Strategies for the Selection of Substitute Meteorological Data

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Basis of Problem

- Pilgrim Station was experiencing problems with the upper-level wind direction indication on the primary tower
- *Question*: Can Pilgrim substitute data from its backup tower to meet data recovery goals?
- *Proposed Solution*: Compare various multiple measurements of meteorological parameters to determine suitability for substitution

Pilgrim Meteorological Towers

- Primary Tower
  - 220-ft tall, based at ~80 ft above sea level on vegetated area 270m from ocean
  - Effective height = 300 ft
  - Wind and temperature at top and 10m
- Secondary (Backup) Tower
  - 160-ft tall, based at ~20 ft above sea level in parking lot 100m from ocean
  - Effective height = 180 ft
  - Wind and temperature at top and 10m
- Hourly averages for 2-year period, yielded ~17,500 observations

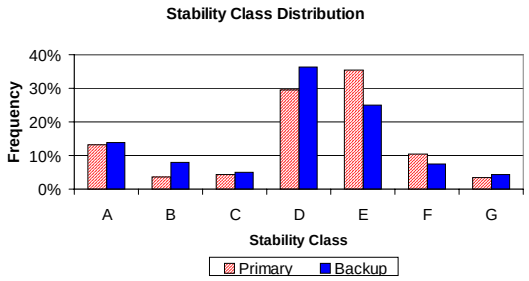
Tower Placement Guidance

- Safety Guide 23... minimal guidance
  - Minimize effects from plant structures
- ANSI/ANS-2.5-1984
  - Represent release point
  - Minimize effect from manmade structures
  - Avoid downwind from plant
  - Distance from structures should be >10 times the structure height

Tower Placement Guidance
continued

- ANSI/ANS-3.11-2000
  - More detailed than other guidance
  - Avoid asphalt/concrete surfaces
  - Not endorsed/'required' by NRC
  - Post-dates most pre-existing nuclear plant meteorological installations
- Backup tower fails to meet many criteria
  - Downwind, nearby buildings, asphalt

Stability Class Frequencies



Problem with Frequency Data

- Relative frequencies for two sources do not reflect the comparability of simultaneous measurements
- Identified need for comparing paired measurements through time to determine how well they compare
- Summarize comparisons of paired data to determine degree of differences

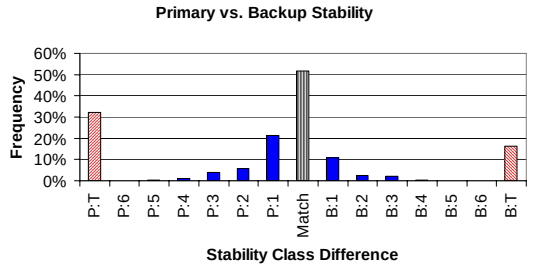
Agreement Matrix: Stability Class

Primary Tower	Backup Tower						
	A	B	C	D	E	F	G
A	**1128**	426	154	350	64	9	3
B	218	**171**	72	124	14	3	0
C	213	152	**96**	205	28	4	0
D	479	429	405	**3191**	365	29	9
E	170	135	105	2041	**2996**	396	78
F	29	10	8	118	557	**669**	348
G	7	8	7	25	85	158	**299**

Agreement Matrix Summary: Summation of Diagonals

Stability Class Difference	Primary Tower Conservative		Backup Tower Conservative	
Match	8550	51.5%	8550	51.5%
1	3531	21.3%	1812	10.9%
2	950	5.7%	413	2.5%
3	647	3.9%	377	2.3%
4	187	1.1%	67	0.4%
5	37	0.2%	9	0.1%
6	7	0.0%	3	0.0%
Total	5359	32.3%	2681	16.2%

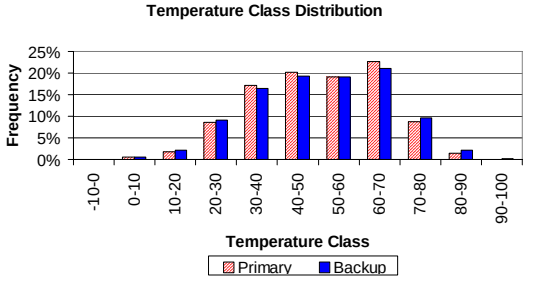
Stability Class Differences



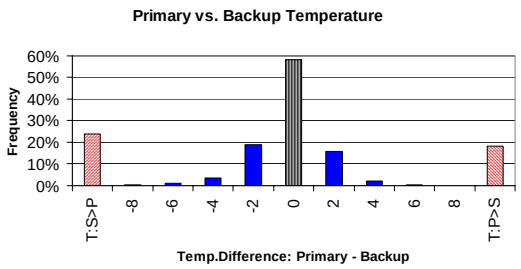
Candidate for Substitution? Delta-T

- Primary tower delta-T yields more conservative stability class ~30% of cases
- May be good substitute, but consider...
  - Backup tower is in middle of parking lot, and does not meet ANSI meteorological standards
  - Heating from blacktop, cars, adjacent buildings, etc. could bias readings, and would be expected to yield more negative delta-T values and lower stability classes

Temperature Frequencies



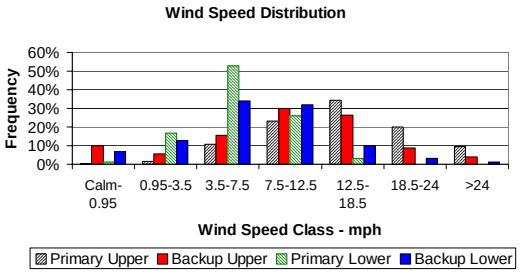
Temperature Differences



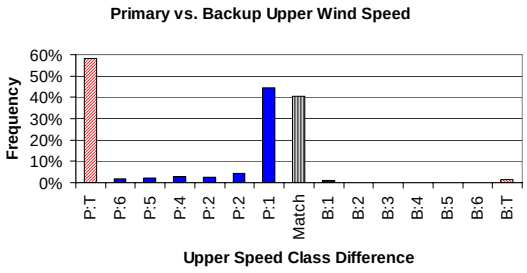
Candidate for Substitution?
Temperature

- >75% readings from both towers are within ±2 degrees of each other
- Acceptable substitute, but consider…
  - Backup tower is in middle of parking lot, and does not meet ANSI meteorological standards
  - Heating from blacktop, cars, adjacent buildings, etc. could bias readings

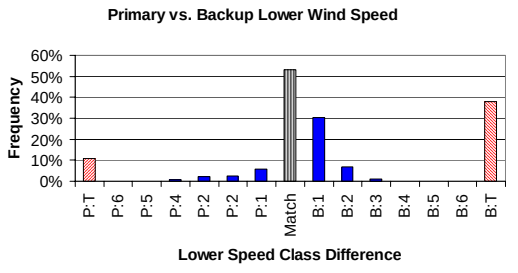
Wind Speed Frequencies



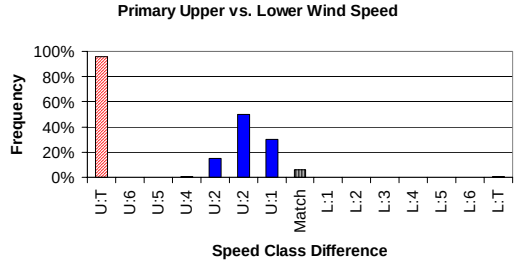
Wind Speed Differences:
Primary vs. Backup, Upper Level



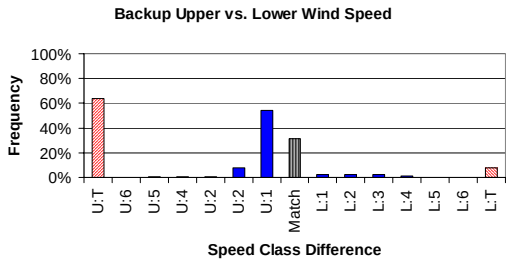
Wind Speed Differences:
Primary vs. Backup, Lower Level



Wind Speed Differences:
Primary, Upper vs. Lower Level



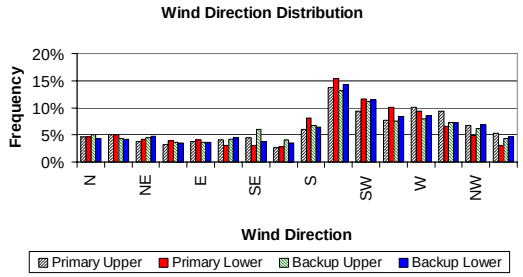
Wind Speed Differences: Backup, Upper vs. Lower Level



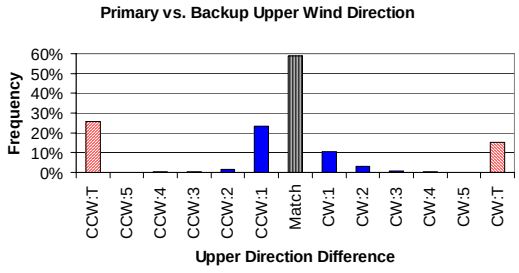
Candidate for Substitution? Wind Speed

- Upper readings > lower readings... expected
- Differences in wind speeds as a function of height would make substitution difficult
  - Possible correction factors by extrapolation
- The fact that the lower level of primary tower shows lowest wind speeds may indicate influence of nearby trees
  - Implications to wind direction at this location

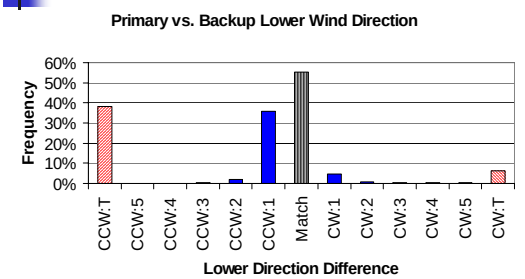
Wind Direction Frequencies



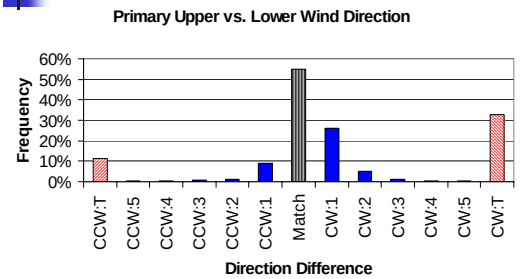
Wind Direction Differences: Primary vs. Backup, Upper Level



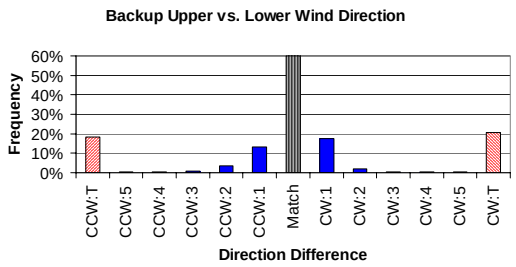
Wind Direction Differences: Primary vs. Backup, Lower Level



Wind Direction Differences: Primary, Upper vs. Lower Level



Wind Direction Differences: Backup, Upper vs. Lower Level



Candidate for Substitution? Wind Direction

- Primary tower seems to indicate slight counterclockwise bias compared to backup at both levels
  - Alignment?
  - Topography effect?

Candidate for Substitution? Wind Direction

- Primary tower upper level shows clockwise bias compared to lower level
  - Alignment?
  - Potential effects of nearby trees?
  - Lower level of primary tower exhibits greatest fluctuations… evidence of influence of trees?
  - When coupled with low wind speeds at this level, may point to influence from trees

Candidate for Substitution? Wind Direction

- Backup tower upper and lower levels show good agreement
- Acceptable substitute, but consider…
  - Backup tower is in middle of parking lot, and does not meet ANSI meteorological standards
  - The good agreement may indicate minimal influence from nearby structures, but difficult to quantify

Summary

- Delta-T, temperature, and wind direction show potential for substitution, but need to consider placement of backup tower (non-ANSI)
- Wind speed is poor candidate for substitution
- Lower wind speed and direction readings at primary tower may indicate influence of nearby trees and topography

Summary - continued

- Of all readings from backup tower, upper wind direction would likely be least affected by adjacent structures, and would be most suitable for substitution
  - Need to resolve potential bias?
  - Upper wind speed may also be candidate, but would need to be adjusted for height difference

Summary - continued

- Although backup tower location does not meet ANSI standards in regard to ground cover, adjacent buildings, etc., its readings appear reasonable and acceptable for backup use if primary is lost
  - Local data is better than alternate data from a remote site
  - Most remote sites (airport, NWS) are not equipped to provide met data for emergency operations