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Safety during Degradation of Automated Air Traffic Control Systems

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The degradation of radar systems represent a high level of risk and modern aviation can't allow that. This text contains options for calculation in the descent of an aircraft during degradation of air traffic automated systems. Visibility procedures are mentioned here as well as minimal valid distances in procedural control, which should air traffic controller apply in the event that radar systems are degrading.

Keywords: safety, air traffic, sir traffic controller, procedural control

Introduction

Degradation of automated systems may reduce the required level of safety. In order to avoid such a situation, it is important for individual air traffic controllers to participate in regular maintenance training. He should prepare either aircraft crew or ground staff to emergencies that can happen in a normal working day. Such a situation can arise whether the radar system degrades or when operating under low visibility or other crises. The air traffic controller shall promptly decide on the airborne situation in order to maintain the fluidity of operation and perform the most efficient air traffic control. This applies twice if the radar system or other crises are degraded.

1. Calculation of Aircraft Separations During Degradation of Automated Systems

If there is a degradation of the radar system, it is necessary to proceed to the procedural air traffic control. During transitioning to procedural control, minimal spacing increases. In such a case, the air traffic controller shall be obliged to address the airborne situation on the basis of aircraft crew reports. In order for an air traffic controller to be able to safely manage air traffic despite the degradation of the system, it is necessary to master the basic mathematical calculations that are important in ensuring minimum distances. In mathematical calculations, it is important to know the meaning of the prescriptive constraints, the required plane clearance, the radius of curvature, the budget angle and the plane's approach. The wind component remains neglected. Figure 1 shows the following relationship:

$$tg\frac{\varphi}{2}=\frac{R}{Dnv}\Rightarrow\varphi=2*tg\frac{\varphi}{2} \quad (1)$$

The radius of curvature can be calculated according to:

$$R=\left(\frac{(v*0{,}514)^2}{g*tg\beta}\right)*0{,}00054 \quad (2)$$

where :

- v - speed in knots;
- 0.514 - transmission constant from knot velocity to $m.s^{-1}$;
- g - gravitational acceleration, which is constant, and therefore 9,80665 $m.s^{-2}$;
- β - the angle of the aircraft's heel;
- 0.00054 - transmission constant from distance m to Nm

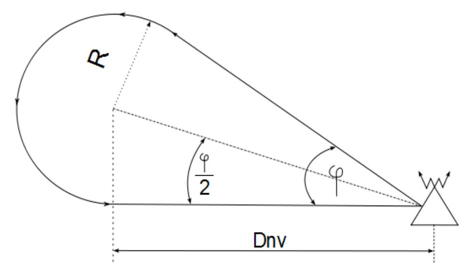

Figure 1 The radius of curvature

The following relationship can be used to calculate the required flight deviation distance:

$$Dnv=\left(\frac{0{,}514*v_{zos}}{3600}*t_{sv}\right)*0{,}00054\,; \quad (3)$$

where:

- v_{zos} at low speed in knots;
- 0.514 - transmission constant from Knot unit to $m.s^{-1}$;
- t_{sv} - sink time in seconds;
- 0.00054 - transmission constant from distance m to Nm.

Air traffic must adapt to meteorological changes. There may be a situation where meteorological conditions deteriorate to such an extent that air traffic constitutes a possible threat to safety. In such a case, it is important to apply low visibility procedures. In order for transport to be possible under such conditions, it was also necessary to integrate into air traffic systems that allow air traffic to be carried out even under conditions such as reduced visibility and low cloud cover. It is assumed that these procedures must be applied when the path visibility value falls below 2000 ft or if the cloud base or vertical visibility drops to 200 ft. Nowadays, the only device that can be used to appproach in at low visibility values is the exact ILS approach device. (Sloboda et al., 2016)

In the event of system degradation, it is important for an air traffic controller to be able to apply the aforementioned relationships to ensure minimum separations. Separations that can be secured between aircraft are either vertical or horizontal. Horizontal separations can be further subdivided into longitudinal or transverse separations. In ensuring minimal separations in procedural control, it is important that the surrounding operation is informed of the navigation device to be used. In Regulations is a division of the transverse slots, which must be ensured in the course of the procedure for the flight operations. Figure 2 shows a minimum pitch that can be used for both landing and take-off aircraft. From Figure 2, it is clear that the navigation device being used is VOR. Under this separation, it is important to ensure that both aircraft are stationary on radials that differ by 15 degrees and at least one aircraft is at a distance of 15

NM or more from the VOR navigation device. (Svetlík et al., 2017; Kicko et al., 2017)

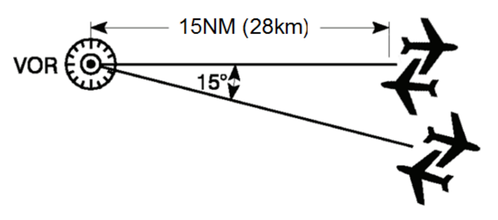

Figure 2 VOR 15 miles separation

NDB can also be used to ensure a minimum separation. This rossope is only valid if the aircraft are seated on tracks that are at least 30 degrees different and at least one aircraft is at a distance of 15 NM from the NDB navigation device. This separation is shown in Figure 3.

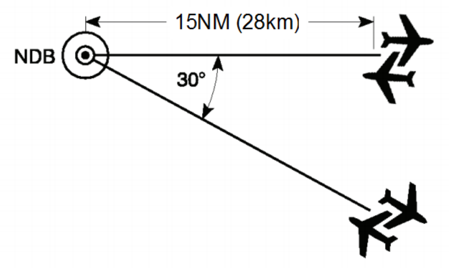

Figure 3 NDB 15 miles separation

The longitudinal separation must be such that the time intervals or distances between the calculated positions of the aircraft are never less than the prescribed minimum. A speed adjustment is applied to maintain the separation between aircraft flying on the same track. (Božek et al., 2016; Sabo et al., 2017)

Figure 4 15 minutes separation on the same track

Figure 4 shows the longitudinal separation between aircraft on the same track, which is applicable to aircraft flying on the same flight level. This separation may be reduced if the navigation device is often able to determine the position and speed of aircraft. In this case, the separation is reduced to 10 minutes. Reducing this separation is only possible if the aircraft are flying on the same track and on the same flight level and if the front aircraft maintains a true airspeed of 20 kt higher than the rear aircraft. The time interval between aircraft in this case is 5 minutes. However, when the front aircraft maintains a true airspeed of 40 kt higher, the separation may be reduced to 3 minutes. (Hovanec et al., 2017; Kaľavksý et al., 2015)

Conclusion

An air traffic controller is an important part of the air traffic safety system in case of air traffic systems degradation. In crisis situations, it must be able to apply appropriate procedures to maintain safe operation. Given the great emphasis in recent years on the impact of aviation on the environment, it is important that the air traffic controller also takes into account the most economical solution to the airspace.

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