[Tail Plane Icing] NCC3-624 CASI

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## Background

The Aviation Safety Program initiated by NASA in 1997, in response to a call by the "Gore Commission" on improved aviation safety and security, has put greater emphasis in safety related research activities. Ice-contaminated-tailplane stall (ICTS) has been identified by the NASA Lewis Icing Technology Branch as an important activity for aircraft safety related research.

The ICTS phenomenon is characterized as a sudden, often uncontrollable aircraft nose-down pitching moment, which occurs due to increased angle-of-attack of the horizontal tailplane resulting in tailplane stall. Typically, this phenomenon occurs when lowering the flaps during final approach while operating in or recently departing from icing conditions. Ice formation on the tailplane leading edge can reduce tailplane angle-of-attack range and cause flow separation resulting in a significant reduction or complete loss of aircraft pitch control. At least 139 fatalities have resulted from 16 accidents involving primarily turbopropeller powered transport and commuter category airplanes caused by ICTS.

In 1991, the FAA initiated a comprehensive review of all aspects of tail plane icing and subsequent tailplane stalling of turbopropeller powered commuter and transport category airplanes. Results from this review process, as well as input from two recent international workshops on ICTS, prompted FAA to request NASA assistance in conducting research into the characteristics of ICTS.

In 1993, FAA and NASA embarked upon a four-year research program to address the problem of tailplane stall and to quantify the effect of tailplane ice accretion on aircraft performance and handling characteristics. The goals of this program, which was completed in March 1998, were to collect aerodynamic data for an aircraft tail with and without ice contamination and to develop analytical methods for predicting the effects of tailplane ice contamination. Extensive dry air and icing tunnel tests with a Twin Otter tail and a series of flight tests with a DeHavilland DHC-6 Twin Otter aircraft were performed. These tests resulted in a database of the aerodynamic effects associated with tailplane ice contamination for the Twin Otter aircraft.

Although the FAA/NASA tailplane icing program generated some answers regarding ice-contaminated-tailplane stall (ICTS) phenomena, NASA researchers have found many open questions that warrant further investigation into ICTS. In addition, several aircraft manufactures have expressed interest in a second research program to expand the database to other tail configurations and to develop experimental and computational methodologies for evaluating the ICTS phenomenon.

In 1998, the icing branch at NASA Lewis initiated a second multi-phase research program for tailplane icing (TIP II) to develop test methodologies and tailplane performance and handling qualities evaluation tools. A grant was awarded to Wichita State University to conduct and coordinate the research activities with support from the Bombardier/Learjet Company in

Wichita, Kansas. The main objectives of this new NASA/Industry/Academia collaborative research program were as follows:

1. Define and evaluate a sub-scale wind tunnel test methodology for determining tailplane performance degradation due to icing.

2. Develop an experimental database of tailplane aerodynamic performance with and without ice contamination for a range of tailplane configurations. This database will support verification and development of analysis tools.

To accomplish the above objectives extensive wind tunnel tests were planned with a modern business jet (Learjet 45) and a twin engine low speed general aviation aircraft. These aircraft which are representative of general aviation aircraft were selected based on input from NASA and industry. Availability of high quality sub-scale wind tunnel models for these airplanes was an important factor in their selection. Use of available wind tunnel models reduced the cost of the research program significantly. Experiments with a full-scale empennage, a 25% sub-scale empennage and with a 15% sub-scale complete model of the Lear 45 business jet were planned to develop the experimental methodology. Selected flight test data for the Lear 45 horizontal tail were made available by Bombardier/Learjet to validate the experimental results obtained from wind tunnel tests of the sub-scale and full-scale models.

Tail specific configuration studies were included in TIP II to investigate the effect of horizontal tail location and to expand the tailplane performance database. The twin engine general aviation aircraft was selected for this study. This aircraft model has three tail configurations including a mid-tail, a cruciform tail and a T-tail.

This proposal provides a summary of the research activities performed during the first Year (July 1, 1998 - November 30, 1998) of this new research program and outlines the work tasks for the second year (12/1/98 to 11/30/99) of the TIP II program.

## Summary of Work for Year 1 (7/1/98 to 11/30/98)

The work tasks originally planned for Year 1 were as follows:

1. Obtain full scale Lear 45 empennage model and prepare it for testing
2. Generate and manufacture simulated ice shapes for testing. Two ice shapes generated with the NASA Lewis LEWICE code and sand paper ice will be tested along with the clean (baseline) configuration
3. Conduct tests in a large scale NASA tunnel to obtain, force, moment, hinge moment, pressure and flow visualization data.
4. Perform Reynolds number studies with the baseline and "iced" tail configurations.
5. Reduce and analyze the wind tunnel results and compare with available flight test data.
6. Obtain business jet sub-scale empennage and complete airplane models.
7. Obtain general aviation twin engine model.
8. Prepare progress report for Year 1.

These tasks, however, were modified to accommodate wind tunnel schedules at NASA Ames and at Wichita State University. Large-scale wind tunnel tests for the full-scale Lear 45 empennage originally planned for the fall of 1998 were rescheduled for the spring of 1999 because test time could not be secured in the NASA Ames 40-ft x 80-ft wind tunnel facility required for the tests. Instead, the 25% sub-scale Lear-45 empennage was selected for testing during the first year of the TIP II program. The original work tasks given above were replaced with the new tasks described below:

1. Conduct a computational study using the XFOIL computer code to investigate high and low Reynolds number characteristics of the LJ-267 airfoil section. The LJ-267 airfoil is the section for the Lear-45 horizontal tail. This task has been completed.

2. Select ice shapes for the wind tunnel tests of the 25% sub-scale empennage. Ice shapes selected include a 22.5 minute and 9 minute LEWICE generated shapes, 40, 80, 120 and 180 grit sand paper ice, as well as spoiler type ice shapes. This task has been completed.

3. Conduct Navier-Stokes analyses with the clean and ice contaminated horizontal tail section for various Reynolds numbers and angles of attack to better understand the flow field characteristics. The 22.5 minute ice shape was used in these studies. This task has been completed.

4. Design and construct a new half-span horizontal tail for the 25% sub-scale Lear-45 empennage with pressure taps to obtain surface pressure distributions during the WSU wind tunnel tests. Pressure taps were incorporated at three spanwise locations. The construction of the tail was performed by Prototype Technologies, Inc in California. This task has been completed.

5. Design and construct 22.5 and a 9-minute LEWICE ice shapes for the 25% LEAR-45 horizontal tail model. Incorporate pressure taps into the 22.5-minute ice shape at the 50% and 90% spanwise locations. This task has been completed.

6. Develop a test matrix for the wind tunnel tests at Wichita State University (WSU). This task has been completed. Details of this test matrix are provided in Table 1. The test matrix was reviewed by Learjet and NASA personnel.

7. Conduct extensive wind tunnel tests at the WSU 7-ft x 10-ft wind tunnel facility with the 25% sub-scale empennage. These wind tunnel tests will start on September 24, 1998 and will end on October 16, 1998.

8. Analyze and process the experimental force, moment, hinge moment and pressure coefficients as well as the flow visualization data obtained during the WSU wind tunnel tests.

9. Develop a test matrix for the NASA Ames wind tunnel tests planned for the spring of 1999. This task has been completed. Details of the proposed test matrix are provided in Table 2.

10. Participate in a pre-test meeting at the NASA Ames 40ft x 80ft wind tunnel facility to plan the full-scale Lear-45 empennage tests. This meeting will take place on October 19 and 20 of 1998.

11. Initiate progress report for the work performed during the first Year of TIP II.

## Work Tasks for Year 2 (12/1/98 to 11/30/99)

The proposed tasks will provide full-scale data for the business jet aircraft to verify the sub-scale methodology. Proposed work tasks for year 2 of TIP-II are as follows.

1. Complete progress report of work performed during Year 1
2. Obtain full scale business jet empennage model and prepare it for testing
3. Generate and manufacture simulated ice shapes for testing of the full scale Lear 45 empennage. A 22.5 min ice shape with and without roughness, a 9 min ice shape as well as 40 and 120 grit sand paper ice will be tested along with the clean (baseline) configuration. The 22.5 and 9 minute shapes were generated with the NASA Lewis LEWICE ice accretion code.
4. Conduct tests in the 40-ft x 80-ft NASA Ames wind tunnel to obtain, force, moment, hinge moment, pressure and flow visualization data. Test details are given below.
5. Perform Reynolds number studies with the baseline and "iced" tail configurations.
6. Reduce and analyze the wind tunnel results and correlate with available flight test data as well as with the sub-scale test results obtained during Year 1.
7. Prepare final report for the work conducted during Year 1 and Year 2.
8. Obtain the Lear 45 15% sub-scale complete airplane model and prepare it for testing. This airplane will be tested in year 3 of TIP II.
9. Obtain twin engine general aircraft model and prepare it for testing. This is a 1/5 scale model with three different tail configurations: mid-tail, cruciform tail and T-tail. This model will be tested during year 3 of the TIP II program.
10. Develop a test matrix for the complete Lear 45 and twin engine general aviation models Isee items 8 and 9 above).

<u>Wind Tunnel Tests of Lear-45 full-scale empennage at NASA Ames 40'x80' Tunnel Facility</u>

Test variables for the wind tunnel tests of the full-scale empennage include angle of attack ($\alpha$), sideslip ($\beta$), elevator deflection ($\delta$), ice shape, and Reynolds number (Re) as shown in Table 2. Angle of attack sweeps from 0 to -25 degrees will be performed in increments of 1 degree to resolve the behavior of the force and moment coefficients (26 alphas). Sideslip angles of 0 to 16° in increments of 1 degree will be considered. Elevator settings of -15°, -10°, 0°, +10°and +15° will be tested. Two artificial ice shapes will be tested as well as sand paper ice. The proposed ice shapes will be obtained using the NASA Lewis LEWICE code and will include a 22.5 minute glaze ice and a 9 minute ice shape. In addition, 40 and 120 grit sandpaper will be used to simulate roughness effects. Two airspeeds will be used in most of the tests to provide two

Reynolds numbers. One of the Reynolds numbers will be selected to match flight test conditions for comparing the full scale wind tunnel data with flight test data. The second Reynolds number will be set to match the 25% Lear-45 sub-scale wind tunnel tests. Limited Reynolds number studies will also be conducted for selected test configurations. Test measurements will include force, moment, and hinge moment data. For selected cases, pressure and flow visualization data will also be obtained. Surface pressure measurements will be conducted with pressure belts. Flow visualization will be performed with tufts.

## Proposed Costs

The proposed budget for Year 2 is given in Table 3. A time period of one year is requested to complete the tasks described above starting December 1, 1998.

A subcontract will be awarded to the Bombardier/Learjet Company in Wichita to support the wind tunnel tests during Year 2. In addition, Learjet will provide flight test data for comparison with the wind tunnel experiments.

NASA Lewis will cover the cost of the full-scale Lear-45 empennage wind tunnel tests at the NASA Ames 40-ft x 80-ft facility. Note that this cost is not included in the attached budget (Table 3).

## Personnel

Dr. Michael Papadakis (PI) and Mr. David Ellis (Co-PI) will lead the proposed research effort and they will be assisted by one graduate student and one undergraduate student. In addition, a subcontract will be awarded to the Learjet Company in Wichita to assist with the wind tunnel tests.

Dr. Papadakis has had over 18 years experience in experimental and computational aerodynamics. His experimental research includes water droplet impingement on aircraft surfaces, single and multi-element airfoil flow field experiments, gurney flap studies, tunnel wall correction methods, jet flows for STOVL aircraft applications and turbulence measurements on a McDonnell Douglas airfoil with vortex generators. He has also performed extensive research in computational aerodynamics. He has developed two-dimensional panel and Navier-Stokes computer codes and has conducted computational investigations on massively separated flows about single and multi-element airfoils. During his work at PILATUS aircraft in Switzerland, he participated in various flight test activities of the PC-7 aircraft.

Mr. David Ellis is Director of Research and development at NIAR. He received a B.S. degree in Aeronautical Engineering from the University of Colorado and an M.S.E. (aero) degree from Princeton University. He has had 35 years of experience in flight research, teaching and airplane design and development. He was directly involved in the icing certification and testing of the Cessna T303 Crusader aircraft. He also carried out the T303 tailplane icing investigation program.

**Michael Papadakis (PI) - (Short Biographical Sketch)**

**Current Position:**

Associate Professor, Department of Aerospace Engineering, Wichita State University, Wichita, Kansas, 67260-0044 , Tel: (316) 978-5936, Fax: (316) 978-3307, E-Mail: papadaki@twsuvm.uc.twsu.edu

**Academic Degrees:**

Ph.D. Aeronautical Engineering, Wichita State University, Wichita, KS, 1986

M.S. Aeronautical Engineering, Loughborough University, England, UK, 1981

B.S. Aeronautical Engineering, Loughborough University, England, UK, 1979

**Recent Honors and Awards:**

- Bombardier/Learjet Fellow, 1998-2001
- Wichita Section AIAA Best Technical Paper Award, June 1997
- Boeing Fellow, September 1992-1995
- University of Wichita Regent's Award for Excellence in Teaching, Wichita State University, May 1993
- DOW Outstanding Young Faculty Award, ASEE Midwest Section, March 1991

**Professional Affiliations:**

Member of the American Institute of Aeronautics and Astronautics

Member of the American Society of Engineering Education

**Publications**

Over 55 articles have been published in refereed journals and conference proceedings. In addition, a book and a number of contractor reports have been authored. Selected publications related to icing research are provided below.

**Selected Refereed Publications**

1. M. Papadakis, M. Seltmann and S. Experimental Study of Simulated Ice Shapes on a NACA 0011 Airfoil," AIAA Paper 99-0096, AIAA 37th Aerospace Sciences Meeting and Exhibit, Reno, NV, January 11-14, 1999.

2. M. Papadakis, G.T. Vu, E.K. Hung, C.S. Bidwell, T. Bencic and M.D. Breer "Progress in Measuring Water Impingement Characteristics on Aircraft Surfaces" AIAA Paper 98-0488, AIAA 36th Aerospace Sciences Meeting and Exhibit, Reno, NV, January 12-15, 1998.

3. M. Papadakis, R. Elangovan, G.A. Freund, and M.D. Breer, "Methods for Obtaining and Reducing Experimental Droplet Impingement Data on Arbitrary Bodies," *AIAA Journal of Aircraft,* vol. 28, Number 5, May 1991.

4. M. Papadakis, R. Elangovan, G.A. Freund, and M.D. Breer, "Water Droplet Impingement on Airfoils and Aircraft Engine Inlets for Icing Analysis," *AIAA Journal of Aircraft*, vol. 28, Number 3, March 1991.

5. M. Papadakis, M.D. Breer, N.C. Craig, and C.S. Bidwell, "Experimental Water Droplet Impingement Data on Modern Aircraft Surfaces," AIAA-91-0445, AIAA 29th Aerospace Science Meeting, Reno, Nevada, January 7-10, 1991.

6. G.A. Freund, F.M. Dickey, R. Elangovan, M.D. Breer, and M. Papadakis, "An Automated Optical Instrument for Extracting Water Droplet Impingement Data from Wind Tunnel Experiments," SPIE 81824, SPIE's 31st Annual International Technical Symposium on Optical and Optoelectronic Applied Science and Engineering, August 16-21, 1987.

7. M. Papadakis, G.A. Freund, R. Elangovan, and M.D. Breer, "Experimental Water Droplet Impingement Data on Two Dimensional Airfoils, Axisymmetric Inlet and Boeing 737-300 Inlet," AIAA-87-0097, Invited Paper, AIAA 25th Aerospace Science Meeting, Reno, Nevada, January 12-15, 1987.

8. M. Papadakis, G.W. Zumwalt, J.J. Kim, R. Elangovan, G.A. Freund, W. Seibel, and M.D., Breer, "An Experimental Method for Measuring Droplet Impingement Efficiency on Two and Three Dimensional Bodies," AIAA-86-0406, AIAA 24th Aerospace Science Meeting, Reno, Nevada, January 6-9, 1986.

David R. Ellis
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## EDUCATION

| | | |
|---|---|---|
| B.S. Aero. Eng. | 1957 | University of Colorado |
| M.S.E. Aero | 1962 | Princeton University |

## EMPLOYMENT

Mr. Ellis is presently Director, Research and Development, at the National Institute for Aviation Research, Wichita State University, where he oversees wind and water tunnels, and structures, materials, impact dynamics, flight simulation, propulsion, icing, and cryogenics laboratories.

Industry positions have included that of V.P. of Engineering at Commander Aircraft and Manager of Advanced Design and Systems Research at Cessna Aircraft; in the latter post he was in charge of design and development of the Model T303 Crusader and the Model 208 Caravan, and directed major research programs in laminar flow wing technology, electro-impulse de-icing systems, and advanced general aviation engines.

He has been an Associate Professor of Aerospace Engineering at the University of Kansas and an Adjunct Associate Professor of Aerospace Engineering at Wichita State University. As Manager of Flight Dynamics Research at Princeton University, he led the development and use of variable stability in-flight simulators for flying qualities research.

He worked as an aerodynamicist in two different full-scale wind tunnels at NACA and NASA, and has consulted extensively in the areas of airplane design, flying qualities, and ice protection.

## OTHER ACTIVITIES

Mr. Ellis served on NASA's Aeronautical Research and Technology Subcommittee and on NASA Ad Hoc Committees on general aviation, flight research, and advanced materials. He has served in the past on Congressional, National Academy of Science, and Department of Energy advisory committees.

He has served on the General Aviation Manufacturers Association Technical Policy Committee, and currently represents GAMA on international committees dealing with harmonization of U.S. and European airworthiness regulations and with aging commuter aircraft.

Mr. Ellis is an Associate Fellow of AIAA and past chairman of the AIAA General Aviation Systems Technical Committee. He is a participant in SAE aeronautical activities.

He is a former flight instructor and research pilot.

## Table 1 - Test Matrix for 25% sub-scale Lear-45 empennage tests at WSU

**Test Facility**: WSU 7-ft x 10-ft Wind Tunnel
**Test Dates**: September 24 to October 17, 1998
**Experimental Data**: Force, moment, hinge moment and pressure coefficients
**Number of Test Runs**: 242
**Simulated Ice Shapes for Horizontal Tail**

- L22: Lewice 22.5 minute ice shape with smooth surface scaled to model size (scale = 1/4)
- L22B: Lewice 22.5 minute ice shape with beads; scaled to model size (scale = 1/4). Simulate beads with 24 grit
- L9B: Lewice 9 minute ice shape with beads; scaled to model size (scale = 1/4). Simulate beads with 24 grit
- S40: 40 grit sandpaper. Cover surface as shown in Fig. 1
- S40-10: 40 grit sandpaper. Cover surface from 10% chord on lower surface to 10% chord on upper surface
- S80: 80 grit sandpaper. Cover surface as shown in Fig. 1
- S120: 120 grit sandpaper. Cover surface as shown in Fig. 1
- S180: 180 grit sandpaper. Cover surface as shown in Fig. 1
- S180-10: 180 grit sandpaper. Cover surface from 10% chord on lower surface to 10% chord on upper surface
- SP47C: Spoiler - 4.7mm Constant height. Place at 2% chord on tail lower surface (4.7mm, 4.7/312.7375=0.015MAC)
- SP47V: Spoiler - 4.7mm Variable height (h) but constant (h/local c). Place at 2% chord on tail lower surface (4.7mm, 4.7/312.7375=0.015MAC)
- SP94C: Spoiler - 9.4mm Constant height. Place at 2% chord on tail lower surface (9.4mm, 9.4/312.7375=.03 MAC)
- SP94V: Spoiler - 9.4mm Variable height (h) but constant (h/local c). Place at 2% chord on tail lower surface (9.4mm, 9.4/312.7375=.03 MAC)

Tail Root Chord = 16.35 in, Tail Tip Chord = 7.04 in, Tail Span=51.56 in, MAC = 12.31 in (312.74mm), Tail Area = 603.135 sq in, 4.189sq ft

Horizontal Tail Setting = -9 degrees

Alpha Sweep (body): +9 ro -16 in 1 deg. increments (26 alphas) (note: alpha range for tail = 0 to -25)

Beta Sweep: -16 to 16 in 2 deg. increments (17 betas)

Tunnel Q = 50 psf, 121.4 kts, 139.8 mph, 205f/s, 62.5 m/s, Re=1,300,000/ft
Tunnel Q = 15 psf, 66.5 kts, 76.6 mph, 112.3f/s, 34.2 m/s, Re=710,000/ft
Tunnel Q = 5 psf, 38.4 kts, 44.2 mph, 64.84f/s, 19.8 m/s, Re=410,000/ft

Transition strips for horizontal and vertical tail: Boundary Layer transition dots (Boeing Cylinders). Location of transition strips : At 10% chord upper and lower surface. Size: 0.007 inches

Boundary Layer Profile Measurements will be conducted for selected test configurations with a boundary layer mouse located at 65% MAC. The velocity profiles will be used to compare boundary layer behavior due to the ice shapes and sandpapers.

| Test # | Q psf | Ice Shape | Surface | Elevator Deflection | Sweep | Data Points |
|---|---|---|---|---|---|---|
| 1 | 50 | none (clean) | NA | 0 | alpha, beta=-16,0,16 | 104 |
| 2 | 15 | none (clean) | NA | 0 | alpha, beta=-16,0,16 | 104 |
| 3 | 5 | none (clean) | NA | 0 | alpha, beta=-16,0,16 | 104 |
| 4 | 50 | none (clean) | NA | 0 | Beta, alpha=+9,-6,-16 | 51 |
| 5 | 15 | none (clean) | NA | 0 | Beta, alpha=+9,-6,-16 | 51 |
| 6 | 50 | none (clean) | NA | 15 | alpha, beta=-16,0,16 | 104 |
| 7 | 15 | none (clean) | NA | 15 | alpha, beta=-16,0,16 | 104 |
| 8 | 5 | none (clean) | NA | 15 | alpha, beta=-16,0,16 | 104 |
| 9 | 50 | none (clean) | NA | -15,-10,10 | alpha | 78 |
| 10 | 15 | none (clean) | NA | -15,-10,10 | alpha | 78 |
| 11 | 50 | L22B | NA | 0 | alpha, beta=-16,0,16 | 104 |
| 12 | 15 | L22B | NA | 0 | alpha, beta=-16,0,16 | 104 |
| 13 | 5 | L22B | NA | 0 | alpha, beta=-16,0,16 | 104 |
| 14 | 50 | L22B | NA | 0 | Beta, alpha=+9,-6,-16 | 51 |
| 15 | 15 | L22B | NA | 0 | Beta, alpha=+9,-6,-16 | 51 |
| 16 | 50 | L22B | NA | 15 | alpha, beta=-16,0,16 | 104 |
| 17 | 15 | L22B | NA | 15 | alpha, beta=-16,0,16 | 104 |
| 18 | 5 | L22B | NA | 15 | alpha, beta=-16,0,16 | 104 |
| 19 | 50 | L22B | NA | -15,-10,10 | alpha | 78 |
| 20 | 15 | L22B | NA | -15,-10,10 | alpha | 78 |
| 21 | 50 | L22 | NA | 0 | alpha, beta=-16,0,16 | 104 |
| 22 | 15 | L22 | NA | 0 | alpha, beta=-16,0,16 | 104 |
| 23 | 5 | L22 | NA | 0 | alpha | 26 |
| 24 | 50 | L22 | NA | 15 | alpha, beta=-16,0,16 | 104 |
| 25 | 15 | L22 | NA | 15 | alpha, beta=-16,0,16 | 104 |
| 26 | 5 | L22 | NA | 15 | alpha | 26 |
| 27 | 50 | L22 | NA | -15,-10,10 | alpha | 78 |
| 28 | 15 | L22 | NA | -15,-10,10 | alpha | 78 |
| 29 | 50 | S40 | NA | 0 | alpha, beta=-16,0,16 | 104 |
| 30 | 15 | S40 | NA | 0 | alpha, beta=-16,0,16 | 104 |
| 31 | 5 | S40 | NA | 0 | alpha | 26 |
| 32 | 50 | S40 | NA | 0 | Beta, alpha=+9,-6,-16 | 51 |
| 33 | 15 | S40 | NA | 0 | Beta, alpha=+9,-6,-16 | 51 |
| 34 | 50 | S40 | NA | 15 | alpha, beta=-16,0,16 | 104 |
| 35 | 15 | S40 | NA | 15 | alpha, beta=-16,0,16 | 104 |
| 36 | 5 | S40 | NA | 15 | alpha | 26 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 37 | 50 | S40 | NA | -15,-10,10 | alpha | 78 |
| 38 | 15 | S40 | NA | -15,-10,10 | alpha | 78 |
| 39 | 50 | S120 | NA | 0 | alpha, beta=-16,0,16 | 104 |
| 40 | 15 | S120 | NA | 0 | alpha, beta=-16,0,16 | 104 |
| 41 | 5 | S120 | NA | 0 | alpha | 26 |
| 42 | 50 | S120 | NA | 0 | Beta, alpha=+9,-6,-16 | 51 |
| 43 | 15 | S120 | NA | 0 | Beta, alpha=+9,-6,-16 | 51 |
| 44 | 50 | S120 | NA | 15 | alpha, beta=-16,0,16 | 104 |
| 45 | 15 | S120 | NA | 15 | alpha, beta=-16,0,16 | 104 |
| 46 | 5 | S120 | NA | 15 | alpha | 26 |
| 47 | 50 | S120 | NA | -15,-10,10 | alpha | 78 |
| 48 | 15 | S120 | NA | -15,-10,10 | alpha | 78 |
| 49 | 50 | L9B | NA | 0 | alpha, beta=-16,0,16 | 104 |
| 50 | 15 | L9B | NA | 0 | alpha, beta=-16,0,16 | 104 |
| 51 | 5 | L9B | NA | 0 | alpha | 26 |
| 52 | 50 | L9B | NA | 0 | Beta, alpha=+9,-6,-16 | 51 |
| 53 | 15 | L9B | NA | 0 | Beta, alpha=+9,-6,-16 | 51 |
| 54 | 50 | L9B | NA | 15 | alpha, beta=-16,0,16 | 104 |
| 55 | 15 | L9B | NA | 15 | alpha, beta=-16,0,16 | 104 |
| 56 | 5 | L9B | NA | 15 | alpha | 26 |
| 57 | 50 | L9B | NA | -15,-10,10 | alpha | 78 |
| 58 | 15 | L9B | NA | -15,-10,10 | alpha | 78 |
| 59 | 50 | S80 | NA | 0 | alpha, beta=-16,0,16 | 104 |
| 60 | 15 | S80 | NA | 0 | alpha, beta=-16,0,16 | 104 |
| 61 | 50 | S80 | NA | 15 | alpha, beta=-16,0,16 | 104 |
| 62 | 15 | S80 | NA | 15 | alpha, beta=-16,0,16 | 104 |
| 63 | 50 | S180 | NA | 0 | alpha, beta=-16,0,16 | 104 |
| 64 | 15 | S180 | NA | 0 | alpha, beta=-16,0,16 | 104 |
| 65 | 5 | S180 | NA | 0 | alpha, beta=-16,0,16 | 104 |
| 66 | 50 | S40-10 | NA | 0 | alpha, beta=-16,0,16 | 104 |
| 67 | 15 | S40-10 | NA | 0 | alpha, beta=-16,0,16 | 104 |
| 68 | 5 | S40-10 | NA | 0 | alpha, beta=-16,0,16 | 104 |
| 69 | 50 | S180-10 | NA | 0 | alpha, beta=-16,0,16 | 104 |
| 70 | 15 | S180-10 | NA | 0 | alpha, beta=-16,0,16 | 104 |
| 71 | 5 | S180-10 | NA | 0 | alpha, beta=-16,0,16 | 104 |
| 72 | 50 | SP47C | Lifting (lower) | 0 | alpha, beta=-16,0,16 | 104 |
| 73 | 15 | SP47C | Lifting (lower) | 0 | alpha, beta=-16,0,16 | 104 |
| 74 | 50 | SP47C | Lifting (lower) | 15 | alpha, beta=0 | 26 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 75 | 15 | SP47C | Lifting (lower) | 15 | alpha, beta=0 | 26 |
| 76 | 50 | SP47V | Lifting (lower) | 0 | alpha, beta=-16,0,16 | 104 |
| 77 | 15 | SP47V | Lifting (lower) | 0 | alpha, beta=-16,0,16 | 104 |
| 78 | 50 | SP47V | Lifting (lower) | 15 | alpha, beta=0 | 26 |
| 79 | 15 | SP47V | Lifting (lower) | 15 | alpha, beta=0 | 26 |
| 80 | 50 | SP94C | Lifting (lower) | 0 | alpha, beta=-16,0,16 | 104 |
| 81 | 15 | SP94C | Lifting (lower) | 0 | alpha, beta=-16,0,16 | 104 |
| 82 | 50 | SP94C | Lifting (lower) | 15 | alpha, beta=0 | 26 |
| 83 | 15 | SP94C | Lifting (lower) | 15 | alpha, beta=0 | 26 |
| 84 | 50 | SP94V | Lifting (lower) | 0 | alpha, beta=-16,0,16 | 104 |
| 85 | 15 | SP94V | Lifting (lower) | 0 | alpha, beta=-16,0,16 | 104 |
| 86 | 50 | SP94V | Lifting (lower) | 15 | alpha, beta=0 | 26 |
| 87 | 15 | SP94V | Lifting (lower) | 15 | alpha, beta=0 | 26 |

**FLOW VISUALIZATION (Micro tufts)**

| | | | | | | |
|---|---|---|---|---|---|---|
| 88 | 50 | none (clean) | NA | 0 | alpha, beta=0,-16 | 52 |
| 89 | 15 | none (clean) | NA | 0 | alpha, beta=0,-16 | 52 |
| 90 | 50 | none (clean) | NA | 15 | alpha, beta=0,-16 | 52 |
| 91 | 15 | none (clean) | NA | 15 | alpha, beta=0,-16 | 52 |
| 92 | 50 | L22B | NA | 0 | alpha, beta=0,-16 | 52 |
| 93 | 15 | L22B | NA | 0 | alpha, beta=0,-16 | 52 |
| 94 | 50 | L22B | NA | 15 | alpha, beta=0,-16 | 52 |
| 95 | 15 | L22B | NA | 15 | alpha, beta=0,-16 | 52 |
| 96 | 50 | L22 | NA | 0 | alpha, beta=0,-16 | 52 |
| 97 | 15 | L22 | NA | 0 | alpha, beta=0,-16 | 52 |
| 98 | 5 | L22 | NA | 0 | alpha, beta=0,-16 | 52 |
| 99 | 50 | S40 | NA | 0 | alpha, beta=0,-16 | 52 |
| 100 | 15 | S40 | NA | 0 | alpha, beta=0,-16 | 52 |
| 101 | 50 | S40 | NA | 15 | alpha, beta=0,-16 | 52 |
| 102 | 15 | S40 | NA | 15 | alpha, beta=0,-16 | 52 |
| 103 | 50 | S180 | NA | 0 | alpha, beta=0,-16 | 52 |
| 104 | 15 | S180 | NA | 0 | alpha, beta=0,-16 | 52 |
| 105 | 50 | S180 | NA | 15 | alpha, beta=0,-16 | 52 |
| 106 | 15 | S180 | NA | 15 | alpha, beta=0,-16 | 52 |
| 107 | 50 | SP47C | Lifting (lower) | 0 | alpha, beta=0,-16 | 52 |
| 108 | 50 | SP47V | Lifting (lower) | 0 | alpha, beta=0,-16 | 52 |
| 109 | 50 | SP94C | Lifting (lower) | 0 | alpha, beta=0,-16 | 52 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 110 | 50 | SP94V | Lifting (lower) | 0 | alpha, beta=0,-16 | 52 |
| Boundary Layer Profile Measurements at 65% MAC ( Select Cases from tests 1-87) | | | | | | |
| **REMOVE HORIZONTAL TAIL** | | | | | | |
| 111 | 50 | none (clean) | NA | 0 | alpha, beta=-16,0,16 | 104 |
| 112 | 15 | none (clean) | NA | 0 | alpha, beta=-16,0,16 | 104 |
| 113 | 50 | none (clean) | NA | 0 | Beta, alpha=+9,-6,-16 | 48 |
| 114 | 15 | none (clean) | NA | 0 | Beta, alpha=+9,-6,-16 | 48 |

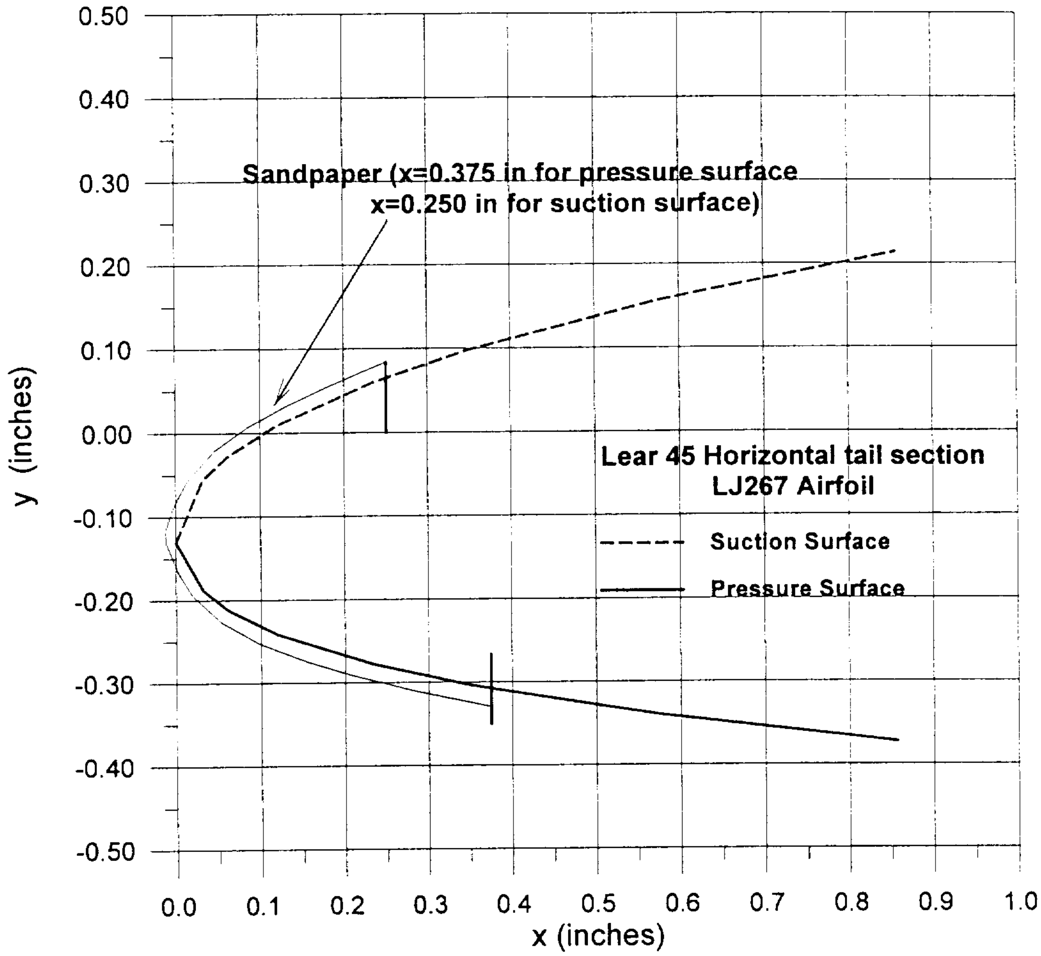


Figure 1: Sand paper coverage for upper and lower surfaces of Lear-45 horizontal tail

## Table 2 - Test Matrix for full-scale Lear-45 Empennage Tests at NASA Ames 40-ft x 80-ft Tunnel

Note: *$a_{ht}$ sweep=[0,-2,-4,-6,-7,-8,-9,-10,-11,-12,-13,-14,-15,-16,-17,-18,-19,-20,-21,-22,-23,-24,-25] - 23 alphas*
*b sweep=[0 to 16 deg in 1 deg increments] - 17 angles of sideslip*
*MAC* =1.25 meters
*Set horizontal tail incidence to -9 deg with respect to fuselage axis*

| Test Type | Ice Shape | dE | Re No. | Ma | Vel | alpha | beta | RUN |
|---|---|---|---|---|---|---|---|---|
| | | | | | *(knots)* | *(deg)* | *(deg)* | # |
| Flow Angularity | clean | 0 | 5,102,227 | 0.18 | 116 | a sweep | 0 | 1 |
| Flow Angularity | clean | 0 | 5,102,227 | 0.18 | 116 | 0 | b sweep | 2 |
| [redacted] | | | | | | | | |
| Alpha Sweep | clean | 0 | 1,337,135 | 0.05 | 30.4 | a sweep | 0 | 8 |
| Alpha Sweep | clean | -10 | 1,337,135 | 0.05 | 30.4 | a sweep | 0 | 9 |
| Alpha Sweep | clean | -15 | 1,337,135 | 0.05 | 30.4 | a sweep | 0 | 10 |
| Alpha Sweep | clean | 10 | 1,337,135 | 0.05 | 30.4 | a sweep | 0 | 11 |
| Alpha Sweep | clean | 15 | 1,337,135 | 0.05 | 30.4 | a sweep | 0 | 12 |
| [redacted] | | | | | | | | |
| Alpha Sweep | 22.5 min w/beads | 0 | 1,337,135 | 0.05 | 30.4 | a sweep | 0 | 18 |
| Alpha Sweep | 22.5 min w/beads | -10 | 1,337,135 | 0.05 | 30.4 | a sweep | 0 | 19 |
| Alpha Sweep | 22.5 min w/beads | -15 | 1,337,135 | 0.05 | 30.4 | a sweep | 0 | 20 |
| Alpha Sweep | 22.5 min w/beads | 10 | 1,337,135 | 0.05 | 30.4 | a sweep | 0 | 21 |
| Alpha Sweep | 22.5 min w/beads | 15 | 1,337,135 | 0.05 | 30.4 | a sweep | 0 | 22 |
| [redacted] | | | | | | | | |
| Alpha Sweep | 40 grit sandpaper | 0 | 1,337,135 | 0.05 | 30.4 | a sweep | 0 | 28 |
| Alpha Sweep | 40 grit sandpaper | -10 | 1,337,135 | 0.05 | 30.4 | a sweep | 0 | 29 |
| Alpha Sweep | 40 grit sandpaper | -15 | 1,337,135 | 0.05 | 30.4 | a sweep | 0 | 30 |
| Alpha Sweep | 40 grit sandpaper | 10 | 1,337,135 | 0.05 | 30.4 | a sweep | 0 | 31 |
| Alpha Sweep | 40 grit sandpaper | 15 | 1,337,135 | 0.05 | 30.4 | a sweep | 0 | 32 |
| [redacted] | | | | | | | | |
| Alpha Sweep | 120 grit sandpaper | 0 | 1,337,135 | 0.05 | 30.4 | a sweep | 0 | 38 |
| Alpha Sweep | 120 grit sandpaper | -10 | 1,337,135 | 0.05 | 30.4 | a sweep | 0 | 39 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Alpha Sweep | 120 grit sandpaper | -15 | 1,337,135 | 0.05 | 30.4 | a sweep | 0 | 40 | |
| Alpha Sweep | 120 grit sandpaper | 10 | 1,337,135 | 0.05 | 30.4 | a sweep | 0 | 41 | |
| Alpha Sweep | 120 grit sandpaper | 15 | 1,337,135 | 0.05 | 30.4 | a sweep | 0 | 42 | |
| Alpha Sweep | 22.5 min no beads | 0 | 5,102,227 | 0.18 | 116 | a sweep | 0 | 43 | |
| Alpha Sweep | 22.5 min no beads | 10 | 5,102,227 | 0.18 | 116 | a sweep | 0 | 44 | |
| Alpha Sweep | 22.5 min no beads | 15 | 5,102,227 | 0.18 | 116 | a sweep | 0 | 45 | |
| Alpha Sweep | 22.5 min no beads | 0 | 1,337,135 | 0.05 | 30.4 | a sweep | 0 | 46 | |
| Alpha Sweep | 22.5 min no beads | 10 | 1,337,135 | 0.05 | 30.4 | a sweep | 0 | 47 | |
| Alpha Sweep | 22.5 min no beads | 15 | 1,337,135 | 0.05 | 30.4 | a sweep | 0 | 48 | |
| Alpha Sweep | 22.5 min from IRT | 0 | 5,102,227 | 0.18 | 116 | a sweep | 0 | 49 | |
| Alpha Sweep | 22.5 min from IRT | 15 | 5,102,227 | 0.18 | 116 | a sweep | 0 | 50 | |
| Alpha Sweep | 22.5 min from IRT | 0 | 1,337,135 | 0.05 | 30.4 | a sweep | 0 | 51 | |
| Alpha Sweep | 22.5 min from IRT | 15 | 1,337,135 | 0.05 | 30.4 | a sweep | 0 | 52 | |
| Alpha Sweep | 2 min from IRT | 0 | 5,102,227 | 0.18 | 116 | a sweep | 0 | 53 | |
| Alpha Sweep | 2 min from IRT | 15 | 5,102,227 | 0.18 | 116 | a sweep | 0 | 54 | |
| Alpha Sweep | 2 min from IRT | 0 | 1,337,135 | 0.05 | 30.4 | a sweep | 0 | 55 | |
| Alpha Sweep | 2 min from IRT | 15 | 1,337,135 | 0.05 | 30.4 | a sweep | 0 | 56 | |
| Alpha Sweep | 120 grit sandpaper | 0 | 5,102,227 | 0.18 | 116 | a sweep | 0 | 57 | 10% local c coverage |
| Alpha Sweep | 120 grit sandpaper | 15 | 5,102,227 | 0.18 | 116 | a sweep | 0 | 58 | 10% local c coverage |
| Alpha Sweep | 120 grit sandpaper | 0 | 1,337,135 | 0.05 | 30.4 | a sweep | 0 | 59 | 10% local c coverage |
| Alpha Sweep | 120 grit sandpaper | 15 | 1,337,135 | 0.05 | 30.4 | a sweep | 0 | 60 | 10% local c coverage |
| Alpha Sweep | 40 grit sandpaper | 0 | 5,102,227 | 0.18 | 116 | a sweep | 0 | 61 | 10% local c coverage |
| Alpha Sweep | 40 grit sandpaper | 15 | 5,102,227 | 0.18 | 116 | a sweep | 0 | 62 | 10% local c coverage |
| Alpha Sweep | 40 grit sandpaper | 0 | 1,337,135 | 0.05 | 30.4 | a sweep | 0 | 63 | 10% local c coverage |
| Alpha Sweep | 40 grit sandpaper | 15 | 1,337,135 | 0.05 | 30.4 | a sweep | 0 | 64 | 10% local c coverage |
| Alpha Sweep | 9 min w/beads | 0 | 5,102,227 | 0.18 | 116 | a sweep | 0 | 65 | |
| Alpha Sweep | 9 min w/beads | 10 | 5,102,227 | 0.18 | 116 | a sweep | 0 | 66 | |
| Alpha Sweep | 9 min w/beads | 15 | 5,102,227 | 0.18 | 116 | a sweep | 0 | 67 | |
| Alpha Sweep | 9 min w/beads | 0 | 1,337,135 | 0.05 | 30.4 | a sweep | 0 | 68 | |
| Alpha Sweep | 9 min w/beads | 10 | 1,337,135 | 0.05 | 30.4 | a sweep | 0 | 69 | |
| Alpha Sweep | 9 min w/beads | 15 | 1,337,135 | 0.05 | 30.4 | a sweep | 0 | 70 | |
| Alpha Sweep | clean | 0 | 2,199,236 | 0.08 | 50 | a sweep | 0 | 71 | |
| Alpha Sweep | clean | 0 | 3,078,930 | 0.11 | 70 | a sweep | 0 | 72 | |
| Alpha Sweep | clean | 0 | 4,046,594 | 0.14 | 92 | a sweep | 0 | 73 | |
| Alpha Sweep | clean | 0 | 6,157,860 | 0.21 | 140 | a sweep | 0 | 74 | |
| Alpha Sweep | clean | 0 | 7,037,554 | 0.24 | 160 | a sweep | 0 | 75 | |
| Alpha Sweep | clean | 0 | 7,917,249 | 0.27 | 180 | a sweep | 0 | 76 | |
| Alpha Sweep | 40 grit sandpaper | 0 | 2,199,236 | 0.08 | 50 | a sweep | 0 | 77 | |
| Alpha Sweep | 40 grit sandpaper | 0 | 3,078,930 | 0.11 | 70 | a sweep | 0 | 78 | |
| Alpha Sweep | 40 grit sandpaper | 0 | 4,046,594 | 0.14 | 92 | a sweep | 0 | 79 | |
| Alpha Sweep | 40 grit sandpaper | 0 | 6,157,860 | 0.21 | 140 | a sweep | 0 | 80 | |
| Alpha Sweep | 40 grit sandpaper | 0 | 7,037,554 | 0.24 | 160 | a sweep | 0 | 81 | |
| Alpha Sweep | 40 grit sandpaper | 0 | 7,917,249 | 0.27 | 180 | a sweep | 0 | 82 | |
| Alpha Sweep | 22.5 min no beads | 0 | 2,199,236 | 0.08 | 50 | a sweep | 0 | 83 | |
| Alpha Sweep | 22.5 min no beads | 0 | 3,078,930 | 0.11 | 70 | a sweep | 0 | 84 | |
| Alpha Sweep | 22.5 min no beads | 0 | 4,046,594 | 0.14 | 92 | a sweep | 0 | 85 | |
| Alpha Sweep | 22.5 min no beads | 0 | 6,157,860 | 0.21 | 140 | a sweep | 0 | 86 | |
| Alpha Sweep | 22.5 min no beads | 0 | 7,037,554 | 0.24 | 160 | a sweep | 0 | 87 | |
| Alpha Sweep | 22.5 min no beads | 0 | 7,917,249 | 0.27 | 180 | a sweep | 0 | 88 | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Alpha Sweep | 22.5 min from IRT | 0 | 2,199,236 | 0.08 | 50 | a sweep | 0 | 89 |
| Alpha Sweep | 22.5 min from IRT | 0 | 3,078,930 | 0.11 | 70 | a sweep | 0 | 90 |
| Alpha Sweep | 22.5 min from IRT | 0 | 4,046,594 | 0.14 | 92 | a sweep | 0 | 91 |
| Alpha Sweep | 22.5 min from IRT | 0 | 6,157,860 | 0.21 | 140 | a sweep | 0 | 92 |
| Alpha Sweep | 22.5 min from IRT | 0 | 7,037,554 | 0.24 | 160 | a sweep | 0 | 93 |
| Alpha Sweep | 22.5 min from IRT | 0 | 7,917,249 | 0.27 | 180 | a sweep | 0 | 94 |
| Alpha Sweep | 22.5 min with beads | 0 | 2,199,236 | 0.08 | 50 | a sweep | 0 | 95 |
| Alpha Sweep | 22.5 min with beads | 0 | 3,078,930 | 0.11 | 70 | a sweep | 0 | 96 |
| Alpha Sweep | 22.5 min with beads | 0 | 4,046,594 | 0.14 | 92 | a sweep | 0 | 97 |
| Alpha Sweep | 22.5 min with beads | 0 | 6,157,860 | 0.21 | 140 | a sweep | 0 | 98 |
| Alpha Sweep | 22.5 min with beads | 0 | 7,037,554 | 0.24 | 160 | a sweep | 0 | 99 |
| Alpha Sweep | 22.5 min with beads | 0 | 7,917,249 | 0.27 | 180 | a sweep | 0 | 100 |
| Alpha Sweep | 120 grit sandpaper | 0 | 2,199,236 | 0.08 | 50 | a sweep | 0 | 101 |
| Alpha Sweep | 120 grit sandpaper | 0 | 3,078,930 | 0.11 | 70 | a sweep | 0 | 102 |
| Alpha Sweep | 120 grit sandpaper | 0 | 4,046,594 | 0.14 | 92 | a sweep | 0 | 103 |
| Alpha Sweep | 120 grit sandpaper | 0 | 6,157,860 | 0.21 | 140 | a sweep | 0 | 104 |
| Alpha Sweep | 120 grit sandpaper | 0 | 7,037,554 | 0.24 | 160 | a sweep | 0 | 105 |
| Alpha Sweep | 120 grit sandpaper | 0 | 7,917,249 | 0.27 | 180 | a sweep | 0 | 106 |
| Beta Sweep | clean | 0 | 5,102,227 | 0.18 | 116 | 0 | b sweep | 107 |
| Beta Sweep | clean | 0 | 1,337,135 | 0.05 | 30.4 | 0 | b sweep | 108 |
| Beta Sweep | 22.5 min w/beads | 0 | 5,102,227 | 0.18 | 116 | 0 | b sweep | 109 |
| Beta Sweep | 22.5 min w/beads | 0 | 1,337,135 | 0.05 | 30.4 | 0 | b sweep | 110 |
| Beta Sweep | 40 grit sandpaper | 0 | 5,102,227 | 0.18 | 116 | 0 | b sweep | 111 |
| Beta Sweep | 40 grit sandpaper | 0 | 1,337,135 | 0.05 | 30.4 | 0 | b sweep | 112 |
| Beta Sweep | 120 grit sandpaper | 0 | 1,337,135 | 0.05 | 30.4 | 0 | b sweep | 113 |
| Beta Sweep | 120 grit sandpaper | 0 | 1,337,135 | 0.05 | 30.4 | 0 | b sweep | 114 |
| Flow Visualization | clean | 0 | 5,102,227 | 0.18 | 116 | a sweep | 0 | 115 |
| Flow Visualization | clean | 0 | 5,102,227 | 0.18 | 116 | 0 | b sweep | 116 |
| Flow Visualization | 22.5 min w/beads | 0 | 5,102,227 | 0.18 | 116 | a sweep | 0 | 117 |
| Flow Visualization | 22.5 min w/beads | 0 | 5,102,227 | 0.18 | 116 | 0 | b sweep | 118 |
| Flow Visualization | 40 grit sandpaper | 0 | 5,102,227 | 0.18 | 116 | a sweep | 0 | 119 |
| Flow Visualization | 40 grit sandpaper | 0 | 5,102,227 | 0.18 | 116 | 0 | b sweep | 120 |
| Interference Effect | no horizontal tail | 0 | 5,102,227 | 0.18 | 116 | a sweep | 0 | 121 |
| Interference Effect | no horizontal tail | 0 | 5,102,227 | 0.18 | 116 | 0 | b sweep | 122 |

Test measurements: Force, Momemt, Hinge Moment and Pressure Coefficients. In addition, boundary layer measurements will be conducet for selected test cases with a boundary layer mouse located at 65% MAC.

CERTIFICATIONS REGARDING LOBBYING; DEBARMENT, SUSPENSION AND OTHER RESPONSIBILITY MATTERS; AND DRUG-FREE WORKPLACE REQUIREMENTS

Applicants should refer to the regulations cited below to determine the certification to which they are required to attest. Applicants should also review the instructions for certification included in the regulations before completing this form. Signature of this form provides for compliance with certification requirements under 34 CFR Part 82, "New Restrictions on Lobbying," and 34 CFR Part 85, "Government-Wide Debarment and Suspension (Nonprocurement) and Government-Wide Requirements for Drug-Free Workplace (Grants)." The certifications shall be treated as a material representation of fact upon which reliance will be placed when the Department of Education determines to award the covered transaction, grant, or cooperative agreement.

1. LOBBYING

As required by Section 1352, Title 31 of the U.S. Code, and implemented at 34 CFR Part 82, for persons entering into a grant or cooperative agreement over $100,000, as defined at 34 CFR Part 82, Sections 82.105 and 82.110, the applicant certifies that:
(a) No Federal appropriated funds have been paid or will be paid, by or on behalf of the undersigned, to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with the making of any Federal grant, the entering into of any cooperative agreement, and the extension, continuation, renewal, amendment, or modification of any Federal grant or cooperative agreement;
(b) If any funds other than Federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with this Federal grant or cooperative agreement, the undersigned shall complete and submit Standard Form - LLL, "Disclosure Form to Report Lobbying," in accordance with its instructions;
(c) The undersigned shall require that the language of this certification be included in the award documents for all subaward at all tiers (including subgrants, contracts under grants and cooperative agreements, and subcontracts) and that all subrecipients shall certify and disclose accordingly.

2. DEBARMENT, SUSPENSION, AND OTHER RESPONSIBILITY MATTERS

As required by Executive Order 12549, Debarment and Suspension, and implemented at 34 CFR Part 85, for prospective participants in primary covered transactions, as defined at 34 CFR Part 85, Sections 85.105 and 85.100 –
A. The applicant certifies that it and its principals:
(a) Are not presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from covered transactions by any Federal department or agency;
(b) Have not within a three-year period preceding this application been convicted of or had a civil judgment rendered against them for commission of fraud or a criminal offense in connection with obtaining, attempting to obtain, or performing a public (Federal, State, or local) transaction or contract under a public transaction; violation of Federal or State antitrust statutes or commission of embezzlement, theft, forgery, bribery, falsification or destruction of records, making false statements, or receiving stolen property;
(c) Are not presently indicted for or otherwise criminally or civilly charged by a governmental entity (Federal, State, or local) with commission of any of the offenses enumerated in paragraph (1)(b) of this certification; and
(d) Have not within a three-year period preceding this application had one or more public transactions (Federal, State, or local) terminated for cause or default; and
B. Where the applicant is unable to certify to any of the statements in this certification, he or she shall attach an explanation to this application.

3. DRUG-FREE WORKPLACE
(GRANTEES OTHER THAN INDIVIDUALS)

As required by the Drug-Free Workplace Act of 1988, and implemented at 34 CFR Part 85, Subpart F, for grantees, as defined at 34 CFR Part 85, Sections 85.605 and 85.610 –
A. The applicant certifies that it will or will continue to provide a drug-free workplace by:
(a) Publishing a statement notifying employees that the unlawful manufacture, distribution, dispensing, possession, or use of a controlled substance is prohibited in the grantee's workplace and specifying the actions that will be taken against employees for violation of such prohibition;
(b) Establishing an on-going drug-free awareness program to inform employees about–
(1) The dangers of drug abuse in the workplace;
(2) The grantee's policy of maintaining a drug-free workplace;
(3) Any available drug counseling, rehabilitation, and employee assistance programs; and
(4) The penalties that may be imposed upon employees for drug abuse violations occurring in the workplace;
((c) Making it a requirement that each employee to be engaged in the performance of the grant be given a copy of the statement required by paragraph (a);
(d) Notifying the employee in the statement required by paragraph (a) that, as a condition of employment under the grant, the employee will–
(1) Abide by the terms of the statement; and
(2) Notify the employer in writing of his or her conviction for a violation of a criminal drug statute occurring in the workplace no later than five calendar days after such conviction;
(e) Notifying the agency, in writing, within 10 calendar days after receiving notice under subparagraph (d)(2) from an employee or otherwise receiving actual notice of such conviction. Employers of convicted employees must provide notice, including position title, to: Director, Grants and Contracts Service, U.S. Department of Education, 400 Maryland Avenue, S.W.(Room 3124, GSA Regional Office, Building No. 3), Washington, DC 20202-4571. Notice shall include the identification numbers(s) of each affected grant;
(f) Taking one of the following actions, within 30 calendar days of receiving notice under subparagraph (d)(2), with respect to any employee who is so convicted–
(1) Taking appropriate personnel action against such an employee, up to and including termination, consistent with the requirements of the Rehabilitation Act of 1973, as amended; or
(2) Requiring such employee to participate satisfactorily in a drug abuse assistance or rehabilitation program approved for such purposes by a Federal, State, or local health, law enforcement, or other appropriate agency.
(g) Making a good faith effort to continue to maintain a drug-free workplace through implementation of paragraphs (a), (b), (c), (d), (e), and (f).
B. The grantee may insert in the space provided below the sites(s) for the performance of work done in connection with the specific grant:
Place of Performance (Street address, city, county, state, zip code)

1845 Fairmount
Wichita, KS 67260 Sedgwick County

Check ( ) if there are workplaces on file that are not identified here.

DRUG-FREE WORKPLACE
(grantees who are individuals)

As required by the Drug-Free Workplace Act of 1988, and implemented at 34 CFR Part 85, Subpart F, for grantees, as defined at 34 CFR Part 85, Sections 85.605 and 85.610 –
A. As a condition of the grant, I certify that I will not engage in the unlawful manufacture, distribution, dispensing, possession, or use of a controlled substance in conducting any activity with the grant; and
B. If convicted of a criminal drug offense resulting from a violation occurring during the conduct of any grant activity, I will report the conviction, in writing, within 10 calendar days of the conviction, to: Director, Grants and Contracts Service, U.S. Department of Education, 400 Maryland Avenue, S.W. (Room 3124, GSA Regional Office Building No. 3), Washington, DC 20202-4571. Notice shall include the identification number(s) of each affected grant.

As the duly authorized representative of the applicant, I hereby certify that the applicant will comply with the above certifications.

NAME OF APPLICANT:
Wichita State University

PR/AWARD NUMBER AND/OR PROJECT NAME
Tailplane Icing Program - Phase II

Gerald D. Loper, Assoc. VP for Research
PRINTED NAME AND TITLE OF AUTHORIZED REPRESENTATIVE

Gerald D. Loper
Signature

DATE 9/14/98

ED 80-0013