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Space Administration

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SPACEPORT
ENGINEERING AND
TECHNOLOGY

EXTREME VELOCITY WIND SENSOR

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National Aeronautics and Space Administration

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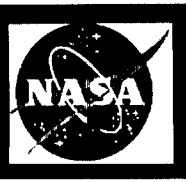
Why A Hurricane Wind Sensor?



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- **Kennedy Space Center (KSC) has the need to assess the mechanical stresses induced by high winds in their building and launch and landing structures.**

- **Most buildings and support structures were fabricated prior or during the Apollo Program era.**

- **If a hurricane hits KSC, there is a need to verify safety factors of buildings and support structures have not been exceeded.**

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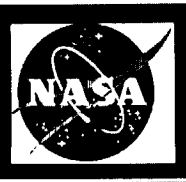

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- **Current wind sensors used at KSC lack in two main areas:**
  - **Rotating cup or vane type anemometers have a high maintainability due to the wear-and-tear of their moving components.**
  - **There is a high degree of failure associated with such systems due to damage from extreme wind conditions.**
- **Experience developed from Hurricane Andrew (1992) demonstrated that existing wind sensing instrumentation would not withstand extreme hurricane winds.**

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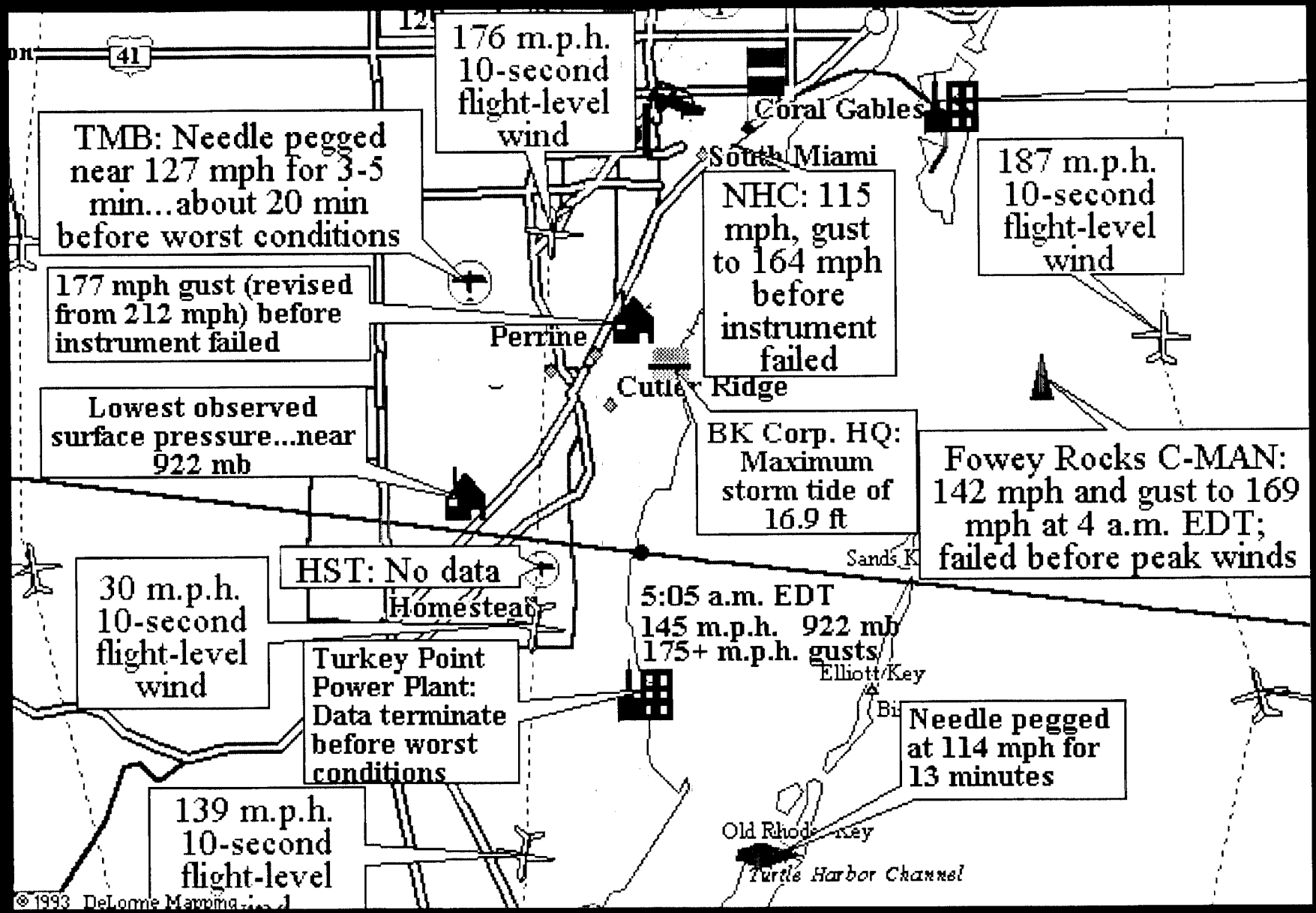

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Why Another Hurricane Wind Sensor?

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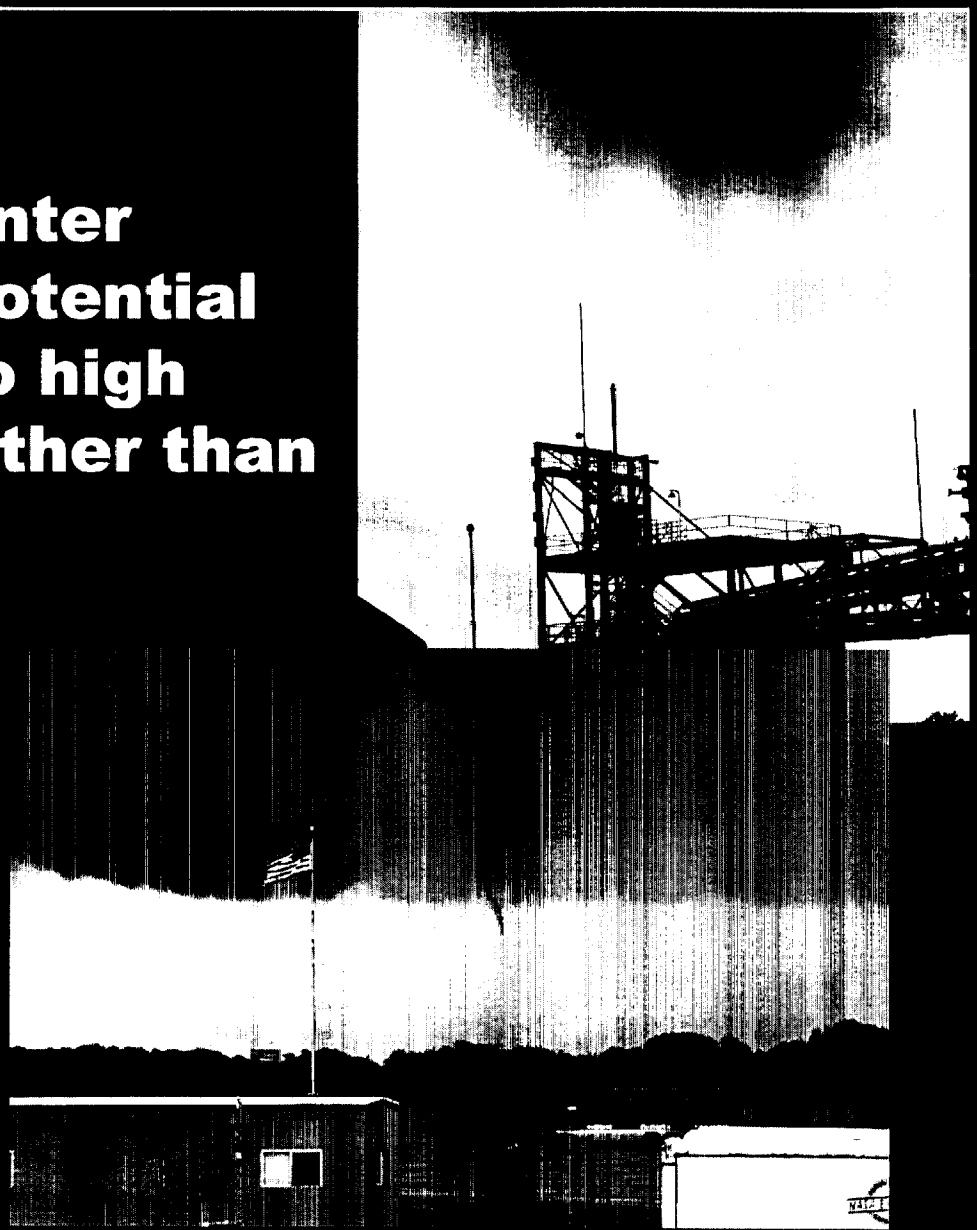
Why Another Hurricane Wind Sensor?

- Kennedy Space Center (KSC) also has the potential of being subjected to high winds produced by other than hurricanes.

- Strong thunderstorms, small tornadoes and water spouts are normally encountered during the summer.



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Our Hurricane Wind Sensor

Project Objectives

- **Provide KSC with a a wind sensor with the following characteristics:**
  - **rugged,**
  - **low profile,**
  - **highly reliable,**
  - **self-contained system for wind speed and direction,**
  - **Capable to measure wind speeds up to 300 mph, wind direction (in 45 degree increments) as well as temperature and RH.**

- **Provide KSC with a wind sensor design that has no moving parts to reduce operation and maintenance costs.**

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Our Hurricane Wind Sensor

Conceptual Design

- The Extreme Velocity Wind Sensor is a device for the measurement of wind speed through the use of pressure measurements across a known shape.
- Form is a typical streamlined Venturi profile (a double-inflection curve) revolved 360 degrees about an axis passing vertically through the center of the profile.
- The profile has a series of instrumented ports located near the center and periphery to allow for pressure measurements along the surface.
- The wind speed is calculated from applying Bernoulli's law to the pressure change created between the ports. (Eqn. $P = \frac{1}{2} \rho * k * V^2$).

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Our Hurricane Wind Sensor

Conceptual Design

- Wind direction is derived from the pressure profile distributed over the surface. Additionally, temperature and relative humidity measurements are incorporated into the design.
- Project involved the use of multi-discipline sensor technology combined with the development of smart embedded software algorithms.
- Project also incorporated the knowledge developed using Computational Fluid Dynamics (CFD) simulation of the design.

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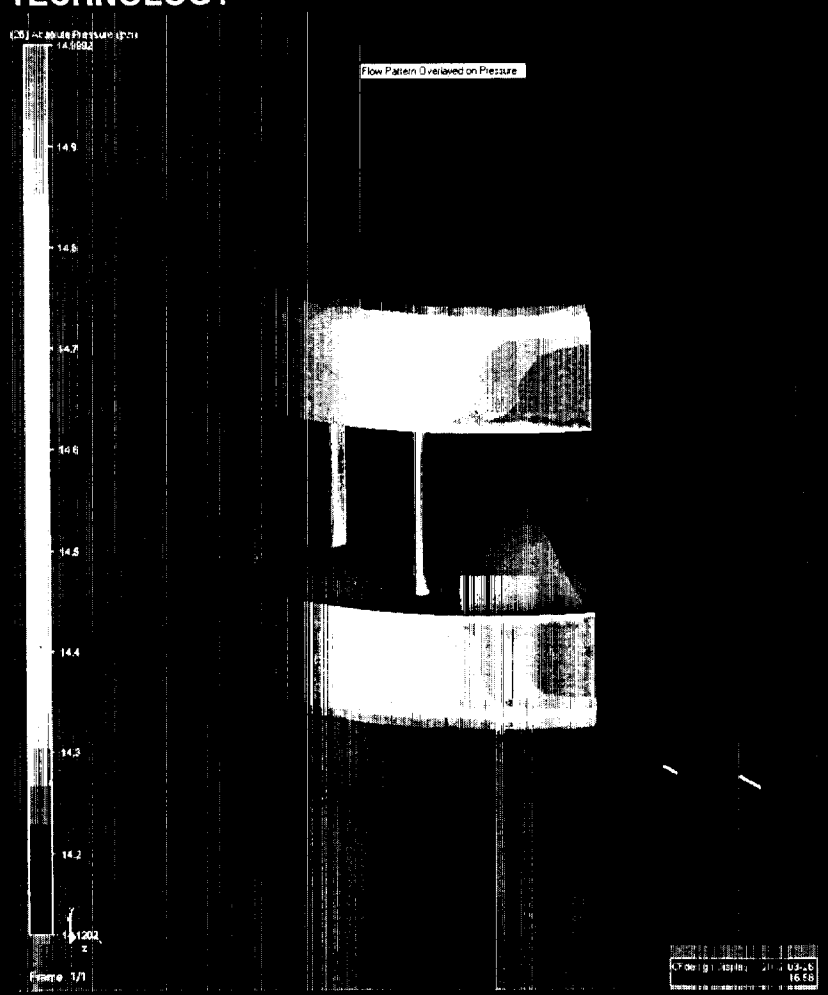

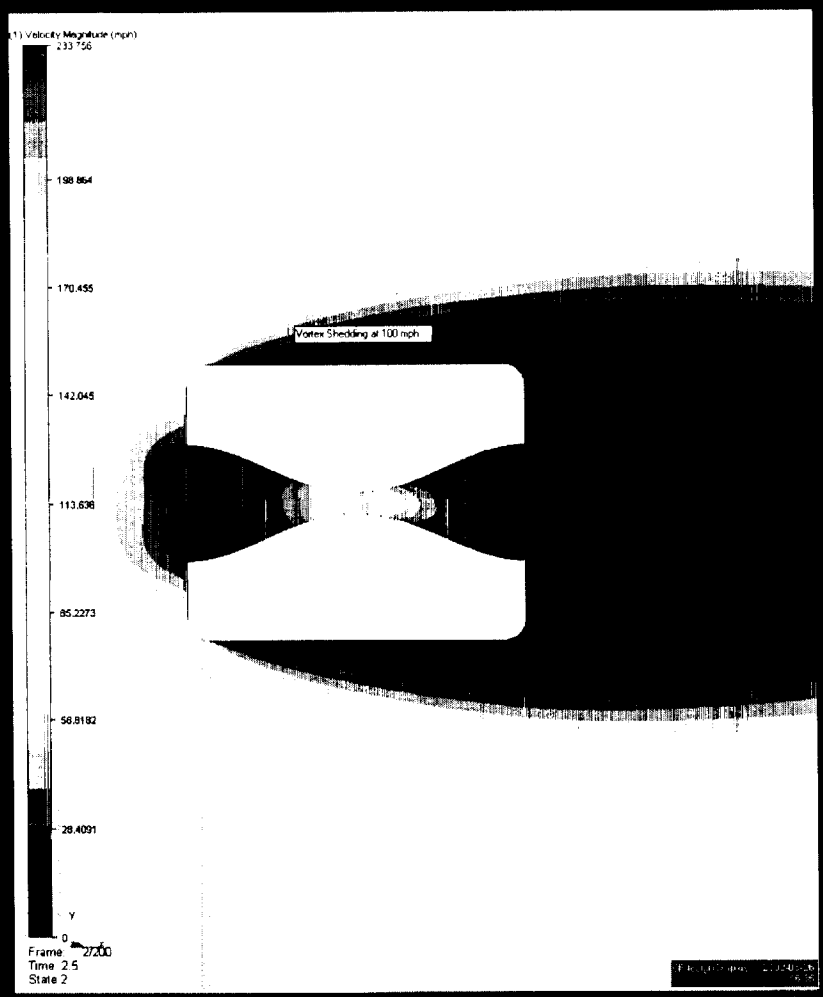

CFD Simulations of design

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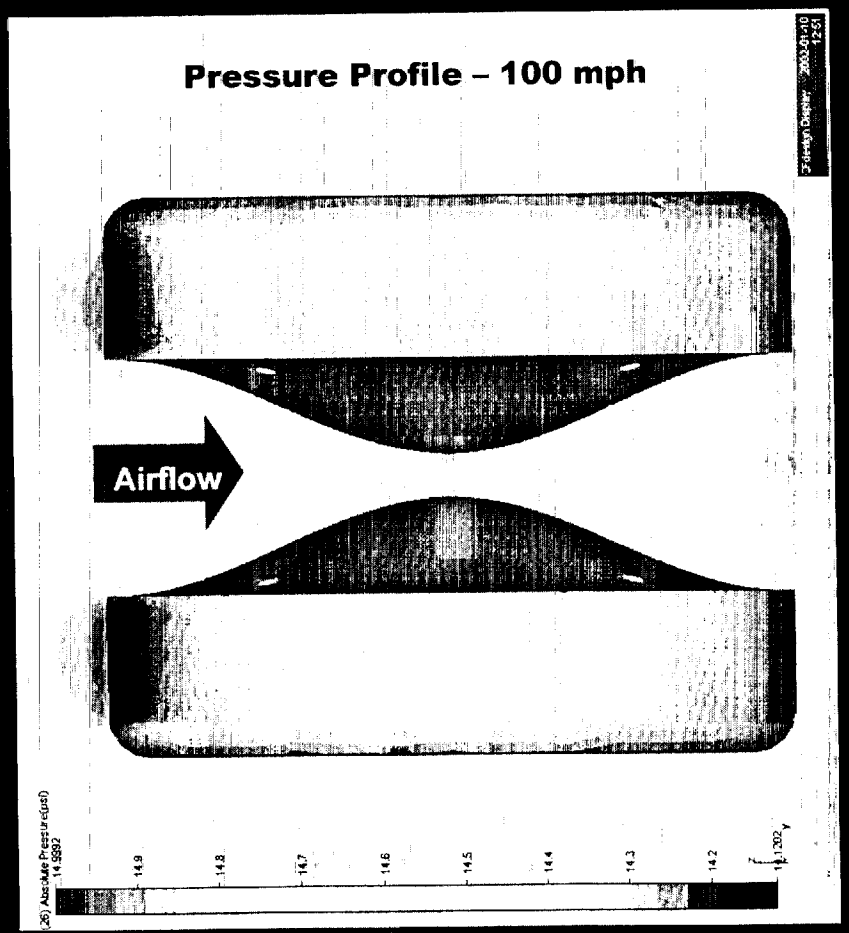

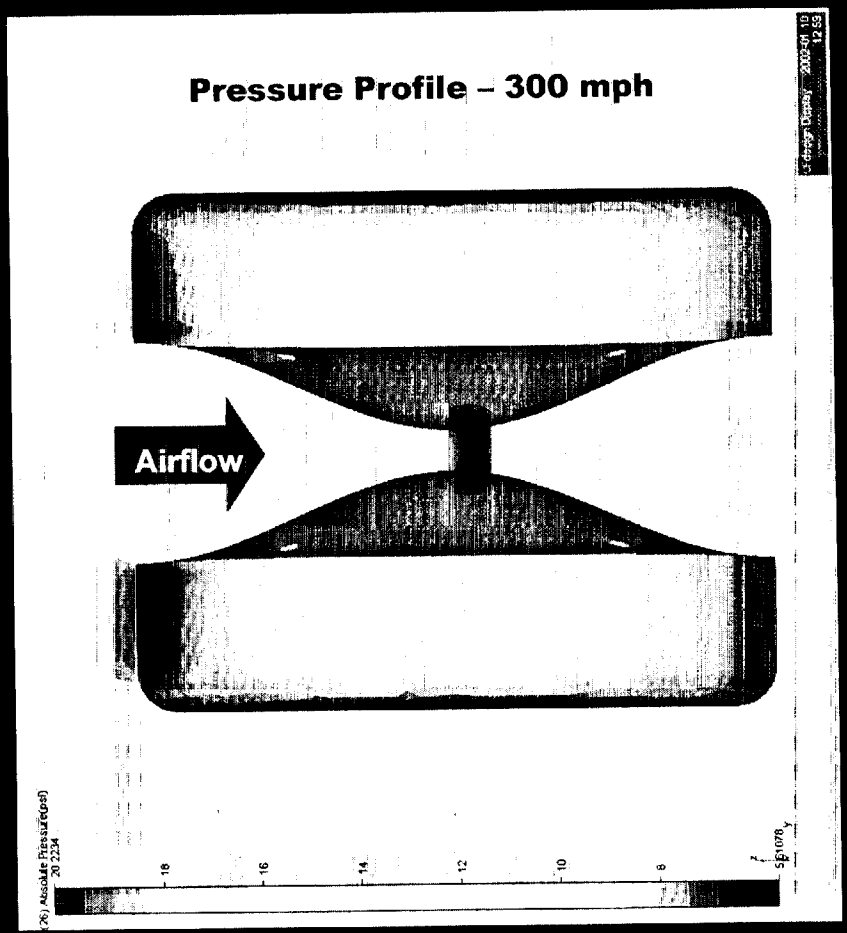

CFD Simulations of design

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Our Hurricane Wind Sensor

Project Present Status

- A Extreme Velocity Wind Sensor has been designed, developed, fabricated and is being tested at the present time.

- Sensor has been modeled and computer simulation has been performed using CFD software.

- Self -contained electronics has been conceptually designed. Analog section of design has been prototyped and initial testing performed.

- Testing of sensor at Embry Riddle Aeronautical University (ERAU) is scheduled for later this year.

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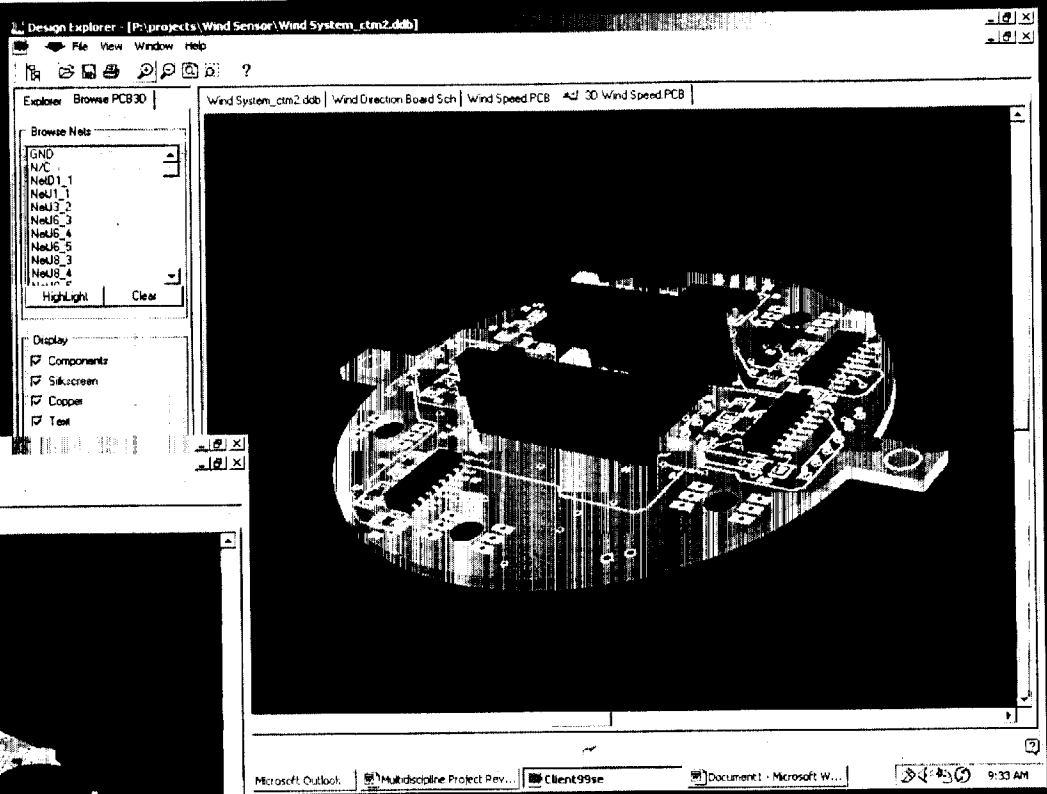
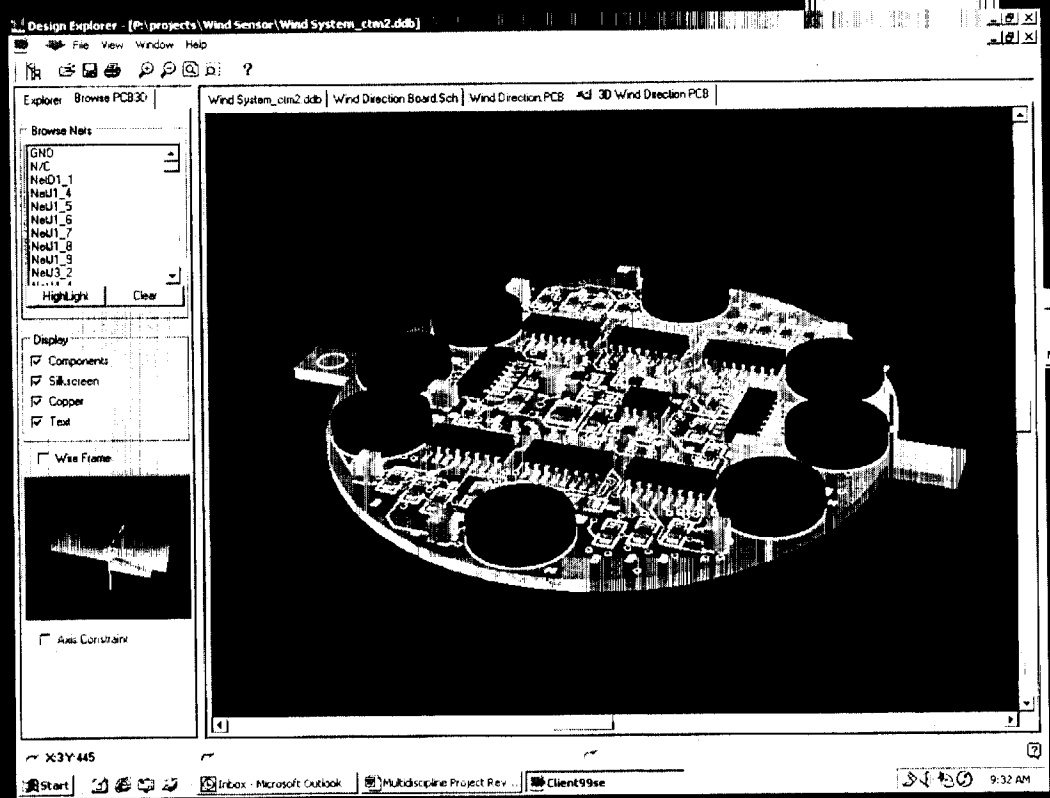
Wind Speed Sensor Module





Wind Direction Sensor Module

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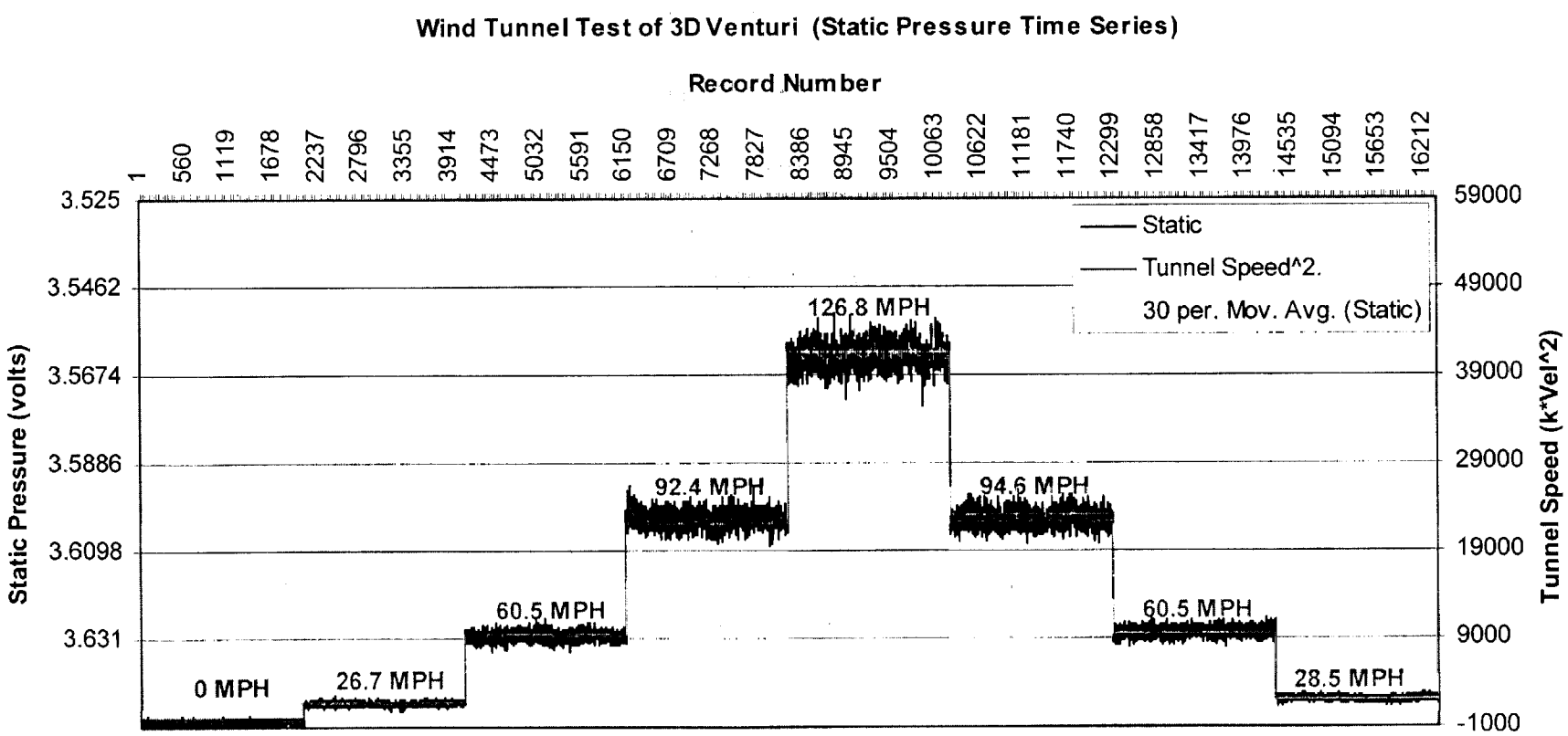

Preliminary testing at ERAU

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Project Next Steps

- Validate design at extreme wind velocities to 300 mph.
- Integrate methodology for wind direction determination.
- Optimize port locations to achieve best sensitivity and dynamic response.
- Optimize design to provide remote, standalone system capable of autonomously acquiring, recording, and storing storm information.
- Ruggedize the design for field deployment.
- Field deploy and test system.