Investigation of Meteorological Tower Siting Criteria

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Presented at the 15th Annual RETS-REMP Workshop

Wilmington, NC / 27-29 June 2005

Tower Siting Criteria

- Safety Guide 23 (1972)
- Regulatory Guide 1.23 – draft, never formally issued
- Proposed Revision 1 to Regulatory Guide 1.23 (1980)
- NUREG-0654 (1980)
- Second Proposed Revision 1 to Regulatory Guide 1.23 (1986)
- ANSI/ANS-2.5-1984 (1984)
- ANSI/ANS-3.11-2000 (2000)

Safety Guide 23 - 1972

- “The tower or mast should be sited at approximately the same elevation as finished plant grade and in an area where plant structures will have little or no influence on the meteorological measurements.”

Proposed Revision 1 to Regulatory Guide 1.23 - 1980

- Same requirements as Safety Guide 23, plus
  - Located upwind of heat dissipating structures
  - Height of natural & man-made obstructions lower than measuring level out to a horizontal distance of *10 times the sensor-height*
  - Instrument booms oriented into prevailing wind to minimize influence of tower
  - Aspirated temperature shields

NUREG-0654 - 1981

- Post-TMI guidance for upgrading emergency response systems
- Appendix 2 refers specifically to meteorological monitoring
- Refers to Proposed Revision 1 to Regulatory Guide 1.23 for design and siting of meteorological monitoring systems

Second Proposed Revision 1 to Regulatory Guide 1.23 - 1986

- Dropped any specific siting criteria
- Endorsed use of ANSI/ANS-2.5-1984 for requirements related to design, siting, calibration, etc.
- However, neither the second proposed revision to Regulatory Guide 1.23, nor ANSI-ANS-2.5-1984 were ever formally adopted by the NRC

ANSI-ANS-2.5-1984

- “The meteorological tower site shall represent as closely as possible the same meteorological characteristics as the region into which any airborne material will be released”
- What about ground-level effluents released ‘on-site’?

ANSI-ANS-2.5-1984 (continued)

- Place tower at plant grade
- Minimal influence from obstructions, away from heat-dissipating structures
- Natural and man-made obstructions no higher than measurement level with horizontal separation of *ten times the obstruction height*.
- Instrument booms oriented into prevailing wind
- Aspirated temperature shields

ANSI/ANS-3.11-2000

- Much more detailed guidance than previous
- Guidance provided for flat-terrain, complex-land, and complex-water sites
- Locate tower away from obstacles (buildings, cooling towers, trees, ponds, large paved areas) in flat terrain.
- Separation between anemometer and obstruction should be ten time obstruction height; can be reduced to 5X for objects with cross-sectional dimension of 1 meter (utility poles, small trees)

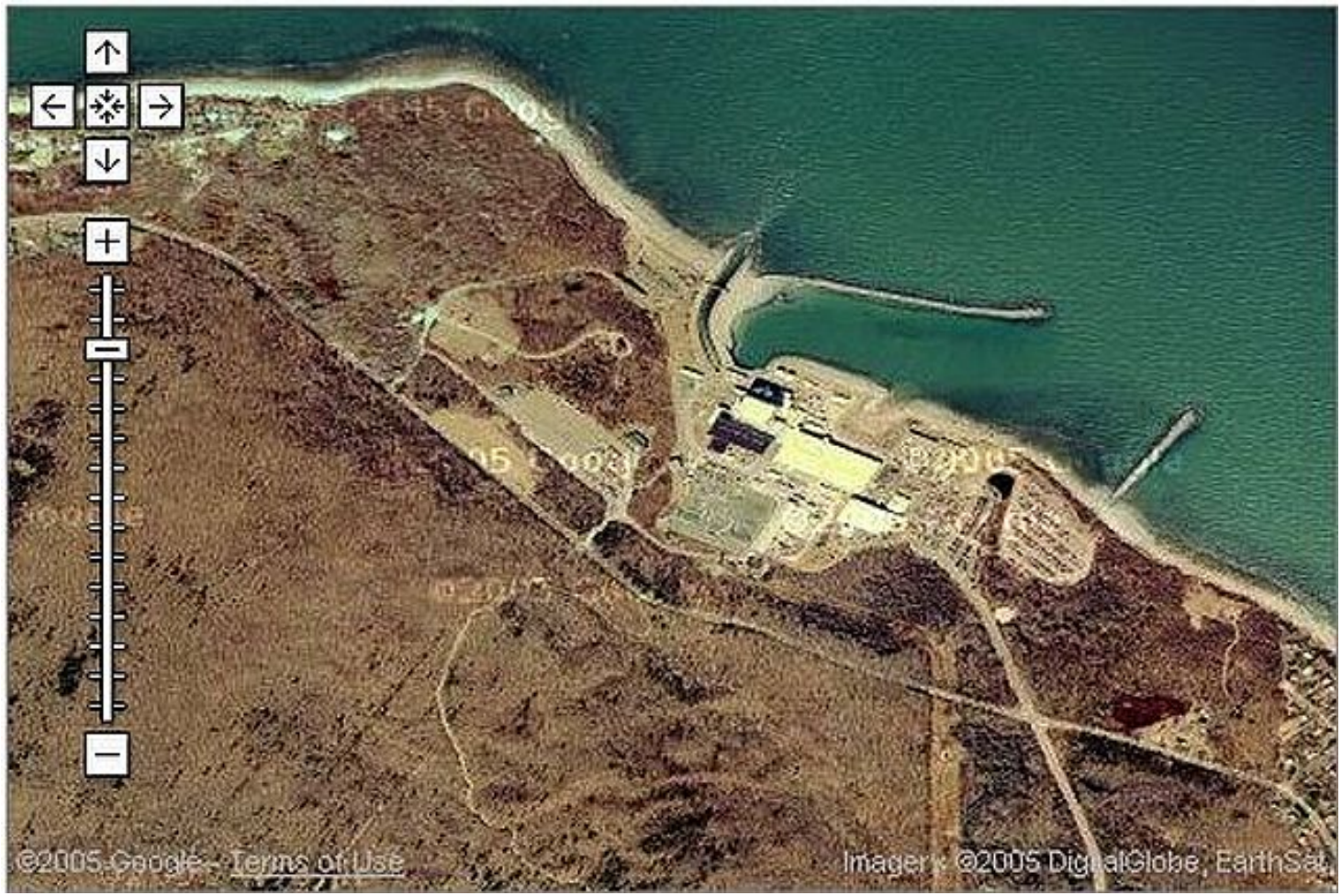
ANSI/ANS-3.11-2000 (continued)

- Wind instruments mounted two tower widths away from tower, in upwind direction
- Avoid air modifications by heat and moisture sources, water bodies, large parking lots; tower should not be located on or near man-made surfaces such as concrete, asphalt, etc.
- Aspirated temperature shields

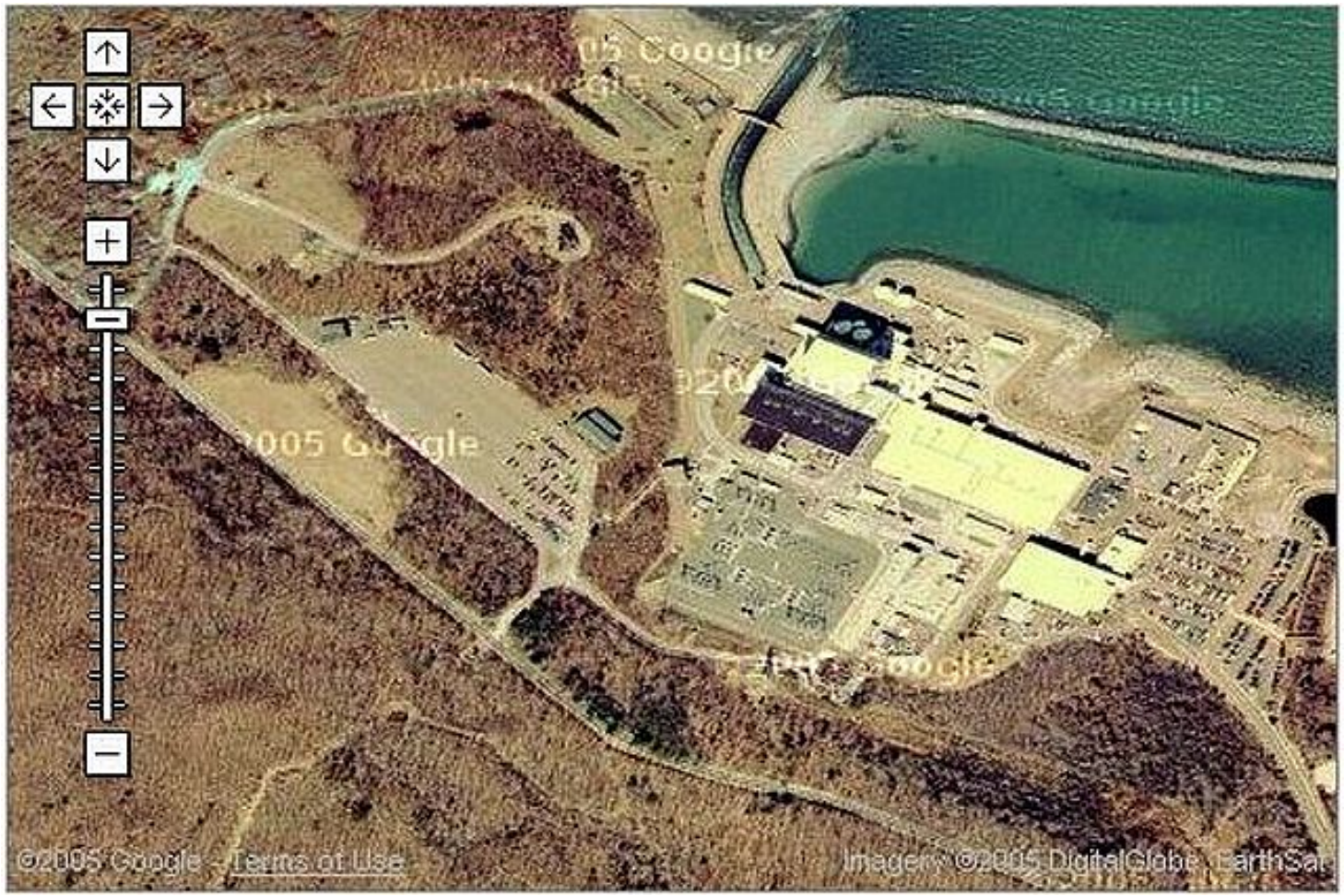
Ideal vs. Realistic

- Reg Guide and ANSI/ANS standards provide standard guidance with the intent of providing consistent siting, while minimizing effects of physical factors
- Is such guidance/requirement realistic? Does it represent real conditions on-site, especially for on-site ground-level release points?

PNPS Aerial View 1



PNPS Aerial View 2



Ground-level Release Points

- Plant grade at 23 feet above Mean Sea Level
- Reactor Building Vent
  - 158 ft above plant grade, 181 ft MSL
  - 15 ft above reactor building roof
  - Nominal flow rate ~150,000 scfm, 1800 ft/min
- Turbine Building Roof Exhausters
  - 85 ft above plant grade, 108 ft MSL
  - 1 to 6 fans (2 typical), at 35,000 scfm each

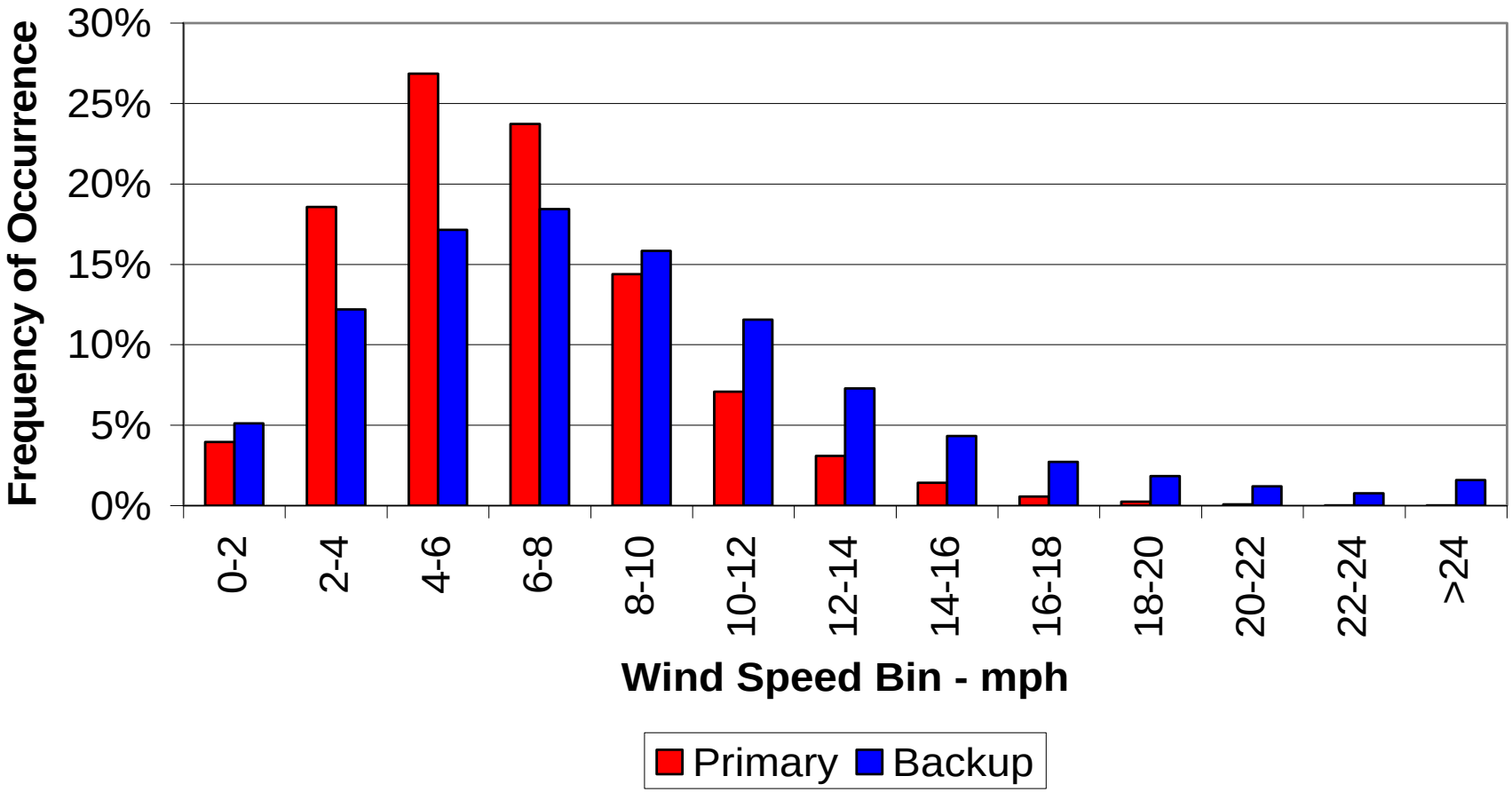
Primary Met Tower

- Located 1350 ft WNW from on-site release point
- Guyed tower 220 ft tall, base at 80 ft MSL
  - WS,WD,Temp sensors at 33 ft, 113 ft MSL
  - WS,WD,Temp sensors at 220 ft, 300 ft MSL
  - Upper level corresponds to elevated release point, 335 ft stack at 65 ft MSL (400 ft MSL)

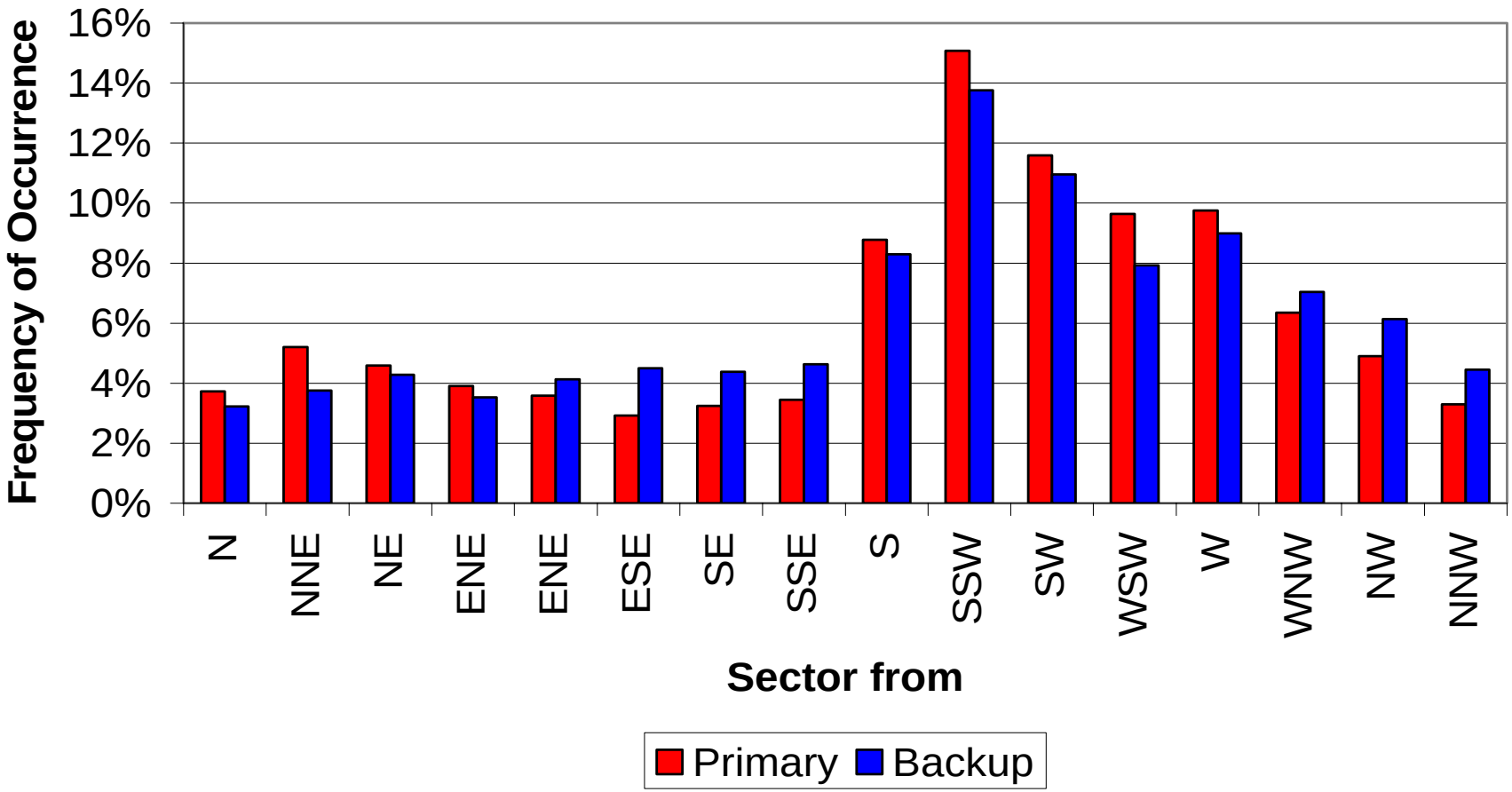
Backup Met Tower

- Located 1000 ft ESE from on-site release point
- Free-standing tower 160 ft tall, base at 23 ft MSL... wide base
  - WS,WD,Temp sensors at 33 ft, 56 ft MSL
  - WS,WD,Temp sensors at 160 ft, 183 ft MSL
  - Upper level corresponds to height of reactor building vent

Wind Speed Comparison

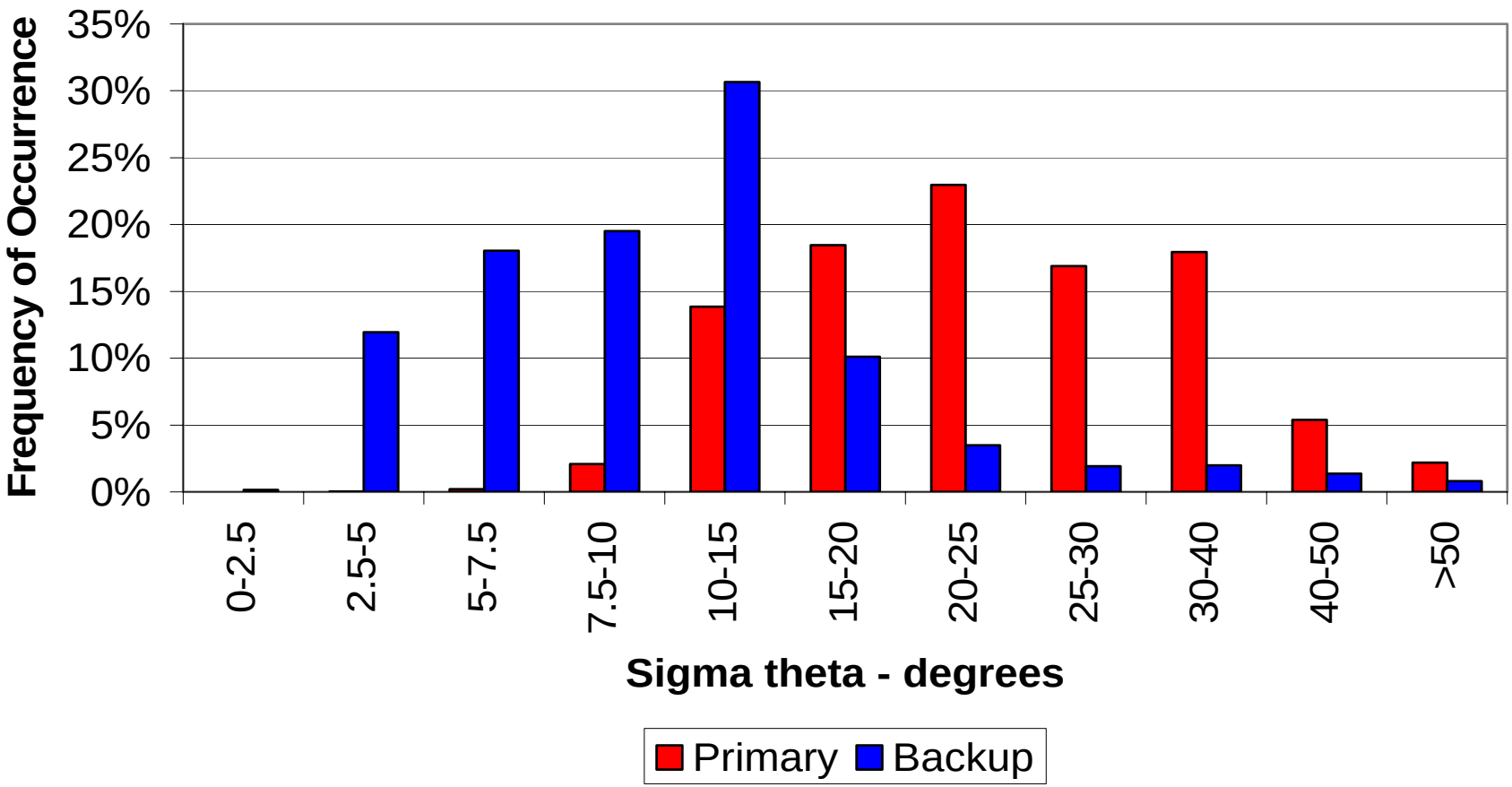


Wind Direction Comparison



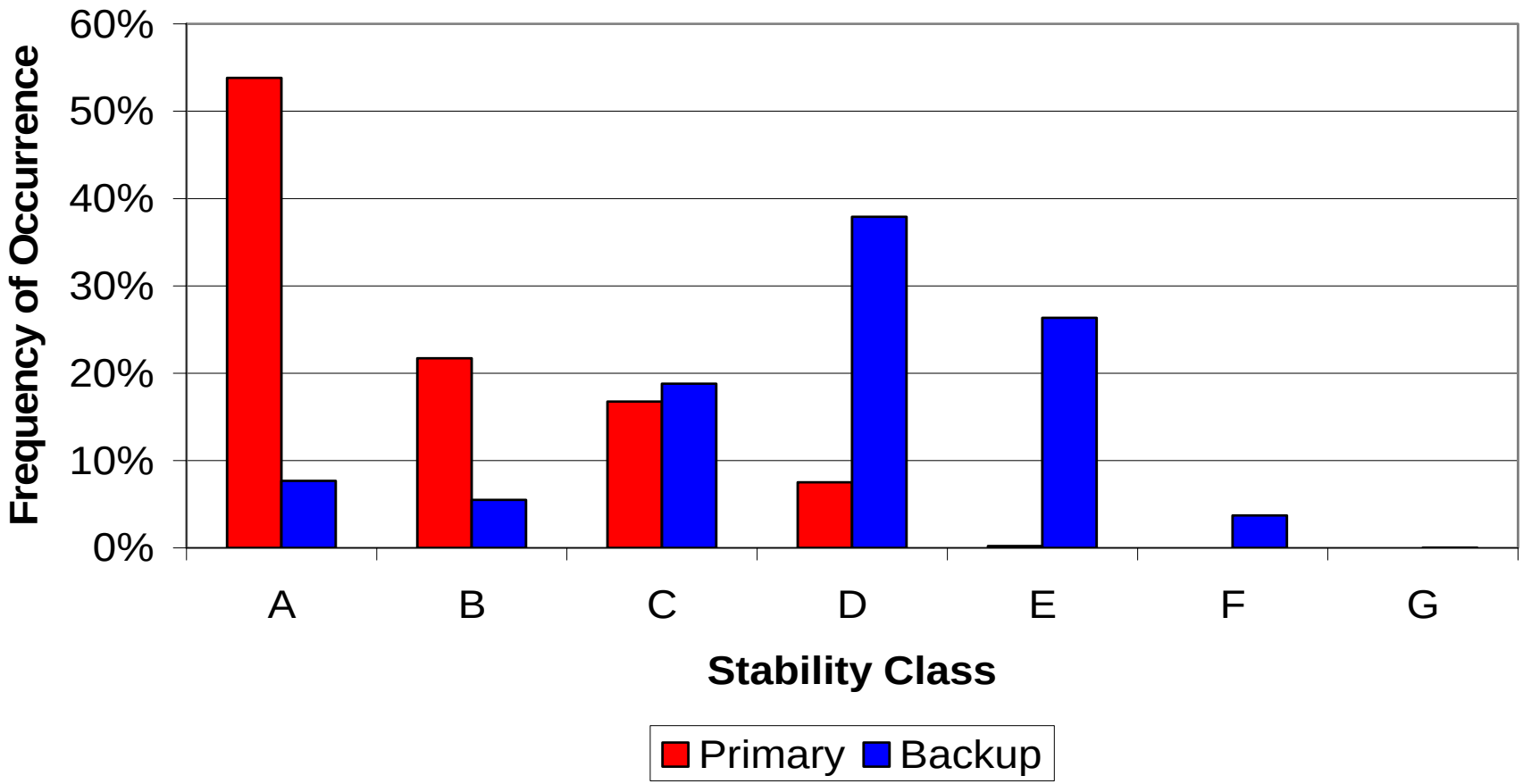
Sigma-theta Comparison

1 yr data set



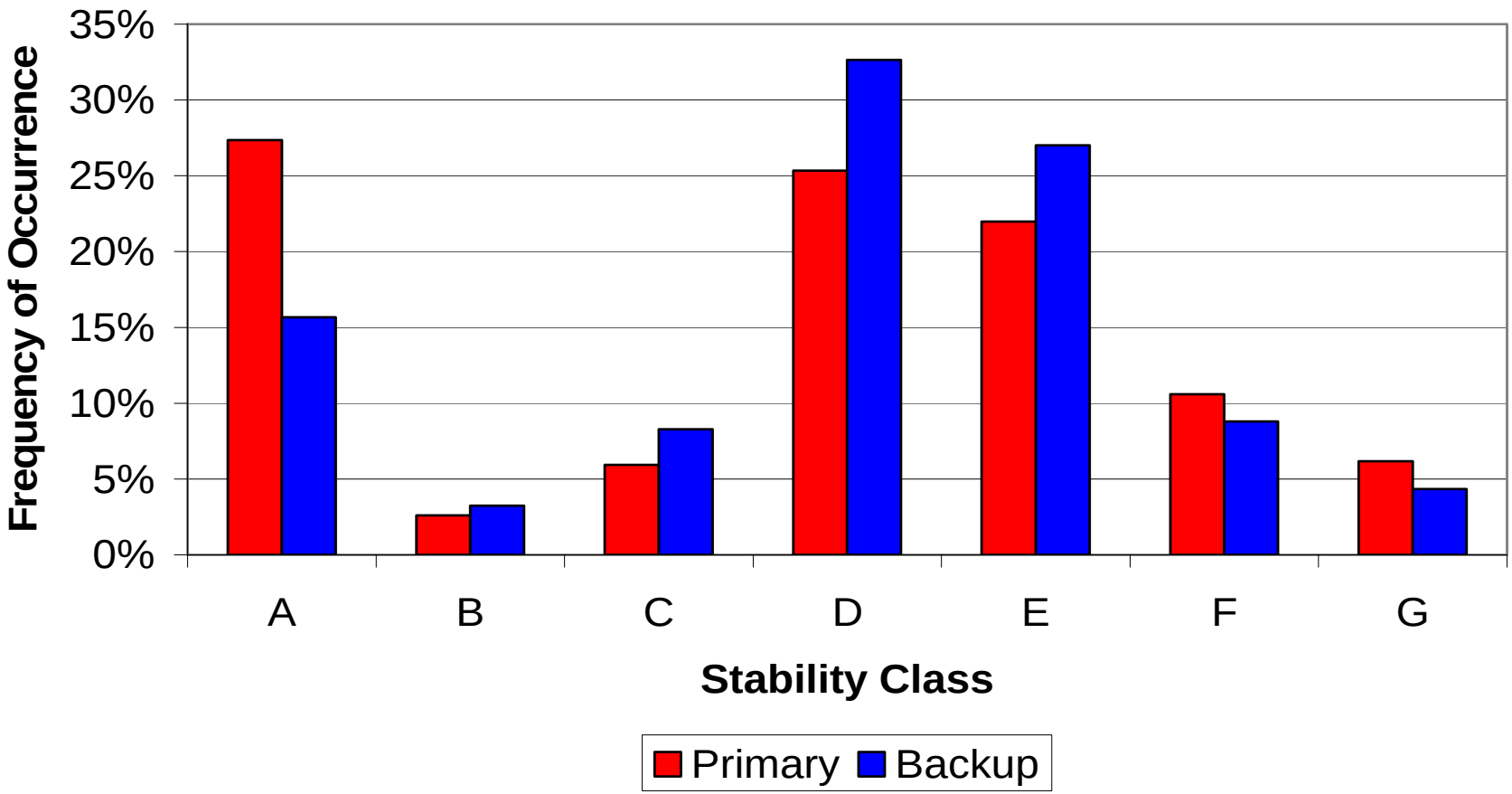
Stability Class Comparison

Sigma-theta Method – 1 yr data set



Stability Class Comparison

Delta-T Method – 10 yr data set



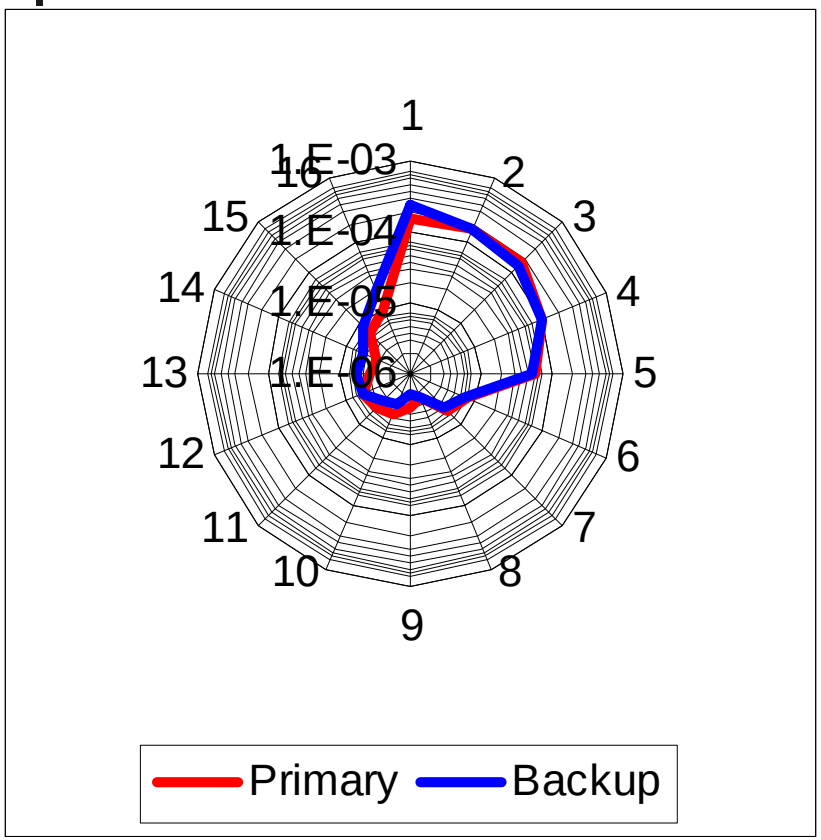
Delta-T Stability Class

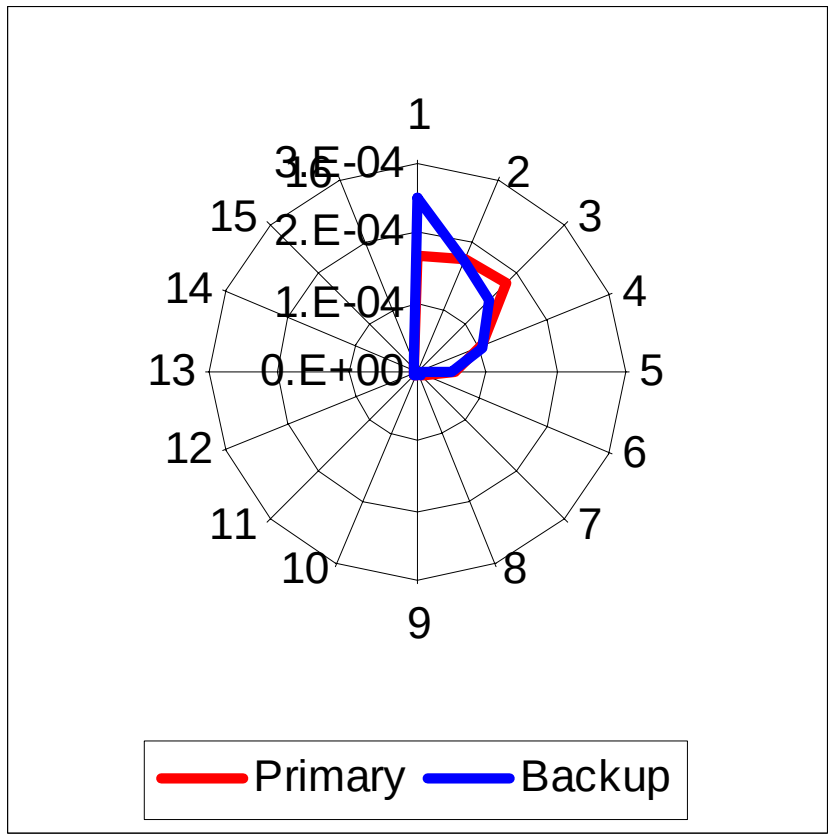
- Results were ***opposite*** of expected...
- Predicted backup tower, located near parking lot with asphalt and cars, would shift stability toward unstable classes
  - Expected asphalt and cars would result in 10-meter temperature value biased in positive direction
  - Since Delta-T = Upper-T minus Lower-T, subtracting a larger 10-m temperature should bias Delta-T in negative direction
  - More negative Delta-T values should bias toward more unstable stability classes

Site Boundary X/Q Comparison
Calculated from Delta-T Stabilities

Sector	Primary	Backup	Sector	Primary	Backup
N	1.6E-04	**2.5E-04**	S	3.2E-06	1.9E-06
NNE	1.8E-04	1.7E-04	SSW	4.2E-06	2.9E-06
NE	**1.8E-04**	1.5E-04	SW	4.4E-06	3.9E-06
ENE	1.0E-04	9.6E-05	WSW	5.0E-06	5.1E-06
E	5.5E-05	4.9E-05	W	3.7E-06	5.6E-06
ESE	8.3E-06	6.3E-06	WNW	3.3E-06	5.1E-06
SE	5.8E-06	4.7E-06	NW	6.5E-06	9.3E-06
SSE	2.4E-06	2.3E-06	NNW	9.9E-06	1.9E-05

Site Boundary X/Q Comparison
Calculated from Delta-T Stabilities





Considerations

- Which tower is “best” for on-site releases? Consider…
  - Backup tower *doesn’t* meet ANSI/ANS siting criteria
  - Plant is surrounded by asphalt… like backup tower – effect of delta-T, stability?
  - Plant is on flat grade… like backup tower – effect on wind profiles?
  - Plant is near ocean… like backup tower

Considerations (continued)

- Which level of instrumentation should be applied to on-site ground-level releases?
  - Upper level of backup tower is at same level as building vent.
  - Convention is to apply 10-meter meteorological measurements to ground-level and mixed-mode releases

Summary

- PNPS backup tower is typically discounted because it does not meet ANSI/ANS siting criteria... site QA won't accept it
- However, backup tower is situated in an environment that more closely mimics the on-site ground-level release points
- Use of backup tower meteorology yields a maximum site-boundary X/Q 39% ***HIGHER*** than that from the primary tower for ground-level releases

Summary (continued)

- *Questions for the experts*...
- Is it always necessary, or desirable, for a meteorological tower to meet ANSI/ANS siting criteria?
- Should I use data from a tower that does not meet ANSI/ANS siting criteria?