

EFFECTS OF WING SIMULATED GROUND FROST ON AIRPLANE PERFORMANCE

1.0 INTRODUCTION

During the 1970's, a series of apparently unrelated winter weather incidents occurred. This trend increased during the 1970's and into the early 1980's, as evident in Figure 1. The nature of the incidents/accidents was not what one might expect, such as an increase in off-runway excursions due to slippery runways. It was not until a close examination of the January, 1982 Boeing 737 accident at Washington D.C that a "winter operations" pattern was established.

In December, 1982 a fully loaded Boeing 727 struck threshold lights and nine sets of approach lights after lifting off from a 10,500 foot runway. Because of icing of the engine inlet pressure probes, erroneous engine instrument readings led to low thrust and degraded airplane performance. The crew had to rotate, 5 to 10 knots early, to the tail skid attitude and maintain a nose high attitude to obtain maximum climb performance. Fortunately, because the crew had insisted on very thorough preflight deicing, normal wing aerodynamic capability was available to fly the aircraft near stall. Less than 1 month later, the serious Washington, D. C. 737 accident occurred with iced engine inlet probes and contaminated wing surfaces. In addition to weather, airplane systems, and crew, airplane preflight maintenance was newly appreciated as a vital safety factor. The safety record showed that a strict "keep-it-clean" philosophy was essential and that preflight maintenance was critical to winter operations safety.

In response to the incident record, the industry took a number of related actions to improve the safety record. Airlines, working with suppliers of deicing equipment, reviewed maintenance procedures to develop improved deicing techniques and fluids. Bulletins, literature, and training videos, refocusing the attention of flight crews and maintenance personnel to the keep-it-clean philosophy, were produced to instruct them in safe cold weather operation. Manufacturers and others stepped up research into the effects of airplane surface frost, ice, and snow on performance and handling qualities. The Boeing Company's extensive flight testing of the 737, 757, and 767 airplanes affirmed the safest airplane is an airplane free of frost, ice or snow. The objective of the following is to review the results of the 1982-83 Boeing flight test programs of the 737, 757, and 767 with simulated ground frost contamination.

2.0 DISCUSSION

2.1 Flight Test Program and Instrumentation

A series of flight tests were conducted during 1982-83 on the Boeing models 737-200ADV, 757-200, and 767-200 to evaluate the effects of inadvertent wing upper surface frost on performance and handling qualities. Specific objectives included:

- o Evaluation of the loss in free air lg maximum lift, C_{LMAX} , and the ensuing loss in the maneuver margins at operational speeds