

Intercomparison of Sonic vs. Mechanical Anemometers – Burden's Creek

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Outline

- **What's the Criteria**
- **The Prop – Vane system**
- **The Sonics**
- **Comparisons**
- **Summary**



Criteria

- **EPA – OAQPS updated the EPA QA Handbook Volume IV**
 - Draft in 2006
 - Final in 2008
- **Chapter 2, Section 2.7, discusses auditing, prop/vane, cup/vane and sonic anemometers**
- **Section 2.7.4.2 discusses the Collocated Transfer System (CTS) Method for sonics**



Strategy

- **Recommended procedure**
- **Collocate a cup/vane or prop/vane system**
- **Locate them as close to the system as you can**
- **Calibrate the mechanical system using motor and compass**
- **Operate the two systems side by side**
- **Recommend 72 hours**



In this Corner: The Prop and Vane



RM Young Wind Monitor

Model 05103

Range: 0 – 100 m/s

Accuracy: +/- 0.3 m/s and +/- 1°

**Threshold: prop: 1.0 m/s and
vane 1.1 m/s**



In this Corner: Sonic System #1



RM Young Ultrasonic

Model 81000

Range: 0 – 40 m/s

Accuracy: +/- 1% (WS) +/- 2° (WD)

Threshold: prop: 0.01 m/s



In this Corner: Sonic System #2



Vaisala

Model WXT 520

Range: 0 – 60 m/s

Accuracy: +/- 0.3 m/s/+/- 3°

Threshold: 0.3 m/s



The Criteria

Table 2-2 Proposed Audit Criteria for the Sonic Systems*

Wind Variable	Average Difference	Standard Deviation of the Differences	Qualifications
Speed	$\pm 0.25 \text{ ms}^{-1} < 5 \text{ ms}^{-1}$ <u>or</u> $\pm 5\%$ <u>or</u> $< 2.5 \text{ ms}^{-1}$ above 5 ms^{-1}	0.2 ms^{-1}	Wind speeds greater than 1 ms^{-1}
Direction	$\pm 5^\circ$	2°	Wind speeds greater than 1 ms^{-1}

***As proposed by Lockhart¹**



The Results are In!

Wind Direction Results

Parameter	RY Sonic vs. Vais Sonic	RY V vs. RY Sonic	RY Vane vs. Vais Sonic	Criteria
Average	-3.8875	0.3868	-4.0277	5 degrees
Count	1355	1355	1355	NA
ST Dev	3.5312	2.1305	10.3253	2 degrees
Slope	0.9476	0.9693	0.9583	1.05 +/- 5 deg
Intercept	7.6096	4.4306	8.4779	5 degrees
Correlation	0.9679	0.9723	0.9411	> 0.95



The Results are In!

Wind Speed Results

Parameter	Prop vs. RMY sonic	Prop vs. Vais Sonic	RMY sonic Vs. Vais	Criteria
Average	-0.0575	0.4176	-0.4754	0.25 m/s*
count	1355	1355	1355	NA
STD	0.1047	0.3000	0.2912	0.2 m/s
Slope	0.9457	0.9096	0.9365	1.05 +/- 0.5 m/s
Intercept	0.0442	0.5486	0.5700	0.5 m/s
Correlation	0.9747	0.8945	0.8936	> 0.95

* Criteria for less than 5 /s, which represents all but one data point



Cause and Effect

- **What could be some of the factors affecting these differences?**
 - **Shorter time duration may be a key to the difference in how the data are stored then calculated**
 - **Less than ideal siting, more turbulence than what is ideal**
 - **Robertson and Katz, and Baxter et. al. found that the criteria by Lockhart may be too stringent.**



Summary

**A comparison was made of two sonic
and prop/vane anemometer
Using the Audit Criteria in the EPA
Volume IV, section 2.7.4.2**

- **We did not meet the audit criteria**
- **However, we were close**
- **Other studies, (Baxter, et. al) also found these to be difficult to meet**
- **Other linear regression data also found some interesting results**



References

Lockhart, T. J. "Accuracy of the collocated transfer standard method for wind instrument auditing", *J. Atmos. And Oceanic Technol.* 1989, 6, 715-723.

Robertson, J. H.; Katz, D. I. "Climatronics' novel sonic anemometer". In *Proceedings, Proceedings of the 9th Joint Conference on the Applications of Air Pollution Meteorology, January 28-February 2, Atlanta, GA, 1966.*

Baxter, R. A.; Yoho, D. L.; Durkee, K. R. "Quality assurance audit program for surface and upper-air meteorological measurements in the South Coast Air Basin of California". In *Proceedings, Proceedings of the American Meteorological Society's 83rd Annual Meeting, 12th Symposium on Meteorological Observations and Instrumentation, Long Beach, CA, February 8-11, 2003.*

