SAFETY MANAGEMENT SYSTEM

• Required by International Civil Aviation Organization (ICAO) and FAA international safety standards
• Began implementation in 2005; approved in 2010
ATO SAFETY MANAGEMENT SYSTEM: WHERE WE’RE GOING

- **Improvement/maturation:**
  - Emphasis on quantifiable data collection/analysis
  - Better monitoring through lower-level indicators of safety risk
  - Incorporation of DO 278 standards
  - Adoption of an international maturity model for assessment

- **Full SMS implementation in other FAA lines of business** (Aviation Safety, Airports, Commercial Space Transportation)

- **Integrated FAA SMS:**
  - FAA-wide hazard tracking system
  - Common taxonomy
  - International harmonization
The combination of locally dense traffic and large separation minima limits altitude changes.
Use airborne ADS-B applications to enable altitude changes otherwise blocked by conventional operations.

Altitude changes required for better fuel economy, winds, and ride quality.

Need  Challenge  =  Opportunities
ADS-B ITP ACCOMPLISHMENTS

• In cooperation with RTCA and the European Organization for Civil Aviation Equipment (EUROCAE):
  • Concept of Operations
  • Operational Performance Assessment
  • Operational Safety Assessment
  • Safety, Performance, and Interoperability Requirements Document
• Collision Risk Analysis
• Collision risk models presented to ICAO Separation and Airspace Safety Panel (SASP) and accepted by the mathematical sub-group
• ITP operation circular approved and forwarded to the ICAO Air Navigation Commission
• ITP procedure to be incorporated in ICAO Procedures for Air Navigation Services, Air Traffic Management
ADS-B ITP SAFETY RISK MANAGEMENT DOCUMENT

- System hazard analysis
- Collision risk models
- Air traffic controller procedures
- Flight crew procedures
- Operational Safety Risk Management monitoring plan
## ADS-B ITP OPERATIONAL HAZARDS

<table>
<thead>
<tr>
<th>NUMBER</th>
<th>HAZARD</th>
<th>INITIAL RISK</th>
<th>PREDICTED RESIDUAL RISK</th>
</tr>
</thead>
<tbody>
<tr>
<td>OH-1</td>
<td>Flight crew performs an ITP operation incorrectly and not compliant with the ITP procedure</td>
<td>4D (Low)</td>
<td>4D (Low)</td>
</tr>
<tr>
<td>OH-2</td>
<td>Air traffic control approves an ITP operation that is not compliant with the ITP procedure</td>
<td>4E (Low)</td>
<td>4E (Low)</td>
</tr>
<tr>
<td>OH-3</td>
<td>Reference aircraft maneuvers during the ITP operation when not cleared by air traffic control</td>
<td>3D (Low)</td>
<td>3D (Low)</td>
</tr>
<tr>
<td>OH-4</td>
<td>ITP or reference aircraft encounters wake turbulence</td>
<td>5A (Low)</td>
<td>5A (Low)</td>
</tr>
<tr>
<td>OH-5</td>
<td>Controller overlooks an actual conflict between aircraft because of the additional Conflict Alerts generated by the ITP operations</td>
<td>3D (Low)</td>
<td>3D (Low)</td>
</tr>
<tr>
<td>OH-6</td>
<td>Failure of ITP Electronic Flight Bag during ITP maneuver causes loss of situational awareness</td>
<td>5C (Low)</td>
<td>5C (Low)</td>
</tr>
</tbody>
</table>
EXAMPLE: SRM QUANTITATIVE ANALYSIS

**OH-6**

Failure of ITP Electronic Flight Bag during ITP maneuver causes loss of situational awareness

- LOSS OF GPS CAPABILITY
  - GATE 1
    - Q=7.13E-5
      - RADIO FREQUENCY INTERFERENCE WITH GPS SIGNAL
        - BC 17
          - Q=5.5E-05
        - FAILURE OF GPS INFRASTRUCTURE
          - BC 18
            - Q=6.35E-6
        - DEGRADATION OF GPS ACCURACY / INTEGRITY BELOW THRESHOLD
          - BC 19
            - Q=1E-05
  - MULTIPLE GPS SATELLITES FAIL
    - BC 18A
      - Q=1E-08
  - GROUND STATIONS UPLINK BAD DATA TO SATELLITES
    - BC 18B
      - Q=6.34E-06
## EXAMPLE: SRM QUANTITATIVE ANALYSIS

<table>
<thead>
<tr>
<th>NUMBER</th>
<th>DESCRIPTION</th>
<th>COMMENTS</th>
<th>RATIONALE / FREQUENCY PER FLIGHT HOUR</th>
</tr>
</thead>
<tbody>
<tr>
<td>BC 17</td>
<td>Radiofrequency interference with GPS signal</td>
<td>Intentional GPS interference is considered a security issue per SCAP. Wide-area jamming is most likely near a terminal area, which should be covered by terminal radar, unless the radar has also failed.</td>
<td>5.5E-05 RTCA DO-318 ADS B RAD 3.2.1.3 (6): It is assumed that the likelihood of a GNSS signal-in-space interference event causing a wide-area loss of horizontal position is 5.5E-05 per flight hour, based on historical performance.</td>
</tr>
<tr>
<td>BC 18</td>
<td>Failure of the GPS infrastructure</td>
<td>There has not been a total system failure since the start of GPS service in 1994.</td>
<td>18 years = 157,680 hours Better than 6.34E-06 per hour</td>
</tr>
<tr>
<td>BC 18A</td>
<td>Multiple GPS satellites fail</td>
<td>1E-8 per hour likelihood of 2 simultaneous independent satellite failures, per GPS SPS PS</td>
<td></td>
</tr>
<tr>
<td>BC 18B</td>
<td>Ground stations uplink bad data to satellites</td>
<td>18 years = 157,680 hours Better than 6.34E-06 per hour</td>
<td></td>
</tr>
<tr>
<td>BC 19</td>
<td>Degradation of GPS accuracy and/or integrity below threshold</td>
<td>The accuracy and integrity of the position reports are below the threshold for surveillance and navigation for many aircraft in a geographic region, but the GPS network is still operational.</td>
<td>GPS SPS PS indicates 1E-5 per hour</td>
</tr>
<tr>
<td>ENV 4</td>
<td>All aircraft not equipped with alternative means of navigation</td>
<td>ANDed with GT 1</td>
<td>Q=0.99248, based on 25% non-alternate electronic navigation equipage rate</td>
</tr>
<tr>
<td>EVENT 1</td>
<td>Two or more radars unavailable in a region, creating an Environment B ADS-B-only airspace</td>
<td></td>
<td>Q=1.14E-3 per flight hour, based on historical radar performance</td>
</tr>
</tbody>
</table>
CURRENT SAFETY MEASURES
## 2012 – YEAR OF TRANSITION
ESTABLISHING A NEW BASELINE

<table>
<thead>
<tr>
<th>FROM</th>
<th>TO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Local Reporting</td>
<td>National Voluntary Reporting</td>
</tr>
<tr>
<td>Minimal Local Electronic Monitoring</td>
<td>Automated Electronic Detection</td>
</tr>
<tr>
<td>Operational Incident Counts</td>
<td>Standardized Risk Analysis</td>
</tr>
<tr>
<td>Distance-Based Categorization</td>
<td>Application of Risk Matrix</td>
</tr>
<tr>
<td>Single Event Mitigation</td>
<td>Addressing Systemic Issues (TOP 5)</td>
</tr>
<tr>
<td>Categorization Buckets (A, B, C)</td>
<td>Identification of High Risk Events</td>
</tr>
<tr>
<td>Event Reporting</td>
<td>Investigation and ID Causal Factors</td>
</tr>
<tr>
<td>A+B Metric</td>
<td>Metric on ratio of High Risk Events</td>
</tr>
<tr>
<td>Local Mitigation Monitoring</td>
<td>National High-Priority Goal on Addressing Risk Mitigation</td>
</tr>
</tbody>
</table>

RESULT: A nearly 300% increase in reported incidents
A NEW APPROACH TO RISK ANALYSIS

TARP
CEDAR
DALR
ATSAP
CISP
OEDP

10x MORE DATA OVER LAST 3 YEARS
RISK ANALYSIS PROCESS: CAUSAL FACTORS

- INDIVIDUAL FACTORS
- SUPERVISORY AND ORG FACTORS
- FATIGUE
- ATC/PILOT COMMS/CLEARANCE
- COORDINATION
- AIRSPACE & PROCEDURES
- AIRCRAFT PERFORMANCE OR PILOT ACTIONS
- WEATHER
- SECTOR, POSITION & ENVIRONMENT
- EQUIPMENT
- TRAINING & EXPERIENCE
- FLIGHT DATA, DISPLAY PROBLEMS & AIRCRAFT OBSERVATION
- AIRPORT & SURFACE
- EMERGENCY SITUATIONS & SPECIAL EVENTS
- TRAFFIC MANAGEMENT
# PROACTIVE OCCURRENCE REPORTING

![Table of Proactive Occurrence Reporting](image)

### APRIL 2012 - MARCH 2013

<table>
<thead>
<tr>
<th>Category</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Volume Air Traffic Operations</td>
<td>130,437,567</td>
</tr>
<tr>
<td>Mandatory/Electronic Occurrences for Review</td>
<td>206,943</td>
</tr>
<tr>
<td>Processed Mandatory/Electronic Occurrences</td>
<td>205,596</td>
</tr>
<tr>
<td>Validated Losses of Separation</td>
<td>5,918</td>
</tr>
<tr>
<td>Risk Analysis Events</td>
<td>1,860</td>
</tr>
<tr>
<td>High-risk Events</td>
<td>37</td>
</tr>
<tr>
<td>Losses per Volume</td>
<td>0.00004537</td>
</tr>
</tbody>
</table>

*Note: Most validated losses have multiple record entries for each loss identified. Data is for a rolling period beginning February 2012.*
SYSTEM RISK EVENT DATA

12-Month Rolling Rate
# of High-risk RAEs / Total # of Validated Losses
RUNWAY INCURSIONS

Category A&B Runway Incursions

Total Runway Incursions

- 113
- 75
- 38
0

Category A&B RIs
Runway Incursions


99 126 127 103 108 95 96 88 87 93 94
2 2 2 1 1 0 0 0 0 0 0

16
SAFETY DATA PORTAL: METRICS

Tower/TRACON Topics

<table>
<thead>
<tr>
<th>Trend?</th>
<th>Details</th>
<th>Topic</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td><strong>Missed Approach / Rejected Landings</strong></td>
</tr>
<tr>
<td></td>
<td><img src="image" alt="Graph" /></td>
<td>View missed approach trends at the airport/runway level, or drill down to individual missed approach events and filter by traffic and aircraft details. Browse missed approaches and pull up interesting flights in the event visualizer.</td>
</tr>
<tr>
<td></td>
<td><img src="image" alt="Graph" /></td>
<td><strong>Final Approach Overshoot</strong></td>
</tr>
<tr>
<td></td>
<td><img src="image" alt="Graph" /></td>
<td>Aircraft typically cross the extended runway centerline during their turn to final approach. Once the centerline has been crossed, an overshoot of the centerline can be measured. The locations of the centerline crossovers and the overshoots are captured and shown.</td>
</tr>
<tr>
<td></td>
<td><img src="image" alt="Graph" /></td>
<td><strong>High Energy Approach</strong></td>
</tr>
<tr>
<td></td>
<td><img src="image" alt="Graph" /></td>
<td>Approaches with significantly elevated energy state levels are classified as high energy approaches. View trends in high energy approaches at the airport/runway level, or drill down to an individual high energy approach and observe the final approach altitude and speed profiles.</td>
</tr>
<tr>
<td></td>
<td><img src="image" alt="Graph" /></td>
<td><strong>ATSAP/MOR Combined Reports</strong></td>
</tr>
<tr>
<td></td>
<td><img src="image" alt="Graph" /></td>
<td>Trends and classifications of ATSAP and MOR reports. Topics and causes of ATSAP Reports. Changes in report counts can be the result of changes in the safety events occurring at a facility or simply changes in reporting practice.</td>
</tr>
<tr>
<td></td>
<td><img src="image" alt="Graph" /></td>
<td><strong>MOR Reports</strong></td>
</tr>
<tr>
<td></td>
<td><img src="image" alt="Graph" /></td>
<td>MOR trends, classifications, and narratives.</td>
</tr>
</tbody>
</table>
SAFETY DATA PORTAL: METRICS

ATSAP and MOR Report Counts

Total Count by Source

ATSAP | 180
MOR | 1,071

Category

Insight Equipment Malfunction
Altitude/Route/Speed

Sub-Category

Insight equipment malfunction requiring special handling
Equipment Issue

ATSAP and MOR Occurrences per Month
Comparison Time for Trend
Last Three Months

Facility
A80

Comparison Cohort

Cohort/Facility Type
ARTCCs
Runways
Runway Configuration
All
Single
Parallel
Converging
Crossing
N/A

Occurrence Date
2/1/2012
1/31/2013
SAFETY DATA PORTAL: METRICS

Causal Factors and Trends for All Towers/TRACONS

Trend

Causal Factor Details

Facility Influences

Clearance Problem

Your Facility is: DCA
Select a type of Facility

1. Your Facility
2. All ARTCCs
3. All Towers/TRACONS
SAFETY DATA PORTAL: METRICS
SAFETY DATA PORTAL: METRICS

En Route Daily Overview - 15 Minute Maximum Sector Occupancy
WE MEASURE SUCCESS BY WHAT WE FIX
2013 TOP 5

- RECOVERY
- TRAFFIC ADVISORIES/SAFETY ALERTS
- MONITORING INITIAL DEPARTURE HEADINGS
- SIMILAR SOUNDING CALL SIGNS
- CONFLICTING PROCEDURES
2013 TOP 5

ANNUAL DOT PERFORMANCE GOAL

80%

FAA PERFORMANCE TO DATE
4 CLOSED

21%

19 MITIGATIONS
RESULTS: VOLUNTARY SAFETY REPORTING

PROACTIVE

63,000
ATSAP REPORTS TO DATE

• 64% OF ELIGIBLE PERSONNEL HAVE FILED REPORT
• 300-350 REPORTS PER WEEK

170 CORRECTIONS SINCE PROGRAM INCEPTION

Note: As of FY13-Q2

REACTIVE

5,000

APPROXIMATE OPERATIONAL INCIDENTS OVER 3 YEARS
RESULTS: CONFIDENTIAL INFORMATION SHARING PROGRAM

2,235 REPORTS

SOUTHWEST.COM

American Airlines

CHAUTAUQUA AIRLINES
A REPUBLIC AIRWAYS COMPANY

934 ATSAP REPORTS

FY12

FEDERAL AVIATION ADMINISTRATION
NEXTGEN

SAFETY PERFORMANCE METRICS
# COMMERCIAL CATASTROPHIC ACCIDENT RATE

**PER FLIGHT HOUR WITH DIRECT ATM CONTRIBUTION**

<table>
<thead>
<tr>
<th></th>
<th>Official European TLS</th>
<th>US Accident Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Operational</td>
<td>Operational</td>
</tr>
<tr>
<td></td>
<td>$1.55 \times 10^{-8}$</td>
<td>$0.72 \times 10^{-8}$</td>
</tr>
<tr>
<td></td>
<td>Design</td>
<td>Design</td>
</tr>
<tr>
<td></td>
<td>$1 \times 10^{-9}$</td>
<td>$1 \times 10^{-9}$</td>
</tr>
</tbody>
</table>

Through Redundancy

How should we value Human Performance in Design Standards?
# NEXTGEN TRANSFORMATION

<table>
<thead>
<tr>
<th>FROM</th>
<th>TO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ground-based navigation/surveillance</td>
<td>Satellite-based navigation/surveillance</td>
</tr>
<tr>
<td>Voice radio control</td>
<td>Digital data exchange</td>
</tr>
<tr>
<td>Disconnected information systems</td>
<td>Net-centric information access</td>
</tr>
<tr>
<td>Human-centric air traffic control</td>
<td>Automation-assisted air traffic management</td>
</tr>
<tr>
<td>Fragmented weather forecasting</td>
<td>Probabilistic weather decision tools</td>
</tr>
<tr>
<td>Limited-visibility airfield parameters</td>
<td>Equivalent visual operations</td>
</tr>
<tr>
<td>Forensic safety system</td>
<td>Prognostic safety system</td>
</tr>
<tr>
<td>Inefficient security screening</td>
<td>Integrated security risk management</td>
</tr>
<tr>
<td>Current aircraft environmental footprint</td>
<td>Reduced aircraft environmental footprint</td>
</tr>
</tbody>
</table>
POTENTIAL SAFETY CHALLENGES IN 2020

• Controller situational awareness
• Increased number of alerts/notifications
• Decision support tools
• Propagation of inaccurate information (throughout interrelated NAS)
• Detection/recovery from safety events
• No reduction in existing safety barriers
• Mixed equipage
INTEGRATED SAFETY MANAGEMENT

- Enterprise-focused, risk-based assessments throughout the lifecycle of solution
- Early identification of safety issues
- Integrated safety analyses across vertical, horizontal, and temporal planes
- Hazard and mitigation effectiveness tracking
Questions?

WWW.FAA.GOV/Go/ATOSafety