



R | S | G INC.
RESOURCE SYSTEMS GROUP, INC.

Wind Turbine Noise Regulation

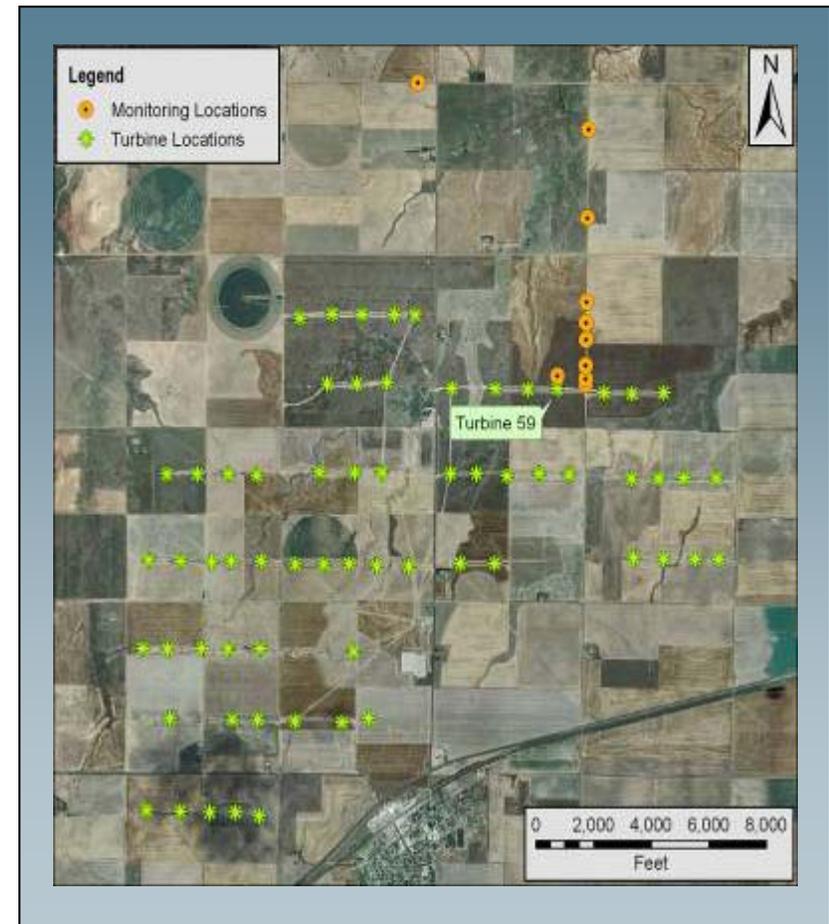
Perspectives in New England

Kenneth Kaliski, P.E., INCE Bd. Cert.
New England Wind Energy Education Project
Webinar #2

July 2010

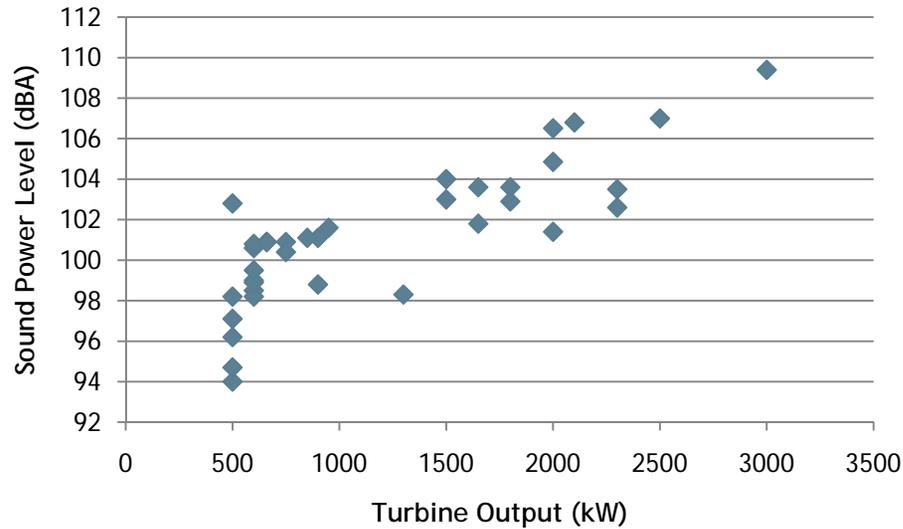
Typical noise impact study process

- Identify preliminary turbine locations and sound power of turbine
- Monitor background sound levels in representative areas (protocol-dependent)
- Conduct sound propagation modeling
- Compare results to standards or guidelines
- Refine turbine locations and remodel
- Prepare report
- Present testimony

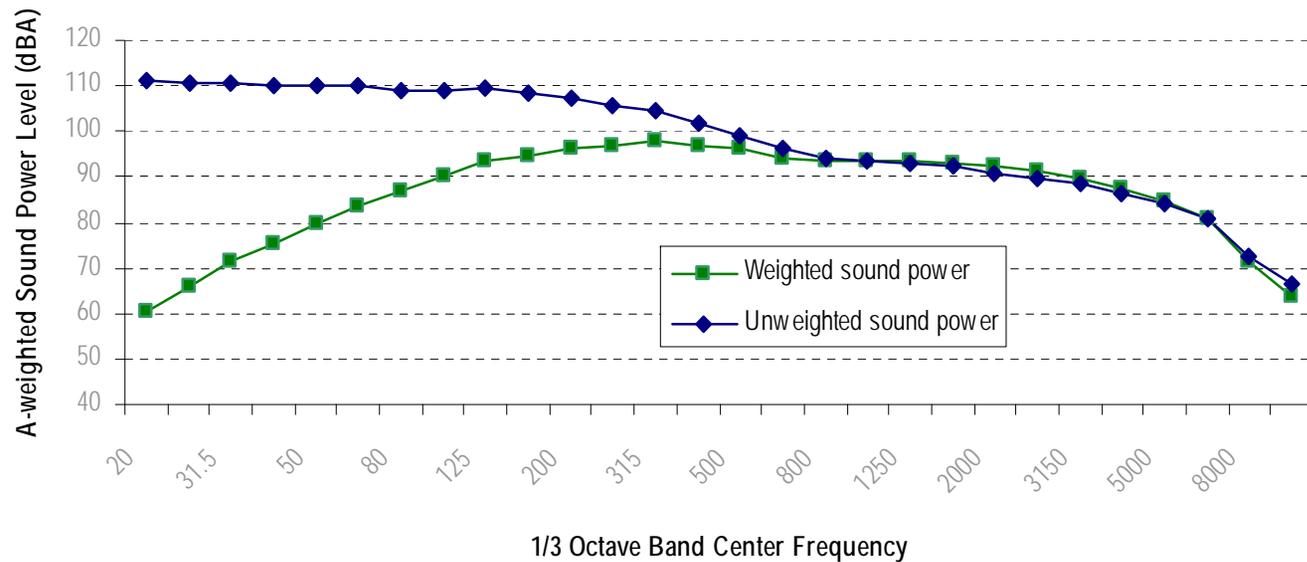


Determine sound power level of the turbine

Sound power of various turbines

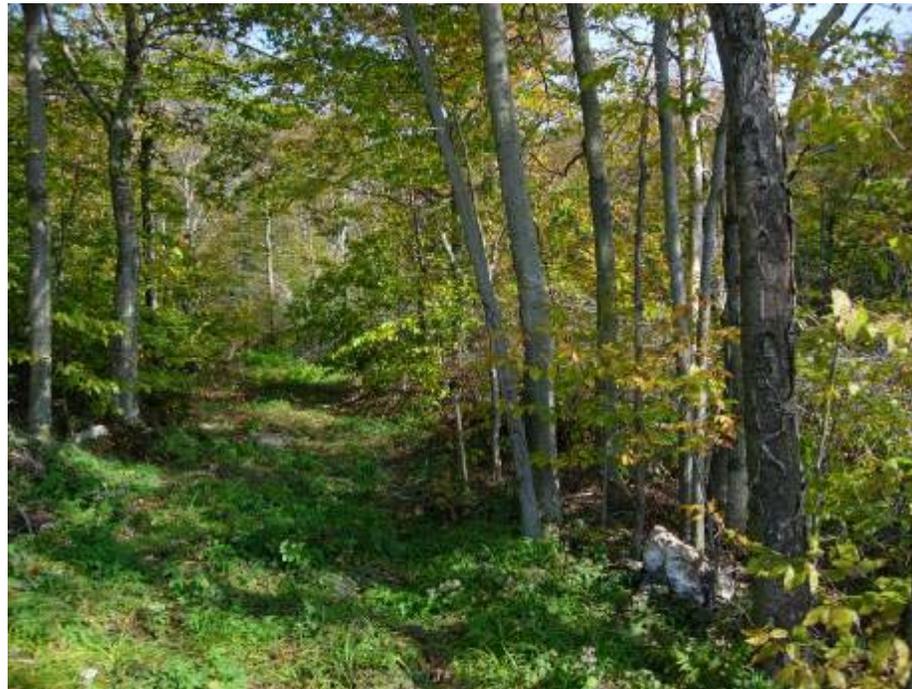


Sound power by frequency



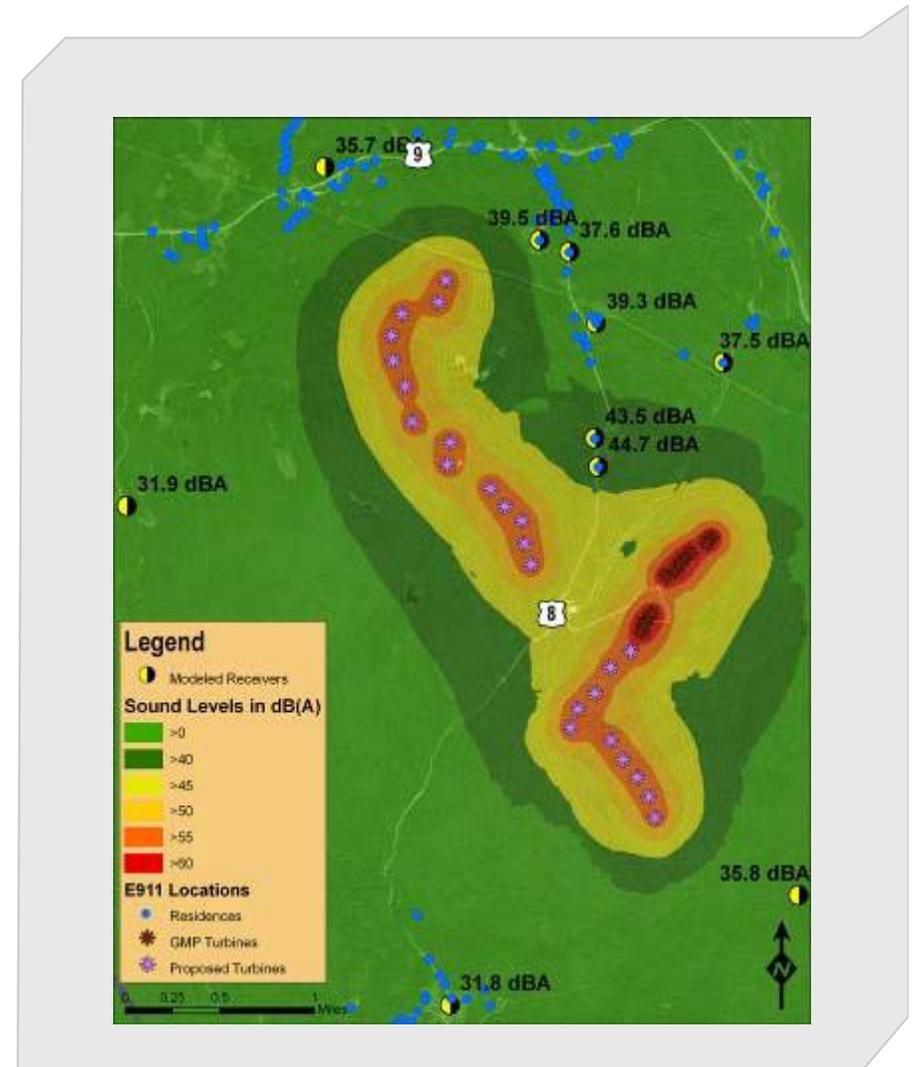
Background sound monitoring

- Identify sensitive receivers -
 - homes, places of worship, schools, wilderness areas, campgrounds, etc.
- Set up sound level monitoring
 - Shorter time frame if background levels are not critical to the standard
 - Longer time frame for relative standards
 - Seasonal, if important

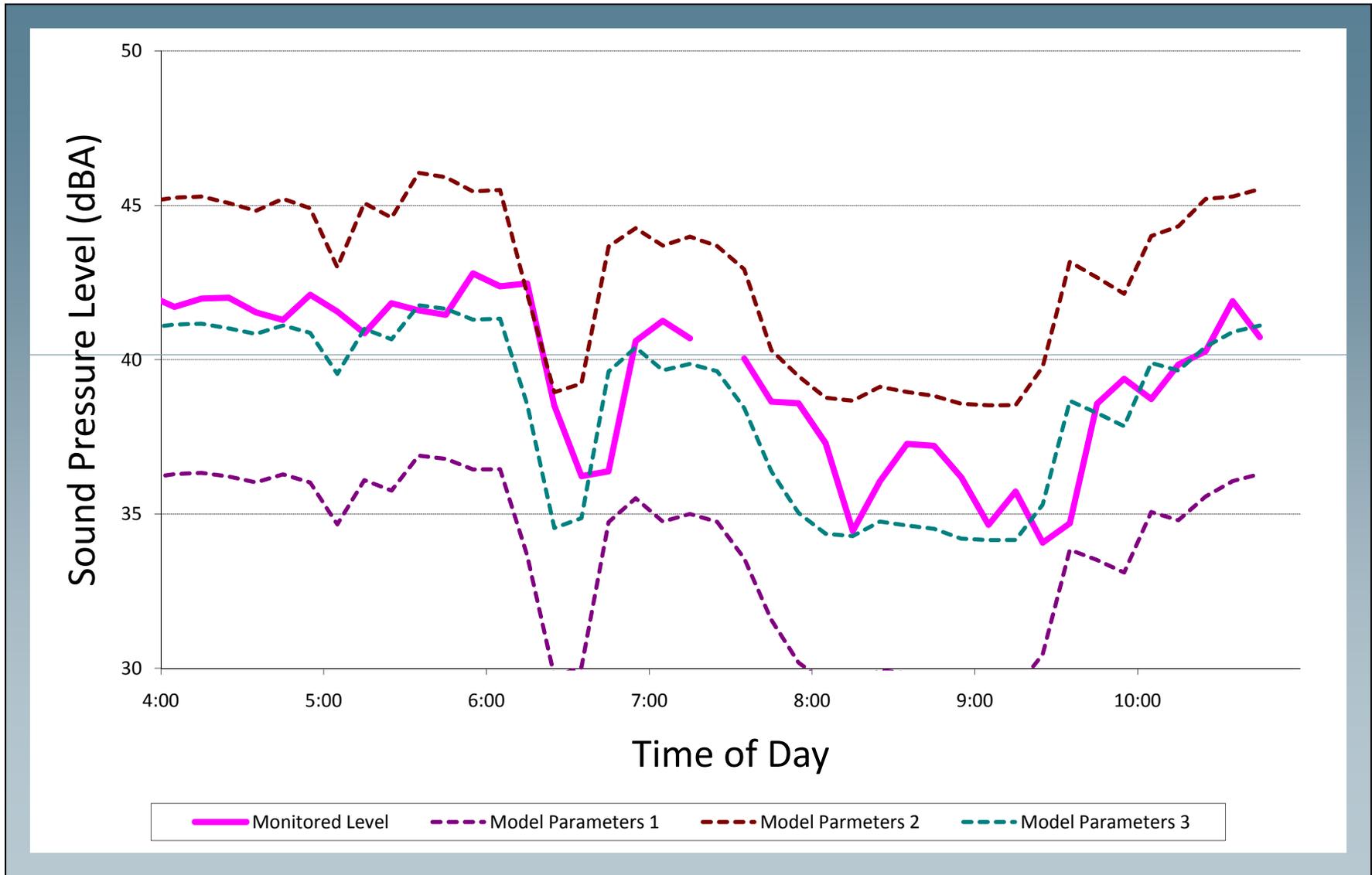


Propagation modeling

- ISO 9613
 - Sound power
 - Spreading Loss
 - Atmospheric attenuation
 - Barriers
 - Ground attenuation
 - Has significant impact on model results
 - Meteorology

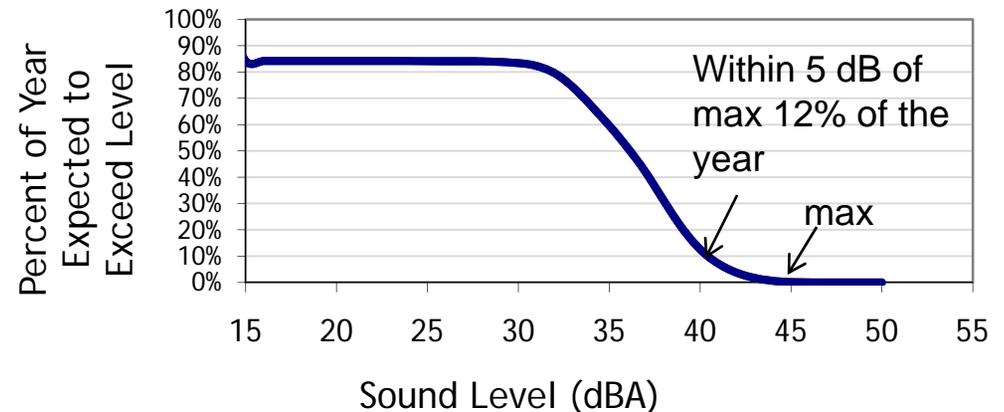
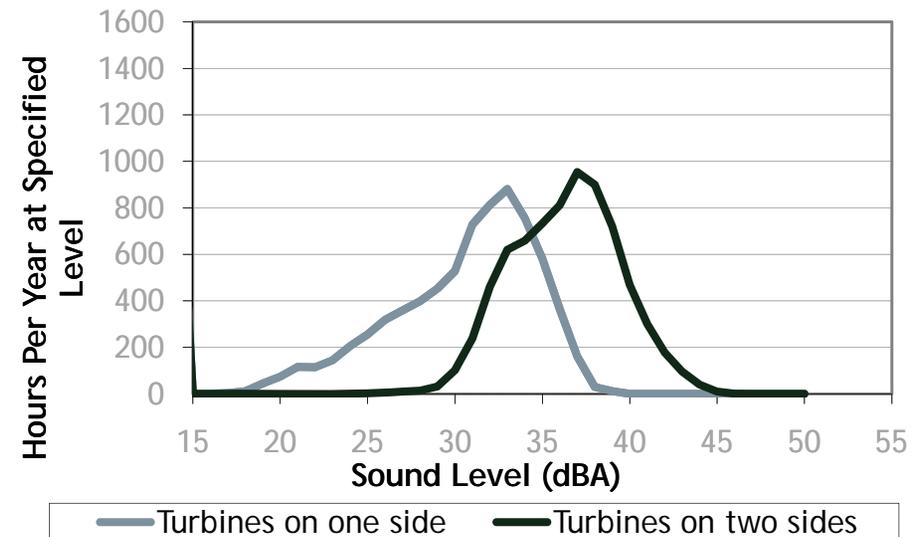


Different modeling parameters yield different results



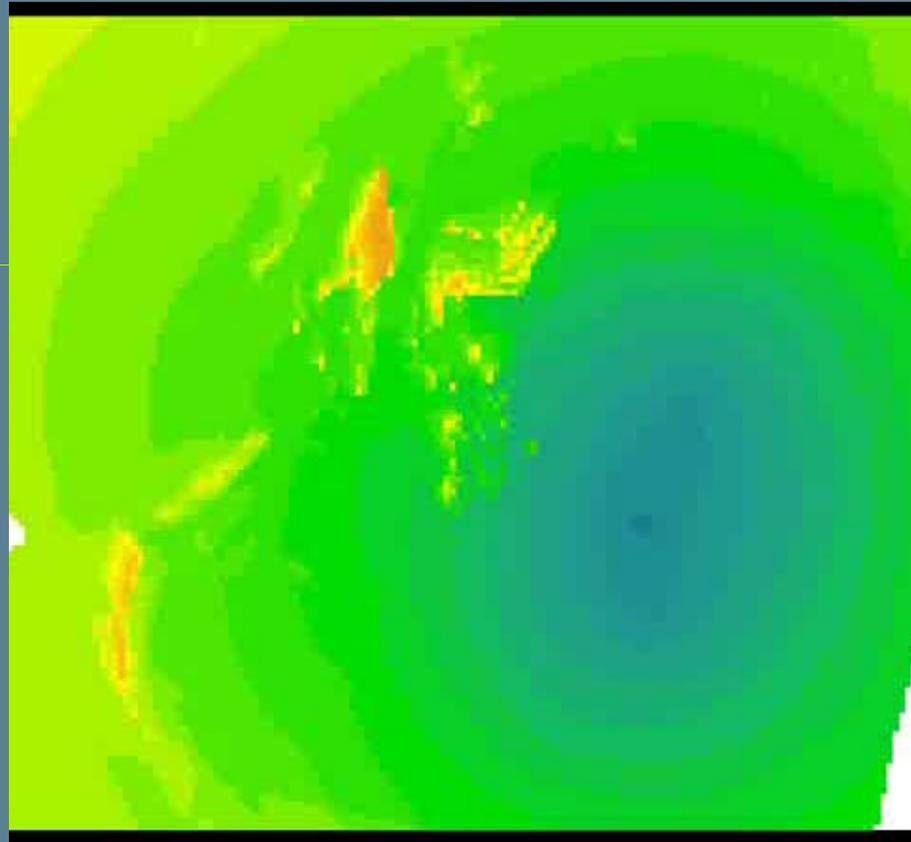
What is being modeled

- Modeling is typically done to estimate the maximum level, but we can also estimate sound levels under other conditions
- The percentile sound levels at a receiver is dependent on
 - The distribution of wind speed and direction over the year
 - The placement of the turbines with respect to the receiver



Wind direction and speed effects

- Sound generally propagates worse (i.e. lower levels at receivers)
 - Upwind
 - Under an unstable atmosphere, like sunny days
 - With lower wind speeds and flatter vertical wind speed gradients



What has been regulated

- Total level
 - Usually expressed in units of A-weighted decibels
- Level by frequency
 - Full or 1/3 octave bands
- Tonality
 - Pure tone penalties and limitations
- Impulsiveness

Components of good regulations

- Detail noise limits and parameters
- Include application requirements
- Detail components of pre-construction noise studies, including
 - Details of background sound monitoring
 - Acceptable models and parameters
 - Spatial limits of monitoring and modeling
 - Modeled receivers
- Address post-constructions issues

Components of good regulations

- **Sound level limits**
 - Absolute
 - Relative
 - Hybrid
- **Low frequency sound**
 - Limit noise-induced vibration (ANSI S12.2)
- **Tonality** (ANSI S12.9 Part 4)
- **Time-averaging**
 - 1-second, 10-minute, 1-hour, nighttime, daytime
- **Time above**
 - Percent of any hour, day, or month

Additional components of regulations

- Exemptions and exceptions
 - Construction noise
 - Maintenance
 - Emergencies
 - Waivers
- Complaint response procedure
- Post-construction monitoring
- Participation guidelines

Examples of regulatory approaches

■ New Zealand

- Specific to wind turbine sound
- Monitoring and modeling protocols
- Hybrid standard (greater of an absolute and relative level) with no maximum
- Uses regression to determine wind speed/SPL correlation
- Penalties for tonality and impulsiveness
- Details compliance protocol

Examples of regulatory approaches

- Oregon 340-035-0035 statewide noise rules
 - Existing regulation modified to address wind turbines
 - Existing regulations consisted of hybrid standard-greater of a relative and absolute level, with a maximum
 - Existing regulations included tonal penalties and provided optional standard for octave bands
- Wind turbine portion of standard established rules on participation and identified options for evaluating existing levels.

New England States' Wind Turbine Noise Regs

■ Maine

- Statewide “Site Law” not specific to wind turbines
 - Absolute limits with lower “quiet area” limits
 - Measurement procedures
 - Penalties for
 - Tonality
 - Short duration repetitive sounds
 - Includes submission requirements
 - Exemptions
 - Variances
 - Waivers

New England States' Wind Turbine Noise Regs

■ Connecticut

- Statewide noise regulations not specific to wind turbines
 - Absolute standard (except in high noise areas)
 - Penalties for
 - Impulse noise
 - Tones
 - Infrasound and ultrasound
 - Measurement procedures
 - Exclusions and exemptions
 - Variances
 - Violations and Enforcement provisions

New England States' Wind Turbine Noise Regs

■ Massachusetts

- Wind farm precedents
 - Varied approaches to setting standards
- Massachusetts Dept. of Air Quality Control Policy
 - Relative standard at property line and home
 - No pure tones allowed
 - No consistent approach on whether and how it applies to wind turbines

New England States' Wind Turbine Noise Regs

■ New Hampshire

- No statewide noise regulations
- Site Evaluation Committee Precedent
 - Absolute limit
 - Post-construction monitoring required

■ Vermont

- No statewide noise regulations
- Public Service Board Section 248 precedents
 - Absolute limit measured inside and outside home
 - No pure tones allowed
 - Post-construction monitoring required

Mitigation

- Re-siting project turbines
 - Increase setbacks
 - Reduce turbulence
 - Identify quieter turbines or components
- Automatic controls to slow tip speeds/reduce noise under specific conditions
- Improve noise insulation on target homes
- Increase the number of project participants

Kenneth Kaliski, P.E., INCE Bd. Cert.
Resource Systems Group, Inc.
55 Railroad Row
White River Junction, VT 05001
kkaliski@rsginc.com