BEFORE THE STATE OF WASHINGTON

ENERGY FACILITY SITE EVAUATION COUNCIL

In the Matter of Application No. 2003-01: SAGEBRUSH POWER PARTNERS, LLC; KITTITAS VALLEY WIND POWER PROJECT	EXHIBIT 40 (AN-T)

APPLICANT'S PREFILED DIRECT TESTIMONY
WITNESS # 21: ARNE NIELSEN

Q Please state your name and business address.

A My name is Arne Nielsen and my business address is 7660 Whitegate Avenue, Riverside CA 92506.

Q Please summarize and briefly describe your educational background and wind power project work experience.

A I hold a Bachelors of Science Degree in mechanical engineering. I have been active in the wind industry since 1983. I have worked with numerous major wind turbine manufacturers including Vestas, Bonus, and NEG-Micon in research and development, repair and retrofit,

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manufacturing, wind farm design, wind analysis, project development, sales, and construction. Since 1991 I have provided wind energy consulting services through Wind Engineers, Inc. (WEI) which specialize in environmental modeling, wind resource assessments, anemometry installation & monitoring, and wind energy project design. WEI has prepared numerous wind reports, project layouts, array-loss assessments, noise and shadow-flicker models, and visual simulation work for projects constructed throughout the USA.

Q What is your present occupation, profession; and what are your duties and responsibilities?

A I am the Chief Engineer and President of an engineering consulting firm called Wind Engineers. Our firm specializes in the engineering and analysis of wind power projects both up and operating, and also under development around the USA. As the Chief Engineer, I am responsible for the review of any analyses performed and reports prepared by our technical staff. For the Kittitas Valley wind power project, I personally performed the shadow flicker analysis and oversaw the preparation of the visual photo simulations.

Q Would you please identify what has been marked for identification as Exhibit 40-1 (AN-1).

A Exhibit 40-1 (AN-1) is a résumé of my educational background and employment experience.

Q Are you sponsoring any portions of the application for site certification for the Kittitas Valley Wind Power Project?

A Yes. I am sponsoring the shadow flicker analysis of the Clarification Information provided to

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EFSEC on June 25, 2003.

Q Are you familiar with this information provided to EFSEC?

A Yes.

Q Did you prepare these sections and exhibits, or, if not, did you supervise their preparation?

A Yes.

Q Are the contents of the Clarification Information provided to EFSEC on June 25, 2003 either based upon your own knowledge, or upon evidence, such as studies and reports that reasonably prudent persons in your field are accustomed to rely on in the conduct of their affairs?

A Yes.

Q To the best of your knowledge, are the contents of the Clarification Information provided to EFSEC on June 25, 2003 true?

A Yes.

Q Do you incorporate the facts and content of the Clarification Information provided to EFSEC on June 25, 2003 as part of your testimony?

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A Yes.

Q Are you able to answer questions under cross examination regarding the Clarification Information provided to EFSEC on June 25, 2003?

A Yes.

Q Do you sponsor the admission into evidence Clarification Information provided to EFSEC on June 25, 2003?

A Yes.

Q Are there any corrections or clarifications to be made to those portions of the Application that you are sponsoring?

A No.

Q Please briefly explain what shadow casting and shadow flicker are.

A Shadow casting is when direct sunlight causes an object to cast a shadow on the ground or on objects. Shadow flicker caused by wind turbines is the phenomenon created by direct sunlight casting a moving shadow through the rotating blades onto the ground or onto stationary objects within the shadowed area. At any given location within the range of the shadow, a flickering effect is then obvious when the shadow passes. The shadow flicker effect within a dwelling can

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be defined as alternating changes in light intensity on stationary objects, such as a window, a glass door or a patio at a dwelling. Shadow flicker is not the alternating shadow/light effect one experiences while moving between light and shadow as one might experience running through the woods on a sunny day.

Q To the best of your knowledge, are there any documented human or animal health impacts associated with shadow flicker from wind turbines?

A No, not from wind turbines. We did investigate the possibility of photosensitive epilepsy sensitivity from the Project. Photosensitive epilepsy is a type of epilepsy which is triggered from the flickering or flashing of light in people suffering from that kind of epilepsy. The Epilepsy Foundation has excellent information available which explains photosensitive epilepsy. The frequency known to trigger seizures is between 5 and 30 flashes per second. The shadow flicker frequency from wind turbines vary between 0.5 and 1 flashes per second for all of the turbine scenarios under consideration for the Project, which is considerably less than the frequency known to trigger photosensitive epilepsy seizures.

Q Under what conditions does shadow flicker usually occur?

A Unless the receptor is very close to the turbine, shadow flicker usually occurs in the morning or evening when the shadows are "long". No shadow flicker will be present when the sun seen from a receptor is obscured by clouds, fog, or by objects already casting a shadow. Also, when the turbine is not operating, or when the rotor is turned parallel to a line between the receptor and the turbine, there will be no shadow flicker. The shape of the shadow flicker area that is

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most affected, duration wise, around a turbine is shaped like a butterfly – with the longest durations and longest shadows to the northeast, northwest, southeast and southwest. The intensity is highest closer to the turbine.

Q Please explain what is meant by the intensity of shadow flicker.

A The intensity of shadow flicker is defined at the observed difference in light intensity between being in the shadow and being out of the shadow cast by the turbine blades. The intensity of shadow flicker depends on the distance from the turbine. Closer to the turbine, the blades will tend to block more of the sun's rays as they pass through the line of sight between the observer and the sun and the shadow line appears relatively wide and dark. This is a relatively high shadow flicker intensity. At distances further away from the turbine, the blades block far less of the sun's rays to the observer and the blade shadows appear thinner and fainter. This is a relatively low shadow flicker intensity.

Q What other factors influence the intensity and duration of shadow flicker?

A The intensity and duration both diminish with the distance to the turbine. Other factors are clouds, trees and other obstructions, wind direction and the locations of windows. For shadow flicker effects inside a dwelling through windows and doors, the duration and intensity depends on all of the above factors plus the size and orientation of windows and doors, blinds and curtains. Both the intensity and duration of shadow flicker is reduced when non-transparent objects are located between the turbine and the receptor – such as buildings, trees, blinds and curtains. When a room is illuminated by light from other windows than the shadowed window

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(such as indoor lighting), then the flicker intensity is significantly mitigated.

Q Please explain how the shadow flicker analysis for a wind power project like the Kittitas Valley project is performed.

A Turbine locations and dwellings are digitized or imported into the modeling software along with turbine dimensions and terrain elevations. Then wind data (speed and direction) is imported as is average sunshine frequency. The model assumes a window on every side (north, south, east, west) of each dwelling, in the project area. Then the model is run and the results are tabulated and plotted.

Q Please explain the models used for visual simulation and shadow flicker analysis at the KVWPP and give a brief summary of the results.

A The model we used, Wind Pro, produced by EMD of Denmark, has been developed over the last 15 years and is internationally accepted. Some 560 companies and organizations hold licenses to the software, many of which are governmental permitting agencies. A list of their primary licensed customers is available on the software developer's web-site.

The visual simulation model uses photograph images that are taken in the field at a specific geo-referenced location using a GPS. The photographs were taken at specific locations based on guidance from Tom Priestley who was retained to perform a visual impact assessment for the Project. The computer model positions 3-dimensional projections of the wind turbines into the image with the correct proportions and shading to create a visual simulation of the turbines as

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would be seen from the specific location where the photograph was taken. The visual simulation or photomontage program contains information on the earth's orbit and rotation relative to the sun. General input parameters are local topography, turbine locations, turbine color and reflection. Input for the individual visual simulations are date and time the photo was taken, camera location and direction the photo was taken. The date and time is used to create shadowed areas on the turbines and to simulate the expected reflection and color hue.

The shadow flicker model calculates the path of shadows which are cast by the wind turbines based on various inputs specific to the Project. The model contains information on the earth's orbit and rotation relative to the sun and the location of the project on the earth's surface. Input variables to the model include: turbine dimensions, local topography, individual turbine locations, locations of residences, wind distribution including wind directions, average monthly sunshine or overcast hours, window properties – orientation, size, angle from horizontal and distance from the ground. The outputs are tables and plots showing which time intervals a specific receptor will be affected by shadows generated by one or more turbines. Project calculations represent the worst case in terms of estimating obstructions since items such as trees, adjacent buildings, etc. that would obstruct shadow flicker effects on receptors were not considered by the model. The model assumed a clear line of sight path without obstructions. Cloud coverage and sunshine days were obtained from NOAA (National Oceanic and Atmospheric Administration).

The study shows residences which do fall in the shadow path of the turbines receive on average between 20 (about 2 tenths of one percent of the hours in a year) and 40 hours (about half of one percent of the hours in a year) of shadow flicker per year in the worst case assuming sunshine on

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all of the days when shadows do fall on the residences. Some of these impacted residences have trees around their properties as well window dressings, such as curtains and blinds that have not been modeled, but which will further reduce the amount of shadow flicker time and intensity from what is predicted by the model. The model runs also assumed windows on all sides of the residences. I feel that the model assumptions are very conservative and result in correspondingly conservative and prudent estimates of the anticipated shadow flicker levels that would be experienced at the impacted residences.

Q Please give an indication of the number of hours per year shadow flicker could occur at the most impacted residence of a non participant of the Kittitas Valley Wind Power Project.

A The non participating residence with the highest predicted shadow flicker impact has rows of turbines both east and west of the residence and would receive flicker for approximately 84 hours per year (less than 1% of the time) in the worst case assuming windows on all sides of the residence, sunshine every day and no trees or window treatments. The 84 hours were split with approximately 45 hours of shadow in the mornings from the east (i.e. about 0.5% of the time) and 39 hours in the evenings from the west (i.e. about 0.4% of the time) annually. The maximum shadow flicker on any one day was calculated at 1.4 hours (1 hour and 24 minutes) which would consist of a maximum of approximately 42 minutes of shadows from the east and 42 minutes from the west in the worst case.

Q Based on your analysis, and experience with operating wind power projects, do these levels of shadow flicker impact appear to indicate that special mitigation measures to reduce the impacts should be performed?

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A No, for the levels of shadow flicker calculated for the Project with these standard modeling parameters applied, mitigation would not be customary compared to other wind power projects installed around the USA. My analysis has revealed no circumstances at the Project that would require mitigation, mainly due to the expected very low flickering intensity.

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EXHIBIT 40-1 (AN-1)

CURRICULUM VITAE
ARNE NIELSEN

WORK EXPERIENCE

5/00 – present Wind Engineers, INC.
Position: Project Consultant / Owner

- Certification by Risø in the use and implementation of WAsP modeling. The certification included aspects of wind resource assessments. Risø is recognized as banks engineers for wind resource assessments and project due diligence.
- Development and installation of precise and conventional anemometry packages, anemometry contributing to the largest uncertainty in wind resource assessments in non-complex terrain.
- Preparation of wind reports and wind resource assessments. Preparation of 3rd
- party wind reports including uncertainties and detailed confidence levels.
- Responsible for computer modeling of: noise, shadow-flicker, photomontage,
- wind farm visibility (ZVI) and modeling of wind variations due to terrain (WAsP) and structured array optimization.
- Responsible for power performance testing and site calibration campaigns including supervision of equipment installation, calibration, monitoring and preparation of reports.
- Development and preparation of wind resource maps showing the most energetic sites within a given boundary.
- Responsible for validation of wind modeling efforts by conducting precise short term anemometry measurement campaigns.
- Preparation of reports and briefings on power quality, utility performance standards and utility interconnection requirements. Conducted studies on wind farm power fluctuations, ramp rates and frequency variations on isolated utility systems. Evaluation of short term storage techniques, economics and controls.
- Early development of wind sites, identification of sites, installation of met. Towers and identification of long term reference wind monitoring stations.
- Preparation of bidding packages for utility RFP's.
- Development and implementation of state of the art methods for turbine siting (GPS, 3D moving map).
- Assigned by enXco to develop wind energy projects in Turkey. Spent 5 months in Izmir Turkey monitoring potential project sites. Implemented early development processes – development conditions being vastly different than European and American conditions.

10/98 – 5/00 NEG-MICON USA, INC.
Position: Project Director

- Responsible for most elements of installation, commissioning and power performance testing of approximately 550 wind turbines.
- Review of contracts and supply agreements for installation, commissioning and testing of NEG-Micon's 750 kW turbines.
- Negotiations with customers and vendors.
- Performed analyses of the progress of installation work. Developed progress reports and made recommendations for adjustments in order to close projects on time.

10/95 - 10/98 SAME MARINE SYSTEMS, INC.
Position: Project Consultant / Owner

- Preparation of documentation for park and turbine efficiencies in wind parks using state of the art software (WindPRO). Recommendations and consulting during project development phase in cooperation with meteorologists.
- Preparation of documentation for noise and shadow-flicker impacts from wind parks using state of the art software (WindPRO). Recommendations and consulting during project development and permitting process.
- Project management and responsible for noise reduction of current line of wind turbines at Zond Energy Systems, Inc., including in depth scrutinization of design of blades, gearboxes, generators, brake systems, yaw motors and yaw gears, towers and yaw decks, hydraulic motors and pumps.
- Preparation of spreadsheets for data treatment and graphing of results of the sound tests. Preparation of engineering memo's and reports according to current international sound standards.
- Made strain gauge, oil temperature, oil pressure measurements and power curve measurements on Vestas, Danwin, NedWind, Advanced Energy Corporation wind turbines using equipment and software especially developed for use on wind turbines. This equipment and software has been developed over the years on an as needed basis for the harsh environmental conditions in the desert.
- Prepared reports on measurements made including charting, data analysis and calibration of equipment.
- Designed and installed oil cooling units Bonus turbines.
- Development of improvements for Apollo Energy Corporation's wind turbine power plant on Hawaii including high voltage power collection system, substation, wind turbines and communication system.
- Responsible for ongoing supervision of service crews on Apollo Energy Corporation's site on Hawaii. Frequent site visits are made where updates, retrofits and improved procedures are implemented.

10/94 - 10/95 VESTAS AMERICAN WIND TECHNOLOGY, INC.
Position: Project Manager

- Responsible for preparation of turn-key quotes for wind power plants. Quotes included wind turbines, towers, foundations, central monitoring system, transformers, transmission lines, sub-stations and other high and low voltage power collection system as well as other infrastructure.
- Participated in due diligence studies on wind parks. Re-design and evaluation of wind power plant layouts. Scrutinization of especially re-powering projects for possible increase of overall plant efficiencies.
- Responsible for wind turbine micro siting including terrain influences, array loss calculations, transmission line loss estimates, etc.
- Coordination and information exchange between potential finance sources and developers / wind plant owners.
- Located and worked with suppliers and construction companies for wind plant installations. Negotiated pricing, terms, bonds etc.
- Project development and pricing of numerous wind plants, wind / pumped hydro storage systems and power regulation / management systems.
- Development of detailed spreadsheet for quotation purposes.
- Worked on market development on an ongoing basis with Vestas' agents and representatives i.e. by attending trade shows and company visits. Developed working relationships with potential agents and customers in the US, Canada and Mexico.
- Acquiring wind data and other environmental data for production verification and estimation purposes and for data base purpose.
- Explored power quality delivered from various wind turbine types. Introduced power quality measurement scheme usable for wind plants and complying with IEEE519 recommendations.
- Performed power quality measurements on wind turbines using state of the art measurement equipment. Reporting of results and comparisons of various production scenarios.
- Project development with CFE (Comision Federal de Electricidad) in Mexico, based on exchange of information, coarse pricing and detailed discussion of wind power plant type and layouts. Different options in construction principles and methods were treated in detail.
- Investigations for optimizing the high voltage collection system, lightning protection and transformer configurations for a proposed 27 MW wind power plant in La Venta, Mexico.
- Follow-up on existing wind park installation in La Venta, Mexico. Responding to and assisting New World Power and New World Entec in performing trouble finding, repair and O&M.
- Performed parallel power curve measurements for production verification purposes. Data treatment and brief reporting of results.
- Collection and formatting of wind data from weather stations and data processing and reporting of collected wind data using Microsoft Access.

1992 - 10/94 SAME MARINE SYSTEMS, INC.
Position: Project Consultant / Owner

- Project manager on various test and measurement projects. Mainly for wind turbine production increase and load determination purpose. Coordination with and reporting to domestic and foreign organizations and companies involved in the test projects, i.e. Apollo Energy Corporation, Dutch Energy Corporation, Dutch Pacific Partners, NedWind, Det Norske Veritas, Risø, SeaWest, BTM Consult Corp., Enerpro, Windgineering (Danwin), Danish Energy Agency, LM Glasfiber, HPA Trading, Dansk Vindteknik.
- Representative in US for Mita Teknik, Denmark. The largest manufacturer of wind turbine microprocessor controllers and a major manufacturer of electronic control & communication equipment.
- Development and installation of lightning and over voltage protection systems, electronic control equipment and microprocessor software for wind turbines.
- Installation of wind turbine monitoring equipment and wind farm management systems. Coordination between software developers.
- Development, purchase, installation and monitoring of state of the art test and data acquisition equipment including systems for i.e.:
    - Advanced anemometry.
    - Precise power production measurements.
    - Precise load and vibration measurements.
- Data treatment, analysis and preparation of test reports including i.e.:
    - Wind potential analysis and documentation.
    - Power curve comparisons and documentation.
    - Lifetime fatigue load spectra and fatigue load comparisons.
    - Determination on PSD and sources.
    - Documentation of test equipment accuracy and calibration.
- Engineering and consulting for various companies, i.e. Apollo Energy Corporation, Dutch Energy Corporation, Vestas, NedWind, Dutch Pacific Partners, SecondWind, SeaWest, Difko, BTM Consult Corp., Enerpro, Field Service & Maintenance, Whitewater Service Corporation, Mita Teknik, Thorsted Maskiner and HPA Trading on an ongoing basis.
- Development and implementation of US manufactured components into various Danish wind turbines.
- Measurements and recommendations for optimizing operational characteristics of various electrical and mechanical components in wind turbines.
- Recommendations for optimizing wind turbine rotor performance.
- Development of software for PC based measurements on wind turbines. Mainly for production verification, enhancement and optimization purposes.
- Custom fit / re-design of comprehensive science, engineering and graphic computer programs (Turbo Pascal) for data acquisition, analyzing and reporting purpose.

- Re-developing of procedures and software for determination of wind potentials at remote sites where little long-term anemometry has been recorded.
- Development and implementation of ISO 9000 series Quality Control procedures at organization level.

1988 - 1992 BONUS WIND TURBINES, INC. / TURBINE MAINTENANCE CORPORATION, BOTH US DIVISIONS OF BONUS ENERGY, BRANDE, DENMARK.
Position: Retrofit Engineer

- Development and dimensioning of retrofit kits for existing wind turbines with Bonus Energy, Denmark.
- Responsible for the testing and optimization of the wind turbine retrofit kits.
- Assistance in the estimation of minor repairs on large wind farms.
- Start-up and monitoring of an extensive retrofit program consisting of 550 108 kW wind turbines owned by Difko Administration, including i.e. setup of shop facilities, cranes and equipment, supervision and some hiring.
- Coordination and development of special equipment with local subcontractors for the production line and installation process at the wind farm.
- Responsible for the development, re-design and implementation of wind turbine controller hardware and software with Mita Teknik, Denmark.
- Assisting in the implementation of a practical functional quality assurance system (ISO 9000, Norske Veritas) for the retrofit program.
- Optimization and follow-up on the dimensioning of the retrofit kits by making comprehensive strain gage measurements, data treatment and reports.
- Development of user friendly wind turbine controller operation features with Mita Teknik, Denmark.
- Writing and implementing functional Service, Operation and Maintenance manuals including complete electrical and hydraulic schematics and trouble finding procedures.
- Re-design of PC science, engineering and graphic computer programs for data acquisition, analyzing and reporting purpose.

1985- 1988: Danish Wind Power A/S Kauslunde, Denmark.
POSITION: R&D Engineer

- Responsible for the design and upgrade of a 65 kW wind turbine to a 110 kW.
- Re-design and dimensioning of tower, yaw system, rotor, hydraulic brake system and canopy with subcontractors (Lindenau Verft, Germany. Dannebrog Værft, Denmark. Parker Hydraulics, Denmark).
- Assistance in the re-design of the gearbox at Kumera OY's plant in Finland.
- Responsible for the preparation of all dimensioning documentation including strain gage measurements on the prototype turbine.
- Test and implementation of the hydraulic brake system with Sabroe Værft, Denmark and Parker Hydraulics, Denmark.

- Preparation of all structural documentation and obtained approvals from Risø, the Danish test and approval facility for wind turbines.
- Specification of controller functions and operation features and implementation of a state of the art controller design from KK-Electronic, Denmark.
- Follow-up on quality control at various subcontractors in Denmark, Germany, Portugal and Finland.
- Supervision and hands on experience during the installation and commissioning of 50 110 kW turbines in Tehachapi, Ca.
- Follow-up on component malfunctions and repairs. Development and implementation of procedures for replacements and repairs.
- Total responsible for the development, design and dimensioning of new integrated 150 kW turbine. Subcontractors were i.e. Dorstener Maschinenfabrik, Germany, LM Glasfiber, Denmark. Sabroe Værft, Denmark. Efacec, Portugal. Parker Hydraulics, Denmark. KK-Electronic, Denmark.
- Responsible for the preparation of all the documentation and testing necessary to meet construction codes, sales information and safety requirements from Arbejds Tilsynet, Denmark - the Danish safety approval facility.
- Obtained approval from Risø, the turbine being the largest commercial manufactured wind turbine at that time.
- Writing and implementing an Operation, Service and Maintenance manual.
- Introduced the 150 kW turbine to the Indian market. The Indian partners were ABB (Asea Brown Bovery) Baroda, Delhi, Madras, Bombay.
- Supervision during installation and commissioning of a pilot wind turbine at DCW Chemicals, a remote site near Tutticorin, Tamil Nadu, India without any kind of modern equipment.
- Development of a reliable short-term wind potential measurement program, utilized at several Indian Government owned Meteorological Stations, parallel with different remote locations in India.
- Negotiation and initialization of know-how transfer to the Indian partners.
- Preparation and design of a 22.5 MW wind turbine power plant in India, including micro siting and dimensioning of the electrical systems.
- Education and training of Indian engineers and technicians, including the writing of all educational pamphlets.
- Total responsible for development, design and dimensioning of a 65 kW integrated wind turbine for the German market. Obtained approval from Germanischer Lloyd.
- Installed, commissioned and followed up on the 65 kW prototype in Germany.

EDUCATION

1978 - 1985: Odense Teknikum

Engineering degree and agricultural degree.

Bachelor Degree in Mechanical Engineering. Specialty achievements in electrical controls and regulation.