FINAL REPORT
(Research Summary)

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"Investigation of Wake-Vortex Aircraft Encounters"

submitted to

Mr. Dan D. Vicroy
Flight Dynamics Branch
NASA Langley Research Center

by

Dr. Sonya T. Smith
Principal Investigator

Department of Mechanical Engineering
Howard University
2300 Sixth Street NW
Washington, DC 20059, USA

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The National Aeronautics and Space Administration is addressing airport capacity enhancements during instrument meteorological conditions though the Terminal Area Productivity (TAP) program. The major goal of the TAP program is to develop the technology that will allow air traffic levels during instrument meteorological condition to approach those achieved during visual operations. The Reduced Spacing Operations (RSO) subelement of TAP at the NASA Langley Research Center (LaRC) will develop the Aircraft Vortex Spacing System (AVOSS). The purpose of the AVOSS is to integrate current and predicted weather conditions, wake vortex transport and decay knowledge, wake vortex sensor data, and operational definitions of acceptable strengths for vortex encounters to produce dynamic wake vortex separation criteria. The proposed research is in support of the wake vortex hazard definition component of the LaRC AVOSS development research. The research program described in the next section provided an analysis of the static test data and uses this data to evaluate the accuracy vortex/wake-encounter models. The accuracy of these models has not before been evaluated using experimental data. The research results also presented the first analysis of the forces and moments imparted on an airplane during a wake vortex encounter using actual flight test data.

I. Project Description

a. Objectives and significance of the research

The National Aeronautics and Space Administration is addressing airport capacity enhancements during instrument meteorological conditions though the Terminal Area Productivity (TAP) program. The major goal of the TAP program is to develop the technology that will allow air traffic levels during instrument meteorological conditions to approach those achieved during visual operations. Two major initiatives under TAP are the enhancements of basic Air Traffic Control (ATC) automation tools and the development of a wake vortex spacing system to improve terminal area efficiency and capacity. The NASA Ames Research Center is charged with developing enhancements to the base Center/TRACON Automation System (CTAS). These enhancements will provide interfaces to the controller, which will aid in the effective scheduling and sequencing of arrivals and will also minimize variations in desired interval spacing. Enhanced CTAS automation will provide an opportunity to dynamically alter the longitudinal wake vortex separation constraint as a function of both the weather effects on wakes and aircraft leader/follower pair types. [1]

The Reduced Spacing Operations (RSO) subelement of TAP at the NASA Langley Research Center (LaRC) will develop the Aircraft Vortex Spacing System (AVOSS). The purpose of the AVOSS is to integrate current and predicted weather conditions, wake vortex transport and decay knowledge, wake vortex sensor data, and operational definitions of acceptable strengths for vortex encounters to produce dynamic wake vortex separation criteria. By considering ambient weather effects on wake transport and decay, the wake separation distances can be decreased during appropriate periods of airport operation. Using this information with an interface to CTAS, spacing can be tailored to specific leader/follower aircraft types rather than the three broad weight categories in use currently [1].

The philosophy behind the AVOSS system is to avoid aircraft encounters with vortices above an "operationally acceptable strength." This avoidance is obtained through consideration of two factors: wake vortex motion away from the flight path of a following aircraft and wake vortex decay. Since these factors are highly dependent on ambient meteorological conditions, as well as the generating aircraft's position and type, the wake vortex constraints are expected to vary significantly with weather. [1]. Providing this information to an automated air traffic control system such as CTAS will produce capacity gains due to considering both the wake transport and decay, and by also providing a large matrix of aircraft pair separations to ATC automation.

The AVOSS consists of three crucial elements: the prediction subsystem, the weather subsystem, and the sensor subsystem. The core of the AVOSS system is the prediction subsystem. The predictor will utilize weather data, an aircraft database to predict the initial wake and the threshold of wake vortex strength for an acceptable encounter, airport configuration data, and wake sensor feedback. Using the weather and sensor data, the prediction system will compute both the time required for vortices from each aircraft to clear the AVOSS corridor and the expected time for them to decay to an acceptable strength for each follower aircraft. The lesser of either the transport or decay time will be taken as the wake spacing constraint at that point. For each aircraft pair, the recommended final approach wake constraint will be the largest of the wake constraint times[1].

Dr. Sonya T. Smith
Howard University