Discussions on Joint EUROCONTROL/FAA Wake Turbulence Re-Categorization Phase II and III Effort

Outline

- Background for Phase I
- Goals for Phase II and III
- Wake Vortex Model Characteristics Desired to Support Phase II and III (day 1)
- Pilot Model Characteristics Desired to Support Phase II and III (day 2)

Recat Phase I Program Participants

Joint effort led by FAA and Eurocontrol

- Federal Aviation Administration FAA
  - ATO Air Traffic Operations
  - AVS Aviation Safety
- EUROCONTROL
  - Airspace Department
  - Performance and Methods/Safety Assessment
  - Performance and Methods/Validation
- Supporting Organizations
  - Department of Transportation Volpe Center
  - Det Norske Veritas
  - International Subject Matter Experts

Why Now

- Current ICAO wake separation standards are widely viewed as being outdated
- Many ANSP's globally have developed their individual variations from the ICAO standard
- Introduction into service of new large aircraft precipitated international cooperation in addressing ICAO wake standards
- ICAO tasked the FAA and EuroControl to update and harmonize wake separation standards for all aircraft

Methodology

- Focused on representative aircraft for process efficiency
- Wake strength used as the hazard metric
  - Data driven wake decay used to derive the hazard metric
  - Wake decay data from joint FAA and Eurocontrol measurements on both continents used
- Categories optimized for capacity increase
- Relative Safety argument: No worse than today

Results and Accomplishments from Phase I

- Modest changes in aircraft categories and associates separation minima (~5-10% capacity increases)
- First step towards performance based separation minima
  - Moves beyond weight based categories
  - Includes aircraft wingspan, speed, roll moment of inertia,…
  - Provides ATC and automation developers with an understanding of implications of Phase I and the ability to plan for Phases II and III

Phase II Goal

- Static pair-wise separation standards
  - Think of flexible categories where an aircraft can be in one category as a leader and another as a trailer
  - Allows each aircraft (or those that make up 90% of operations) to be optimally categorized
- Tentative schedule: Recommendation to ICAO by Sept 2013

Phase III Goal

- Dynamic pair-wise separation
  - Optimum performance based separation
  - Supports 4-D trajectory planning and execution
- ICAO role to issue system requirements and guidance for ANSP implementation
- Tentative schedule is 2018
  - Recommend system requirements and implementation guidance (e.g., ADS in and out)

Guiding Principles for Phase II and III

- Publically available data, models and tools
- Schedule must be maintained in order to ensure funding
  - Project moves slowly, but a defined pace
  - R&D breakthroughs cannot conform to pre-determined schedules
- We can make progress with current plans for data collection, existing models, etc but
  - Any improvement in wake data, aircraft data and wake & encounter models are obviously welcome
  - Those improvements will enhance results and increase capacity
  - This is why workshops like this one are particularly important to us

Requirements for Phase II and III Recat Wake and Encounter Models

- More wake data, better wake data
  - Primarily through service providers to date (FAA, EUROCONTROL, NATS,…)
  - Operational data on new aircraft after entry into service (A380, B748, A350, B787,…)
  - Filling in the gaps for existing fleet
- Better aircraft data
  - Through manufacturers contributions and operations, supplemented through observations
  - For Phase II
    - Range of aircraft speeds and speed profiles, weights, configurations
    - Approach, departure, en-route
  - For Phase III actual and planned elements should be provided real time
    - Planned approach and departure profile (4-D trajectory)
    - Planned 4-D en-route trajectory including climb and descent intent
    - Actual weight, configuration and observed weather data
    - Methodology to exchange information from cockpit to ground and back

Requirements for Phase II and III Recat Wake and Encounter Models (concluded)

- NextGen and SESAR envision Aircraft based weather sensors
  - Consider the quality and timing of available weather data
  - Work developing ADS-B reporting standards are underway
    - Wx elements
    - Individual timing for each
  - Wake modeling should consider the quality and timing of available weather data
- Discussion: What else should be included?

Discussion on Phase II and III Wake Models Needs

- Wake strength has been the primary safety metric
  - Similar to other wake separation efforts (7110.308, WIDAO, B757, A380, B748) focus was on single wake
  - Double wake system may be worth considering
    - Pilots cite this as a potential plausible worst case encounter
    - For many of the aircraft pairing types (heavy leading and smaller trailing), the differences in wingspan suggest that this type of encounter may be modeled as 2 independent encounters
    - Recat team has not conducted a literature survey in this area
- Discussion: Should we consider encounters with a wake system (pair)?

Discussion on Phase II and III Wake Models Needs (continued)

- Wake data collected and used to date naturally contains perturbed vortices especially at longer times
- Previous encounter modeling efforts have assumed a straight line vortex
- Topics today included encounters with perturbed vortices
- Discussion: Should we consider encounter modeling with a perturbed vortices?

Discussion on Phase II and III Wake Model Needs (concluded)

- While wake strength has been the primary safety metric for Phase I, bank angle and roll acceleration were also reviewed
  - General observations included higher bank angles for smaller aircraft trailing at the longer ICAO separation distances than heavier aircraft at shorter ICAO distances
  - Similarly, wake induced rolling moment as a percentage of roll control authority was higher for smaller aircraft trailing at the longer ICAO separation distances than heavier aircraft at shorter ICAO distances
- Static elements of encounter model might include
  - Wake induced rolling moment
  - Roll control authority of the aircraft
- Discussion: What other metrics should be considered as a measure of safety?

Pilot Model Needs for Recat Phase II and III

Discussion on Phase II and III Pilot Model Needs

- Static elements of encounter model might include
  - Wake induced rolling moment
  - Roll control authority of the aircraft
- Dynamic elements of encounter model might include
  - Roll inertia of the aircraft
  - Pilot and automation response times
- Performance-based operations and standards sought by NextGen and SESAR look to reduce the human variability in the system
- Multiple approaches to modeling pilot behavior have been presented today
- Discussion: Should the analysis of wake encounters in a performance-based system include pilot responses or autopilot responses or both?
  - Is the answer different for Phase II than III?

Discussion on Phase II and III Pilot Model Needs (concluded)

- Why should pilot response models be included in the analysis for Phase II or Phase III?
  - If WVE severity metrics are developed that include the effects of pilot responses, what is the goal of decoupling pilot responses from overall severity?
- How complex of a pilot model is required, if one is required?
- If pilot response models should be included in the analysis for Phase II and III
  - What characteristics should it have?
    - How is base behavior defined ?
    - What deviations from base behavior should be considered?
  - How should pilot response models be incorporated into the analysis?
    - Use autopilot simulations to resolve open issues about worst case encounter angles, etc
    - Add pilot responses near the end of the analysis to isolate its contribution to risk
  - Discussion: What kind of pilot response models should be included and how should they be included?

Discussion on Phase II and III Pilot Model Needs (concluded)

- Some evidence indicates that pilot intervention may increase the severity of a wake encounter
- Clearly there are encounters where pilot intervention is necessary to:
  - counteract the wake during an encounter
  - recover from the upset after the encounter
- If pilot response models should be included in the analysis for Phase II and III…
  - Is it possible to define practical guidance on when a pilot should and should not intervene?
  - Are there existing performance criteria from which we can define this "boundary"
    - RNP 0.1 => 600 ft deviations are probably too large for consideration
    - <1 dot lateral offsets inside the OM (~100 ft) is closer to a useful value
  - Could we use some % of an acceptable wake encounter criteria as a boundary?
  - Is there any way to implement guidance in a practical way?
- Discussion: In a performance based system, is today's pilot behavior a given in the modeling of wake encounter severity or can some changes be justified and incorporated?