

## Appendix C – Key Studies on Aircraft Deviation

ACRP 4-09 - Risk Assessment Method to Support Modification of Airfield Separation Standards

The following table summarizes some of the most relevant studies addressing lateral aircraft deviations during runway, taxiway and taxilane operations. The models developed by Scholz (2003a and 2003b) were used in the approach to analyze taxiway and taxilane separations.

Table C-1. Relevant studies on aircraft lateral deviation in airfields

Title	Year/Author	Description
Evaluation of Existing Airfields for C-5A Operations	Brown & Thompson, 1973	This study was conducted with test sections for B-47 (Stratojet), B-52, KC-87, and KC-135 aircraft. The report also makes reference to studies conducted in 1949 and field observations carried out in 1956. The concept of wander was introduced. Wander was defined as “the maximum lateral movement of a point on the centerline of an aircraft about the centerline (or guideline) on taxiways or runways during operation of the aircraft.” The lateral deviations for those aircraft from the taxiway and runway centerlines can be considered as approximately 3.2 ft and 33.7 ft, respectively, during 75 percent of the time.
Field Survey and Analysis of Aircraft Distribution on Airport Pavements	HoSang, 1975	Deviation data were collected from 9 airports and 12 types of commercial aircraft with maximum gross weights above 50,000 pounds, including: Boeing 747, 707, 727 and 737; McDonnell-Douglas DC-10, DC-8 and DC-9; Lockheed L-1101; General Dynamics Convair 880 and 580; British Aircraft Corporation BAC-111; and Nihon YS-11. The standard deviations for individual aircraft types, compared at the various airports, varied from 3 to 8 ft for takeoffs and from 4 to 9 ft for landings. The mean offsets were consistently to the right of the pavement centerline. The mean offset for all 48 operations on the 75-ft taxiway was 2.09 ft, compared with 3.2 ft for all 102 operations on the 100-ft taxiway. The standard deviations on the 75-ft taxiways generally ranged between 2.5 and 4 ft, and those on the 100-ft taxiway were generally wider, with an overall average of about 6 ft
Taxiway Deviation Study	British Airport Authority, 1987	Before the introduction of the Boeing 747-400, in 1987, the British Airport Authority conducted a research study to assess the degree random aircraft lateral deviation during taxiing operations. The analysis involved over 77,000 observations on both straight and curved sections of taxiways. Data was gathered at London Heathrow airport from March to September 1987. The analysis

Title	Year/Author	Description
		demonstrated that the probability of 2 B 747-400 aircraft colliding, when passing each other on parallel taxiways with 251 ft separation between centerlines was approximately $1 \times 10^{-8}$ . It was assumed a 213 ft wing span for the Boeing-747-400 aircraft.
Statistical Analysis of Aircraft Deviations from Taxiway Centerline	Boeing Information and Support Services, 1995	The objective of this study was to assess the probabilities of extreme deviations from the taxiway centerline. The analysis was conducted by Boeing and utilized taxiway deviation data collected at Amsterdam Schiphol Airport for B-747 aircraft (100, 200, 300 and 400 series). Over 9,000 observations on both straight and curved taxiway sections were collected for the analysis. The analysis conclude that the collision risk was less than $10^{-9}$ on taxiway pairs providing a nominal 28 ft wingtip-to-wingtip separation.
Preliminary Analysis of Taxiway Deviation Data and Estimates of Airplane Wingtip Collision Probability	Cohen-Nir & Marchi, 2003	Preliminary analysis of the risk of collisions involving airplanes in common taxiing situations, based on FAA data collected for B747-100/-200/-300/-400 and SP models at Anchorage International Airport (ANC) and New York John Fitzgerald Kennedy Airport (JFK). The analysis estimated the risk of NLA wing tip contact with fixed or movable objects and the joint probability of collision between two airplanes taxiing simultaneously.
Statistical Extreme Value Analysis of ANC Taxiway Centerline Deviations for 747 Aircraft	Scholz, 2003a	This study was carried out based on the same data collected at ANC and used in the study by Cohen and Marchi. The goal was to provide a basis for understanding the extreme behavior of centerline deviations of B-747. The sample size was equivalent to 9796 deviations obtained in both directions of the taxiways. Two types of bias were considered in this study: parallax bias, attributed to the pilot's cockpit position relative to the 747 centerline; and techniques utilized by pilots to avoid passing over the taxiway centerlights. Wander probability distribution models were developed based on centerline deviation data gathered over one year of operations.
Statistical Extreme Value Analysis of JFK Taxiway Centerline Deviations for 747 Aircraft	Scholz, 2003b	This study was carried out based on the same data collected at JFK and used in the study by Cohen and Marchi. The goal was to provide a basis for understanding the extreme behavior of centerline deviations of B-747. The sample size was equivalent to 2518 deviations obtained in both directions of the taxiways. Wander probability distribution models were developed based on centerline deviation data gathered

Title	Year/Author	Description
		over one year of operations. The methodology was similar to the one presented in the previous study.
Statistical Extreme Value Analysis Concerning Risk of Wingtip to Wingtip or Fixed Object Collision for Taxiing Large Aircraft	Scholz, 2005	This report describes the analysis concerning the risk of collision between two large aircraft taxiing on parallel taxiways and the risk of collision between a large taxiing aircraft and a fixed object, such as a building. The basis are the two previous studies by the same author for data gathered at ANC and JFK. The study characterizes the relation between object separation from taxiway centerline (T), wingspan (W), aircraft deviation (d) from taxiway centerline, and collision risk (p). Moreover the study estimates the risk of two aircraft colliding with each other at their respective wingtips while taxiing on parallel taxiways. This study is also the basis of the risk curves for taxiway/taxilane/object separation presented in this ACRP report.