

# Strategies for the Selection of Substitute Meteorological Data



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# Basis of Problem

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- 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

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- 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

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- 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

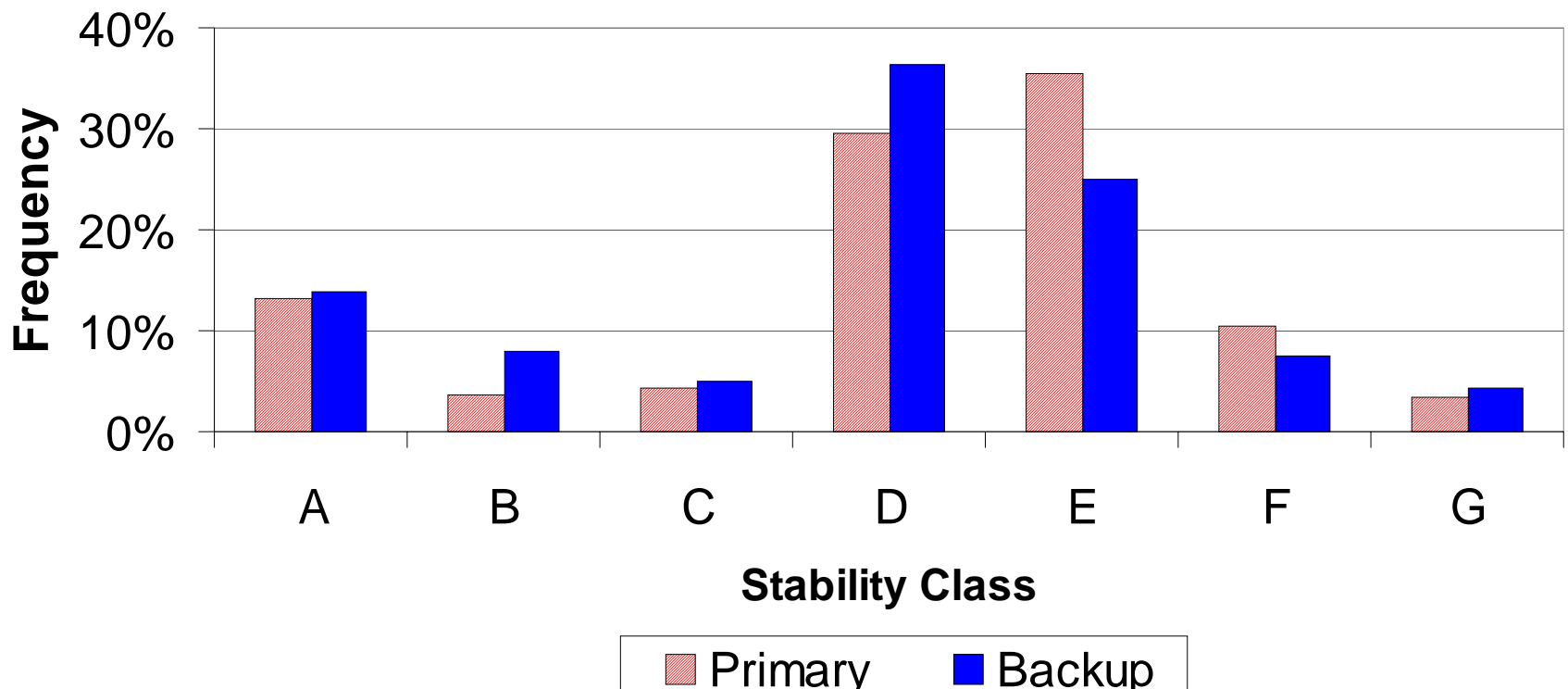
continued

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- 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

## Stability Class Distribution





# Problem with Frequency Data

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

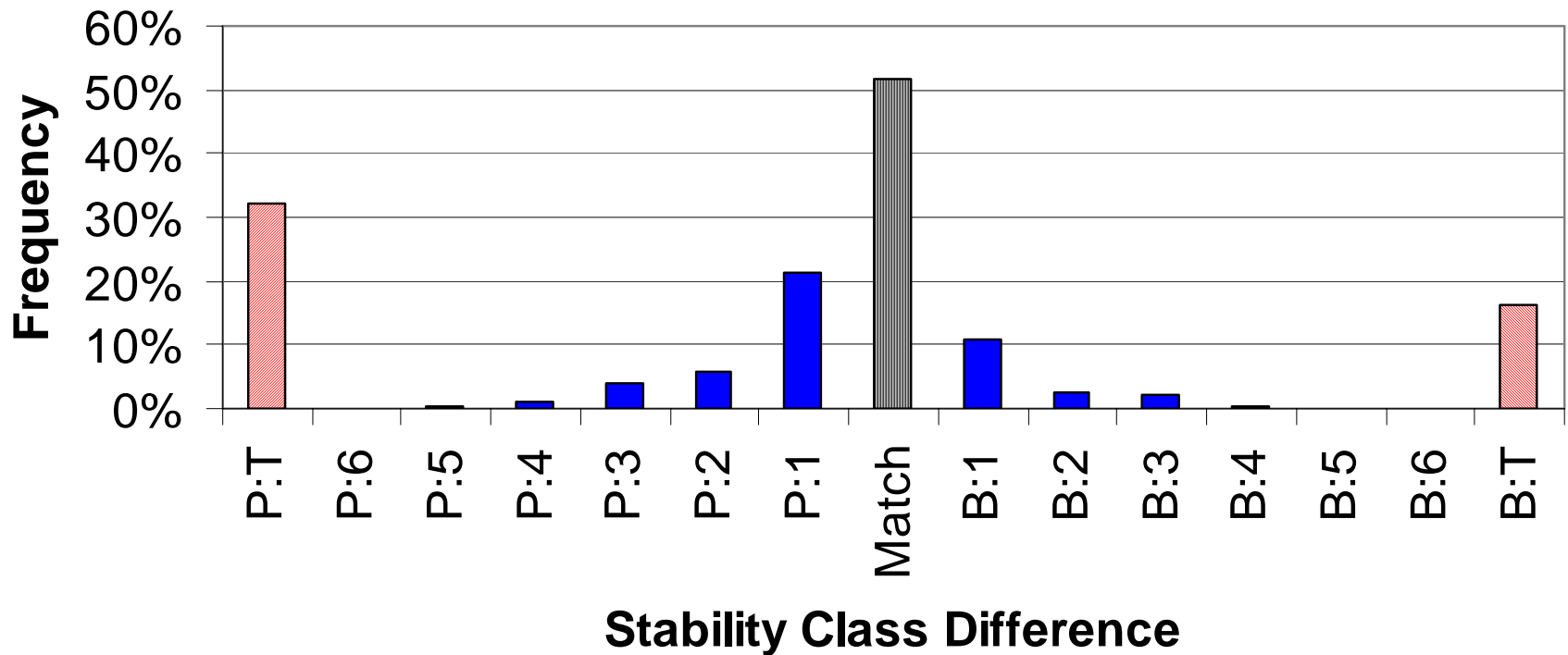


# Agreement Matrix Summary: Summation of Diagonals

Stability Class Difference	Primary Tower Conservative		Backup Tower Conservative	
	Match	8550	51.5%	8550
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

## Primary vs. Backup Stability





# Candidate for Substitution?

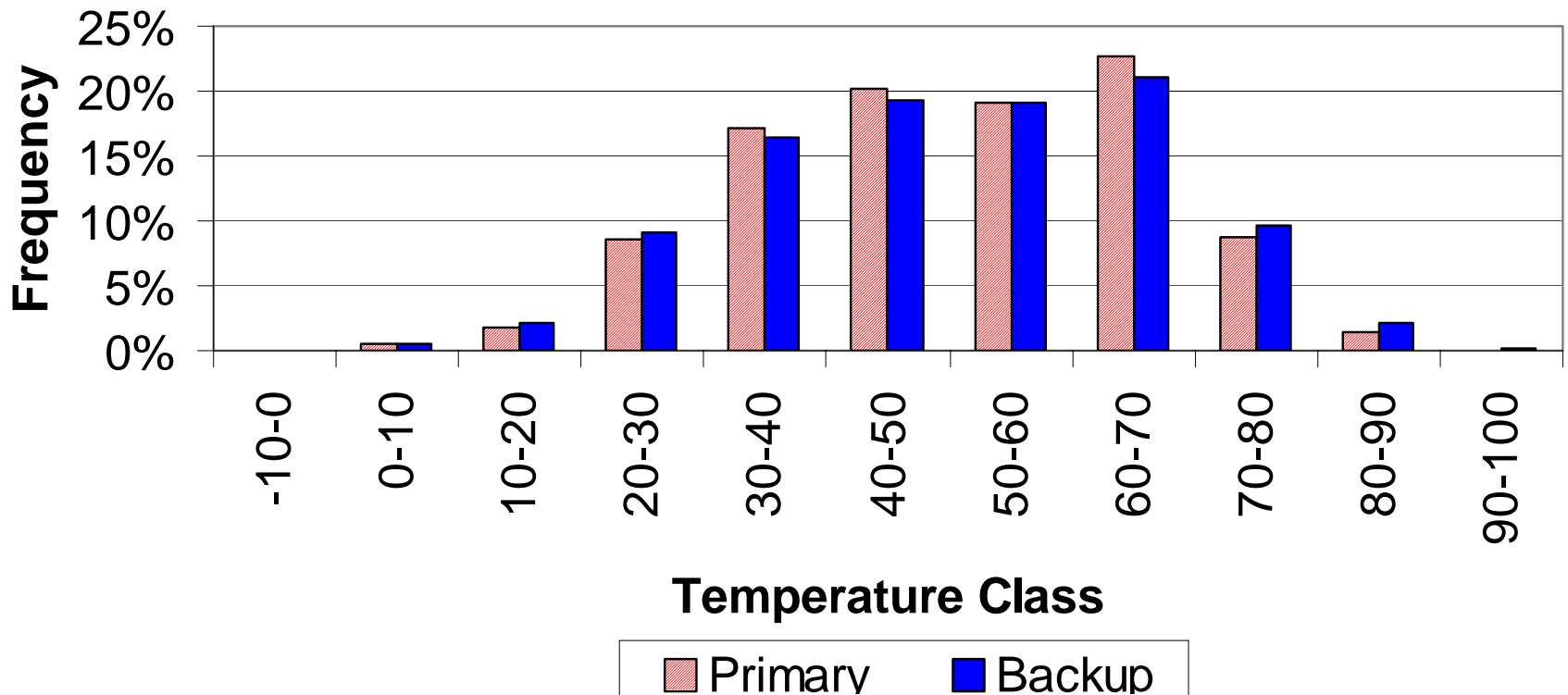
## Delta-T

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- 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

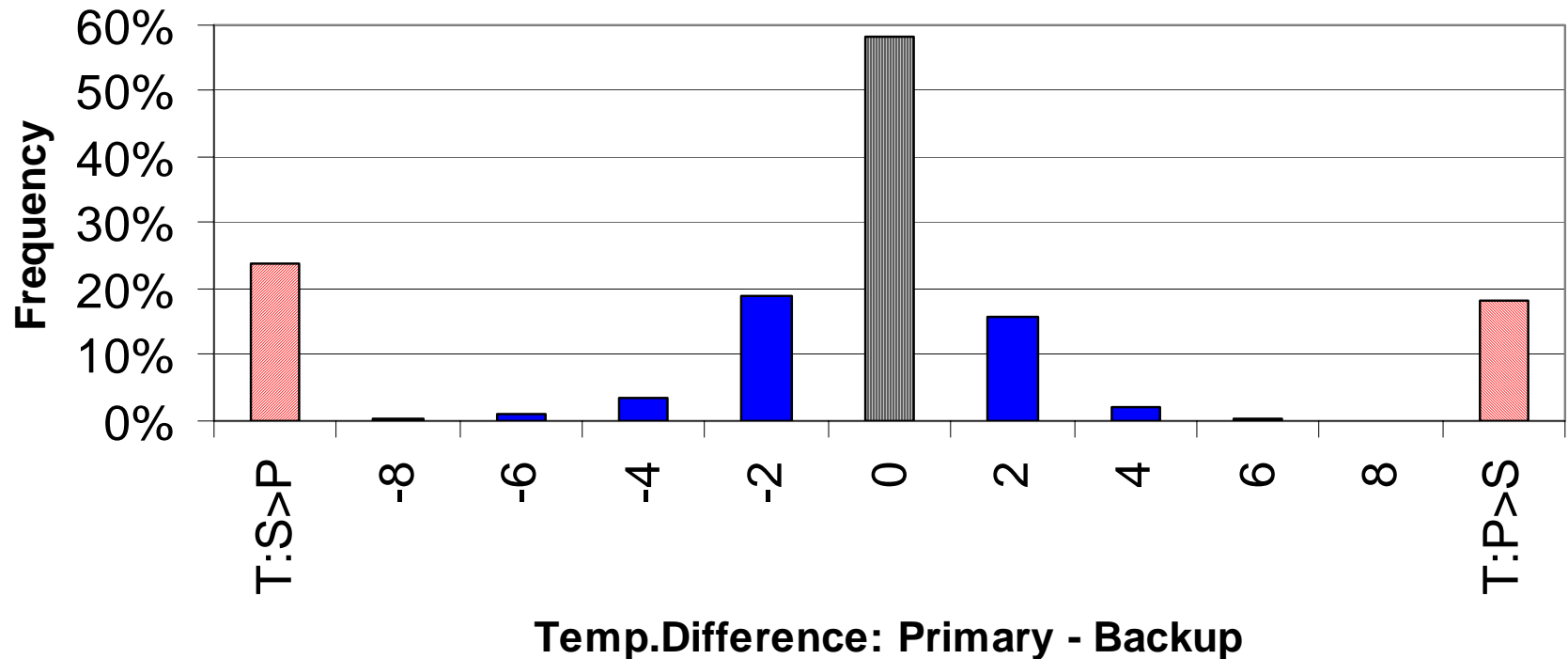
# Temperature Frequencies

## Temperature Class Distribution



# Temperature Differences

## Primary vs. Backup Temperature





# Candidate for Substitution?

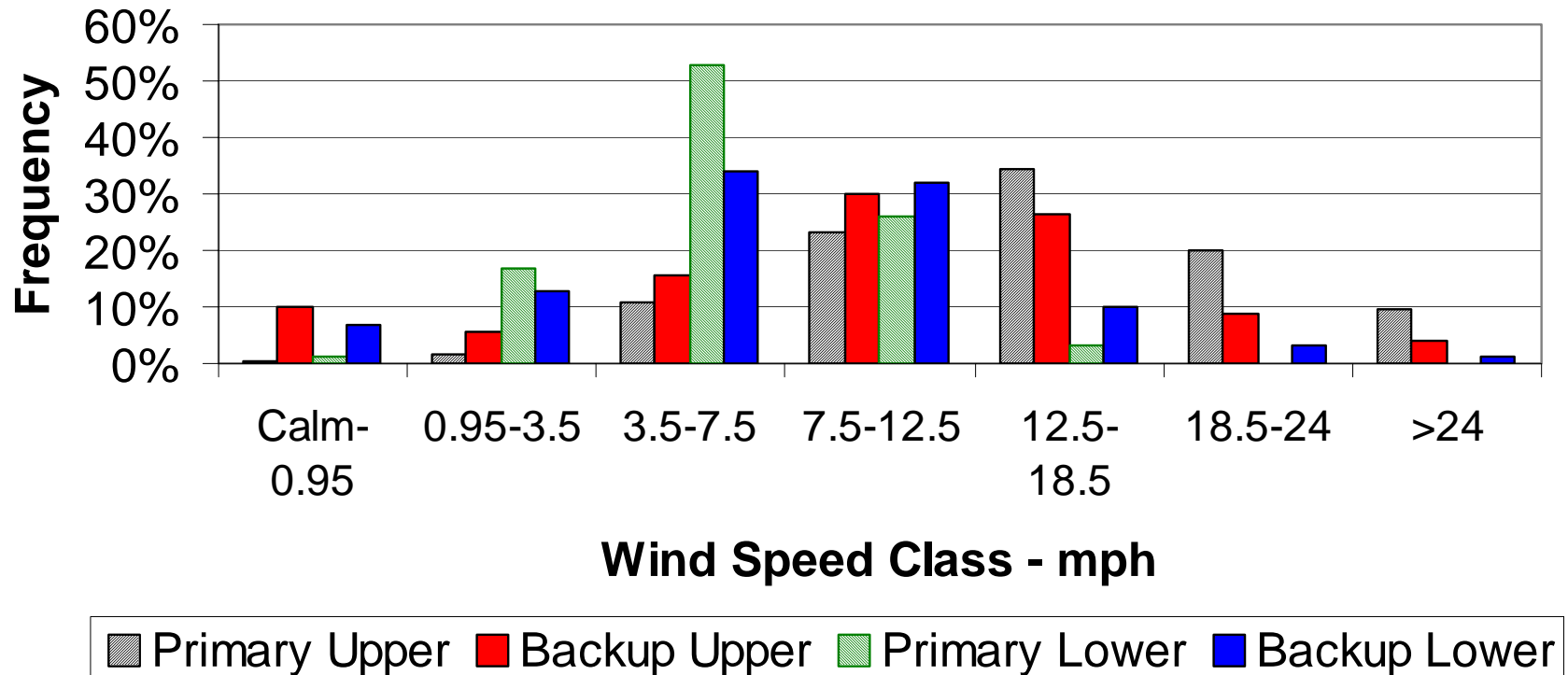
## Temperature

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- >75% readings from both towers are within  $\pm 2$  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

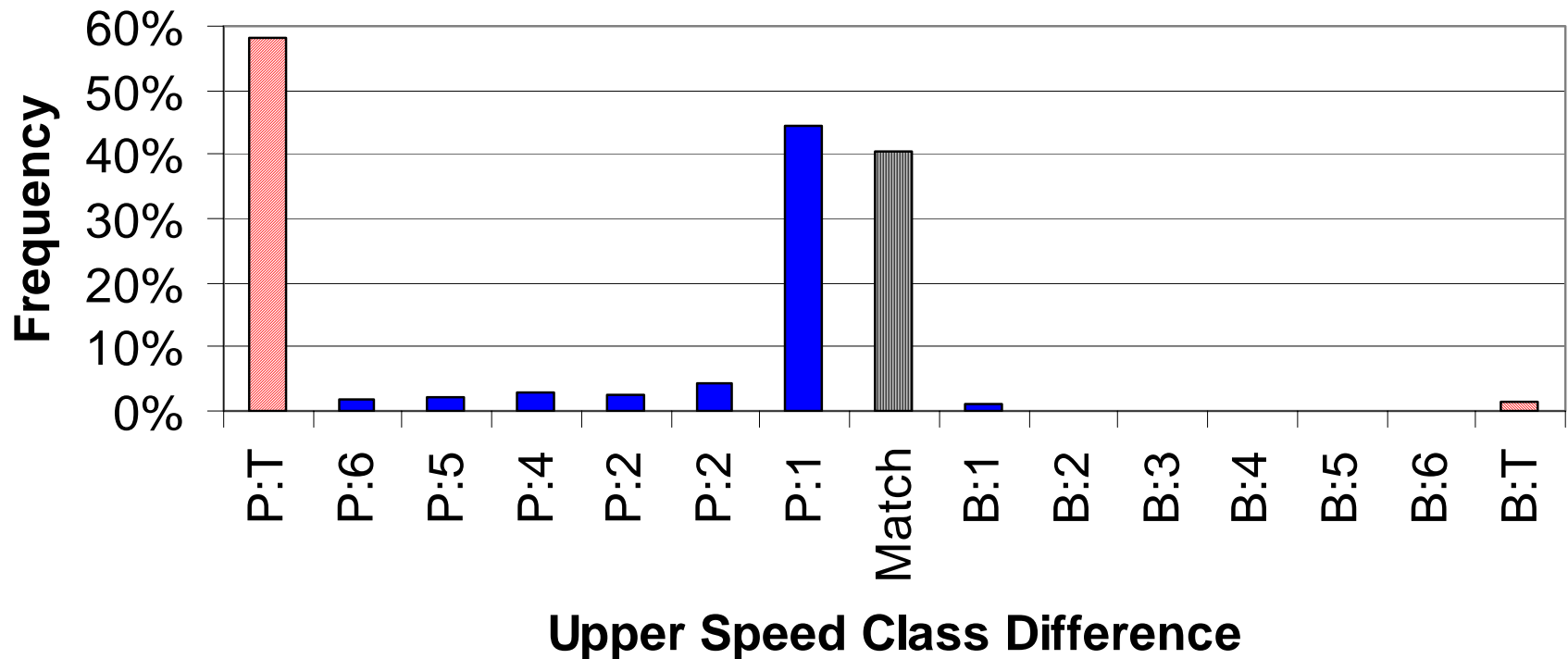
# Wind Speed Frequencies

## Wind Speed Distribution



# Wind Speed Differences: Primary vs. Backup, Upper Level

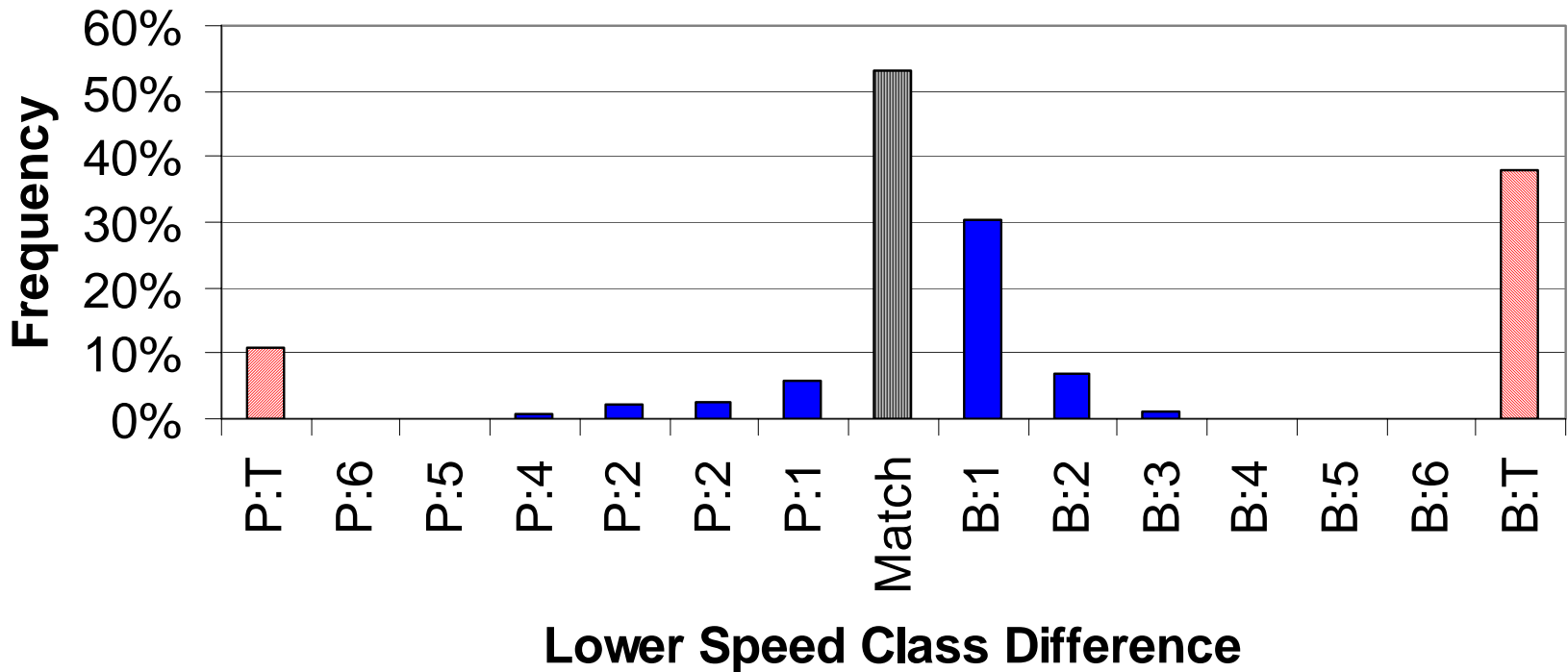
**Primary vs. Backup Upper Wind Speed**





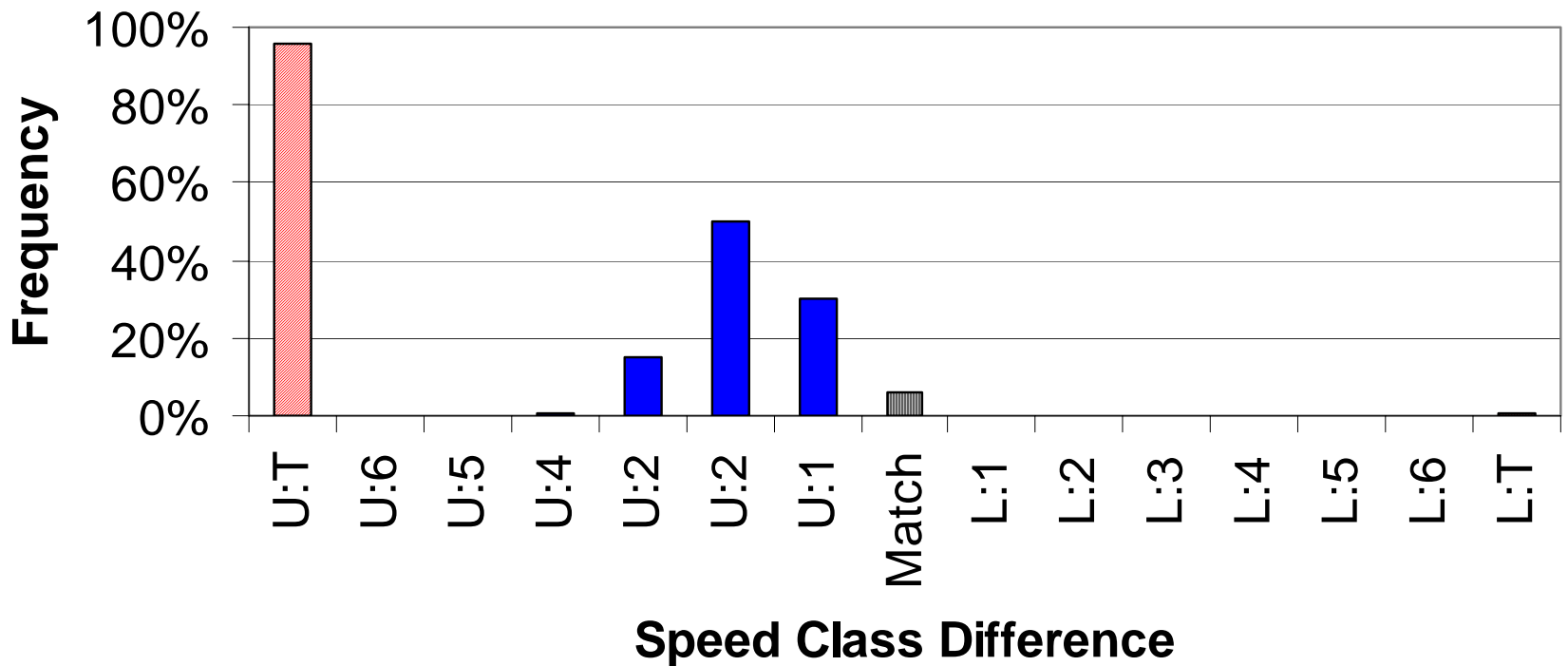
# Wind Speed Differences: Primary vs. Backup, Lower Level

Primary vs. Backup Lower Wind Speed



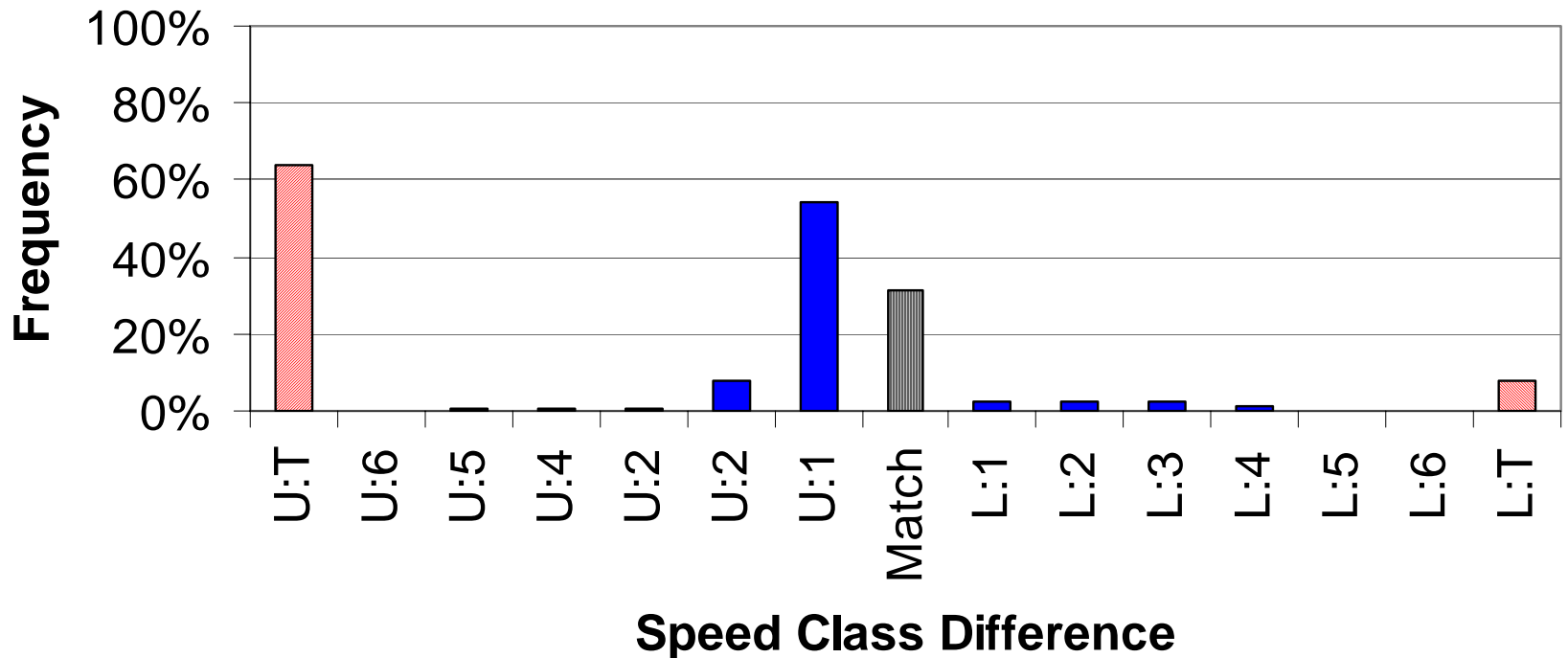
# Wind Speed Differences: Primary, Upper vs. Lower Level

**Primary Upper vs. Lower Wind Speed**



# Wind Speed Differences: Backup, Upper vs. Lower Level

**Backup Upper vs. Lower Wind Speed**





# Candidate for Substitution?

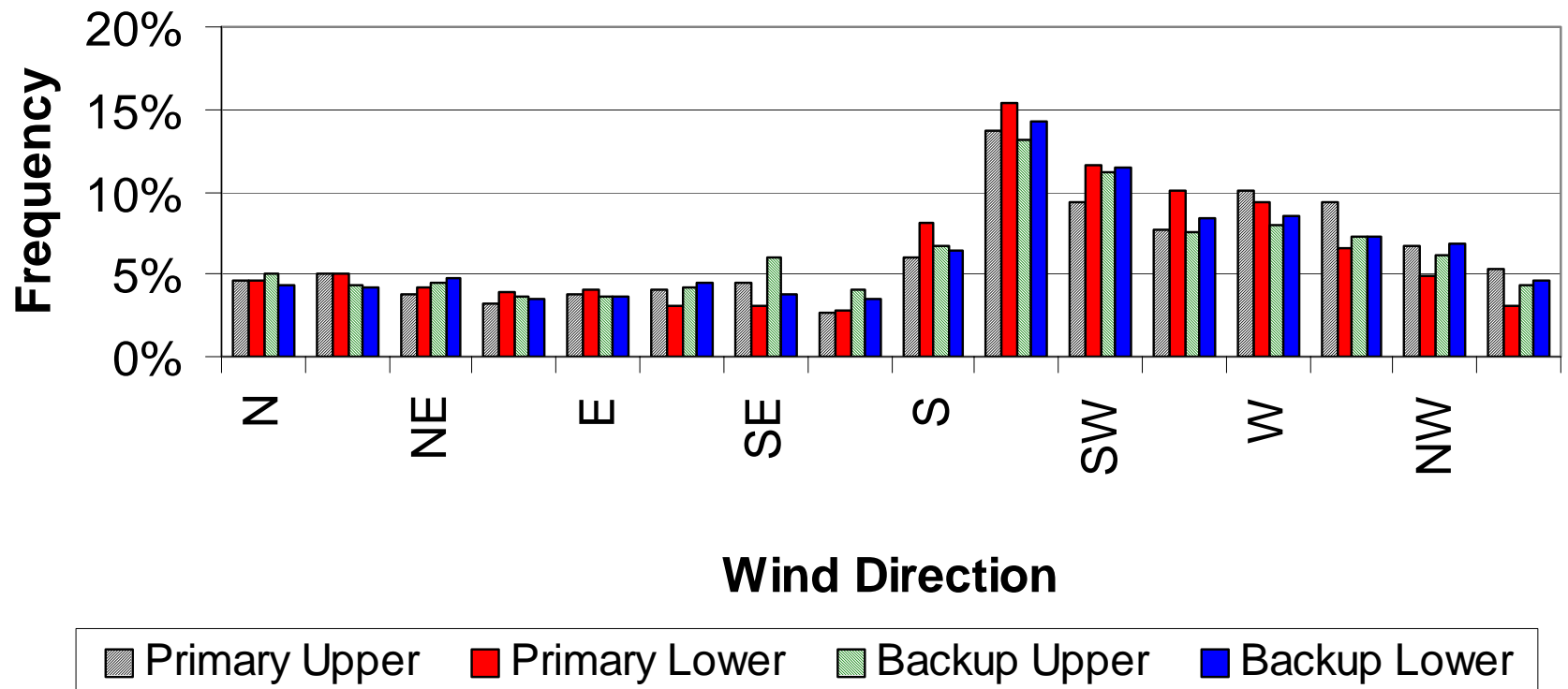
## Wind Speed

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- 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

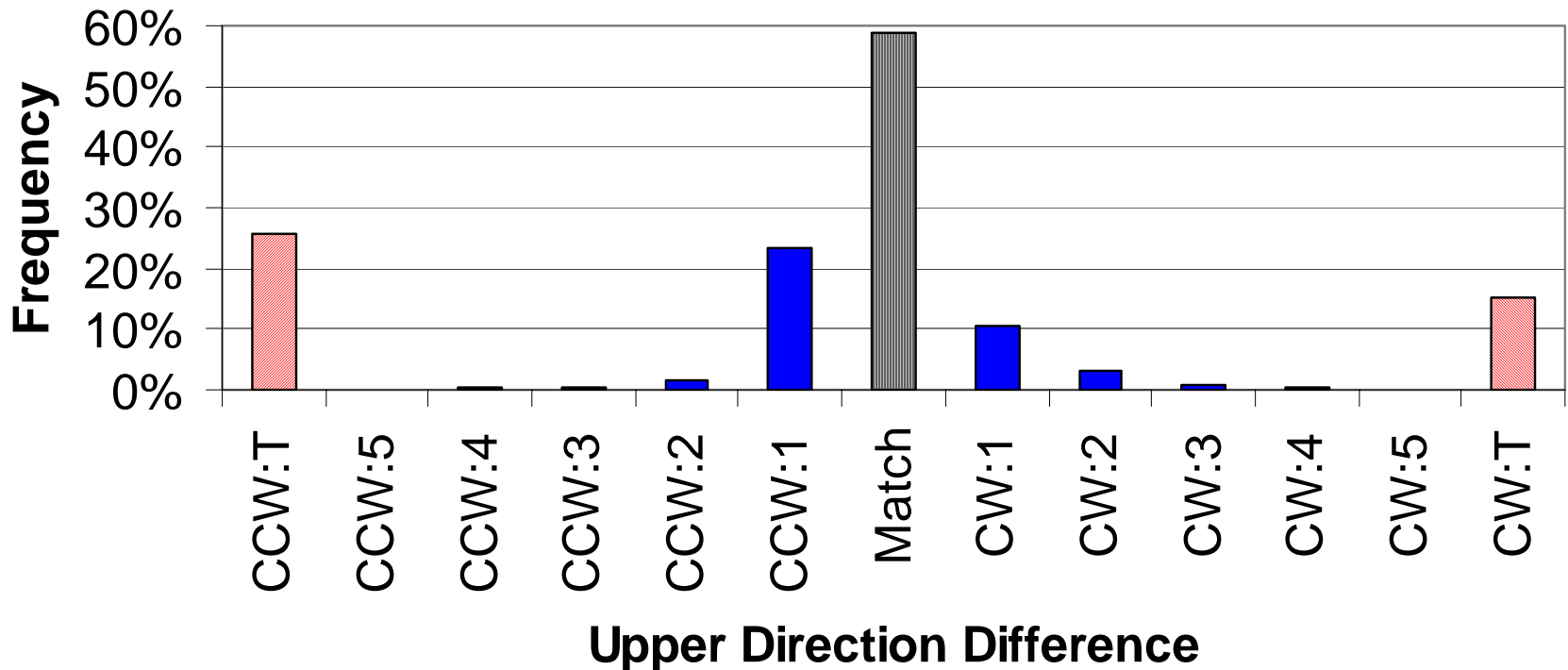
# Wind Direction Frequencies

## Wind Direction Distribution



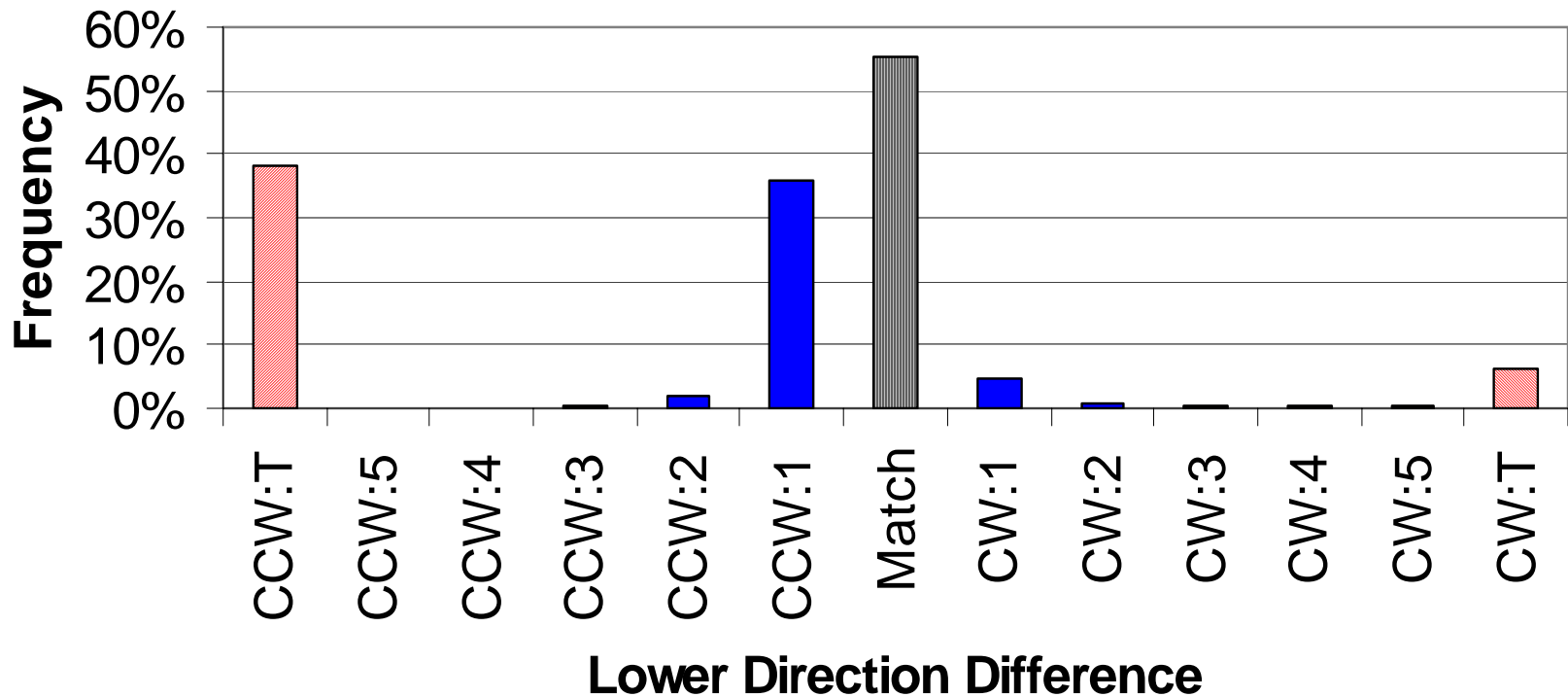
# Wind Direction Differences: Primary vs. Backup, Upper Level

## Primary vs. Backup Upper Wind Direction



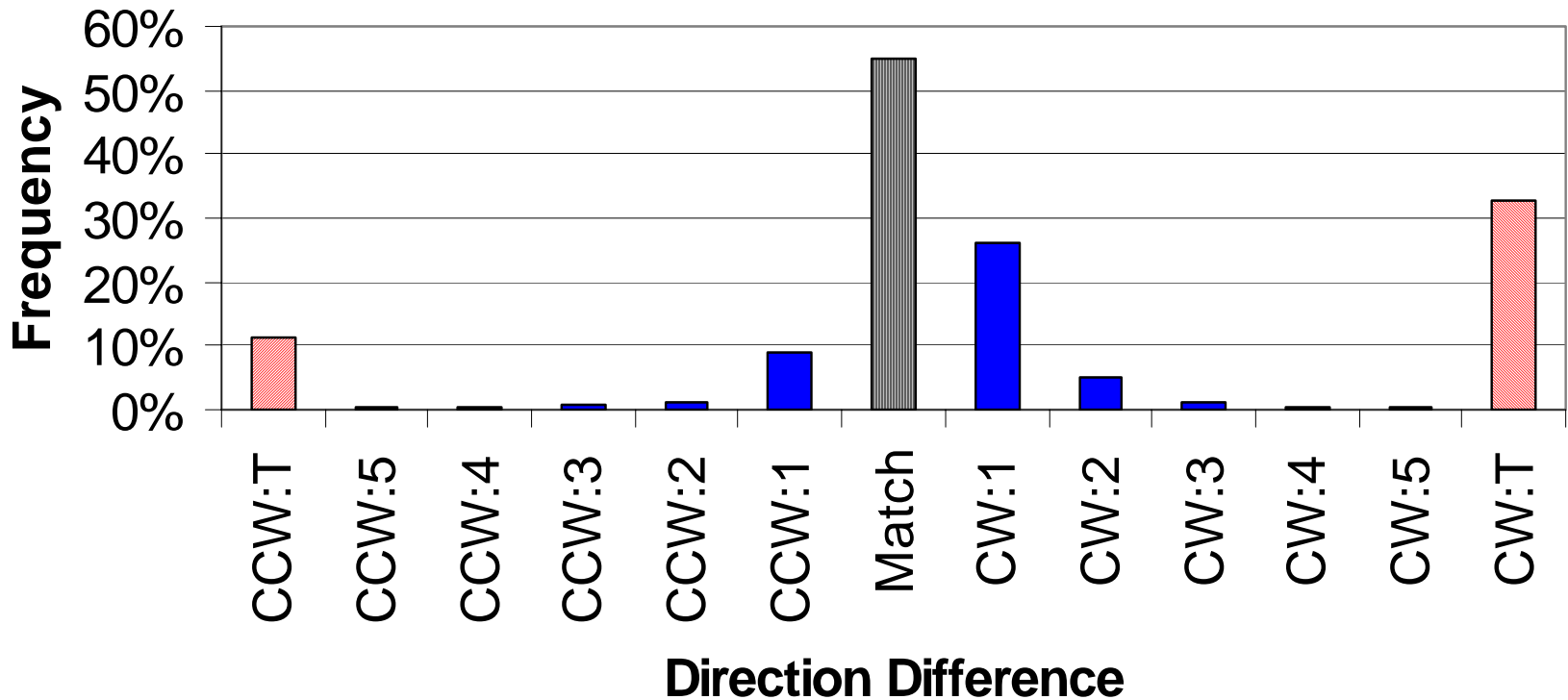
# Wind Direction Differences: Primary vs. Backup, Lower Level

**Primary vs. Backup Lower Wind Direction**



# Wind Direction Differences: Primary, Upper vs. Lower Level

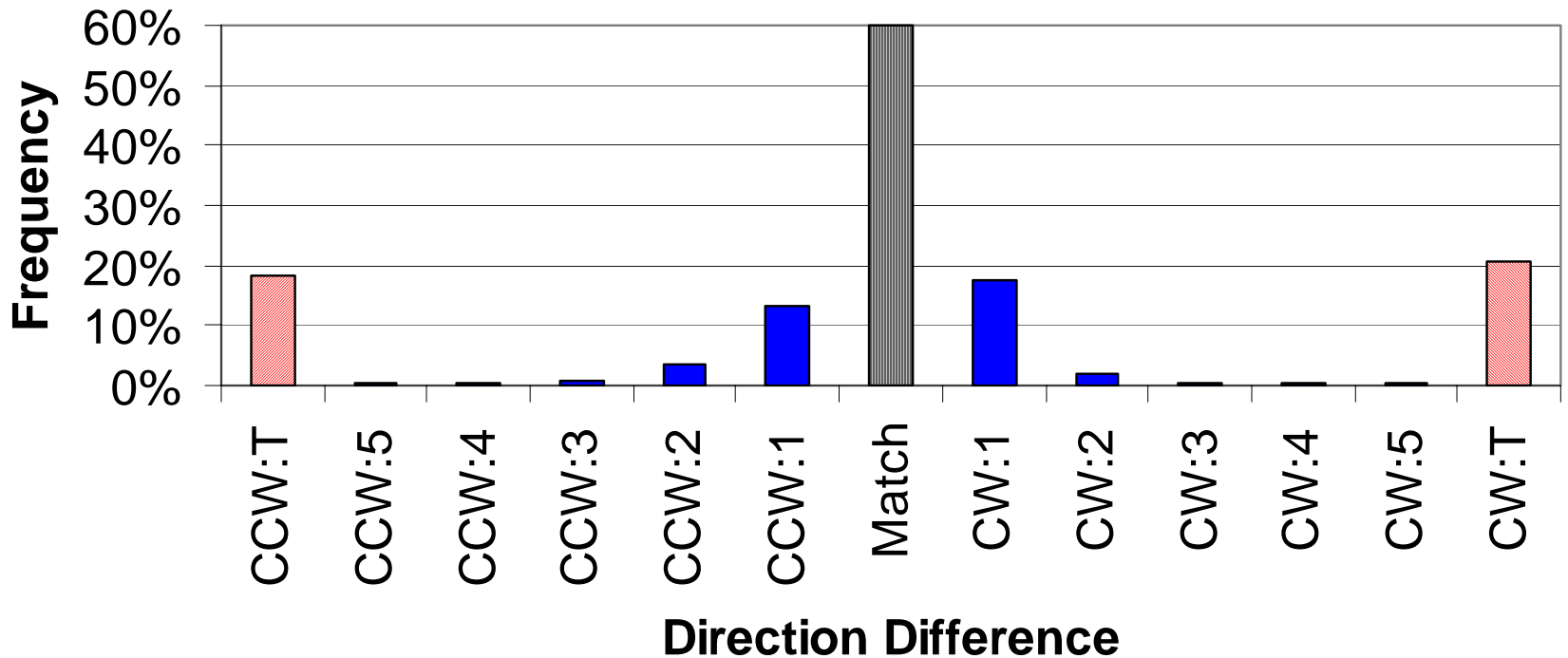
## Primary Upper vs. Lower Wind Direction





# Wind Direction Differences: Backup, Upper vs. Lower Level

**Backup Upper vs. Lower Wind Direction**





# Candidate for Substitution?

## Wind Direction

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



# Candidate for Substitution?

## Wind Direction

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- 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

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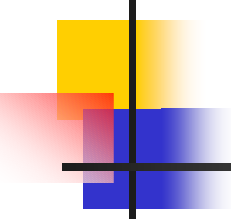
- Backup tower upper and lower levels show good agreement
- Acceptable substitute, but consider...
  - Backup tower is in middle of parking lot, and does not meet ANSI meteorological standards
  - The good agreement may indicate minimal influence from nearby structures, but difficult to quantify



# Summary

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- 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

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- 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

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- 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