CONCEPTS and RATIONALE

Loren Rosenthal

The Unmet Data Need

- **Reliable, stable numbers with system-wide scope**
  - To inform policy decisions
  - And, investment decisions
- **Providing better and more rapid feedback on system change**
  - Technological and procedural
- **Facilitating a truly data-driven basis for safety decisions**
  - An escape from the accident *du jour* policy-making syndrome

After examining various possibilities, it was decided that a survey approach could best meet the unmet requirements

Features of the Survey Method

- **Human-centered**
- **Quantitative**
- **Flexible (versatile, topical)**
- **Comprehensive**
- **Well developed methodology**
- **Statistically accurate**
- **Stable**

Users of Survey Research

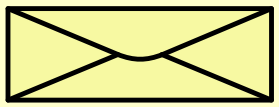
The advantages of the survey method have been demonstrated by its wide use in:

- Federal, State, and Local Government
- Academia
- Federal and State Courts
- Consumer Research

NAOMS Survey Approach

- **Regularly survey pilots, controllers, mechanics, flight attendants and others who operate the national aviation system (NAS)**
  - View the national aviation system through their eyes
  - Includes all types of operations (air carrier, regional, corporate, general aviation)
- **Collect data on respondents events (as operationally experienced)**
- **Guarantee confidentiality of data**
- **Normalize for risk exposure (hours, legs, etc.)**
- **Achieve scientific integrity by using well crafted survey instruments and statistical analysis methods**

NAOMS PROCESS



Pre-Survey Notifications,
Requests and Reminders

CONTROLLERS

FLIGHT ATTENDANTS

AIR CARRIER PILOTS

GENERAL AVIATION PILOTS

MECHANICS

OTHERS

NASA / NAOMS

DEIDENTIFIED SURVEY DATA

RESEARCH PRODUCTS

NAOMS Outputs

- **Safety Event Rates and Trends**
- **Quantitative Analyses of Safety Issues**

NAOMS EVENT RATE ESTIMATES

Preliminary Estimates for Internal Use Only

Equipment Problems

	Question	Risk Exposure Factor	Estimated Event Frequency per Million Exposure Units (COV)* SMA	MED	LRG	WDB
ER1	Diversion Due to Equipment Problem	Hours	2,197.5 (7.16%)	780.8 (6.9%)	496.7 (12.4%)	577.3 (6.9%)
ER2	Hazmat Spill, Fire, or Fumes	Legs		67.4 (32.9%)	53.4 (104.3%)	334.0 (25.2%)
ER3	Cargo Shift	Legs	262.1 (17.54%)	115.2 (29.7%)	2,159.6 (13.9%)	2,674.9 (9.8%)
ER4A	Uncommanded Movement of Elevators	Hours	578.7 (27.50%)	243.7 (15.4%)	115.5 (50.9%)	137.0 (17.8%)
ER4B	Uncommanded Movement of Rudder	Hours	219.5 (39.66%)	81.5 (19.7%)	46.3 (35.8%)	61.2 (29.3%)
ER4C	Uncommanded Movement of Ailerons	Hours	262.0 (53.84%)	103.3 (19.8%)	23.6 (66.2%)	67.6 (27.5%)
ER4D	Uncommanded Movement of Spoilers	Hours	85.2 (45.39%)	97.8 (24.6%)	72.5 (59.5%)	82.3 (24.7%)
ER4E	Uncommanded Movement of Speedbrakes	Hours	78.8 (58.24%)	54.0 (34.5%)	27.4 (48.0%)	37.6 (34.8%)
ER4F	Uncommanded Movement of Trimtabs	Hours	217.2 (43.99%)	53.6 (23.4%)	15.2 (75.3%)	19.9 (49.7%)
ER4G	Uncommanded Movement of Flaps	Hours	216.5 (37.93%)	44.6 (24.9%)	64.5 (34.7%)	50.1 (23.9%)
ER4H	Uncommanded Movement of Slats	Hours	12.2 (286.23%)	42.0 (26.6%)	53.5 (35.1%)	61.1 (29.1%)
ER4I	Uncommanded Movement of Other	Hours	475.6 (32.64%)	178.4 (12.7%)	193.6 (21.6%)	161.2 (13.3%)
ER5A	Fire, Smoke, or Fumes; Engine or Nacelle	Hours	177.8 (54.82%)	70.8 (24.1%)	65.0 (31.5%)	64.8 (28.5%)
ER5B	Fire, Smoke, or Fumes; Flight Deck	Hours	140.5 (48.84%)	50.7 (22.8%)	63.3 (29.6%)	66.1 (19.6%)
ER5C	Fire, Smoke, or Fumes; Cargo Hold	Hours		21.6 (37.8%)	20.2 (70.6%)	47.5 (28.6%)
ER5D	Fire, Smoke, or Fumes; Galley	Hours	116.9 (51.47%)	32.2 (9.8%)	199.7 (44.3%)	266.3 (10.2%)
ER5E	Fire, Smoke, or Fumes; Elsewhere in Pax Compart't	Hours	136.6 (44.9%)	231.5 (11.0%)	157.4 (17.5%)	230.1 (12.5%)
ER5F	Fire, Smoke, or Fumes; Elsewhere	Hours	92.5 (49.4%)	185.1 (13.2%)	88.4 (40.2%)	114.5 (18.6%)
ER6	Precautionary Engine Shutdown	Hours	570.3 (35.08%)	94.2 (17.2%)	50.9 (45.8%)	119.0 (16.9%)
ER7	Total Engine Failure	Hours	187.8 (90.02%)	24.8 (33.6%)	2.9 (126.1%)	43.1 (36.8%)

Protocol Development and Description

Jon Krosnick

Surveys Can Measure:

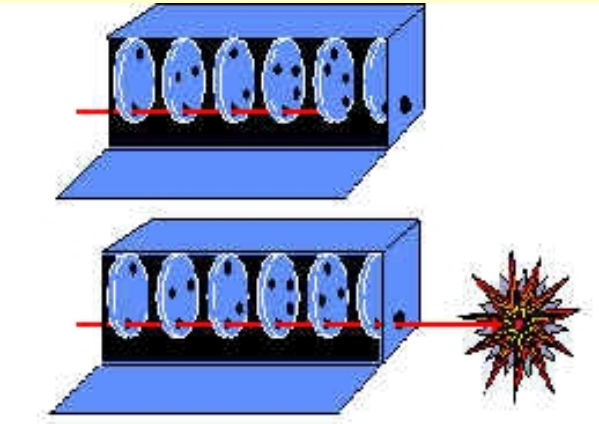
- **Attitudes**
- **Preferences**
- **Beliefs about the state of the world**
- **Predictions about the future**
- **Past behavioral experiences or events**

NAOMS will focus on
the measurement of events

NAOMS
Design Decisions

- **What events to address?**
- **What order of questions?**
- **How long of a recall period?**
- **What mode?**

Types of Events



Accidents

↑

Proximal Causal Events

↑

Distal Causal Events

↑

Static Contribution Factors

Mid-air collision

Incorrect altitude

Altitude clearance misunderstood by pilot

Microphone, earphones, radios, pilot's hearing, noise, etc

Building Lists of Events

- **Focus Groups with Active Professional Participants**
- **Consultation with Industry/Gov't Safety Group, e.g.**
  - CAST
  - FAA
  - ASRS Analysts
  - Workshops
- **Review of Aviation Databases, e.g.,**
  - ASRS
  - NTSB
  - NAIMS
  - BTS
- **Decision: Sample Events at Distal or Proximal Levels of Event Chain**

Question Ordering

Question Ordering Relates to Memory Organization:

- Records of experiences are organized systematically and thematically in memory
- Asking questions in clusters that match a person's memory organization improves measurement precision
- Various hypotheses about how pilots might organize their memories discussed, but no hard data.

Memory Organizations

- **Severity**
- **Causes**
- **Phase of Flight**

Identifying Memory Organization

- **Experiments**
- **Participants: Air carrier pilots**
- **Various tasks**
  - Order of Recall
  - Labeling of Clusters
  - Sorting of Events into Categories
- **Decision: A "hybrid" organization emerged: mostly causes with some phases**

Recall Period

Recall Period - The optimal time between event occurrence and survey

- Needs to maximize recall and balance survey logistics
- Memories fade over time
- Participants should not be asked to recall things from too far in the past
- Literature Review: A literature review resulted in data that we felt to be insufficient for our purposes
- Our own study of pilots' recall of mundane flight events: 7 days maximum
- We needed to determine how long more serious events can be remembered

Recall Period: Validity Analysis

- Association of hours flown with number of events witnessed
- Association of days in the recall period with number of events witnessed
- Strongest relationships for one month and two months
- Decision: Keep recall period less than four months (60 days chosen as recall period)

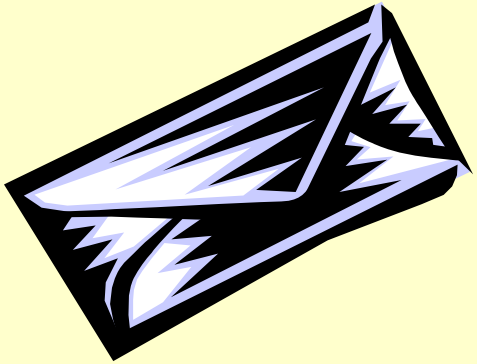
Data Collection Modes

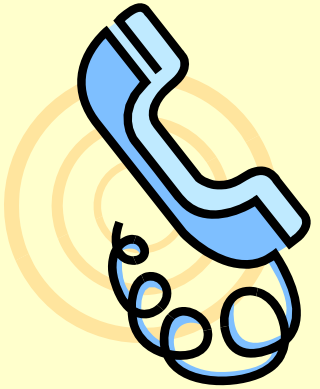
- **Mailed, Self-Administered (SAQ)**
- **Telephone (CATI)**
- **In-Person**

Each mode has positive and negative aspects related to a variety of considerations

Test Findings:

- **Response Rate**
  - Mail 73%
  - Telephone 81%
- **Completion Rate**
  (% missing responses)
  - Mail 4.8%
  - Telephone 0.0%
- **Confidence Rating**
  - Mail 80%
  - Telephone 91%





In-Person Interviewing Terminated Early d/t Time and Cost Investment

Mode: Selection and Validation

- **Validation results:**
  - More hours flown should be associated with more events witnessed
  - More days in the recall period should be associated with more events witnessed
  - Stronger relationships indicate more accurate reporting
- **Mode selection:**
  - 30% stronger relationships for telephone than mail
- **Decision: Perform telephone interviewing (Computer Assisted Telephone Interview - CATI)**

Summary of Design Conclusions

- **Address as many safety events identified during preliminary investigations as practical**
- **Order questions to match hybrid clustering**
- **Use 60-day recall period to maximize documentation of rare events**
- **Use telephone interviewing to maximize measurement accuracy**

Data Collection

Joan Cwi

Sample Design

- **Sample source**
  - Airmen Certification Directory (N = 670,000)
  - Available online at FAA Oklahoma City
- **Samples are drawn among U.S.-based pilots**
  - Air Carrier (N = 55,000) currently available
- **Sample drawn on quarterly basis**
  - Sampling without replacement for 12 rolling months

Locating Pilots

- **Addresses updated, telephone numbers obtained**
  - National Change of Address
  - Telematch
  - Other sources, such as Directory Assistance, Web sites
- **Location results**
  - 80% of AC pilots

Interviewing Process

- Sending Advance Letter
- Screening for Eligibility
- Conducting the Interview

Sending Advance Letter

- **Sent to pilots about a week before calling**
- **On NASA letterhead / envelopes**
- **Explains**
  - purpose of study
  - what participation means
  - confidentiality
  - who will call
  - etc.

Screening for Eligibility

- **Attempt to screen all pilots by telephone**
- **AC screener**
  - Determines pilot has flow in last 60 days as air carrier pilot

Conducting the Interview

- Conduct screening and interviewing using computer-assisted telephone interviewing (CATI)
- Interviewer administers questionnaire from telephone center
- Questionnaire pre-programmed into computer so data entered immediately--no additional data entry
- CATI has most error checks built into the programs--requires little editing
- 10% of each interviewer's work is validated

Air Carrier Interviewing Effort

- **Yearly interviewing effort**
  - Sample size (N = 14,300)
  - Screening (N = 10,700)
  - Interview (N = 8,000)
  - Interview length averages 18 minutes
- **Non- completes**
  - No locates (N = 18%)
  - Not eligible (N = 19%)
- **Progress to date (1.5 years)**
  - 11,800 completed interviews

Air Carrier Survey Overview

Linda Connell

Air Carrier Questionnaire Structure*

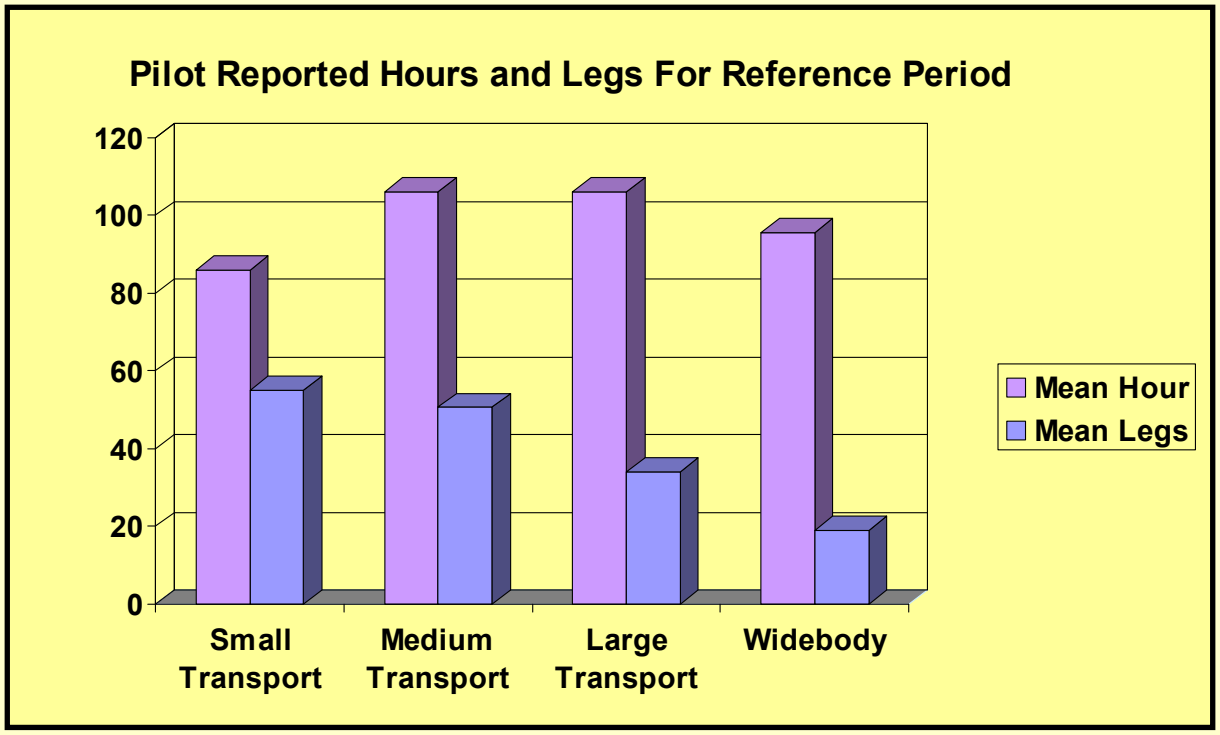
- **Section A: Descriptive Demographic Information**
  - Information suitable for exposure determination: Lifetime hours flown, hours and legs flown last 60 days, aircraft make/model, type flights, crew position and more
- **Section B: Safety Related Events**
  - Consistent data set over time
- **Section C: Focus Questions**
  - Specific topics driven by government/industry high-priority needs
- **Section D: Questionnaire Feedback**

*** Data collection started April, 2001; over 11,800 completed interviews to date**

Air Carrier Results
Section A - Demographics

Respondent Flight Experience	Mean Value
Total Life-Time **Flight Hours**	**10,094 hours**
Last 60 Days **Flight Hours**	**97.8 hours**
Last 60 Days **Departures**	**37 Departures**

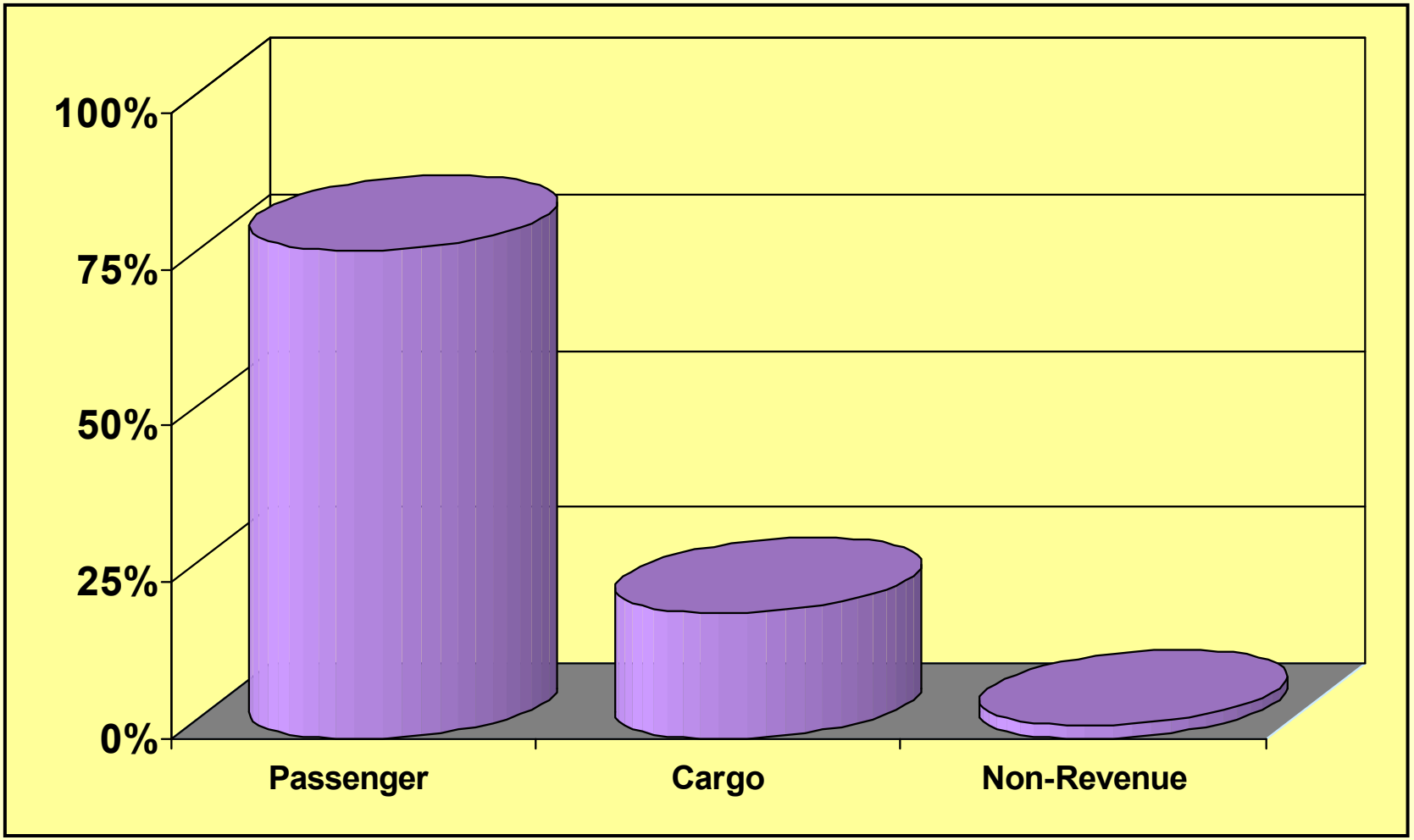
Hours and Legs by Aircraft Size



Aircraft Size	Mean Hours Per Leg
Small Transport	1.5
Medium Transport	2.1
Large Transport	3.1
Widebody	4.9

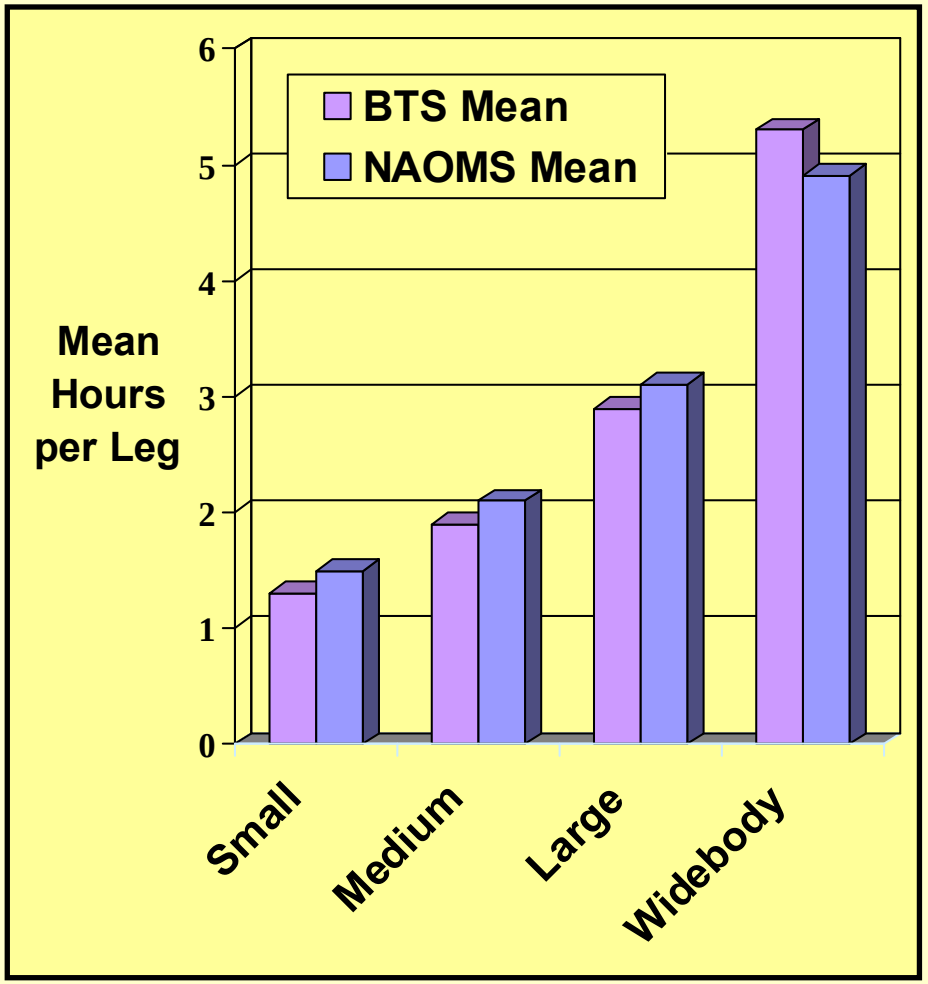
- Small Transport < 100 k lbs GTOW
- Medium Transport ≥ 100 k lbs and < 200 k lbs GTOW
- Large Transport > 200 k lbs GTOW with single aisle
- Widebody > 300k lbs GTOW with two aisles

Type of Flight



NAOMS Flight Time per Leg Estimates Compared to BTS Census Data

Aircraft Category	Estimate Source	Mean Hours Per Leg
Small Transport	NAOMS	1.5
	BTS	1.3
Medium Transport	NAOMS	2.1
	BTS	1.9
Large Transport	NAOMS	3.1
	BTS	2.9
Widebody	NAOMS	4.9
	BTS	5.3



Pre and Post 9-11
Evaluation of Sample Events