Under contract to the Transportation Development Centre (TDC) of Transport Canada (TC), APS Aviation Inc. (APS) undertook a research program to study and document the adhesion of aircraft anti-icing fluids subjected to winter precipitation on aluminum surfaces.

During conduct of Type I snow endurance time testing in the winter of 2001-02, it was observed that at milder temperatures (typically above -3°C), the fluid often completely diluted to water sometime before freezing. When freezing finally occurred, the resulting ice adhered to the surface. Since fluid adhesion is the critical aspect of the clean-wing policy, it would be useful to have a better understanding of the relationship between fluid endurance time and the time that adherence occurs. The difference in those times can be considered a safety buffer, and varies considerably for different conditions.

The objectives of this study were to document the instances in which fluid adhesion occurs and determine the extent of the safety buffer after fluid failure. To satisfy these objectives, laboratory tests under freezing precipitation conditions were conducted at the National Research Council Canada in Ottawa, and natural snow tests were conducted at the APS test site at Dorval Airport. Tests were also performed under artificial snow at PMG Technologies Inc., using an artificial snowmaking system. These tests were conducted using samples of Type I, Type II, and Type IV fluids supplied by fluid manufacturers for endurance time testing, under a wide range of temperature, precipitation rate, precipitation type, and wind conditions.

It was concluded that, in terms of adhesion, Type I and Type II/IV fluids exhibit similar behaviors under freezing precipitation conditions, while they exhibit different patterns in snow conditions. In snow, Type I fluids were found to adhere to the test surface only at moderate and high precipitation rates (typically, above 10 g/dm²/h). It was also observed that the extent of the safety buffer enlarges as the concentration of the glycol in the solution increases. Type II/IV fluids were not observed to adhere to the underlying surface under snow conditions, irrespective of the precipitation rate and outside temperature. These fluids appear to continue to provide a level of protection far beyond the point when failure calls would normally be made. Contrary to snow conditions, adhesion was detected under freezing precipitation conditions for both Type I and Type II/IV fluids. Independent of the fluid type, precipitation rate and ambient temperature, fluid adhesion was observed under freezing drizzle, light freezing rain and rain on cold-soaked wing conditions.

Several recommendations were made for completing this research. These include additional testing related primarily to areas not addressed by the 2002-03 testing sessions (including heated Type II/IV, adhesion testing in frost and bare surface adhesion testing).