Experimental Investigation of the Near Wake of a Sport Utility Vehicle (SUV)

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Report Number - N002139-05

02 April 2003

SUMMARY

The flow in the near wake of SUVs is very unsteady and characterized by separated shear layers from the top, bottom and sides of the vehicle. A better understanding of the unsteady nature of this flow can lead to low drag coefficient, thus reducing the fuel consumption. In addition, separated shear layers can generate aerodynamic noise which in turn may influence the level of comfort in the passenger compartment. The complexity of the flow makes drag prediction tools, including CFD based methods, unreliable. Although SUVs are the most growing vehicles in use today, quite few studies have been reported about the aerodynamics of these vehicles. The main goal of the present study is to gain a better understanding of the SUV aerodynamic by conducting pressure and flow field measurements of the flow in the near wake of the SUV. These measurements are important to identify the steady and unsteady forces that are acting on the vehicle. Another secondary objective of this investigation is to obtain quantitative data set for validation of numerical simulation of the flow in the near wake of SUVs. The PIV measurements of the velocity field normal to the freestream behind the model have been obtained in the symmetry and center horizontal planes. The PIV data are processed to obtain not only the instantaneous velocity field but also the mean flow and turbulence properties by averaging 300 instantaneous realizations. The mean pressure distribution on the top and bottom surfaces of the SUV shows expected behavior and a base pressure coefficient in the range of -0.23 to -0.1. The spectrum of the pressure coefficient fluctuations in the base of the SUV shows a weak Strouhal peak around $\tilde{f} = 0.07$ and a large energy density at low frequencies. The flow field measurements in the symmetry plane show a relatively large recirculation region near the bottom edge of the model and another relatively small near the top shear layer. In addition, two shear layers originating from the top and bottom of the SUV have been observed. The underbody flow accelerates upward very rapidly towards the freestream flow. In the horizontal plane, two relatively large recirculation regions in both sides of the symmetry plane and two shear layers originating from the sides of the SUV are found. The downstream extent of these recirculation regions is about 175 mm which is almost 1.15 times the width of the model.