AEROACOUSTICS OF TWIN SUPERSONIC IMPINGING JETS

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A method of controlling the acoustic and aerodynamic characteristics of ideally expanded impinging twin jets has been proposed. As a means of control microjets were used at the nozzle exit. The effect of the controlling method on the flow field and acoustic field was investigated. Particle Image Velocimetry was used as the main tool for flow field diagnostics. The results show that the predominant unsteady character of the impinging twin jets were reduced considerably by the control. Consequently at certain ground plane heights, up to 5 dB reductions in Over All Sound Pressure Level of jet noise was observed and up to 25% of the lift loss was recovered. The lift loss recovery was obtained by decreasing the entrainment of the ambient fluid in to the main jet and thus lower suction pressures on the lift plate. On the other hand no significant effect of control on the fountain flow, which helps lift recovery with up wash, was found.

1. INTRODUCTION

Experimental studies relating to jet flows representative of V/STOL aircraft in ground effect have been carried out in our laboratory to provide a basic understanding of the flow phenomena involved. Although much literature exists on this topic[1], our focus has been on the role of flow-generated noise and its mitigation on the aerodynamic performance of STOVL aircraft in hover, in particular, at higher jet exhaust velocities.

While hovering in close proximity to the ground, Short Take-off and Vertical Landing (STOVL) aircraft experience a suckdown force, commonly known as "lift loss"[2]. This lift loss is due to the entrainment flow associated with the lifting jets which induce low surface pressures on the airframe resulting in a force opposite to lift. The lift loss in hover increases in magnitude as the aircraft approaches the ground. When the aircraft is in vertical landing mode and is near touch down, in addition to lift loss, the impingement of the high speed lifting jets on the ground plane lead to significant ground erosion[3]. Increased Over All Sound Pressure Levels (OASPL) associated with the supersonic jets is also of concern with respect to sonic fatigue of structural elements in the vicinity of the nozzle exhaust. These problems become more severe when the jets operate at supersonic speeds, which is the case in the current and future generation, STOVL aircraft (e.g. the Joint Strike Fighter). When two or more jets are impinging on a ground plane, the resulting wall jets create a fountain between the jets. The impingement of the fountain flow on the aircraft body produces an upload, which partially offsets the suckdown due to entrainment flow associated with lifting jets[4]. This positive effect is seen only under certain jet operating conditions.

The subject of this paper is the investigation of the noise and flow field characteristics of twin impinging supersonic jets with the configuration shown in figure 2. This particular configuration is similar to that used in our single impinging jet studies carried out earlier and the results of which are reported in reference 2.

2. EXPERIMENTAL APARATUS AND PROCEDURES

The experiments were conducted in STOVL supersonic jet facility of the Fluid Mechanics Research Laboratory located at the Florida State University (figure 1). The facility was designed to obtain the jet-induced forces on a STOVL aircraft model hovering in and out of ground effect. In order to simulate the hover effect, the distance between the ground plane and the jet nozzle exit was varied by moving the ground plane up

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