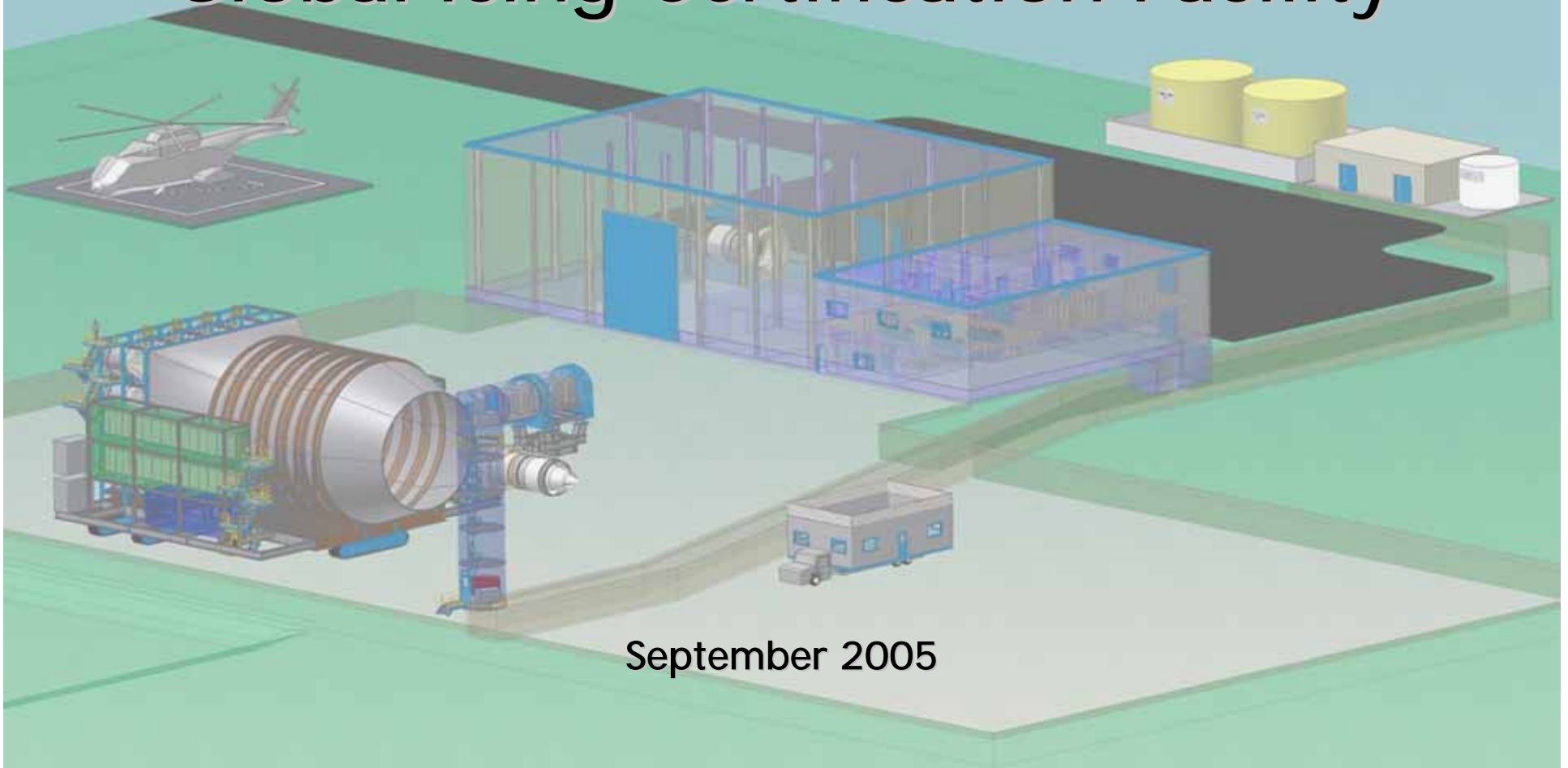


Global Icing Certification Facility



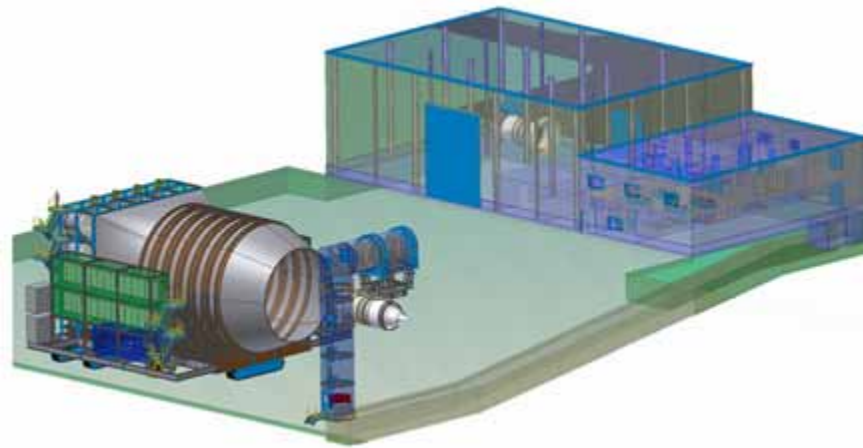
September 2005

Background

- Existing Facility Restrictions
 - Suitable weather
 - Power supply restrictions
 - Escalating costs
 - Scheduling difficulties
- Increased Certification Requirements
 - Airworthiness improvement requirements
 - Increased test requirements

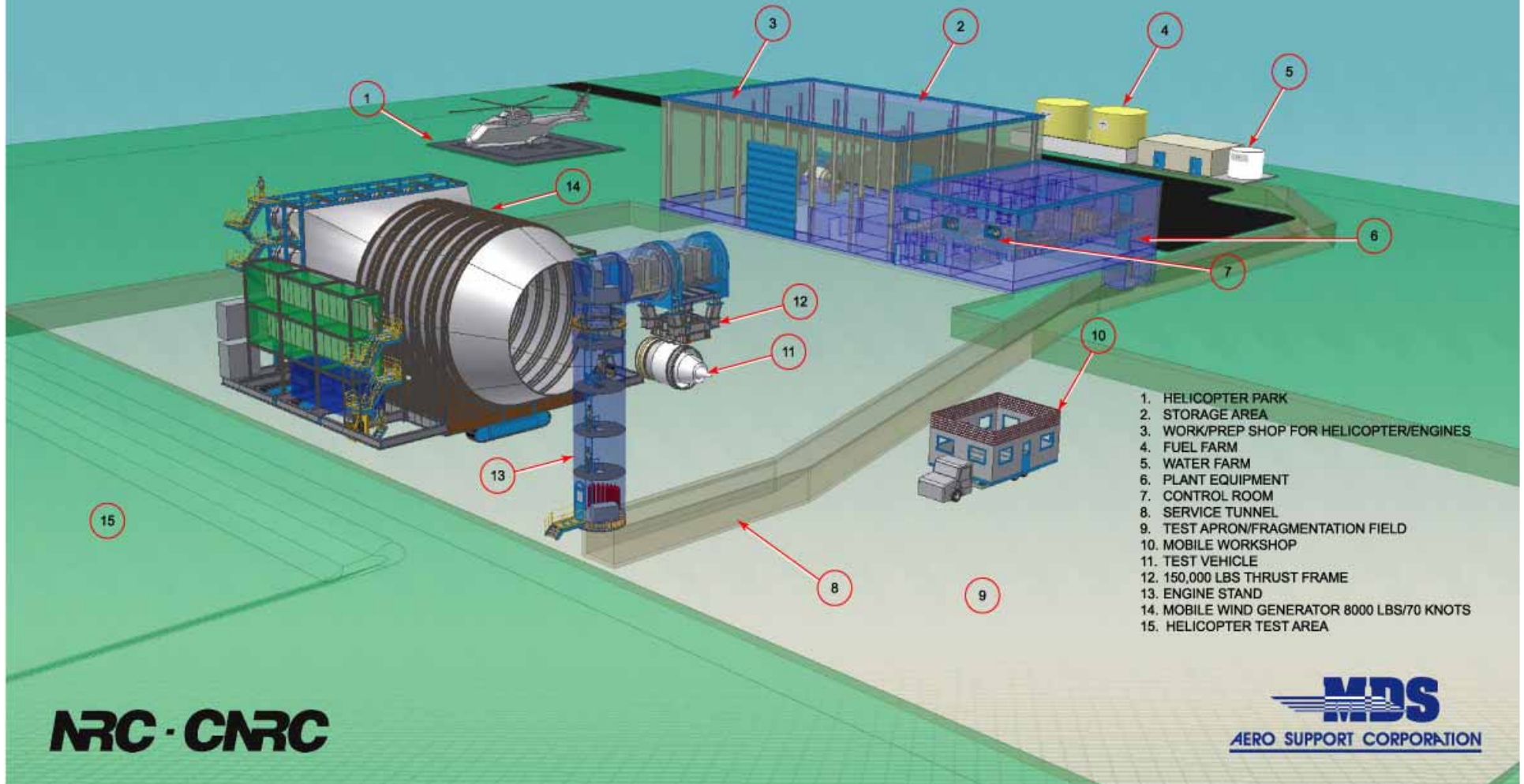


MDS Global Icing Certification Facility



- Multi OEM Outdoor Engine Icing Test Facility (2 icing windows per year)
- Organized & Managed by MDS and NRC
- Other Potential Outdoor Tests – cold soak, endurance, x-wind, bird strike, hail ingestion, blade off, helicopter icing, helicopter flight dynamics

GLOBAL ICING FACILITY



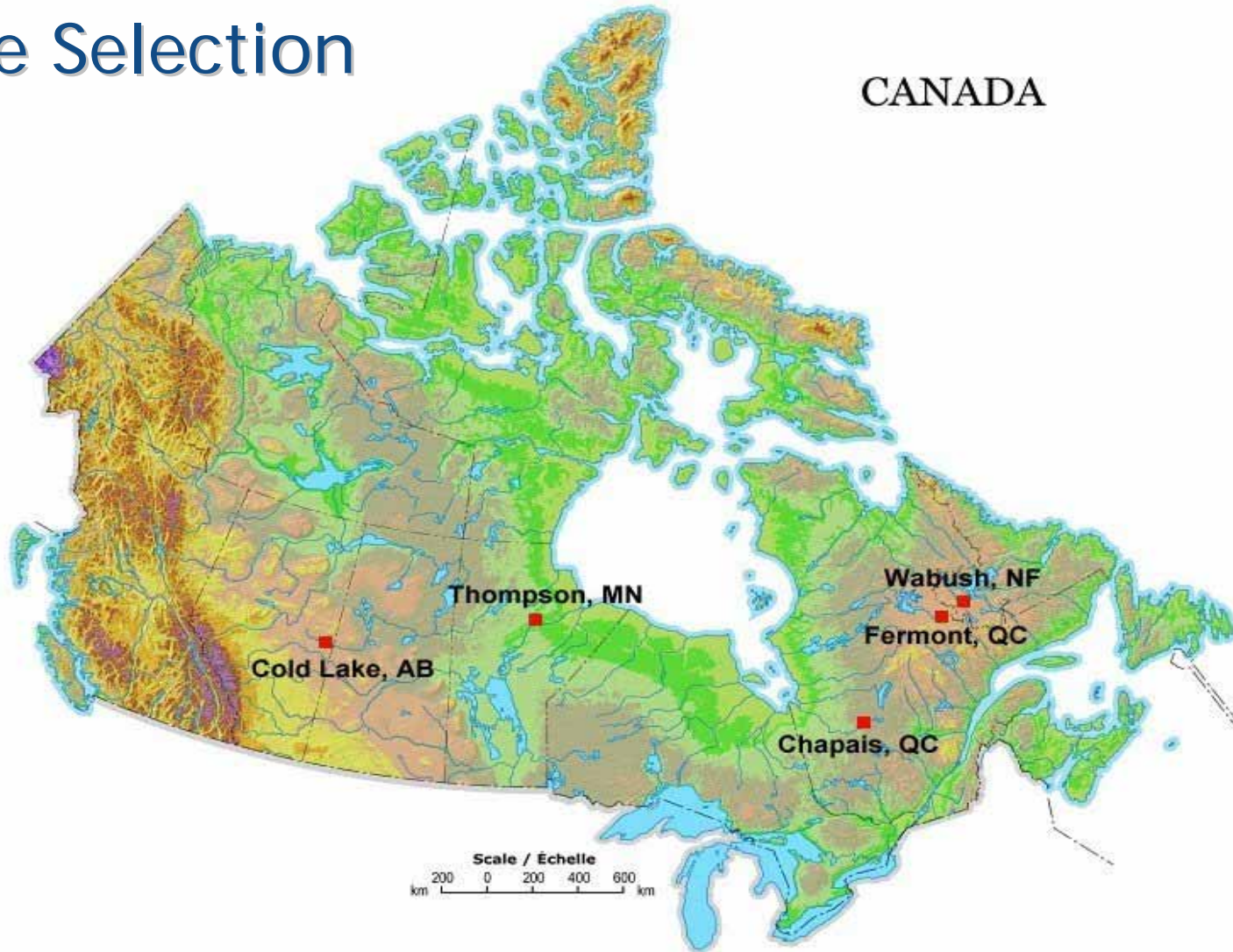
NRC - CMRC

What Does This Facility Offer OEMS

- Increased scheduling confidence/low risk
- Fair & reasonable price structure
(Pay Per Use)
- State-Of-The-Art equipment and test capability
- Regulatory agency approvals
- Data security
- Alternate test capabilities/multi-purpose

Site Selection

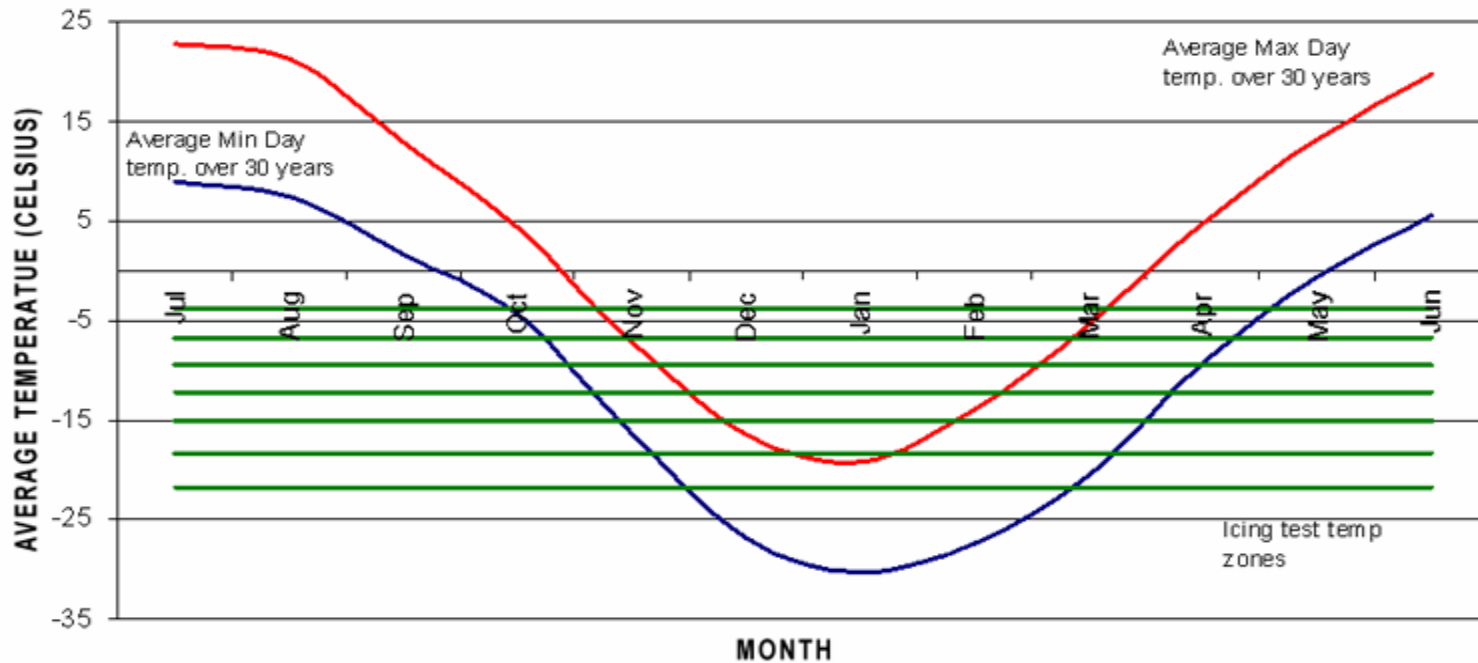
CANADA



Weather Profile

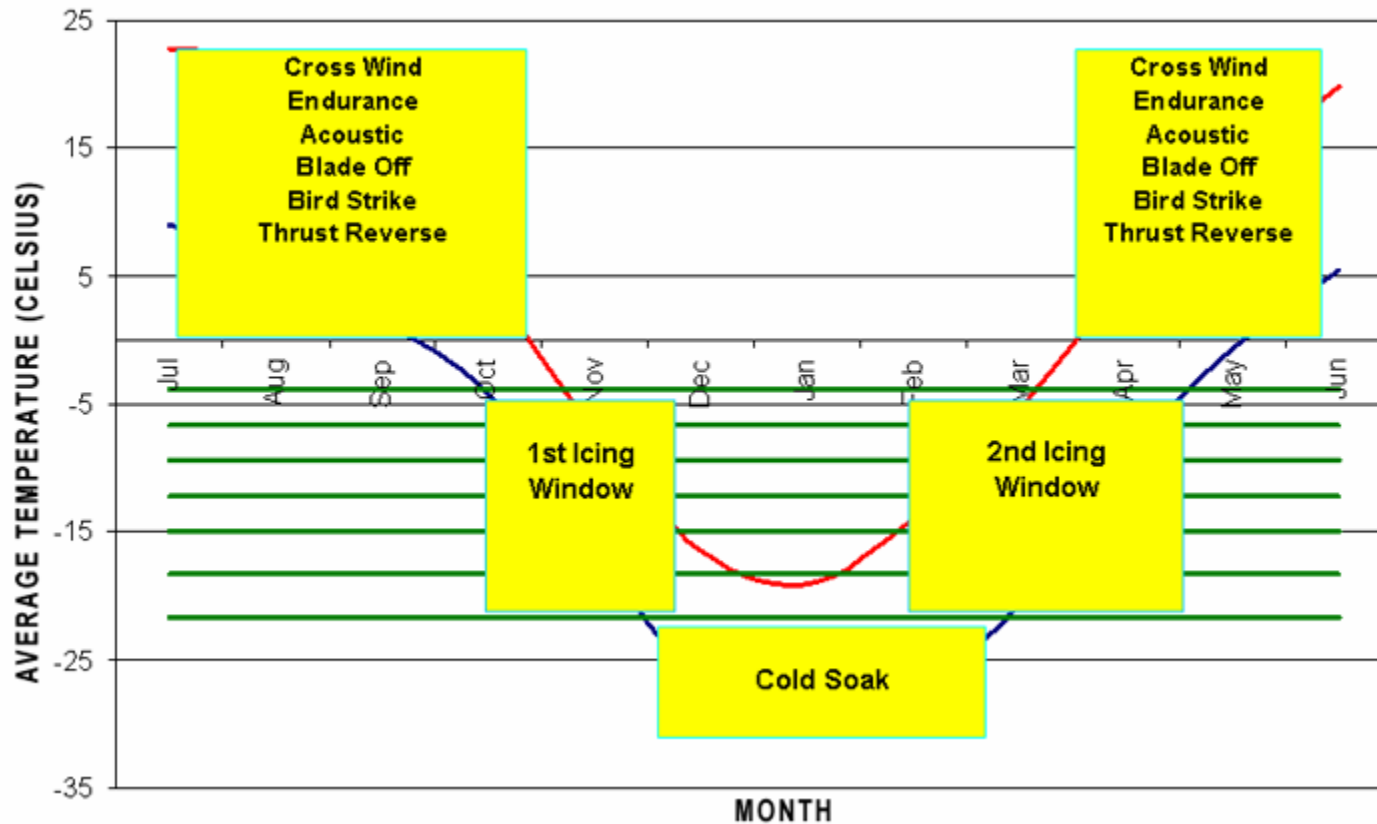
	Bin 1	Bin 2	Bin 3	Bin 4	Bin 5	Bin 6	Bin 7
Bin Low Temp	-21.7 Deg C	-18.3 Deg C	-15.0 Deg C	-12.2 Deg C	-9.4 Deg C	-6.7 Deg C	.-21.7deg C
Bin Hi Temp	-18.3 Deg C	-15.0 Deg C	-12.2 Deg C	-9.4 Deg C	-6.7 Deg C	-3.8 Deg C	.->-20 deg C
#days with 2 sigma Confidence	62	62	60	58	54	58	24

MAX AND MIN TEMPERATURE VALUES FOR THE IDEAL SITE

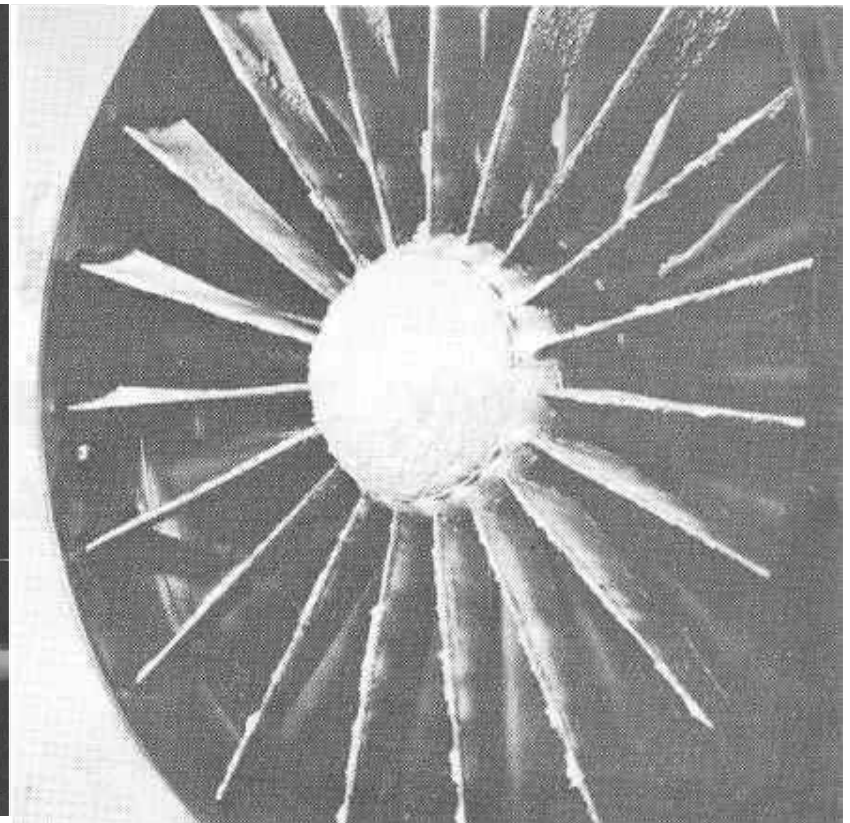
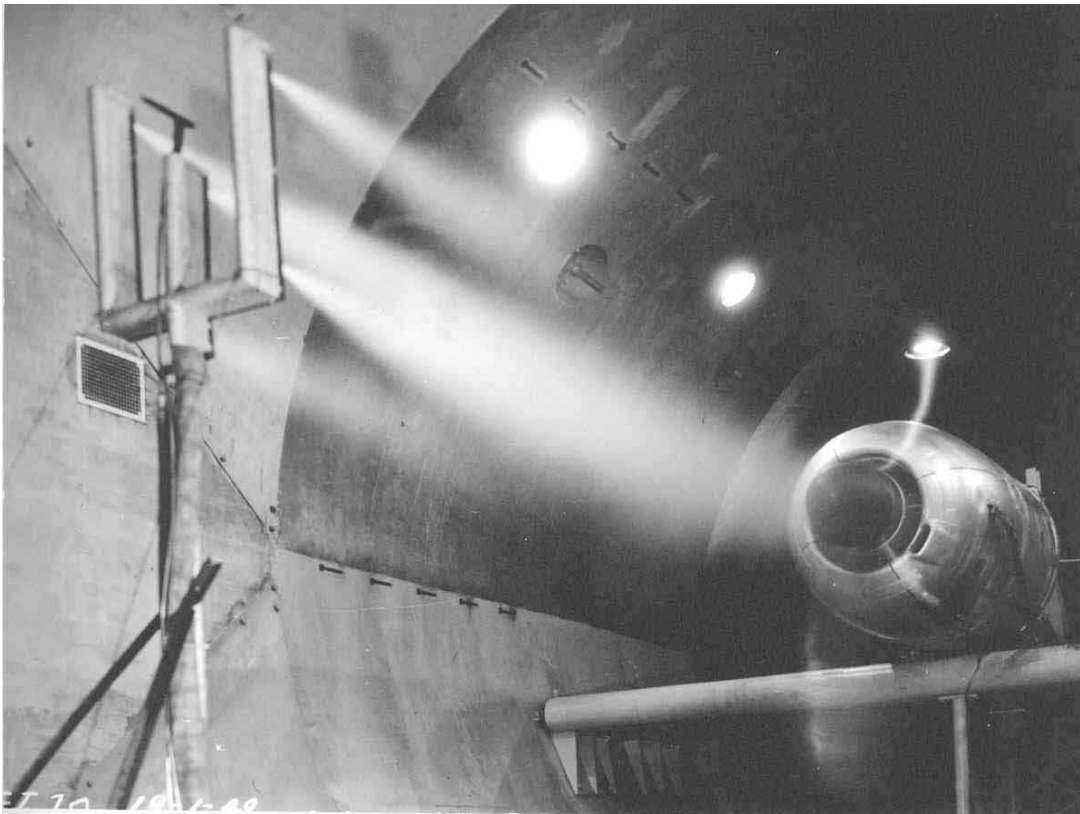


Operational Test Windows

MAX AND MIN TEMPERATURE VALUES FOR THE IDEAL SITE



Gas Turbine Icing Certification



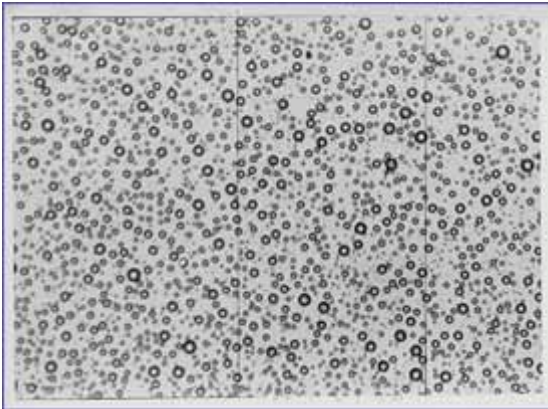
Environmental Threats

Threat	Characteristics	Reference	Capability
Icing- Continuous Maximum	0.1 to 1.1 g/m ³ 15 to 40 microns 32°F to -22°F	FAR25 App.C	Yes- sea level
Icing- Intermittent Maximum	0.1 to 3.8 g/m ³ 15 to 40 microns 26°F to -40°F	FAR25 App.C	Yes-sea level
Ground Icing	>0.3 g/m ³ >20 microns 15°F to 30°F	FAR33.68b	Yes
Hail stones, Rain	1, 2 inch diameter	FAR33.78(1) FAR33.78(2)	Yes
Super Large Droplets	100-500 microns Near freezing	FAR33 App.X	up to 150 micron
Ice Crystals, Mixed phase	0.3 g/m ³ 0.2 to 5 g/m ³	FAR33 App.X	TBD

Traceability of Key Parameters

Characteristic	Nominal Tolerance	Instrument	Process under ISO 9001 control
Uniformity	5%	J&W probe Inlet Screen	Individual nozzle calibration in Icing Tunnel Two axis traverse in situ
Median Volume Droplet Diameter	± 2 micron	Forward Scattering Spectrometer & Optical Array probe Malvern probe	Individual nozzle calibration in Icing Tunnel Two axis traverse in situ
Liquid Water Content	± 0.1 g/ m ³	J&W probe King probe Water mass flow meter	Two axis traverse in situ Calibration to national standard

Full Turn Key Icing Certification Testing



1. Droplet Calibration



2. Cloud Distribution Verification



3. Icing Certification Testing

Icing Technology Specification

- Temperature range
-2°C to -22°C
- Liquid Water Content (LWC)
0.2 g/m³ to 4.0 g/m³
- Median Volume Diameter (MVD)
 - FAR App C 13-45 microns
 - New FAR App X. Super large droplets 100-150 microns
- Mixed Phase (infrastructure)
 - Liquid water/Ice crystals mixed also FAR App X 0.2-5.0 g/m³



Icing Technology Specification



- Snow/ Ice crystals only, artificially generated 0.3 g/m^3
- 800 spraying/icing nozzles
400 large and 400 small
- Water flow
200 gpm-100,000 pph
- Cloud spec
Uniformity 5%,
MVD ± 2 microns
LWC $\pm 0.1 \text{ g/m}^3$

Current Rotorcraft Icing Certification

- Clean Air Test
 - Cold weather
 - No icing
 - Simulate icing shapes
- HISS Flight Test
 - 8 ft by 36 ft cloud size
 - Droplet size: 20 – 70 micron
 - Ice liquid content .25 – 1.0 g/m³
- Flight in Actual Icing Conditions

Open Air Flight Test - HISS

Current HISS Capability

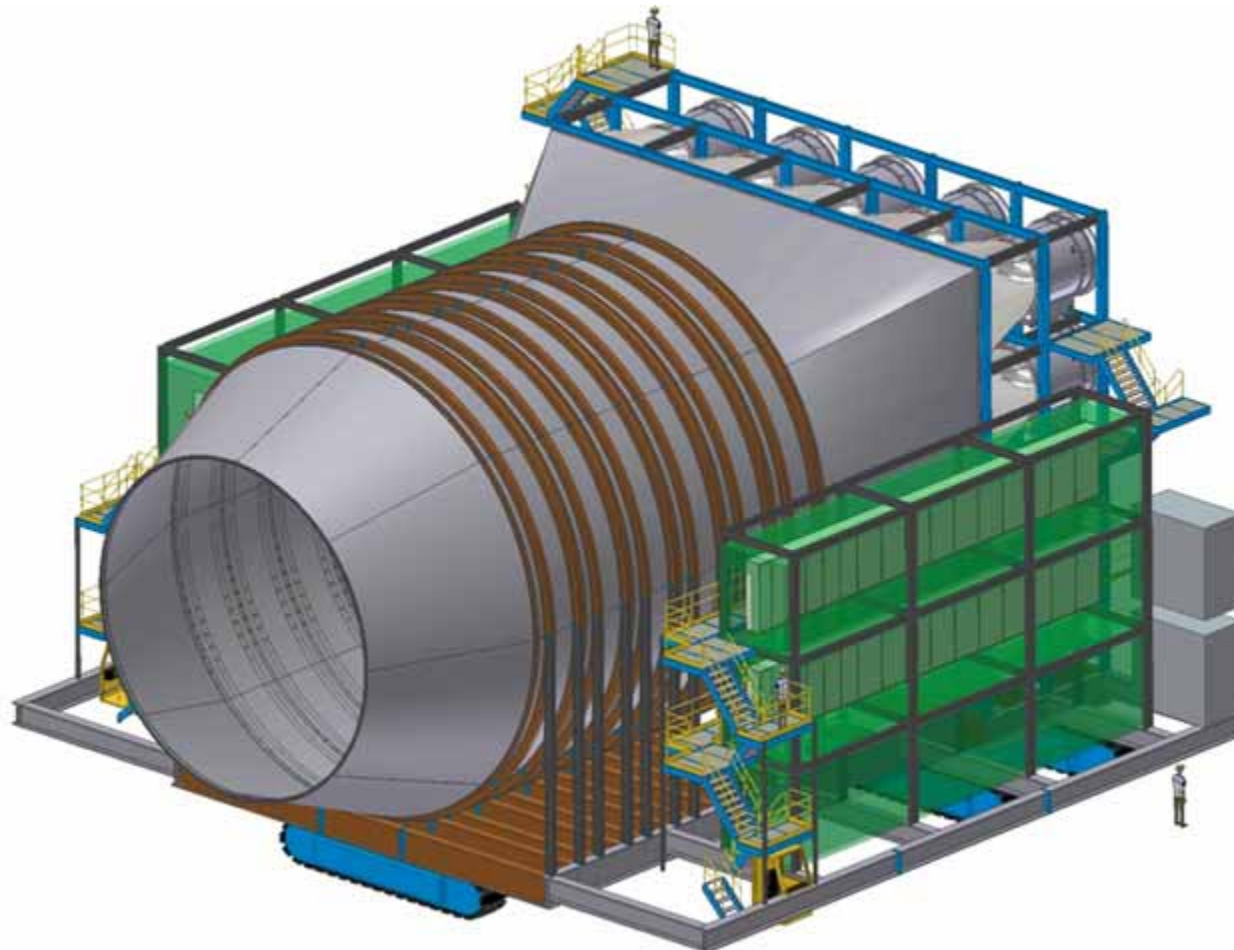
- 8 ft x 36 ft cloud size
- Ice droplet size: 20 –70 micron
- Ice Liquid Water Content: 0.25 –1.0 gm/m³



Regulatory Requirements

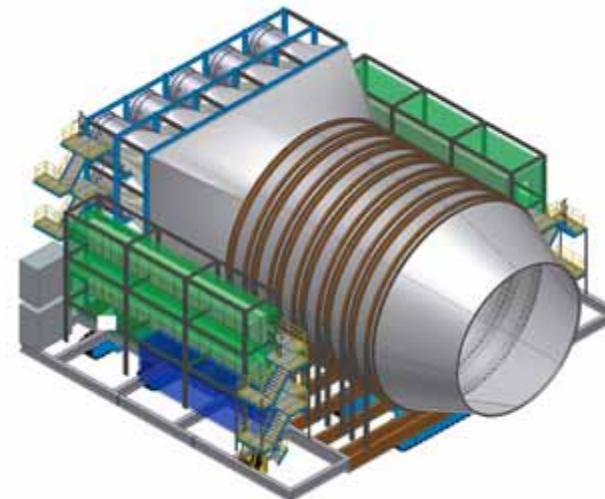
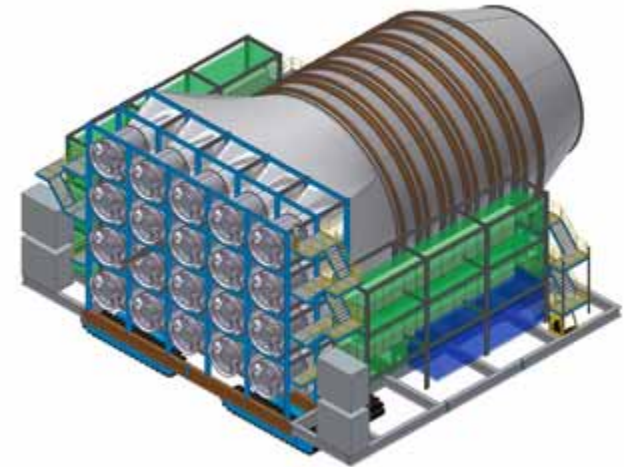
- Regulatory requirements going forward:
 - 60 ft cloud size
 - Droplet size: 15 –70 micron
 - Liquid Water Content: .25 –3.0 g/m³
- GICF capabilities:
 - 60 ft cloud size
 - Droplet size: 13 – 45 micron and 100 - 150 micron
 - Liquid Water Content: .2 – 4.0 g/m³
 - Improved test durations

Wind Generator

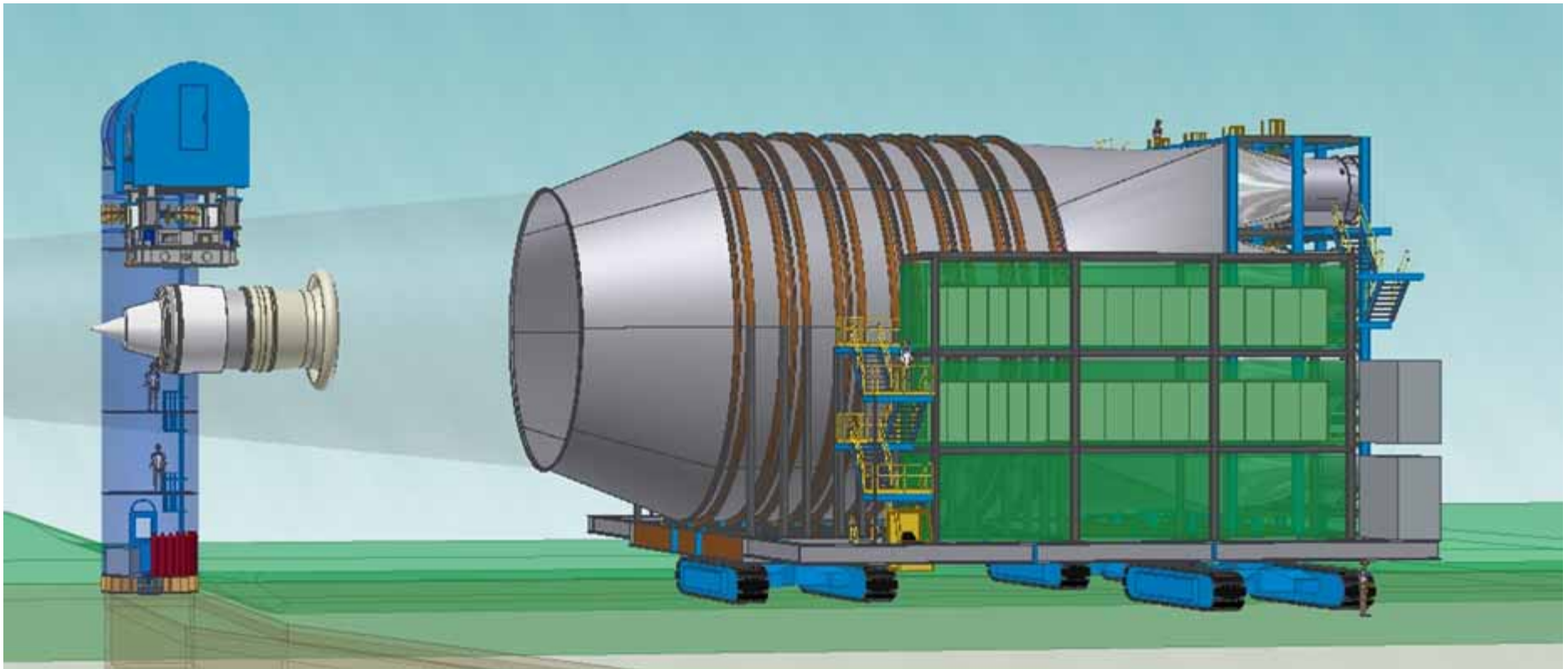


Wind Generator

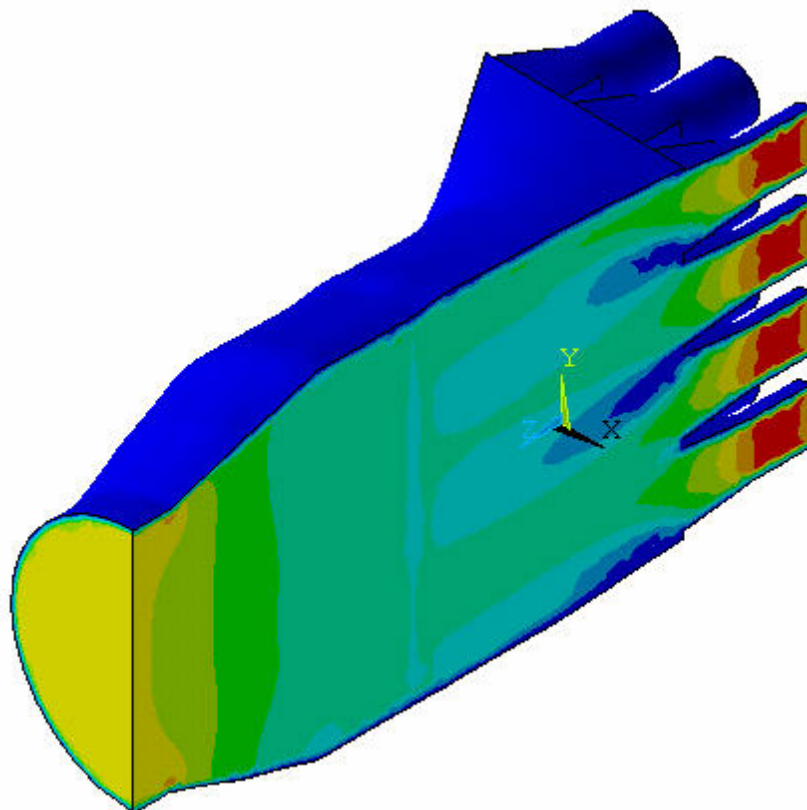
- Largest in the world
- 8000 lbs/sec at 70 knots
- 10 meter diameter exit nozzle
- Velocity Distortion at Nozzle <10%
- Approx. 650,000 kg
- Equivalent in height to a six story building



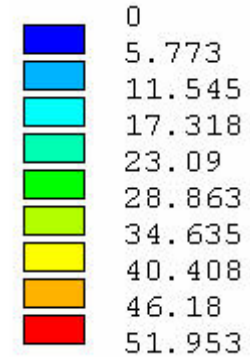
Wind Generator

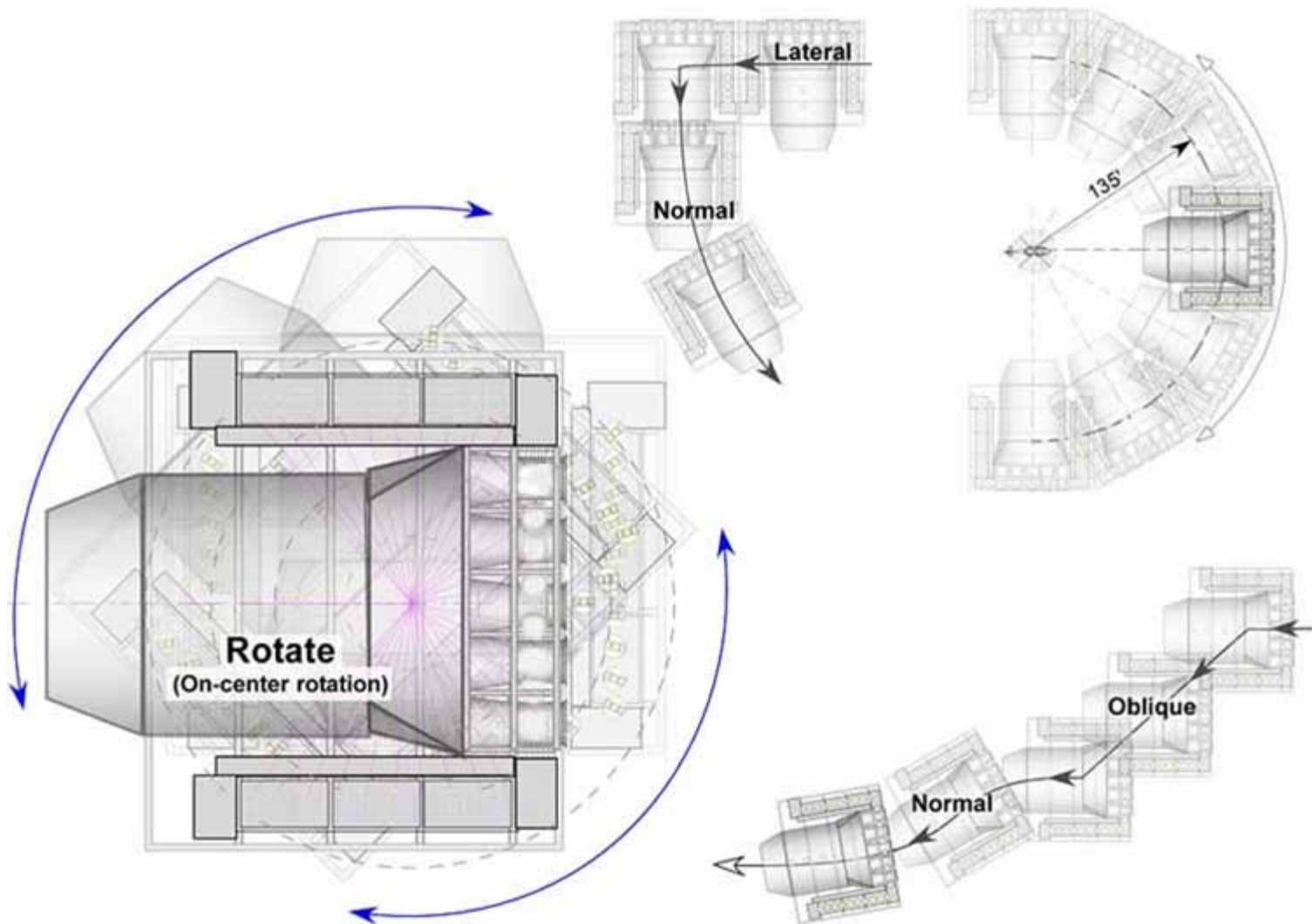


Flow Velocity Profile



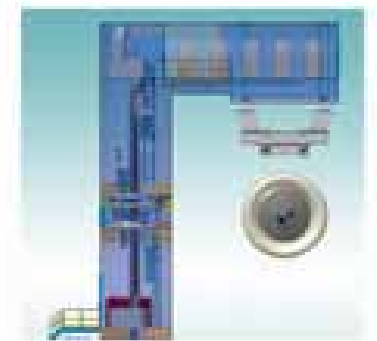
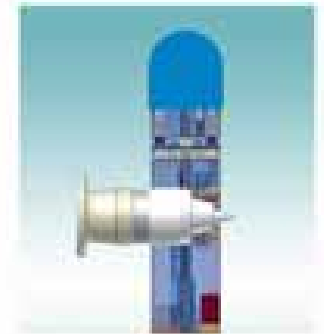
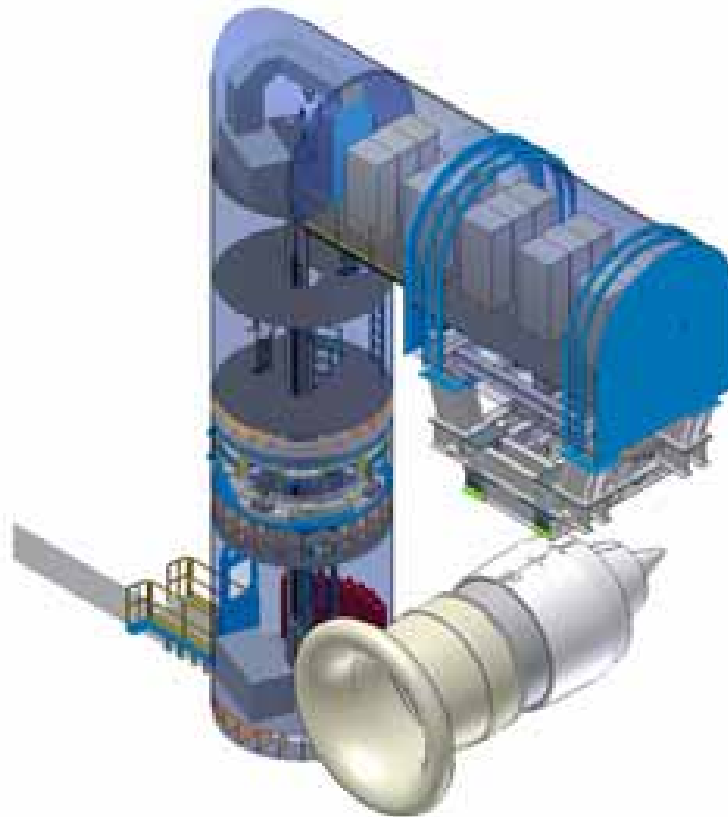
Velocity (m/s)





Thrust Measurement

- 150, 000 lb thrust capability
- Accuracy 0.1% of FS range
- Mobile lift for engine access



Steady-State and Transient System

- proDAS Data Acquisition System
 - PC-based
 - Based on Real-time LINUX OS
 - Windows look and feel
 - Scan rates up to 2000 Hz.
 - Deterministic response to alarms



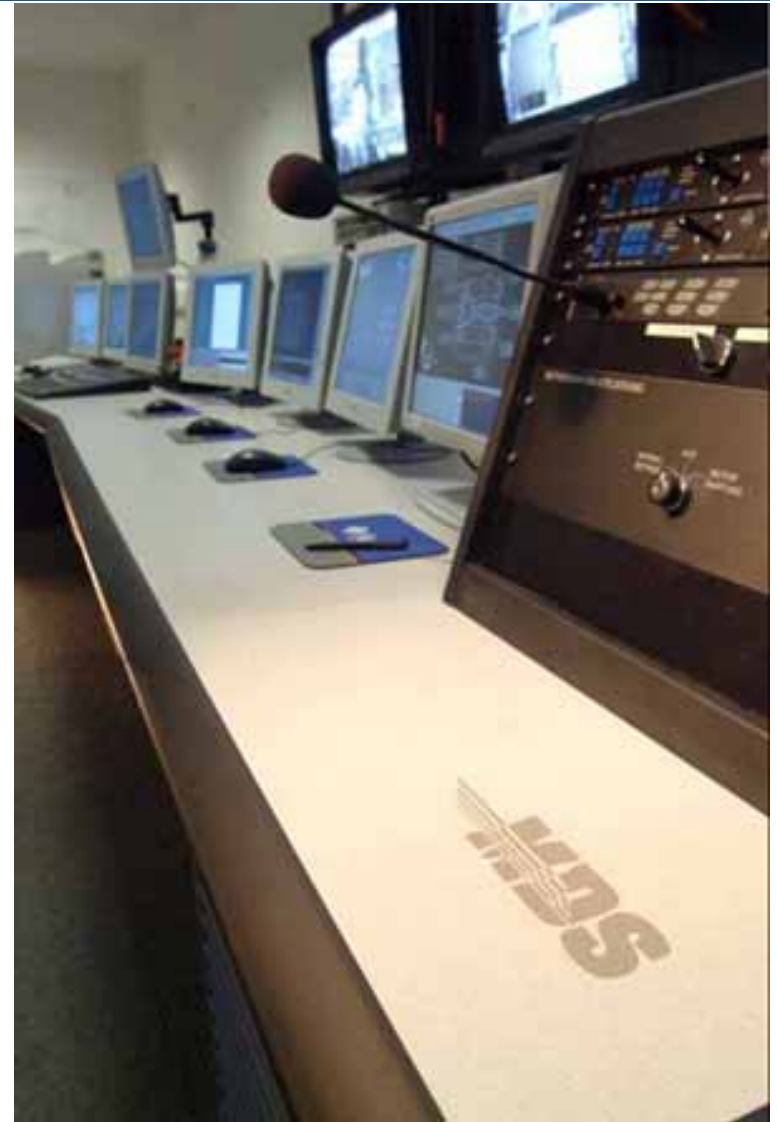
proDAS Channel List

- 256 Voltage inputs (200 Hz)
- 16 High-speed voltage inputs (2000 Hz)
- 256 Thermocouple inputs
- 16 RTD inputs
- 400 pneumatic pressures
- 10 liquid pressures
- 10 frequency inputs
- 4 Vibration broadband
- 6 Tracked order vibration
- ARINC 429 (8 Rx, 4 Tx)
- 32 Digital I/O
- Thrust measurements
- Ambient conditions



proDAS Console

- 3 proDAS real-time data monitors
- 1 User Interface monitor
- 1 Engine / facility control monitor
- 2 CCTV monitors
- 1 CCTV control panel
- 2 Video cassette recorders (NTSC)
- 1 Color laser printer
- 1 Intercom base station
- 1 Emergency stop panel



Dynamic Data System

- DSPCon Piranha III system
 - VME based
 - 64 channels up to 115 KHz. (bandwidth)
 - Archive system produces tapes in wide range of formats
 - Data formats are published
- Channel types
 - 32 AC Strain
 - 16 Dynamic pressures
 - 4 Vibration (piezo-electric or piezo-resistive)
 - 4 speed inputs
 - 8 spare analog input channels
 - IRIG-B

DDS Console

- Standalone console will include
 - 2 Real-time data monitors
 - 1 control monitor



Mechanical Support Systems

- Air start system
(90 psia @ 13 lb/s)
- Fuel conditioning system
(Jet A @ 65,000 lb/hr)
- Remote oil filling system
- Engine preservation system
- Load bank (2 x 250kw)



Facility Test Capabilities

- Icing certification testing
- Cross wind testing
- Cold soak testing
- Endurance testing
- Thrust reverse testing
- Bird strike
- Hail and water ingestion
- Rotorcraft/winged aircraft icing
- Rotorcraft flight dynamics testing

