GA - Systems Safety Management Research: Aviation Safety Information Analysis and Sharing – General Aviation (ASIAS-GA)

CGAR May 2011

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- Brief review of prior work – Alan, Gary
- Three tasks for CY2011
  - Proof of Concept – Alan, Gary
  - Metrics - Tony
  - Flight Risk Analysis Tool (FRAT) - Alan

Agenda

Research Objective: To examine the feasibility of developing ASIAS for GA industry

ERAU researchers (current phase)

- Alan Stolzer
- Tony Pickering
- Cass Howell
- Jim Cannon, Chris Broyhill, David Freiwald (doctoral students)

UND researchers

- Gary Ullrich
- Jim Higgins
- Dan Mallot
- Leslie Martin

UAA researcher

- Leonard Kirk

What is ASIAS?

A ***collaborative*** Government and Industry initiative on ***data sharing & analysis*** to proactively discover safety concerns ***before*** accidents or incidents occur, leading to **timely mitigation and prevention**

Review of GA Studies

- Reviewed several existing aviation safety studies from GAJSC, JSAT, JSIT for suggestions, insights, lessons learned
  - Developed a series of observations, such as:
    - **GA safety outcome metrics require further consideration and improved operational definitions (e.g., per flight hour metrics, which is invalid for many studies)**
    - Forensic type case analyses are inadequate for making quantitative inferences

- Reports provide little background or context, e.g., literature review
- Reports tend to be broad in nature, yet lead to numerous mitigations
  - The 5 reports reviewed yielded about 400 (largely untested) mitigations
- Data sources are not always thoroughly described. Study design, methodology rarely justified.
- Reports appear limited to data from accident and incident flights. Other flights, where *unsafe acts* may have occurred, are not considered.
- No formal peer-review process is followed
- Reports do not follow consistent formatting or content guidelines (e.g., APA)

- Further examine quality issues
- Expand types of research questions, use different techniques (quantitative, qualitative, mixed methods); study design should be major focus for area of improvement
- Examine outcome metrics for suitability in reporting GA safety statistics
- Improve aviation safety reports (structure, content, formatting, etc.)
- Designate CGAR as a research node on the ASIAS network for GA research

Recommendations From Previous Work

Governance

- **CAST model would form strong basis for ASIAS-GA**
  - Proven record of success
  - Widely modeled by other safety teams worldwide
  - Serves as pseudo-model for GAJSC

Data

- Examined numerous data issues
  - Determination of data sources available to GA - No FOQA or ASAP
  - Data integration
    - Ideally, each data source will include a data field structure that can uniquely relate content of its records to those of other available data sources
    - Did not have access to data to examine integration
  - Data analysis
    - Approach should depend on the research question under consideration and the nature of the data

Observations Regarding GA Data Sources and Data Collection

- There is a paucity of robust data sources for GA as compared to commercial aviation
  - Essentially, no FOQA or ASAP (Jim Higgins' and Dave Esser's work on GA-FDM is promising, but at present, a very limited number of corporate/business flight operations are doing C-FOQA)
- We need to conceive of additional data sources that can contribute to GA safety

Data Sources Available to GA

(Rated highest in our review)

- Wildlife Database
- AOPA Nall Report
- NTSB Accident and Incident Data System
- FAA Accident/Incident data system
- University online safety reporting system
- Air Traffic Quality Assurance Program
- NTSB Safety Recommendations to the FAA
- Service Difficulty Reporting System
- Aviation Safety Reporting System
- National Offload Program
- ADS-B
- Airport Surface Detection Equipment, Model X (ASDE-X)

Conduct an ASIAS-GA Proof-of-Concept Study

Tasks & Goals:

1. Coordinate with the FAA, ASIAS, CAST, GAJSC, MITRE, to refine nature of governance model. Identify an archetypic ASIAS-GA Executive Board
2. Develop protocol for identification and prioritization of GA safety studies
3. Identify safety issue for proof-of-concept GA study (runway incursions)
4. Identify specific research questions
5. Design research methodology to be used in the study, including data and analysis methods/tools to be used
6. Obtain FAA support and ASIAS AEB approval for research node
7. Obtain and familiarize with MITRE's text analytics tool and/or Concept Banks
8. Develop methods and metrics
9. Complete Study Design

Sounds Like Success

FAA Announces Serious Runway Incursions Down by 50 Percent

Federal Aviation Administration

WASHINGTON, D.C. — Federal Aviation Administration (FAA) Administrator Randy Babbitt announced today that serious runway incursions were down 50 percent for the most recent 12-month period compared to the previous year.

There were 12 serious incursions in fiscal year 2009 which ended Sept. 30, with only two involving commercial carriers, compared to 25 such events in fiscal year 2008, with nine involving commercial carriers. A runway incursion occurs when something or someone intrudes on a runway without authorization. A serious incursion is one in which a collision was narrowly avoided, or there was a significant potential for collision that resulted in the need to take quick corrective action.

"The aviation community agreed two years ago at FAA's Runway Safety 'Call to Action' meeting to implement safety improvements at U.S. airports," said Administrator Babbitt. "Teamwork helped get us to where we are today. But while the 50 percent reduction is remarkable, there is still much work to be done to continue to reduce the potential risk."

Close calls in 2007 at some of the busiest U.S. airports prompted the FAA to take immediate action to reduce the risk of runway incursions and wrong runway departures. There were 24 serious runway incursions that year, eight of them involving commercial carriers. FAA management met with aviation leaders from airlines, airports, air traffic control and pilot unions, and aerospace manufacturers to encourage them to take action in areas that would result in safety improvements. As a result, an intense effort was launched to expedite the installation of new technology at airports, complete proper signage and markings at airports and conduct outreach and re-train pilots.

January 2011 FAA Press Release

Proof-of-Concept Study – Runway Incursions

- Runway Incursions are a significant safety hazard and need to be mitigated
  - Severity is extreme – RI's have been responsible for some of the worst accidents in aviation history
  - Likelihood is NOT decreasing in spite of FAA's attempt to define the problem into success
    - FAA says "most severe" incursions are decreasing, but overall number and rate of runway incursions are increasing
  - GA Aircraft are the largest source of pilot-driven runway incursions

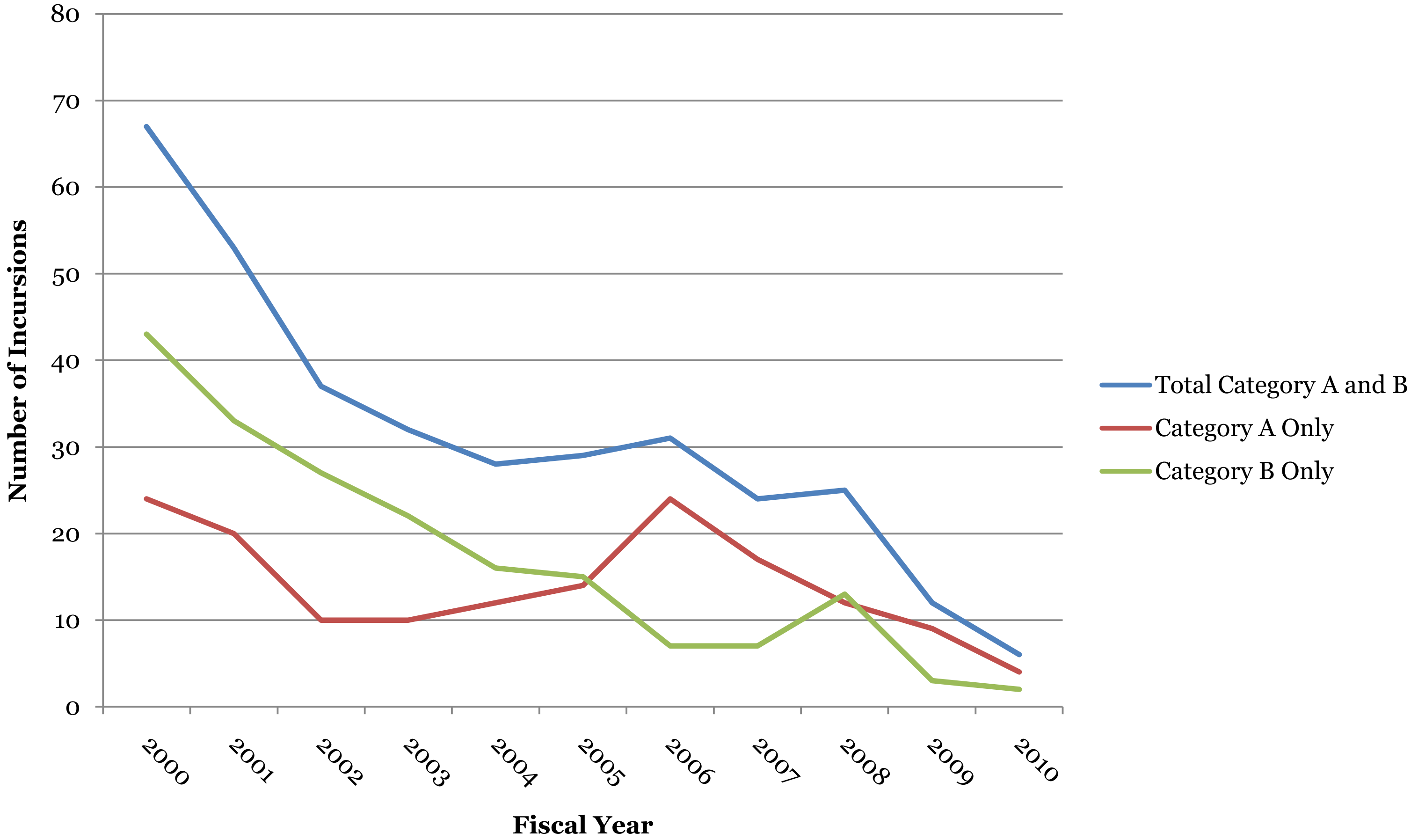
Definitions
Runway Incursion Severity

- **Category A** — A serious incident in which a collision was narrowly avoided.
- **Category B**— An incident in which separation decreases and there is a significant potential for collision, which may result in a time critical corrective/evasive response to avoid a collision.
- **Category C**— An incident characterized by ample time and/or distance to avoid a collision.
- **Category D** — Incident that meets the definition of runway incursion such as incorrect presence of a single vehicle/person/aircraft on the protected area of a surface designated for the landing and takeoff of aircraft but with no immediate safety consequences.

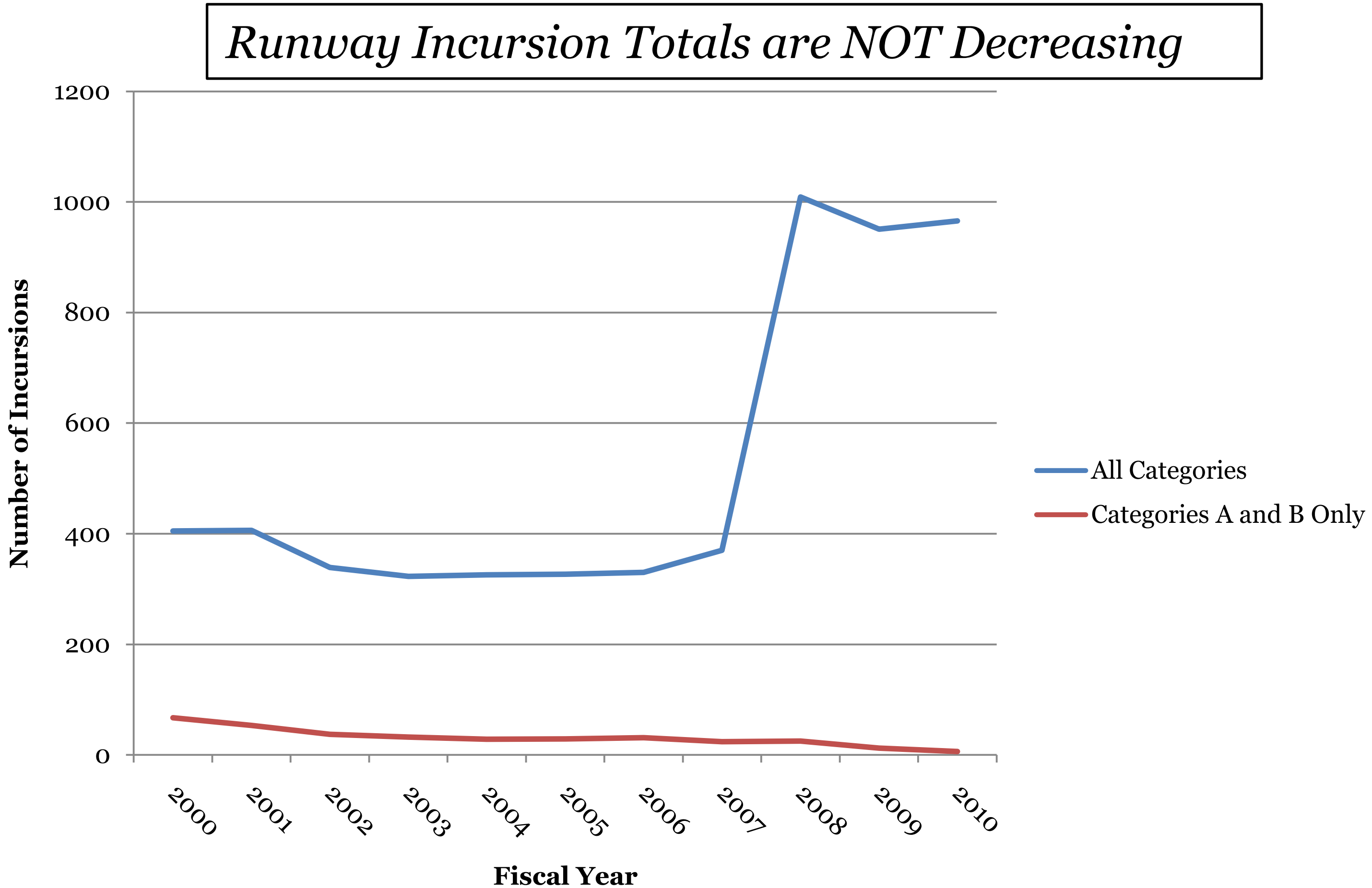
- *The same severity ranking scheme is used by both the FAA and ICAO, but . .*
  - *It is merely a function of elapsed time between an aircraft taking off or landing and another aircraft/vehicle/pedestrian occupying the same space*
  - *It is a measure or what* ***almost*** *happened at a particular time and place*
  - *It is, essentially, a measure of* ***chance***

Category A & B RI's
FY 2000 – FY 2010

Category A and B Incursions ARE Decreasing – Hence the FAA's Declaration of Progress

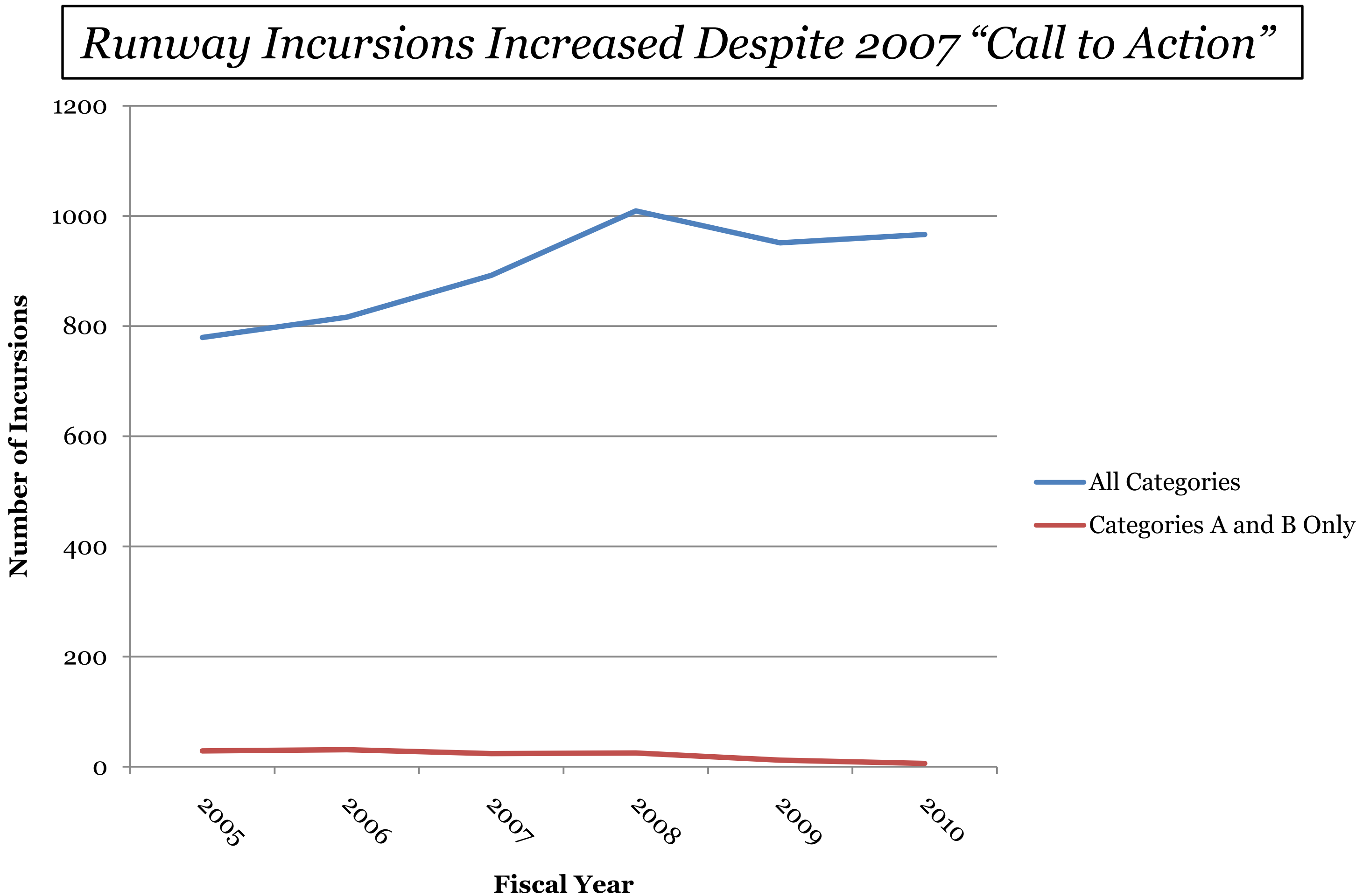


Category A & B RI's vs All RI Categories
FY 2000 – FY 2010

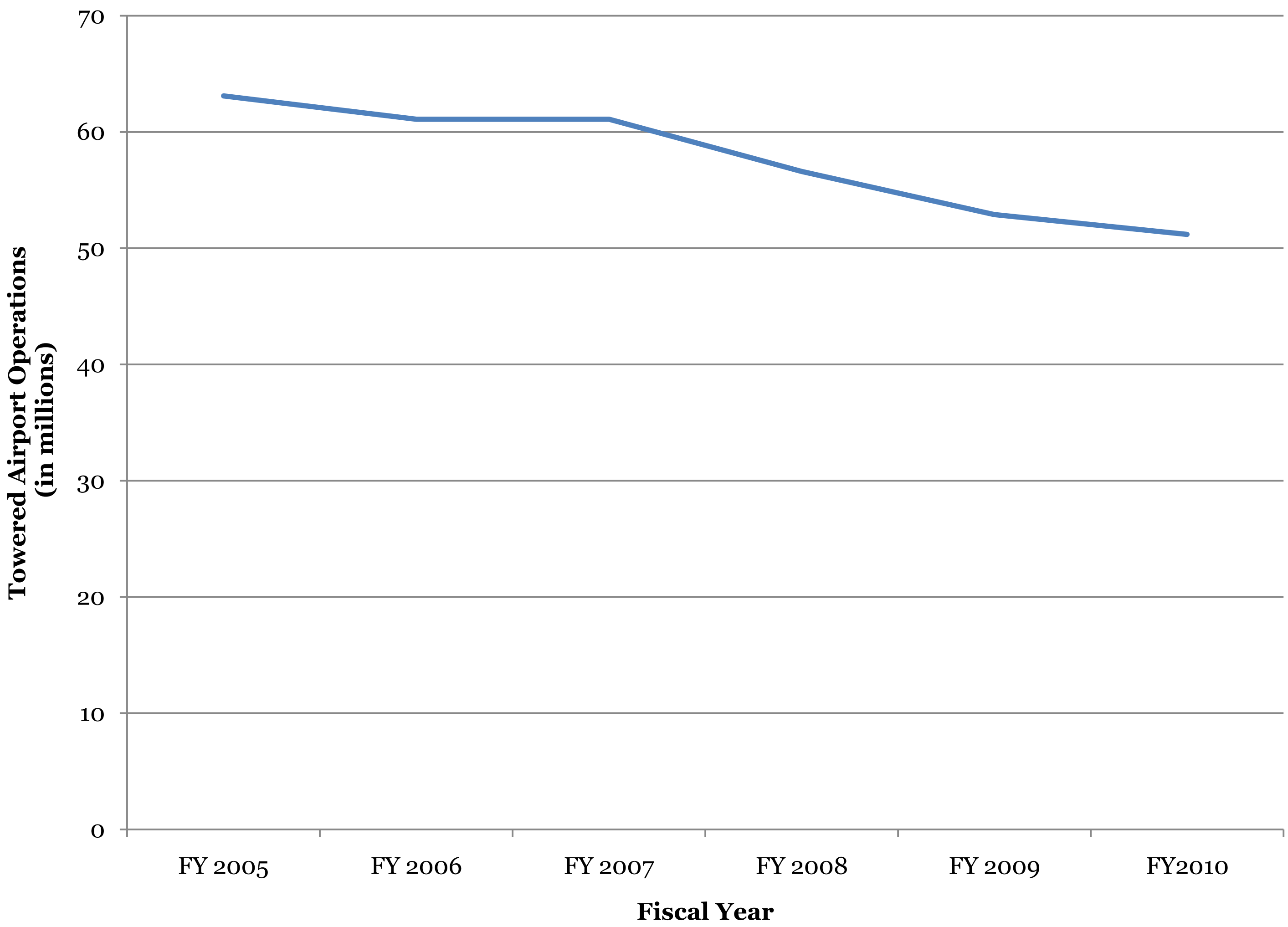


Note: Large increase from 2007-2008 is the result of FAA changing to ICAO RI definition and categories

Category A & B RI’s vs All RI Categories *FY 2005 - FY 2010 / Corrected for ICAO Criteria*

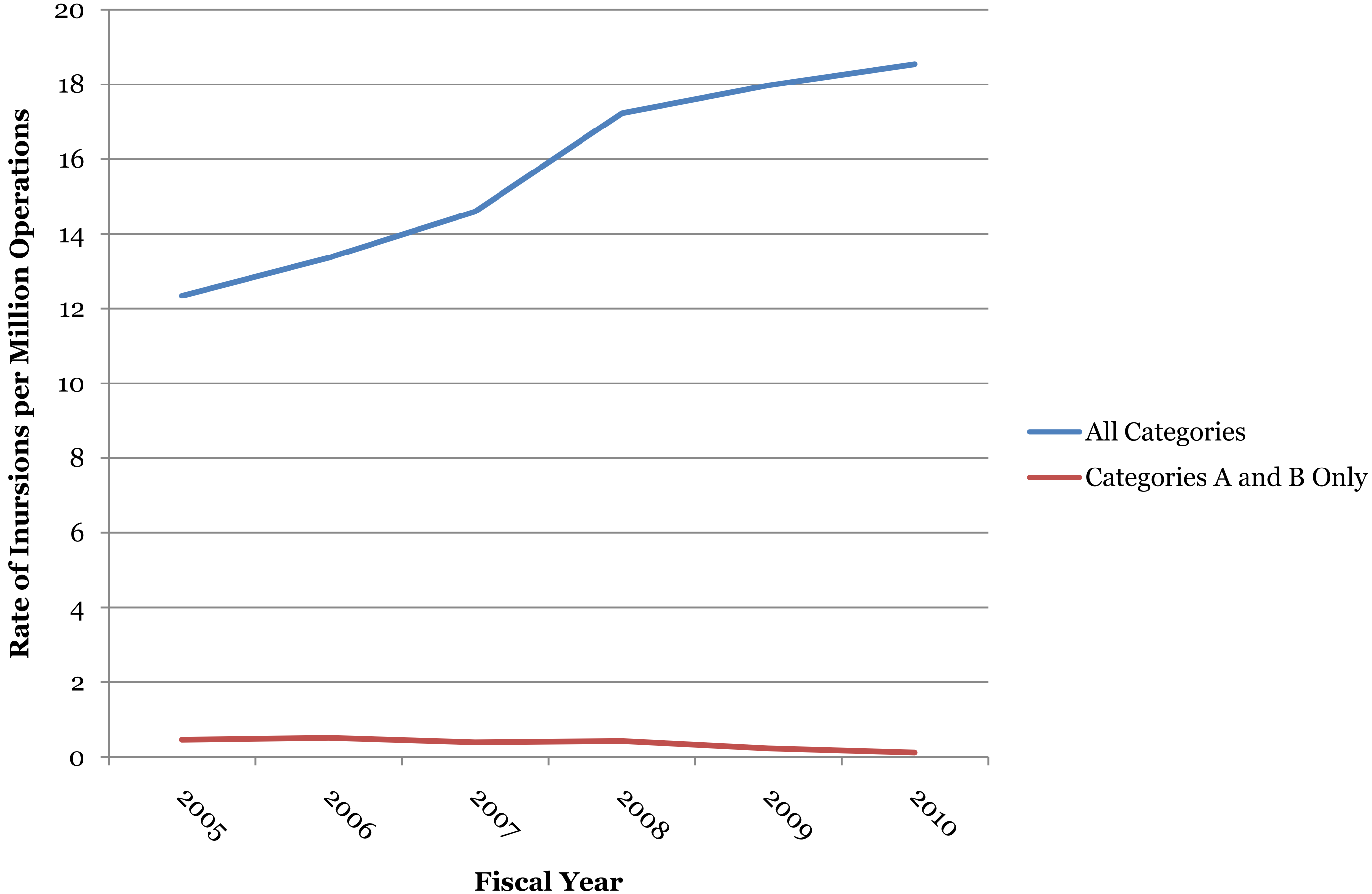


Airport Operations
FY 2005 - FY 2010 at Towered Airports



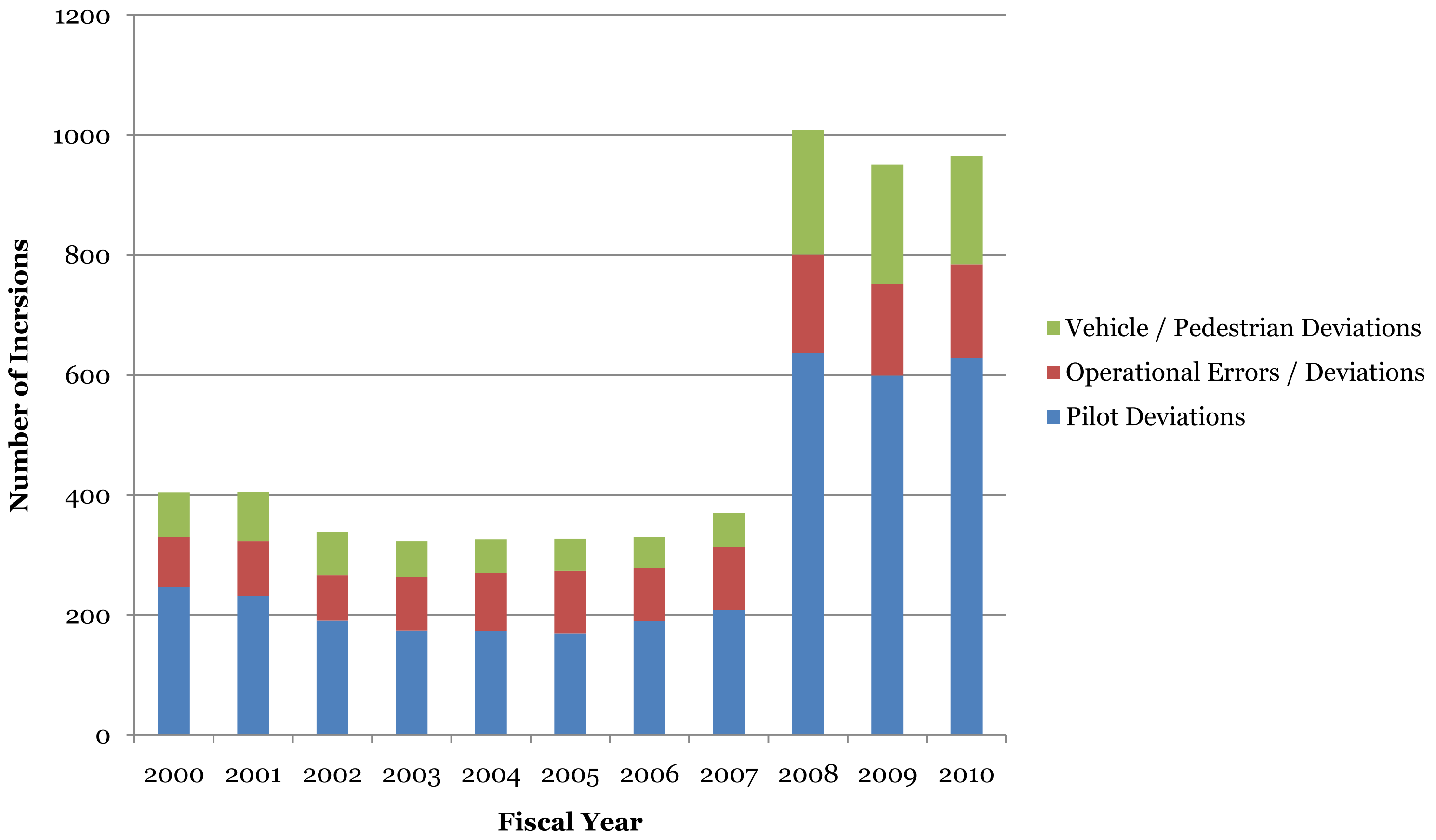
Rate of RI's *FY 2005 - FY 2010 / Corrected for ICAO Criteria*

Decreasing Number of Airport Operations – Rate of RI's is INCREASING



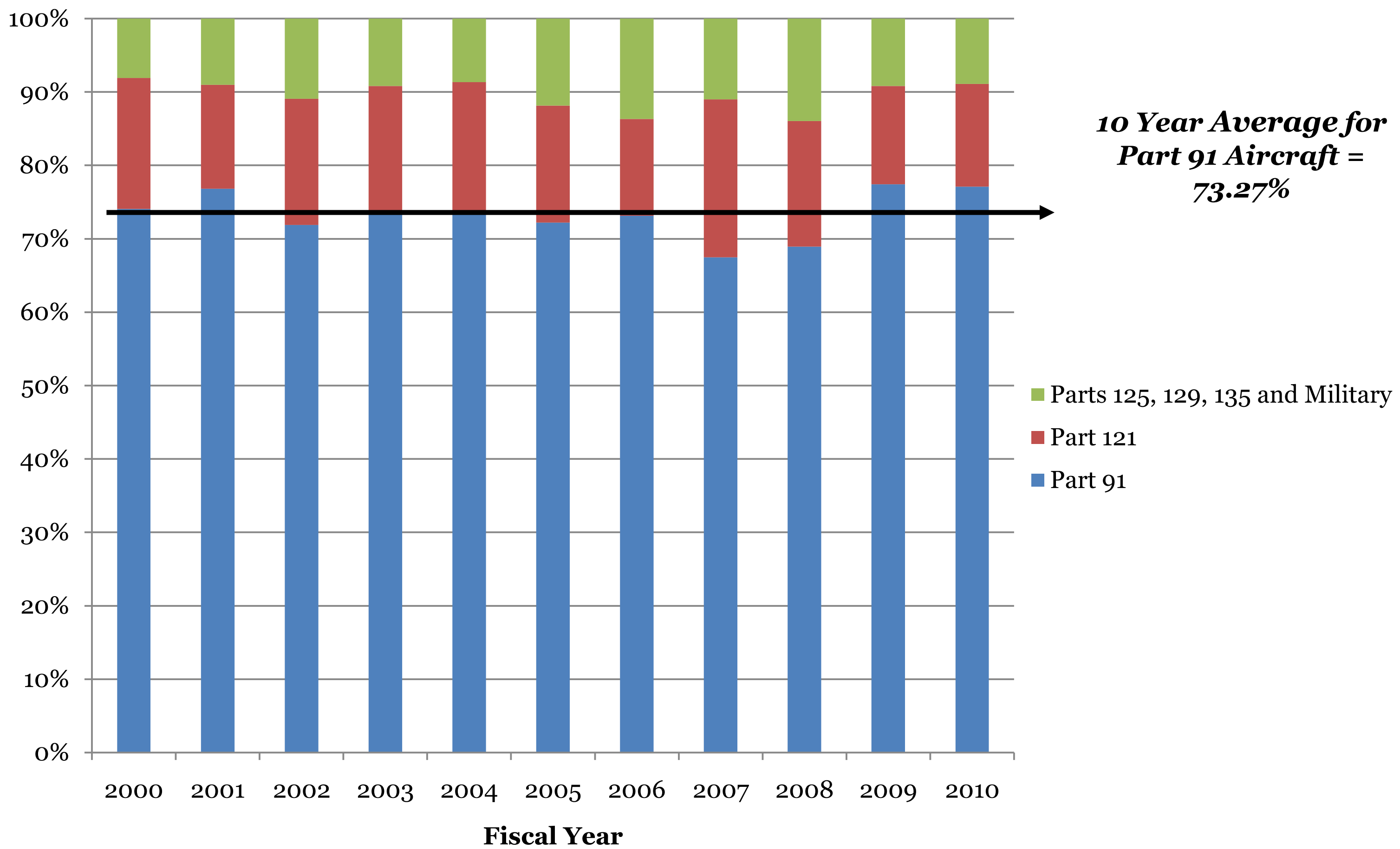
Runway Incursion Error Comparison
FY 2000 – FY 2010

Pilot Deviations Account for More Errors than the other Two Categories Combined

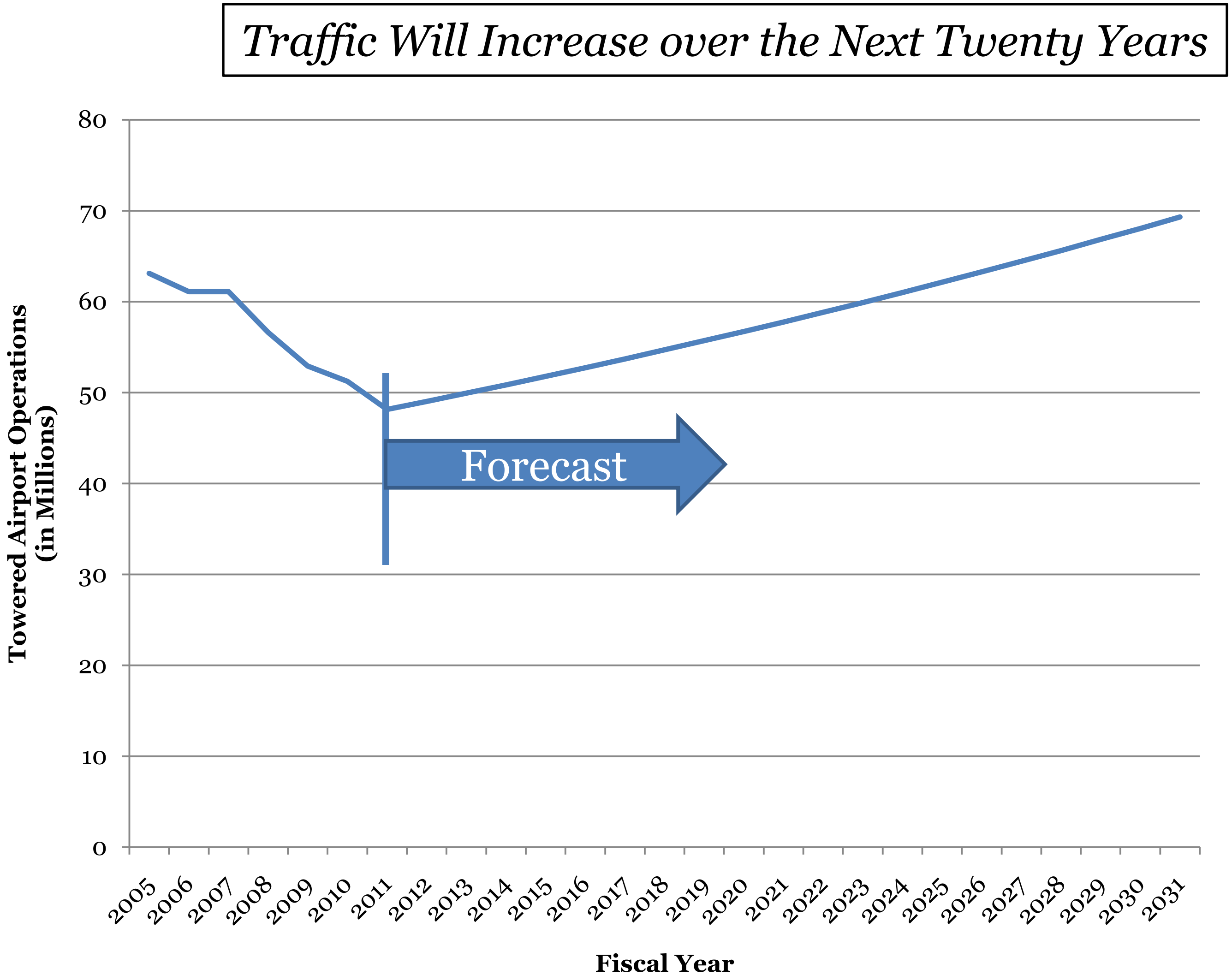


RI's by Operating Regulation
FY 2000 – FY 2010

General Aviation Aircraft Account for the Vast Majority of Runway Incursions



The Past, Present and Future
Airport Operations FY 2005 – FY 2031



Conclusions

- FAA Press Release
  - Category A and B decrease not a true measure of *effective* because "severity" rating is questionable
  - Runway Incursions *overall* are definitely not decreasing
- GA aircraft account for largest source of RI's
  - Focus on GA problem to effect the greatest reduction
  - To address the problem, GA RIs must first be understood in greater detail

Proof of Concept Study—Runway Incursions

- Scrub the databases to analyze General Aviation’s contribution to Runway Incursions
- Two part study, three research questions
  - Descriptive (two research questions)
  - Deep dive (one research question)

Research Question #1

- Where are the GA Runway Incursions occurring?
  - Looking at all data, Chicago O'Hare and LAX have the highest number of runway incursions
  - When the databases are scrubbed to reflect only GA related runway incursions, how does the result change?

Research Question #2

- Once the high risk airports are identified, what are the attributes of these locations?
  - As an example:
    - Location
    - Specific location on the aerodrome
    - Runway layout
    - Pilot experience, certificate, currency
    - Day/night
    - Weather conditions
    - Number of pilots on board (solo, dual, etc)

Deep Dive

- Can a model be developed to predict, using GA attributes, deviations from clearance instructions?
  - Analyze deviations using mathematical algorithms based on taxi path tables derived from Airport Surface Detection Equipment, Model X data (ASDE-X)

The General Aviation Pilot Survey (GAPS)

Improving Safety Metrics

Outline

- Background
- Objectives
- Study Design
- Metric Estimation Method
- The Questionnaire(s)
- Sample Calculations (recruitment, activity, metrics)

- Nall Report

Background

- "The Missing Denominator Problem"
  - Hinkelbein, Neuhaus, Schwalbe, Dambier (2010). Letter to Editor. Aviation, Space and Environmental Medicine.
  - 2009 Nall Report

    "… **To compare different airplanes, pilots, types of operations, etc., we must first 'level the playing field' in terms of exposure to risk**. The most common way to do this is to compare accidents per 100,000 flight hours…"

Background

- "The Wrong Denominator Problem"

- (1997) Aviation Safety Data Accessibility Study Index: A Report On Issues Related to Publish Interest in Aviation Safety Data.

- **Computation of an accident or incident rate requires normalizing information about the level of exposure** to risk. For comparative purposes, it is essential that accident and incident data be normalized in some way, since the system's (or a carrier's) exposure to risk changes over time. One carrier's exposure to risk in a particular time period will likely differ from that of another, because different carriers have different levels and types of activity. Measures of exposure to risk commonly used to normalize event data include number of flights, hours flown, passenger enplanements, and passenger miles flown. Villareal (1988) discusses advantages and disadvantages of the various exposure measures used for normalizing safety research data**. Most researchers prefer to use the number of flights (measured as departures) for normalizing data, rather than hours or miles flown, because the risk of accident for an aircraft is greatest during takeoff and landing**. For consumers, the most relevant measure is also likely to be a flight or a round trip.

- Although a commercial aircraft spends only about six percent of its flight time in the takeoff, initial climb, final approach, and landing components of its flight, around 70 percent of "hull loss" accidents have occurred during these stages (Weener and Wheeler, 1992**). Because of this, using an hours flown-based measure or a mileage-based measure of risk can be misleading. This is especially true when comparisons are being made between segments of the industry that have different average flight lengths**. **Using a mileage-based measure will make a commuter type carrier with very short average flight lengths look more risk prone relative to a major jet carrier flying longer stage lengths on average. (This occurs because a carrier with shorter average flights will make more takeoffs and landings per mile flown, and a carrier is most exposed to the risk of an accident or incident during takeoff and landing.**) Prior research has shown the importance of comparing like groups of carriers (termed "peer groups") when comparing safety performance (GRA 1988).

Background

- Recent EAA statement. March 31, 2011 EAA Website
  - "A flight hour is not a flight hour across the board of all aircraft," Elliott explained. "Three hours in a corporate jet with one takeoff and landing is not the same as three hours in a GA training or recreational aircraft, where there might be numerous takeoffs, landings, and low-altitude maneuvering within that period. FAA's continued use of that methodology presents an unrealistic picture of real-world use of various airplanes. We have asked that the FAA, through the GA-JSC, explore better ways to measure the safety record of GA aircraft."
- Despite recent and long-term recognition of the missing and wrong denominator issues, Nall Report consists of almost exclusively raw flight activity counts or per hour metrics.

Objectives

- In Summary: Flight counts and per hour metrics likely do not capture essence of General Aviation safety, particularly when comparing across GA subcategories.

- Furthermore, no centralized data source exists for tracking either flight hours or number of departures of General Aviation flight activity.

- Therefore, the driving aim of this research is to study feasibility of developing methods and metrics to more appropriately assess General Aviation safety by
  - Obtaining/Estimating GA flight activity
  - Incorporating/Comparing flight hour with per flight safety metrics

Survey Approach

- Potential for survey data to be used to estimate GA activity levels to address the denominator issue.
- Need to determine cost efficient and methods of obtaining most valid estimates of flight activity.
- Obtain representative sample of GA pilots from FAA Airmen Database
- Two phase data collection
  - Objective Phase 1 - Determine best participant recruitment method
  - Objective Phase II - Obtain sufficient data for metric calculations

Study Design

- Testing 8 conditions varying response burden and response modality options.
  - 4 (response burden) X 2 (response options)
- Rolling recruitment to obtain response quotas
  - 2000 initial mailings from May 2011 FAA Airmen Database
- Once most effective data collection strategy determined, will be used to obtain data for metric estimation calculations.

Metric Estimation Method

- NTSB accident data can serve as numerator in safety metric computations.
- GAPS data can serve as flight type activity denominator for either per hour or per flight estimates.
- Basic Equation

Flight Type Accident Frequency / Flight Type Activity Estimate (i.e. hrs or flights)

Where:
Flight Type Activity Estimate =
[(average reported activity)(% respondents engaged in activity)(total pilots)]

The questionnaires

- Hard copy – USPS Invitations
- Hardcopy questionnaire
  - Versions A, B, C, D
- Instructions will include a PASSCODE and PASSWORD to use for responding online.
- Online survey
  - www.gapssurvey.com

Sample Calculations (metrics)

- Mock data:
  - **FAA Airmen Database:** 750K active pilots
  - **NTSB data:** 49 GA stall spin accidents
  - **NTSB data:** 15 of 49 GA stall spins occurred in experimental aircraft
  - **GAPS data:** 150 survey respondents
    - Median number of GA flights (TO/LD) was 199
    - Mean number of GA flight hours was 135.40
  - **GAPS data:** 53 flew at least one exp. flight
    - Typical (median) number of experimental flights (TO/LD) was 150
    - Typical (mean) number of experimental flight hours was 81.75

Statistics

		EXP_HRS	EXP_TO	EXP_LD
N	Valid	53	53	53
	Missing	103	103	103
Mean		81.75	168.49	168.49
Median		68.00	150.00	150.00
Minimum		12	18	18
Maximum		181	370	370

Sample Calculations (metrics)

- Experimental Stall-Spin Per Hour Metric
  - 53/150 (35%) of GAPS respondents flew at least one experimental flight

  [15 Exp Stall-Spins] / [(81.75 Exp hrs)(.35)(750,000 pilots)] = 6.99 X 10^{-7} Stall/Spins per hr

- Experimental Stall-Spin Per Flight Metric
  - 53/150 (35%) of GAPS respondents flew at least one experimental flight

  [15 Exp Stall-Spins] / [(150 Exp flights)(.35)(750,000 pilots)] = 3.81 X 10^{-7} Stall/Spins per flight

- Overall Stall-Spin Per Hour Metric

  [49Exp Stall-Spins] / [(135.40 mean GA hrs)(750,000 pilots)] = 5.31 X 10^{-7} Stall/Spins per hr

- Overall Stall-Spin Per Flight Metric

  [49Exp Stall-Spins] / [(199 median GA flights)(750,000 pilots)] = 3.28 X 10^{-7} Stall/Spins per flight

Experimental/Overall GA Ratio Metrics:

Per Hour: 1.32 Per Flight: 1.16

Potential Activity Metrics

- Experimental vs. Overall GA
- High HP vs. < 200 HP
- Single Engine vs. Multi Engine
- Male vs. Female
- Age Groups
- Experience Levels
- Certification Levels
- IFR vs VFR (flight plans)
- IMC vs. VMC (weather conditions)
- Night vs. Daytime

Flight Risk Analysis Tool

Establish a new Data Source for ASIAS-GA Through the Use of a Flight Risk Analysis Tool (FRAT)

Flight Risk Analysis Tool

Tasks & Goals:

1. Research current risk management valuation tools in general aviation
   - Coordinate with NBAA
   - Gather examples / best practices with respect to current FRATs
2. Construct an effective tool for pre-departure risk assessment
   - Evaluate the strengths and weaknesses of each FRAT tool analyzed
   - Design a comprehensive web-based tool, to include incident documentation and safety assurance, coupled with smart phone functionality (Blackberry, iPhone, etc.)
   - Beta test tool
3. Recommend means to collect data and analyze results
   - Determine appropriate database structure
4. Recommend a means to disseminate results

Flight Risk Assessment Tool

Purpose:

To design and implement a standardized risk assessment tool based upon current pre-departure hazard identification criteria in the business aviation industry

- Allows GA pilots to assess their overall risk factors involved with a proposed flight
- FRAT tool will be posted on a nationally recognized business aviation website for use by corporate flight departments, i.e., web-based
- The de-identified data gathered will be analyzed to extract information on the nature of flight operations within this segment of the industry