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**RESOLUTION NO. 57-10**

**A RESOLUTION OF THE NAVAJO COUNTY BOARD OF SUPERVISORS, ADOPTING THE NAVAJO COUNTY SOUND REQUIREMENT GUIDELINES FOR WIND ENERGY GENERATION FACILITIES**

**WHEREAS**, Article 20 of the Navajo County Zoning Ordinance, Ordinance No. Z90-1, as amended by the Board of Supervisors on this date pursuant to Ordinance No. 06-10, established a new Section 2008 thereof regarding the regulation and development of "Wind Energy Generation Facilities" by resolution of the Board of Supervisors; and,

**WHEREAS**, the Public Works Department staff have recommended Sound Requirement Guidelines for Wind Energy Generation Facilities attached hereto; and,

**WHEREAS**, the Board of Supervisors finds that the recommended Sound Requirement Guidelines for Wind Energy Generation Facilities are in the public interest and should be approved,

**NOW, THEREFORE, BE IT RESOLVED** by the Board of Supervisors that the Sound Requirement Guidelines for Wind Energy Generation Facilities in the form attached hereto are hereby adopted to govern in and apply to all Wind Energy Generation Facilities.

**PASSED, ADOPTED AND APPROVED** by the Navajo County Board of Supervisors at Holbrook, Arizona, on October 26, 2010, by a vote of 5 ayes and 0 nays.

**NAVAJO COUNTY BOARD OF SUPERVISORS**

By Jesse Thompson  
Jesse Thompson  
Chairman of the Board

Attest:

Melissa W. Buckley  
Melissa Buckley, Clerk of the Board

**As presented to the Navajo County Board of Supervisors  
(October 26, 2010)**

***Sound Requirement Guidelines***

*for*

***Wind Energy Generation Facilities***

**1. Pre-development sound modeling:**

Sound pressure level simulations (modeling) and related reporting shall satisfy the following:

- a. Sound pressure levels shall be developed under source, atmospheric and receiver site conditions that will yield the maximum expected sound pressure levels at the receiver location.
- b. Follow International Electrotechnical Commission (IEC) standard 61400-11 and other applicable IEC standards for determining wind turbine sound power levels.
- c. Follow applicable International Organization for Standardization (ISO) 9613-1 and 9613-2 (latest editions), or use appropriate American National Standards Institute (ANSI) standards for wind turbine sound modeling.
- d. Utilize a model and modeling methodology that can yield reliable forecasts of both A-weighted and C-weighted sound pressure levels at distances of interest.
- e. Identify and explain the simulation model, as well as codes, sound propagation physics, phenomena or approaches included in the model. Identify and explain model assumptions or simplifications.
- f. Quantitatively assess and describe model sensitivity – i.e., on what parameters do the simulation results strongly depend, and on what parameters do the results only weakly depend?
- g. Explain whether and how frequency-dependent sound attenuation is included in the simulation(s).
- h. Explain whether and how low-frequency sound (approximately 1-125 Hz) is included in the simulation(s).
- i. Explain whether and how the simulation(s) capture known or anticipated atmospheric stability (wind shear) impact(s) on sound pressure levels. Follow contemporary standards of practice in acoustic science, or use Annex A and C in IEC 61400-11 as a guideline for determining turbulence intensity and amplitude modulation.
- j. Interpret the simulation results in terms of known or anticipated diurnal (daily) variations in background and wind turbine contributions to sound pressure levels at receiver locations.
- k. Explain whether and how synchronization during high wind conditions of multiple wind turbines and possible effects due to coherent sound pressure wave propagation are included in the simulation(s).
- l. Identify and explain atmospheric temperature, pressure and humidity values used for simulations.
- m. Explain whether and how impacts of atmospheric temperature inversions and monsoonal atmospheric conditions are included in the simulation(s);
- n. Explain whether and how sound pressure wave refraction is included in the simulation(s).

- o. Prepare a sound contour map that utilizes an aerial photo showing the project boundary, areas within two miles of the project boundary, and maximum expected sound contours at 5 dBA intervals (with a range from 30 dBA up to 50 dBA). The sound model analysis shall include predictions based on a maximum turbine sound power level determined in accordance with IEC 61400-11.
- p. For each turbine configuration, provide a map of forecast sound level contours.
- q. Indicate on a topographical map for each wind turbine the manufacturer, model number and location of sources, including hub height.
- r. Include results of independent source power level testing, inclusive of tonal audibility, authorized by the source manufacturer and conducted in accord with IEC 61400-11.
- s. Follow contemporary standards of practice in acoustic science.
- t. Models used to simulate sound propagation shall be calibrated and validated.
- u. The modeling shall include a +2dBA adjustment, or be based on declared sound power levels in accordance with IEC 61400-14.
- v. If sound due to a Wind Energy Generation facility is expected or known to contain a steady or intermittent pure (or near pure) tone, the A-weighted sound pressure level standards for audible noise set forth in the ordinance shall be reduced by 5 dB. Follow ANSI S1.13 for pure tone criteria.
- w. The coordinate system for the pre-project evaluation and post-construction compliance evaluation shall be: North American Datum 1983 Arizona State Plane Eastern Zone, U.S. Survey Feet, North American Vertical Datum 1988.

**2. Sound measurement study criteria:**

Sound pressure level measurements and related reporting shall satisfy the following:

- a. Follow contemporary standards of practice in acoustic science.
- b. Follow applicable International Organization for Standardization (ISO), American National Standards Institute (ANSI), and Acoustical Society of America (ASA) standards that apply to noise measurements.
- c. Sound pressure level measurement locations shall be developed in consultation with the Public Works Department. Sound pressure level measurements shall be made at locations that have received prior approval by the Public Works Department.
- d. In order to meet the Low Frequency Noise (LFN) and vibration requirements in ANSI S12.2 (RNC-25) and ANSI S12.9, the following sound pressure levels for the 1/1 Octave band will not be exceeded at the exterior of any existing legal residence, school, library or hospital at the time of the approval of the Special Use Permit:
  - (1) 16 Hz: 68 dB
  - (2) 31.5Hz: 65 dB
  - (3) 63Hz: 63 dB
- e. Measure and provide both A-weighted and C-weighted sound pressure levels.

- f. The background and compliance-period sound pressure levels at measurement locations shall be measured at a range of hub height wind speeds, in approximate increments of 3-4 ft/s, between cut-in and up to the speed(s) corresponding to the rated turbine power levels.
- g. The background (pre-development, and prior to issuance of an SUP) and compliance-period (post-development) sound levels shall be determined, as a function of hub-height wind speed, using  $L_{A90,10}$  and  $L_{Aeq,10}$  for an appropriate number of determinations and meeting with ANSI S12.18 standards. Each such measurement must also satisfy the following criterion: during the measurement, the mean of direction(s) from the source(s) to the measurement locations and the mean of time-averaged wind direction(s) at the source(s) are within 45 degrees of one another. In other words, measurements are only valid when the wind is blowing from the source(s) toward the measurement location. In addition to satisfying this criterion, the difference in the two directions for each such measurement shall be recorded. These data and standard defensible regression methods shall be used, for each measurement location, to develop the background and compliance-period sound levels as a function of hub-height wind speed for each measurement location.
- h. For each measurement location, the results of simulations of sound levels during facility operation shall be evaluated in the context of the background sound level function, which will generally be a smooth curve – valid only at that location – utilizing the  $L_{A90,10} + 5$  dB and  $L_{Aeq,10}$  ordinance criteria.
- i. Results from compliance-period sound level monitoring for each measurement location during facility operation, which will generally yield a smooth curve – valid only at that location – shall be evaluated in the context of the background sound level function for that location, as determined above, utilizing the  $L_{A90,10} + 5$  dB and  $L_{Aeq,10}$  ordinance criteria.
- j. Identify and explain regression methods used to develop background and compliance-period sound level functions of facility site hub-height wind speed, and provide complete regression analysis results, including correlation coefficients.
- k. Measurement receivers shall be determined in consultation with the Public Works Department.
- l. Sound measurements shall be made using ANSI S1.4 Type 1 or Type 2 instrumentation, industry-standard equipment, methods and techniques.
- m. Quantitatively address uncertainties present in sound pressure level measurements.
- n. Utilize outdoor sound pressure level measurements only.
- o. Use only those data acquired during precipitation-free periods.
- p. Consider seasonality of prevailing wind direction that may be relevant to the selection of measurement periods and to the interpretation of measurement results.
- q. Provide descriptions of sound-level measuring equipment used (including microphones and windscreens), including manufacturer, model and type, as well as valid calibration records for applicable equipment.
- r. Address wind-induced microphone noise.
- s. The evaluation of pure tones shall be conducted utilizing equipment capable of reporting one-third octave band levels.
- t. Provide times and durations of monitoring.
- u. Provide descriptions of sound measurement locations, with microphone heights above ground, wind speeds, distances to nearest site features (buildings, trees, etc.), distances to nearest Wind

Energy Generation facility sources, discussion of audible sounds such as due to equipment/construction operations, landscape maintenance, seasonal sources (bird talk, insect sounds, leaf rustle), etc.

- v. Provide facility site atmospheric conditions – specifically wind speed at 10 m, as well as wind direction, barometric pressure, humidity and temperature.
- w. Provide measurement sampling duration(s).
- x. For post-development period monitoring, provide information on which sources were in operation.
- y. Provide graphs for each measurement location that indicate sound pressure level versus hub-height wind speed data, regression results, correlation coefficients, forecast sound level versus hub-height wind speed, and threshold criteria identified in the ordinance.
- z. Provide electronic records in non-proprietary format, of sound pressure level time histories, unweighted spectra and corresponding weighted sound pressure levels.
- aa. Provide map(s) with locations of monitoring, as well as monitoring site photographs with equipment in the foreground and key site features in the background. Include the following:
  - (1) Indicate locations used for wind measurements and sound level measurements.
  - (2) Indicate locations of affected structures within two miles of any source.
  - (3) Provide coordinates for all locations identified herein.
  - (4) Indicate  $L_{A90}$  and  $L_{Aeq}$  for each measurement point.
- bb. Furnish graphical and tabular data presentation, together with analysis and interpretation, to facilitate understanding by County staff, professionals and the public.