Incursion Risk at Rapid Exit Taxiway Taxi-outs

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Abstract

Aircraft safety in the airport maneuvering areas is one of the key objectives in air transport. One factor that threatens airfield safety is incursion accidents. ICAO Runway and Ground Safety Working Group has identified runway incursions as a high-risk accident category. The number of runway incursion incidents remains at a rate of 1 per day. The three main causes for incursions are operational incidents, pilot deviation, and vehicle/pedestrian deviations. According to the historical accident investigations, pilot errors, air traffic control (ATC) faults, communication errors, ground vehicle driver faults, visibility, sight distance, and sight angle issues are causal factors. According to the Transportation Safety Board of Canada (TSB), the majority of incursions occur when the exiting aircraft crossed the holding position stop-bar in the completion of the exiting maneuver. Changing designs and positions of the rapid exits were some of the top recommendations to the Greater Toronto Airports Authority. Planning and designing taxiways are important aspects in minimizing incursions. The present design guidelines cover the rapid exit taxiway design elements at taxi-in in terms of aircraft safety. Nevertheless, aircraft incursion risk at taxi-out locations is not focused on design guidelines. Considering this research gap and the emerging demand for rapid exit taxiways, this paper developed a methodology to evaluate incursion risk at rapid exit taxiway taxi-outs. Considering two aircraft that both are approaching to the intersection of rapid exit taxiway -parallel taxiway. One aircraft is coming from the rapid exit taxiway and the other one is on the parallel taxiway. At any given moment, the aircraft on the parallel taxiway is a certain distance from the intersection and the aircraft on the rapid exit taxiway is also a certain distance from the intersection. Using the fundamental equations of motion, a mathematical formula is developed to evaluate the distance between two aircraft when the high-speed taxiing aircraft is at the intersection. Accordingly, this mathematical formula is further extended to the following criteria that the distance between two aircraft is not less than the required minimum separation to not to conflict them together. A conflict between two aircraft depends on the aircraft's performance and dimensional characteristics, taxiway configurations. These factors are included in the mathematical condition and they could be adapted to any rapid exit taxiway configuration to evaluate the related conflict probabilities. Here, the term “conflict” is evaluated as potential conflicts may appear even though pilot or controller interventions may stop them to grow up to incursions. Using the methodology, the rapid exit taxiway with the associated least conflict probability at the taxi-out was found. Accordingly, 45-degree acute angle taxiways cause the minimum incursion risk. The greatest conflict probability is given by the 20-degree super acute angle. This seems that conflict probability decrease when the acute angle increases. This is in line with the FAA recommendation for larger taxiway angles such as 90-angle as much as possible to avoid runway incursions. Even though conflict probability decreases with the increasing acute angle, conversely, when the acute angle increases, excursion risk increases at the taxi-in location of the rapid exit taxiways. Therefore, the best suitable rapid exit taxiway configuration should be chosen by considering both excursion and incursion risk.

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