

INTRODUCTION

Based on a data sampling of the current Air Transport fleet, a significant number of ADS-B equipped aircraft do not meet the requirements for Enhanced Visual Approach (EV App) in the ASA MASPS (RTCA DO-289) and are therefore considered invalid for EV App operations. This is mainly due to the large number of those aircraft whose GPS assume that Selective Availability (SA) is on. GPS which assume SA on calculate a large Horizontal Protection Limit (HPL), despite the fact that their position accuracy (as measured by horizontal figure of merit – HFOM) is quite good. The large HPL values in turn cause transponders to calculate low integrity values.

The result of all this is that a significant number of ADS-B equipped aircraft cannot reap the benefits of the EV App operation, even though their position accuracy is quite high.

An analysis of the safety implications of allowing lower quality and integrity limits to be used for EV App operation was performed. No adverse safety impact was found as a result of lowering the accuracy and integrity limits.

Based on this analysis, ACSS believes that lower accuracy and integrity thresholds for EV App should be considered in order to accommodate the current ADS-B equipage of aircraft.

CURRENT REQUIREMENTS EV APP

The requirements for EV App are as follows.

- A Navigation Accuracy Category – Position (NACp) of 7 or higher is required, implying a 95% probability that the actual aircraft position lies within 185m (0.10nm) of the calculated position. A NACp of 6 is considered degraded but valid for continued operation.
- A Navigation Integrity Category (NIC) of 7 or higher is required, implying a containment radius of 370m (0.2nm).
- A Surveillance Integrity Level (SIL) of 1 or higher is required, implying a 10^{-3} probability that the actual aircraft position is more than the containment radius from the calculated position.

The current NACp and NIC limits are illustrated in Table 1.

Table 1: Current Requirements for EV App

		NAC																																			
		0	1	2	3	4	5	6	7	8	9	10	11																								
		10 NM	4 NM	2 NM	1 NM	0.5 NM	0.3 NM	185.2 m	92.6 m	30 m	10 m	3 m																									
NIC	0	NOT VALID																																			
	20 NM																																				
	1													DEGRADED																							
	8 NM																																				
	2																									VALID											
	4 NM																																				
	3	VALID																																			
	2 NM																																				
	4													VALID																							
	1 NM																																				
	5																									VALID											
	0.6 NM																																				
6	VALID																																				
370.4 m																																					
7													VALID																								
185.2 m																																					
8																									VALID												
75 m																																					
9	VALID																																				
25 m																																					
10													VALID																								
7.5 m																																					
11																									VALID												

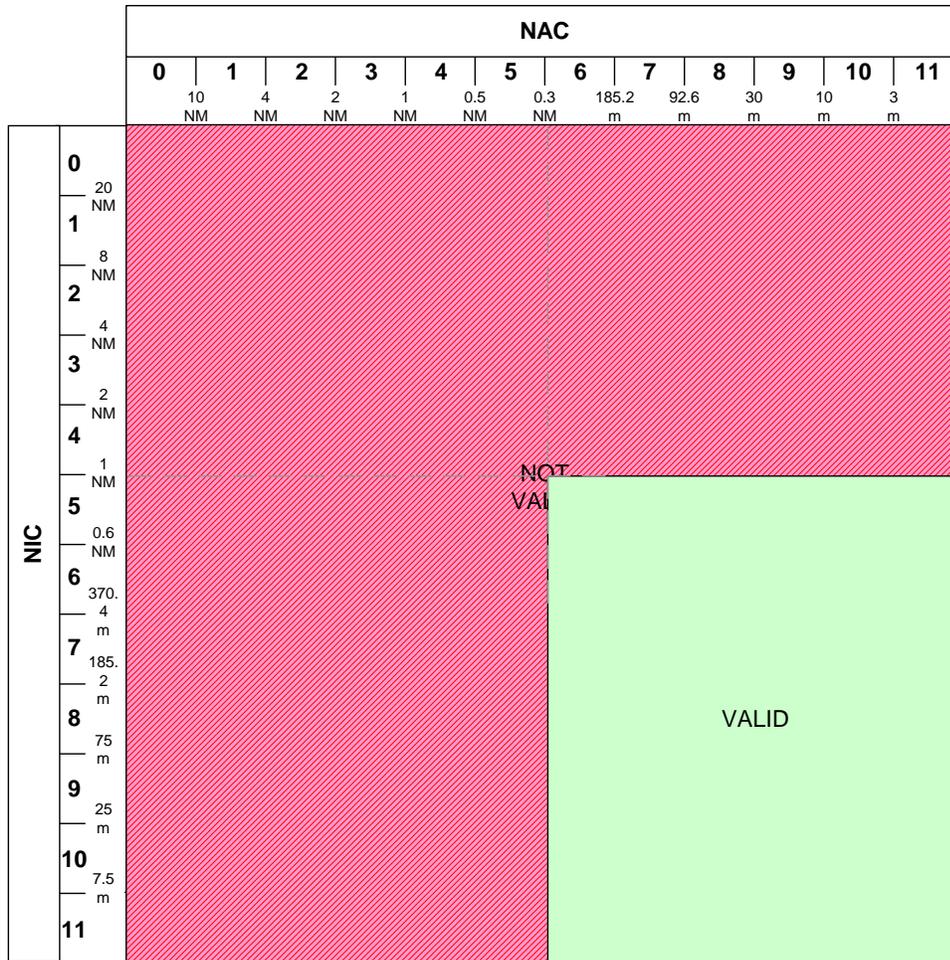
A significant number of MMR-equipped aircraft today have GPS which assume that Selective Availability (SA) is on. These systems typically calculate accuracy, as measured by HFOM, on the order of 15m. However, because of the assumption of SA –On, these same systems calculate integrity, as measured by HPL, on the order of 130m to 460m. These values of HPL result in a DO-260A compliant transponder calculating a NIC as low as 6. For instance, during a 2 hour flight test, the MMR reported a NIC of 6 for about 30% of the flight. As a result, despite the high accuracy of the calculated position, these aircraft cannot currently perform EV App (either as ownship or target to follow).

PROPOSED REQUIREMENTS FOR EV APP

A lower NIC value of 5 and NACp value of 6 are proposed for EV App operations. A NIC of 5 corresponds to a containment radius of 1.0nm. A NACp of 6 corresponds to an accuracy radius of 0.3nm. Assuming independent position errors between the lead aircraft and the trail aircraft, the separation error can be expected to have an upper bound of 1.4 nm [based on a containment radius of 1.0nm for ownship and the traffic to follow, and a root mean square sum of the errors $(1^2+1^2)^{1/2}$].¹

¹ Note that GPS position errors for two proximate aircraft may not be independent, but a common error would likely shift both positions in the same direction, which would have little effect on the separation between the two position estimates.

Table 2: Proposed Requirements for EV App

		NAC											
		0	1	2	3	4	5	6	7	8	9	10	11
		10 NM	4 NM	2 NM	1 NM	0.5 NM	0.3 NM	185.2 m	92.6 m	30 m	10 m	3 m	
NIC	0												
	1												
	2												
	3												
	4												
	5												
	6												
	7												
	8												
	9												
	10												
	11												

SAFETY CONSIDERATIONS

EV App is a traffic situational awareness application to assist the flight crew during the approach phase of flight. The requirements for EV App operations include that the crew continues to obtain visual out-the-window contact with the traffic to follow and has correlated the out-the-window traffic with the traffic displayed on the CDTI. This includes confirming that the traffic to follow on the CDTI is consistent with the information provided by ATC. EV App will be performed in VMC conditions; therefore the pilot will continue to perform normal VMC traffic scanning. Additionally, under EV App operations, the traffic to follow will be proceeding to the same runway as ownship.

Errors in GPS position will result in an inaccurate display on the CDTI. If the error is large (as compared to the actual spacing between the aircraft when ATC calls out the traffic to follow) the crew will not be able to correlate the out-the-window traffic with the CDTI traffic. If the error is not large enough to be noticed by the pilot, then the nature of the EV App operation will limit the risk of a minimum separation distance being violated. During EV App, the aircraft are nominally following the same ground track and flying in

the same direction to the same runway. Additionally, due to the finite time and distance that an aircraft will operate under EV App, the amount of overtake that one aircraft can have on another is similarly limited, since at the point where radar separation is terminated the aircraft will have at least 4nm separation.

RTCA document DO-303 "Safety, Performance and Interoperability Requirements Document for the ADS-B Non-Radar-Airspace (NRA) Application", concluded that a NACp of 6 and a NIC of 5 were sufficient to allow ADS-B to be used as a sole means of separation with a separation minimum of 3.0nm. (The document also concluded that a NACp of 5 and a NIC of 4 were sufficient when the separation minimum was 5.0nm.) It is worth noting that the NRA application is based on maintaining separation of aircraft going in different directions for arbitrary periods of time.

In contrast to the independent flight paths associated with the generic NRA application, an aircraft performing EV App is, by definition, in a visual approach environment. The duration of the approach operation is limited by its very nature. Additionally, ownship and the traffic to follow will be traveling in the same general direction and going to the same runway. With all of these mitigating factors, the probability for a conflict is much smaller for EV App as compared to NRA.

The minimum separation in the terminal area is about 3.0 NM. Even at minimum reported separation and expected maximum error, the aircraft would still have positive physical separation. As calculated above, even with a maximum error of both aircraft positions that can be expected 10^{-3} of the time and with the pilot intending to fly with a minimum separation of 3nm, and even with the crew not losing visual contact with the traffic to follow, the aircraft separation would still be over 1.6nm.

SUMMARY

ACSS believes that the integrity limit for EV App operations should be changed from a NIC of 7 or greater to a NIC of 5 or greater. Also the accuracy limit should be changed from a NACp of 7 or greater to a NACp of 6 or greater. This change would significantly increase the usability of the EV App function while maintaining safe separation between participating aircraft.