Pre-certification testing why, when, where, & how
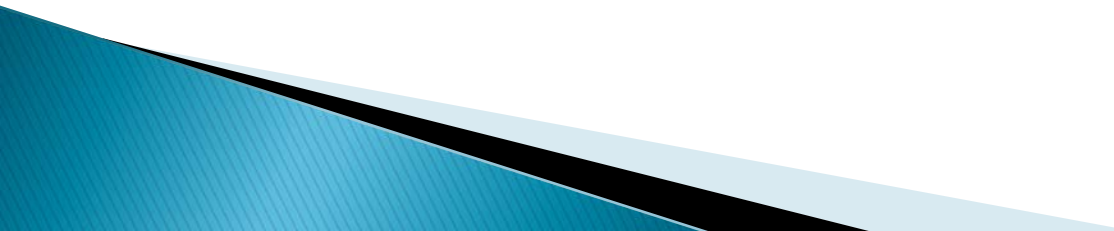

- James Jarvis
- APRS World, LLC
- www.aprsworld.com

Why?

- "Certification Testing"
  - NOT DESIGN TESTING!
  - NOT PROTOTYPE TESTING!
  - Is expensive
  - Is not convenient
  - Likely need to be restarted if changes are made
- Design should be tested before certification testing is started.

When

- As soon as possible!
- Test components
- Test sub-systems
- Test systems

Where

- Office
- Shop
- Highway
- Field

Where – Office: Design for test

- Design turbine to IEC standards.
- Model test setup to IEC standards where reasonable and feasible

INTERNATIONAL
STANDARD

IEC
61400-2

Second edition
2006-03

Wind turbines –

Part 2:
Design requirements for small wind turbines

AL

IEC
61400-12-1

First edition
2005-12

Part 12-1:
Power performance measurements of electricity producing wind turbines

Where – Shop: Dynamometer

- Availability
- Controlled lab environment
- Controlled RPMs, torque
- Mechanical forces can be measured
- Ideal for safety testing

- Generator testing only, no airfoils
- Capital $$$ intensive

Pros	Cons

Dynamometers, Blade

Photo from APRS World, LLC

Photo from Windward Engineering / Endurance

Dynamometers, Generator

Photo from APRS World, LLC

Photo from Windward Engineering / Endurance

- ▸ Use the same test equipment for production testing

Photo from Bergey Wind Power Company

Where – Highway: Truck Testing

Pros	Cons
- Availability - High Speed Winds - Cheap	- Small turbines only - Non-laminar flow - Vibrations - Influenced by natural wind - Trees, power lines, sonic booms

Field Test Sites, Facilities

- Put in appropriate places, not just convenient places
- Have un-restricted access to test site
  - Customers expect turbine to work and make them $$$. Do not expect them to be your test sites.
- Have appropriate basic infrastructure
  - Shelter
  - Power
  - Internet
  - Site access
- Build what you need to, but remember that infrastructure takes a lot of time and $$$

Shelter

- Environmental protection
  - Humans
    - Warm, dry, out of the wind, and comfortable
    - Food prep
    - Communications
  - Equipment
    - Specific to test
- Mini shop
  - Supplies for basic maintenance and repairs
  - Basic tools
  - Heavy tools & fixtures
- Safety Equipment
  - Hard hats, climbing harness, fire extinguisher, first aid kit

Bad Places to Work

Fact: Plywood alone does not make humans comfortable
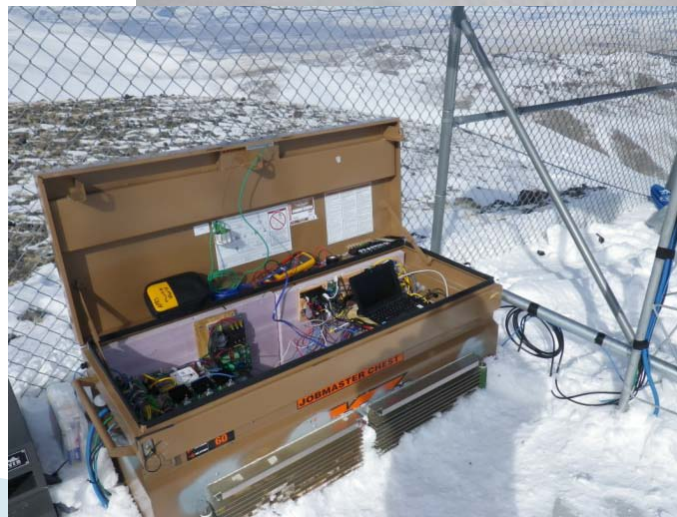
… but having a piece of plywood over your head would be an improvement in some places

Good places to work, NREL

Photo courtesy of Amy Bowen / NREL

Photo from APRS World, LLC

IP Cameras

- Mega–pixel IP Cameras EVERYWHERE
- Record video or periodic stills
- Synchronize time between data sources
- Place a camera very close to turbine for infrared Illumination at night
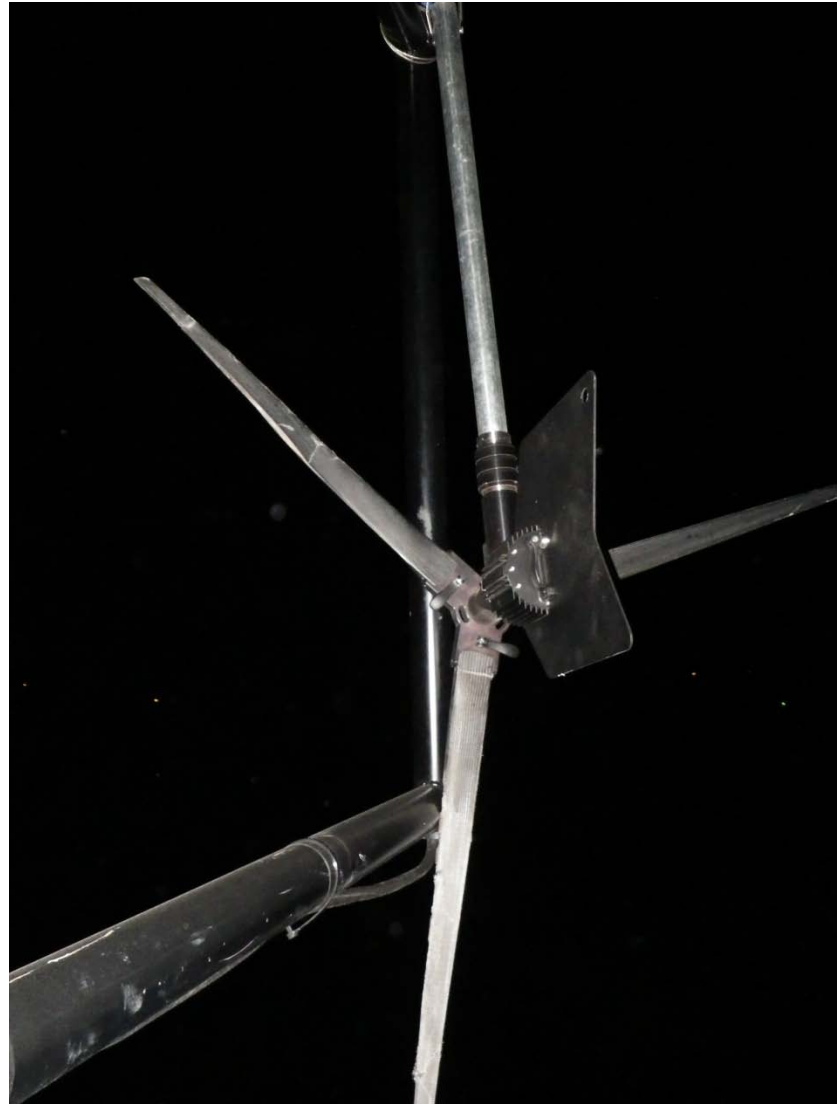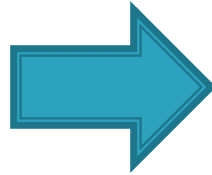- Cheap @ < $400 per camera

IP Camera Example

6:09PM

6:10PM

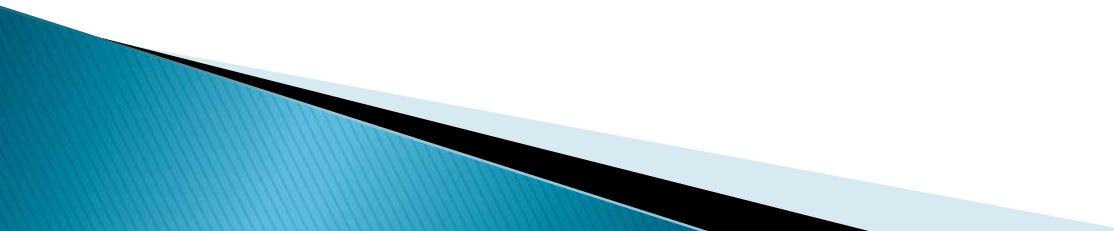# IP Camera Example, Continued

What I found
@ 8:55PM

Data

- Look at it daily or more
  - Catch problems early
  - Integrate with your normal workflow
    - Daily e-mail?
    - iPod Touch before bed and first thing in the morning?
    - Second monitor at your desk?
- Historical trends
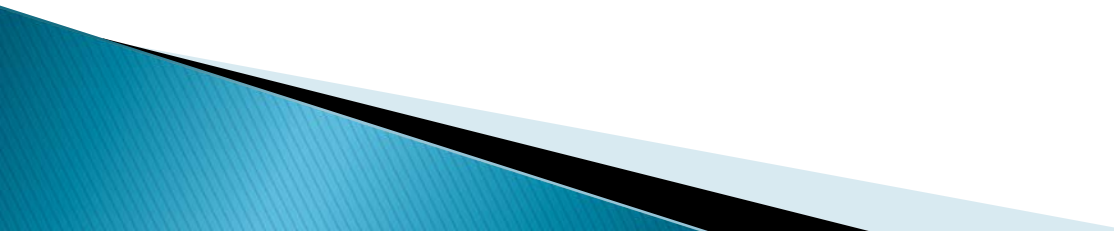 - Example: Decrease in RPM at given wind speed could indicate broken blade.

Turbines and Towers and Electronics (oh my!)

- Certification is on turbine AND tower AND electronics
- Develop strategy for testing sub-systems independently of each other
  ◦ Dynamometer is great for testing generator and generator / inverter combination.
- Test all of the pieces together!
  ◦ Electronics do REALLY effect mechanical bits
  ◦ Turbines can REALLY effect towers

When ready for certification testing?

- Design is stable and meets relevant IEC standards
- Turbine can survive for period of time and wind greater than what is required for endurance testing
- When an approximation of all safety tests have been passed

Conclusions

- Git 'r done
  - ◦ Certification testing is perfection
  - ◦ Pre-certification testing making sure you are ready for perfection
- Move fast, be agile
- Test everything independently and together
- Test early, test often
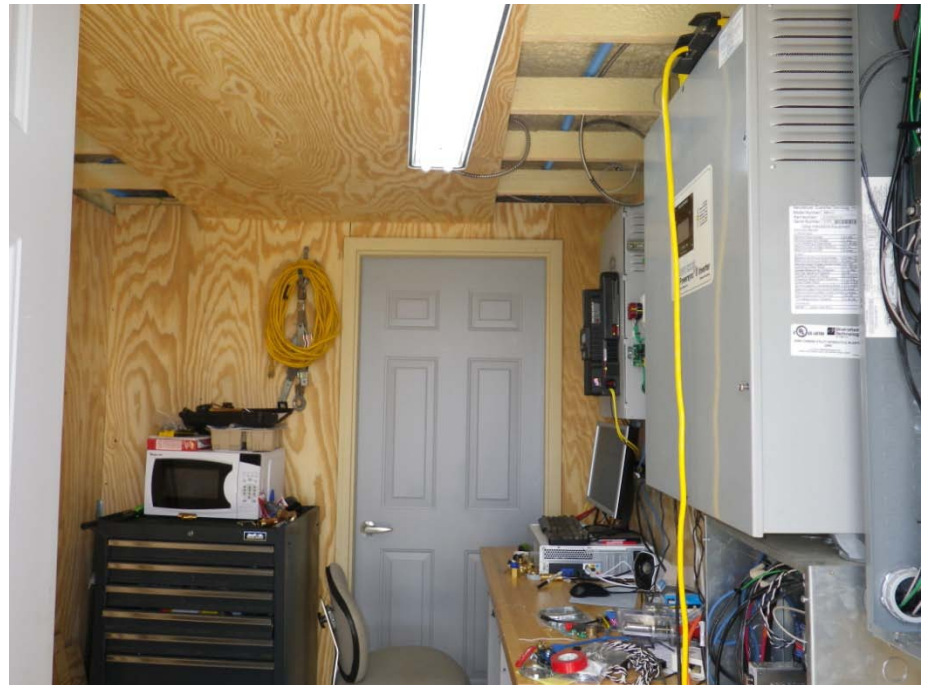- Test with more than one unit!

Be realistic!

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web: www.aprsworld.com

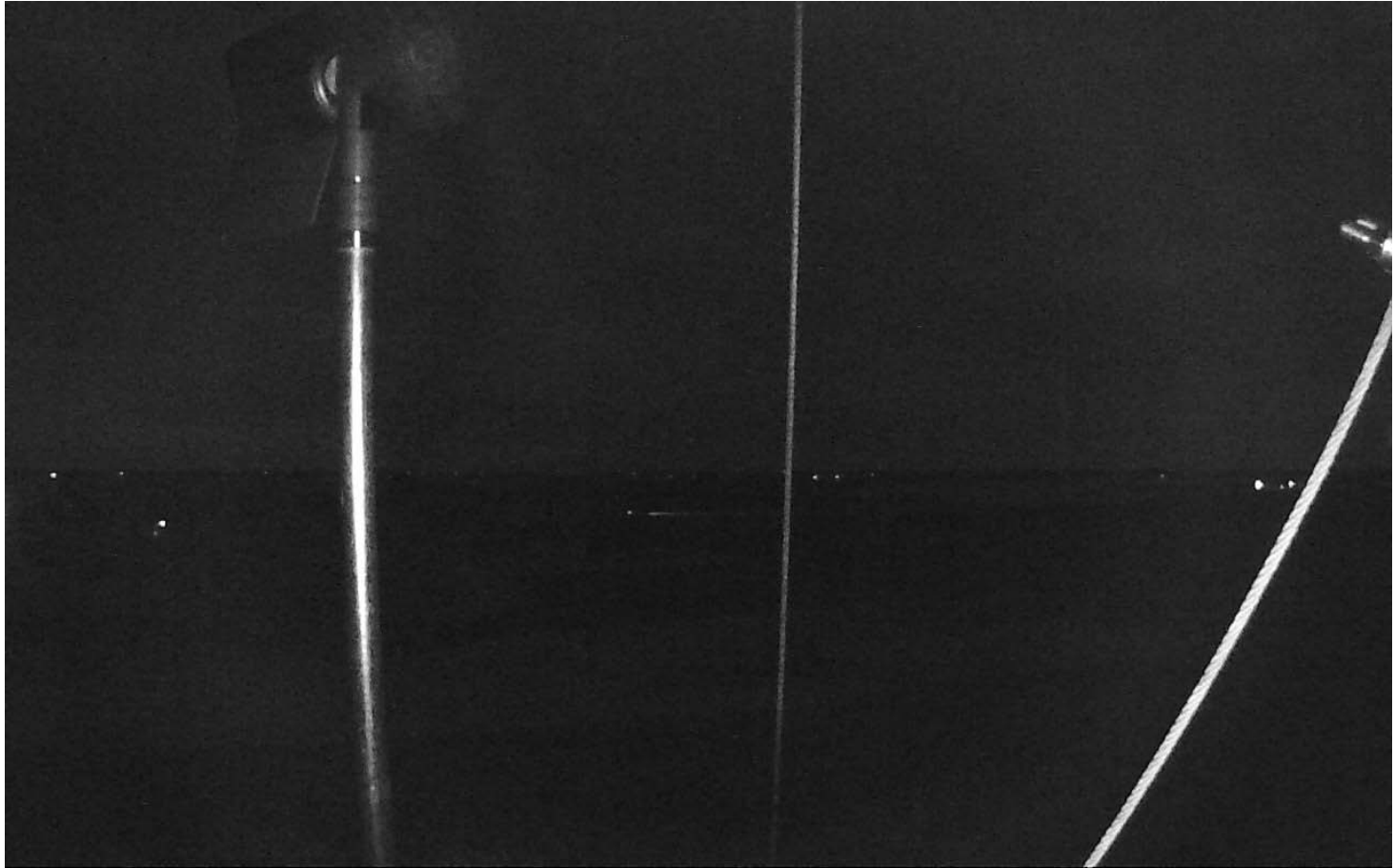# Slides cut for lack of time...

Good places to work, APRS World

Good places to work, Windward Engineering

IP Camera, Infrared Example

HD Video Cameras

- Use to capture likely events
  - Example: Grid fault simulation
- Quantity of data is staggering
  - 10's of gigabytes per hour
  - Hard to share over internet
- Trade-off in size versus frame rate
  - Example: 120 FPS at WVGA, 30 FPS at 1080p
- Hard to time synchronize automatically
- Incredibly boring to watch
- Cheap @ $300 per camera (HD Hero 2)

VOIP – Voice Over IP

- Inexpensive way to have reliable voice communications
- Improve safety with fixed phone for 911 / emergency
- Three connections
  - Power
  - Ethernet / Internet
  - Normal telephone
- Cheap @ < $0.02 per minute + $5 per month