

Risk Assessment Summary

The above calculations are probabilistic estimates and are not precise calculations. These estimates are intended to convey a sense of the reduced MAC risk that will result from this rule. The rule will result in reduced collision risk to all types of airplanes with the greatest risk reduction benefiting cargo airplanes.

Quantifiable Benefits of Collision Avoidance Systems for Air Cargo Airplanes

Introduction

This section quantifies, to the extent possible, the expected dollar benefits of installing CAS on cargo airplanes. The process is to determine the risk of a MAC between different types of airplanes, incorporate the expected number of accidents without the final rule, estimate the cost of potential accidents, and finally estimate the expected loss.

Accidents: Risk

Earlier in the benefits analysis the FAA estimated that the number of cargo airplane MAC's will be 0.5 accidents in a 20 year time period. The risk of a cargo airplane MAC with another airplane depends on the pairs of airplanes present in the same airspace at about the same time and whether such airplanes have a CAS. This section estimates the risk of a cargo airplane MAC with another airplane.

MITRE computes the conditional pair probabilities of three combinations of airplanes that fly in the same U.S. airspace at about the same time. In this case, a conditional pair probability is a pair of airplanes where at least one of the airplanes is a cargo airplane. It is assumed that the risk of a near midair collision (NMAC) is proportional to the pair probabilities. The risk of a NMAC is used rather than the risk of a MAC, because most of the statistical models used in studying the safety of TCAS II were derived from encounter data and not from MAC data. Accordingly, risk reduction estimates from equipping cargo airplanes can be obtained by multiplying the pair probability of each relevant pair by the risk reduction factor associated with collision avoidance equipage.

There are three cargo airplane potential MAC combinations: a cargo airplane and another cargo airplane, a cargo airplane and a general aviation airplane, and a cargo airplane and a passenger airplane. MITRE calculated that the conditional pair probability for two cargo airplanes is 0.324, for a cargo and general aviation airplane, 0.174,

and for a cargo and passenger airplane, 0.503 (Row 1 of Table V-1 in the full Regulatory Evaluation).

These conditional pair probabilities are based on cargo airplane proximity with other airplanes. However, passenger airplanes are already equipped with CAS, thereby reducing their risk of a MAC. The cargo/passenger conditional pair probability is multiplied by the MITRE-estimated passenger-equipped CAS risk ratio of 0.092 to obtain the NMAC cargo/passenger conditional risk probability (Row 3 of Table V-1 in the full Regulatory Evaluation). This calculation results in a cargo/passenger NMAC probability of 0.046 and a total NMAC risk of 0.544 for all combinations (Row 3, Column 4 of Table V-1 in the full Regulatory Evaluation). Finally, the percentage of risk by equipment (Row 5) is determined by dividing the conditional pair probabilities (Row 3) by 0.544. Then, given that there is a cargo airplane MAC, approximately 60 percent of these accidents will be with a cargo airplane, 32 percent will be with a general aviation airplane, and 9 percent will be with a passenger airplane.

The expected number of accidents without the final rule has previously been estimated to be 0.5 over the next 20 years. Multiplying this expected number of cargo accidents by the percentage of risk (or probability in Table V-1 in the full Regulatory Evaluation) by equipment results in the expected number of accidents by equipment. Thus the expected number of cargo airplane MAC accidents without this final rule equals 0.298 with another cargo airplane; 0.160 with a general aviation airplane; and 0.043 with a passenger airplane.

Expected Costs of Accidents

The expected costs of a cargo airplane MAC is equal to the probability of such an accident with another airplane multiplied by the value of averted fatalities and equipment, plus the collateral damages. Unlike accidents occurring on an airport, it is assumed that a midair collision will result in fatalities for all passengers and crew, rather than some percentage attributed to various classifications of injuries. The value per averted fatality is estimated to be \$3.0 million. This estimate increased from the \$2.7 million used in the IRE because the Department of Transportation increased this value for benefit/cost analysis purposes. Cargo airplanes are valued here at \$5 million each with 2 crew for each airplane resulting in an estimated benefit of \$22 million per averted MAC. An averted

cargo airplane MAC with a general aviation airplane is valued at \$23.5 million, with the general aviation (GA) airplane valued at \$500,000 with one GA pilot and with three GA passengers. Given the wide range of seating for commercial airplanes, herein the FAA uses a representative 150-seat airplane with a 75 percent load factor. With such a passenger airplane valued at \$30 million dollars, then an averted midair collision with a cargo airplane is valued at \$396.5 million. The expected averted value of a cargo airplane MAC then is the percent of expected accidents by equipment multiplied by the value of the averted accidents, summed for the three possible cases, or approximately \$27 million in a 20 year time period.

Collateral damage is the damage on the ground that occurs as a result of a MAC. Collateral damage may be the greatest cost of a MAC. However, the costs of collateral damage are very dependent on where the accident occurs. If the MAC occurs over a relatively unpopulated area, the costs of the collateral damage may be relatively low. However, even in unpopulated areas collateral damage can be serious and costly. For example, collateral damage from a MAC could start a fire with ensuing damage. The FAA assumed a low collateral damage estimate of \$1 million, essentially a couple of buildings and no loss of life.

The expected total averted loss equals the sum of expected accident loss by equipment plus the \$1 million collateral damage. This estimate is very conservative in not including emergency response and legal/court costs estimated at approximately \$120,000 per averted fatality. The total expected loss is approximately \$28 million over twenty years. However, operators of approximately 65 percent of the existing cargo fleet have voluntarily equipped their airplanes with TCAS. Therefore, only 35 percent of the fleet will undergo the costs of installing TCAS purely as a result of this rule. Reflecting the voluntary compliance of 65 percent of the air cargo fleet, the total benefit of this rule is reduced to approximately \$10 million (\$28 million multiplied by .35).

Sensitivity Analysis

The estimated benefit of \$10 million is the product of an expected accident rate, the percent of the fleet whose operators have not voluntarily complied, and the expected preventable loss of a midair collision with a cargo airplane and another airplane. As the above discussion just outlined the value of a preventable midair collision is many times greater than \$10 million.