Sikorsky S-92A® and S-76D™ Rotor Ice Protection Systems

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Sikorsky
A United Technologies Company

Summary

Sikorsky Aircraft designed and certificated a rotor ice protection system for the S-92A helicopter.

The S-92A ice protection systems were tested in a series of ground and flight tests and certificated by the FAA, with Transport Canada and European Aviation Safety Agency (EASA) validation.

Sikorsky will produce a new version of the S-76 helicopter with blades that incorporate new airfoils, larger blade chord, blade tip enhancements, and a rotor ice protection systems, similar to that of the S-92A helicopter.

The S-76D will be certificated for flight in icing conditions, following the same process used for the successful S-92A icing certification.

Content of Presentation

The need for all-weather capability and ice protection

Description of the S-92A and S-76D helicopters

Description of helicopter ice protection systems

Anti-ice systems and deice systems

Analyses to confirm acceptable performance

Test data for icing certification of the S-92A

The S-76D ice protection system

Tests for S-76D icing certification

Civil customers have a need to fly in icing conditions

- Icing conditions exist throughout the world.
- Helicopters need to be able to fly in all-weather conditions and ice protection is needed to enable flight in these conditions.
- Sikorsky Aircraft has designed, tested, and certificated ice protection systems to allow flight in the icing conditions found in nature.

S-92A after a flight in natural icing conditions

S-92A Type Certificate was modified by the FAA on October 14, 2005, to allow flight in icing conditions, achieving the first Federal Aviation Administration certification of a helicopter for flight operations into icing conditions.

The Sikorsky S-92A™ Helicopter

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The Sikorsky S-76D™ Helicopter

S-92A Anti-iced Components

Engine and Inlet - the engine front frame is anti-iced with bleed air and the inlet lip, interior walls of the inlet, and nose gearbox fairing are electrothermally anti-iced

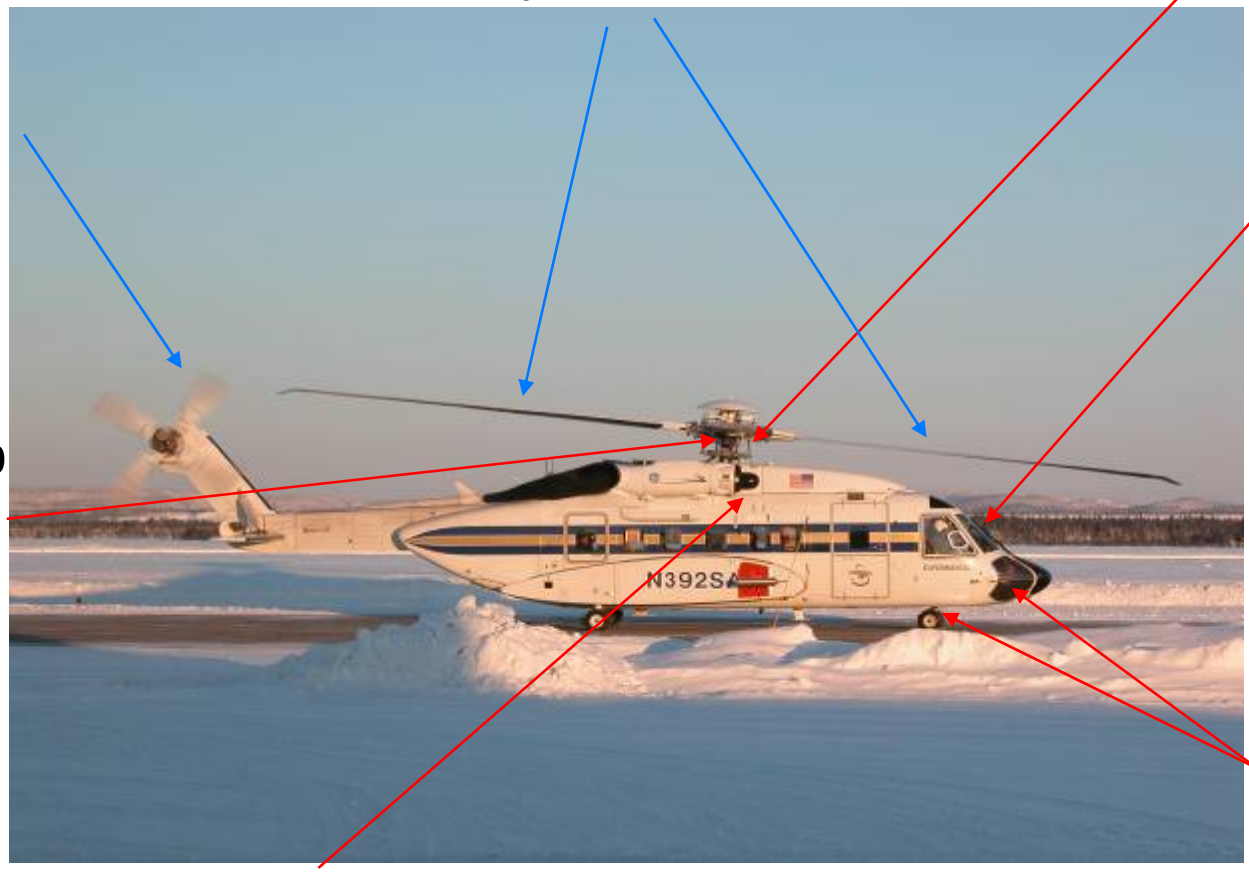
Air Data System - the Pitot-static probe heads and probe supports are anti-iced and the outside-air-temperature sensors are shielded from ice accretion

Main Cockpit Windshields - each main windshield contains heating zones to maintain an ice-free area for visibility

Ice Rate Meter - probe head and supports are anti-iced; active probe element is deiced

Droop Stops - droop stop pins are anti-iced to maintain droop stop function during rotor shutdown

S-92A Ice Protection System



S-92A and S-76D Deiced Components

Main Rotor Blades - a four-zone spanwise heater mat is installed in the leading edge sheath of each blade, with the heaters controlled by the dual-redundant RIPS control system.

Tail Rotor Blades - a single heater mat is installed in each tail rotor blade.

RIPS control can be either automatic (based on measured LWC) or manual (for an icing intensity level set by the pilot).

Automatic mode is controlled by a dual Primary Manual Ice Detection System and by static temperature.

S-92A and S-76D Icing Envelopes

Both aircraft have ice protection systems that are designed for the full Appendix C Maximum Intermittent and Maximum Continuous icing envelopes.

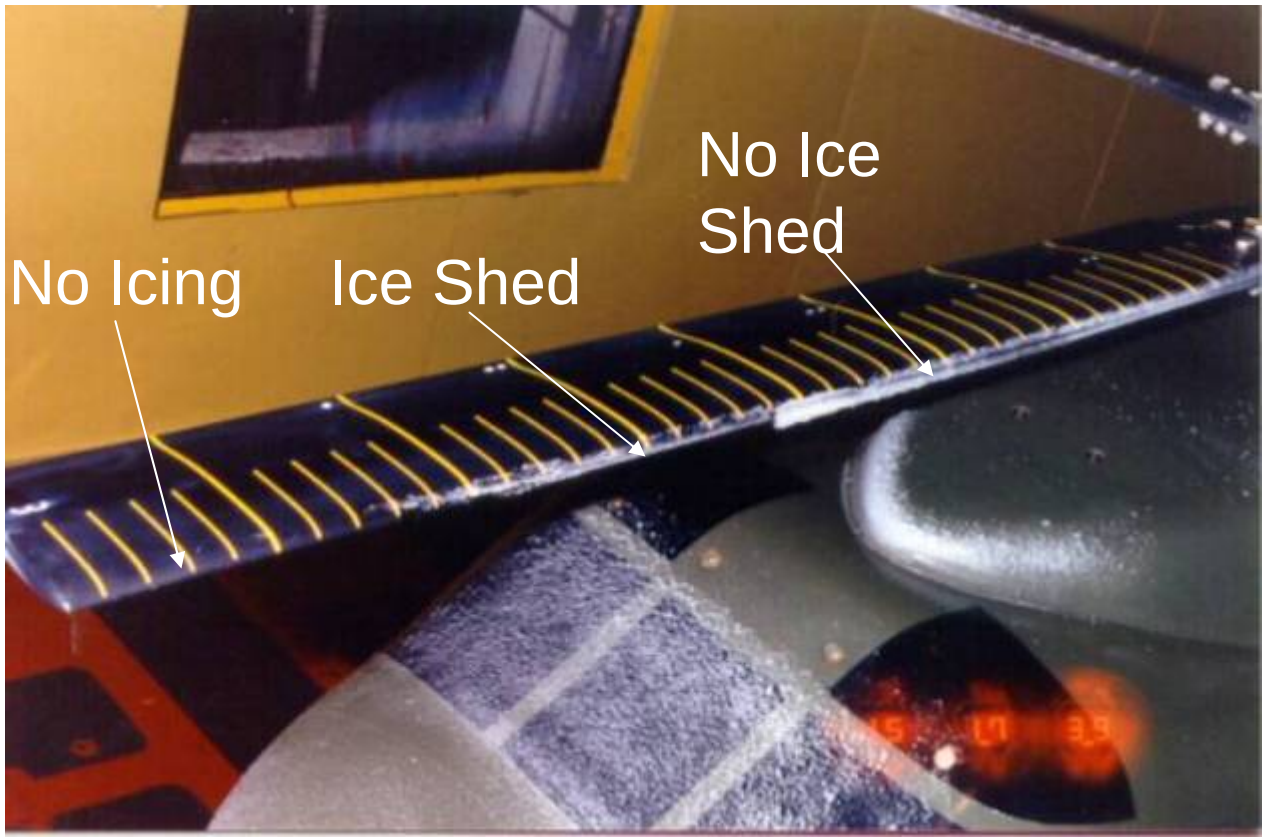
It is difficult to find the most intense icing of the full Appendix C envelopes during a helicopter icing certification program.

Sikorsky decided to certificate these helicopters to the 10,000-foot icing envelopes of AC 29-2C.

Model Rotor Blade After Artificial Icing Encounter

1993 TEST IN THE NASA ICING RESEARCH TUNNEL

Region of ice accretion inboard, region with regrowth ice after a shed midspan, and region of no icing toward the blade tip



S-92A RIPS Development and Test Program

Key features of the S-92A rotor ice protection system (RIPS)

- Digital system architecture
- Dual RIPS controllers and ice rate meters
- Dual channels in junction box, main rotor slip ring and main rotor distributor

Many tests led to RIPS certification

- Laboratory component tests
- Simulated ice tests - for blade roughness and horizontal and vertical tail surfaces
- Artificial icing tests - MCL Climatic Lab and HISS tanker
- Dry air ice protection system flight tests
- Natural icing tests

S-92A Artificial Icing at the McKinley Climatic Lab

S-92A Icing Flight Tests-Feb 2004 Through Oct 2005

- We conducted flight tests of the RIPS from February 2004 through March 2005 in Marquette, Michigan, Presque Isle, Maine, Sept-Iles and Montreal, Quebec, and Elmira, New York.
- We briefed the FAA and Transport Canada several times during the course of the test program and submitted the icing flight test report to the regulatory agencies in July 2005.
- FAA, Transport Canada, and EASA flew the S-92A in icing conditions Fairbanks, Alaska, in September and October 2005 to evaluate the ice protection systems in normal operation and with failure mode simulations.
- Received FAA certification on October 14, 2005, and Transport Canada validation on October 25, 2005, followed by EASA validation in April 2006.
- The S-92A is now flying in icing conditions in civil operations in Canada, Europe, Turkey, and the United States.

The Tests Were Supported by Scout Aircraft

US ARMY C-12G

NASA DHC-6
TWIN OTTER

UNIVERSITY OF NORTH
DAKOTA CITATION II

SAE®

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US Army HISS Tanker

S-92A AND CH-47D HISS

PHOTOS TAKEN FROM C-12G
IN THE SKIES ABOVE
MARQUETTE, MICH

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The S-92A During Icing Tests

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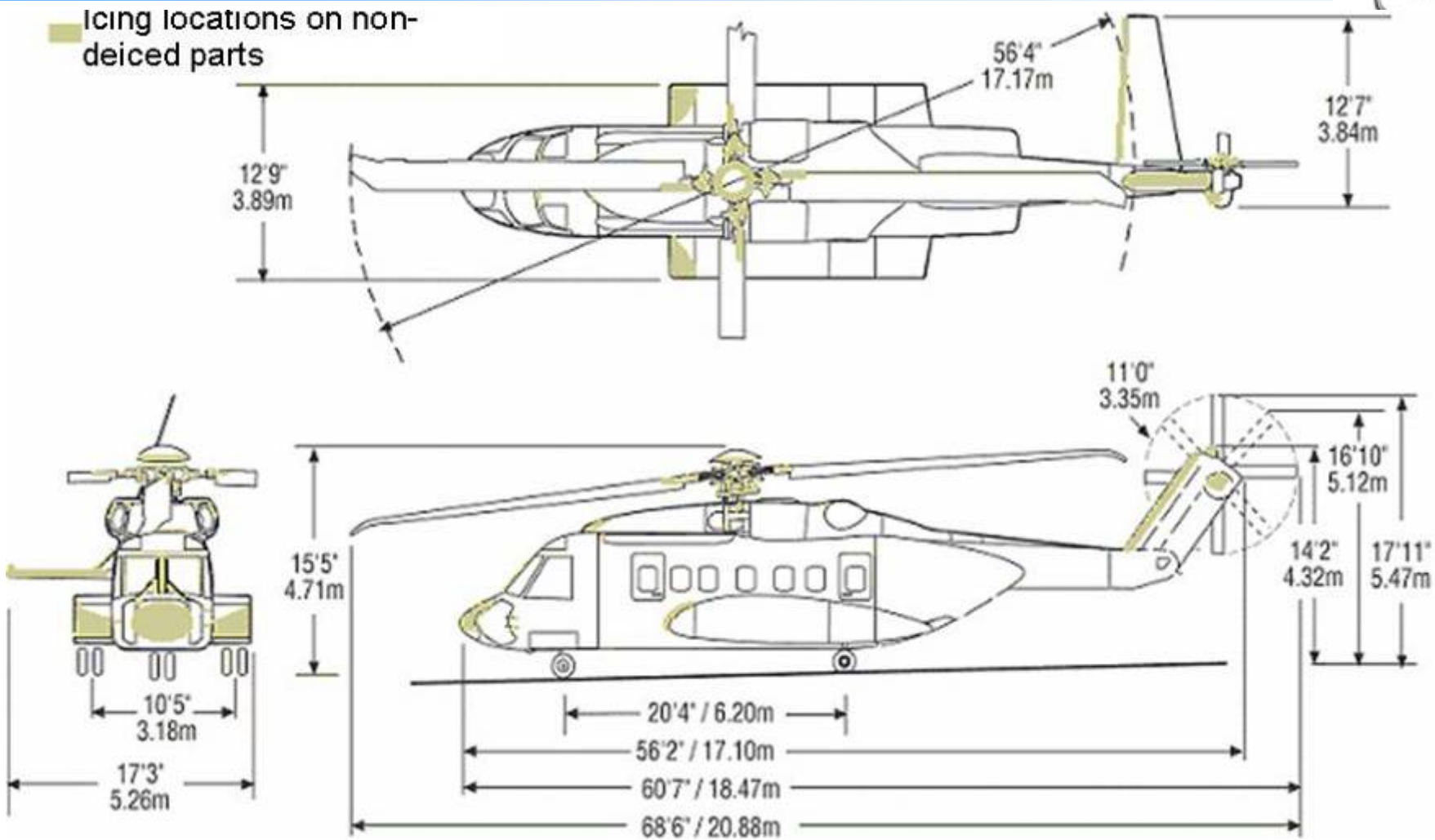
S-92A Ice Accretion



Total icing flight test time was 296 hours, with 94 of these hours in icing clouds

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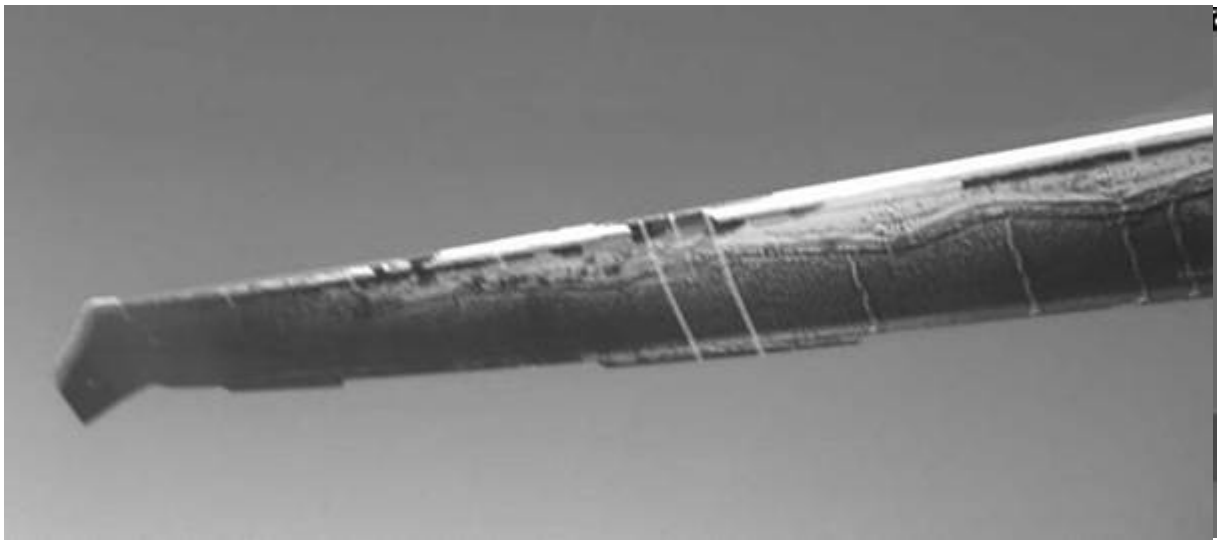
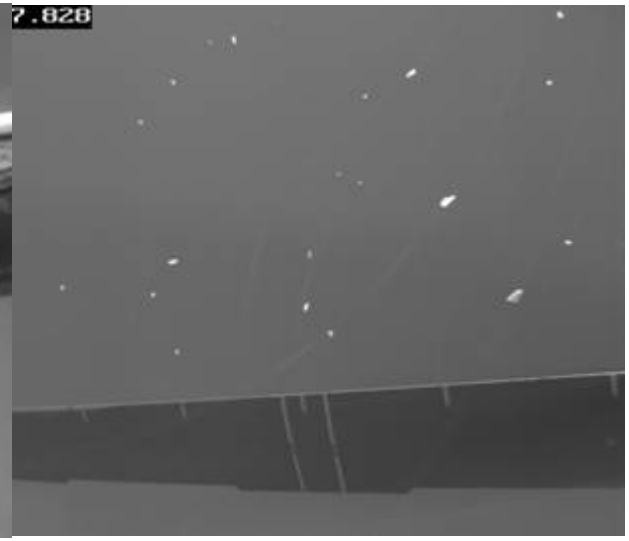
S-92A Horizontal Tail Icing

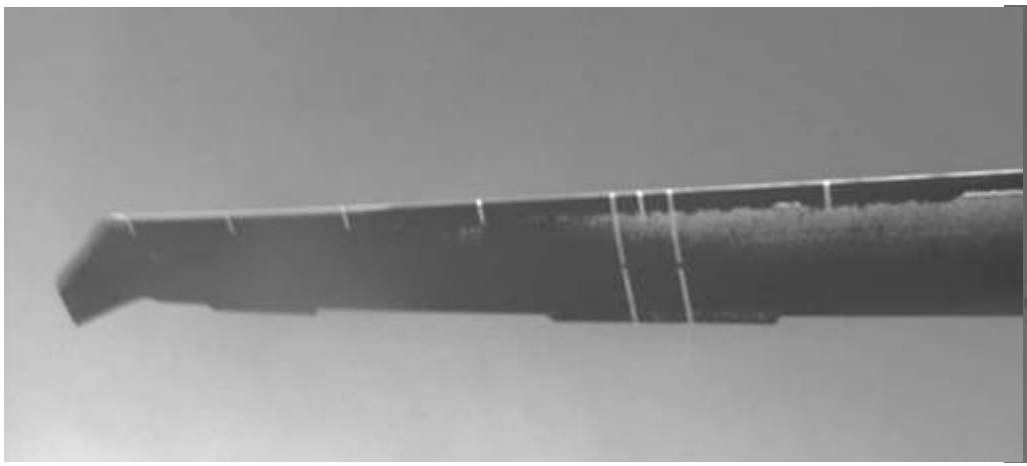
Simulated Ice

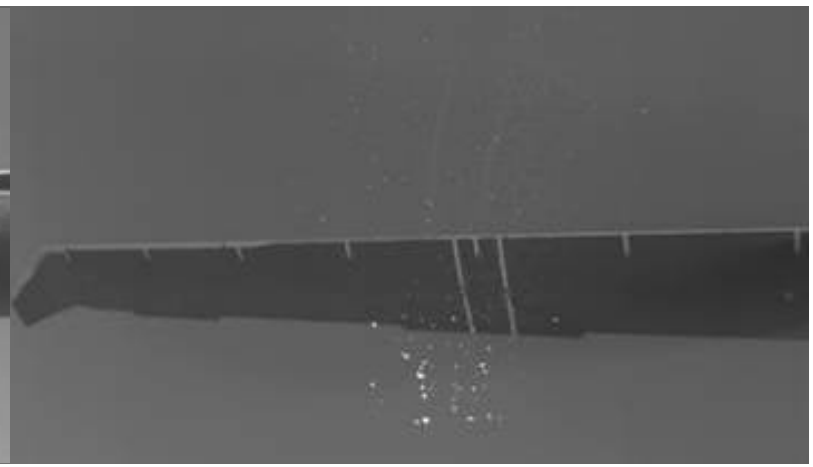
Natural Ice

Main Rotor Blade During a Flight in Natural Conditions









S-92A After Flights in Icing Conditions

Main Rotor After Failure Simulation in Artificial Icing

Tail Rotor and Vertical Tail in Natural Icing

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S-76D RIPS Equipment Similar to S-92A RIPS

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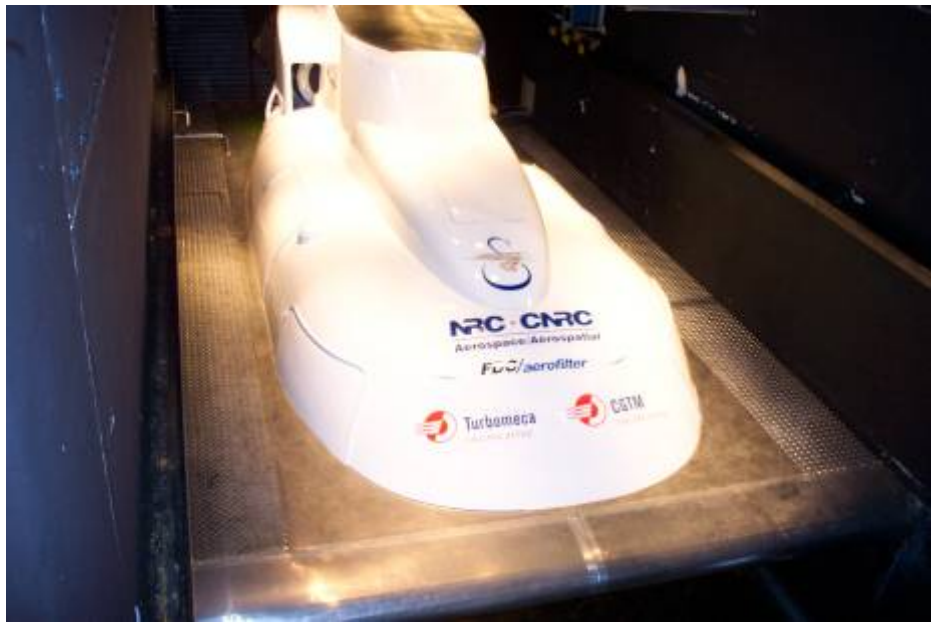
S-76D Component Tests

Tests of S-76D Heater Elements in NASA IRT

Tested over a range of temperatures from -30 deg C to +5 deg C

RIPS timing cycles optimized

S-76D Inlet Will Be Tested at NRC of Canada



S-76D inlet icing test are planned for December 2007 through February 2008. Pictured is the S-76C inlet icing test model

Falling and Blowing Snow

S-76C++ Certificated for Flight in Falling and Blowing Snow
Similar certification will be obtained for the S-76D

Sikorsky S-92A and S-76D Icing Conclusions

Sikorsky successfully developed and tested the ice protection systems for the S-92A.

The S-92A RIPS is certificated and in production.

A similar system is in development for the S-76D, with icing flight tests scheduled to begin in the winter of 2009-2010.