
# *Flight Test Hazard Planning Near the Speed of Light*

*Bart Henwood*
*NASA Dryden*

*Rod Huete*
*FAA NY Office*

# Concept

- Hazard Centric database targeted at flight test hazards
- Appends related data and experience
- Hosted by NASA
  - Funded as research effort for a “Handbook”
  - Enabled/Expanded by web portal technology
  - Provides a government agency foundation

# Concept

- Based on “higher ethical ground”
- Vision is to look to knowledge management
- Considered a “Professional’s” database
- Test community orientation
- Disclaimer protected
- Public accessible data (no sign in required)
- Meaningful/tailored results

# Portal Content

- Essentially 4 Data Sections
  - Hazard Info
  - Application Data (Test Reports, videos, etc…)
  - Reference Data (Definitions, acronyms, Safety Review Board Concepts, HR processes, …
  - Test Community Partners & Expert Contact Info
    - Gov't, Industry, Consultants, …
    - Self declared capability – no gov't

# Activity to Date

- NASA funding development of web portal (~$900K to date)
  - April 07: Initial core capability on existing NASA web structure
    - 132 records for FAR Part 25
    - Ability to search across hazard records
- NASA facilitating generation of FAA, FAR Part flight test certification hazard data
  - FAA Providing Funding ($165K per year)
  - Continuing effort; National TPS sub-contractor

# FTS DATABASE UPDATE
# FAA PROGRAM

Presented to: FTSW

By: Rod Huete, FAA

Date: May, 2007

# OUTLINE

- Risk Management Initiatives
- Part 21 Changes
- Concept for use of Database

# FAA Flight Test Risk Management

- As a safety organization we promote best safety practices during certification flight tests
  - We published FAA Order 4040.26A in 2001
  - However, FAA Order 4040.26A is incomplete as a tool for Flight Test Risk Management
  - We are taking a corporate approach to further improve flight test safety by:
    - Modernizing our CFR 14 Part 21 Requirements for flight test safety
    - Providing the tools to implement risk assessments

# PART 21 CHANGES

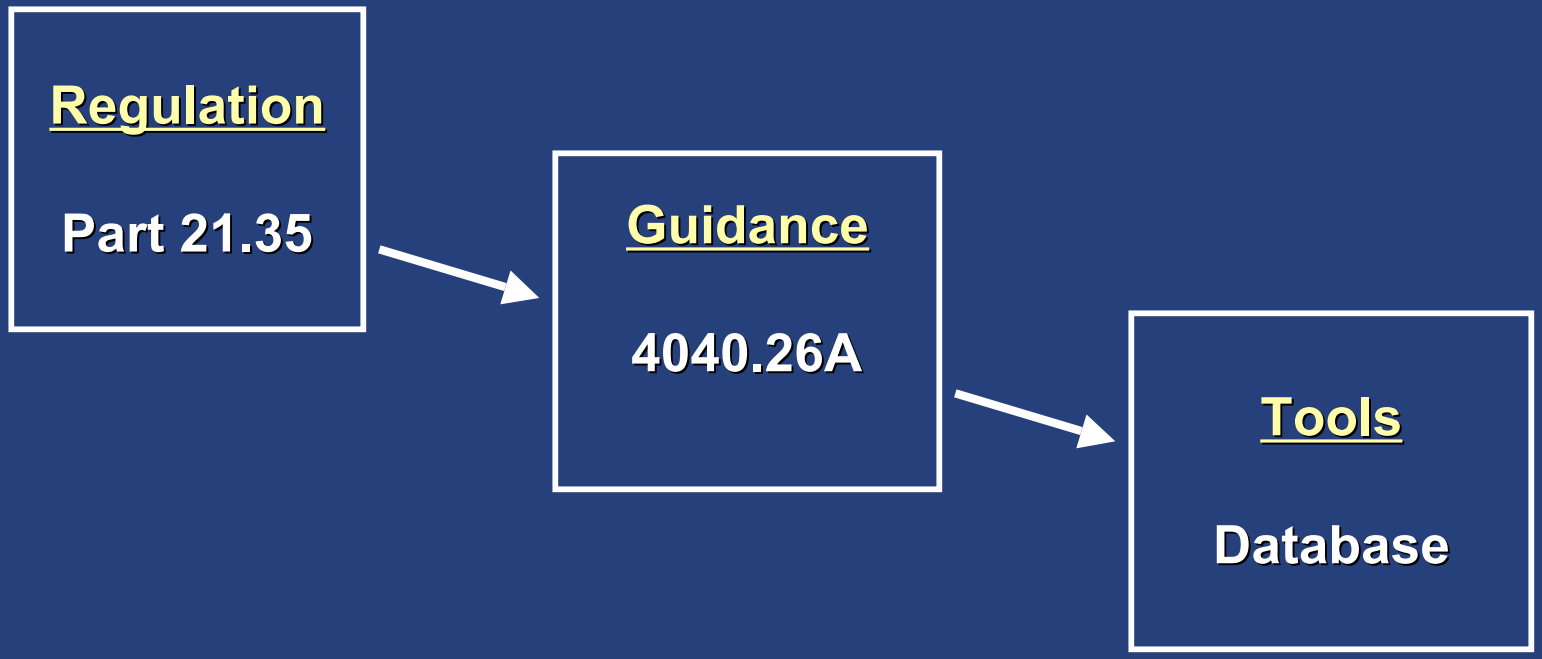
# CFR 14 Part 21.35 Current

- Para (d) only requires parachutes and emergency egress provisions for certification flight tests
- Para (e) *excludes* gliders and manned free balloons in pilot decision to discontinue flight test due to hazards
- These rules are severely outdated

# CFR 14 Part 21.35 Proposed Changes

- Para (d) will require a Risk Assessment (may include parachutes and/or emergency egress)
- Broader in scope and in line with industry standard
- Para (e) will *include* gliders and manned free balloons in pilot decision to discontinue flight test due to hazards
- Unknown why these were excluded
- Immediately Adopted Rule (IAR) expected in 2007

# CONCEPT

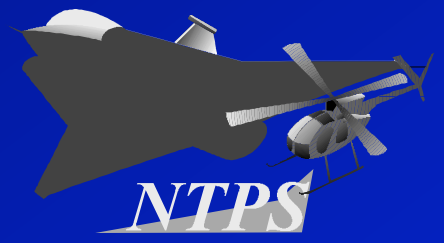


# Database

- FAA needs a database to complete the process
- We joined forces with NASA's lessons Learned Handbook process
- We established an MOU with NASA
- NASA contracted with NTPS for populating the data
- We provided funding for initial data development for civil certification CFR Parts 23, 25, 27, 29, 31
- Part 25 THA's "complete"
- Part 23/27/29/31 under construction

# An Online Resource for Flight Test Safety Planning

**Greg Lewis**
*National Test Pilot School*



## Test Hazard Analysis Worksheet

**Test Title:**

**Aircraft/System:**

| Hazard Category | Subjective Probability of Occurrence | | | | |
|---|---|---|---|---|---|
| | high | probable | uncertain | remote | improbable |
| catastrophic | | | | | |
| critical | | | | | |
| marginal | | | | | |
| negligible | | | | | |

**Hazard:**

**Cause:**

**Effect:**

**Minimizing Procedures:**

**Emergency Procedures:**

**Risk Level** (after minimizing procedures taken into account):
High ____ Medium ____ Low ____X____

Hazard

Cause

Effect

Minimizing Procedures

EP's

Residual Risk

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# Data Gathering

- NTPS THA's
  - Demonstration of classic Flight Test Techniques
  - Conservative limits
- Added inputs from the FAA
  - Aircraft Certification Offices in New York and Atlanta
- Next collected data from manufacturer's
  - Boeing Long Beach, Gulfstream, Lockheed, Bombardier, Cessna, Raytheon, Boeing Seattle, Schweizer, Tiger, Boeing Rotary Systems, New Piper and Sikorsky
  - data still coming in
- All existing safety planning info, freely shared



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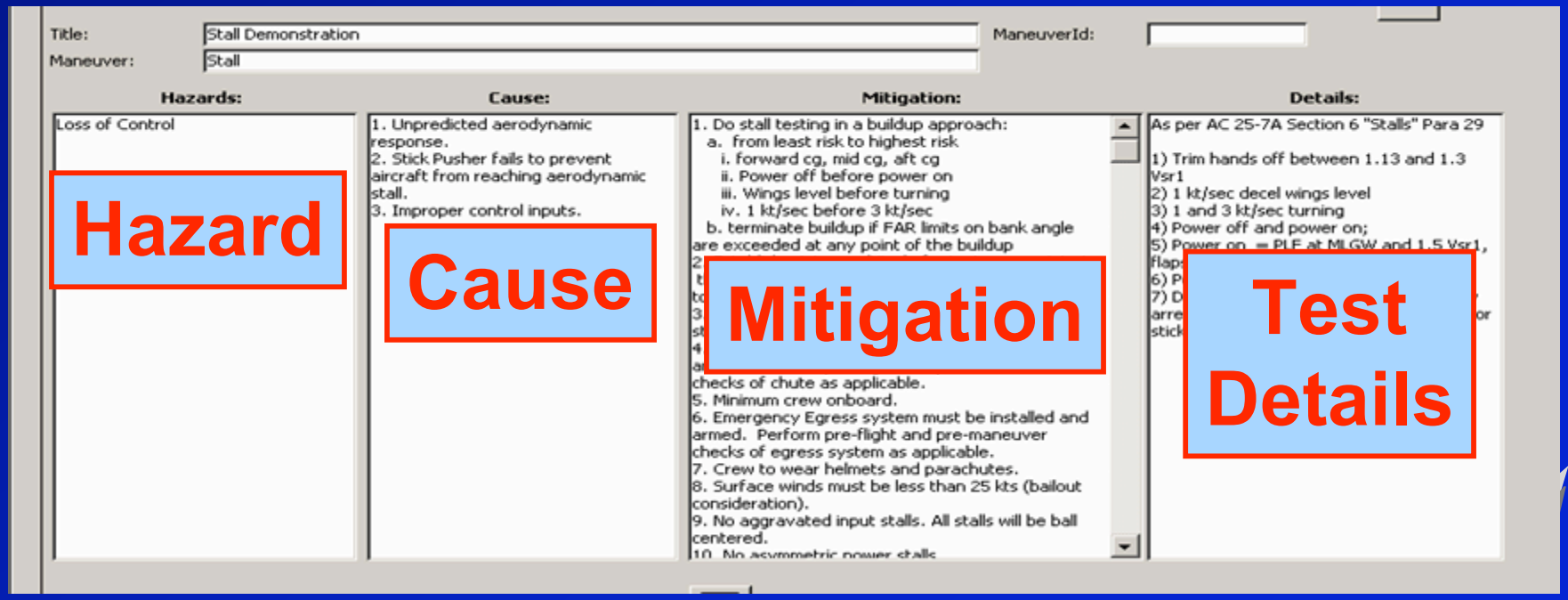
# NTPS Role

- After gathering data
  - We put the data into a common format
  - Not asking industry to change their process
    - just share what they have



# NTPS Role (cont'd)

- Too many ways of saying nearly the same thing
- "Mature" the data
  - To make the database useful to a user, there must be some integration of inputs
  - Mitigations consolidated by
    - Hazard (e.g. Loss of Control) and by
    - Maneuver (e.g. Stalls)
  - Mine the data to:
    - Extract the unique safety suggestions in each area
    - Remove duplication
    - Make the database easier to use

# Example Maturation

## Part 25 Stall Hazards

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# Many Varied Inputs

- Six different organizations submitted inputs for stalls
- Total of 66 different THA's
  - M
- Used
- Used
- A pl
- Hun
  - Again many were redundant

"There is a risk of stall/departure from controlled flight when increasing angle-of-attack at low airspeeds."



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# Matured Stall Hazards

- **In the end, six stall hazards were identified**
  1. **Loss of control**
  2. **Loss of operating engine(s)**
  3. **Stall/spin chute fails to deploy**
  4. **Stall/spin chute fails to jettison when commanded**
  5. **Recovery chute uncommanded deployment**
  6. **Departing runway surface**

     **(During ground test of stall spin chute)**

# Loss of Control Mitigations

- "Loss of Control" mitigations matured into just twelve
- The matured mitigations include:

1. Do stall testing in a **buildup approach**:
   a. from least risk to highest risk
      i. forward cg, mid cg, aft cg
      ii. Power off before power on
      iii. Wings level before turning
      iv. 1 kt/sec before 3 kt/sec
   b. **terminate buildup** if FAR limits on bank angle are exceeded at any point of the buildup



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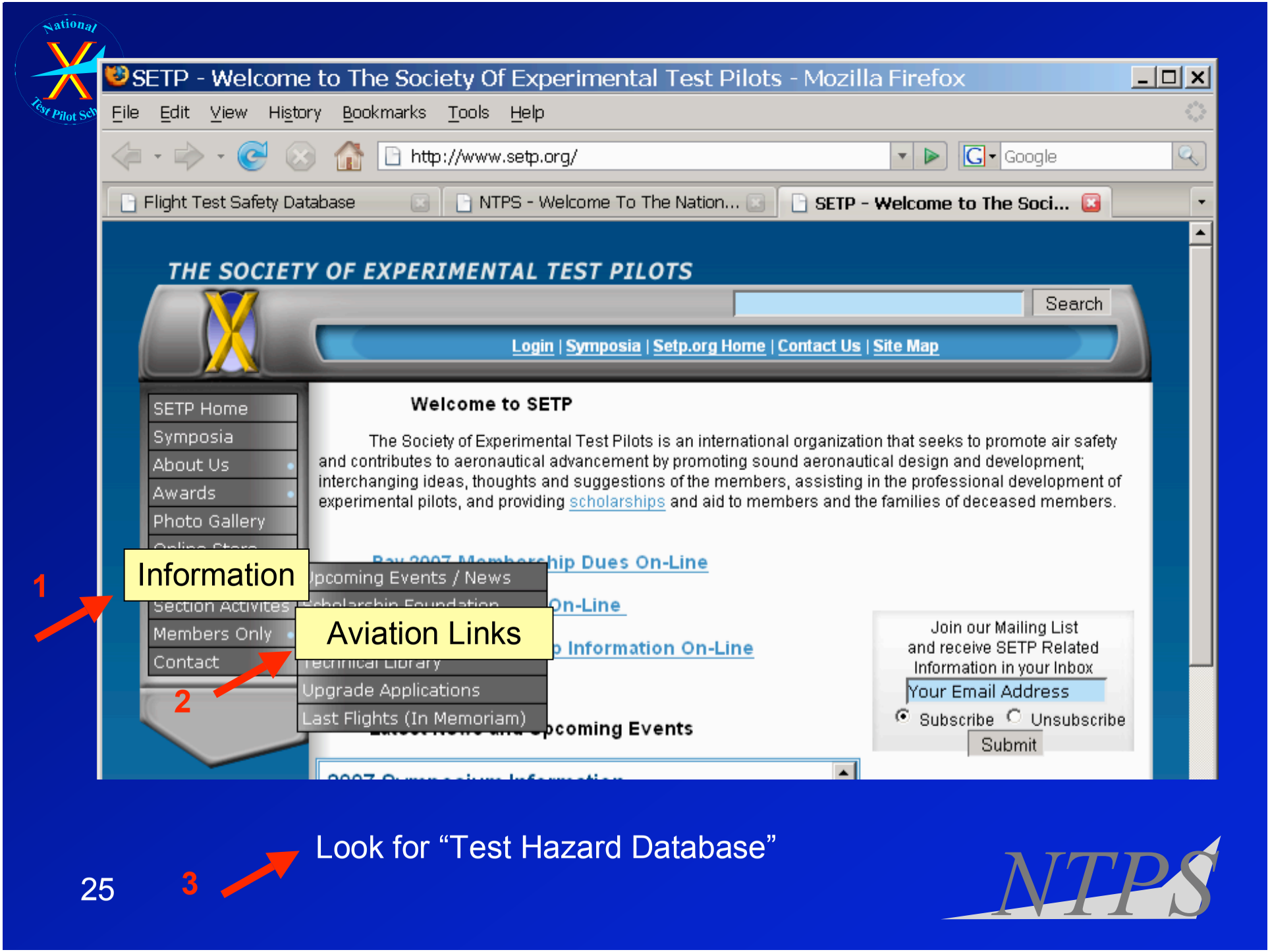
# Mitigations (continued)

2. Establish minimum altitudes for:
   a. entry,
   b. recovery initiation,
   c. recovery chute deployment and
   d. manual bailout.
3. Perform pre-flight checks of stall warning and stick pusher, as applicable.
4. Anti-spin chute must be installed, functional and armed. Perform pre-flight and pre-maneuver checks of chute as applicable.
5. Minimum crew onboard.
6. Emergency Egress system must be installed and armed. Perform pre-flight and pre-maneuver checks of egress system as applicable.

# Mitigations (continued)

7. Crew to wear **helmets and parachutes**.
8. **Surface winds** must be less than xx kts (parachute dependent).
9. **No aggravated input stalls**. All stalls will be ball centered.
10. **No asymmetric power** stalls.
11. If departing controlled flight retard **throttles to idle and centralize controls**.
12. **Do not add power** during recovery until airspeed is increasing above 1.2 Vs.




3 → Look for “Test Hazard Database”



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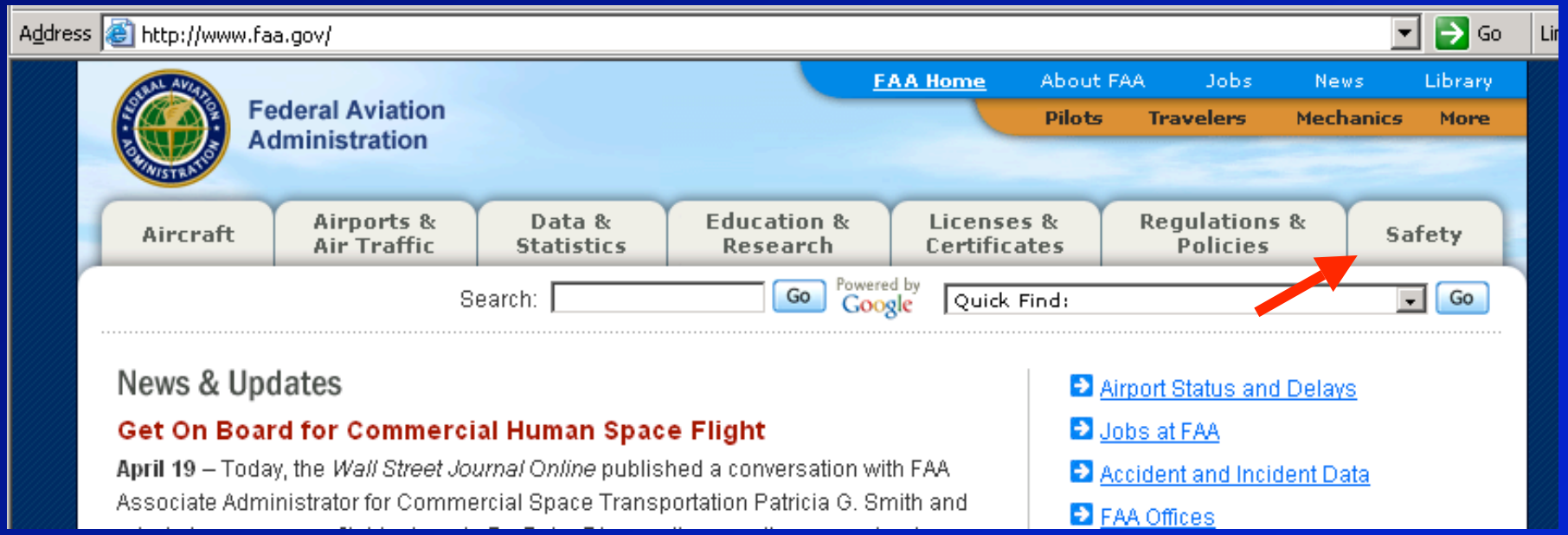
# FAA Access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April 19 – Today, the Wall Street Journal Online published a conversation with FAA Associate Administrator for Commercial Space Transportation Patricia G. Smith and
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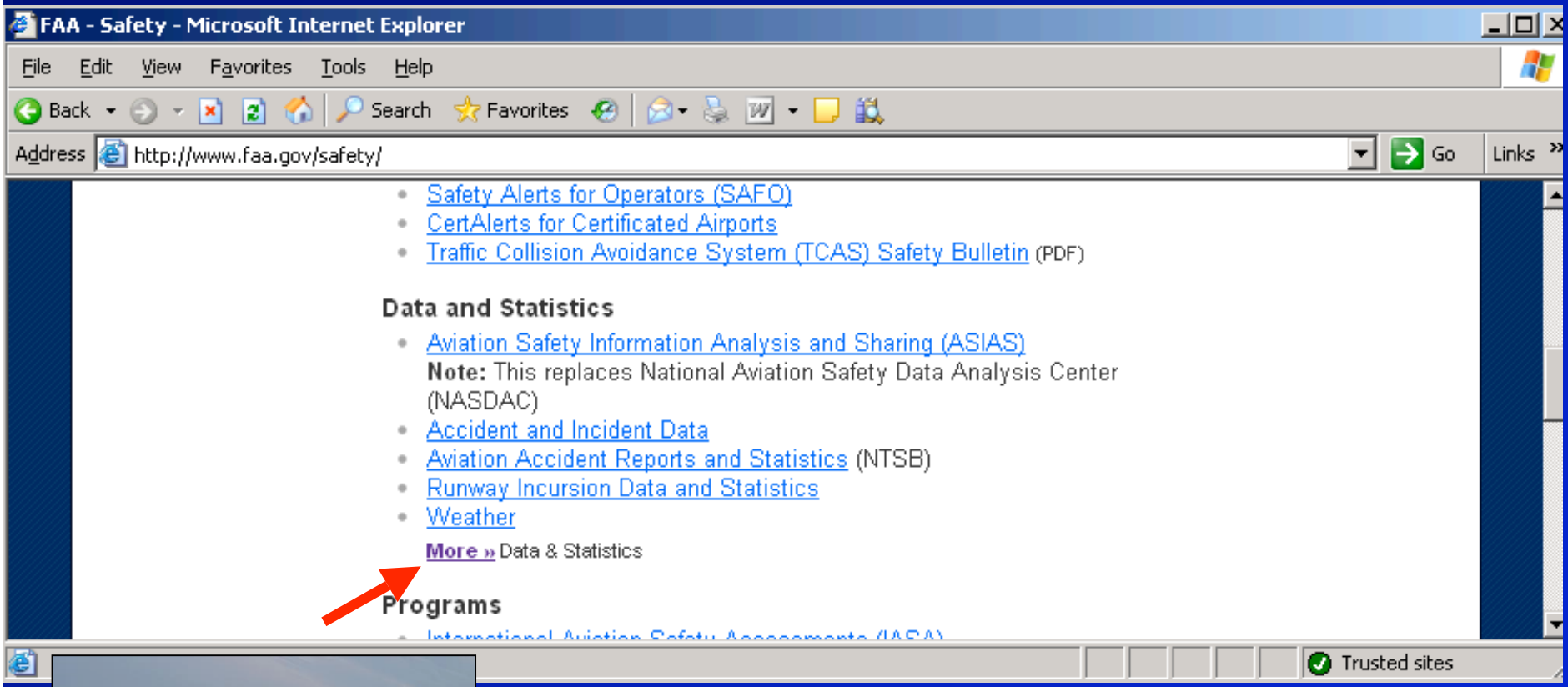
Jobs at FAA
Accident and Incident Data
FAA Offices

# FAA Access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Go Links
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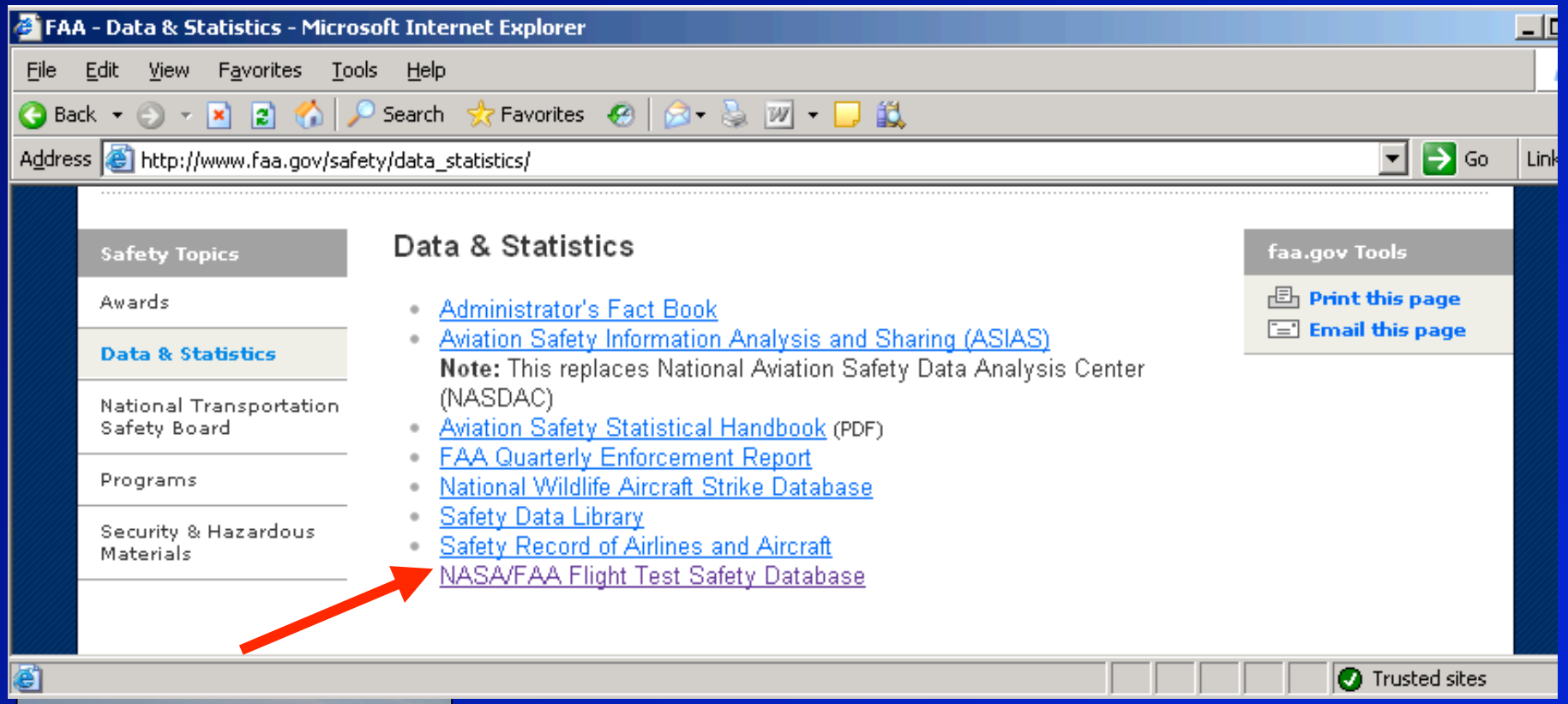
CertAlerts for Certificated Airports
Traffic Collision Avoidance System (TCAS) Safety Bulletin (PDF)
Data and Statistics
Aviation Safety Information Analysis and Sharing (ASIAS)
Note: This replaces National Aviation Safety Data Analysis Center (NASDAC)
Accident and Incident Data
Aviation Accident Reports and Statistics (NTSB)
Runway Incursion Data and Statistics
Weather
More » Data & Statistics
Programs
Trusted sites

# FAA Access

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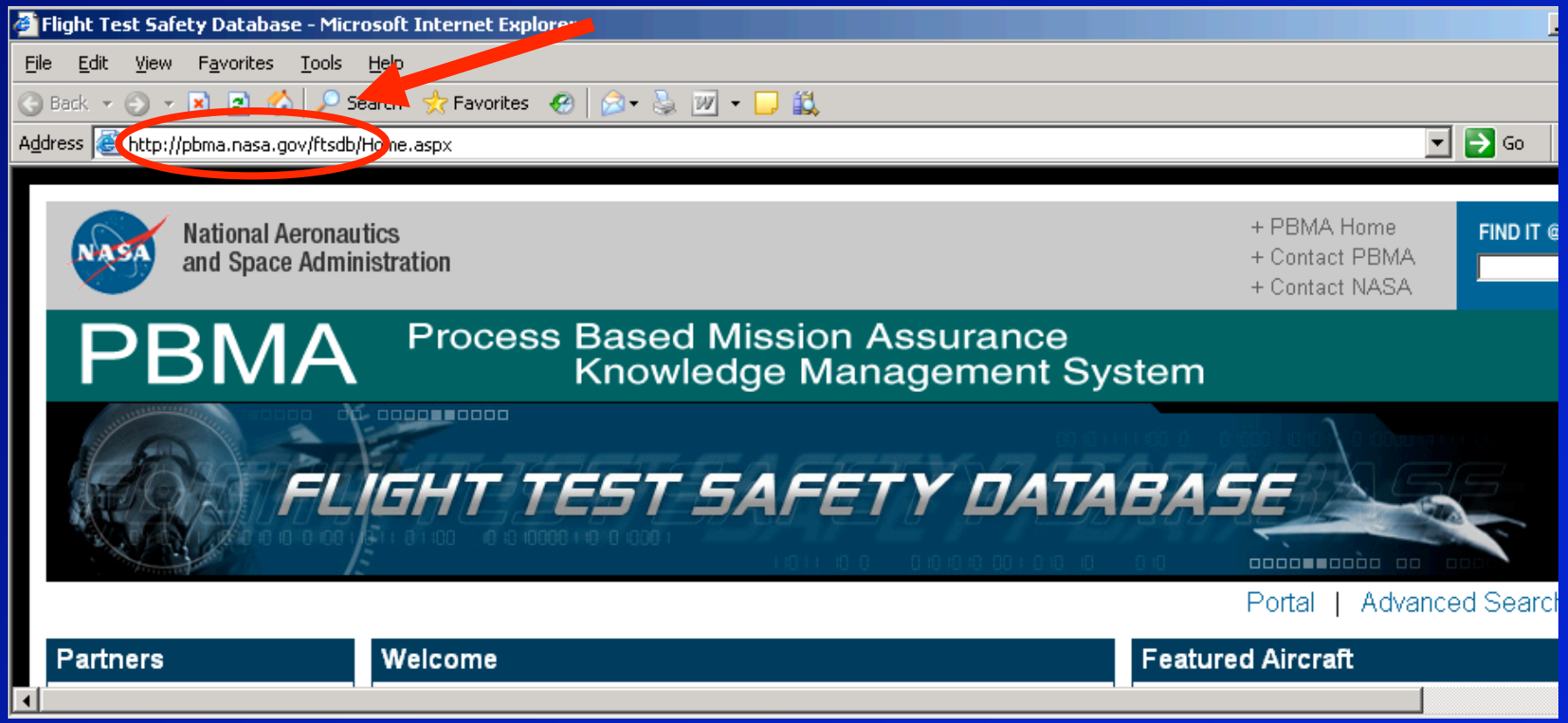
# NASA PBMA Website Link

http://pbma.nasa.gov/ftsdb/home.aspx



http://pbma.nasa.gov/ftsdb/

PBMA Process Based Mission Assurance Knowledge Management System

FLIGHT TEST SAFETY DATABASE

Portal | Advanced Search

**Partners**

NAVAIR

**Welcome**

For years the International Flight Test community has had a need for easy access to flight test maneuver descriptions, test hazards, and hazard mitigation techniques. This portal is a step in that direction, and builds on similar efforts by the Flight Test Safety Committee, the Society of Experimental Test Pilots, and the Society of Flight Test Engineers, and other professional organizations. Our objective is to identify and document hazards and mitigations associated with flight testing and provide a compilation of the flight test industry's corporate knowledge regarding flight test safety risk assessment. Where applicable, the database cross-references FAR guidance from Parts 23, 25 and other flight-test-related sections. It also discusses typical industry risk levels assigned to specific types of tests. All data has been reviewed by at least two persons with extensive Flight Test and/or Aviation Safety Experience. We hope you find this tool helpful, and solicit your feedback and contributions as we work to keep it up to date.

**Featured Aircraft**

**Enter Portal Here**

Use of the FTSDB Portal does not require you to register and login. However, as this Portal evolves, registration will provide you with a number of benefits in relation to what you can access and view in the Portal, as well as customization and privileges.

Please enjoy the Portal as our guest and come back often to see what new features have been added.

**Nonregistered users** enter **Portal** here

**Registered User Sign In (optional)**

User Name:

Password:

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**Last Update of Test Hazard Analyses**

4/20/2007

National Aeronautics and Space Administration

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+ Site Map
+ Contact PBMA
+ Contact NASA

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# PBMA Process Based Mission Assurance Knowledge Management System

## FLIGHT TEST SAFETY DATABASE

Gregory Lewis

Home | Portal | Search | Change Password | Log out

### Reference Materials

- Acronyms
- Terminology
- Centers of Expertise
- Awareness and Safety Review Process
- FAR Parts
- Subject Matter Experts (SMEs)

### Hazard Search

Search Hazard Information from FAA Certification (FAR), Military Development, and Research data

Search Page

### FTSDB Key-Word Search

Keyword Search Page

### Announcements and Meetings

Annoucements

### Favorites

Favorites

### Data Submission

Submit Additional Flight Test Data

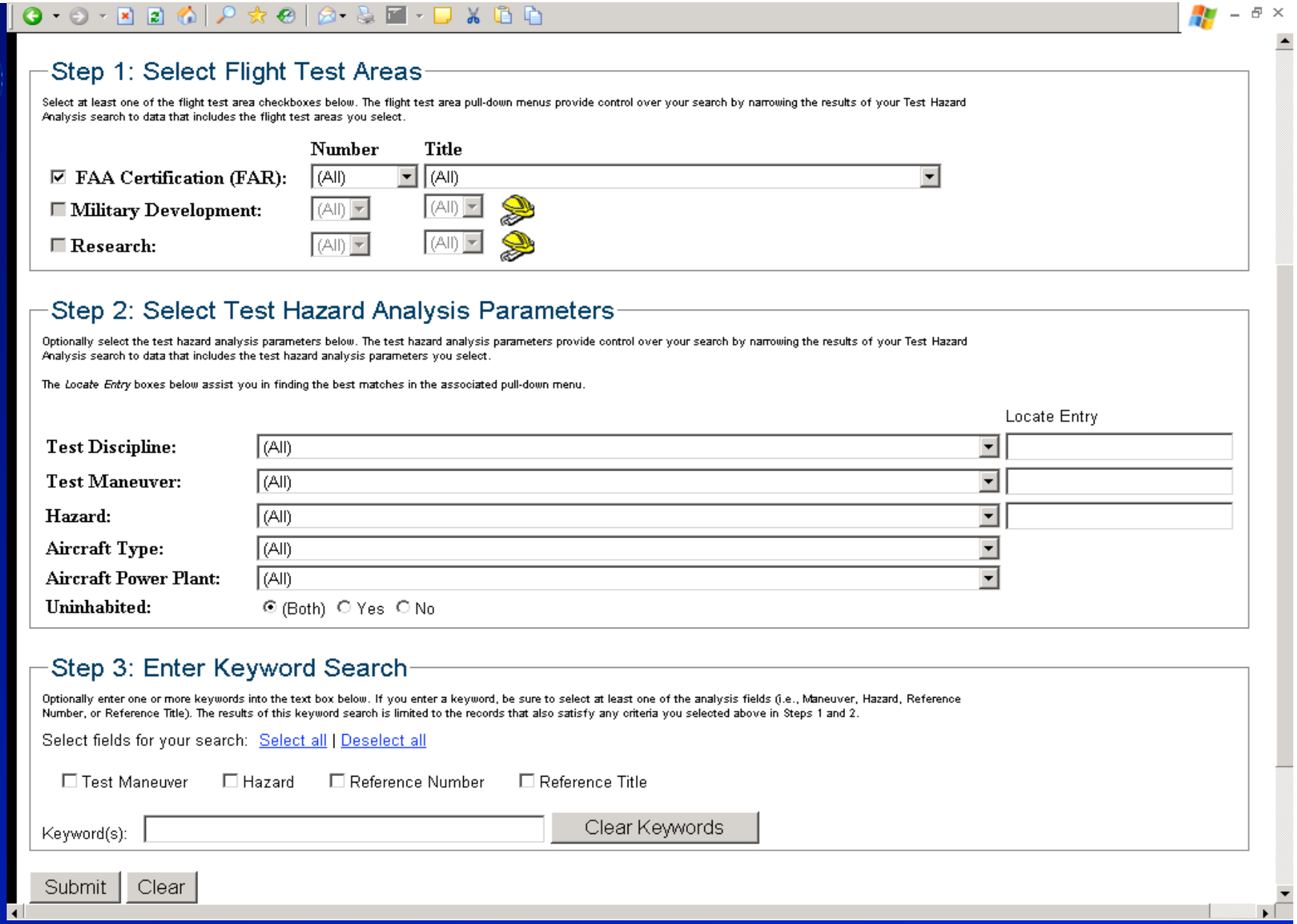
### Collaborative Tools

- Event Calendar
- Discussion Forum
- Document Management
- Instant Messaging

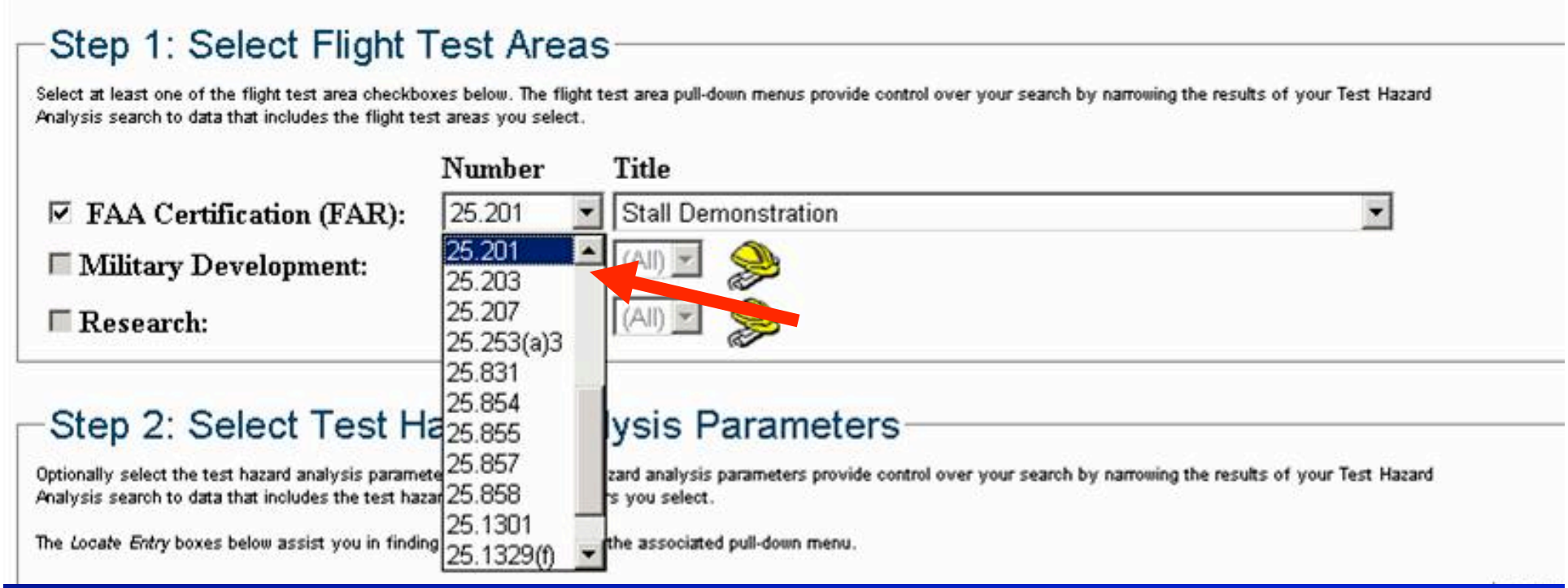
### Internet Search

Google

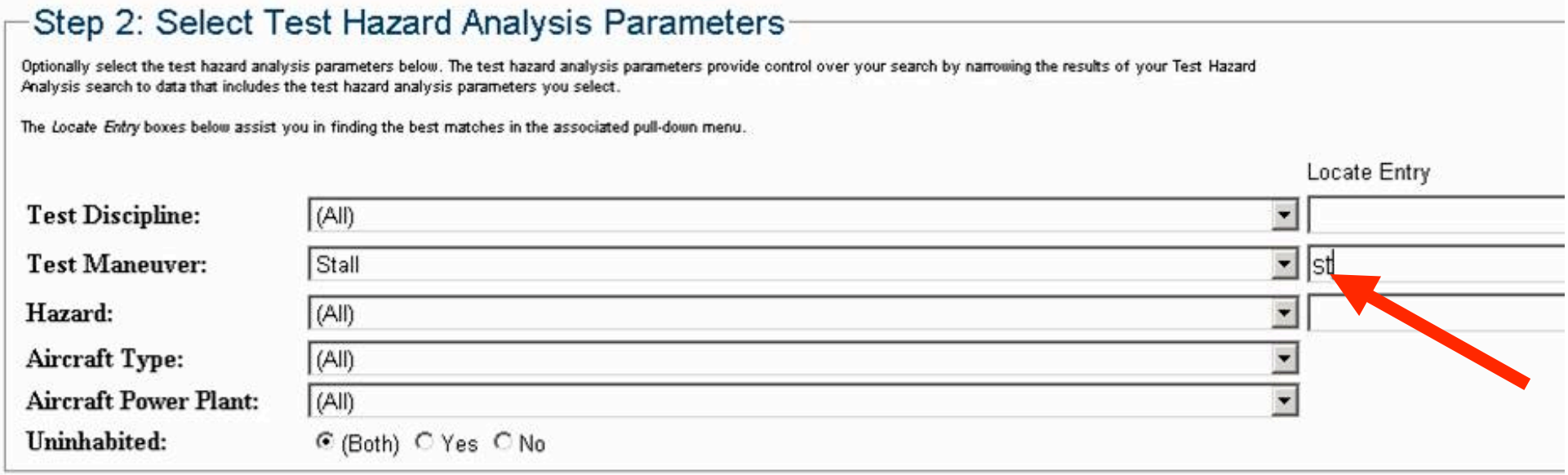
Google Search

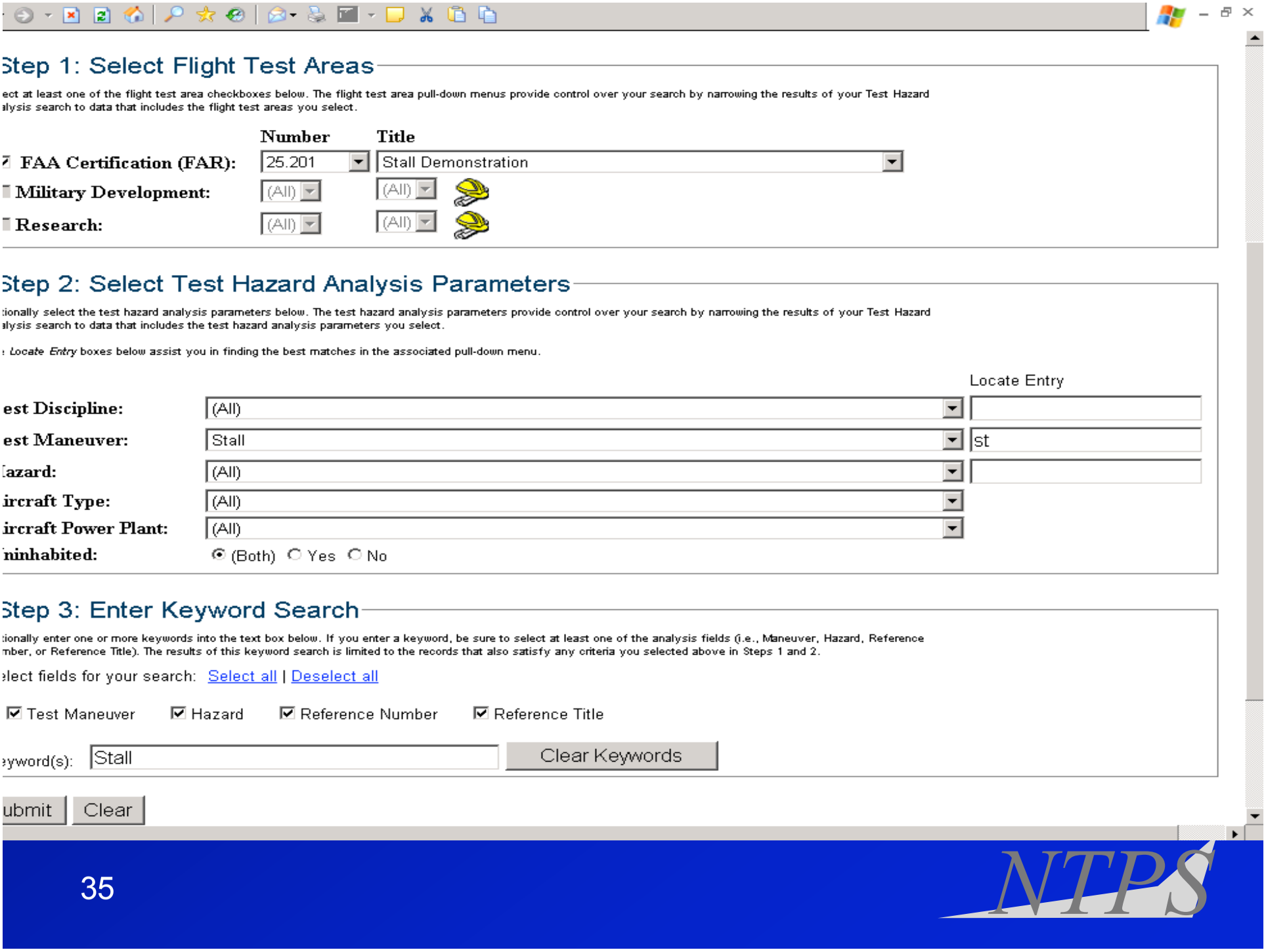

Step 1: Select Flight Test Areas
Select at least one of the flight test area checkboxes below. The flight test area pull-down menus provide control over your search by narrowing the results of your Test Hazard Analysis search to data that includes the flight test areas you select.
Number
Title
FAA Certification (FAR):
(All)
(All)
Military Development:
(All)
(All)
Research:
(All)
(All)
Step 2: Select Test Hazard Analysis Parameters
Optionally select the test hazard analysis parameters below. The test hazard analysis parameters provide control over your search by narrowing the results of your Test Hazard Analysis search to data that includes the test hazard analysis parameters you select.
The Locate Entry boxes below assist you in finding the best matches in the associated pull-down menu.
Locate Entry
Test Discipline:
(All)
Test Maneuver:
(All)
Hazard:
(All)
Aircraft Type:
(All)
Aircraft Power Plant:
(All)
Uninhabited:
(Both) Yes No
Step 3: Enter Keyword Search
Optionally enter one or more keywords into the text box below. If you enter a keyword, be sure to select at least one of the analysis fields (i.e., Maneuver, Hazard, Reference Number, or Reference Title). The results of this keyword search is limited to the records that also satisfy any criteria you selected above in Steps 1 and 2.
Select fields for your search: Select all | Deselect all
Test Maneuver
Hazard
Reference Number
Reference Title
Keyword(s):
Clear Keywords
Submit
Clear

# FAR Reference Search



# Record Field Search




Step 1: Select Flight Test Areas
ect at least one of the flight test area checkboxes below. The flight test area pull-down menus provide control over your search by narrowing the results of your Test Hazard
alysis search to data that includes the flight test areas you select.
Number
Title
FAA Certification (FAR):
25.201
Stall Demonstration
Military Development:
(All)
(All)
Research:
(All)
(All)
Step 2: Select Test Hazard Analysis Parameters
tionally select the test hazard analysis parameters below. The test hazard analysis parameters provide control over your search by narrowing the results of your Test Hazard
alysis search to data that includes the test hazard analysis parameters you select.
Locate Entry boxes below assist you in finding the best matches in the associated pull-down menu.
Locate Entry
est Discipline:
(All)
est Maneuver:
Stall
st
Hazard:
(All)
ircraft Type:
(All)
ircraft Power Plant:
(All)
Uninhabited:
(Both)
Yes
No
Step 3: Enter Keyword Search
tionally enter one or more keywords into the text box below. If you enter a keyword, be sure to select at least one of the analysis fields (i.e., Maneuver, Hazard, Reference
mber, or Reference Title). The results of this keyword search is limited to the records that also satisfy any criteria you selected above in Steps 1 and 2.
elect fields for your search:
Select all
Deselect all
Test Maneuver
Hazard
Reference Number
Reference Title
eyword(s):
Stall
Clear Keywords
ubmit
Clear



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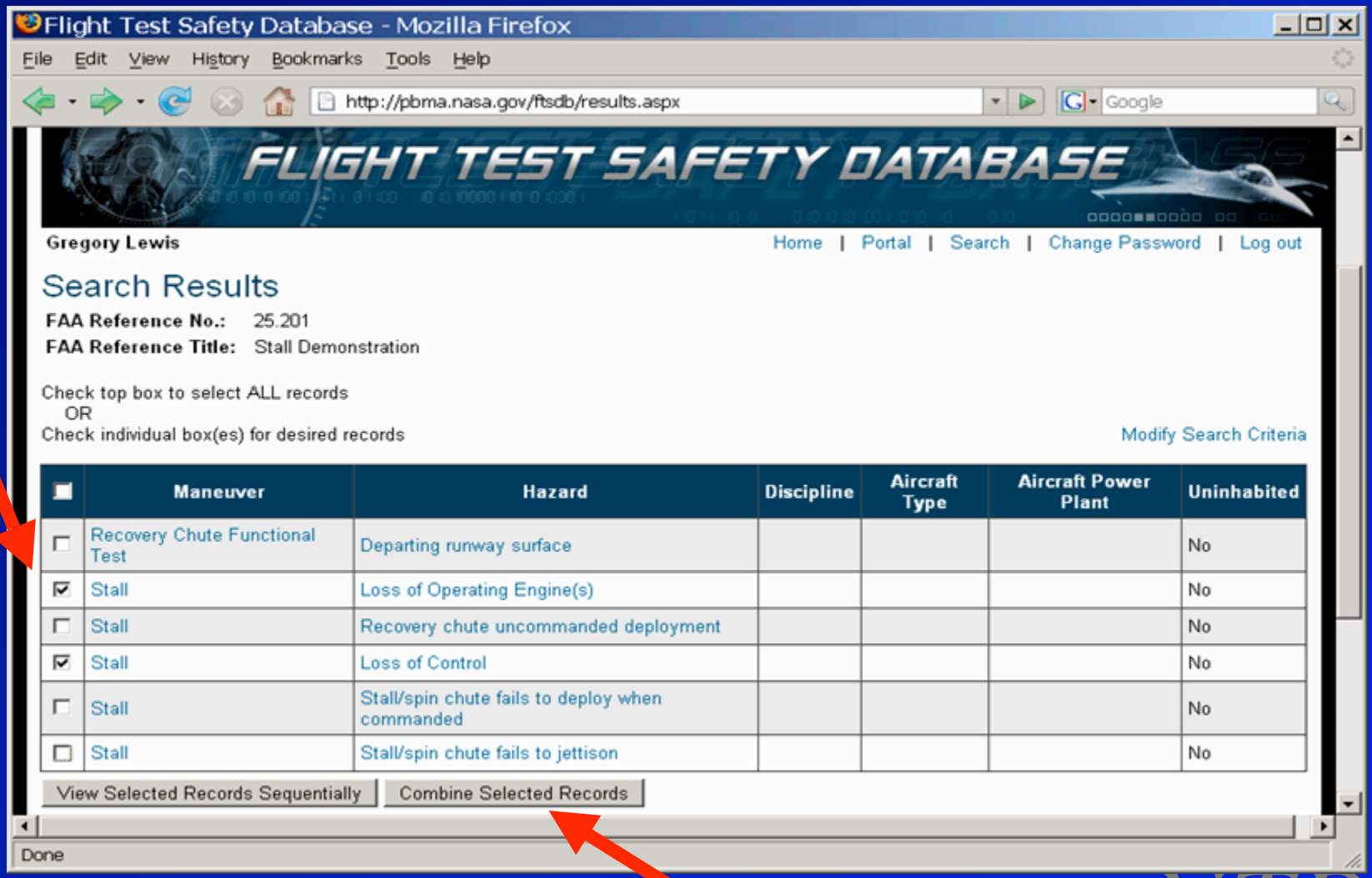
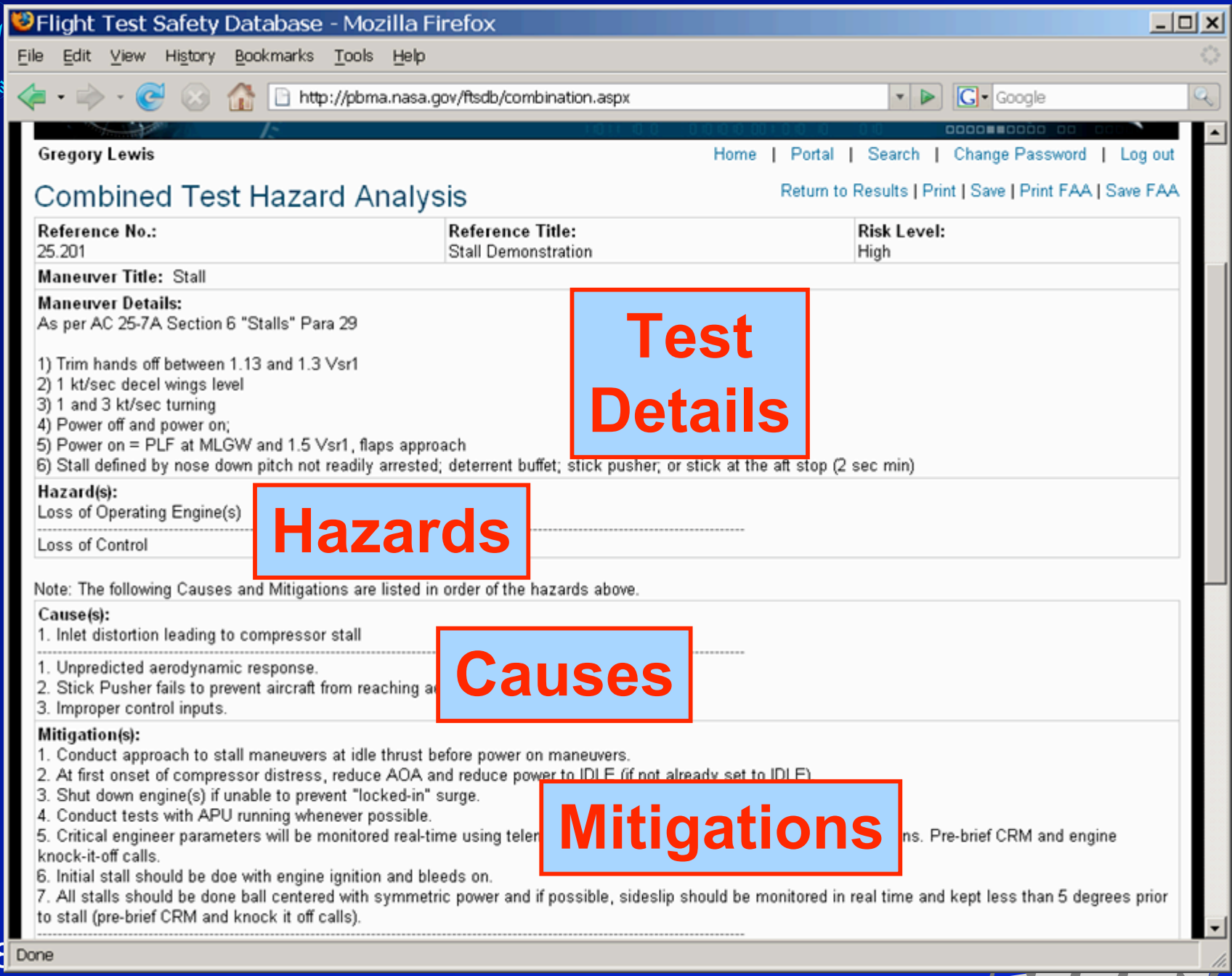
# Keyword Search

# Results of FAR Reference Search




Flight Test Safety Database - Mozilla Firefox
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http://pbma.nasa.gov/ftsdb/combination.aspx
Google
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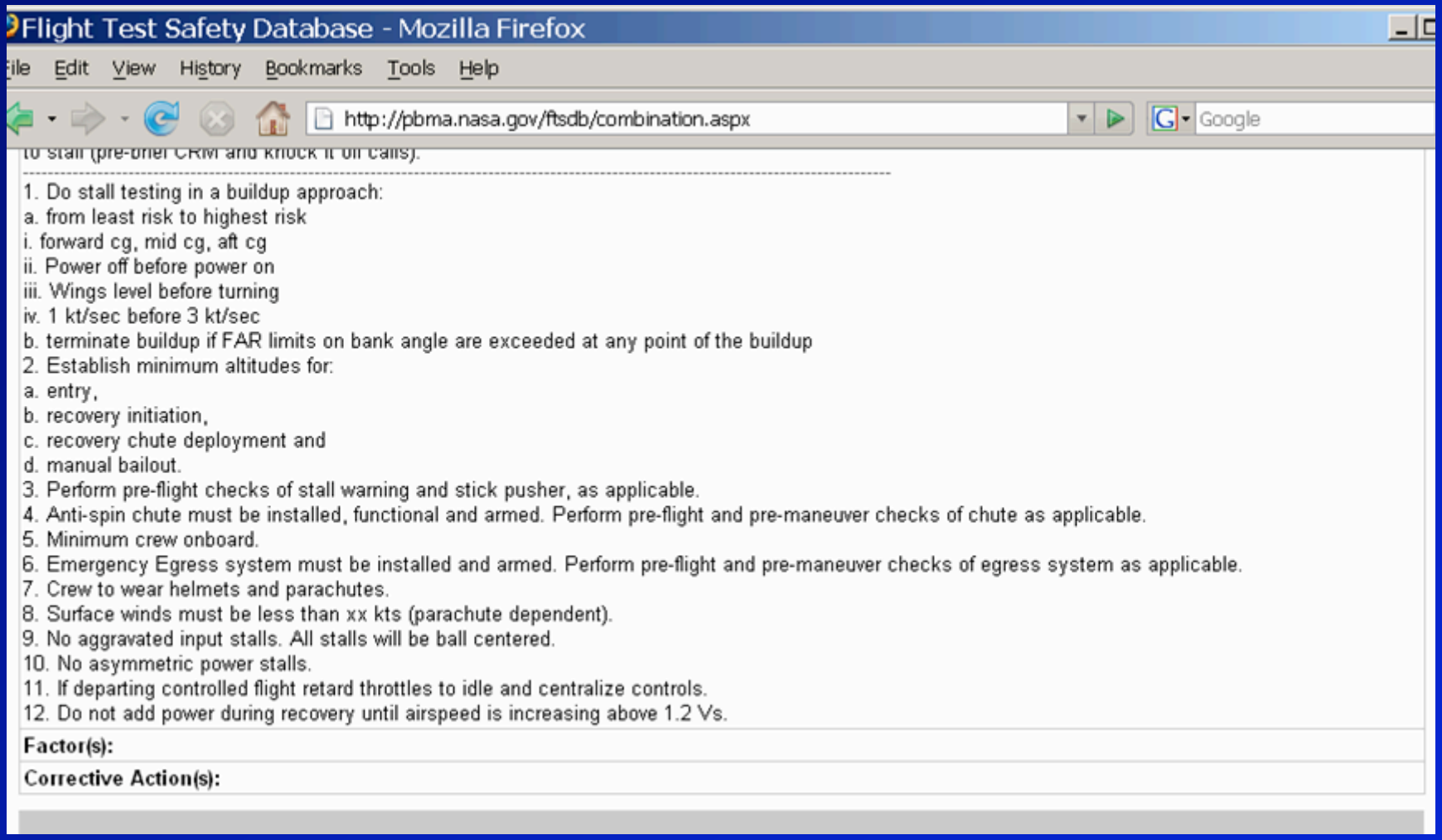
Home | Portal | Search | Change Password | Log out
Combined Test Hazard Analysis
Return to Results | Print | Save | Print FAA | Save FAA
Reference No.: 25.201
Reference Title: Stall Demonstration
Risk Level: High
Maneuver Title: Stall
Maneuver Details:
As per AC 25-7A Section 6 "Stalls" Para 29
1) Trim hands off between 1.13 and 1.3 Vsr1
2) 1 kt/sec decel wings level
3) 1 and 3 kt/sec turning
4) Power off and power on;
5) Power on = PLF at MLGW and 1.5 Vsr1, flaps approach
6) Stall defined by nose down pitch not readily arrested; deterrent buffet; stick pusher; or stick at the aft stop (2 sec min)
Test Details
Hazard(s):
Loss of Operating Engine(s)
Loss of Control
Hazards
Note: The following Causes and Mitigations are listed in order of the hazards above.
Cause(s):
1. Inlet distortion leading to compressor stall
1. Unpredicted aerodynamic response.
2. Stick Pusher fails to prevent aircraft from reaching a
3. Improper control inputs.
Causes
Mitigation(s):
1. Conduct approach to stall maneuvers at idle thrust before power on maneuvers.
2. At first onset of compressor distress, reduce AOA and reduce power to IDLE (if not already set to IDLE)
3. Shut down engine(s) if unable to prevent "locked-in" surge.
4. Conduct tests with APU running whenever possible.
5. Critical engineer parameters will be monitored real-time using teler
ns. Pre-brief CRM and engine knock-it-off calls.
6. Initial stall should be doe with engine ignition and bleeds on.
7. All stalls should be done ball centered with symmetric power and if possible, sideslip should be monitored in real time and kept less than 5 degrees prior to stall (pre-brief CRM and knock it off calls).
Mitigations
Done


Flight Test Safety Database - Mozilla Firefox
File Edit View History Bookmarks Tools Help
http://pbma.nasa.gov/ftsdb/combination.aspx
Google
to stall (pre-brief CRM and knock it off calls).
1. Do stall testing in a buildup approach:
a. from least risk to highest risk
i. forward cg, mid cg, aft cg
ii. Power off before power on
iii. Wings level before turning
iv. 1 kt/sec before 3 kt/sec
b. terminate buildup if FAR limits on bank angle are exceeded at any point of the buildup
2. Establish minimum altitudes for:
a. entry,
b. recovery initiation,
c. recovery chute deployment and
d. manual bailout.
3. Perform pre-flight checks of stall warning and stick pusher, as applicable.
4. Anti-spin chute must be installed, functional and armed. Perform pre-flight and pre-maneuver checks of chute as applicable.
5. Minimum crew onboard.
6. Emergency Egress system must be installed and armed. Perform pre-flight and pre-maneuver checks of egress system as applicable.
7. Crew to wear helmets and parachutes.
8. Surface winds must be less than xx kts (parachute dependent).
9. No aggravated input stalls. All stalls will be ball centered.
10. No asymmetric power stalls.
11. If departing controlled flight retard throttles to idle and centralize controls.
12. Do not add power during recovery until airspeed is increasing above 1.2 Vs.
Factor(s):
Corrective Action(s):

# In Conclusion

- The matured THA database **IS** a wide array of test safety ideas and suggestions
  - But it is **NOT** an FAA-mandated solution
  - It is **NOT** a government-approved solution
  - And it is **NOT** an auto-safety planning device
    - The matured hazards, causes and mitigations are necessarily generic
    - Your test will have unique problems and will require unique solutions
    - The THA database can be an **excellent starting point**

# In Conclusion

- **Military/Research Database Status**
  - Data under development at monthly Webex/telecon meetings

| Test Area | Date/Time | Lead |
|---|---|---|
| Fixed Wing Icing | 3rd Wednesday at 0900 PST | Kurt Blankenship (Glen Research Center) |
| Rotary Wing Icing | 1st Thursday at 0900 PST | Kim Hanks (Army Test & Training Center) |
| Propulsion | 4th Thursday at 0900 PST | Brian Markowich (NAVAIR Pax River) |

- **Contact Joe Orwat (x3866) or Bart Henwood (x5746)**

# In Conclusion

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  - Data under development at monthly Webex/telecon meetings

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# Next Year's activity

- Initiate DDC for research/military flight test
  - High AoA
- Continue portal development activity
  - Input/Data Submission Module
  - Create reference information
    - Airworthiness and flight safety review process
    - Hazard management process

# Come Join Us!


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(425) 917-6518

## Flight Test Safety


Questions?

Suggestions?