1.0 INTRODUCTION

The hazards of airplane contamination, such as that resulting from frost, ice, and snow during winter operations, to flight safety are well established. A survey of aviation accident/incident data bases, reported in Reference 1, revealed 67 reported accidents/incidents related to on-ground icing between 1977 and 1985. Fourteen of the 67 accidents resulted in 114 fatalities. Operational regulations requiring clean airplane surfaces, such as those contained in FAR's 91, 121, and 135, are long standing. Many articles extolling the virtues of a "keep it clean" maintenance policy have been published by airlines, certification agencies, airframe manufacturers, and others. Yet, day-to-day airline operations during the winter season must combine considerations of safety with the constraints of schedules (including that of the passenger, aircraft and crew) and economics. For example, how does the flight crew respond to unknown wing contamination which has accumulated during a three hour taxi to the takeoff runway in freezing rain or snow at a crowded international airport? Airplane contamination during winter operations has been a perplexing problem, especially for airlines operating in the Northern hemisphere.

European airlines have worked together, as the Association of European Airlines (AEA), to establish guidelines, procedures and specifications for materials and equipment for deicing and anti-icing aircraft on the ground. By working closely with fluid manufacturers, a thixotropic aircraft deicing fluid has been developed which provides protection against ice, snow, and frost for extended holdover periods of time. The glycol based Type II deicing fluids are highly viscous after being applied to an aircraft, and remain on the aircraft preventing ice, snow, and frost from adhering to the airplane surface while the airplane is parked or taxied at slow speeds. In concept, the shear stress at the wing surface reduces the fluid viscosity as the aircraft accelerates during the takeoff ground roll and at the same time displaces the fluid toward the trailing edge.

In-service roll-off incidents, results of small scale wind tunnel experiments by The Boeing Company, and full scale tests performed by airlines indicate that current Type II anti-icing fluids do not completely flow off the aircraft prior to rotation speed, as once was expected. Boeing test data suggest that the presence of residual fluid may result in a loss in lift and an increase in drag. Results of the Boeing wind tunnel testing were transmitted to the airlines by a service letter, with a recommendation to carefully review use of de-/anti-icing fluids to avoid possible adverse aerodynamic effects.

The following discussion details wind tunnel testing performed by Boeing to evaluate flow behavior and aerodynamic effects of the aircraft de-/anti-icing fluids.

2.0 DISCUSSION

2.1 Aircraft De-/Anti-icing Fluids

The general purpose of aircraft de-/anti-icing fluids (ADF) is to provide an "aerodynamically clean" aircraft prior to flight when operating in weather conditions conducive to frost and precipitation contamination. There are two generic type of ADF's.