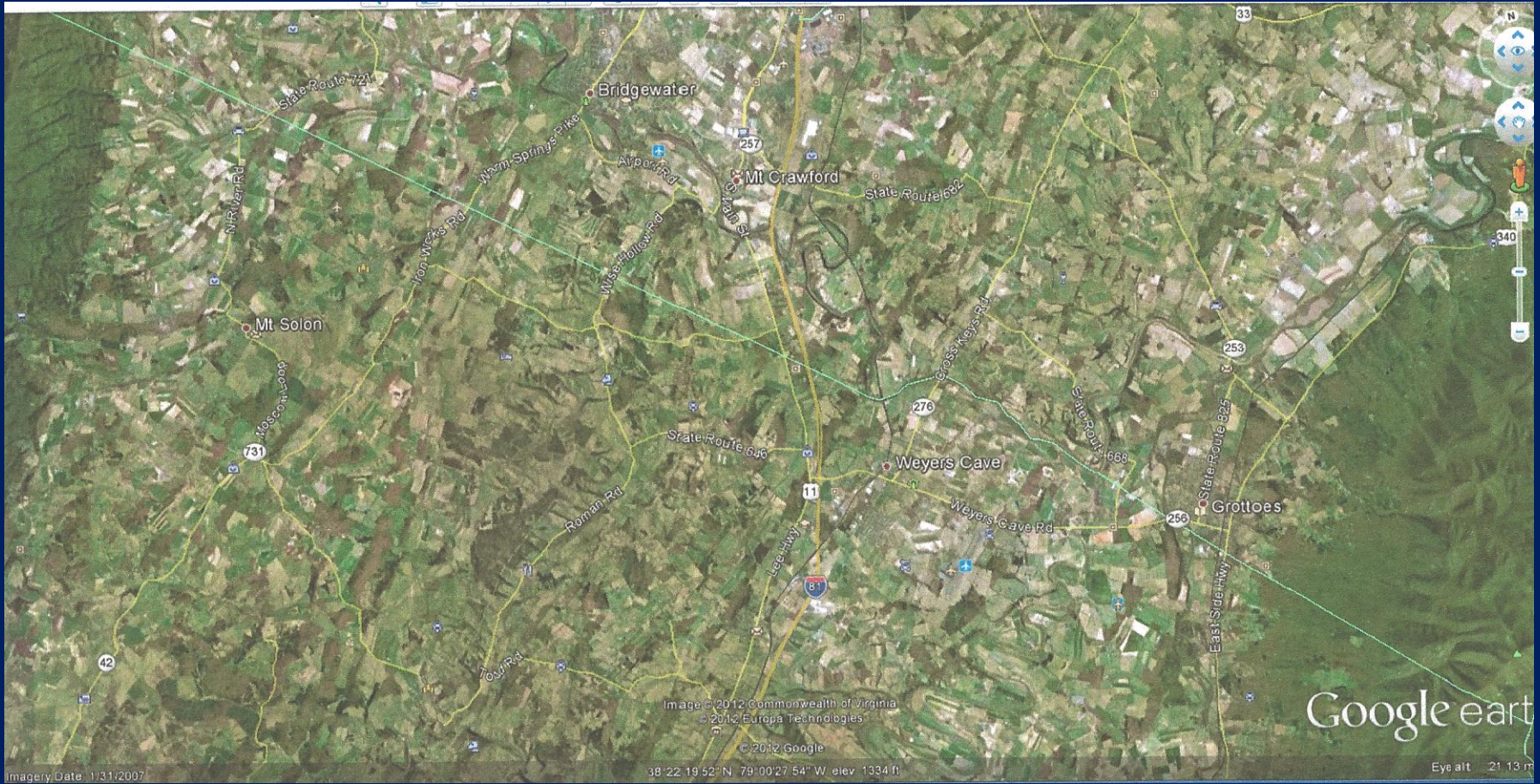


# ENVELOPE EXPANSION





# CHALLENGE - TEST SITE

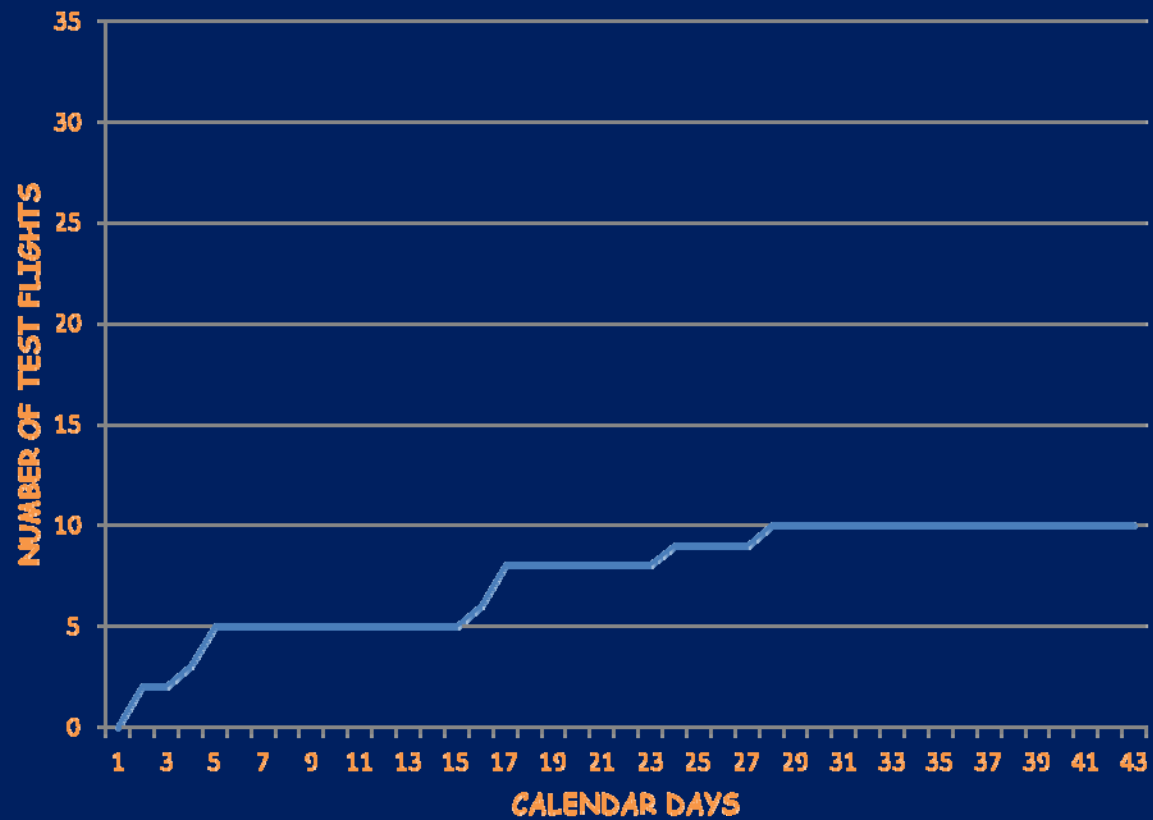


# CHALLENGE - TEST SITE

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

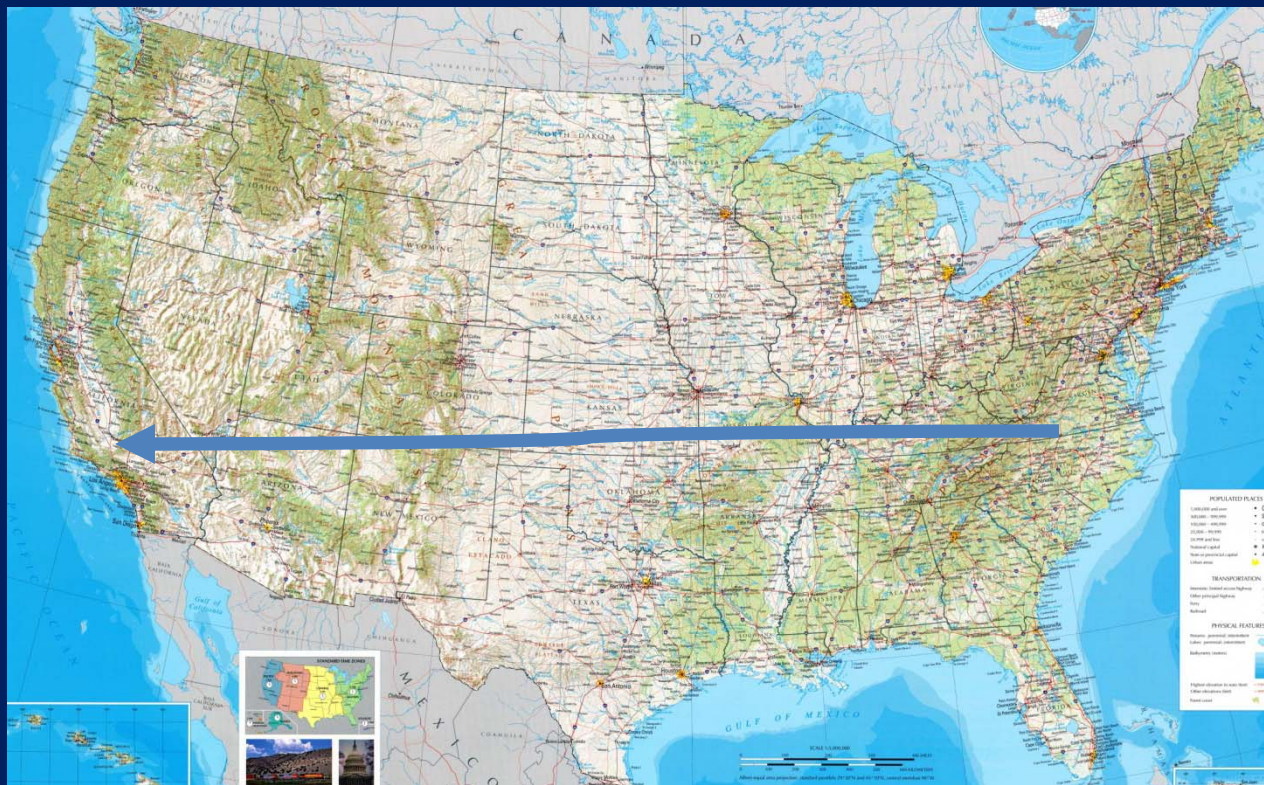


# FLIGHT TEST PROGRESS - ORIGINAL TEST SITE



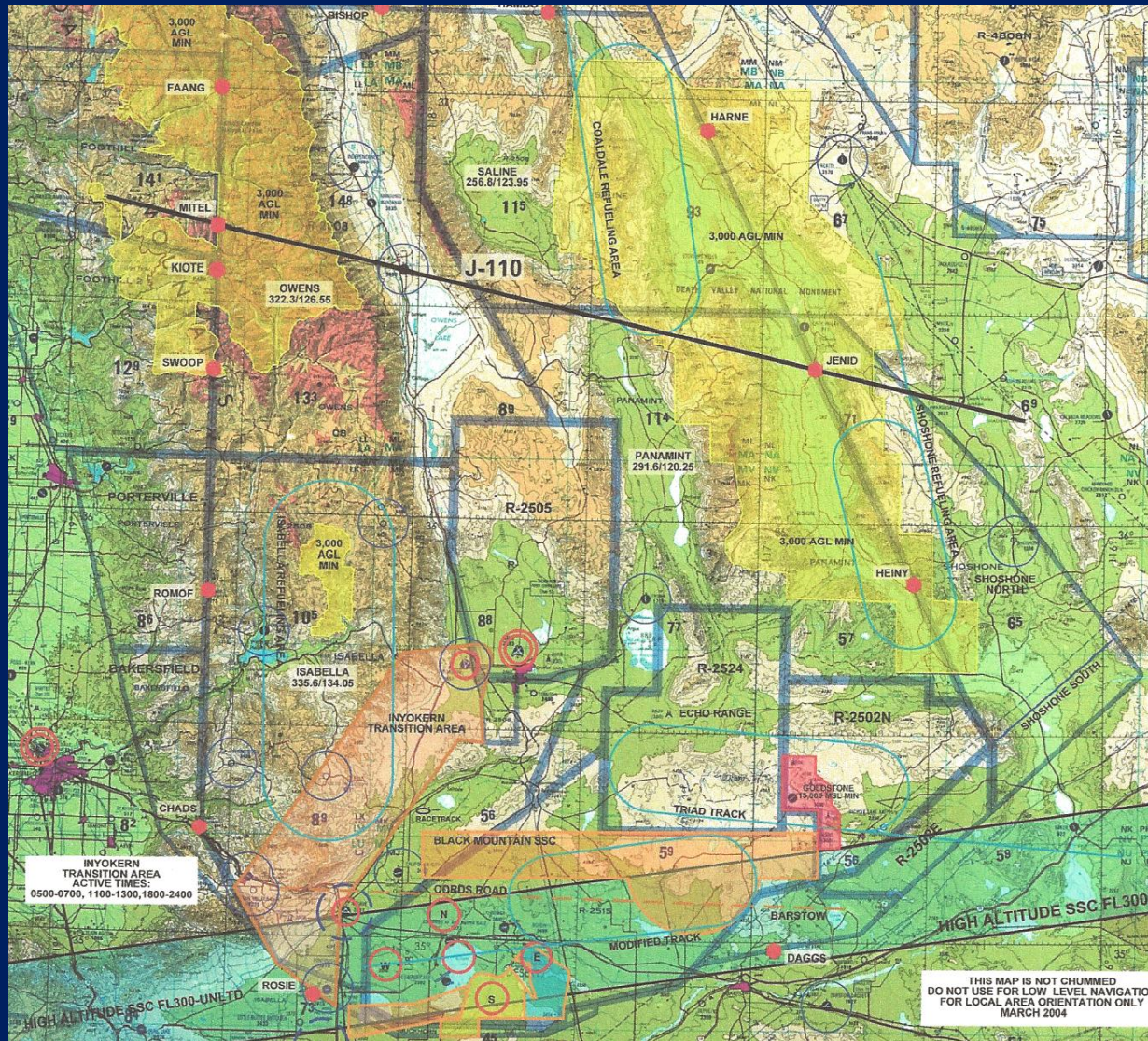


# DEPLOY !!!

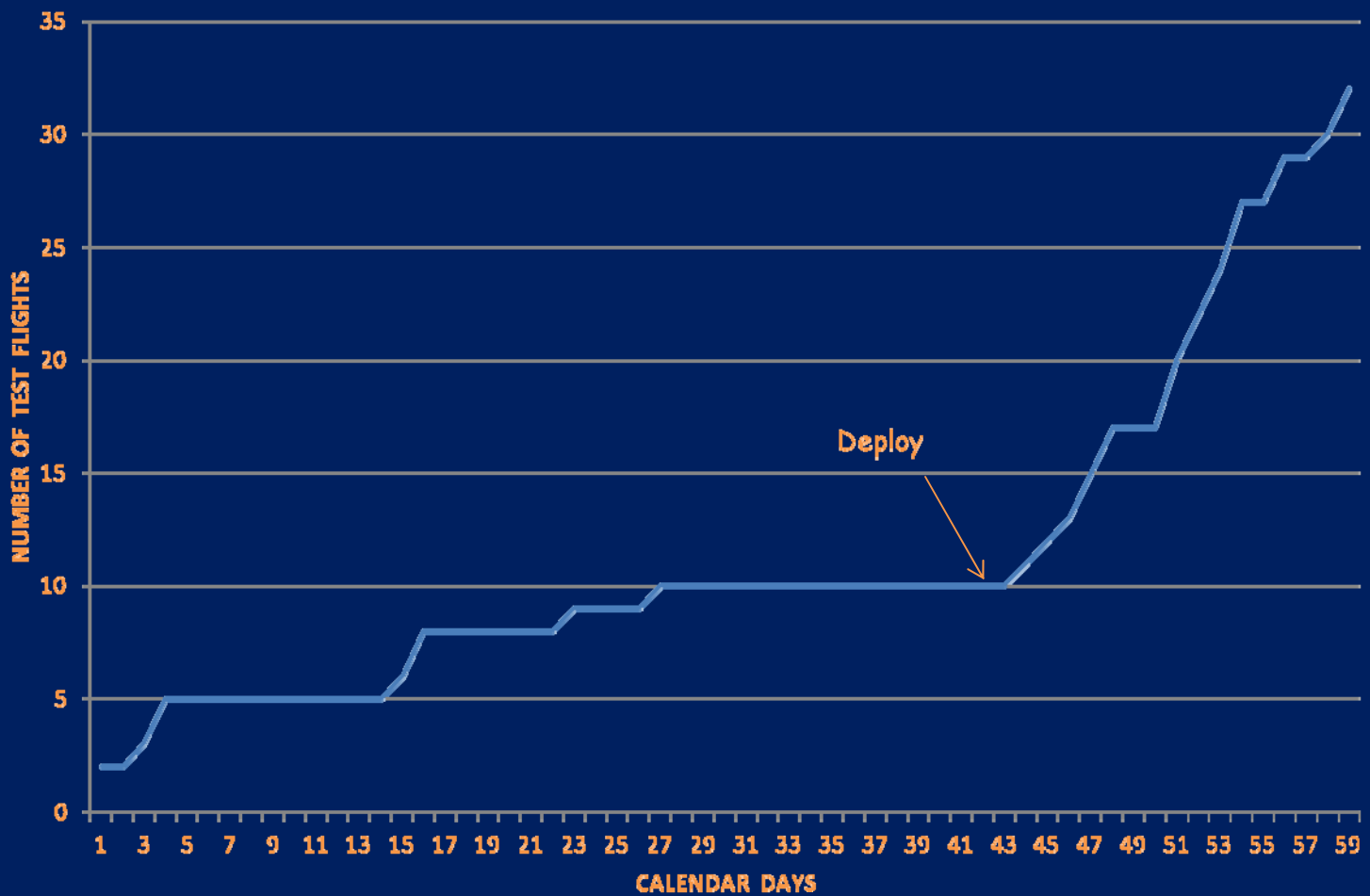




# BETTER TEST SITE



# FLIGHT PROGRESS



# LONG - STAB IN THEORY



## Measuring Stick Free Stability

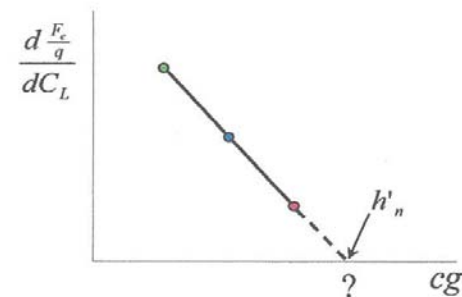
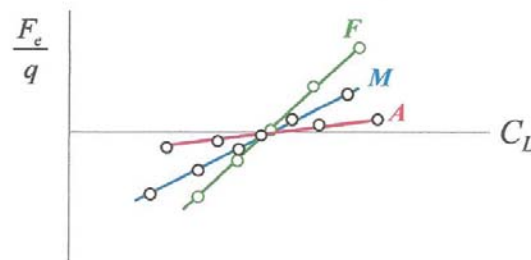
Dividing eqn  
3.34 by q gives

$$\frac{F_e}{q} = A(B + C_{h_{\delta_1}} \delta_1) - \frac{AC_L C_{h_{\delta}}}{C_{M_{\delta_e}}} \left[ \frac{dC_M}{dC_L} \right]_{free}$$

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

$$\frac{d \frac{F_s}{q}}{dC_L} = f \left[ \frac{dC_M}{dC_L} \right]_{free}$$

$$h'_n = cg \text{ position where } \frac{dC_M}{dC_L} \Big|_{stick \text{ free}} = 0$$

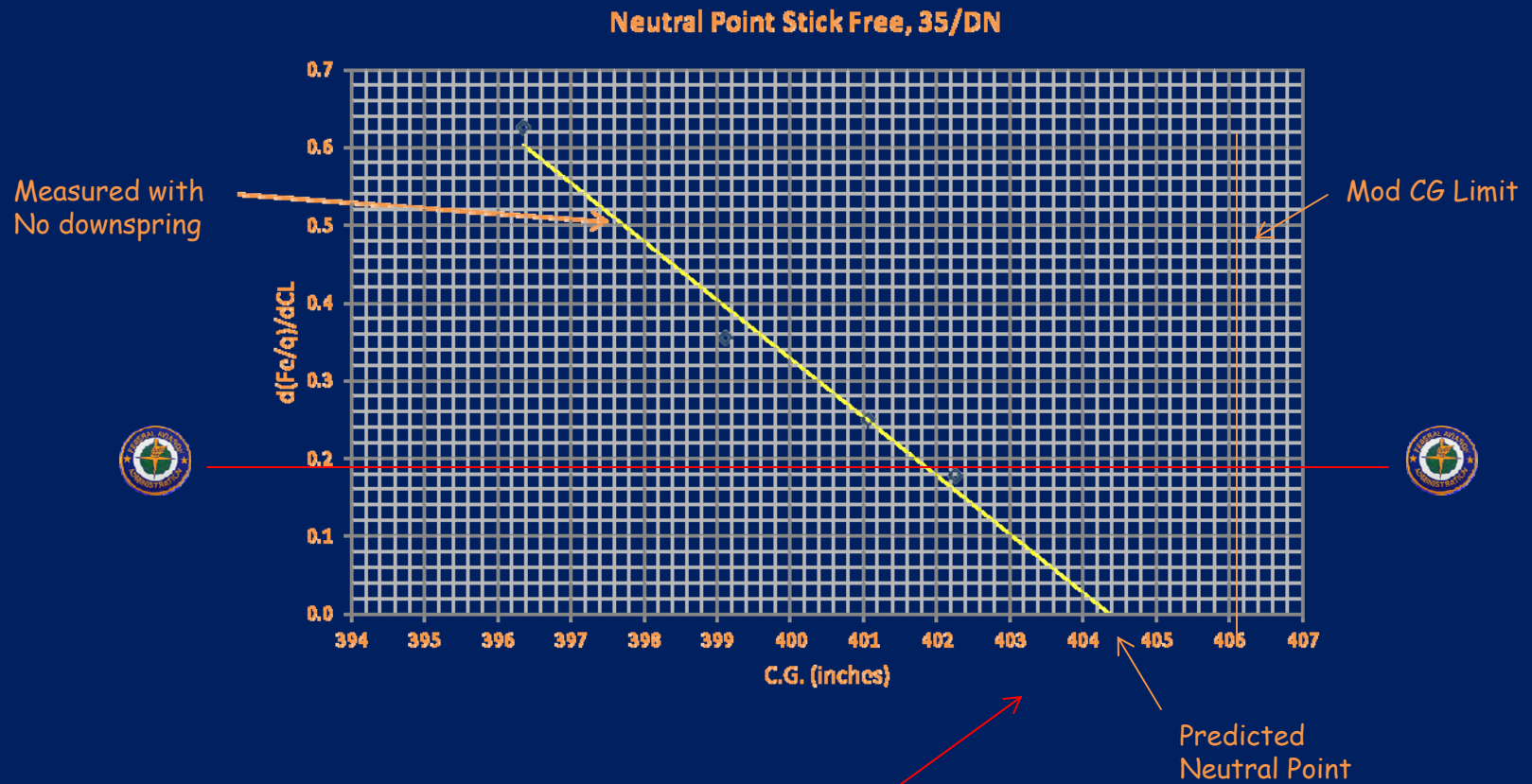


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# LONG - STAB IN PRACTICE



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)

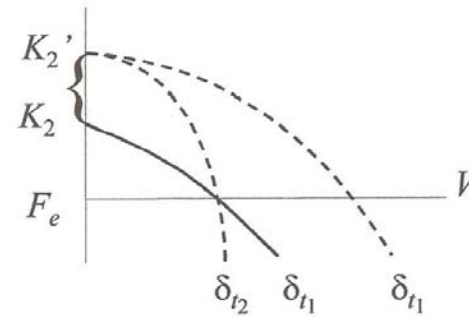
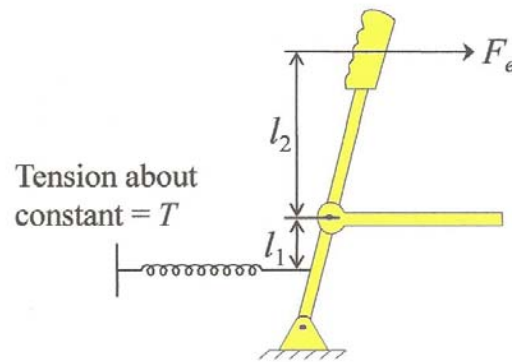


# DOWNSPRING - IN THEORY



## Altering Speed Stability using a Downspring

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



$$F_e = T \frac{l_1}{l_2} = K_3$$

$$F_e = K_1 V_e^2 + K_2 + K_3$$

- Extra tab required to offset  $K_3$  which increases apparent stability

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# THE BUNGEE CHORD EXPERIENCE

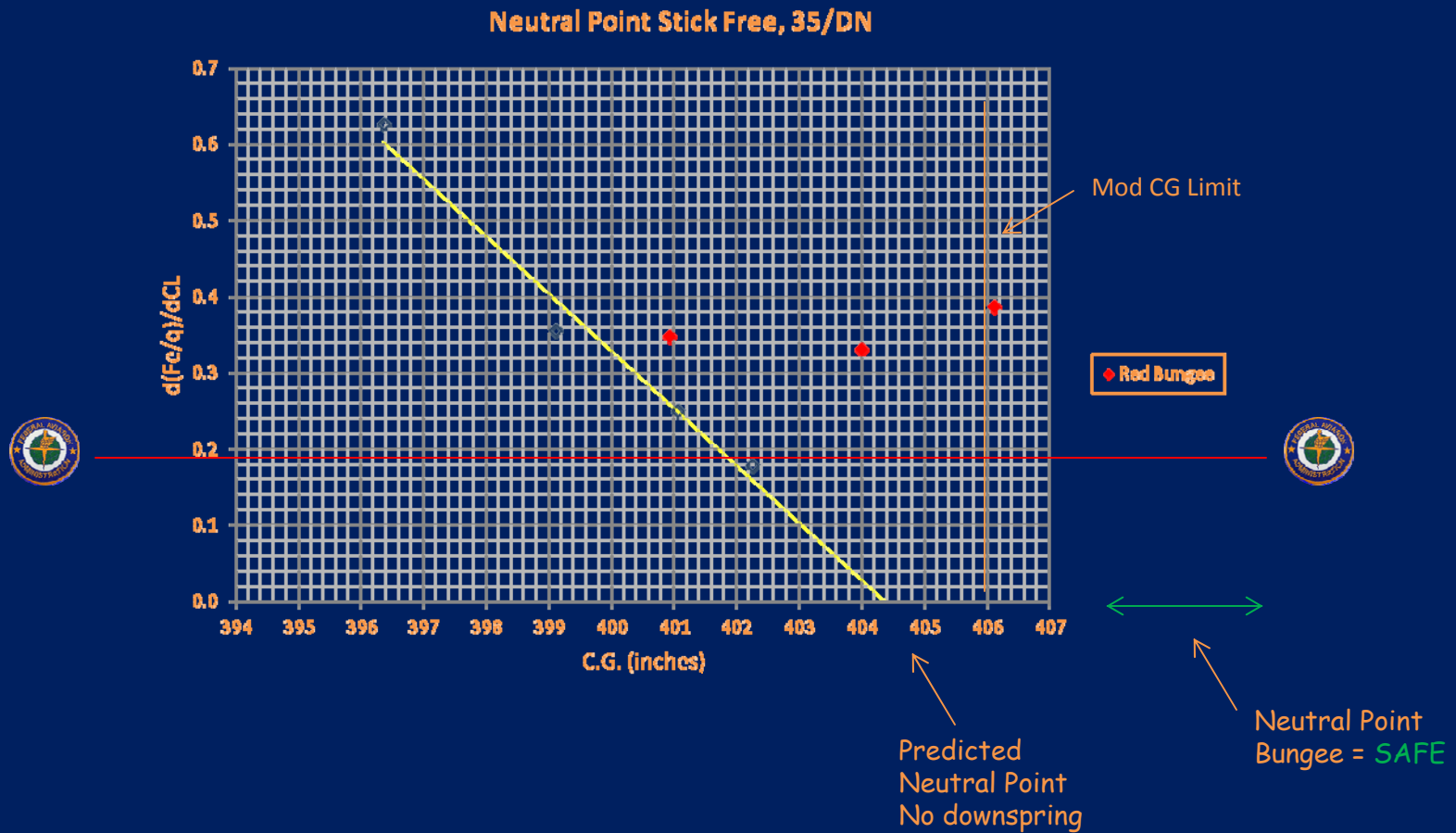




# DOWNSPRING - IN PRACTICE



# BUNGEE CHORD EFFECT



# 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  $V_{mo}$*
  - *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 ?

