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AERODYNAMIC PREDICTIONS, COMPARISONS, AND VALIDATIONS USING MISSILE DATCOM (97) AND AEROPREDICTION 98 (AP98)

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The US Air Force Missile DATCOM (97 Version) and the Naval Surface Warfare Center Dahlgren Division AP98 are two widely used aerodynamic prediction codes. These codes predict aerodynamic forces, moments, and stability derivatives as a function of angle of attack and Mach number for a wide range of axisymmetric and non-axisymmetric missile configurations. This study evaluates the accuracy of each code compared to experimental wind tunnel data for a variety of missile configurations and flight conditions. The missile configurations in this study include axisymmetric body-alone, body-wing-tail, and body-tail. The aerodynamic forces under investigation were normal force, pitching moment, axial force, and center of pressure location. For the configurations detailed in this paper, these case studies show normal force prediction for both codes to have minimal error. Both AP98 and Missile DATCOM were effective in predicting pitching moment coefficients, though at times limiting factors were necessary. Finally, both AP98 and DATCOM predict reasonable axial force coefficients for most cases, though AP98 proved more accurate for body-wing-tail and body-tail configurations.

NOMENCLATURE

C_A	= Axial Force Coefficient
CG	= Center Of Gravity
C_m	= Pitching Moment Coefficient
C_N	= Normal Force Coefficient
l_b	= Length of Body (calibers)
M_∞	= Mach Number
Re	= Reynolds Number
S_t	= Sum of the Squares of the Residuals Between the Error at Each Data Point and the Mean Error
s_y	= Standard Deviation from Mean Error (RMS error)
X_{CP}	= Center Of Pressure Location
y_i	= Error at Each Data Point
α	= Angle Of Attack
ϕ	= Roll Angle From Vertical (ϕ=0° is "+" configuration)

1.0 INTRODUCTION

The 1997 Version of the United States Air Force (USAF) Missile DATCOM[1] and the Naval Surface Warfare Center Dahlgren Division (NSWC/DD) AP98[2] are semi-empirical aerodynamic prediction codes that calculate aerodynamic forces, moments, and stability derivatives as a function of angle of attack and Mach number for a variety of axisymmetric and non-axisymmetric missile configurations. Both codes have the added capability to predict pressure contours and interference factors as well as the capability for the user to easily substitute and/or change aerodynamic parameters to fit specific applications for a broad range of flight conditions. Flight conditions and aerodynamic parameters range from subsonic to hypersonic speeds, angles of attack up to 90 degrees, and control surface deflections from -35 to 35 degrees. The output computes fin-alone, body-alone, and body+finset aerodynamic forces and moments in addition to center of pressure location, interference factors, and geometric data. The capabilities of each aeroprediction code are very comprehensive.

This validation effort was conducted to determine the accuracy of each code for specific missile types when compared to wind tunnel data. The following case studies are representative of a variety of missile configurations that include axisymmetric body-alone, body-tail, and body-wing-tail at various flight conditions. Missiles with inlets were not studied in this validation effort because AP98's prediction capability does not yet extend to air-breathing systems. Normal forces, pitching moments, axial forces, and center of pressure location were compared with experimental results.

2.0 DETAILS

The configurations and flight conditions presented in this paper are shown in Table 1. Unless otherwise noted, all cases are modeled with untrimmed fin data,

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