THE FORTY-FIFTH MEETING OF THE INFORMAL PACIFIC ATC CO-ORDINATING GROUP (IPACG/45)

(Tokyo, Japan, 9-13 December 2019)

Agenda Item 3: Air Traffic Management (ATM) Issues

United States Concept of Operations for Weather Deviation Clearances

(Presented by the Federal Aviation Administration)

SUMMARY

Convective weather creates a serious risk and aircrews need to avoid it for the safety of the aircraft and its passengers. Whenever possible, ATC should provide lateral deviation clearances when requested if separation will be maintained. Because an aircraft with a lateral deviation clearance may make several turns to avoid the weather, ATC currently has no predictability on how longitudinal separation will be affected. This paper provides information on the United States' effort to introduce longitudinal predictability to weather deviations and increase the availability of lateral deviation clearances.

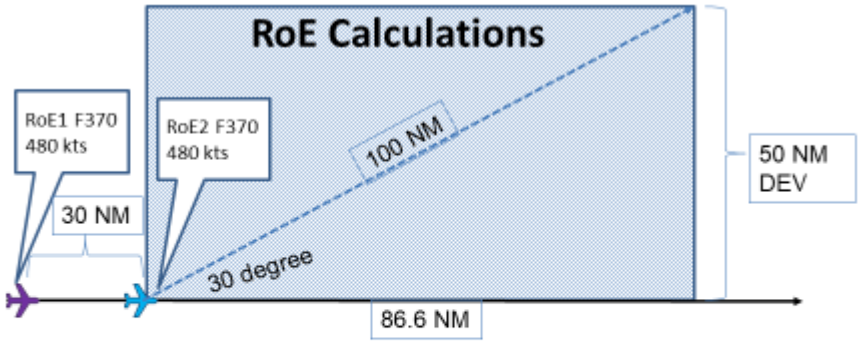
1. Introduction

1.1. When an aircraft is issued a lateral deviation clearance, they are given approval to deviate as necessary within the expanded lateral confines of the deviation clearance. The aircraft may make several turns at unknown angles while on the deviation without announcing its intentions to ATC. Currently, ATC has no predictability of the aircraft flight path while the aircraft is executing a lateral deviation. Without predictability, it is not possible for ATC to evaluate the effects of the lateral deviation on longitudinal spacing between aircraft pairs. Per ICAO Doc 4444 5.4.2.9.5, the Performance Based Longitudinal Separation (PBLS) minima are applied "so that the distance or time between the calculated positions of the aircraft is never less than the prescribed minimum." ATC must protect against the lateral deviation worst-case scenario to ensure the aircraft do not fall below the prescribed minimum. Protecting against the worst-case scenario frequently requires ATC to deny lead aircraft requests for lateral deviation clearances that could have been safely completed if there was longitudinal spacing predictability.

1.2. This paper discusses the FAA efforts to introduce longitudinal predictability with lateral deviation clearances by issuing an angular limitation on the deviation course. This will increase the percentage of lateral deviation requests that can be approved

2. Discussion

2.1. When the lead aircraft in a pair of aircraft separated by a PBLS minimum is deviating, there is a large potential for erosion of the longitudinal spacing. This Rate of Erosion (RoE) is a factor of the ground speeds and deviation path of the aircraft. The greater the angle of the deviation in reference to the cleared flight path, the greater the RoE will be. Figure 2-1 illustrates how RoE can be calculated.



•RoE2 distance traveled 100 NM; 12.5 mins at 480 kts

•RoE1 distance traveled 86.6 NM

•13.4 extra NM traveled by RoE2 divided by 12.5 minutes travel time for RoE2 = 1.072 NM per minute Rate of Erosion.

Figure 2-1 Rate of Erosion Calculation

In Figure 2-1 both aircraft have a ground speed of 480 knots for the ease of the explanation. The lead aircraft, RoE2 deviates from the cleared route of flight at a 30 degree angle to reach the limit of the 50 NM lateral deviation clearance. RoE2 will fly 100 NM to reach the 50 NM limit of the cleared deviation. If RoE1 remains on the cleared route of flight, it will fly a shorter 86.6 NM to reach the point abeam of RoE2. The extra 13.4 NM RoE2 will fly is divided by the 12.5 minutes it takes to fly 100 NM to calculate a RoE of 1.072 NM per minute. The RoE is also affected by the difference between the two aircraft ground speeds. For example if RoE2 is 75 knots faster that RoE1, the RoE is a negative number and not a factor.

2.2. Figure 2-2 illustrates how greater deviation angles create a larger RoE.

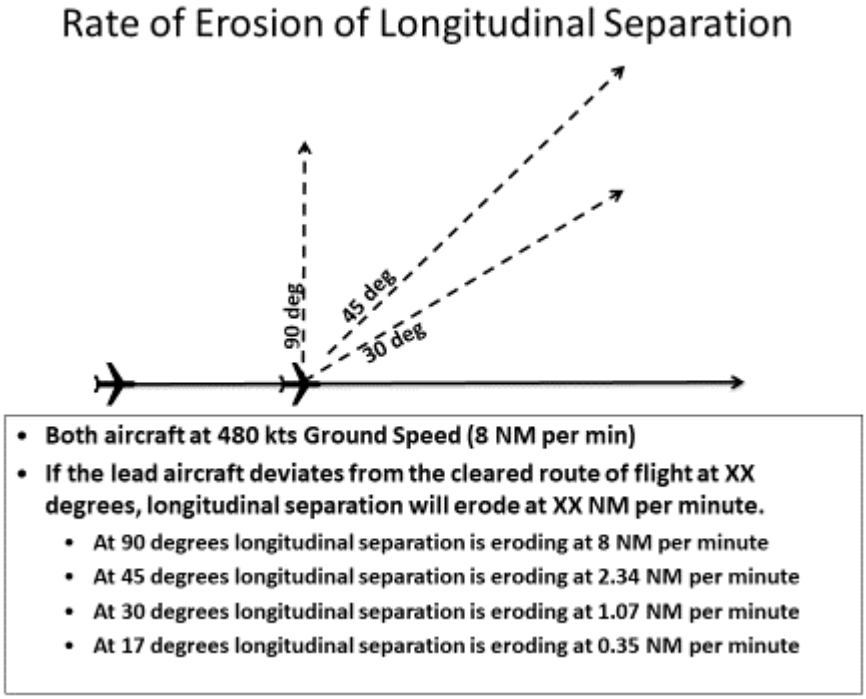


Figure 2-2 Deviation Angle effect on RoE

If the lead aircraft deviates at a 90-degree angle, spacing will erode at 8 NM per minute. However if the lead aircraft deviates at 17 degrees, the RoE is a much more reasonable 0.35 NM per minute. Without a limitation on the deviation angle, ATC must protect for the worst-case scenario and in most cases must deny a lateral deviation request when the lead aircraft is deviating and a PBLS minimum is being applied.

2.3 The United States presented WP03 to SASP WG29, which provided statistics on the angles aircraft deviated from their cleared route of flight in US controlled oceanic FIRs. Overall, the data from SASP29 WP03 showed that 89 % of the aircraft studied had a deviation angle of 30 degrees or less. The average deviation angle was around 17 degrees. The largest deviation angle encountered was 52 degrees. These figures are important to consider when developing lateral deviation procedures. You want the procedure to apply to most weather deviation instances.

2.4 For the calculation of the RoE, Figures 2-1 and 2-2 showed aircraft deviating at a constant angle to reach the limit of the deviation clearance. If all aircraft deviated in this manner it would be easy to calculate the extra spacing required to allow the lead aircraft to deviate. In reality, lateral deviations can be more complex. An aircraft on a lateral deviation clearance may need to make several turns that continue for an undetermined length of time around different weather cells. There is no way to determine how much longitudinal spacing will be lost with a lateral deviation. However if the lateral deviation clearance contained a limit on the deviation angle, the controller/ATC computer would be able to calculate a maximum RoE and know how fast aircraft spacing could erode. The Communication and Intervention timing models used in the PBLS Collision Risk Model provide timelines allocated for ATC intervention. The ANSP may analyze operational data and determine an intervention time for their airspace. The ANSP would be able to calculate a buffer distance above the longitudinal minima when ATC would need to take action to prevent an aircraft pair from falling below the minimum by multiplying the intervention time and the RoE from the limitation on the deviation angle.

2.4.1 The US is developing software to support controllers issuing lateral deviation clearances using the concept above. When a controller was applying a PBLS minima between two aircraft and the lead aircraft requested a lateral deviation, the controller would append the lateral deviation clearance with a deviation angle limitation.

UM82 CLEARED TO DEVIATE UP TO *(distance) (direction)* OF ROUTE
UM169 MAINTAIN A COURSE WITHIN 30 DEGREES OF THE CLEARED ROUTE AT ALL TIMES

If the controller issues this clearance they know that spacing will erode at worst case 1.07 NM per minute (both aircraft 480 kts). If the ATOP intervention time is set at 5 minutes, when the spacing erodes to 5.35NM (5 min * 1.07 RoE) above the minimum, the controller would be alerted to take action to ensure separation. The 30 degree limitation would not be required with all deviation clearances.

2.4.2 The ATOP system would protect against the 30 degree deviation angle limitation RoE and the need to protect for the rarer extreme deviation angles has been eliminated. By using a 30 degree limitation most aircraft (89%) will be able to comply with limitation and still remain clear of the convective weather. If an aircraft couldn't comply with the 30 degree limitation, the controller/ATOP system would apply a standard time based separation minima. When aircraft are deviating laterally the ATOP system would increase ADS-C periodic rate to monitor the spacing changes. On average aircraft will deviate at a 17 degree angle which causes a smaller RoE than ATOP is protecting for.

2.4.3 When the controller probes a lateral deviation clearance for potential conflicts, the ATOP system would also provide information alerts to the controller on the likelihood that an aircraft would have enough spacing to complete the deviation. The alert is based on the extra spacing required for the aircraft to fly to the limit of the deviation and a multiplication factor. The initial multiplication factor is expected to be 2, that is the extra distance to fly to the deviation limit and back to the route. The multiplication factor can be changed in the facility adaptation and adjustments can be made to provide the controller with the alerts they desire. This alert is not an absolute calculation, but it provides the controller with information to assist in making an informed control decision.

2.4.4 The ATOP System Conflict Probe will also account for the potential spacing variations that can be caused by intersecting routes and turns in the route of flight..

2.5 Placing an angular limit on deviation courses will increase safety by eliminating unexpected extreme deviation course changes and increase the percentage of times when a controller is able to issue a deviation clearance.

3 Conclusion

3.1 The meeting is invited to note the information provided; and

3.2 Support ATC angular limits on deviation courses.