Pavement effects in TNM and temperature corrections for noise measurements

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FHWA TNM Pavement Effects Implementation Study

Pavement Effects in TNM

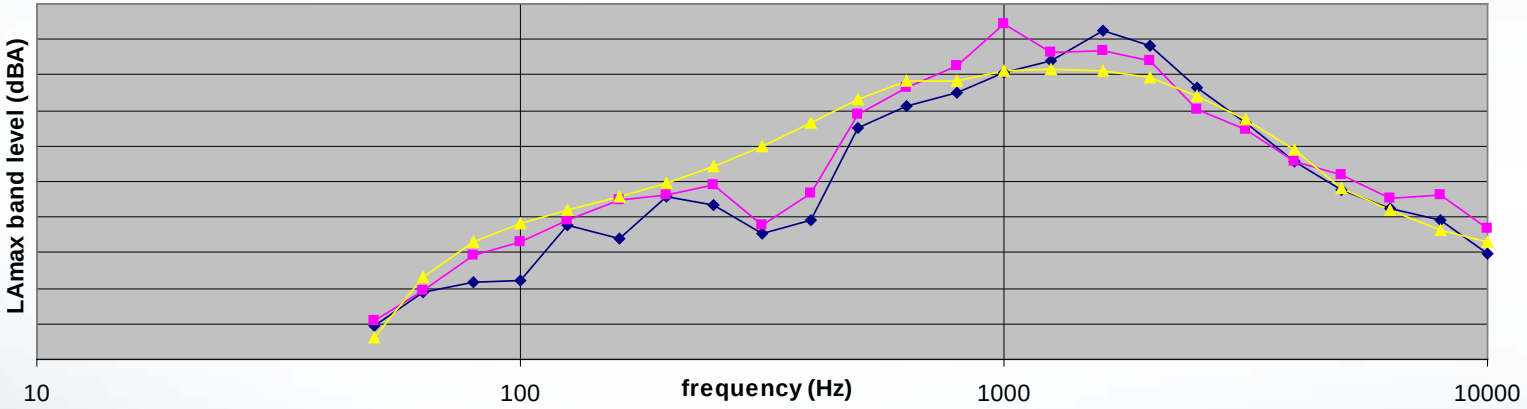
- TNM PEI Study

  FHWA Traffic Noise Model® (TNM®) Pavement Effects Implementation Study
  - Assessing options for implementing in TNM the effects of pavement on tire/pavement interaction noise

- Investigating …
  - introducing new pavement-specific vehicle noise emission (REMEL) data
  - introducing tire/pavement noise source adjustments using pavement-specific on-board sound intensity (OBSI) data
  - introducing pavement-specific sound absorption (EFR) values

Pavement-specific REMEL implementation

- Valid option for including a specific pavement type in TNM
  - May be limitations with tonal pavements

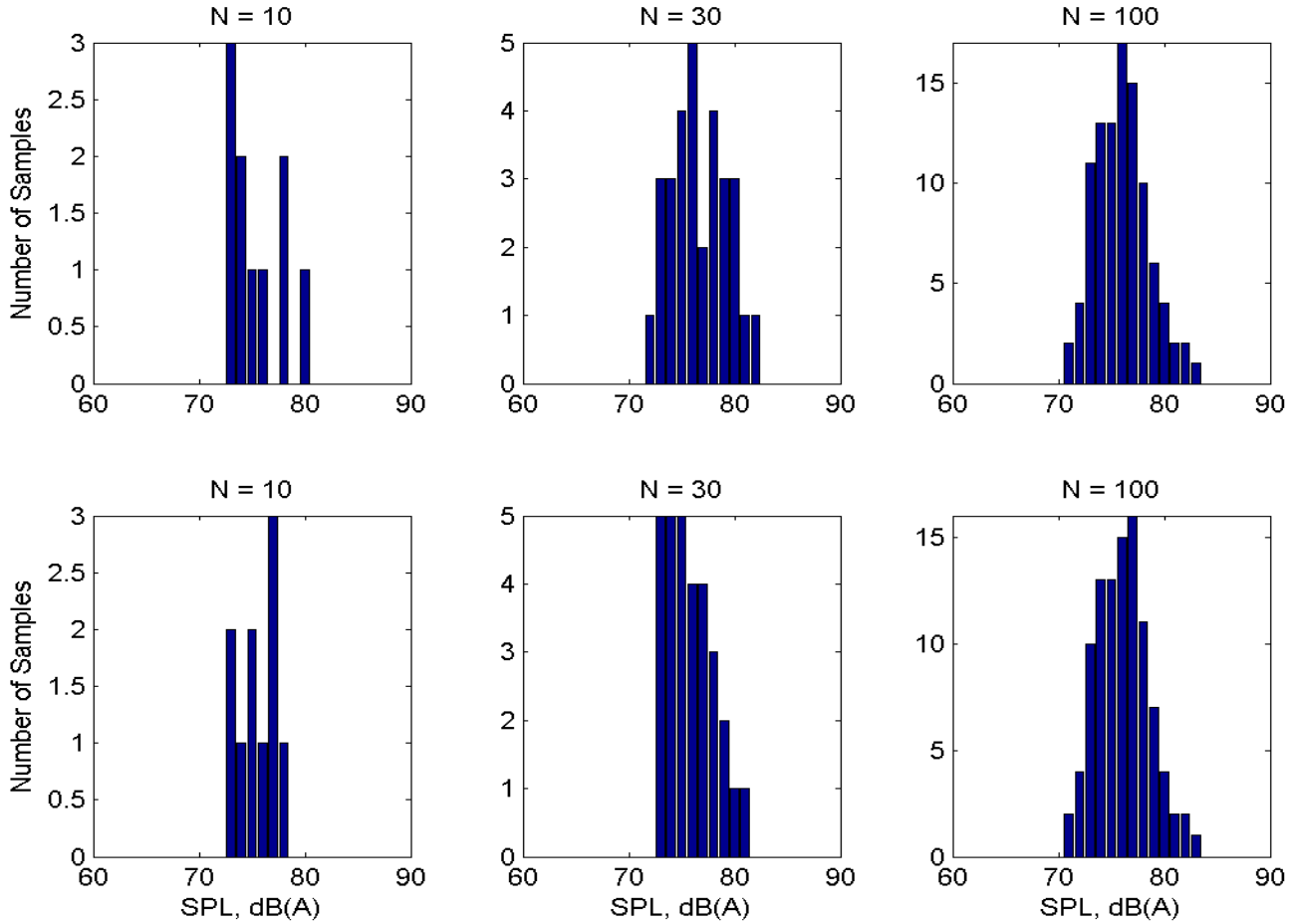


- Recommendations for implementation
  - Possible tonality check
  - Sound levels should represent those near the end of pavement surface life
  - Minimum number of events required per vehicle type (in low and high speed ranges)

Pavement-specific REMEL data – # events

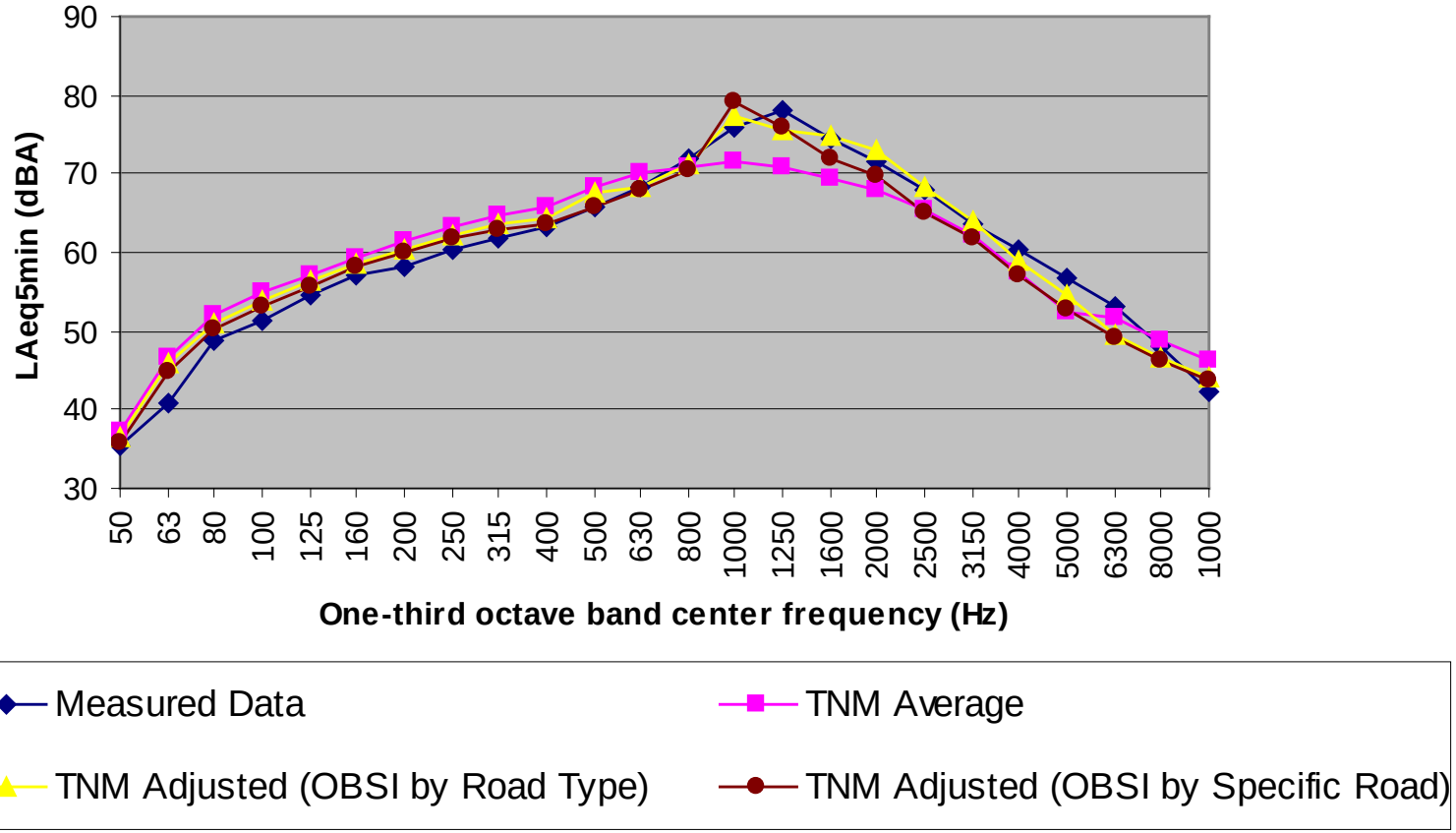
Data set #1

Data set #2



Pavement-specific OBSI adjustments

- Preliminary implementation results
  - Determined to be a valid way to account for pavement effects in TNM
  - Need to further investigate variation by vehicle type
  - Need to investigate adjustments below 500 Hz



Pavement-specific OBSI adjustments

- Recommendations for implementation
  - Need extensive OBSI data representing many pavement types
    - Volpe will be contacting state highway agencies to either
      1) obtain approved OBSI data for frequently used pavements

      or

      2) collect OBSI data for frequently used pavements

Pavement-specific OBSI adjustments

- Recommendations for implementation (continued)
  - Choice of pavement bin in TNM (general categories and subcategories)

Example categories

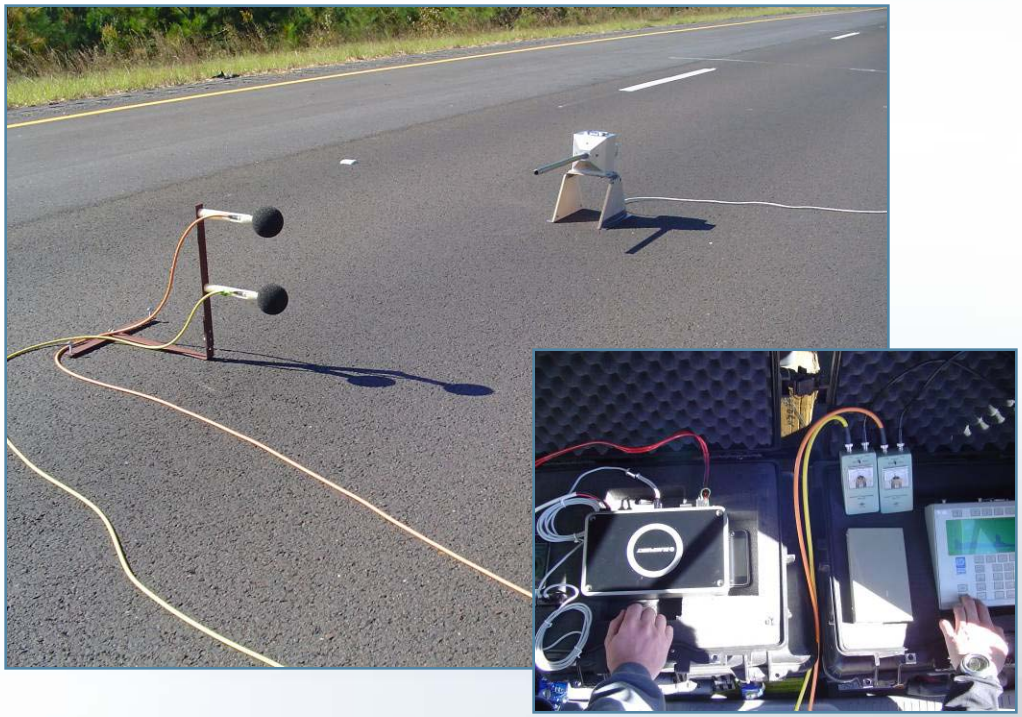
general category	sub category	sub-sub category
DGAC	max aggregate < x (x = 12 mm?)	
	max aggregate ≥ x	
OGAC or PFC	max aggregate < x	porosity < y (y = 15%?)
		porosity ≥ y
	max aggregate ≥ x	porosity < y
		porosity ≥ y
PCC	Diamond ground	
	Brushed, broomed, burlap-dragged	
	Longitudinally tined	Possibly tine spacing or depth
	Transversely tined	Possibly tine spacing or depth

Pavement-specific OBSI adjustments

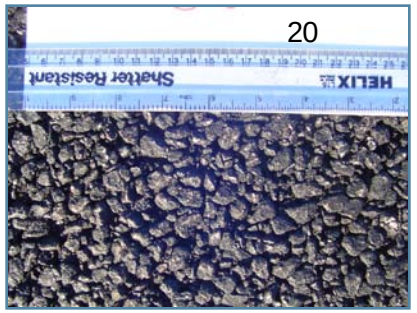
- Recommendations for implementation (continued)
  - Option for FHWA-approved user-defined pavement type
  - Sound levels should represent those near the end of pavement surface life

Pavement-specific EFR values

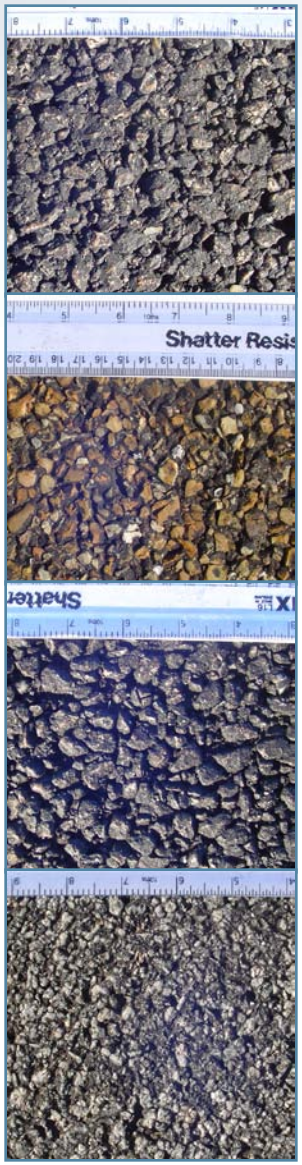
- Preliminary implementation results
  - TNM analysis showed potential for 2-dB differences wayside, depending on pavement specifications and number of traffic lanes
  - Sound absorption measurements in general conformance with ANSI S1.18 revealed broad range in effective flow resistivity (EFR) values for various pavements



Pavement-specific EFR values



Porous pavements – Can reflections from an underlying pavement explain some “anomalies” in measured sound levels?



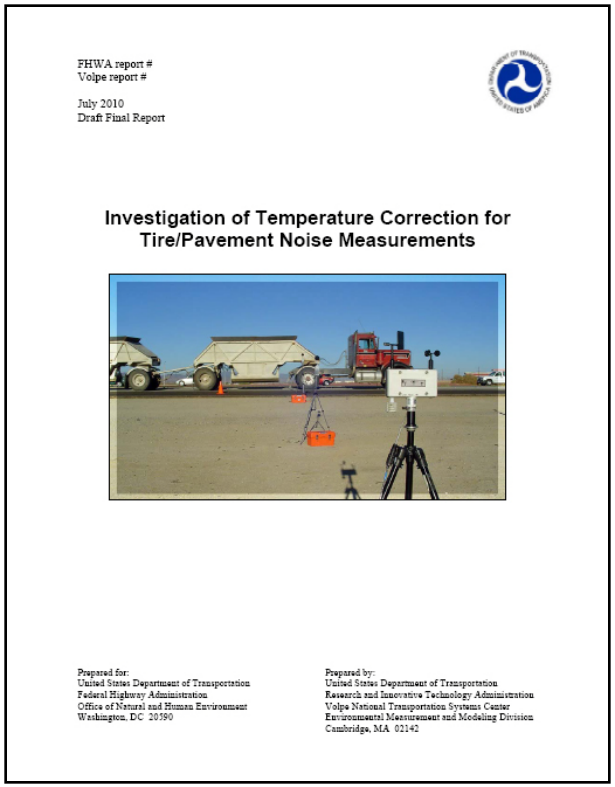
Pavement type	Air void (%)	Max aggr size (mm)	Layer thickness	Reflections seen?	OBSI level (dBA)
PFC	16.8	12.5	0.7	YES	101.5
OGFC	21.8	9.5	1.3-1.5	YES	101.3
PFC	16.8	12.5	1.3	YES	99.9
OGFC/ PEM	17.6/13.6	9.5/12.5	0.63/1.25	NO	97.0

FHWA Study of Temperature Corrections for Roadway Vehicles or Traffic Noise Measurements

Temperature corrections study

- Tire/pavement noise measurements temperature effects study
  - Determine relationship between sound level and temperature
  - Contribute to database of temperature correction coefficients
  - Make recommendation on application of temperature corrections

- Draft report completed



FHWA report #
Volpe report #

July 2010
Draft Final Report

Investigation of Temperature Correction for Tire/Pavement Noise Measurements

Prepared for:
United States Department of Transportation
Federal Highway Administration
Office of Natural and Human Environment
Washington, DC 20590

Prepared by:
United States Department of Transportation
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Temperature corrections data and analysis

- Wayside data sets examined from the following studies:
  - AZ QPPP Study
  - Caltrans Thin Lift Study (LA 138)
  - TNM PEI Study

  (air temperature ranges up to 26 °F (14 °C))

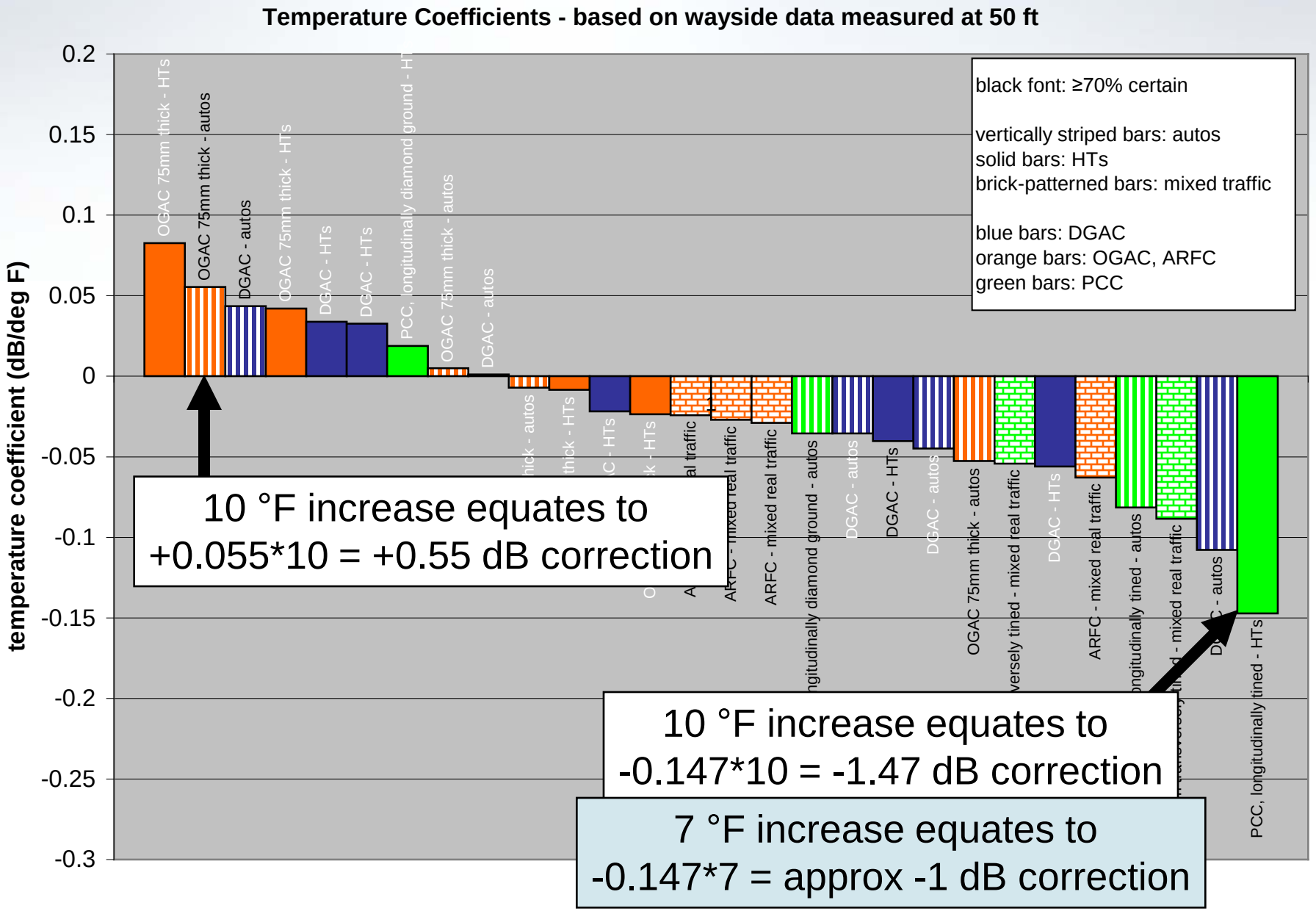
- Determined temperature correction coefficient for each data set

  (slope of linear regression through data – sound level as a function of temperature)

- Determined certainty of slope: “percent certain” = [100 * (1 – P-value)]

- Examined application of various temperature correction schemes
  - Includes semi-generic schemes where corrections are categorized by vehicle and pavement type

Temperature correction coefficients



Application of temperature correction coefficients

Potential dB error for a change in temperature of 18 °F (10 °C)

	Temperature Correction Schemes						
Statistics	None	Generic (-0.033 °F, -0.06 °C)	Semi-generic				This study data-set-specific
			Sandberg 2004	Bendtsen 2009	This study Scheme #1	This study Scheme #2	
Average	-0.41	0.19	0.12	0.03	0.02	0.00	0.00
Standard error of average	0.1787	0.1787	0.1780	0.1771	0.1624	0.1517	0.0000
Evidence of decreased variability (F-test)?		no	no	no	no	no	yes

Temperature corrections – conclusions

- Sound levels *usually* decrease slightly with increasing temperature
- Without temperature corrections, there *may* be an error due to temperature variations when comparing data sets
- Recommendations
  - Measure under similar meteorological conditions to minimize temperature effects
  - Determine if it's necessary to make temperature corrections
  - When possible, determine data-set-specific temperature coefficients and apply corrections
  - When specific coefficient is not possible, chose a semi-generic temperature correction scheme (look to ISO) and apply cautiously
    - Will *likely* improve comparability of data sets but there is a risk of impairing comparability
  - For now, report sound levels with and without temperature corrections


Questions?