WIND ENERGY CONVERSION SYSTEM ORDINANCE

1. GENERAL PROVISIONS

1.1 Title

These regulations shall officially be known, cited and referred to as the Wind Energy Conversion System (WECS) of Town of _____, and hereinafter will be referred to as "The Ordinance."

1.2 Purposes

1.2.1 State Regulatory History: Pursuant to Wisconsin Act 204, (enacted in 1998) state regulation and oversight (by the PSCW and DNR) of "small" electrical generating facilities less than 100 MW was virtually eliminated. As a direct result, the responsibility for review and approval of these facilities was shifted from Wisconsin state agencies to local units of government.

1.2.2 Local Regulatory History: Town of _____ ordinances did not address wind energy conversion systems prior to this ordinance and therefore lacked the appropriate standards to ensure public health and safety.

1.2.3 Local Authority: Wisconsin state statutes preserve local authority regarding zoning related to wind energy conversion systems and allow for reasonable restrictions.

1.2.4 Visual Impact: It is in the public interest to minimize the visual impact of wind energy conversion units through careful design and siting standards, particularly in circumstances in which the community places a high value on its visual quality.

1.2.5 Minimize Conflict Between Incompatible Land Uses: It is in the public interest to ensure that conflict between incompatible land uses is minimized by limiting wind energy conversion system development in the vicinity of existing or planned residential or development and certain sensitive or high value environmental areas.

1.2.6 Public Health, Safety, and Welfare: Government officials have a duty to protect the public health, safety and welfare of it citizens and their environment and enact appropriate ordinances as they relate to the public health and safety issues associated with wind energy conversion systems. The quality and integrity of the environment are paramount to good health and impact many factors related to the safety of watersheds and water quality.

1.2.7 Decommissioning: Wind energy conversion systems are expected to have a useful life of twenty (20) or more years. Decommissioning and removal of wind energy conversion systems and restoring the site at some point years into the future has proven to be very expensive, therefore it is in the public interest that the developer provide financial security to insure the removal of these facilities at some point in the future.

1.3 Ordinance: THEREFORE BE IT ORDAINED, that it is the intent of the Town of _____ Board, in adopting this ordinance, to permit the use of proven wind energy conversion systems for energy production, and to promote safeguards ensuring the maintenance of the health and safety of the citizens of Town of _____. Furthermore, it is the intent of the Town of _____ Board that site-specific application of this Ordinance shall occur only in a manner

that provides a harmonious balance between the suitability of a project site with existing land use and physical surroundings.

1.4 Authority: The Planning Commission of Town of _____ is vested with the authority, after consultation with affected municipalities, to review and recommend approval, conditional approval, and rejection of applications for wind energy conversion systems, including preliminary and final plans.

1.5 Jurisdiction: This ordinance applies to all WECSs, as defined in Table 1-1 and Section 2, proposed after (date), to be developed within the boundaries of Town of _____. Furthermore, no WECS shall be constructed without obtaining the approval of the Town of _____ and duly issued permit(s).

Table 1-1

Wind driven machine on a tower or other support that produces electricity.	• Greater than 20 kw **or** • Over 125 ft. total height **or** • Produces power for commercial resale.	• Subject to WECSO • Requires a conditional use permit • • Requires a building permit
	• 20 kw or less **and** • Less than 125 ft. total height **and** • Produces power for personal use.	• Requires conditional use permit • Requires a building permit • WECSO setbacks section 5.1.2 applies, but is not subject to the 1000 ft. minimum setback. • Section 5.18 and 5.10.1.1 also apply.
Wind driven machine that does not produce electricity.	Total height of 50 ft. or less.	• Not subject to WECSO • Requires a building permit • Land Use Permit required
	A meteorological or wind test tower.	• Requires conditional use permit • Requires a building permit • WECSO sections 3.1, 5.1.2 and 5.18 apply.

1.6 Enactment: In order that all WECUs be constructed in accordance with the purposes and policies, these regulations are hereby adopted and made effective as of (date). All applications submitted after this date shall be reviewed pursuant to these regulations.

1.7 Interpretation, Conflict and Separability

1.7.1 Interpretation: In interpreting these regulations and their application, the provisions of these regulations shall be held to be the requirements for the protection of public

health and safety. These regulations shall be construed broadly to promote the purposes for which they are adopted.

1.7.2 Conflict: These regulations are not intended to interfere with, abrogate, or annul any other ordinance, rule or regulation, statute, or other provision of law except as provided in these regulations. Any other provision of these regulations that imposes restrictions different from any other ordinance, rule or regulation statute, or other provision of law, the provision that is more restrictive or imposes higher standards shall control.

1.7.3 Separability: If any part, provision, or appendices of these regulations or the application of these regulations to any developer or circumstances is adjudged invalid by any court of competent jurisdiction, the judgment shall be confined in its operation to the part, provision or application directly involved in the controversy in which the judgment shall be rendered and shall not affect or impair the validity of the remained of these regulations or the application of them to other developers of circumstances. The Town of _____ Board of Supervisors hereby declares that it would have enacted the remainder of these regulations even without any such part, provision or application, which is adjudged to be invalid.

1.8 Amendments: The Town Board may from time to time recommend amendments to these regulations at a public meeting following public notice. As technology advances, some or all of these regulations may become obsolete. Therefore, periodic review and revision of these regulations will be necessary.

1.9 Public Purpose: Regulation of the siting of WECSs is an exercise of valid Town zoning enforcement authority delegated by the State of Wisconsin. The developer has the duty to comply with reasonable conditions set forth by the Town of _____.

1.10 Enforcement, Violations, and Penalties

1.10.1 Enforcement. Enforcement authority shall be the responsibility of the Town of _____ Zoning Enforcement Officer or his/her designees. See Appendix B.

1.10.2 Violations. It shall be unlawful to construct, install, reconstruct, substantially repair, improve, extend, enlarge, relocate, or convert any wind energy conversion unit (WECU) in violation of the provisions of this Ordinance. It shall also be unlawful to fail to obtain wind access permits as required by this ordinance.

1.10.3 Penalties. There shall be penalties for any person, owner/operator, landowner, firm, association, corporation or representative agent who fails to comply with the provisions of this Ordinance or orders from the Zoning Enforcement Officer. Upon written notification from the Zoning Enforcement Officer, the initial penalty may be to cease operation of the applicable WECU(s) and/or a fine of not less than $1,000 per occurrence for the first day. This penalty shall be doubled from that of the previous day for each day of continued violation. Town of _____ shall also be entitled to other relief including a temporary or permanent injunction, costs and reasonable attorney fees.

1.10.4 Penalties. Excessive or continued violations of this ordinance may result in the revocation of the WECS CUP under Section 3.4 of this ordinance.

2. **DEFINITIONS**

Ampacity: The current carrying capacity of conductors or equipment expressed in Amperes.

Ampere: The basic unit measuring the quantity of electricity.

Anemometer: A device for measuring the speed and direction of the wind.

Applicant: The person, firm, corporation, company, limited liability corporation or other entity which applies for approval under this ordinance, as well as the applicant's successor(s), assign(s) and/or transferee(s) as to any approved WECS or testing facility. An applicant must have the legal authority to represent and bind the landowner or lessee who will construct, own, and operate the WECS or testing facility. The duties and obligations regarding a zoning approval for any approved WECS or testing facility shall be with the owner of the WECS or testing facility, and jointly and severally with the owner and operator or lessee of the WECS or testing facility. Also known as owner or operator.

Aerodynamic noise: A noise that is caused by the flow of air over and past the blades of a WECU.

Ambient noise: Intermittent noise events such as from aircraft flying over, dogs barking, mobile farm or construction machinery, and the occasional vehicle traveling along a nearby road are all part of the ambient noise environment but would not be considered part of the background noise unless they were present for at least ninety percent (90%) of the time.

Background noise: Sound that would normally be present at least ninety percent (90%) of the time. The lull in the ambient noise environment.

Blade Glint: The intermittent reflection of the sun off the surface of the blades of a single or multiple WECUs.

Broadband noise: The "swishing" or "whooshing" sound emitted as a function of a WECU(s) operation.

Cultural Resources: The structural and cultural evidence of the history of human development. They include both prehistoric and historic archaeological resources, as well as ethnographic and ethnic resources.

CUP: Conditional Use Permit

Ethnographic resources: The material important to the heritage of a particular ethnic or cultural group. Cultural resources may be encountered as sub-surface deposits or as surface trails, sites, artifacts, or structures.

High Voltage Electrical Termination: Connecting of conductors to a device or system where the voltage exceeds 600 volts.

Inoperable: A WECU shall be determined inoperable if it has not generated power within the preceding two calendar quarters equal to at least sixty percent (60%) of the expected production.

Ice Throws: Accumulated frozen moisture or ice buildup on the rotor and/or blades of a WECU that is or can be thrown during normal spinning or rotation.

Impermissible Interference: The blockage of wind from a wind energy conversion unit or system for which a permit has been granted under this ordinance during a use period if such blockage is by any structure or vegetation on property, an owner of which was notified in advance by certified mail or delivered by hand of any property which the applicant proposed to be restricted by the permit. Impermissible interference does not include: 1) Blockage by a narrow protrusion, including but not limited to a pole or wire, which does not substantially block the wind from a wind energy conversion unit or system, 2) Blockage by any structure constructed, under construction or for which a building permit has been applied for before the date the last notice was mailed or delivered, and 3) Blockage by any vegetation planted before the date the last notice was mailed or delivered.

Impulsive noise: Short acoustical impulses or thumping sounds, which vary in amplitude and are caused by the interaction of wind turbine blades with distributed air flow around the tower of downwind WECU's.

Livestock Facility: A confinement area designed specifically for raising, controlling, feeding, and providing care for livestock. This may include, but is not limited to: dairy barns, pastures, feedlots, freestall barns, calf hutches, horse barns, veal barns, feed storage areas, brooder and laying barns, farrowing and finishing barns, and veterinary care.

Low Frequency noise: An ongoing debilitation sound emitted during periods of turbulence as the blades are buffeted by changing winds that can cause structural vibration.

Measurement Point (MP): Location where sound and/or vibration measurements are taken such that no significant obstruction blocks sound and vibration from the site.

Mechanical noise: Sound produced as a byproduct of the operation of the mechanical components of a WECU. Also known as "tonal noise". Tonal noises are distinct and tend to be more noticeable at the same relative loudness of other types of noises.

Meteorological Tower: Used for the measurement of wind speed and direction, also known as a MET tower or wind test tower.

Nacelle: The enclosure located at the top of a WECU tower that houses the gearbox, generator and other equipment.

Noise: Any unwanted sound.

Operator: The entity responsible for the day-to-day operation and maintenance of the WECS, including any third party subcontractors.

Owner: The entity or entities with an equity interest in the WECS(s), including their respective successors and assigns. Owner does not mean 1) the property owner from whom land is leased for locating the WECS; or 2) any person holding a security interest in the WECS solely to secure an extension of credit or a person foreclosing on such security interest provided that after foreclosure, such person seeks to sell the WECS at the earliest practicable date.

Ownership Property Line: A continuous line surrounding all contiguous adjacent parcels of property owner by a single individual, company, corporation, partnership or other legal entity.

Paleontological resources: The fossilized remains or trace evidence of prehistoric plants, animals, or very ancient humans preserved in soil or rock.

Prehistoric archaeological resources: The materials relating to prehistoric human occupation and use of an area. Historic archaeological resources usually are associated with Euro-American exploration and settlement of an area and the beginning of a written historical record.

Professional Engineer: A qualified individual who is licensed as a professional engineer in any state in the United States.

Project Area: All of the properties within the project boundary and within a one-mile radius beyond the project boundary of a proposed or approved WECS project.

Project Boundary: A continuous line, which encompasses all WECU's and related equipment to be used in association with a WECS project.

Property Line: The recognized and mapped property parcel boundary line.

Related equipment: Transformers, tower, electrical conductors, termination points, switches, fences, substations, and any other equipment necessary to operate a WECS.

Sensitive Environmental Area: An identified habitat for endangered species, or other designated area as identified by the county, state, or federal authorities.

Sensitive receptor: Places that are likely to be more sensitive to the exposure of the noise or vibration generated by WECS(s). This includes, but is not limited to: schools, day-care centers, hospitals, parks, residences, residential neighborhoods, places of worship, and elderly care facilities.

Setback: The minimum allowable horizontal distance from a given point or line of reference, such as a thoroughfare right-of-way, water line, or prospective line to the nearest vertical wall or other element of building or structure.

Setback Area: The land base that falls within a specified setback.

Shadow Flicker: The effect when the blades of an operating wind energy conversion unit pass between the sun and an observer, casting a readily observable, moving shadow on the observer and his/her immediate environment.

Structures: Residences, livestock facilities, communications towers, commercial businesses, and all sensitive receptors.

Substation: The apparatus that connects the electrical collection system of the WECS and increases the voltage for connections with the utility's transmission lines.

Total Height: The distance between the ground at normal grade and the highest point of the installed WECU (being the tip of the blade when the blade is in the full vertical position).

Turbine: A wind driven machine that converts wind energy into electrical power, also known as a wind energy conversion unit.

Wetland: An area of land, which regularly persists in a wet state, or as, otherwise defined by the WDNR.

Wind Energy Conversion Unit (WECU): A wind driven machine with an output rating greater than 20 Kilowatts (kW) or with a total height of greater than one hundred twenty five (125) feet that converts wind energy into electrical power for the primary purpose of sale, resale, or off-site use. The WECU includes the tower, turbine, footings, and all equipment associated with individual units including the land area beneath encompassing the equivalent area of the circumference of the rotors.

Wind Energy Conversion System (WECS): All WECU's, related transformers, electrical conductors substations, and connection points to transmission or distribution lines.

Windmill: A wind-driven machine that does not produce electricity.

Wind test tower: The tower on which meteorological equipment is located to measure wind speed, direction, strength, etc., for the purpose of evaluation a potential for WECS siting.

3. Procedure and Application:
   - 3.1 Procedure for Wind Test Tower: A public hearing is required in order to obtain a Conditional Use Permit (CUP) for each wind test tower.
     - 3.1.1 Preliminary consultation. Applicant must meet with Town of _____ staff to verify application materials and procedures.
     - 3.1.2 A Conditional Use Permit is required for installing a meteorological or wind test tower.
       - 3.1.2.1 Conditions may include but are not limited to setbacks, height limitations, and limited term use; funds in escrow for potential damage to roads, installation and removal of the tower and legal, consulting, and committee fees.
   - 3.2 Procedure for Wind Energy Conversion System: A CUP is required for a WECS. A public hearing is required for preliminary approval of a WECS and a second public hearing for final approval of a WECS.
     - 3.2.1 Preliminary consultation. Applicant must meet with Town of _____ staff to verify application materials and procedures.
     - 3.2.2 Applicant shall submit proof of sufficient liability insurance and all other insurances necessary so as to indemnify or otherwise hold the applicable governmental authorities harmless to any and all claims.
     - 3.2.3 Applicant shall notify affected local municipalities and the Rock County Planning & Development Committee of intent to apply for a CUP for a WECS.
     - 3.2.4 At least one public informational meeting held in consultation with any and all affected local municipalities.
     - 3.2.5 Notice of hearing for preliminary approval of the WECS project shall be given by First Class Mail to owners of real property located within the project boundary and a

two-mile radius beyond the project boundary, as such owners are reflected on the last tax assessment roll and any updates.

3.2.6 A public hearing shall be held on an application for a WECS Conditional Use Permit in accordance with the provisions of this ordinance and all of the procedural requirements and rights of appeal set forth herein shall apply. A hearing shall be held first with the affected local municipalities and then with the Rock County Planning & Development Committee, who shall make a recommendation to the Town of _____ and provide public input minutes.

3.3 Application: Every application for a WECS and/or wind tower shall be made in writing to the Town of _____ on forms provided by the Town and shall be accompanied by the filing fee set forth in the Town of _____ Services and Ordinance Fee Schedule. The Conditional Use Permit Application shall include the following information:

3.3.1 Applicant: WECS owner/operator name and address.

3.3.2 Property owner(s): Name, address and phone number of owners for all properties on which a WECU will be located.

3.3.3 Proof of Permission: Evidence that the applicant is the owner of the property involved or has the written permission of the owner(s) to make such an application.

3.3.4 Proof of Approval by an Architect: Evidence that the plans for the WECS and the characteristics of each WECU have been reviewed and approved by a State Certified Architect.

3.3.5 Affected Property Owners: Name and address of property owners within WECS setback areas.

3.3.6 Impermissible Interference Notification: The applicant shall deliver by Certified Mail or by hand a notice to the owner of any property, which the applicant proposes to be restricted by the permit. The applicant shall submit to the Town of _____ Planning & Development Agency a copy of a signed receipt for every notice delivered in addition to the following information:

3.3.6.1 The name and address of the applicant, and the address of the land upon which the WECU is or will be located.

3.3.6.2 That the applicant has filed an application.

3.3.6.3 That the permit, if granted, may affect the rights of the notified owner to development his or her property and to plant vegetation.

3.3.6.4 The telephone number, address, and office hours of the Town of _____ Planning & Development Agency.

3.3.6.5 That any person may request a hearing within 30 days after receipt of the notice, and the address and procedure for filing the request.

3.3.7 Wind Access Agreements: Evidence (a signed statement from the applicant) that the applicant has negotiated with adjacent landowners and has obtained written agreements with all landowners who could potentially interfere with the applicant's access to the wind.

3.3.8 Agricultural Impact Statement: Prepared by the Department of Agriculture Trade and Consumer Protection (DATCP) for the proposed WECS project area.

3.3.9 Avian and Bat Impact Study Plan: The applicant shall submit a plan for monitoring the avian and bat impact of the WECS to the Town of _____ for its review and approval. Such plan shall document and follow accepted scientific study procedures. In addition, the applicant shall agree to submit a quarterly report to the Town of

_____ that identifies the number of bird and bat fatalities found within five hundred (500) feet of the WECU.

3.3.10 Site Plans and Reports: Plat map drawings and development plans in sufficient detail to clearly describe the following:

3.3.10.1 Legal description of the proposed project area and parcel numbers for the properties included in the project area, physical dimensions of existing structures and proposed facilities/structures.

3.3.10.2 Location of each WECS Tower.

3.3.10.3 Location of all wells active or abandoned within the project boundary and a one-mile radius beyond the project boundary.

3.3.10.3.1 Before any construction activities commence, testing of all wells shall be completed to provide a baseline inventory of existing water quality conditions.

3.3.10.3.2 All property owners or occupants with wells within the project boundary and a one-mile radius beyond the project boundary shall be notified at least sixty (60) days in advance of planned commencement of well testing and offered permission forms.

3.3.10.3.3 Applicant shall receive written permission from property owners prior to sampling any wells. It shall be understood that when permission is denied, all responsibility for water quality remains with the property owner.

3.3.10.3.4 Tests shall be performed in accordance with all applicable laboratory standards and protocols by a state-approved testing laboratory. Testing shall include, but is not limited to, levels of arsenic, nitrates, phosphorus, calcium, magnesium, iron, lead, atrazine, bacteria, total dissolved solids and documentation of flow rates.

3.3.10.3.5 Test results shall be submitted to the Town of _____ and the well owner.

3.3.10.4 Location of existing and proposed electrical lines and facilities. Denote underground and overhead installation method on existing lines. (Note: All proposed electrical lines shall be located underground.)

3.3.10.4.1 Easement: Applicant must submit copies of signed letters of intent to grant easements from all involved landowners and any governmental units responsible for the affected rights-of-way.

3.3.10.5 Erosion Control Plan Required: The Plan shall comply with all state statutes, county and local ordinances to minimize the potential adverse impacts on wetlands and Class I and II streams and the banks and vegetation along those streams and wetlands and to minimize erosion or sedimentation. The Plan should include but is not limited to the following practices:

3.3.10.5.1 Structures and access roads should use natural contours and avoid areas of steep slopes where high cuts and fills are required. If fills are required, the fill shall be compacted to at least ninety percent (90%) density and finished grades shall not exceed a gradient of 2 to 1. Cut slope shall not exceed a gradient of 1½ to 1.

3.3.10.5.2 The smallest practical area of land should be exposed for the shortest practical time during development. The amount of

vegetation removed during construction shall be the minimum necessary to operate equipment. Areas where vegetation is removed during construction shall be replanted prior to project startup.

3.3.10.5.3 Measures shall be used to prevent erosion until vegetation is re-established on areas from which it is removed, such as seeding and sodding, stockpiling and reuse of topsoil, temporary use of straw or fabric cover, aggregate cover, diversions authorized by state permit, sediment basins and filters.

3.3.10.5.4 No soils shall remain un-stabilized for more than twenty (20) days during the period from October 1 through April 30. From May 1 through September 30, no soils shall remain un-stabilized for more than seven (7) days.

3.3.10.6 Proposed plan for site restoration after construction.

3.3.10.7 Location of public and private airports and approaches.

3.3.10.8 All applicable setbacks from proposed WECU's.

3.3.10.9 Methods of electrical interconnection.

3.3.10.10 Plan for ingress and egress to the proposed WECU site(s) identifying the following:

3.3.10.10.1 A description of the specific access route(s) to include:

3.3.10.10.1.1 All State, County, and/or Town-maintained roads.

3.3.10.10.1.2 A pre-construction inventory of road conditions paid for by the applicant. Identify road surface materials stating the type and amount of surface cover, PASER ratings, and photographic or video documentation, performed by a Wisconsin Certified Professional Engineer mutually agreed upon by applicant and municipality.

3.3.10.10.1.3 Dust control procedures.

3.3.10.10.1.4 A road maintenance schedule or program.

3.3.10.10.1.5 New road development associated with the project is not allowed.

3.3.10.10.1.6 Service drives are permitted, except for single private towers for personal use, and must conform to the driveway ordinance in affect for the subject area.

3.3.11 Maps: All maps shall include the location of all proposed WECUs and related structures/facilities and access roads without obscuring map details. The Town may require additional studies or maps, as it deems necessary.

3.3.11.1 Wind Resource Map: A map identifying wind characteristics including prevailing wind direction and minimum, maximum, and average wind speeds.

3.3.11.2 Land use Maps: A location map to scale of current and planned land uses (based on the current land use plan and/or comprehensive plan) within the project boundary and a one-mile (1 mile) radius beyond the project boundary on which the WECS is to be located.

3.3.11.3 Zoning Maps: A location map to scale of the existing zoning districts including all dwelling within the project boundary and a one-mile (1 mile) radium beyond the project boundary on which the WECS is to be located.

3.3.11.4 USGS Topographic Maps: (scale of 1 to 24,000), original WDNR wetland maps.

3.3.11.5 Plat Maps: showing land ownership.

3.3.11.6 Flood Plain Maps: Flood Insurance Rate Maps (FIRM) if the site is within one-half mile (1/2 mile) of a floodplain.

3.3.11.7 Soil Survey Map

3.3.11.8 Sensitive Environmental Resources Maps: A location map to scale identifying the sensitive environmental resources that are located in the vicinity of the proposed WECS, including but not limited to endangered or threatened fish, wildlife, or plant species or their critical habitats, and other significant habitats identified in *Town of _____ Comprehensive Plan*, regional planning commission plans or studies, Natural Heritage Inventory, Wisconsin Breeding Bird Atlas and similar authoritative sources. The map shall include all sensitive environmental areas within the project boundary and a five-mile (5 mile) radius beyond the project boundary.

3.3.11.9 Historical, Cultural, Archeological, and Paleontological Resource Map: A map identifying sensitive historical, cultural, or archeological resources.

3.3.12 WECU Information and Certification: Specific information on the type, size, total installed height, rotor material, rated power output, performance history, safety history, and noise characteristics of each type of WECU, tower and electrical transmission equipment. Identify the length of service of the proposed components. The following information shall also be provided:

3.3.12.1 A structural safety certificate from a professional engineer stating that the structure has been designed to operate in cold weather and severe wind conditions, and is safe.

3.3.12.2 Certification of Structural Components: The compatibility of the foundation, tower, and generating unit (including the rotor and rotor-related equipment) shall be certified in writing by a professional engineer registered in Wisconsin. The Engineer shall certify compliance with sound engineering practices and compliance with the appropriate provisions of the Wisconsin building codes.

3.3.12.3 Certification of Electrical System: The electrical system design shall be certified in writing by an electrical engineer registered in Wisconsin as a Professional Engineer. The Engineer shall certify compliance with good engineering practices and with the appropriate provisions of the National Electric Code that have been adopted by the State.

3.3.12.4 Certification of Rotor Overspeed Control: The rotor overspeed control system shall be certified in writing by a mechanical engineer registered in Wisconsin as a Professional Engineer. The Engineer shall certify compliance with good engineering practices.

3.3.12.5 Ice Throw Calculations: A report from a Wisconsin Professional Engineer that: a) calculates the maximum distance that ice from the turbine blades could be thrown (the basis of the calculation and all assumptions must be disclosed.); and b) the incidence of reported ice throws and the conditions reported at the time of the ice throw.

3.3.12.6 Blade Throw Calculations: A report from a Wisconsin Professional Engineer that: a) calculates the maximum distance that pieces of the turbine blades could be thrown (the basis of the calculation and all assumptions must be disclosed) and b) the incidence of reported blade throws and the conditions at the time of the blade throw.

3.3.12.7 WECU Specifications: Photographs or detailed drawing of each wind turbine model including the tower and foundation. Foundation at and around the tower base shall be designed so that no surface water or runoff can access subsurface aquifer at any time during construction, operation or decommissioning.

3.3.13 Computer Simulation or Drawings: Detailed computer and photographic simulation(s) overlaid on existing environment showing the proposed WECS project area fully developed with all proposed wind energy conversion units and related facilities. Contact the Town of _____ for approved formats.

3.3.14 Abandonment, Removal and Site Restoration Plan Required: The applicant shall submit a decommissioning and site restoration plan and removal and site restoration plan cost estimate to the Town of _____ for its review and approval. The restoration plan shall identify the following:

3.3.14.1.1.1 Provisions for the removal of structures, debris and underground cabling, to a depth of six (6) feet below ground level;

3.3.14.1.1.2 Provisions for the removal of any residual spills;

3.3.14.1.1.3 Provisions for the clean-up of storage yards and maintenance shops;

3.3.14.1.1.4 Provisions for the restoration to the previous natural state, and shall reflect the site-specific character including topography, vegetation, drainage, and any unique environmental features;

3.3.14.1.1.5 Provisions to comply with all state, county, or local erosion control, soil stabilization and/or runoff requirements or ordinances as pertain to WECS removal and site restoration.

3.3.14.1.1.6 Identification of and procedures for the Town of _____ access to Financial Assurances;

3.3.14.1.1.7 Provision that the terms of the Decommissioning Plan shall be binding upon the Owner or Operator and any of their successors, assigns, or heirs; and

3.3.14.1.1.8 Provision that the Town of _____ shall have access to the site, pursuant to reasonable notice, to effect or complete decommissioning.

3.3.14.1.1.9 Provision that all decommissioning and restoration work be completed within one year of the first day of abandonment.

3.3.15 Abandonment Liability: Signed and notarized legal document stating the landowner will be held liable for removal of the wind turbine(s) should the owner or operator's LLC (or other corporate distinction) become liquidated or the posted bond not be sufficient to cover the costs associated with removal.

3.3.16 Noise Report: A noise report that shall at a minimum include the following and be prepared by an acoustic engineer:

3.3.16.1 A sound and vibration assessment as identified in Appendix A.

3.3.16.2 A description of the project's proposed noise control features, including specific measures proposed to protect workers, and specific measures

proposed to mitigate noise impacts for sensitive receptors to a level of insignificance.

3.3.16.3 A report that outlines issues and considerations for individuals that use hearing aids.

3.3.17 Soils Report: A geotechnical report that shall at a minimum include the following:

3.3.17.1 Soils engineering and engineering geologic characteristics of the site based on on-site sampling and testing.

3.3.17.2 Foundation design criteria for all proposed structures.

3.3.17.3 Slope stability analysis.

3.3.17.4 Grading criteria for ground preparation, cuts and fills, soil compaction.

3.3.18 Shadow Flicker and Blade Glint Zone Map: The applicant shall provide a shadow flicker and blade glint model for any proposed wind energy conversion unit. The model shall:

3.3.18.1 Model and describe the zones where shadow flicker and blade glint will likely be present within the project boundary and a one-mile (1 mile) radius beyond the project boundary. Include the topography, existing residences and locations of their windows, locations of other structures, wind speeds and directions, and existing vegetation and roadways. The model shall represent the most probable scenarios of wind constancy, sunshine constancy, and wind directions and speeds.

3.3.18.2 Calculate the locations of shadow flicker caused by the proposed project and the expected durations of the flicker at these locations, calculate the total number of hours per year of flicker at all locations.

3.3.18.3 Identify problem zones where shadow flicker will interfere with existing or future residences and roadways and describe proposed measures to mitigate these problems, including but not limited to a change in siting of the facility, a change in the operation of the facility, or grading or landscaping mitigation measures.

3.3.18.4 Name and address of property owners within shadow flicker and/or blade glint zones. Considering that development rights of adjacent property owners may be forfeited due to these zones as per this ordinance, a written agreement for non-development within the specified zone must be obtained and recorded on the affected properties' deeds. Copies of the agreements must be submitted with the application.

3.3.19 Fire Prevention, Emergency Rescue and Control Program: Proof that the site plans and reports have been reviewed by the presiding fire department. A statement of the potential fire and rescue scenarios and a plan to identify, fund and provide rescue service agencies to ensure readiness and appropriate response.

3.3.20 Engineering Schematics and Specifications: Complete system-wide specifications including but not limited to: power collection and electric interconnection system, towers, generating units, controls, transformers, grounding terminations and provisions for possible expansion.

3.3.21 Catastrophic Failure Report and Test Results: Data from the tower and turbine manufacturers stating the wind speed and conditions that the turbine and tower are designed to withstand (including all assumptions), the incidence of catastrophic failures and the conditions reported at the time of failure, and the effectiveness of all automatic electrical and mechanical shutdown devices.

3.3.22 Air Navigation Plan: A plan to minimize potential "clutter" on airport radar facilities from the proposed WECUs. FAA Notification: A copy of written notification to the Federal Aviation Administration of intent to construct a WECS and the project proposal. Applicant must also include any responses from the Federal Aviation Administration.

3.3.23 FAA Notification: A copy of written notification to the Federal Aviation Administration of intent to construct a WECS and the project proposal. Applicant must also include any responses from the Federal Aviation Administration.

3.3.24 Lighting Plan: A plan showing lighting on and around all WECUs and related facilities. WECS facilities shall not be artificially lighted, except to the extent required by the FAA or other applicable authority.

3.3.25 Utility Interconnection: Plan for interconnection and copy of written notification to the utility, and proof of approval by the utility company, for both WECSs and private towers for personal use.

3.3.26 Microwave Communications Link Operators Notification: A copy of written notification of intent to construct a WECS with project details to any microwave communications link operations link operators that are located within the project boundary and a two-mile radius beyond the boundary of a WECS.

3.3.27 Flood Plain Delineation: If a WECU is located within a one hundred year (100-year) floodplain area, as such flood hazard areas are shown on Federal Emergency Management Agency maps, there shall be a report to identify the potential for wind erosion, water erosion, sedimentation and flooding, and to propose mitigation measures for such impacts.

3.3.28 Avian and Bat Habitat Study Results: The applicant for the WECS shall pay and arrange for a qualified professional, such as an ornithologist or wildlife biologist, to determine if the installation of the WECS Facility will have a substantial adverse impact on birds and bats.

3.3.29 Sufficient Wind Resource Study Results: Since the site shall have documented annual wind resources sufficient for the operation of the WECU (this requirement shall not apply to an anemometer tower), a study indicating these resources for a minimum of one year (1 year) is required. Said study shall indicate the long-term commercial economic viability of the project. Anemometers to be placed shall be calibrated regularly to ensure a measurement of error of 1 percent (1%) or less. All anemometers shall be placed at the expected hub height of the wind turbine to be used. Sufficient wind resources, as described by the U.S. Department of Energy, include areas with a wind power Class 4 or higher. The Town shall retain the services of an independent, recognized expert to review the results of the wind resources study prior to acting on the application for a Conditional Use Permit.

3.3.30 Communications Interference Test Results: The applicant for a WECS shall pay for and perform pre-project testing of television signal strength and video taping of all channels in all residences and businesses within the project boundary and a three-mile radius beyond the project boundary. The applicant shall submit a report summarizing the findings and identifying any potential interference of television, telephone (including cellular and digital), microwave, satellite (dish), navigational, or radio reception.

3.3.31 Stray Voltage Test Results: The applicant must perform two (2) pre-construction stray voltage tests on all livestock facilities within the project boundary and a one-mile radius beyond the project boundary. The tests shall be performed by a mutually

acceptable Wisconsin certified stray voltage investigator once in the spring and once in the fall. The tests shall be performed according to PSCW Phase II Stray Voltage Testing Protocol identified in Appendix C. A copy of the test results shall be sent to each of the following: property owners and PSCW Rural Electric Power Services staff and Town of _____.

3.3.31.1 Applicant shall receive written permission from property owners prior to stray voltage testing. It shall be understood that when permission is denied, all responsibility for stray voltage remains with the property owner.

3.3.32 HAZMAT Reports: Copies of all HAZMAT reports shall be submitted, with assurances that there will be no pollution.

3.3.33 Financial Security to cover the following shall be provided by the applicant prior to preliminary project approval:

3.3.33.1 Legal and Consultant Fees. The applicant shall deposit in a joint escrow account with the appropriate municipal authorities a sum of twenty five thousand dollars ($25,000), as partial payment for the appropriate town and county planning commissions' expenses in hiring consultants and experts, as these authorities shall, at their discretion, together deem desirable, through the recommendations of an appointed joint committee. At any time the balance of this fund shall fall below fifteen thousand ($15,000), the applicant shall submit an additional fifteen thousand ($15,000), so that the applicable municipal authority's full and actual expenses of examining and verifying the data presented shall be covered in total by the applicant. This deposit shall accompany the initial application and be considered a part thereof. If at any time the balance of this fund shall fall below fifteen thousand ($15,000) for a period of thirty (30) days, the application shall be considered to have been withdrawn.

3.3.33.2 Road repair costs for all classes of roads. The amount to be agreed upon by the applicant and the appropriate municipal authority with guidance from applicable experts to be deposited in a joint escrow account. When determining the amount of such required security, the governing authorities may also require an annual escalator or increase based on current construction costs and/or the Federal Consumer Price Index. Such financial security shall be deposited or filed with the appropriate governing authorities prior to commencement of construction. This security shall be kept in full force and effect during the entire time that a WECS is in existence. Such security shall be irrevocable or non-cancelable (except by written consent by both the governing authorities and the current owner of the WECS) for the life of the approved permit. Failure to comply will subject the applicant to all available remedies of the governing authority, including possible enforcement action and revocation of the Conditional Use Permit.

3.3.33.3 Advance payment for WECs site decommissioning and restoration is to be placed in joint escrow account or surety bond, the amount to be determined by the appropriate municipal governing authorities to be sufficient to have the WECS fully removed and all components properly disposed of and the land returned to its original state should such structure become abandoned, dangerous, or not in compliance with this ordinance. Such financial security shall be kept in full force and effect during the entire time while a WECS facility exists or is in place and shall be adjusted every five (5) years to

address inflation. Such financial security shall be irrevocable and non-cancelable until such time as appropriate municipalities certify that reclamation and restoration are complete and release the obligation.

3.3.34 Complaint Resolution Procedure: Applicant shall submit a Complaint Resolution Procedure per Appendix B.

3.3.35 Other Information: The applicant shall submit such additional information as may be reasonably requested by the Town of _____ or their designees.

3.4 Use of Permit:

3.4.1 Project Start: Any WECS CUP that is granted shall be used not later than two (2) years from the date of issuance, or within such additional time as may be set in the conditions of approval, which shall not exceed a total of five (5) years; otherwise the permit shall be null and void. Notwithstanding the foregoing, if a permit is required to be used within less than five (5) years, the applicant may, prior to its expiration, request an extension of time to use the permit. A request for extension of time shall be made to the Town of _____ with recommendation of the local municipality. Extensions of time shall be made on forms provided by the Town of _____ Zoning enforcement Officer or his or her designees and shall be accompanied by the filing fee set forth in the Town of _____ Ordinance and Services Fee Schedule. Within thirty (30) days following the filing of a request for an extension, the Town of _____ Zoning Enforcement Officer or his/her designee shall review the application, make a recommendation thereon, and forward the matter on the regular agenda of the Town Board. An extension of time may be granted upon a determination that valid reason(s) exist for applicant not using the permit within the required period of time. If an extension of time is granted, the total time allowed for the use of the permit shall not exceed a period of five (5) years, calculated from the effective date of the issuance of the permit.

3.4.2 Term of Permit: A WECS CUP shall be valid for the useful life of the equipment described in the permit. The term of the permit shall be determined at the time of approval, and shall not exceed twenty (20) years. The Town of _____ shall review the permit every five (5) years to ensure compliance with this ordinance and the provisions of the CUP, and adjust the abandonment bond for inflation. The owner/operator who seeks to extend the permit of an existing WECS beyond the original twenty (20) years shall meet the requirements of this ordinance, as amended from time to time, as if the WECS were a new facility.

3.5 Revocation of Permit: Grounds for revocation of a WECS CUP shall be limited to one of the following findings as determined by the Town of _____ Planning & Development Committee.

3.5.1 The owner or operator of the facility fails to comply with the requirements of this ordinance at the time of issuance of the applicable permit.

3.5.2 The owner/operator has failed to comply with the conditions of approval imposed.

3.5.3 The facility has not been maintained in accordance with the standards of this ordinance.

3.5.4 There have been excessive or continued violations.

3.6 Revocation Process:

3.6.1 The owner/operator of a WECS shall be notified, by Certified Mail with return receipt requested, of noncompliance by the Town of _____ Zoning Enforcement Officer or his/her designee.

3.6.2 The owner/operator shall comply within thirty (30) days to the satisfaction of the Town of _____ Zoning Enforcement Officer or his/her designee.

3.6.3 If compliance is not obtained within thirty (30) days, the Town of _____ Zoning Enforcement Officer or his/her designee shall notify the Town of _____ of the noncompliance and request permission to proceed with the revocation process. This time period may be extended by staff to adjust for seasonal limitations.

3.6.4 The Town of _____ Zoning Enforcement officer or his/her designee shall appear at the hearing before the Town of _____ Board to present the evidence of noncompliance. All other interested parties may also give testimony to the Committee.

3.6.5 A written decision of the Town of _____ Board will be made. In instances where compliance with this ordinance cannot be established, the matter may be forwarded to the Town of _____ Attorney for appropriate legal action.

3.7 Appeals Procedures:

3.7.1 Administrative Decisions and Ordinance Interpretations

3.7.1.1 Any person aggrieved or affected by any action of the Town of _____ Zoning Enforcement Officer or his/her designees may take appeals to the Town.

3.7.1.2 Appeals shall be taken within ten (10) calendar days of the date of the decision in which the party is aggrieved, by filing with the Town a notice of appeal specifying the grounds thereof. The Town of _____ Zoning Enforcement Officer or his/her designees shall forthwith transmit to the Committee all the papers constituting the record upon which the action appealed from was taken. The Town is empowered to hear and decide appeals to:

3.7.1.2.1 Grant or deny appeals of administrative decisions of the Town of _____ Zoning Enforcement Officer or his/her designees.

3.7.1.2.2 Grant or deny appeals of administrative interpretation of the ordinance by the Town of _____ Zoning Enforcement Officer or his/her designees.

3.7.2 Variance Procedure and Appeals of Town of _____ Decisions

3.7.2.1 The Town of _____ Board of Adjustment shall hear variance Requests to the provisions of this ordinance and appeals of Town of _____ Board decisions. Variance and appeals requests to the Board of Adjustment may be taken by any person requesting a variance from the standards set forth in this ordinance or who may be aggrieved or affected by any decision of the Planning & Development Committee. Variance requests will be heard at the regularly scheduled meetings of the Board of Adjustment.

3.7.2.2 Appeals shall be taken within ten (10) calendar days of the date of the decision in which the party is aggrieved by filing with the Town, a notice specifying the grounds thereof. The Town of _____ Zoning Enforcement officer or his/her designees shall forthwith transmit to the Board all the papers constituting the record upon which the action appealed from was taken. The Board of Adjustment may:

3.7.2.2.1 Grant relief by variance when hardship results from strict application of the provisions of the ordinance.

3.7.2.2.2 Grant or deny appeals of Town of _____ Board decisions.

3.7.3 Principles Guiding Board Decisions. The following are principles that shall guide the County Board of Adjustment:

3.7.3.1 The burden is upon the appellant to prove the need for a variance.

3.7.3.2 Pecuniary hardships, loss of profit, self-imposed hardships, such as that caused by ignorance, deed restrictions, proceeding without a permit, or illegal sales, are not sufficient reasons for granting a variance.

3.7.3.3 The Board is bound to accept the WECS Ordinance as being correct.

3.7.3.4 The plight of the appellant must be unique, such as a shallow or steep parcel of land, or situation caused by other than her/his own action.

3.7.3.5 The hardship justifying a variance must apply to individual appellants parcel or structure and not generally to other properties in the same district.

3.7.3.6 The variance must not be detrimental to adjacent properties.

3.7.3.7 The Board of Adjustment in fulfilling its duties may modify, alter, or change any application.

4. Findings Necessary to Grant a WECS CUP: A WECS CUP shall not be granted unless the Town of _____ makes the following findings based on substantial evidence:

4.1 In Accordance with the Purpose and Intent of this Ordinance: The proposed WECS is in accordance with the purpose and intent of this ordinance.

4.2 Will Not Unreasonably Interfere With the Orderly Land Use and Development Plans: The proposed WECS will not unreasonably interfere with the orderly land use and development plans of Town of _____ and/or affected municipalities.

4.3 Benefits to the Public Shall Exceed Any Burdens: The benefits to the public of the proposed WECS shall exceed any burdens.

4.4 Not Detrimental to the Public Health and Safety of the Community: The proposed WECS will not be detrimental to the public health and safety of the community.

4.5 Not Otherwise Adverse to the Environment, Neighborhood or Community: The proposed WECS will not be hazardous or harmful to the environment or the neighborhood or community.

4.6 Complies With All Required Provisions of the Zoning Ordinance: The proposed WECS shall comply with all required provisions of this zoning ordinance, unless variances have been properly applied for and granted pursuant to Section 3.6.2 of this Ordinance.

4.7 No Person With Building Plans Affected: No person has demonstrated that she or he has present plans to build a structure that would create an impermissible interference by showing that she or he has applied for a building permit prior to receipt of a notice pursuant to Section 3.2.5 of this Ordinance, or has expended at least five hundred ($500) on planning or designing such a structure or by submitting any other credible evidence that she or he has made substantial progress toward planning or constructing a structure that would create an impermissible interference.

5. Development/Performance Standards All WECS and testing structures shall comply with the Development/Performance Standards set forth in this section.

5.1 Safety Setbacks

5.1.1 Structure Setbacks: Four (4) times the total height of the WECU from all sensitive receptors, including but not limited to: schools, day-care centers, hospitals, parks,

residences, residential neighborhoods, places of worship, and elderly care facilities and livestock facilities, but in no case less than one thousand (1,000) feet.

5.1.2 Property Line Setbacks: Four (4) times the total height of the WECU from all ownership property lines, but in no case less than one thousand (1,000) feet.

5.1.3 Public Roads and Highways Setbacks: Four (4) times the total height of the WECU from the right-of-way line of any public road or highway, but in no case less than one thousand (1,000) feet.

5.1.4 Railroad Setbacks: One and one-half (1.5) times the total height of the WECU from all railroad right-of-ways, but in no case less than five hundred (500) feet.

5.1.5 Above Ground Transmission Line Greater than 12 kV Setbacks: One and one-half (1.5) times the total height of the WECU from the edge of the easement, but in no case less than five hundred (500) feet.

5.1.6 Water bodies Setbacks: Four (4) times the total height of the WECU from the ordinary high water mark of the water body, but in no case less than one thousand (1,000) feet.

5.1.7 Wetland Setbacks: Four (4) times the total height of the WECU from the delineated boundary of the wetland, but in no case less than one thousand (1,000) feet.

5.1.8 Sensitive Environmental Areas Setbacks: WECUs shall be located a minimum of two (2) miles from identified sensitive environmental areas.

5.1.9 Historical, Cultural and Archeological Resource Setbacks: Four (4) times the total height of the WECU from all historical, cultural and archeological resources, but in no case less than one thousand (1,000) feet.

5.1.10 Turbine spacing: Minimum setback distances between turbines shall be two (2) times the total height of each WECU

5.1.11 Scenic Setbacks: No WECU shall be located within one (1) mile of any State, County, Village or Town Park or designated recreation area.

5.2 Evidence of Development Restrictions

5.2.1 Affected Property Owners: name and address of property owners within WECS setback areas, shadow flicker zones, and blade glint zones. Copies of the affected property owners' deeds with appropriate development restrictions must be submitted after preliminary approval to the Town of _____ prior to final approval.

5.2.2 Impermissible Interference: A signed agreement with adjacent landowners who agree to restrict development on their land in such a way as to avoid decreasing wind velocity or increasing wind turbulence or otherwise create an impermissible interference at the location of the proposed WECU.

5.3 Easement: A signed agreement with all affected landowners and governing municipalities permitting right-of-way easements for all overhead and underground control and distribution systems. Landowners who have signed easement agreements related to the WECS have the following specific rights. These rights are applicable for power lines for the distribution or transmission of power from a WECS.

5.3.1 In constructing and maintaining high-voltage transmission lines on the property covered by the easement the owner/operator of a WECS shall:

5.3.1.1 If excavation is necessary, ensure that the topsoil is stripped, piled and replaced upon completion of the operation.

5.3.1.2 Restore to its original condition any slope, terrace, or waterway which is disturbed by the construction or maintenance.

5.3.1.3 Insofar as it is practicable and when the landowner requests, schedule any construction work in an area used for agricultural production at times when the ground is frozen, in order to prevent or reduce soil compaction.

5.3.1.4 Clear all debris and remove all stones and rocks resulting from construction activity upon completion of construction.

5.3.1.5 Satisfactorily repair to its original condition any fence damaged as a result of construction or maintenance operations. If cutting a fence is necessary, a temporary gate shall be installed. Any such gate shall be left in place at the landowner's request.

5.3.1.6 Repair any drainage tile line within the easement damaged by such construction or maintenance.

5.3.1.7 Pay for any crop damage caused by such construction or maintenance.

5.3.1.8 Supply and install any necessary grounding of a landowner's fences, machinery or buildings.

5.3.2 The landowner shall be afforded a reasonable time prior to commencement of construction to harvest any trees located within the easement boundaries, and if the landowner fails to do so, the landowner shall nevertheless retain title to all trees cut by the owner/operator of a WECS.

5.3.3 The landowner shall not be responsible for any injury.

5.4 Safety and Security

5.4.1 Safety Shutdown: Each WECU shall be equipped with both manual and automatic controls to limit the rotational speed of the blade within the design limits of the rotor. All turbines shall be equipped with redundant braking systems. This includes both aerodynamic (including variable pitch) overspeed controls, and mechanical brakes. Mechanical brakes shall be operated in a failsafe mode, whereby they are engaged in the case of loss of load on the generator. Stall regulation should not be considered a sufficient braking system for overspeed protection. A manual electrical and/or overspeed shutdown disconnect switches shall be provided and clearly labeled on/in the WECU structure.

5.4.2 Grounding: All structures associated with a WECS, which may be charged with lightning, shall be grounded.

5.4.3 Wiring: All electrical conductors, telecommunications, and fiber-optics cables associated with the WECS shall be underground.

5.4.4 Ground Clearance: The blade tip of any WECU shall, at its lowest point, have ground clearance of not less than seventy-five (75) feet.

5.4.5 Climbability: WECU's shall not be climbable up to fifteen (15) feet above ground level.

5.4.6 Access Doors Locked: All access doors to WECU's and electrical equipment shall be lockable and shall remain locked at all times when operator personnel are not present.

5.4.7 Self-Supporting Structures: All structures shall be self-supporting. No guy wire supported structures shall be permitted with the exception of meteorological towers.

5.4.8 Signage: Reasonable visible warning signage concerning voltage must be placed on WECUs, electrical equipment, and WECS entrances. No advertising or promotional signage is permitted. See Section 5.16.

5.4.9 Fencing: Fencing or other appropriate measures at the periphery of the WECU site may be required to prevent unauthorized access to the WECU.

5.4.10 Post-construction Road Conditions and Repair: The applicant/owner/operator of the WECS shall reimburse the municipality for any and all maintenance, repairs and reconstruction to the public roads resulting directly from the construction and any subsequent maintenance of the WECS.

5.4.10.1 A post-construction inventory of road conditions paid for by applicant shall be performed within thirty (30) days of WECS completion. Identify road surface materials stating the type and amount of surface cover, PASER ratings, and photographic or video documentation, performed by a Wisconsin certified professional engineer mutually agreed upon by applicant and municipality.

5.4.10.2 Applicant agrees to confine construction traffic to previously agreed upon routes.

5.4.10.3 Roads shall be repaired or reconstructed to equivalent pre-construction PASER rating or better.

5.4.10.4 The municipality shall determine when and who maintains, repairs or reconstructs the applicable roads.

5.5 Noise and Vibration

5.5.1 Noise Regulations Compliance: A WECS shall be considered in violation of the CUP unless the applicant demonstrates that the project complies with all noise level limits. Noise levels in excess of the limits established in this ordinance shall be ground for the Zoning Enforcement Officer or his/her designee to order immediate shut down of all non-compliant WECUs.

5.5.2 Post Construction Noise and Vibration Measurements: Within twelve (12) months of the date when the project is fully operational, and within two (2) weeks of the anniversary date of the pre-construction background noise measurements, repeat the existing sound and vibration environment measurements taken before the project approval. Post-construction sound level measurements shall be taken both with all WECUs running and with all WECUs off. Report post-construction measurements to the Town of _____ (available for public review) using the same format as used for the pre-construction sound and vibration studies.

5.5.3 Noise Setbacks: The Town of _____ may impose a noise setback that exceeds the other setbacks set out in this ordinance if it deems that such greater setbacks are necessary to protect the public health, safety, and welfare of the community.

5.5.4 Noise Standard: The noise due to WECU operations shall not be greater than five (5) dBA above the established background noise level for mote than five (5) minutes out of any one (1) hour time period as measured per Appendix A.

5.5.5 Low Frequency Noise or Infrasound Noise: No low frequency noise or infrasound noise from wind turbine operations shall be created which causes the noise level both within the project boundary and a one-mile radius beyond the project boundary to exceed the following limits:

1/3 Octave Band Center Frequency (Hz)	Sound Pressure Level (dB)
2 to 1	70 (each band)
16^2	68

20	68
25	67
31.5	65
40	62
50	60
63	57
80	55
100	52
125	50
250	47
500	45
1000	42
2000	40
4000	37
8000	35

5.5.6 Pure Tone Penalty: In the event audible noise due to wind turbine operations contains a steady pure tone, such as a whine, screech, or hum, the standards for Audible Noise shall be reduced by five (5) dB(A). A pure tone is defined to exist when: the one-third (1/3) octave band sound pressure level in the band, including the tone, exceeds the arithmetic average of the sound pressure levels on the two (2) contiguous one-third (1/3) octave bands by five (5) dB(A) for center frequencies of 500 HZ and above, and eight (8) dB(A) for center frequencies between 160 and 400 Hz, and by fifteen (15) dB(A) for center frequencies less than or equal to 125 Hz.

5.5.7 Repetitive, Impulsive Sound Penalty: In the event the audible noise due to wind turbine operations contains repetitive impulsive sounds, the standards for Audible Noise shall be reduced by five (5) dB(A).

5.5.8 Pure Tone and Repetitive, Impulsive Tone Penalty: In the event the audible noise due to wind turbine operations contains both a pure tone and repetitive impulsive sounds, the standards for Audible Noise shall be reduced by a total of five (5) dB(A).

5.5.9 Operations – Low Frequency Noise: A WECU that emits impulsive sound below twenty (20) Hz that adversely affects the habitability or use of any existing dwelling unit, hospital, school, library, nursing home, or other sensitive noise receptor shall be deemed unsafe and must be shut down immediately.

5.5.10 Noise Complaint and Investigation Process: See Appendix B.

5.6 Rescue, Fire and Hazard Protection: Owner/operator shall assure that the WECS complies with the following fire control and Prevention measures and incurs associated costs, which must all be approved by the presiding fire department.

5.6.1 Fireproof or fire resistant building materials and buffers or fire retardant landscaping.

5.6.2 Maintain firebreak areas cleared of vegetation and maintained as a fire/fuel break as long as the WECU is in operation. Firebreaks shall be thirty (30) feet around the periphery of the proposed WECU site, ten (10) feet around all transformers and thirty (30) feet around all buildings.

5.6.3 Fire fighting and rescue services, including programs and costs associated with equipment and training, for local fire protection and rescue personnel.

5.6.4 The owner/operator shall be responsible for compliance with all laws applicable to the generation, storage, clean up, transportation and disposal of hazardous wastes generated during any phase of the project's life.

5.7 Impacts on Wildlife Species and Habitat

5.7.1 Development Prohibited in PSCW (Public Service Commission of Wisconsin) "Exclusion/Constraint" Zones: WECUs shall be prohibited within areas designated on the PSCW's Wind Energy Biological Resources Map as the five-mile (5 mile) "Exclusion/Constraint" zones surrounding significant sensitive environmental areas.

5.7.2 Endangered or Threatened Species: Development and operation of a WECS shall not have a significant adverse impact on endangered or threatened fish, wildlife, or plant species or their critical habitats, or other significant habitats identified in the *Town of _____ Comprehensive Plan* and/or the studies and plans of the regional planning commission.

5.7.3 Migratory Birds: Development and operation of a WECS shall not have an adverse impact on migratory bird species.

5.7.4 Avian Impact Reporting: The owner/operator shall submit a quarterly report to the Town of _____ Planning & Development Agency that identifies all dead birds found within five hundred (500) feet of the WECU.

5.7.4.1 In the event of an extraordinary avian mortality kill of threatened or endangered species, or discovery of an unexpected large number of dead birds of any variety on site, the WDNR shall also be notified within twenty-four (24) hours. The owner/operator shall, within thirty (30) days of the occurrence, submit a report to the Town of _____ Planning & Development Agency describing the cause of the occurrence and the steps taken to avoid future occurrences.

5.8 Interconnection and Electrical Distribution Facilities

5.8.1 All conductors associated with the distribution, control, and transmission of energy from WECUs shall be installed underground.

5.8.2 All underground conductors, including neutral conductors, shall be insulated for the applicable voltage and of the same ampacity.

5.8.3 Underground installations regardless of voltage must comply with all right-of-way requirements and clearances as identified in this ordinance.

5.8.3.1 Rights of way width for distances greater than one hundred (100) feet of underground installation in unpaved areas shall be a minimum of thirty (30) feet and a maximum of fifty (50) feet unless otherwise specifically agreed to by the property owner.

5.8.3.2 Rights of way width for distances of one hundred (100) feet or less of underground installation in unpaved areas shall be a minimum of twenty (20) feet unless otherwise specifically agreed to by the property owner.

5.8.3.3 Wherever practical, easements shall be placed immediately adjacent to the outside edge of road rights of way.

5.9 Stray Voltage

5.9.1 The owner/operator of the WECS shall respond within five (5) business days to any request for a stray voltage investigation by a property owner within the project boundary and a one-mile radius beyond the project boundary.

5.9.2 The tests shall be performed by a mutually acceptable Wisconsin certified stray voltage investigator.

5.9.3 The owner/operator is financially responsible for the cost of the tests.

5.9.4 The tests shall be performed according to PSCW Phase II Stray Voltage Testing Protocol identified in Appendix C.

5.9.5 Testing shall commence within (10) ten working days of the request. If testing cannot be initiated within (10) ten days, the WECU(s) in question shall be shut down until the testing can be started.

5.9.6 The investigation shall be provided to the property owner at no cost up to a maximum of two (2) investigations within a 12-month period. See Appendix C.

5.9.7 At no time shall the operation of a WECS increase the measured cow contact voltage (Vcc) or primary neutral to remove voltage (Vpn) on a livestock facility within the project boundary and a one-mile radius beyond the project boundary, above the maximum pre-construction levels.

5.9.8 The owner/operator agrees to abide by all rules, procedures, standards, and reporting established by the PSCW for stray/voltage and related electrical phenomena.

5.9.9 Owner/operator is responsible for mitigating within five (5) working days from determination any net increase in cow contact voltages (Vcc) or primary neutral to remote voltages (Vpm) attributed to the operation of the WECS. If corrections cannot be initiated within (5) working days, the WECU(s) in question shall be shut down until the voltages in question are mitigated.

5.9.10 A copy of the test results shall be sent to the property owner, PSCW Rural Electric Power Services staff, and the Town of _____ within (30) thirty days of test completion.

5.10 Unsafe and Inoperable WECUs: Site Reclamation:

5.10.1 Inoperable:

5.10.1.1.1 A single WECS tower shall be deemed inoperable if it has not generated power within the preceding three (3) months equal to at least 50 percent (50%) of the expected production, and shall be repaired or removed promptly.

5.10.1.1.2 A WECU shall be deemed inoperable if it has not generated power within the preceding six (6) months equal to at least 50 percent (50%) of the expected production, and shall be promptly dismantled and removed from the property.

5.10.2 Unsafe: Any WECU that is found to present an imminent physical threat of danger to life or significant threat of damage to property shall be immediately shut down and repaired or otherwise made safe and certified so by a Wisconsin professional engineer prior to resumption of operation.

5.10.2.1 If a serious adverse unforeseen impact develops due to the operation of one or more WECUs that has a serious detrimental effect on the affected municipality or a particular resident, the affected municipality has a right to request the Town of _____ to order the cessation of the operation of the WECU(s) in question until the situation has been corrected.

5.10.2.2 Within twenty-four (24) hours of an occurrence of a tower collapse, turbine failure, fires, thrown blade or hub, collector or feeder line failure, injured WECS working or private person, the owner/operator shall notify the Town of _____.

5.10.3 Removal and Site Restoration: The owner/operator shall remove all equipment associated with the WECUs and restore the site to its original condition at the end of the permit or when any WECU is deemed inoperable or unsafe. The restoration shall abide by the plan submitted per Section 3.3.13.

5.10.4 Public Nuisance: Every unsafe WECU and every inoperable WECU is hereby declared a public nuisance, which shall be subject to abatement by repair, rehabilitation, demolition, or removal. An inoperable WECU shall not be considered a public nuisance provided the owner can demonstrate that modernization, rebuilding or repairs are in progress or planned and will be completed within no more than six (6) months.

5.11 Communications interference: Any WECU shall be sited and operated so that they do not interfere with television, telephone (including cellular and digital), microwave, satellite (dish), navigational, or radio reception to neighboring areas. The applicant and/or operator of the facility shall be responsible for the full cost of any remediation necessary to provide equivalent alternate service or correct any problems; including relocation or removal of the facility, caused or exacerbated by the operation of such equipment and any and all related transmission lines, transformers, and other components related thereto. The owner/operator of the WECS shall respond within five (5) business days to any request for a communications interference investigation by a property owner within the project boundary and a three-mile (3-mile) radius beyond the project boundary. Testing shall commence within ten (10) working days of the request. Owner/operator is responsible for mitigating within ten (10) working days from determination of interference cause attributed to the operation of the WECS.

5.12 Interference with Aviation Navigational System

5.12.1 No interference with Aviation Facilities: No WECS shall be installed or operated in a manner that causes interference with the operation of any aviation facility.

5.12.2 Compliance with FAA Regulations: All wind energy siting shall comply with Federal Aviation Administration ("FAA") regulations for siting structure near an airport.

5.12.3 Locking Mechanisms to Limit Radar Interference Required: All WECs shall include a locking mechanism that prevents the blades from rotating when not producing power, in order to limit airport radar interference or "clutter". The Town may modify or eliminate the requirement for a locking mechanism if sufficient evidence is presented that no significant airport radar interference or "clutter" will be caused by the WECs.

5.13 Certification of Insurance: Owner/operator shall maintain liability and other insurances as specified in Section 3.1.2 for the duration of the WECS project including decommissioning and reclamation. The insurance carrier shall be instructed to notify all applicable governmental authorities of any delinquency in payment of premiums. Failure to provide such insurances shall be considered abandonment and full and sufficient grounds for termination of the permit and disposal of the equipment and appurtenances as stated herein.

5.14 Monitoring

5.14.1 Right to Enter Premises for Monitoring: Upon reasonable notice, Town of _____ officials or their designated representatives may enter a lot on which a WECS CUP has been granted for the purpose of monitoring noise, environmental impacts, and other impacts, which may arise. Twenty-four (24) hours advance notice shall be deemed reasonable notice.

5.14.2 Post-construction Well Testing: All previously tested wells shall be tested again within thirty (30) days of WECS start-up. Pre-construction notification and testing procedures shall be followed (see Section 3.2.9.3). Applicant/owner/operator is responsible for all costs associated with well testing and corrective action if necessary.

5.14.2.1 Corrective Action: Adverse changes in flow rate or adverse changes in water quality that cause any of the tested wells that were previously in compliance with the applicable Wisconsin DNR drinking water quality standards for such substances in NR 809 to come out of compliance with such standards will be considered evidence of damage caused by WECS construction and require corrective action by the applicant. If any such well owners contact the applicant after construction commences, but prior to the end of one (1) year from WECS project completion, and provide applicant with evidence that the integrity of their well or water quality in their well has been damaged by applicant's construction, the applicant shall promptly investigate all such complaints. If such investigation demonstrates that the likely cause of such damage was the construction, then applicant shall correct the problem by implementing reasonable corrective measures. Applicant's obligation to take corrective action or implement reasonable corrective measures shall be deemed satisfied if applicant provides the affected well owner with a reasonable emergency water supply immediately and commences measures to implement a permanent fix of the problem with the damaged well within thirty (30) days.

5.14.3 Termination Testing: After installation of the WECS, the applicant/operator shall perform annual thermal imaging on all high voltage electrical terminations. Testing shall be performed according to industry standards to include a photographic/digital record. A copy of the results including documentation of any maintenance performed shall be sent to the Town.

5.14.4 Insulation Testing: After installation of the WECS, the applicant/operator shall perform an annual evaluation of high voltage electrical conductor insulation known in the electrical industry as HIPOT. All insulated high voltage conductors must be tested. Testing shall be performed according to industry standards. A copy of the results including documentation of any maintenance performed shall be sent to the Town.

5.14.5 Noise Testing: After installation of the WECS, the applicant/operator shall perform noise testing according to Section Two of Appendix A, Sites with Existing WECUs.

5.14.6 Periodic Reporting: The owner/operator shall submit periodic monitoring reports to the Town of _____. The report shall contain data on the operations and environmental impacts, and shall be in the form prescribed by the Town.

5.14.7 Power Production Report: The owner/operator shall submit a quarterly power production report to the Town of _____. The power production report shall cover the proceeding calendar quarter, and shall be in the form prescribed by the Town of _____ and shall include actual power production in kilowatt-hours for each WECU.

5.15 Time Related Conditions

5.15.1 Phased Development May Be Required: A WECS CUP may require phased development in order to mitigate adverse impacts from such factors, including but not

limited to: the number of WECUs, the location of the wind energy conversion units and construction schedules.

5.15.2 Demonstration of Performance Characteristics May Be Required: The granting of a WECS CUP may be conditioned upon the installation and operation of one or more WECU for a period not to exceed six (6) months in order to demonstrate the performance characteristics of the WECU. If such monitoring condition is imposed, the permit shall specify the standards which must be met in order to continue development. If a standard has not been met at the expiration of the required monitoring period, the applicant and the Town of _____ may agree to an extension. The time within which the permit must be used shall be extended to include the period of the required monitoring.

5.16 Signage Limited: No advertising sign or logo shall be placed or painted on any WECU. A WECS CUP may allow the placement of no more than two (2) advertising signs relating to the development of the project site, but no sign shall exceed fifteen (15) square feet in surface area or eight (8) feet in height.

5.17 Shadow Flicker or Blade Glint: The facility shall be designed such that shadow flicker or blade glint will not fall on, or in, any existing sensitive receptor. Shadow flicker or blade glint expected to fall on a roadway or a portion of a residential parcel may be acceptable under the following circumstances:

5.17.1 The flicker or glint will not exceed ten (10) hours per year; and

5.17.2 The flicker or glint will fall more than one hundred (100) feet from an existing residence; or

5.17.3 The traffic volumes are less than five hundred (500) vehicles per day on the roadway.

5.17.4 The flicker or glint shall not fall onto an intersection.

5.17.5 If shadow flicker or blade glint exceeds any of the conditions listed in Sections 5.17.1-5.17.4, the source WECU(s) shall be shut down until the flicker or glint problem is remedied.

5.18 Color, Finish, Lighting

5.18.1 Color and Finish: Wind energy conversion units shall be painted a non-obtrusive (e.g., light environmental color such as white, gray, or beige) color that is non-reflective.

5.18.2 Camouflage Facilities: The design of WECS buildings and related structures shall, to the extent reasonable possible, use materials, colors, textures, screening, and landscaping that will blend the facility to the natural setting and the existing environment.

5.18.3 Lighting Requirements: Shall be lit to FAA minimal standards only. Where acceptable to the FAA, the Town of _____ will approve red lights over white lights, and steady lights over strobed or intermittent lights. Lighting shall be shielded from ground view to FAA maximum standards. Area and security lighting shall not exceed one hundred seventy five (175) watts each and twenty-five (25) feet in height and shielded from neighboring sensitive receptors.

5.19 Conditions May Be Imposed: Town of _____ may grant a WECS CUP subject to any condition that it deems necessary to minimize the possibility that the future development of nearby property will create an impermissible interference or to minimize any burden on any

person affected by granting the permit. Such conditions or exemptions may include but are not limited to restrictions on the location of the WECS and requirements for the compensation of persons affected by the granting of the permit.

Appendix A

Town of _____ Measurement Protocol for Sound and Vibration Assessment of Proposed and Existing Wind Energy Conversion Systems

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Introduction

The potential sound and vibration impact associated with the operation of wind powered electric generators is often a primary concern for citizens living near proposed wind energy conversion systems (WECS). This is especially true of projects located near homes, residential neighborhoods, schools, and hospitals. Determining the likely sound and vibration impacts is a highly technical undertaking and requires a serious effort in order to collect reliable and meaningful data for both the public and decision makers.

This protocol is based in part on criteria published in the Standard Guide for Selection of Environmental Noise Measurements and Criteria.[1] and the Public Service Commission of Wisconsin publication Measurement Protocol for Sound and Vibration Assessment of Proposed and Existing Electric Power Plants (February 2002).[2] The purpose is to first establish a consistent and scientifically sound procedure for estimating existing ambient sound and vibration levels in a project area, and second to determine the likely impact that operation of a new wind energy conversion system project will have on the existing sound and vibration environment.

The characteristics of the proposed WECS project and the features of the surrounding environment will influence the design of the sound and vibration study. Site layout, types of wind energy conversion units (WECU) selected and the existence of the significant local sound and vibration sources and sensitive receptors should be taken into consideration when designing a sound and vibration study. It will be necessary to have a qualified consultant conduct the sound and vibration study.

Note: Consult with the Town of _____ prior to conducting any sound and vibration measurements.
These guidelines are meant to be general in nature and may need to be modified to accommodate unique site characteristics. Consult with Town staff assigned to the project for guidance on study design before you begin the sound and vibration study. During consultation, good quality maps or diagrams of the site will be necessary. Maps and diagrams should show the proposed project area layout and boundaries[5], and identify important landscape features as well as significant local sound and vibration sources and sensitive receptors.

Measurement of the Existing Sound and Vibration Environment

An assessment of the proposed WECS project areas existing sound and vibration environment is necessary in order to predict the likely impact resulting from a proposed project. The following guidelines must be used in developing a reasonable estimate of an area's existing sound and vibration environment. All testing is to be performed by an acoustical testing engineer approved by the Town of _____. All measurements are to be conducted with industry certified testing equipment[4]. All test results must be reported to the Town of _____.

Sites with No Existing Wind Energy Conversion Units

Sound level measurements shall be taken as follows:

At all properties within the proposed WECS project boundaries[5]

At all properties within a one-mile radius of the proposed WECS project boundaries[5].

One test must be performed during each season of the year.

Spring March 15 – May 15

Summer June 1 – September 1

Fall September 15- November 15

Winter December 1- March 1

All measurement points (MPs) shall be located in consultation with the property owner(s) and such that no significant obstruction (building, trees, etc.) blocks sound and vibration from the site.

Duration of measurements shall be a minimum of ten continuous minutes for each criterion (See Item C below) at each location.

One set of measurements shall be taken during each of the following four periods:

Morning (6 - 8 a.m.)

Midday (12 noon – 2 p.m.)

Evening (6 – 8 p.m.)

Night (10 p.m. – 12 midnight)

Sound level measurements must be made on a weekday of a non-holiday week.

Measurements must be taken at 6 feet above the ground and at least 15 feet from any reflective surface[3].

For each MP and for each measurement period, provide each of the following measurement criteria:

Unweighted octave-band analysis (16^{2}, 31.5, 63, 125, 250, 500, 1K, 2K, 4K, and 8K Hz)

L_{ave}, L_{10}, L_{50}, and L_{90}, in dBA

L_{ave}, L_{10}, L_{50}, and L_{90}, in dBC

A narrative description of any intermittent sounds registered during each measurement

Wind speed at time of measurement

Wind direction at time of measurement

Description of the weather conditions during the measurement

Provide a map and/or diagram clearly showing:

The layout of the project area, including topography, the project boundary lines[5], and property lines

The locations of the MPs

The minimum and maximum distance between any MPs

The location of significant local sound and vibration sources

The distance between all MPs and significant local sound and vibration sources

The location of all sensitive receptors including but not limited to: schools, day-care centers, hospitals, residences, residential neighborhoods, places of worship, and elderly care facilities.

Sites with Existing Wind Energy Conversion Units

Two complete sets of sound level measurements must be taken as defined below:

One set of measurements with the wind generator(s) off.

One set of measurements with the wind generator(s) running.

Sound level measurements shall be taken as follows:

At all properties within the proposed WECS project boundaries[5]

At all properties within a one mile radius of the proposed WECS project boundaries[5].

One test must be performed during each season of the year.

Spring March 15 – May 15

Summer June 1 – September 1

Fall September 15- November 15

Winter December 1- March 1

All measurement points (MPs) shall be located in consultation with the property owner(s) and such that no significant obstruction (building, trees, etc.) blocks sound and vibration from the site.

Duration of measurements shall be a minimum of ten continuous minutes for each criterion (See Item D below) at each location.

Measurements shall be taken during each of the following four periods:

Morning (6 - 8 a.m.)

Midday (12 noon – 2 p.m.)

Evening (6 – 8 p.m.)

Night (10 p.m. – 12 midnight)

Sound level measurements must be made on a weekday of a non-holiday week.

Measurements must be taken at 6 feet above the ground and at least 15 feet from any reflective surface[3].

For each MP and for each measurement period, provide each of the following measurement criteria:

Unweighted octave-band analysis (16[4], 31.5, 63, 125, 250, 500, 1K, 2K, 4K, and 8K Hz)

L_{ave}, L_{10}, L_{50}, and L_{90}, in dBA

L_{ave}, L_{10}, L_{50}, and L_{90}, in dBC

A narrative description of any intermittent sounds registered during each measurement

Wind speed at time of measurement

Wind direction at time of measurement

Description of the weather conditions during the measurement

Provide a map and/or diagram clearly showing:

The layout of the project area, including topography, the project boundary lines[5], and property lines

The locations of the MPs

The minimum and maximum distance between any MPs

The location of significant local sound and vibration sources

The distance between all MPs and significant local sound and vibration sources

The location of all sensitive receptors including but not limited to: schools, day-care centers, hospitals, residences, residential neighborhoods, places of worship, and elderly care facilities.

Sound level Estimate for Proposed Wind Energy Conversion System

In order to estimate the sound and vibration impact of the proposed WECS project on the existing environment an estimate of the sound and vibration produced by the proposed WECU(s) must be provided.

Provide the manufacturer's sound level characteristics for the proposed WECU(s) operating at full load. Include an unweighted octave-band (16^4, 31.5, 63, 125, 250, 500, 1K, 2K, 4K, and 8K Hz) analysis for the WECU(s) at full operation for distances of 500, 1000, 1500, 2000, 2500 feet from the WECU(s).

Estimate the sound levels for the proposed WECU(s) in dBA and dBC at distances of 500, 1000, 1500, 2000, 2500 feet from the WECU(s). For projects with multiple WECUs, the combined sound level impact for all WECU's operating at full load must be estimated.

Provide a contour map of the expected sound level from the new WECU(s), using 5dBA increments created by the proposed WECU(s) extending out to a distance of 2500 feet.

Determine the impact of the new sound and vibration source on the existing environment. For each MP used in the ambient study (note the sensitive receptor MPs):

Report expected changes to existing sound levels for L_{ave}, L_{10}, L_{50}, and L_{90}, in dBA

Report expected changes to existing sound levels for L_{ave}, L_{10}, L_{50}, and L_{90}, in dBC

Report all assumptions made in arriving at the estimate of impact and any conclusions reached regarding the potential effects on people living near the project area.

Include an estimate of the number of hours of operation expected from the proposed WECU(s) and under what conditions the WECU(s) would be expected to run.

Post-Construction Measurements

1. Within twelve months of the date when the project is fully operational, and within two weeks of the anniversary date of the Pre-construction ambient noise measurements, repeat the existing sound and vibration environment measurements taken before the project approval. Post-construction sound level measurements shall be taken both with all WECU(s) running and with all WECU(s) off.
2. Report post-construction measurements to the Town of _____ (available for public review) using the same format as used for the Pre-approval sound and vibration studies.

[1] Standard Guide for Selection of Environmental Noise Measurements and Criteria (Designation E 1686-96). July 1996. American Society for Testing and Measurements.

[2] Measurement Protocol for Sound and Vibration Assessment of Proposed and Existing Electric Power Plants. February 2002. Public Service Commission of Wisconsin.

[3] Environmental Noise Guidelines: Wind Farms. (ISBN 1 876562 43 9). February 2003. Environment Protection Authority, Adelaide SA.

[4] The Public Service Commission of Wisconsin Staff acknowledges that few sound level meters are capable of measurement of the 16 Hz center frequency octave band. However, because noise complaints from the public most likely involve low frequency noise associate with proposed WECS [power plants], we encourage applicants to pursue the collection of this important ambient noise data. If obtaining the 16 Hz data presents a problem contact PSCW Staff prior to collection of any field ambient measurement data.

[5] Project Boundary: A continuous line encompassing all WECU's and related equipment associated with the WECS project.

Town of _____ Wind Energy Conversion System Ordinance Appendix B

Complaint and Resolution Procedure

Everyone involved with any phase of the WECS is responsible for ensuring an expeditious and equitable resolution of all complaints. It is therefore necessary to establish a uniform method for documenting and handling complaints related to the WECS project. As a part of the application, the applicant shall submit to the Town of _____the procedures to be used to receive and respond to complaints regarding wind energy conversion systems (WECS) and related facilities.

Definitions:

Complaint: A written, signed, and dated statement presented by a person expressing dissatisfaction, resentment, or discontent as a direct result of the WECS and related facilities. Complaints do not include requests, inquiries, questions, or general comments.

Substantial complaint: A complaint, if substantiated, could result in permit modification, suspension, or cessation of WECS operation pursuant to the applicable provisions of this Ordinance. Substantial complaints shall include health and/or safety concerns, or identification of violation(s) of the WECS CUP.

Person or Complainant: An individual, partnership, joint venture, private or public corporation, association, firm, public service company, cooperative, political subdivision, municipal corporation, government agency, public utility district, or any other entity, public or private, however organized.

Requirements:

The applicant/owner/operator shall report to the Town all complaints received concerning any part of the WECS construction or operation in accordance with the following:

1. Complaints received by the applicant/owner/operator concerning the WECS CUP for site preparation, construction, operation, cleanup and restoration, and status of the resolution of such complaints shall be reported to the Town in a uniform and timely manner (within 5 business days). All substantial complaints shall be reported the same day received or on the following working day for complaints received after working hours.

2. The reporting shall encompass a description of the complaint(s) and the frequency of similar complaints.

3. The applicant/owner/operator shall document all complaints by maintaining a record of all applicable information concerning the complaint, including the following:

a. Name of the applicant and WECS project.

b. Name of complainant, address, and phone number.

c. Precise property description or tract numbers (where applicable).
d. Nature of complaint.
e. Weather conditions related to the complaint (if applicable).
f. Response given.
g. Name of person receiving complaint and date of receipt.
h. Name of person reporting complaint to the Town, and phone number.
i. Complaint resolution and date.

4. The applicant/owner/operator shall assign an individual to summarize complaints for transmittal to the Town of _____. The department shall forward copies to any affected municipalities.

5. All substantial complaints shall be investigated on site and the complainant and the zoning enforcement officer shall be invited to attend any such investigations.

6. The procedures shall be used for all complaints received by the applicant/owner/operator.

Complaints received at the Town

Copies of complaints received directly from aggrieved persons regarding site preparation, construction, operation, maintenance, cleanup and restoration, shall be promptly sent to the Applicant.

Complaint Resolution Certification

The zoning enforcement officer or her/his designee(s) shall certify in writing to all parties involved the complaint resolution. In the absence of a mutually acceptable resolution, it shall be the authority of the zoning enforcement officer or his/her designee(s) to resolve the complaint or take action.

PSC STAFF REPORT:
The Phase II Stray Voltage Testing Protocol

Richard S. Reines and Mark A. Cook
Rural Electric Power Services
Public Service Commission of Wisconsin
February 1999

BACKGROUND

The State of Wisconsin first investigated the concept of stray voltage (SV) in the early 1980's. The topic was relatively new to the country at that time, but many farm operators expressed a concern to Wisconsin government officials about the as-yet not well documented effects of stray voltage. Many methods have been used over the intervening years to acquire electrical and other data relevant to the effects of small voltages and currents in animal confinement areas. Through a long and sometimes arduous process, basic scientific techniques of data acquisition were applied to the process of SV investigation. While stray voltage measurements have been taken on dairy farms for many years, the number, types, and interpretation of these measurements can vary greatly. Depending on the investigator making the measurements, any number of different quantities can be recorded at different times of the day, using a wide variety of data acquisition equipment and using various protocols for the equipment's connection into the barn environment (for instance, the concern with the length of test leads was studied in 1996). As a result of these activities, the output of any specific measurement process may or may not generate the valuable or critical information needed for determining the character of the stray voltage present or its source. If the data is not collected with a minimum protocol that ensures its veracity, it should not be used to make economic decisions. The following discussion is offered to outline a specific protocol for obtaining a coherent set of measurements which, when used together, should provide SV investigators with a method useful in determining the character, conditions, and source of any stray voltage present on single- or multiple-service dairy farms. This test protocol is not mandatory in Wisconsin, but is routinely performed by investor-owned and other utilities prior to a visit by the Rural Electric Power Services (REPS) team of the Public Service Commission of Wisconsin (PSCW). As predecessor to the Phase II investigation, the Phase I investigation was developed in Wisconsin for first-time visits by utility SV investigative personnel, dairy field-men, veterinarians, and other dairy trade allies to "spot-check" for possible stray voltage at a small number of cow contact areas. It is also used to assess the basic characteristics of the farm's electrical system and the utility distribution system in the vicinity of the farm.

The PSCW, in its 1989 docket 05-EI-106, proposed a battery of tests for SV investigators whose goal is to determine the source of the stray voltage. The test set consists of a load box test, a secondary neutral test, and an equipment signature test, as well as the basic procedure of setting the cow contact measuring points. One must also determine the source resistance for each such point and determine if any cow contact voltages can be found above the "level of concern." From the 1996 PSCW docket 05-EI-115, the "level of concern" is defined as 2.0 milliamps, alternating current (AC), 60 Hertz (Hz), rms (root mean square), steady-state or 1.0 volt, AC, 60 Hz, rms, steady-state across a 500-ohm resistor in the cow contact area[1]. The State of Wisconsin deems that this level of voltage/current is an amount of electricity where some form of mitigative action is taken on the farmer's behalf, although only some small percentage of cows may actually perceive its presence. The "level of concern" is not a damage level. Instead, it is a very conservative, pre-injury level, below the point where moderate avoidance behavior is likely to occur and well below where a cow's behavior or milk production would be harmed. The “level of concern” refers only to the exposure of farm animals in a confinement area to electricity from off-farm or on-farm electrical supply systems and not to any farm personnel in the same area. The “level of concern” is further broken down into two parts. The first part is a 1-milliamp contribution from the utility, at which level mitigative

[1]“Steady-state” is defined by the Institute of Electrical and Electronics Engineers (IEEE) as “the value of a current or voltage after all transients have decayed to a negligible value.”

action must be taken by that utility to reduce its contribution to below the 1-milliamp level. The second part is a 1-milliamp contribution from the farm system, at which level mitigative action should be taken by the farmer. Numerous studies at the University of Wisconsin and other quality research institutions have documented avoidance behaviors in the range of 3 to 6 milliamps of current flowing through the cow. This response assumes that the cow comes into contact with conductive objects that have different voltages and that this voltage difference causes sufficient current to flow through the cow. The exact methodology and the value of the data gathered by the aforementioned tests were not further explained in the docket nor were the techniques for analyzing the data. This paper is offered to expand on the concepts presented in docket 05-EI-106.

PURPOSE AND FORM

The Phase II protocol was developed to provide SV investigators with a tool to collect a reasonable set of data useful in the analysis of the quantity and "quality" of stray voltage that may be present under a variety of conditions, and the source of such stray voltage. The farm customer should expect that a written comprehensive SV investigation report be provided to him/her as the final result of a thorough investigation. It should contain reliable, scientifically-derived numbers indicating where any significant levels of stray voltage were found on his/her farmstead and the physical mechanisms whereby those voltages arose. The utilities, in their ongoing mission to assist farm customers to the best of their ability, need to employ consistent testing methods applied by well-trained personnel. With the Phase II protocol, farms may be inter-compared on a level playing field and test results from the same farm taken a number of times over a period of years may be compared against each other with some statistical confidence. Lastly, regulatory agencies, such as the PSCW, charged with collecting the utilities' test summaries, need to be assured that the data collection methodology was independent of the specific equipment used or the specific personnel performing the tests.

Phase II testing is intended to determine AC, 60 Hz, rms, steady-state animal contact voltages on livestock farms. Unfortunately, some farms in Wisconsin have modified electrical system wiring so that it no longer meets the safe operating provisions of the National Electrical Code (NEC). In these cases, the PSCW advises utility personnel to critically assess their risk in beginning a SV investigation on such a farm. If the situation warrants, they may inform the farm customer that SV testing will not continue until the electrical system is brought into compliance with the NEC. That code specifies the minimum wiring requirements for a safe electrical system. The PSCW rules in effect for SV investigations refer strictly to the 60 Hz fundamental voltage or current and not to any harmonic content that may or may not be present in addition to the fundamental frequency. Other electrical phenomena that are not specifically included in the PSCW orders are medium frequency transients (>3 kHz) and RF-source transients (>500 kHz) induced from sources outside the distribution power system including currents in the earth. While these transients can be measured with the proper equipment, there is no defined "level of concern" for these phenomena in the PSCW dockets dealing with stray voltage. In a joint venture of the state of Wisconsin with the state of Minnesota in 1998, a study was conducted that concluded that "no credible scientific evidence supports the claim that currents in the earth or associated electrical parameters such as voltages, magnetic fields and electric fields, are causes of poor health and milk production in dairy herds." Therefore, utilities in Wisconsin have been specifically instructed by the PSCW to monitor AC, rms, 60 Hz, steady-state cow contact voltages to properly determine animal exposure.

The Phase II protocol consists of six data input forms to record the results of a set of five individual electrical tests of the farm/distribution power system network. The main form also provides an area to record background information that is important for the overall understanding of the farm/utility electrical system. Typical forms are found in Appendix A of this paper. These were developed by the PSCW as prototypical and the physical layout of each specific form is somewhat arbitrary. Also included are instruction sheets and diagrams for the uniform wiring and arrangement of the test equipment. It is important to emphasize that this protocol creates a set of data records useful in analyzing SV on multiple service as well as single service farms. However, multiple electric service farms may require other specialized tests to be devised as needed. Each electrical service must be tested individually per the Phase II protocol. Load box testing is not affected by multiple service situations as long as each is tested independently. The stray voltage investigator needs an extensive knowledge of multi-service interactions to fully understand and interpret the data and to draw the proper conclusions. There have been rare instances where neighboring farms have influenced testing on the subject farm, both through the power system and

other utility systems and through the earth. In some cases, a well-trained and experienced SV investigator can easily determine that a simple and solvable condition exists which obviates the direct need for the more extensive Phase II testing.

THE PHASE II FORMS

Appendices A-1a and A-1b are used for documenting the basic background information and animal contact set-up protocol. The information recorded, such as the existing mitigation devices present at the time of the visit, the basic character of the distribution system, and the farm production data, are important in the end analysis of the data and as an historical record of the farm. After a cow contact point is established, the all-important source resistance check is made and recorded. This value should be less than 500 ohms to ensure that the cow contact current/voltage is both meaningful and worst-case. From the PSCW database, the average source resistance in the cow contact area on nearly 3,500 Wisconsin dairy farms is 192 ohms. A second source resistance check is made just prior to tear down to ensure that the original value has not changed significantly over the period of testing. A voltage ratio (VR) test is included to determine if the selected reference rod location is too close to (under the influence of) the distribution or secondary electrical system. The voltage ratio calculated should be greater than 80 percent and less than 120 percent of the measured primary neutral to reference voltage to indicate correct reference rod placement.

Secondly, a load box test is performed and the data logged into the load box test forms (Appendices A-2a, A-2b, and A-2c). This is the most basic test to determine how much the primary system might be contributing to cow contact voltage levels. The load box should be a non-inductive 240-volt rated heater-type load in the range of 18-kilowatt (kW) to 25-kW. If the farm is found in an isolated condition, two load box tests should be performed. The first test records the "as-found" (isolated) condition and the second test records the bonded (non-isolated) condition. It is also important that the main electrical panel serving the animal confinement area be adequately bonded, according to all applicable codes, to the metallic water line/barn metal system. If the metallic water line/barn metal system was not bonded in the "as found" condition, testing in both the bonded and non-bonded condition may be needed.[2] The load box test is performed in four or five stages depending on the type of load box used. First, the background activity of the distribution system from the farm's point of common coupling is recorded with the 240-volt load box de-energized and the farm shut off. The load box can be either a split 9-kW/18-kW (or a split 12.5 kW/25-kW) type that is turned on half, then full or just an 18-kW (25-kW) type. (The PSCW has found that an 18 kW load box is usually adequate to create a worst-case scenario for most small to moderate sized farms). The data is recorded for this load-box-on, farm-off section. Then the farm is turned on in addition to the full load box to record the conditions under maximum electrical impact. Lastly, the load box is turned off and the data recorded representing the background electrical activity of the functioning farm. The types of data typically collected are primary line current (Ip), primary neutral current (Ipn), secondary neutral current (Isn), net secondary neutral current (Isn-net),[3] voltages from primary neutral to reference (Vp), secondary neutral to reference (Vs), and the voltage values at cow contact (Vcc). The cow contact point is selected so as to measure the greatest (meaning worst case) voltage value. The difference in voltage from the primary neutral to the secondary neutral is also recorded (Vps). It is interesting to note that, for over 3,000 dairy farms in Wisconsin, the average primary neutral to reference voltage is 1.39 volts while the average secondary neutral to reference voltage is 1.27 volts (the source of these voltages was not determined). Vp is measured at the bottom of the transformer pole where the primary neutral is connected to its ground rod. Vs is measured at the main electrical service panel of the animal confinement area where the connection is made to the grounding electrode system. Calculations are made as indicated on the form for various resistances, the K-factor and the current return ratio (CR).

The forms in Appendices A-3a, A-3b, and A-3c log the results of a set of secondary neutral voltage drop tests. Secondary neutral voltage drop has been found to be the main on-farm source of stray voltage in Wisconsin. This test is used to determine the source and impact of each secondary service on the farm. For this test, a proxy load of known characteristics, such as a 120-volt rated hair dryer or paint peeler drawing about 10 - 15 amps AC

[2]Note: Extreme caution must be exercised when working on or near equipment and metal structures that are not bonded, because injury or death may occur.

[3] This is recorded by using a current clamp simultaneously around both secondary phase wires and the neutral wire.

rms, is used to create a known and stable neutral current and subsequent voltage drop for each neutral serving a main panel, sub panel, or end of service area. It is important that all other service entrance main disconnects be turned off at this time so the impact of just one service at a time can be determined. The data collected for each such service are neutral wire gauge, exact length of neutral wire, neutral current measured, voltage drop measured, and Vcc, the primary neutral to reference voltage (Vp), and secondary neutral to reference voltage (Vs) at both ends of the circuit. It is important to have the last three voltages measured both before and after the hair dryer load is turned on so that just the difference, found by subtraction, is seen. Ohm's Law is used to calculate the expected neutral voltage drop, based on the measured current and calculated neutral conductor resistance. This can then be compared with the actual recorded voltage drop either as a difference in voltage to reference measured at each end of the circuit or the voltage drop directly measured from one end of the circuit to the other.

Appendices A-4a and A-4b are used to log the data generated by a signature test where individual pieces of major current-drawing electrical equipment are started and stopped at specific times and for specific intervals to determine their impact on the farm's electrical system. Additionally, a proxy load can be used to provide the signature of a long-run circuit that has a 120-volt outlet associated with its far terminus. The signature test is best accomplished shortly after the load-box test when minimal farm electrical activity exists and only one service at a time is energized. For this test, the person recording the data should be in contact (via voice or radio) with the person controlling each load device. He/she must also have a watch or other timing device in synchronization with a recording voltmeter so the data recorded can be properly interpreted. A digitizing data recorder is usually used during this test with the sample interval set to 1 second. The data recorder should be set to monitor a minimum of four data points: voltages from primary neutral to remote reference (Vp), secondary neutral to remote reference (Vs), primary neutral to secondary neutral (Vps), and the cow contact voltage (Vcc). The physical locations monitored are the same as for the load box test. For each piece of electrical equipment for which a signature is desired, the type and location are noted along with the start and stop times, usually separated by 15 or 20 seconds. For clarity, the start times should ideally be on an even minute, half minute or quarter minute. If a piece of equipment is discovered in a running condition, a stop and then restart is performed and the condition annotated (via an asterisk, e.g.) to make proper sense of the sequence in stop and start times.

The forms shown in Appendices A-5a and A-5b are used to record the results of a “primary profile” test that may be performed either during a morning milking or an evening milking or when the electrical activity on the primary distribution system is likely to be at a maximum. This test uses a meter or meters that measure both ground rod resistance and ground rod current at one time. The primary system ground rods for three-fourths of a mile on each side of the farm (if possible) are measured. It is best to start at one end point and work towards the other, if possible, and include such branch circuits or sections thereof that may be within the needed sphere. This may be the case if the farm is not on a linear segment of distribution system. It is important to note the condition of each pole, if out of the ordinary, as well as other devices present such as transformers, capacitor banks, telephone pedestals, or broken ground connections as well as the farm tap pole or transformer pole. This test should ideally record the ground rods of a minimum of about 13 or 14 poles over 1.5 miles. The investigator should then use Ohm's Law to calculate the primary neutral to earth voltage, which exists at each pole.

The form, Appendix A-6a, is used to summarize the results from a long term (“24-hour”) monitoring test where the investigator places a recording voltmeter for about 24 hours to cover at least two milking periods. The four channel assignments are the same as in the signature test described previously. The report form suggests the proper settings and the data to be collected. The “average rms” report graph from the recording voltmeter is the most useful in determining if the steady state level of concern has been exceeded at any time during the recording interval.

DATA ANALYSIS

The greatest benefit of using the results of the Phase II forms is in the overall analysis of the farm and utility electrical systems. In the every day life of dairy farming in Wisconsin, the two should be considered one single system that work together enabling the dairy farmer to perform all the tasks necessary to get his/her product to market in the most efficient, cost-effective manner. Even if the cow contact voltages/currents are found to be below the present “level of concern,” many useful suggestions for improving either the farm wiring system or the

utility distribution system can be offered with proper analysis of the data collected. This proactive approach to SV investigation is meant to avoid future concerns as both the farm electrical system and utility system increase in age or are modified by the normal growth of either system. It has been noted in the past that it is better to prevent possible stray voltage from occurring than to deal with the unmitigated consequences at a later date.

The data collected via the Phase II protocol is intentionally wide ranging to provide some means of cross-checking data, much like the accountant who cross-checks a double-entry bookkeeping system. By examining the primary profile, the load box test, the signature test, and the secondary neutral voltage drop test, the operational characteristics of the primary electrical system, the secondary electrical system, and the individual components of each is revealed. The "24-hour" test should demonstrate that each side of the system has a specific impact on the overall operation of the farm at specific times of day. If the farm is to be isolated in the future, Phase II testing can offer some predictions on the consequent impact to the primary neutral voltage in the area of the farm and to the secondary neutral and cow contact voltages on the farm under the conditions of isolation.

The primary profile should reveal that most primary neutral to earth voltages found in the region of the farm's tap or transformer pole are similar in magnitude to the primary neutral to reference data from the load box test. It is best to graph the data versus consecutive poles to see if a specific pattern indicates an area that may need attention (see Appendices A-5c, A-5d and A-5e). The average value of distribution system ground rod current in Wisconsin from over 3.355 poles measured, is 41 milliamps. The average ground rod resistance is 78 ohms. The average primary neutral to earth voltage calculated is 1.05 volts. Because the primary profile data are taken at a time of nearly maximum electrical activity on the primary system, the influence of neighboring farms can often be seen. It is sometimes the case where one farm's electrical troubles are passed on via a common interconnection by the utility from the previous or subsequent farm on the distribution system. In these cases, a recording device may be set on various points of the primary system to monitor contributions in voltage and current from other sources. In the proper interpretation of the primary profile data, care must be exercised in including the possible contributions of capacitor banks, other transformers and telephone systems to the neutral voltages. A parallel communications system (telephone or cable-access television) interconnected with the distribution system neutral can create a large ground loop and consequently larger than expected neutral voltages or currents.

Load box testing ideally confirms that nearly zero volts should exist between the primary neutral to reference voltage (Vp) and the secondary neutral to reference voltage (Vs) for a non-isolated farm with farm loads off ($Vps \approx 0$). If this is not the condition recorded, an unintended condition of semi-isolation may exist. This may take the form of a high resistance connection between the primary and secondary neutrals. For farms that are intentionally isolated, the secondary neutral to reference voltage with the farm off should ideally be 8 to 10 times less than the primary neutral to reference voltage, to indicate that the isolation device is effectively doing its job. The currents and voltages should increase in a logical progression as one adds more load in each step of the load box test. If a current or voltage decreases when more electrical load is added, phase or interference conditions could be assumed. If there is no corresponding linear increase in voltage and current for a linear increase in the applied load, phase shift or power factor interference may be indicated. Most obvious is the direct impact of the neutral voltage on the cow contact. Because the farm's electrical loads are disconnected, the direct connection between the two neutral systems is the lowest impedance path from the primary neutral to the cow contact area. In Wisconsin, when the voltage at cow contact exceeds 0.5 volts during the full load test, action by the utility is mandated. From the calculated values, the primary neutral resistance should ideally be less than 0.75 ohms, but can reasonably range from about 0.1 to about 3.5 ohms. The farm neutral resistance should ideally be less than 2.0 ohms, but can reasonably range from about 0.3 to about 5.0 ohms. The total system resistance should ideally be less than 0.5 ohms, but can reasonably range from about 0.05 to about 2.5 ohms. The K-factor should ideally be less than 33 percent, but typically may range from 5 percent to 85 percent. The lower this number is, the less impact neutral voltages will have in the cow contact area. The CR should ideally be 66 percent or more. The range is typically about 35 percent to 90 percent. The typical ranges referred to above are based on PSCW REPS team experience. When the farm loads are turned back on, in addition to the full load box being on, the effects of combined secondary neutral voltage drops can be seen. The cow contact voltage may increase or may decrease, depending on the phase of the dominant farm loads drawing current at that time.

The secondary neutral voltage drop test provides data on the calculated drop and the actual measured drop for each major service on the farm. If the measured value of the drop differs from the calculated value, some condition may exist in that circuit that needs attention (e.g. a poor connection or splice). The effect of each service on the cow contact voltage can also be seen. In the overall farm system, the various voltage drops connected to the primary/secondary neutral/ground system may add to or subtract from the neutral to earth voltage at the point of common coupling to influence the readings with the farm on. This is because the service generating the voltage may be either in-phase or out-of-phase with other source voltages. There may also be some minor phase shifting due to the fact that there are complex impedances, not just pure resistances, involved in most circuit load devices. When these undesirable additional voltage drops are found and minimized, the calculated and measured voltage values should agree. Sometimes the actual and calculated values are in agreement but both are larger than desired for the service being measured. Only experience with typical secondary electrical systems can provide information on what the overall value should ideally be, but many times, the neutral conductor size is smaller than required, resulting in excessive secondary neutral voltage drop. Each service neutral on a farm is a potential source of stray voltage. Because each service is characterized at a standard load in this test, the relative impact of each at the cow contact area can be gauged. It is important to remember that this is a 120-volt test and is not characterizing 240-volt loads at each service. Only 120-volt loads use unbalanced secondary current carried by the neutral. Because the 120-volt load may be connected to one hot phase or the other as the test progresses, the total effect may add to or subtract from the combined cow contact voltage.

The signature test is analyzed by examining the impact of each major electrical device and circuit in the farm system. The SV investigator should annotate significant contributions to the cow contact voltage (Vec) from the electrical system device or circuit under investigation. The test may indicate a certain piece of electrical equipment generates excessive neutral voltage when it is running or may generate excessive voltage drop upon start up. Most motors use 2 to 8 times their normal running current for several cycles to as much as a full second during a start-up operation. If the signature displays currents and voltages in excess of those expected for the size of the load energized, a condition needing attention may be indicated. The effect of the individual start, run, and stop cycle can also be seen at the cow contact area. Many times it is important to "stage" the signatures to re-create normal operational conditions on the farm. The investigator may ask the farm operator to start a number of pieces of electrical equipment that normally all run at the same time so that the total cumulative effect on the neutral may be recorded. The stopping sequence will be the reverse of the starting sequence. The effect of 240-volt rated devices can be seen which ideally should not affect the secondary neutral voltage except by its common coupling to the primary neutral voltage. It is especially important to include the operation of fencers, trainers, and crowd gates during the signature test. These electronic devices generate very high voltage, low to moderate current signals as a part of their normal operation. Great care must be taken in the installation of these devices such that the high voltage does not couple into animal contact areas at points where it is not intended. The signature library developed during this test may provide interpretative information to some charts resulting from the "24-hour" test and will be valuable as an historic record to gauge any change in operational characteristics of loads for future investigations.

The "24-hour" test can be viewed in a number of different ways. The "average rms" report should be the only source of values used to determine if the cow contact voltages or currents exceed the "level of concern" in addition to the load box test data. Using the "average rms" voltage graph, the investigator can visually track the effects of both the primary and the secondary neutral to reference voltages on the cow contact voltage. The ratio between the secondary neutral to reference voltage (Vs) and the cow contact voltage (Vec), defined as the K-factor, should be a relatively constant proportion which agrees with the value derived in the load box test. The channel recording the difference in voltage between the primary and the secondary neutral to reference voltage should be close to zero for a non-isolated farm and be a larger voltage for an isolated farm. The software used to view graphs allows enlargement of selected portions for more detailed analysis. This tool lets the SV investigator determine the exact voltage levels recorded and the exact duration of specific events. The 'maximum rms report' (non-steady state) may be useful in determining if any faulting condition or transient activity exists which may require further investigation. It should be used for diagnostic and research purposes only. This is because this report logs the single highest rms voltage value reached during the recording interval, usually set at 10 seconds. There is only one 60 Hz. cycle which reaches maximum among the 600 cycles of the recording interval, but the data point is plotted as if all 600 cycles were at this level. If this higher voltage cycle occurs once in each successive data recording

interval, the entire graph appears to present data at a much higher level than actually exists. Therefore, the data from this report must be viewed selectively with the aforementioned interpretation in mind. As mentioned in the signature test section above, the operation of specific equipment used during the daily milking and feeding cycles should be discernable on the "24-hour" test report graph.

CONCLUSIONS

The Phase II protocol can be a very useful format for collecting and documenting data relative to stray voltage investigations on single and multiple electrical source dairy farms. The data acquired can be used to record the amount of AC, 60 Hz, rms, steady state stray voltage found during the investigation and the specific conditions under which it is present. An experienced SV investigator may use the Phase II information to suggest the source of such stray voltage and offer mitigation methods based on scientifically collected data that will properly address the situation.

There are many valid tests that produce useful information in a stray voltage inquiry. The five tests within the Phase II protocol may be basic to any SV investigation and can be used during a comprehensive stray voltage inquiry if the source of stray voltage has not previously been identified. Load testing for on- or off-farm contributions is typically not part of an initial or preliminary (Phase I) stray voltage inquiry. If the source has been determined by some other valid means, such as but not limited to data supplied by a recording voltage meter, a competent SV investigator may deem that a portion of or perhaps all of these five tests may not be required. Stray voltage testing and diagnostic procedures and protocols continue to be utilized on a case-by-case basis for the type of inquiry desired. More often than not, the site-specific characteristics of a SV investigation will require some flexibility on the part of the SV investigator and generally preclude the mandatory use of uniform tests in all situations. This flexibility of investigators is critical during preliminary testing to produce the most satisfactory results as quickly as possible.

STRAY VOLTAGE PHASE II
DATA INPUT FORM

DATE(S):_____

Cow Contact above L.O.C.? **Y N** If Yes, Cow Contact Location: _____

Farm customer: _____ Recorded by:_____

File No: _____ Utility:_____Type: Muni IOU Coop

Miles to substation:_____ Grounds/mile _____ End of Line? **Y N**

Primary Line Voltage:_____Transformer KVA:_____ Primary Service 1 2 3 4

Conductor size: _____ Neutral size: _____

(AS FOUND) FARM ATTRIBUTES:		COMMENTS:
EPP	**Y N**	
EGS	**Y N**	
4-WIRE	**Y N**	
ISOL XFMR	**Y N**	
NEUT ISOL	**Y N**	

HERD SIZE ____ MILK PRODUCTION_____lbs DHI? **Y N** SCC (x1,000) ____

SOURCE RESISTANCE CHECK #1: (SET-UP)

R_{shunt} = Ω

Vwo=_____ Vw= _____ Rsource=[(Vwo-Vw)xRshunt]/Vw = ☐

SOURCE RESISTANCE CHECK #2: (TAKE-DOWN)

Vwo=_____ Vw= _____ Rsource=[(Vwo-Vw)xRshunt]/Vw = ☐

Vr TEST

Ipg meas =_____mA Rpg meas = _____ Ω

Vpncalc = Ipg meas x Rpg meas= _____ mV **Vr = Vp / Vpncalc =** ☐

Vp (from load box test) = _____ mV

PHASE II DATA INPUT INSTRUCTIONS

ITEM	EXPLANATION
1	Enter date(s) of testing period.
2	LOC = Level of Concern exceeded?, i.e. ≥ 1 volt (2 mA) in cow contact area.
3	Exact location of any SV above LOC.
4	Customer name.
5	Name of person recording data.
6	File reference number.
7	Name of utility serving farm.
8	Type of utility (IOU = Investor Owned Utility).
9	Circuit miles from farm to substation.
10	Number of grounds per mile average for 3/4 mile each side of farm.
11	Check if end-of-line customer (This is a customer who is the last one on a radial distribution feeder or the last one served by a tap off the main feeder located more than 0.5 mile from the source distribution facility where it goes in two different directions.)
12	Primary line voltage to neutral serving farm transformer (4,800, 7,200, 14,400, etc).
13	Farm transformer kVA rating (note multiple transformers separately).
14	Type of service: 1 = single phase, 2 = two phase, 3 = three phase, 4 = multiple phases.
15	Phase conductor size and wire type (#8 CW, 1/0 ACSR, #4 CU, etc.)
16	Same for neutral conductor size and type.
17	Circle if attribute present at this time: EPP = Equi-Potential Plane, EGS = Electronic Grounding System, 4-wire =4 or 5 wire secondary system, ISOL XFMR = Isolation Transformer, NEUT ISOLATOR = Primary/Secondary isolation device present (Note type: Ronk, Dairyland, etc.).
18	Record any useful comments about devices present (i.e. “EGS not working or disconnected”).
19	Note farm characteristics of milking herd size, rolling herd average production, if on DHI and the present somatic cell count.
20	Record shunt resistor value and data from two source resistance measurements: one just after setting the cow contact point and the other just before tear down.
21	Voltage ratio test to see if the reference rod is under the influence of the farm/primary electrical system. Measure farm primary pole ground resistance and current. (If main disconnect is within 30 feet of this ground rod, use the next existing rod back towards the substation). Calculate primary neutral voltage and compare to value measured by load box test with load box off, farm on. If the two values are within 20 percent (hi or lo), reference rod is in the correct location.

LOAD BOX TEST

DATE: _____ Customer Name: _____

	FARM OFF:			FARM ON:	
TIME:					
Condition:	**NO LOAD**	**½ LOAD**	**FULL LOAD**	**FULL LOAD**	**NO LOAD**
Ip	**A**	**A**	**A**	**A**	**A**
Ipn	**A**	**A**	**A**	**A**	**A**
lsn	**A**	**A**	**A**	**A**	**A**
Isn net	**A**	**A**	**A**	**A**	**A**
Vp	**V**	**V**	**V**	**V**	**V**
Vs	**V**	**V**	**V**	**V**	**V**
Vps	**V**	**V**	**V**	**V**	**V**
Vcc	**V**	**V**	**V**	**V**	**V**
	(lo)		**(hi)**		

CALCULATIONS (FARM OFF): **SUMMARY:**

$$Rt = \frac{Vp\ hi - Vp\ lo}{Ip\ hi - Ip\ lo} = \_\_\_\_\_ = \quad \Omega$$

$$Rp = \frac{Vp\ hi - Vp\ lo}{Ipn\ hi - Ipn\ lo} = \_\_\_\_\_ = \quad \Omega$$

$$Rf = \frac{Vs\ hi - Vs\ lo}{Isn\ hi - Isn\ lo} = \_\_\_\_\_ = \quad \Omega$$

$$K = \frac{Vcc\ hi}{Vs\ hi} = \_\_\_\_\_ = \quad \%$$

$$Cr = \frac{Ipn\ hi}{Ip\ hi} = \_\_\_\_\_ = \quad \%$$

LOAD BOX TEST INSTRUCTIONS

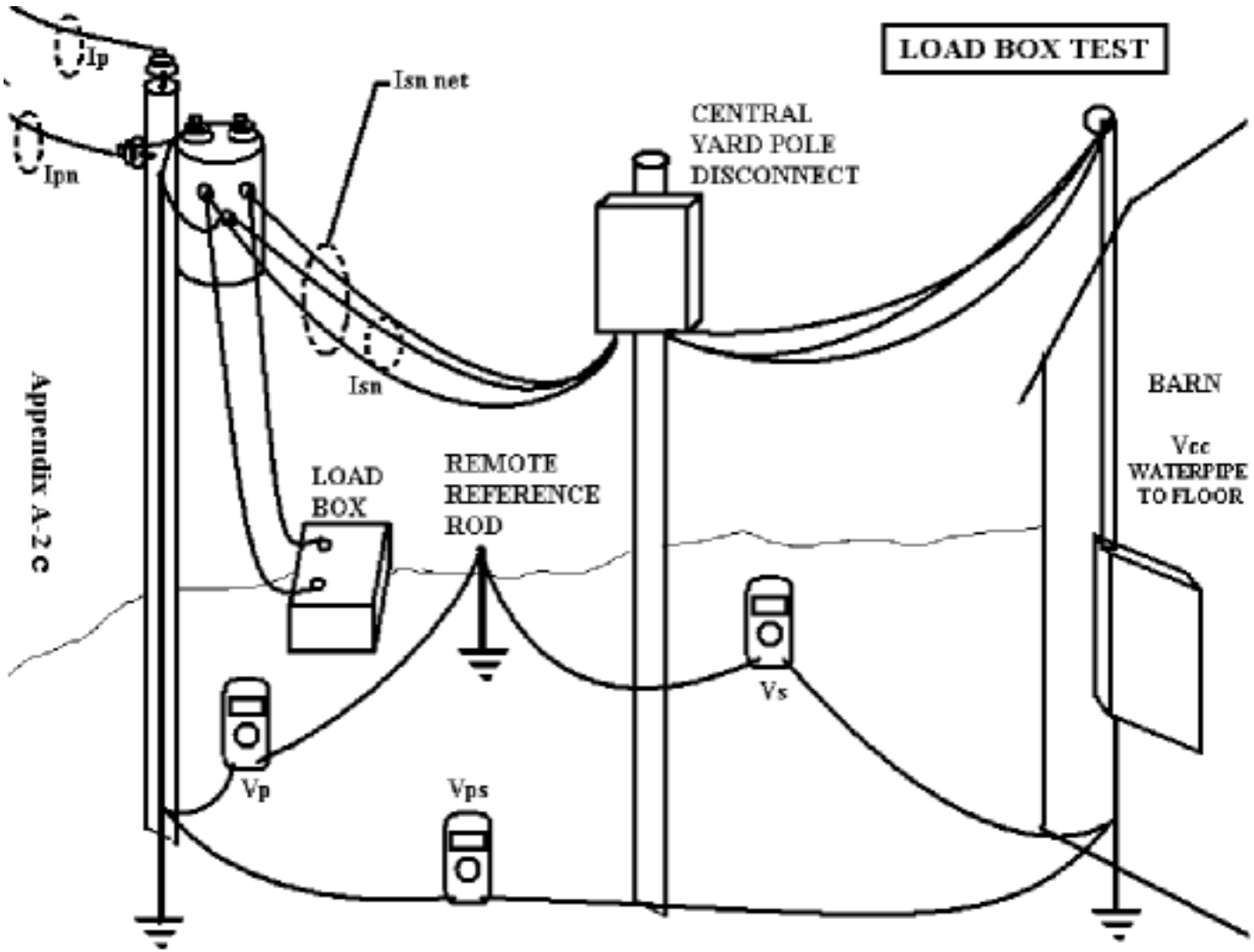
Note 1: Testing may be accomplished by a single 18/25 kW load box or a dual element 9/18 or 12.5/25 kW load box. The difference between full load and no load measurements is used in most calculations. There must be a continuous metallic bond between the main disconnect's neutral/grounding electrode system and the barn water pipe/stanchion structures.

Note 2: If the farm is found in an isolated condition, two load box tests must be performed: an isolated test and a non-isolated test.

Note 3: If the farm is served by a three-phase system, measure and record only the farm-off, load box off column and the farm-on, load box off column or test only one phase of the three.

ITEM	EXPLANATION
1	Enter date and customer name.
2	Attach load box to the 240-volt secondary side of transformer. With load box off, shut off all electrical service to farm and record time. Measure and record 7 data points as follows: Ip = current on primary phase line,* Ipn = current on primary neutral line, Isn = current on secondary neutral line, Vp = voltage from primary pole ground rod to remote reference rod, Vs voltage from barn's main disconnect neutral/ground electrode system to remote reference rod, Vps = voltage between last two points, Vcc cow contact area voltage
3	If dual element load box is used, turn on first half of load box, record time and 7 data points. If using a single load box, skip this step.
4	Turn on full load box, record time and 7 data points.
5	Turn all electrical service to farm back on. Record time and 7 data points and one additional data point of the net current on all three secondary wires from transformer (2 phase wires and the neutral wire grouped together).
6	Turn off load box and record time and 8 data points.
7	Transfer the appropriate numbers to the formula section and calculate the total system resistance , Rt, the primary system resistance, Rp, the farm resistance, Rf, the K-factor, and the primary current ratio, CR.
8	Care must be taken when performing this test. If the transformer is located on the distribution right-of-way, the phase and neutral currents must be measured both upstream (towards the substation) and downstream of the transformer.

* The primary phase current may be calculated using the measured secondary current of the load box and the known transformer ratio. (e.g for a 100 amp @ 240 volt secondary load box with a 30:1 transformer ratio, the primary phase current at 7,200 volts would be 3.3 amps.)


LOAD BOX TEST
Ip
Ipn
Isn net
Isn
CENTRAL
YARD POLE
DISCONNECT
BARN
Vcc
WATERPIPE
TO FLOOR
LOAD
BOX
REMOTE
REFERENCE
ROD
Vp
Vps
Vs
Appendix A-2 c

SECONDARY NEUTRAL VOLTAGE DROP TEST

Test performed by: _____ Date: _____

Customer name: _____

(All other farm loads must be off. Use only one load per circuit)

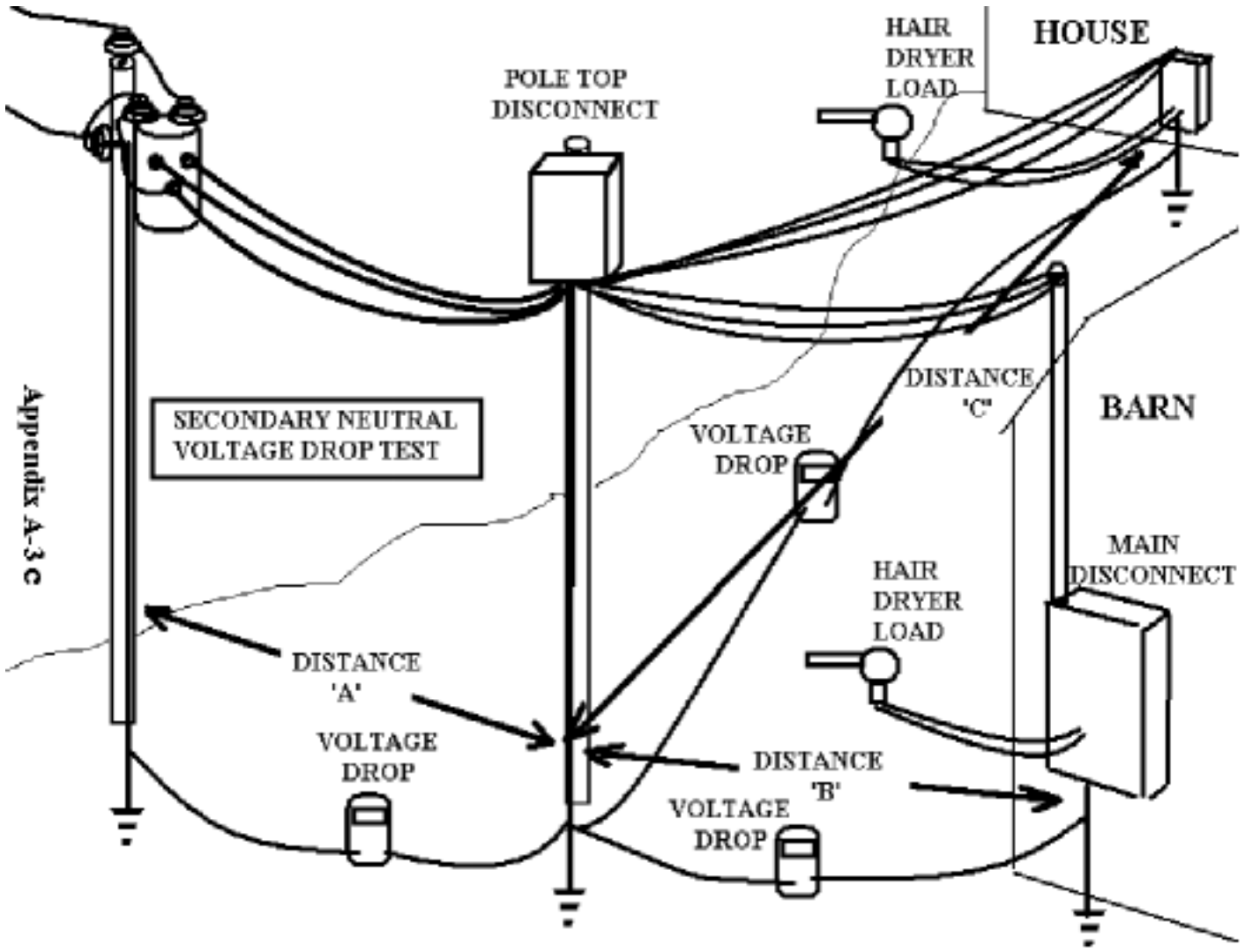
	SITE:	1	2	3	4	5	
	Site Location:						**UNITS**
A.	Circuit neut. wire gauge						
B.	Wire length (in 100's ft.)						100 ft
C.	Ω/100ft.						Ω
D.	Total Q (B times C)						Ω
E.	Measured neut. Current						A
F.	Calculated voltage drop (D times F)						V
G.	Measured voltage drop						V
H	Percent difference ({|G-F|}/G *100)						%
	Vp load off						V
	Vs load off						V
	Vcc load off						V
	Vp load on						V
	Vs load on						V
	Vcc load on						V

SECONDARY NEUTRAL VOLTAGE DROP TEST INSTRUCTIONS

ITEM	EXPLANATION
1	Enter names of those performing test
2	Enter date test is performed
3	Enter customer name
4-8	Describe load site location, neutral wire gauge, neutral wire length (in 100's of feet), resistance per 100 feet (see table below), measured neutral current, measured voltage drop, Vp, Vs and Vcc for load off and load on.
9-13	Calculate the total circuit resistance. Calculate, using Ohm's Law, the expected neutral voltage drop. Calculate the absolute value of the difference and divide by the measured voltage drop. Express this as a percentage. If the two values (measured voltage drop and calculated voltage drop) do not agree, further investigation is warranted to discover the reason for the discrepancy. Prioritize your investigation to look at the largest percentage difference cases first.

Resistance Chart (Ohms per 100 feet)

MATERIAL				MATERIAL		
GAUGE	AL	CU		GAUGE	AL	CU
14	0.42	0.26		2	0.027	0.016
12	0.26	0.16		1	0.021	0.013
10	0.17	0.10		1/0	0.017	0.010
8	0.11	0.064		2/0	0.013	0.008
6	0.67	0.041		3/0	0.011	0.006
4	0.34	0.020		4/0	0.008	0.005


Appendix A-3 c
SECONDARY NEUTRAL
VOLTAGE DROP TEST
POLE TOP
DISCONNECT
HAIR
DRYER
LOAD
HOUSE
DISTANCE
'C'
BARN
VOLTAGE
DROP
MAIN
DISCONNECT
HAIR
DRYER
LOAD
DISTANCE
'A'
VOLTAGE
DROP
DISTANCE
'B'
VOLTAGE
DROP

SIGNATURE TEST FORM

Customer Name: _____ Date: _____

	Type of Load	Location	Time On	Time Off	(*)
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					
21					
22					
23					
24					
25					
26					
27					
28					
29					
30					
31					
32					
33					
34					
35					

SIGNATURE TEST FORM INSTRUCTIONS

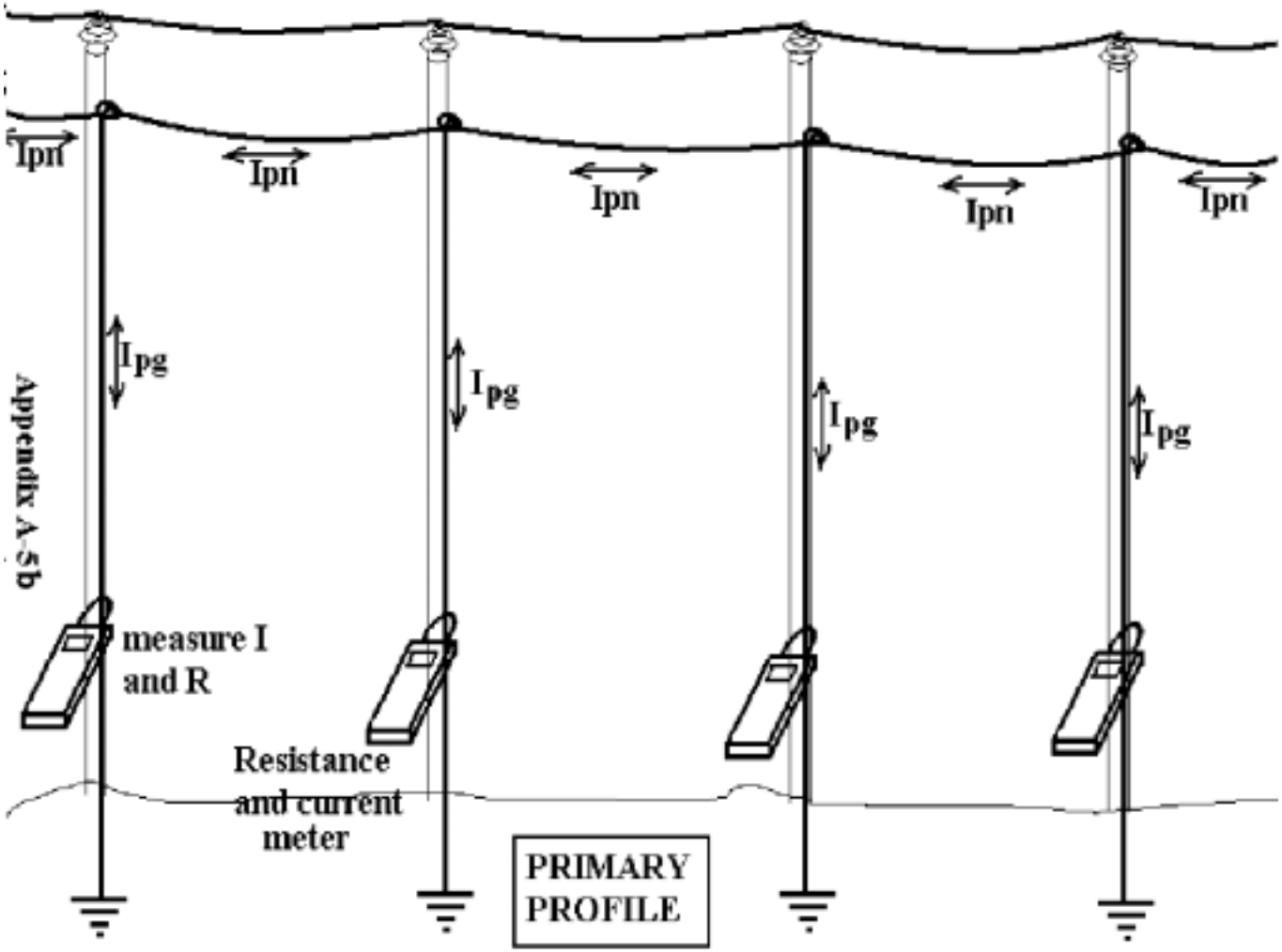
ITEM	EXPLANATION
1	Enter the date the test is performed.
2	Enter the customer's name.
3	Enter the description of the load for which the signature will be recorded (If using a hair dryer, note it as HD).
4	Enter the location of the load.
5	Note the time of turn-on and time of turn-off. Equipment should be on for a period of not less than 10 seconds. If equipment is found in the on condition, turn it off then turn it back on and note the event with a star in the right column to make sense of the difference in on and off time events.
6	Repeat for all major circuits and pieces of equipment (both 120 volt and 240 volt). Some equipment may normally be operated in sequence. Start each piece at 15-second intervals until all are running, then turn off in reverse order in 15-second intervals.

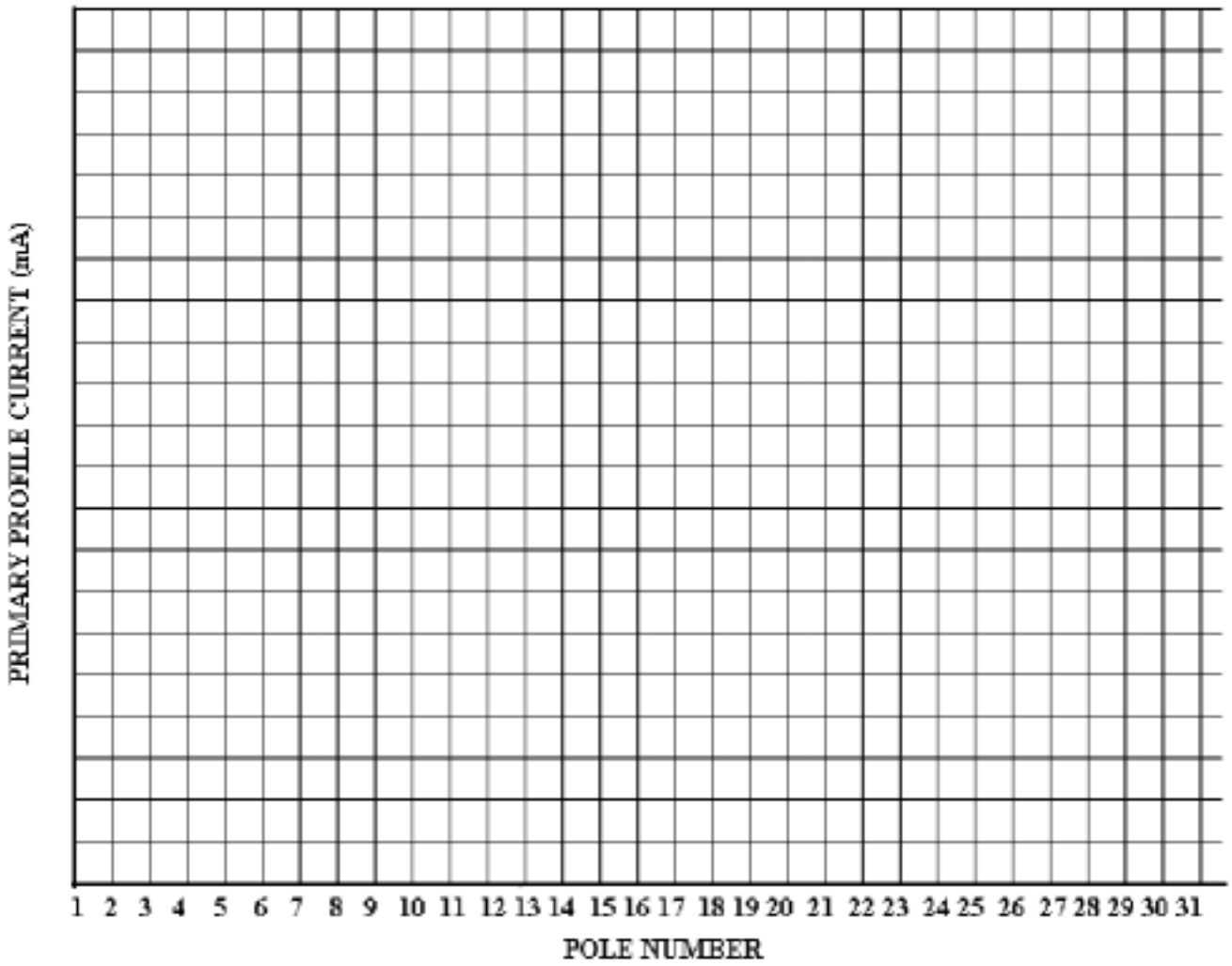
PRIMARY PROFILE DATA FORM

Customer name:_____ Date: _____
Test performed by: _____

Record the current (Ipg) and the resistance (Rpg) of each ground rod in a linear pattern ¾ ths of a mile on each side of the farm's tap/transformer pole. Calculate, using Ohm's Law, the primary neutral to earth voltage (Vpne) for each pole. Use the notes section to annotate the condition of each pole and if the pole has a transformer, capacitor bank, recloser, arrestor, telephone pedestal or CATV device, etc. attached.

POLE #	POLE ID #	Ipg (mA)	Rpg (Ω)	Calc. Vpne (V)	Notes
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					
21					
22					
23					
24					
25					
26					


Ipn
Ipn
Ipn
Ipn
Ipn
Ipg
Ipg
Ipg
Ipg
Appendix A-5b
measure I
and R
Resistance
and current
meter
PRIMARY
PROFILE



Appendix A-5 C

PRIMARY PROFILE RESISTANCE (ohms)

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31

POLE NUMBER

Appendix A-5d

PRIMARY PROFILE VOLTAGE (volts)

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31

POLE NUMBER

Appendix A-5e

"24-HOUR" TEST REPORT FORM

Customer name: _____ Date: _____

Start time: _____ Stop time: _____

Measure the following points with a long term digitizing data recorder: Vp from the primary pole ground rod to remote reference, Vs from the barn's main disconnect panel neutral/ground electrode, Vps between the previous two points, and Vcc, the cow contact voltage.

Data Recorder Settings and Assignments:

Waveform capture: OFF, Impulse capture: ON, Record min RMS: NO, Record RMS: YES, Record max RMS: YES, Record time: Maximum, RMS Storage interval: 10 Sec.

Channel	Variable	Inputs	Lower RMS	Upper RMS	Impulse
Red	**Vp**	**ON**	**OFF**	**OFF**	**15 V.**
Black	**Vs**	**ON**	**OFF**	**OFF**	**15 V.**
Blue	**Vps**	**ON**	**OFF**	**OFF**	**15 V.**
White	**Vcc**	**ON**	**OFF**	**ON, 3V.**	**10 V.**

After recording the data, analyze the reports section and record the following for the number of occurrences of each type of event. The first is from the excedence report and the second two are from the out-of-limits report.

1. VOLTAGE LEVEL: exceeding 1.0 v. RMS max. Occurrences: ☐

2. VOLTAGE LEVEL: exceeding 3.0 v. RMS max. Occurrences: ☐

3 IMPULSE VOLTAGE LEVEL:
exceeding 10.0 v. PEAK max.
(For a time duration of 130 microseconds
to 16.67 milliseconds.) Occurrences: ☐

Additional comments: