SBW-3

INTERCONNECTION AGREEMENT FOR LEMPSTER WIND PROJECT

THIS INTERCONNECTION AGREEMENT (this "Agreement") dated January 2, 2008 ("Effective Date") is by and between **LEMPSTER WIND, LLC**, a Delaware limited liability company having its principal office at 201 King of Prussia Road, Suite 500, Radnor, Pennsylvania 19087 (hereinafter the "Interconnector"), and **PUBLIC SERVICE COMPANY OF NEW HAMPSHIRE**, a New Hampshire corporation having its principal office at 780 North Commercial Street, Manchester, New Hampshire 03105 (hereinafter "PSNH"). Interconnector and PSNH are each referred to as a "Party" and collectively as the "Parties".

RECITALS:

WHEREAS, Interconnector's twenty-four (24) megawatt ("MW") electric generating facility, as more particularly described in Exhibit A (the "Facility"), which is located in Lempster, New Hampshire, will be interconnected to PSNH's electric transmission and distribution system (the "PSNH Electric System") in accordance with Applicable Laws (as defined below); and

WHEREAS, Interconnector represents, covenants and warrants that, prior to the date on which Energy (as defined below) is first delivered from the Facility to the PSNH Electric System (the "Initial Synchronization Date"), Interconnector's Facility will be certified as a QF under PURPA (as defined below); and

WHEREAS, the Parties now wish to enter into this Agreement to govern the interconnection of the Facility to the PSNH Electric System; and

WHEREAS, the Interconnector and PSNH have entered into a separate Power Purchase Agreement dated as of the Effective Date (the "Power Purchase Agreement") for PSNH to purchase the Facility's Energy, capacity ("Capacity") and RECs (as defined in the Power Purchase Agreement).

NOW, THEREFORE, for good and valuable consideration, the receipt and sufficiency of which is hereby acknowledged by Interconnector and PSNH, the Parties hereby agree as follows:

1. **Definitions**.

"Access Party" has the meaning provided in paragraph 1(f) of Exhibit C to this Agreement.

"Agreement" has the meaning provided in the first paragraph of this Agreement.

"Applicable Laws" means all duly promulgated applicable federal, state and local laws, regulations, rules, ordinances, codes, decrees, judgments, directives, or judicial or administrative orders, permits and other duly authorized actions of any Governmental Authority.

"Breach" has the meaning provided in Section 8(b) of this Agreement.

"Capacity" has the meaning provided in the recitals to this Agreement.

"Change In Law Or ISO-NE Rules" has the meaning provided in Section 19(a) of this Agreement.

"Dedicated Distribution Circuit" has the meaning provided in Exhibit B of this Agreement.

"Distribution Circuit Upgrades" has the meaning provided in Exhibit B of this Agreement.

"Effective Date" has the meaning provided in the first paragraph of this Agreement.

"Emergency Condition" has the meaning provided in Section 1(e) of Exhibit D of this Agreement.

"Energy" means the three-phase, 60-cycle alternating current electric energy output of the Facility.

"ESCC" has the meaning provided in Section 18 of this Agreement.

"Event of Default" has the meaning provided in Section 8(c) of this Agreement.

"Facility" has the meaning provided in the recitals to this Agreement.

"FERC" has the meaning provided in Section 16 of this Agreement.

"Force Majeure" has the meaning provided in Section 10 of this Agreement.

"Good Utility Practice" has the meaning provided in paragraph 1(a)(i) of Exhibit C to this Agreement.

"Governmental Authority" has the meaning provided in Section 8(d) of this Agreement.

"Granting Party" has the meaning provided in paragraph 1(f) of Exhibit C to this Agreement.

"Indemnified Party" has the meaning provided in Section 9(a) of this Agreement.

"Indemnifying Party" has the meaning provided in Section 9(a) of this Agreement.

"Initial Synchronization Date" has the meaning provided in the recitals to this Agreement.

"Initial Term" has the meaning provided in Section 8(a) of this Agreement.

"Interconnection Point" has the meaning provided in Section 2(b) of this Agreement.

"Interconnector" has the meaning provided in the first paragraph of this Agreement.

"Interconnector Interconnection Facilities" has the meaning provided in Section 2(d) of this Agreement.

"ISO-NE" has the meaning provided in Section 3(b) of this Agreement.

"ISO-NE Documents" means (i) the ISO New England Inc. Transmission, Markets and Services Tariff, ISO New England Inc. FERC Electric Tariff No. 3 (Section III - Market Rule 1 – Standard Market Design), (ii) ISO-NE manuals, rules, regulations, procedures and related documents, (iii) any successor to the documents in subsections (i) and (ii) above, or (iv) requests, orders or directives of ISO-NE.

"ISO-NE Requirements" has the meaning provided in Section 18 of this Agreement.

"ISO-NE System Impact Study" has the meaning provided in Exhibit B to this Agreement.

"Meter" has the meaning provided in Section 3(b) of this Agreement.

"NHPUC" has the meaning provided in Section 3(b) of this Agreement.

"NTP" has the meaning provided in paragraph 1(a)(iii)(2) of Exhibit C to this Agreement.

"Notice Of Modification" has the meaning provided in Section 5(c)(i) of this Agreement.

"OP-18" has the meaning provided in Section 3(b) of this Agreement.

"Parties" has the meaning provided in the first paragraph of this Agreement.

"Party" has the meaning provided in the first paragraph of this Agreement.

"Power Purchase Agreement" has the meaning provided in the recitals to this Agreement.

"PSNH" has the meaning provided in the first paragraph of this Agreement.

"PSNH Electric System" has the meaning provided in the recitals to this Agreement.

"PSNH Interconnection Facilities" has the meaning provided in Section 2(c) of this Agreement.

"PSNH Interconnection Report" has the meaning provided in Exhibit B to this Agreement.

"PSNH's Estimated Design & Construction Costs" has the meaning provided in paragraph 1(a)(i) of Exhibit C to this Agreement.

"PURPA" has the meaning provided in Section 16 of this Agreement.

"QF" has the meaning provided in Section 16 of this Agreement.

"Review Period" has the meaning provided in Section 5(c)(i) of this Agreement.

"Reasonable Efforts" has the meaning provided in paragraph 1(a)(i) of Exhibit C to this Agreement.

"Renewal Term" has the meaning provided in Section 8(a) of this Agreement.

"Rules" has the meaning provided in Section 11(c) of this Agreement.

"TBP" has the meaning provided in Attachment 2 to Exhibit C of this Agreement.

"Term" has the meaning provided in Section 8(a) of this Agreement.

"Third Party Contractor" has the meaning provided in paragraph 1(a)(ii) of Exhibit C to this Agreement.

"Verizon" has the meaning provided in paragraph 1(a)(vi) of Exhibit C to this Agreement.

"Verizon Adverse Impact" has the meaning provided in paragraph 1(a)(vi) of Exhibit C to this Agreement.

"Verizon Agreement" has the meaning provided in paragraph 1(a)(vi) of Exhibit C to this Agreement.

2. **Interconnection and Voltage Characteristics**.

(a) Interconnection Service. PSNH shall permit the interconnection of the Facility to the PSNH Electric System at the Interconnection Point thereby enabling the delivery of Energy and Capacity at the Interconnection Point in accordance with the terms and conditions of this Agreement. The execution of this Agreement does not constitute a request for, nor the provision of, transmission delivery service.

(b) Interconnection Point. The interconnection point (the "Interconnection Point") shall be that point at which the Facility interconnects with the PSNH Electric System, which point is described as the "Delivery Point" in Attachment 2 to Exhibit B the location of which is identified on Sketch SK-AJM-260-1 attached to Attachment 2 to Exhibit B.

(c) PSNH Interconnection Facilities. The interconnection facilities identified in Attachment 2 to Exhibit B that will be owned by PSNH and, to the extent deemed necessary or appropriate by PSNH, a portion thereof may be owned by PSNH's designee(s) (collectively, hereinafter the "PSNH Interconnection Facilities") shall be procured, constructed and installed (at the Interconnector's sole cost and expense) in accordance with the requirements set forth in Exhibit C. Interconnector shall reimburse PSNH for one hundred percent (100%) of the costs for the design, construction, installation and testing of the PSNH Interconnection Facilities in accordance with the requirements set forth in Exhibit C. The PSNH Electric System and the PSNH Interconnection Facilities shall be operated, maintained and controlled in accordance with the requirements set forth in Exhibit D and all other applicable provisions of this Agreement.

(d) Interconnector Interconnection Facilities. The interconnection facilities identified in Attachment 2 to Exhibit B that will be owned by Interconnector (the "Interconnector Interconnection Facilities") shall be procured, constructed and installed at Interconnector's sole expense in accordance with the requirements set forth in Exhibit C and all other applicable provisions of this Agreement. The Facility and the Interconnector Interconnection Facilities shall be operated, maintained and controlled in accordance with the requirements set forth in Exhibit D and all other applicable provisions of this Agreement.

3. **Metering**.

(a) Metering Configuration and Installation. The metering shall be configured so as to measure the Energy delivered from the Facility to the Interconnection Point. Interconnector shall be responsible for all costs associated with the metering required for sales of Energy, Capacity and other products from the Facility.

(b) Meter Testing and Corrections. Interconnector will own and will maintain all of the metering equipment identified in, or required by, this Agreement, to measure the physical flow of Energy from the Facility to the Interconnection Point and, to the extent possible, the Facility's Capacity and other products (collectively, the "Meters" and individually, each "Meter"). The accuracy, testing and calibrations of the watt-hour Meters shall meet the requirements of ISO New England Inc. or its successor ("ISO-NE") Operating Procedure No. 18 Metering and Telemetering Criteria ("OP-18"), Section IX.D.2.a.i, ii, and iv on pages 16 and 17, as amended or superseded from time to time; and Interconnector is responsible for assuring that Meter tests are performed, at Interconnector's expense, as required by OP-18. All tests and calibrations of the Meters shall be made in accordance with the applicable provisions of the New Hampshire Code of Administrative Rules, Chapter PUC 300 Rules and Regulations for Electric Service, as amended from time to time, and any applicable rules, regulations, manuals, policies and procedures of the New Hampshire Public Utilities Commission or its successor ("NHPUC"), ISO-NE, the ISO-NE Documents and Applicable Laws. Interconnector is responsible for assuring that Meter tests are performed, at Interconnector's expense, in accordance with the requirements of this paragraph. The Interconnector must provide advance notice to, and coordinate with, the PSNH Meter Laboratory or its successor to arrange for such Meter testing. Interconnector shall cause the Meters to be tested at any time upon request of either Party and, at PSNH's option, in the presence of a representative of PSNH. If any Meter proves accurate (as specified by OP-18), the expense of the test shall be borne by the requesting Party. If, and to the extent that, there are any conflicts between the applicable provisions of OP-18 and the applicable rules, regulations, manuals, policies and procedures of the NHPUC described above, the applicable provisions of OP-18 shall govern and Interconnector shall be deemed to be in compliance with its obligations under this Section 3(b) to the extent it complies with OP-18.

(c) Securing and Sealing Meters; Recording of Facility's Output. PSNH reserves the right to secure or seal the Meters, but upon the written request of Interconnector, PSNH will provide such information regarding, and access to, the Meters as Interconnector requests. Interconnector is required to record Energy physically delivered to the PSNH Electric System on an hour-by-hour basis, and to electronically make available to PSNH, Interconnector's Energy output from the Facility in kilowatt-hours for each hour during the prior twenty-four (24) hours. Interconnector is also responsible for recording, or causing to be recorded by an appropriate third party, all of the data necessary to document and measure sales of, or transactions concerning, the Facility's entire output of Energy, Capacity and any other products.

(d) Metering Changes to Facilitate Sales by the Facility. In the event that Interconnector is permitted to make sales of all or a portion of its Energy, Capacity and other products to a party other than PSNH and to the extent that such third party sales can be made subject to the terms of this Agreement, then (i) PSNH shall cooperate with and assist Interconnector to make the Meters applicable to the Facility compliant with the specifications and operational characteristics that are necessary to effectuate such sales by Interconnector to third parties and (ii) Interconnector shall promptly reimburse PSNH for all costs incurred by PSNH pursuant to this paragraph.

(e) No Annexation. Any and all equipment placed on the premises of a Party (other than the PSNH Interconnection Facilities, which shall be the property of PSNH after installation thereof unless the Parties otherwise agree) shall be and remain the property of the Party providing such equipment regardless of the mode and manner of annexation or attachment to real property, unless otherwise mutually agreed by the Parties, provided, however, that this subsection (e) shall not constitute a waiver of, or limitation of, any of PSNH's electric transmission and distribution franchise rights and any other rights held by PSNH as an electric utility company operating in the State of New Hampshire.

4. **Purchase by PSNH of Energy, Capacity and Other Products**.

Except as provided in Section 1(i) of Exhibit D, any purchases by PSNH of the Facility's Energy, Capacity and/or other products are subject to the terms of the Power Purchase Agreement, as may be amended in writing from time to time by the Parties.

5. **Interconnection and Protection Requirements**.

(a) Voltage Characteristics. Unless PSNH converts its interconnection circuit, all Energy delivered from the Facility to the PSNH Electric System shall be 34.5 kV, three-phase, 60 hertz.

(b) Interconnection Guidelines. The Interconnector represents, covenants and warrants that it will install all interconnection, protection, metering, and control equipment specified in the ISO-NE System Impact Study and the PSNH Interconnection Report.

(c) Modifications.

(i) Necessary Modifications. No additional studies are required to be performed, as of the Effective Date, in order to maintain the interconnection of the Facility with the PSNH Electric System; provided, however, that (1) PSNH reserves the right to inspect the Interconnector Interconnection Facilities and the PSNH Interconnection Facilities at any time during the Term of this Agreement; (2) following such inspection if PSNH reasonably determines that changes, modifications or upgrades are necessary to all or any portion of the Interconnector Interconnection Facilities or the PSNH Interconnection Facilities in order to maintain the safe or reliable operation of the Facility or the PSNH Electric System in accordance with Good Utility Practice or to maintain or upgrade such Interconnector's Interconnection Facilities consistent with ISO-NE Requirements, ISO-NE Documents or Applicable Laws, then PSNH shall provide the Interconnector with written notice thereof ("Notice Of Modification") and a 60 day period following Interconnector's receipt of the Notice of Modification during which to review plans or diagrams of PSNH's proposal (the "Review Period"); (3) if the Interconnector fails to provide written notice during the Review Period of its objection to all or any portion of the changes, modifications or upgrades in the Notice Of Modification, then the changes, modifications and upgrades in the Notice Of Modification shall be deemed to be approved by the Interconnector; (4) if the Interconnector timely provides written notice during the Review Period of its objection to the changes, modifications or upgrades in the Notice Of Modification, then the specific changes, modifications or upgrades objected to by the Interconnector shall be subject to the dispute resolution process in Section 11 and all of the remaining changes, modifications and upgrades in the Notice Of Modification shall be deemed to be approved by the Interconnector; and (5) all reasonable and documented costs incurred by PSNH to design, construct and implement the changes, upgrades and modifications authorized pursuant to this Section 5(c)(i) shall be paid for by the Interconnector.

(ii) Voluntary Modifications of Facilities that Affect Other Party's Facilities. Either Party may voluntarily undertake modifications to its facilities. If a Party plans to voluntarily undertake a modification that reasonably may be expected to affect the other Party's facilities or that may require a modification, change or upgrade to the other Party's facilities (and such voluntary modification is not governed by Section 5(c)(i) hereof because such modification is not required by, or deemed necessary to comply with, Good Utility Practice, ISO-NE Requirements, ISO-NE Documents and/or Applicable Laws), then (1) that Party shall provide the other Party with sufficient information regarding such modification so that the other Party may evaluate the potential impact of such modification prior to commencement of the work, including information regarding when such modifications are expected to be made and whether such modifications are expected to interrupt the flow of Energy from the Facility; (2) such information shall be deemed to be confidential hereunder; (3) the Party desiring to undertake modifications to its facilities that reasonably may be expected to affect the other Party's facilities or that may require a modification, change or upgrade to the other Party's facilities shall provide the relevant drawings, plans, and specifications to the other Party for review and approval (which approval shall not be unreasonably withheld, conditioned or delayed) at least ninety (90) days in advance of the commencement of the work, or such shorter period upon which the Parties may agree, provided, however, that if at the end of said 90-day period, the Parties have not reached mutual agreement concerning the proposed modification, then either Party can submit the dispute for resolution pursuant to the dispute resolution process in Section 11 of this Agreement and such proposed modification shall not be implemented until the completion of the dispute resolution process or unless mutually agreed to by the Parties; (4) if PSNH approves a modification request from the Interconnector pursuant to this Section 5(c)(ii) or if such modification request is required to be implemented following the completion of the dispute resolution process in Section 11 of this Agreement, then all costs borne by PSNH to design and/or construct any necessary or appropriate modifications, changes or upgrades to the PSNH Interconnection Facilities and/or the PSNH Electric System shall be borne by the Interconnector; and (5) if Interconnector approves a modification request from PSNH pursuant to this Section 5(c)(ii) or if such modification request is required to be implemented following the completion of the dispute resolution process in Section 11 of this Agreement, then all costs borne by Interconnector to design and/or construct any necessary or appropriate modifications, changes or upgrades to the Interconnector Interconnection Facilities shall be borne by PSNH. Interconnector shall not be responsible for the costs of any additions, modifications, or replacements that PSNH makes to the PSNH Interconnection Facilities or the PSNH Electric

System to facilitate the interconnection of a third party to the PSNH Interconnection Facilities or the PSNH Electric System.

(d) Ownership. Up to the Interconnection Point, all of the equipment located on the Facility-side of the Interconnection Point shall remain the sole property of Interconnector. Interconnector shall have sole responsibility for the operation, maintenance, replacement, and repair of the Facility, including the Interconnector Interconnection Facilities.

(e) Testing. Prior to the interconnection of the Facility to the PSNH Electric System, Interconnector shall test, and every twelve (12) months thereafter, Interconnector shall continue to test, or cause to be tested, all protection devices including verification of calibration and tripping functions and Interconnector shall provide PSNH with a copy of the tests and results. Such tests shall be performed by qualified personnel approved in advance by PSNH, provided, that such approval shall not be unreasonably withheld, conditioned or delayed.

(f) Standards. Any additions, modifications, or replacements made to a Party's facilities shall be designed, constructed and operated in accordance with this Agreement and Good Utility Practice.

6. **Right of Access.**

Upon prior written or oral notice to Interconnector, PSNH shall have the right to enter the property of Interconnector at mutually agreed upon times and shall be provided reasonable access to Interconnector's metering, protection and control equipment to review for compliance with this Agreement.

7. **Payments.**

The Interconnector's obligation to reimburse PSNH for the costs PSNH incurs to design and construct the PSNH Interconnection Facilities shall be governed by the payment schedule and final invoice process set forth in Exhibit C to this Agreement.

All other invoices shall be rendered to the paying Party at the address specified in Section 12 of this Agreement. The Party receiving the invoice shall pay the undisputed amount of the invoice within thirty (30) days of receipt thereof. All payments shall be made in immediately available funds payable to the other Party, or by wire transfer to a bank named and account designated by the invoicing Party. Payment of invoices by either Party will not constitute a waiver of any rights or claims either Party may have under this Agreement. Any disputes over invoiced amounts shall be resolved in accordance with the dispute resolution procedures set forth in Section 11 of this Agreement.

8. **Term; Default, Cure and Termination.**

(a) Term. This Agreement shall commence on the Effective Date and shall remain in effect for a period of sixty-five (65) years (the "Initial Term") unless earlier terminated pursuant to this Section 8 or Section 19, and shall be automatically renewed for each successive one-year period thereafter (each, a "Renewal Term" and together with the Initial Term, are collectively the "Term").

(b) Breach. It shall be a "Breach" under this Agreement if a Party fails to perform any of its material obligations hereunder, provided that no Breach shall exist where such failure to perform an obligation (other than the payment of money) is the result of Force Majeure or the result of an act or omission of the other Party. Upon a Breach, the non-breaching Party, when it becomes aware of the Breach, shall give written notice of such Breach to the breaching Party.

(c) Cure and Event of Default. Upon receiving written notice of a Breach under this Agreement, the breaching Party shall have thirty (30) days to cure such Breach. An "Event of Default" shall be deemed to have occurred under this Agreement if the breaching Party fails to cure the Breach within thirty (30) days of its receipt of written notice of such Breach from the other Party, or if the Breach is such that it cannot be cured within thirty (30) days, the breaching Party fails to commence within such thirty (30) day time period in good faith all steps as are reasonable and appropriate to cure such Breach and thereafter fails to diligently pursue such action to completion.

(d) Termination Following an Event of Default. The non-breaching Party may terminate this Agreement upon the occurrence of an Event of Default caused by the other Party in accordance with the terms of this Agreement by providing at least thirty (30) days prior written notice of such termination to the other Party. PSNH's termination right for an Interconnector Event of Default shall be subject to any required notices to, or approvals from, the NHPUC or any other applicable federal, state, local or other governmental regulatory or administrative agency, court, commission, department, board, or other governmental subdivision, legislature, rulemaking board, tribunal, or other governmental authority having jurisdiction over the Parties, their respective facilities, or the respective services they provide, and exercising or entitled to exercise any administrative, executive, police, or taxing authority or power (collectively, "Governmental Authority").

(e) Termination by Written Notice. Interconnector may elect to terminate this Agreement for any reason by providing PSNH with sixty (60) days prior written notice thereof; provided, however, that (i) the Interconnector cannot elect (under any circumstances whatsoever) to terminate this Agreement pursuant to this Section 8(e) during the term of the Power Purchase Agreement; (ii) if the Interconnector elects to exercise its right of termination pursuant to this Section 8(e), this Agreement shall not terminate until the Interconnector has first reimbursed PSNH for all costs incurred by PSNH to design, engineer, construct and test the PSNH Interconnection Facilities; and (iii) if the Interconnector elects to exercise its right of termination pursuant to this Section 8(e) prior to the date on which the PSNH Interconnection Facilities are fully completed, then, in addition to the costs in subsection (e)(ii) above, the Interconnector shall also reimburse PSNH for the costs PSNH incurs pursuant to Section 1(i) of Exhibit C in order to ensure that the PSNH Electric System is placed in a safe and reliable condition in accordance with Good Utility Practice and PSNH's safety and reliability criteria. After Interconnector has notified PSNH in writing that the Facility has permanently ceased commercial operation, PSNH may terminate this Agreement by providing Interconnector with sixty (60) days prior written notice thereof, subject to any required notices to, or approvals from, the NHPUC or any other applicable Governmental Authority.

(f) Effect of Termination of the Agreement. After any termination of this Agreement, both Parties shall be discharged from all further obligations under this Agreement, with the exception of any liability or obligation that arose or accrued prior to the date of such termination and each Party may pursue any of its available remedies at law or in equity following such termination. Any reasonable and documented costs incurred by PSNH to physically disconnect the Facility as a result of the termination of this Agreement shall be paid by Interconnector.

9. **Indemnification; Insurance; Limitation on Damages.**

(a) Indemnification. Each Party (each, an "Indemnifying Party") shall indemnify, defend and hold harmless the other Party, its parents and affiliates and its and their respective members, managers, officers, directors, lenders, trustees, employees, contractors, subcontractors, and agents (each an "Indemnified Party"), from and against any and all damages, losses, claims, including claims and actions relating to injury to or death of any person or damage to property, demands, suits, recoveries, costs and expenses, court costs, attorneys' fees, and all other obligations by or to third parties arising out of or resulting from the Indemnifying Party's (including its affiliates', agents', employees', contractors' and subcontractors') negligence or actions or omissions under, in connection with, or arising out of, this Agreement; provided, however, that the Indemnifying Party shall not be liable for damages or losses arising out of gross negligence or intentional misconduct by the Indemnified Party, its affiliates and its and their respective members, managers, officers, directors, trustees, employees, contractors, subcontractors, or agents.

(b) Insurance to be Maintained by Interconnector.

(i) Interconnector shall, at its own expense, maintain or continue to maintain, as appropriate, throughout the Term of this Agreement comprehensive general liability insurance with a combined single limit of not less than $3,000,000 for each occurrence. Said insurance policy shall name PSNH, Northeast Utilities and each of their subsidiaries, trustees, officers, directors, managers, attorneys, employees and agents, as additional insureds with respect to any and all third party bodily injury and/or property damage claims arising from Interconnector's acts and omissions arising out of, or in connection with, this Agreement. It is further agreed that neither PSNH nor any of its affiliates shall by reason of its inclusion as an additional insured incur liability to the insurance carrier for the payment of premiums for such insurance. The insurance policy shall not be canceled, terminated, altered, reduced or materially changed without at least thirty (30) days prior written notice to PSNH.

(ii) Evidence of the insurance Interconnector is required to provide under this Section 9(b) shall be provided to PSNH in the form of a certificate of insurance prior to the actual physical interconnection of the Facility, and annually thereafter. During the Term of this Agreement, Interconnector, upon PSNH's reasonable request, shall furnish PSNH with certified copies of the actual insurance coverage required by this Section 9(b).

(iii) The insurance coverage Interconnector is required to provide under this Section 9(b) is and shall continue to be primary and is not in excess to or contributing with any insurance or self-insurance maintained by PSNH or its affiliates and shall not be deemed to limit Interconnector's liability under this Agreement.

(c) Limitation on Damages. In no event shall either Party be liable, whether in contract, tort (including negligence), strict liability, warranty, or otherwise, for any special, indirect, incidental, punitive or consequential losses or damages suffered or incurred by the other Party or any person or entity and arising out of or related to this Agreement, including, but not limited to, cost of capital, cost of replacement power, loss of profits or revenues, or the loss of the use thereof. This Section 9(c) shall apply notwithstanding any other statement to the contrary, if any, in this Agreement and shall survive the termination of this Agreement.

10. **Force Majeure**.

Neither Party shall be considered to be in default hereunder, and shall be excused from performance of its obligations hereunder (other than an obligation to pay money when due), if and to the extent that it shall be prevented from performing its obligations by an event of Force Majeure, provided that the Party claiming Force Majeure (a) uses commercially reasonable efforts to remedy its inability to perform at the earliest practical time and (b) provides a status report of such remedial efforts to eliminate the event of Force Majeure to the other Party at least every thirty (30) days. "Force Majeure" means any of the following events beyond the control of the Party affected which wholly or party prevents or delays the performance of any obligation under this Agreement: (i) acts of God or the public enemy, war, whether declared or not, blockade, insurrection, riot, civil disturbance, public disorders, rebellion, violent demonstrations, revolution, sabotage or terrorist action; (ii) any effect of unusual natural elements, including fire, subsidence, earthquakes, floods, lightning, tornados, unusually severe storms, or similar cataclysmic occurrence or other unusual natural calamities; (iii) environmental and other contamination at or affecting the Facility; (iv) explosion, accident or epidemic; (v) actions of a Governmental Authority or inaction of a Governmental Authority, provided, however, this subsection (v) shall not limit PSNH's rights and remedies or the Interconnector's obligations in Sections 16, 18 and 19 of this Agreement; (vi) general strikes, lockouts or other collective or industrial action by workers or employees, or other labor difficulties; (vi) the unavailability of experienced and trained labor, fuel, power or raw materials, the breakdown of the Facility or other plant breakdown or equipment failure, and any event affecting the ability of any supplier (including under any engineering, procurement or construction agreement for the Facility) to fulfill its obligations to PSNH or the Interconnector; (vii) accidents of navigation or breakdown or injury of vessels, accidents to harbors, docks, canals, or other assistances to or adjuncts of shipping or navigation, or quarantine; (viii) nuclear emergency, radioactive contamination or ionizing radiation or the release of any hazardous waste or materials; (ix) air crash, shipwreck, train wrecks or other failures or delays of transportation; (x) the occurrence of an Emergency Condition; (xi) or any other cause beyond the reasonable control of either Party and not due to the fault, gross negligence or intentional misconduct of the Party claiming the Force Majeure; or (xii) any event or circumstance expressly defined as a Force Majeure under Section 1(a)(vi) of Exhibit C to this Agreement, which, in any of the foregoing cases described in clauses (i) through (xi), by the exercise of reasonable diligence such Party could not reasonably have been expected to avoid and which, by the exercise of reasonable diligence, it has been unable to overcome.

If an Event of Force Majeure is caused by, or results from, a Change In Law Or ISO-NE Rules, then, consistent with Section 19 hereof, the Parties shall negotiate in good faith to attempt to modify this Agreement to restore the balance that existed between the Parties prior to the Change In Law Or ISO-NE Rules; and if the Parties are unable to reach mutual agreement within sixty (60) days of the commencement of negotiations concerning such Change In Law Or ISO-NE Rules, then either Party may elect to submit the dispute for resolution pursuant to the dispute resolution process in Section 11 of this Agreement.

11. **Dispute Resolution.**

(a) Disputes. In the event of any dispute, disagreement or claim arising out of or relating to this Agreement, the Party that believes there is such a dispute will give written notice to the other Party of such dispute.

(b) Initial Negotiation Among the Parties. The Parties shall negotiate in good faith to attempt to resolve such dispute. If such negotiations have not resulted in resolution of such dispute to the mutual satisfaction of the Parties within thirty (30) days after notice of the dispute has been given, then such dispute shall be submitted to the NHPUC unless the parties mutually agree to submit the dispute to binding arbitration pursuant to the arbitration process set forth in Section 11(c); provided, however, that if the NHPUC has not issued a statement (within 30 days of the date on which the dispute was first submitted to the NHPUC) that the NHPUC will review the dispute, then either Party may elect to have such dispute resolved pursuant to the binding arbitration procedure set forth in Section 11(c).

(c) Binding Arbitration. Any dispute arising out of or relating to this Agreement that is required to be resolved by arbitration pursuant to Section 11(b), shall be finally resolved by arbitration in accordance with the then current CPR Rules for Non-Administered Arbitration (the "Rules") by a sole arbitrator, for disputes involving amounts in the aggregate under three million dollars ($3,000,000), or three arbitrators, for disputes involving amounts in the aggregate equal to or greater than three million dollars ($3,000,000), of whom each Party shall designate one in accordance with the "screened" appointment procedure provided in Rule 5.4. A decision and award of the arbitrator(s) made under the Rules and within the scope of jurisdiction of such arbitrator(s) shall be exclusive, final, and binding on the Parties, their successors, and assigns. The arbitration shall be governed by the Federal Arbitration Act, 9 U.S.C. §§ 1-16, and judgment upon the award rendered by the arbitrator(s) may be entered by any court having jurisdiction thereof. The place of arbitration shall be Manchester, New Hampshire. The arbitrator(s) are not empowered to award damages in excess of compensatory damages and each Party expressly waives and foregoes any right to punitive, exemplary or similar damages unless a statute requires that compensatory damages be increased in a specified manner. The fees and expenses associated with arbitration, including the costs of arbitrators, shall be divided equally between the Parties. Each Party shall be responsible for its own legal fees, including but not limited to attorney fees. The Parties may, by written agreement signed by both Parties, alter any time deadline, location(s) for meeting(s), or procedure outlined herein or in the Rules. The procedure specified herein shall be the sole and exclusive procedure for the resolution of disputes arising out of or related to this Agreement. To the fullest extent permitted by law, any arbitration proceeding and the settlement or arbitrator's award shall be maintained in confidence by the Parties.

12. **Notices and Service**.

All notices that are required or permitted under this Agreement shall be in writing, except as otherwise provided or as reasonable under the circumstances. Service of a notice may be accomplished and will be deemed to have been received by the recipient Party on (a) the day of delivery if delivered by personal service, (b) on the day of confirmed receipt if delivered by facsimile or e-mail, (c) by nationally recognized overnight courier service, or (d) by registered or certified mail, postage prepaid and return receipt requested, and in each case addressed as follows:

Interconnector:

Lempster Wind, LLC
c/o Iberdrola Renewable Energies USA, Ltd.
201 King of Prussia Road, Suite 500
Radnor, PA 19087
Attention: Eduardo Brunet and Pablo Canales
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PSNH:

Public Service Company of New Hampshire
780 North Commercial Street
P. O. Box 330
Manchester, NH 03105-0330
Attn.: Manager, Supplemental Energy Sources Department
Tel: (603) 634-2312
Fax: (603) 634-2449
email: psnhsesd@psnh.com

13. **Waiver of Terms or Conditions**.

The failure of either Party to enforce or insist upon compliance with any of the terms or conditions of this Agreement shall not constitute a general waiver or relinquishment of any such terms or conditions, but the same shall remain at all times in full force and effect. Any waiver is only effective if given to the other Party in writing.

14. **Binding Effect; Assignment.**

(a) Successors and Permitted Assigns. This Agreement shall be binding upon, and shall inure to the benefit of, the respective successors and permitted assigns of the Parties.

(b) Assignment by PSNH. PSNH shall not assign this Agreement, or any of its rights or obligations hereunder, without the prior written consent of Interconnector, which consent shall not be unreasonably withheld, conditioned or delayed; provided, however, that PSNH has the unrestricted right to assign all of its rights and obligations hereunder without the consent of Interconnector to (i) any entity that acquires all or substantially all of PSNH's assets via sale, merger, consolidation, purchase, stock transfer or otherwise, or (ii) any entity that acquires all or substantially all of the PSNH Electric System. PSNH shall provide written notice to Interconnector of any such permitted assignment to a successor-in-interest within fifteen (15) days following the effective date of the assignment; and PSNH's permitted assignee shall deliver to Interconnector an executed assignment and assumption agreement in which the permitted assignee agrees to assume all of PSNH's obligations under this Agreement.

(c) Assignment by Interconnector. Interconnector shall not assign this Agreement, or any of its rights or obligations hereunder, without the prior written consent of PSNH, which consent shall not be unreasonably withheld, conditioned or delayed; provided, however, that Interconnector has the unrestricted right, without the prior written consent of PSNH, to (i) collaterally assign this Agreement in connection with any financing or refinancing involving the Facility or the Interconnector and (ii) assign all of its rights and obligations hereunder to (A) any entity or person that acquires all or substantially all of Interconnector's assets via sale, merger, consolidation, purchase, membership interest transfer or otherwise, or (B) an affiliate of Interconnector; provided, however, that no assignment authorized pursuant to subsection (c)(ii)(A) or (c)(ii)(B) above shall release Interconnector from any of its obligations as the Interconnector under this Agreement unless a written release is executed by PSNH in PSNH's sole discretion. Interconnector shall notify PSNH in writing within fifteen (15) days following the effective date of the assignment; and, in the case of any assignment other than a collateral assignment pursuant to clause (i) of the proviso to the preceding sentence, the Interconnector's permitted assignee shall deliver to PSNH an executed assignment and assumption agreement in which the permitted assignee agrees to assume all of Interconnector's obligations under this Agreement.

(d) Un-permitted Assignments Are Void. Any assignment in violation of this Section 14 shall be null and void at the option of the non-assigning Party.

15. **Applicable Law**.

This Agreement is made under the laws of the State of New Hampshire and the interpretation and performance hereof shall be in accordance with and controlled by such laws, excluding any conflicts of law provisions of the State of New Hampshire that could require application of the laws of any other state.

16. **Qualifying Facility Status**.

Interconnector has stated its intent to continue to maintain, during the Term of this Agreement, its valid Federal Energy Regulatory Commission ("FERC") certification of its Facility as a qualifying facility ("QF") as defined by Section 210 of the Public Utility Regulatory Policies Act of 1978 ("PURPA") and FERC regulations thereunder, both as in effect as of the Effective Date, unless PURPA is repealed, the concept of QF is modified after the Effective Date such that the Facility will no longer qualify as a QF in its configuration as contemplated by this Agreement or the concept of QF is otherwise eliminated from the laws and regulations relating to electric generating facilities. If the QF status for the Facility is not maintained, then the Interconnector is responsible for taking all necessary steps (at the Interconnector's expense) to ensure that the interconnection of the Facility complies with ISO-NE Documents and Applicable Laws, including but not limited to cooperating with PSNH to determine whether the Facility's loss of QF status will require the Parties, pursuant to Applicable Law, to enter into a new interconnection agreement that replaces this Agreement. If a new interconnection agreement is not entered into, the Parties shall cooperate and shall each be responsible for compliance with any new requirements and shall take such actions as may be required pursuant to Section 19.

17. **Headings; Construction**.

Captions and headings in this Agreement are for ease of reference and shall not be used to and do not affect the meaning of this Agreement. Ambiguities or uncertainties in the wording of this Agreement shall not be construed for or against any Party, but shall be construed in the manner that most accurately reflects the Parties' intent as of the time they executed this Agreement.

18. **ISO-NE Requirements**.

The Interconnector understands that the Facility operates as part of an integrated electrical system in New England operated by ISO-NE and that from time to time ISO-NE may direct owners of New England transmission facilities and other entities, including PSNH, PSNH's Electric System Control Center ("ESCC") and affiliates of Northeast Utilities, to take certain actions (or to fail to take certain actions) that may affect the Facility or the Interconnection Facilities (collectively, the "ISO-NE Requirements"). In the event that PSNH, ESCC or any affiliate of Northeast Utilities is ordered to, or decides to, comply with any ISO-NE Requirements that affect the Facility or the Interconnector Interconnection Facilities, then Interconnector must cooperate in good faith and take all actions (at Interconnector's expense) that are necessary or appropriate to bring the Facility and/or the Interconnector

Interconnection Facilities in compliance with such ISO-NE Requirements. Interconnector is responsible for any costs and expenses incurred by, imposed upon, or suffered by, the Facility and the Interconnector Interconnection Facilities resulting from any of such ISO-NE Requirements. Nothing in this Agreement is intended to preclude, or is to be interpreted to preclude, a Party from challenging (at said Party's expense) the applicability of any ISO-NE Requirements to the Facility, the Interconnector Interconnection Facilities, the PSNH Interconnection Facilities or the Interconnector, and each Party retains the right to challenge (at said Party's expense) the applicability of any such ISO-NE Requirements before the ISO-NE, FERC or any Governmental Authority of competent jurisdiction.

19. **Changes Requiring Modifications**.

(a) If, after the Effective Date, changes in Applicable Laws, or changes in applicable ISO-NE Documents, occur that materially affect a Party's ability to perform its obligations under this Agreement (a "Change In Law Or ISO-NE Rules"), then the Parties shall negotiate in good faith to attempt to modify this Agreement to restore the balance that existed between the Parties prior to the Change In Law Or ISO-NE Rules. In the event that either (i) a Change In Law Or ISO-NE Rules requires PSNH and Interconnector to enter into another form of interconnection agreement (other than this Agreement) or (ii) as a result of a termination of the Power Purchase Agreement, PSNH and Interconnector are required to enter into another form of interconnection agreement (other than this Agreement) in order to meet applicable FERC and/or ISO-NE requirements for interconnection agreements, then PSNH and Interconnector shall cooperate in good faith to negotiate and enter into a new appropriate interconnection agreement required by, and consistent with, Applicable Laws, applicable ISO-NE Documents and applicable Change(s) In Law Or ISO-NE Rules.

(b) If the Parties are unable to reach mutual agreement within sixty (60) days of the commencement of negotiations concerning a dispute regarding any Change In Law Or ISO-NE Rules, then either Party may elect to submit the dispute for resolution pursuant to the dispute resolution process in Section 11 of this Agreement.

20. **Confidentiality**.

(a) This Agreement does not constitute confidential information. Any information that is explicitly designated as containing "CONFIDENTIAL INFORMATION" that is exchanged by PSNH and Interconnector relating to this Agreement, shall not be disclosed to any person not employed or retained by PSNH or Interconnector or their affiliates, except to the extent disclosure is (i) required by Applicable Laws, required to be made to any Governmental Authority for obtaining any approval, permits and licenses, or making any filing in connection therewith, required by this Agreement or delivered by Interconnector to the ISO-NE or to any person or entity exercising authority over Interconnector or the Facility for the purpose of maintaining the safety or reliability of the PSNH Electric System, (ii) reasonably deemed by the disclosing Party to be required to be disclosed in connection with a dispute between or among the Parties, or the defense of any litigation or dispute,

(iii) otherwise permitted by consent of the other Party, which consent shall not be unreasonably withheld, conditioned or delayed, (iv) required to be made in connection with regulatory proceedings (including proceedings relating to FERC, the United States Securities and Exchange Commission or any other federal, state or provincial regulatory agency) or pursuant to the rules and regulations of any stock exchange applicable to a Party or any of its Affiliates or (v) to any actual or potential lender, to any actual or potential investor in Interconnector or to any other potential acquiror of any direct or indirect ownership interest in Interconnector or to any advisor providing professional advice to Interconnector or to any such actual or potential lender, investor or acquiror. In the event disclosure is made pursuant to this provision, the Parties shall use reasonable efforts to minimize the scope of any disclosure and have the recipients maintain the confidentiality of any documents or confidential information covered by this provision, including, if appropriate, seeking a protective order or similar mechanism in connection with any disclosure. This provision shall not apply to any information that was or is hereafter in the public domain (except as a result of a breach of this provision). The Parties specifically agree that any press release or other public statement that addresses specific commercial terms of this Agreement shall be mutually agreed upon by the Parties. Notwithstanding the foregoing, Interconnector may disclose (including by press release) without the consent of PSNH (a) the identity of PSNH as the owner of the electric system to which the Facility is interconnected, (b) the existence of this Agreement and (c) that this Agreement permits the interconnection of the Facility to the PSNH Electric System.

(b) The obligations of the Parties under this Section 20 shall remain in full force and effect for three (3) years following the expiration or termination of this Agreement.

21. **Amendments**.

In order for any modification to this Agreement, including the Exhibits and attachments to the Exhibits attached hereto, to be binding upon the Parties, said modification must be in writing and signed by both Parties. The following Exhibits are attached hereto:

Exhibit A – Description Of Facility

Exhibit B – Interconnection Point and Interconnection Facilities

Exhibit C – Interconnection Facilities Engineering, Procurement, Construction, Invoice And Payment

Exhibit D – Operations And Maintenance

22. **Entire Agreement; Prior Agreements Superseded**.

This Agreement, including the Exhibits attached hereto, represent the entire agreement between the Parties with respect to the interconnection of the Facility to the PSNH Electric

System, and, as between Interconnector and PSNH, all previous agreements, discussions and communications related thereto are superseded by the execution of this Agreement.

23. **Independent Contractor Status**.

Nothing in this Agreement shall be interpreted or construed to create an association, joint venture, agency relationship, or partnership between the Parties or to impose any partnership obligation or partnership liability upon either Party.

24. **No Third Party Beneficiaries**.

This Agreement is not intended to and does not create rights, remedies, or benefits of any character whatsoever in favor of any persons, corporations, associations, or entities other than the Parties, and the obligations herein assumed are solely for the use and benefit of the Parties, their successors in interest and, where permitted, their assigns.

25. **Representations And Warranties**.

As of the Effective Date, each Party hereby makes the following representations and warranties:

(a) Good Standing. Each Party is a corporation, limited liability company and/or partnership duly organized, validly existing and in good standing under the laws of its state of incorporation or organization.

(b) Authority. Each Party has all requisite power and authority to conduct its business, to own its properties, and to execute, deliver and perform its obligations under this Agreement. This Agreement is a legal, valid and binding obligation of each Party, enforceable in accordance with its terms, except as the enforceability thereof may be limited by applicable bankruptcy, insolvency, reorganization or other similar laws affecting creditors' rights generally and by general equitable principles (regardless of whether enforceability is sought in a proceeding in equity or at law).

(c) No Conflict. The execution, delivery and performance of this Agreement has been duly authorized by all necessary action, and do not and will not (i) require any approval or consent of any holder (or any trustee for any holder) of any indebtedness or other obligation of such Party or of any other person or entity, except approvals or consents that have been obtained, (ii) violate any provision of such Party's organic documents, any indenture, contract or agreement to which it is a party or by which it or its properties may be bound, or any law, ordinance, rule, regulation, order, writ, judgment, injunction, decree, determination or award presently in effect, or (iii) result in a breach of or constitute a default under such Party's organic documents or other material indentures, contracts or agreements to which it is a party or by which it or its properties may be bound.

(d) No Pending Actions. There is no pending or, to its best knowledge, threatened action or proceeding against such Party before any court, governmental agency or arbitrator that could reasonably be expected to affect materially and adversely the ability of such Party to perform its obligations under this Agreement, or that purports to affect the legality, validity or enforceability of this Agreement.

(e) Consent and Approval. Each Party has sought or obtained, or, in accordance with this Agreement, will seek or obtain, each consent, approval, authorization, order or acceptance by any Governmental Authority required in connection with the execution, delivery and performance of this Agreement and it will provide to any governmental authority any notices of actions under this Agreement that are required by Applicable Laws.

26. **Counterparts**.

This Agreement may be executed in one or more counterparts, all of which will be considered one and the same Agreement, and each of which shall be deemed an original.

[signature pages follow]

IN WITNESS WHEREOF, the Parties, each by its duly authorized representative, have hereunto caused their names to be subscribed, as of the Effective Date.

LEMPSTER WIND, LLC

By: Eric Blank

Name: Eric Blank

Title: Manager

IBERDROLA

DEC 20 2007

VISADO LEGAL

By:

Name: Pablo Canales Abaitua

Title: Manager

PUBLIC SERVICE COMPANY OF NEW HAMPSHIRE

By: *[signature]*

Name: Gary A. Long

Title: President and Chief Operating Officer

EXHIBIT A

DESCRIPTION OF FACILITY

The Facility is located on Lempster Mountain in Lempster, New Hampshire. The Facility is expected to have 12 Gamesa G87 wind turbine generators, each rated 2.0 MW for a total installed capacity of 24 MW. The Facility is being developed by Interconnector and is expected to achieve commercial operation in 2008. The interconnection is with PSNH and consists of an approximately 10.5 mile dedicated 34.5 kV line built over an existing distribution circuit from the Facility's site to PSNH's Newport Substation in Newport, New Hampshire.

EXHIBIT B

INTERCONNECTION POINT AND INTERCONNECTION FACILITIES

Attached to this Exhibit B (i) as Attachment 1 is the "Lempster Wind Project System Impact Study Final Report November 2006" prepared by E/PRO Engineering & Environmental Consulting, LLC on behalf of ISO-NE and PSNH (the "ISO-NE System Impact Study") and (ii) Attachment 2 is the PSNH Interconnection Report dated October 4, 2007 (the "PSNH Interconnection Report"). The reports in Attachments 1 and 2 hereto describe and provide diagrams of:

(a) the PSNH Interconnection Facilities, which are comprised of the following two sub-components:

(i) Electrical upgrades that will be made to PSNH's Newport electrical substation in Newport, New Hampshire and PSNH's North Road electrical substation in Sunapee, New Hampshire in order to facilitate the interconnection of the Facility to the PSNH Electric System, and

(ii) Distribution circuit upgrades that are comprised of the following: (A) approximately 10.5 miles of dedicated 34.5 Kv electric distribution line that will be used to interconnect the Facility to the PSNH Electric System (the "Dedicated Distribution Circuit") and (B) upgrades (which are deemed necessary or appropriate by PSNH) of the existing electric distribution circuits of PSNH and the New Hampshire Electric Cooperative, including but not limited to, related facilities, equipment and appurtenances that will be used to support, facilitate and carry the Dedicated Distribution Circuit (collectively, the work described in subsections (ii)(A) and (ii)(B) of this paragraph are the "Distribution Circuit Upgrades").

(b) the Interconnector Interconnection Facilities, and

(c) the Interconnection Point.

ATTACHMENT 1 TO EXHIBIT B

ISO-NE SYSTEM IMPACT STUDY

ISO-NE SIS
Copied Separately

ATTACHMENT 2 TO EXHIBIT B

PSNH INTERCONNECTION REPORT

PSNH INTERCONNECTION REPORT
FOR
CUSTOMER GENERATION

LEMPSTER WIND POWER

<u>FINAL REPORT</u>

SESD SITE NO. 260

A.J. Marandola
October 4, 2007

CONTENTS

B. DESCRIPTION OF RESPONSIBILITIES

VII. DRAWINGS

A. PARTIAL ONE-LINE DIAGRAM (SK-AJM-260-1)

I. INTRODUCTION

A study has been performed to determine the impact of this facility on the PSNH system. All technical analysis was based on the equipment listed under Section II, and the facility arrangement illustrated on partial one-line diagram SK-AJM-260-1. Where actual site-specific data was not readily available, estimated or "typical" values were utilized in any required calculations. Any deviation from the listed equipment and/or the illustrated configuration may have significant safety and/or technical ramifications. Consequently, if changes are anticipated now or in the future, PSNH should be informed immediately so that the requirements and recommendations contained within the report may be revised where necessary. This procedure will ensure that the Developer is informed of PSNH requirements in a timely fashion and should eliminate the delays and expense which could otherwise be experienced by the Developer.

II. DESCRIPTION OF MAJOR COMPONENTS

A. Description Of Facilities

The Developer will operate twelve (12) wind powered doubly fed induction generators at their Lempster, New Hampshire site, interconnected to PSNH in Lempster, NH. The generation capability of this development will be 24,000 KW. The generators will be tied to the 34.5 kV line 42X4 out of Newport S/S that will be built to accommodate this interconnection.

B. Electrical Components

1. Generators (12) – Doubly Fed Induction, 690 V, 2000 KW, 0.91 pf. Transient, subtransient, synchronous and negative sequence reactance values used for system modeling, respectively: 0.604, 0.376, 14.05, 0.376 pu on 2.03 MVA base.

2. Generator Step Up Transformers (12) - 2,350 kVA, 690/400 V grounded wye – 34.5kV delta (Z=11.6%).

3. Grounding Bank - 19.9/34.5 kV GrdY – 7.2 kV Delta connected using 3 - 500 KVA step transformers. Details per Section IV.A.5.

4. High Side Interrupter – 38kV vacuum recloser with a SEL-651R electronic control.

C. Mechanical Components

1. Turbines (12). Gamesa G87 Wind Turbine.

III. PSNH REQUIREMENTS - GENERAL

A. Safety Considerations

1. The connection of the facility to the PSNH system must not compromise the safety of PSNH's customers, personnel, or the owner's personnel.

2. The generating facility must not have the capability of energizing a de-energized PSNH circuit.

3. An emergency shutdown switch with facility status indicator lights, and a disconnecting device with a visible open shall be made available for unrestricted use by PSNH personnel. The operation of the switch shall cause all of the facility's generation to be removed from service, and shall block all automatic startup of generation until the switch is reset. The status lights, mounted with the shutdown switch, shall be located outdoors at a position acceptable to PSNH Operating Division personnel and visible from the outside. A red light shall indicate that the facility may have generation connected to the PSNH system. A green light shall indicate that all generation is disconnected from the PSNH system. The lights shall be driven directly from auxiliary switches located on the facility's breaker(s), or an output contact from a recloser control if no auxiliary switches are available. The disconnecting device with visible open shall be located between the PSNH system and the facility's generation.

4. The Developer is responsible for determining and applying the complete settings for all non PSNH required protective relays. PSNH will determine only, at the Developer's expense, voltage, frequency and current set-points for the PSNH required protection functions. The Developer is responsible for applying and testing the PSNH required set-points. The Developer is responsible for determining and applying the complete settings of all relays used for PSNH required protection functions.

   Dedicated relays will be used for PSNH required protection functions. No joint use of relays, containing PSNH required set-points, is allowed.

5. A PSNH approved testing company will be required to verify the proper functioning of those protective systems required by PSNH. This work will be performed at the Developer's expense.

6. The generating facility has full responsibility for ensuring that the protective system and the associated devices are maintained in reliable operating condition. PSNH reserves the right to inspect and test all protective equipment at the generator site whenever it is considered necessary. This inspection may include tripping of the breakers.

7. The short circuit interrupting device(s) must have sufficient interrupting capacity for all faults that might exist. The PSNH system impedance at the facility will be supplied on request.

8. All shunt-tripped short circuit interrupting devices applied to generators must be equipped with reliable power sources. A D.C. battery with associated charging facilities is considered a reliable source.

9. All synchronous generator facilities must be equipped with battery-tripped circuit breakers.

10. Any protection scheme utilizing AC control power must be designed in a fail-safe mode. That is, all protective components must utilize contacts which are closed during normal operating conditions, but which open during abnormal conditions or when control power is lost to de-energize the generator contactor coil. These schemes may be utilized only with non-latching contactors and may not be used with synchronous generators.

11. All PSNH-required protective relays designed to trip generation off-line must do so directly through hard-wired connections. Trip signals shall not be redirected through programmable logic controls or other microprocessor based controllers.

12. A complete set of AC and DC elementary diagrams showing the implementation of all systems required by PSNH must be supplied for PSNH review. These drawings should be supplied as soon as possible so that any non-conforming items may be corrected by the Developer without impacting the scheduled completion date of the facility.

13. All voltage transformers driving PSNH-required protection systems must be rated by the manufacturer as to accuracy class, and must be capable of driving their connected burdens with an error not exceeding 1.2 percent.

14. All current transformers driving PSNH-required protection systems must be rated by the manufacturer as to accuracy class and must be capable of driving their connected burdens with an error not exceeding 10 percent at maximum fault requirements.

15. All PSNH-required protective relays, and any other relays which PSNH might be requested to test, must be equipped with test facilities which allow secondary quantity injection and output contact isolation.

16. It is not the policy of PSNH to maintain a stock of protective relays for resale to facility Developers. Since many protective devices have delivery times of several months, Developers are strongly advised to order them as soon as possible after PSNH type-approval is received.

17. Protection of the generating facility equipment for problems and/or disturbances which might occur internal or external to the facility is the responsibility of the Developer.

18. No operation of the facility's generation is allowed until all requirements in Sections III and IV of this report have been met, and all systems required therein, are in place, calibrated, and, if applicable, proven functional. This requirement may be waived by PSNH for a given system if generation is required to demonstrate the proper functioning of that system.

B. Service Quality Considerations

1. The connection of the facility to the PSNH system must not reduce the quality of service currently existing on the PSNH system. Voltage fluctuations, flicker, and excessive voltage and current harmonic content are among the service quality considerations. Harmonic limitations should conform to the latest IEEE guidelines and/or ANSI standards.

2. In general, induction generators must be accelerated to "synchronous" speed prior to connection to the PSNH system to reduce the magnitude and duration of accelerating current and resulting voltage drop to PSNH customers to acceptable levels.

3. In general, synchronous generators may not use the "pull-in" method of synchronizing due to excessive voltage drops to PSNH customers.

4. Power factor correction capacitors may be required for some facilities either at the time of initial installation, or, at some later date. The installation will normally be done by the Developer at his expense.

5. PSNH may need to make modifications to control systems and tap changers in the electrical vicinity of facilities whose installed capacity is close in magnitude to connected circuit load. Should this be necessary, the modifications will be made at the Developer's expense.

6. Automatic reclosing of the PSNH circuit after a tripping operation may occur after an appropriate time delay. If additional voltage blocking of automatic reclosing is required, it will be added at the Developer's expense.

C. Metering Considerations

1. Except for protection/control and metering voltage sensing and generator and/or capacitor contactor supply voltage, no unmetered station service AC shall be taken from the PSNH system.

D. Other Considerations

1. The following is a list of information which must be available to the PSNH Electric System Control Center for this generation interconnection.

a) Telemetry as defined in Section IV.D.

b) When generating onto the grid, the Station Operator is to report expected output for the following day, outage and return times, and significant limitations to the PSNH dispatcher.

c) Dates for planned annual inspection along with any flexibility in the planned period in accordance with NEPEX Operating Procedure #5.

d) Report all generator trips caused by relay action, as well as the associated relay targets, to the PSNH dispatchers.

IV. PSNH REQUIREMENTS - SPECIFIC

A. System Configuration and Protection

1. The facility must be arranged and equipped as per partial one-line diagram SK-AJM-260-1.

2. The following protective functions must be supplied and connected to automatically trip at least the recloser as shown. These devices must be utility grade as approved by PSNH.

   a) 50/51 - Phase Overcurrent, Trip Recloser "Lempster Recloser"
   b) 50/51G - Residual Overcurrent, Trip Recloser "Lempster Recloser"
   c) 81O/U - Over/Underfrequency, Trip Recloser "Lempster Recloser"
   d) 27/59 - Under/Overvoltage, Trip Recloser "Lempster Recloser"
   e) 51V - Voltage Controlled Overcurrent, Trip Recloser "Lempster Recloser"
   f) 59L - System Overvoltage, Alarm/Trip, Trip Recloser "Lempster Recloser"
   g) 50/51N - Grounding Bank Neutral Overcurrent, Trip Recloser "Lempster Recloser"

3. The 59L functionality is required to avoid extended overvoltage conditions to PSNH customers on the system. A high drop-out to pickup ratio should be utilized to avoid nuisance trips of the breaker.

4. In addition to the protective devices listed above, direct transfer trip is required from PSNH's North Road and Newport Substations to the Developer's Substation. Operation of PSNH's 3150 line breaker or 42X4 recloser, as well as the low side transformer breakers TB38 and TB49 and associated 115 kV relaying, will initiate transfer trip. Transfer trip equipment will be specified by PSNH. Transmitters, receivers and modems to be supplied and tested by RFL.

   Rental and maintenance of the dedicated digital telephone line(s) will be at the Developer's expense.

   In the future, maintenance of the transfer trip equipment both at the generation site and at the PSNH substations will be at the Developer's expense.

   Maintenance costs associated with the new recloser at the generation site and replacement costs, if necessary, will be at the Developer's expense.

5. The facility must have a grounding bank connected to the Lempster Wind Power 34.5kV bus. The following grounding bank transformer specifications are required.

   a) The grounding bank will be comprised of three (3) 500 KVA, single phase, step transformers.
   b) The transformers will be supplied with four bushings.
   c) The grounding bank will have a 19.9/34.5 kV Grounded Wye – 7.2 kV Delta connection.

d) The step transformer's impedance (Z %) will be between 2% and 5 %.
e) A solid connection must be made between the make-up of the grounded wye connection at the single phase step transformers and the Lempster Wind Power system neutral (no neutral reactors or resistors will be installed).
f) The PSNH system neutral must be bonded to the Lempster Wind Power system neutral. A bond (connection) involving only earth is not acceptable.
g) The grounding bank transformers shall not be internally or externally fused. A failure of a step transformer must result in the trip and lockout of the Lempster recloser.

The grounding bank must be in-service when the Lempster Wind Power generators are operating and the PSNH and Lempster Wind Power electrical systems are interconnected. Stated another way, if the grounding bank is out of service for any reason, the generators must be off-line or the Lempster Wind Power 34.5 kV tie breaker (Lempster Recloser) must be open.

It is strongly recommended that an additional single phase, step transformer be purchased as a spare. PSNH material specifications allow for step transformer impedances to vary between 2 and 5 percent. PSNH offers no guarantee that a step transformer with the necessary requirements (Z %) will be available for rental or purchase should a unit fail. The consequence of replacing a failed unit with one that has the wrong impedance is that the generators must be off-line when both the PSNH and Lempster Wind Power electrical systems are interconnected.

6. A three phase recloser (the "Lempster Recloser") will be required to serve as the emergency shutdown device for this station. This recloser will also provide line protection and allow for isolation of PSNH customers for faults on the developer's line. The installation of these devices, application of the settings and testing are the responsibility of the developer.

7. A disturbance monitor as described in the PSNH memo "DRANETZ-BMI 5590 DUALNODE AND 5530 DATANODE ORDERING PROCEDURE" will be installed for monitoring purposes. A copy of this memo is available upon the Developer's request. This unit will utilize the metering outfits as described in section IV.B.2.b of the interconnection agreement for current and potential signals. The installation of these devices is the responsibility of the developer.

B. <u>System Metering</u>

1. The facility must be arranged and equipped with the three element metering system as shown on partial one line diagram SK-AJM-260-1.

2. PSNH will provide the following and bill the Developer using Sundry Billing:

    a. One (1) Multi-function meter with load profile memory, telephone modem and reactive measurement capability, PSNH Stock Code 181807 Group 997.
    b. Three (3) single phase metering outfits, 34.5 kV insulation class, 200 kV BIL, 200/400:5 Current Transformer ratios, 175:1 voltage transformer ratio, PSNH Stock Code 166838.
    c. One (1) thirteen (13) terminal meter socket with a pre-wired ten (10) pole test switch, equivalent to a Milbank SC2420-RL-21 or Durham 1008432, PSNH Stock Code 166777.
    d. One hundred (100) feet seven (7) conductor, 12 AWG, type TC , PSNH Stock Code 143522.
    e. One (1) 45 foot, Class 3 Utility Pole for meter mounting.
    f. One (1) Crossarm with associated insulator and mounting hardware.
    g. One (1) set of three (3) inline 35 kV, 900A disconnect switches for meter bypass, PSNH Stock Code 426495.

3. PSNH will test, install and analyze the metering and charge the Developer using the work order for this project.

4. The multi-function meter must remain energized regardless of generator status.

5. The developer shall install and maintain an analog telephone line that will be connected to the multi-function meter modem and the disturbance monitor. The phone line will be connected to a line sharing device such that PSNH has unfettered access to the metering data and disturbance monitor data through remote interrogation on a daily basis.

6. PSNH will meter three phase station service in excess of generation by reverse registration through the multi-function generation meter and bill under the standard three phase tariff rates.

C. Primary Interconnection

The new generator will be connected to the PSNH, 34.5kV, distribution circuit designated 42X4 by a 34.5kV recloser as illustrated on partial one-line diagram SK-AJM-260-1. The 10.5 mile 34.5kV distribution circuit designated as 42X4 will be constructed by a third-party contractor for PSNH. Supervision of line construction will be provided by PSNH and paid for by the Developer.

If applicable, the Developer will be responsible for providing all easements associated with the Developer's Primary Interconnection facilities at the Delivery Point. The Delivery Point shall be defined in Section VI.A. of this report.

D. Telemetry

The following is a summary of the telemetry requirements from PSNH's Electric System Control Center. For further details please refer to PSNH Operating Procedure OP-0045 "NH-LCC Minimum Interconnection Requirements of Merchant Generators". This document is available upon Developer's request.

Transducers and telemetry using a 56K BPS, DDS2 telephone line from Lempster's RTU to PSNH's Electric System Control Center (ESCC) in Manchester, NH will be required. The following data is required by the ESCC:

a) Instantaneous net MW adjusted to the delivery point
b) Instantaneous net MVAR adjusted to the delivery point
c) High side voltage as measured on the generator side of the delivery point
d) Lempster Wind Power Recloser status
e) Transfer Trip Trouble (both receivers)
f) 69 Transfer Trip Cutoff status (both receivers)

Additionally, a separate RTU will be required to transmit the following data and control points between PSNH's Electric System Control Center (ESCC) in Manchester, NH and the Newport S/S:

g) Newport S/S 42X4 Recloser status
h) Newport S/S 42X4 Recloser control

The host protocol for the ESCC SCADA computer is Landis & Gyr Telegyr 8979.

At the Developer's facility, test devices are required to isolate each transducer input and output for routine test purposes.

The Developer shall install a stand-alone Digital Service Unit (DSU) manufactured by Telenetics, model number DDS/MR64, # TEL 6456524700020 at the IPP RTU site.

The developer shall provide the cable used from the RTU at the generating station to the DSU with the following serial cable from GE Harris, P/N 977-0128/60-00A.

The Developer shall provide to the ESCC a rack mounted DSU manufactured by Telenetics, model number DDS/MR64 # TEL 6456524600010.

The Developer shall provide (lease) a 56K BPS DDS2 telephone line between the IPP RTU and the ESCC located at 44 West Pennacook Street, Manchester, NH.

The Developer shall provide (lease) a 56K BPS DDS2 telephone line between the Newport S/S RTU and the ESCC located at 44 West Pennacook Street, Manchester, NH.

The Developer shall provide an uninterruptible power supply (UPS) to the Lempster DSU and RTU with a burden of at least 8 hours.

In the future, maintenance of telemetry at both the Developer's facility and related PSNH locations will be at the Developer's expense. Maintenance and rental of the dedicated telephone line(s) will be at the Developer's expense.

E. System Operation

For steady state operation at almost all load and generation levels, the generation system will have to operate absorbing VARs to maintain an acceptable voltage. 1.035 was modeled at the generator interconnection and delivery point defined as the intersection of Bean Mountain Road and Nichols Road. Power factor ranges from Unity to -95% (absorbing VARs). This is required to hold the steady state voltage down on the line.
The generation facility will not be allowed to provide VARs to the system because the resultant voltages are above acceptable limits for 34.5kV distribution. If adverse system conditions are created as a result of this facility, they shall be rectified expeditiously at the Developer's expense.

Also, PSNH reserves the right to request adjustment to generator operation, such as scheduled voltage, to optimize system performance due to future changes to the PSNH system.

Any generating facility will require machines with voltage control, remote fault ride-through, and equipment with state-of-the-art control capabilities.

The generation at this site is required to operate in compliance with the Northeast Power Coordinating Council (NPCC) automatic underfrequency load shedding criteria as outlined in document A-03 "Emergency Operation Criteria", located at www.npcc.org. If for any reason the Developer will not meet the criteria, he has the option of reimbursing PSNH for the cost to add compensating underfrequency load shedding at least equal to his maximum generating capability.

V. PSNH PRICE ESTIMATES

The following estimates for labor, materials, and overheads are supplied as an aid to the Developer for financial planning purposes. Should the Developer elect to have PSNH perform any of the work described in the estimates, he will ultimately be billed for the full actual cost of any work performed, including overheads.

Authorization for PSNH to perform any of the work or supply any of the equipment described below must be forwarded to the Supplemental Energy Sources Department. A minimum payment covering 50% of the estimated labor and 50% of materials cost is required unless separate payment arrangements are made. PSNH will neither perform work nor order materials until these requirements have been met.

A. System Protection

1. All protective relays and disturbance monitors at the generator plant, including equipment at the outdoor switchgear, will be purchased by the Developer. PSNH must be notified as to exact relay model numbers proposed before ordering to assure that proper setting capability exists for interfacing with the PSNH system.

SUBTOTAL $ 0.00

2. Engineering - PSNH review of control circuits, material specifications and development of PSNH required relay settings at the site.

SUBTOTAL $ 7,000.00

3. Newport S/S - PSNH specification, application, drafting, purchase, installation and commissioning of the transfer trip equipment, RTU and the required telephone circuit interface.

Material:	$40,000.00
Labor:	$60,000.00

SUBTOTAL $ 100,000.00

4. North Road S/S - PSNH specification, application, drafting, purchase, installation and commissioning of the transfer trip equipment and the required telephone circuit interface.

Material:	$25,000.00
Labor:	$45,000.00

SUBTOTAL	$ 70,000.00

5. ESCC, Manchester, NH - Labor and materials required for telemetry connection to the PSNH SCADA computer system.

Labor:	$ 2,850.00
Materials:	$ 650.00

SUBTOTAL	$ 3,500.00
SECTION A TOTAL	$ 180,500.00

NOTE:

The leased digital telephone circuit rentals (3) must be obtained by the Developer. PSNH can assist with the application. Maintenance and operating expenses of the circuits are the Developer's responsibility. The above noted dedicated telephone circuits do not include the dial-up metering telephone line described in section IV.B.

Also, the transfer trip receiver, to be installed at the generator site, must be ordered by the Developer with reference to the associated PSNH equipment to be located at North Road and Newport Substations.

B. Metering

1. Total Labor, Materials, and Overheads for metering. This estimate is based on the details presented in section IV.B. Labor estimate includes PSNH Overheads to be charged against the work order. Materials estimate includes PSNH Overheads to be billed using Sundry Billing.

Labor:	$ 3,225.00
Materials:	$14,000.00

SUBTOTAL	$ 17,225.00
SECTION B TOTAL	$ 17,225.00

C. Primary Interconnection

The following cost estimates are for work required to interconnect the Lempster Wind Power generation facilities with the PSNH system.

Supervision of the construction of approximately 10.5 miles of new 34.5kV, three-phase line from Newport Substation to the site, which is New Hampshire Electric Coop (NHEC) franchise territory.

Alteration of Newport Substation to include a three-phase recloser, recloser control, preparation for transfer trip capabilities and SCADA control.

Labor:	$200,000.00
Materials:	$100,000.00

SUBTOTAL	$ 300,000.00
SECTION C TOTAL	$ 300,000.00

NOTE:

The budgetary estimate is based on historical data and knowledge of the PSNH and NHEC system costs. Actual costs are not available until the work is completely designed, bid and constructed. This estimate includes only the cost for equipment on the utility system. The developer will have additional costs associated with equipment required from the utility interconnection point to the generator(s).

GRAND TOTAL (A + B + C)	$ 497,725.00

VI. INTERCONNECTION EQUIPMENT OWNERSHIP, OPERATION AND MAINTENANCE

A. Delivery Point

For the purpose of establishing ownership, operation and maintenance responsibilities, the location of facility energy delivery to PSNH (the "Delivery Point") must be defined. At this facility, the delivery point will be the point just beyond the 3-phase manually operated disconnect switch (on the PSNH side of the switch) leading to the three phase, primary utility metering.

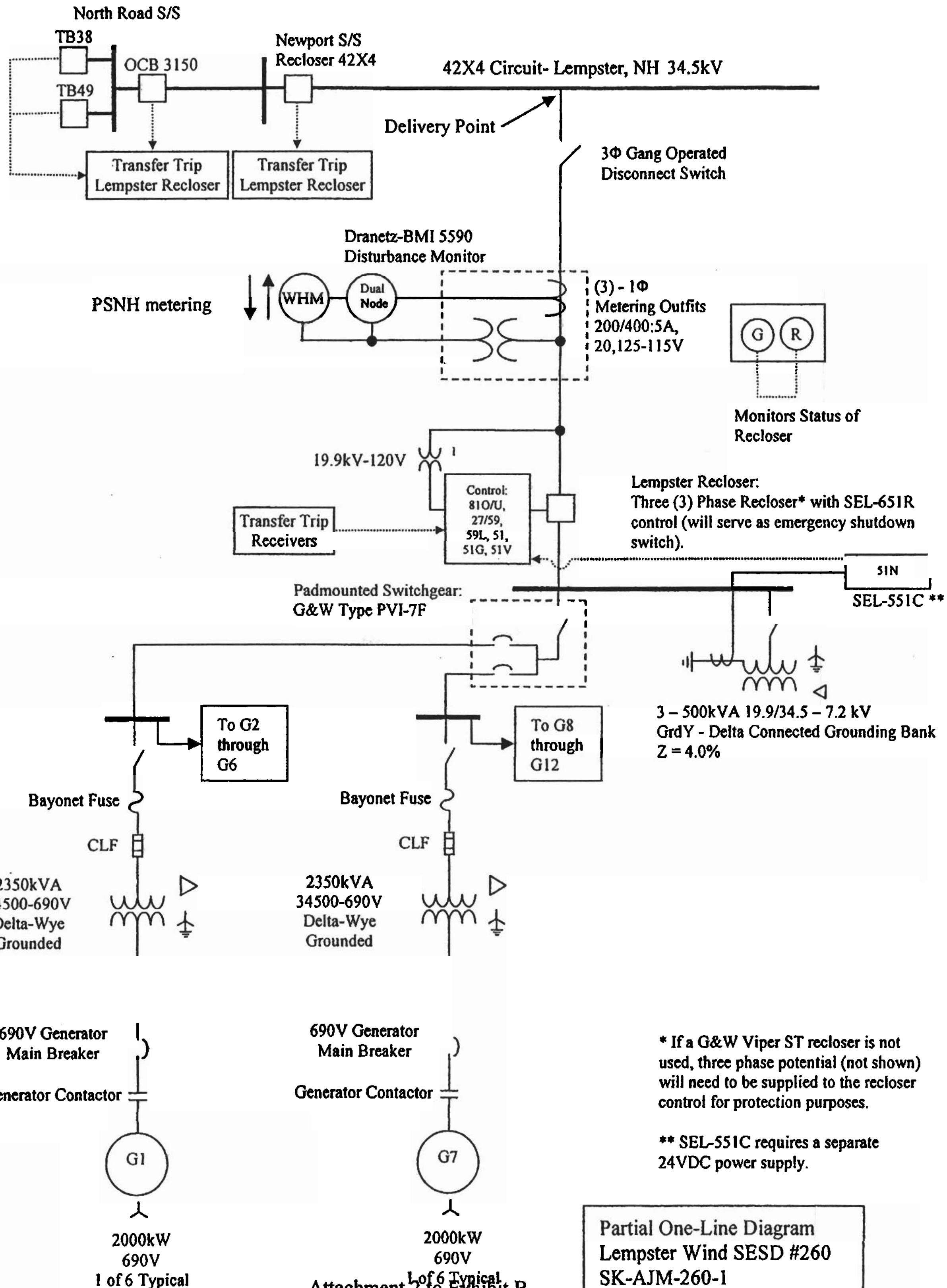
B. Description of Responsibilities

1. PSNH will own and maintain all equipment up to the delivery point. The Developer will own and maintain all equipment from the delivery point into and throughout the plant.

2. The Developer is normally responsible for operating all equipment on the facility side of the delivery point. The only exception to this rule would be if special circumstances required PSNH personnel to operate the emergency shutdown switch (recloser) and/or manually operated disconnect switch.

VII. DRAWINGS

A. Sketch SK-AJM-260-1 is attached.



All generator wind turbines are rated for 2000kW

* If a G&W Viper ST recloser is not used, three phase potential (not shown) will need to be supplied to the recloser control for protection purposes.

** SEL-551C requires a separate 24VDC power supply.

Partial One-Line Diagram
Lempster Wind SESD #260
SK-AJM-260-1
A.J. Marandola 10/04/07

EXHIBIT C

INTERCONNECTION FACILITIES ENGINEERING, PROCUREMENT, CONSTRUCTION, INVOICE AND PAYMENT

1. **Interconnection Facilities**.

(a) PSNH's Construction of the PSNH Interconnection Facilities.

(i) PSNH shall construct (at the Interconnector's sole cost and expense) the PSNH Interconnection Facilities. The Interconnector has selected the target Initial Synchronization Date for the Facility as the date set forth in Attachment 1 to this Exhibit C. PSNH and the Interconnector have mutually agreed to the schedule in Attachment 1 to this Exhibit C, which shows the estimated commencement and completion date for the construction of the PSNH Interconnection Facilities in order for such facilities to be placed in service by the target Initial Synchronization Date. Attachment 2 to this Exhibit C provides PSNH's estimate of the cost to design and construct the PSNH Interconnection Facilities (collectively, "PSNH's Estimated Design & Construction Costs"); and Attachment 2 to this Exhibit C also provides a payment schedule for PSNH's Estimated Design & Construction Costs. PSNH shall design, procure, and construct the PSNH Interconnection Facilities in accordance with Good Utility Practice, using Reasonable Efforts to complete the PSNH Interconnection Facilities and place said facilities in service by the target Initial Synchronization Date set forth in Attachment 1 to this Exhibit C. If PSNH reasonably expects that it will not be able to complete the construction of, and operation of, the PSNH Interconnection Facilities by the target Initial Synchronization Date, PSNH shall promptly provide written notice to Interconnector. If PSNH is unable (for any reason whatsoever) to timely complete all or any portion of the PSNH Interconnection Facilities by the target Initial Synchronization Date set forth in Attachment 1 to this Exhibit C, then (1) PSNH shall use Reasonable Efforts to complete said unperformed work as soon as reasonably practicable thereafter and (2) the Interconnector acknowledges and agrees that PSNH shall not be liable to Interconnector for any fines, penalties, damages, liquidated damages, expenses, costs and lost profits if (for whatever reason) PSNH is unable to timely complete all or any portion of the work by the target Initial Synchronization Date set forth in Attachment 1 to this Exhibit C. PSNH shall not be required to undertake any action which is inconsistent with its standard safety practices, its material, engineering and equipment specifications, its design criteria and construction procedures, its labor agreements, Good Utility Practice or Applicable Laws. "Good Utility Practice" means any of the practices, methods and acts engaged in or approved by a significant portion of the electric industry during the relevant time period, or any of the practices, methods and acts which, in the exercise of reasonable judgment in light of the facts known at the time the decision was made, could have been expected to accomplish the desired result at a reasonable cost consistent with good business practices, reliability, safety and expedition, provided that "Good Utility Practice" is not intended to be limited to the optimum practice, method, or act to the exclusion of all others, but rather to be acceptable practices, methods, or acts generally accepted in the region. "Reasonable Efforts" shall mean, with respect to the actions required by PSNH pursuant to this Exhibit C, efforts that are reasonably timely and consistent with Good Utility Practice and are otherwise substantially equivalent to those PSNH would use to protect its own interests.

(ii) PSNH shall procure necessary equipment for the PSNH Interconnection Facilities in accordance with the PSNH Interconnection Report as soon as PSNH has received written authorization from Interconnector to proceed with the procurement of such equipment, which authorization is expected to be given by Interconnector on or before the date specified in Attachment 1 to this Exhibit C. With respect to each external third party contractor that PSNH elects to retain to construct any portion of the PSNH Interconnection Facilities ("Third Party Contractor"), the Interconnector shall have the right to (A) review, participate in the negotiation of, and provide final approval of, each contract between PSNH and a Third Party Contractor, and (B) the Interconnector can request that a Third Party Contractor be required to pay liquidated damages to the Interconnector in the event the Third Party Contractor fails to timely achieve construction-related milestones in the Third Party Contractor's contract. The Interconnector is responsible for all costs incurred by PSNH in connection with, or arising out of, PSNH's contract(s) with Third Party Contractor(s).

(iii) PSNH shall commence construction of the PSNH Interconnection Facilities as soon as reasonably practicable after the following additional conditions are satisfied:

(1) Approval has been obtained by the Interconnector (at the Interconnector's expense) from the appropriate Governmental Authority(ies) for any facilities requiring regulatory approval; and

(2) (A) PSNH has received written authorization to proceed with construction from Interconnector, which authorization is expected to be given by Interconnector on or before the date specified in Attachment 1 to this Exhibit C (the "NTP") and (B) and PSNH agrees to the schedule contained in the Interconnector's written authorization to proceed with construction.

(iv) The PSNH Interconnection Facilities shall be owned and controlled by PSNH, provided that the Interconnector is responsible for, and shall reimburse PSNH for, one hundred percent (100%) of the cost of the design of, procurement of materials for, construction of, and testing of, the PSNH Interconnection Facilities.

(v) Interconnector shall indemnify, defend and hold PSNH harmless from all taxes, fines and penalties, including but not limited to all contribution in aid of construction (CIAC)-related costs, expenses, fees and taxes, that PSNH incurs or is assessed in connection with, or arising out of, (A) the PSNH Interconnection Facilities and (B) any assets owned by the Interconnector; provided, however, that the Interconnector shall not be responsible for, and shall not be required to indemnify PSNH from, any post-Initial Synchronization Date annual personal property taxes assessed to the PSNH Interconnection Facilities by the State of New Hampshire or any New Hampshire municipality.

(vi) Pursuant to that certain Joint Use Agreement (the "Verizon Agreement"), dated October 15, 1976, as amended and including the Intercompany Operating Procedures incorporated therein by reference, between New England Telephone and Telegraph Company (whose successor under said Joint Use Agreement is Verizon Communications) ("Verizon")) and PSNH, PSNH and Verizon share responsibility for replacement of poles for the dedicated 34.5 kV line to be built over an existing distribution circuit from the Facility's site to PSNH's Newport Substation in Newport, New Hampshire, which line is part of the PSNH Interconnection Facilities. Interconnector acknowledges that PSNH's proposed construction of the PSNH Interconnection Facilities may impact and/or trigger rights held by, or obligations imposed on, Verizon under the Verizon Agreement, and therefore, if PSNH is unable to complete (or unable to timely complete) all or any portion of the PSNH Interconnection Facilities due to, arising out of, or in connection with, rights held by, or obligations imposed on, Verizon under the Verizon Agreement, then such inability by PSNH to complete (and/or inability to timely complete) said construction shall be an event of Force Majeure; provided, however, that (A) in the event Verizon is in default in the performance of its obligations with respect to the construction of a portion of the Dedicated Distribution Circuit or the acts and/or omissions of Verizon prevent PSNH from completing (or prevent PSNH from timely completing) all or any portion of the PSNH Interconnection Facilities (hereinafter, each such event shall be a "Verizon Adverse Impact"), then PSNH agrees to seek enforcement of any rights held by PSNH under the Verizon Agreement (including giving notice pursuant to Article 17 of the Verizon Agreement that Verizon is in default in the performance of its obligations with respect to the construction of a portion of the Dedicated Distribution Circuit and, following the applicable notice period, commencing the performance of the work required to complete the construction required to be performed by Verizon) if PSNH reasonably determines that such enforcement would mitigate or eliminate the Verizon Adverse Impact; (B) all documented costs, fees, expenses, damages, penalties and fines incurred by PSNH arising out of, or in connection with, PSNH's enforcement efforts under subsection (A) of this paragraph, including but not limited to actual costs incurred by PSNH's in-house legal counsel and outside legal counsel and court costs, shall be reimbursed to PSNH by the Interconnector within 30 days of PSNH's submission of an invoice for reimbursement of such costs; and (C) PSNH makes no representation, covenant or warranty concerning (i) the type or scope of any enforcement efforts undertaken by PSNH under subsection (A) above and (ii) the outcome of any enforcement efforts undertaken by PSNH under subsection (A) of this paragraph. Prior to Verizon's performance of Verizon's work that is necessary in order to facilitate the construction of the Dedicated Distribution Circuit, the Interconnector may elect to request from Verizon an estimate of, and/or a "not to exceed" commitment for, the cost of Verizon's performance of such work; and, upon request from the Interconnector, PSNH shall cooperate in good faith with the Interconnector to facilitate the Interconnector's efforts to obtain such an estimate and/or "not to exceed" commitment from Verizon. The Interconnector is responsible for all costs incurred by Verizon in connection with, arising out of, or to facilitate the construction of, the Dedicated Distribution Circuit; and the Interconnector shall indemnify and reimburse PSNH (within 30 days of the Interconnector's receipt of an invoice from PSNH) for any such costs billed by Verizon to PSNH, provided that Interconnector may contest with Verizon and any successor under the Verizon Agreement any such costs so billed to PSNH at Interconnector's sole cost and expense. If Interconnector has paid or reimbursed to PSNH the costs charged by Verizon to PSNH in connection with, arising out of, or to facilitate the construction of, the Dedicated Distribution Circuit and PSNH thereafter receives a reimbursement, credit or payment from Verizon with respect to any portion of those costs, the amounts so received by PSNH shall be paid over to Interconnector or applied as a credit against the amounts then due from Interconnector to PSNH pursuant to this Agreement.

(b) Interconnector Interconnection Facilities. Interconnector shall, at its expense, design, procure, construct, own and install the Interconnector Interconnection Facilities.

(i) Interconnector shall submit initial specifications for the Interconnector Interconnection Facilities, including system protection facilities, to PSNH at least one hundred eighty (180) days prior to the Facility's actual Initial Synchronization Date; and final specifications for review and comment at least ninety (90) days prior to the Facility's actual Initial Synchronization Date. PSNH shall review such specifications to ensure that the Interconnector Interconnection Facilities are compatible with the technical specifications, operational control, and safety requirements of PSNH and comment on such specifications within thirty (30) days of Interconnector's submission. All specifications provided hereunder shall be deemed confidential.

(ii) PSNH's review of Interconnector's final specifications shall not be construed as confirming, endorsing, or providing a warranty as to the design, fitness, safety, durability or reliability of the Facility, or the Interconnector Interconnection Facilities. Interconnector shall make such changes to the Interconnector Interconnection Facilities as may reasonably be required by PSNH, in accordance with Good Utility Practice, to ensure that the Interconnector Interconnection Facilities are compatible with the technical specifications, operational control, and safety requirements of PSNH.

(iii) The Interconnector Interconnection Facilities shall be designed and constructed in accordance with Good Utility Practice. Within one hundred twenty (120) days after the Facility commercial operation date, unless the Parties agree on another mutually acceptable deadline, Interconnector shall deliver to PSNH "as-built" drawings, information and documents for the Interconnector Interconnection Facilities, such as: a one-line diagram, a site plan showing the Facility and the

Interconnector Interconnection Facilities, plan and elevation drawings showing the layout of the Interconnector Interconnection Facilities, a relay functional diagram, relaying AC and DC schematic wiring diagrams and relay settings for all facilities associated with Interconnector's step-up transformers, the facilities connecting the Facility to the step-up transformers and the Interconnector Interconnection Facilities, and the impedances (determined by factory tests) for the associated step-up transformers and the Facility. Interconnector shall provide PSNH specifications for the excitation system, automatic voltage regulator, Facility control and protection settings, transformer tap settings, and communications, if applicable.

(c) Work Progress. The Parties will keep each other advised periodically as to the progress of their respective design, procurement and construction efforts. Either Party may, at any time, request a progress report from the other Party.

(d) Information Exchange. As soon as reasonably practicable after the Effective Date, the Parties shall exchange information regarding the design and compatibility of the PSNH Interconnection Facilities and the Interconnector Interconnection Facilities and compatibility of such interconnection facilities with the PSNH Electric System, and shall work diligently and in good faith to make any necessary design changes.

(e) Limited Operation. If any of the PSNH Interconnection Facilities are not reasonably expected to be completed prior to the target Initial Synchronization Date, PSNH shall, upon the request and at the expense of Interconnector, perform operating studies on a timely basis to determine the extent to which the Facility and the Interconnector Interconnection Facilities may operate prior to the completion of the PSNH Interconnection Facilities consistent with Applicable Laws, Good Utility Practice, and this Agreement. PSNH shall permit Interconnector to operate the Facility and the Interconnector Interconnection Facilities in accordance with the results of such studies only if such studies conclude that operation of the Facility and the Interconnector Interconnection Facilities will not violate Applicable Laws, Good Utility Practice and this Agreement.

(f) Access Rights. Upon reasonable notice and supervision by a Party, and subject to any required or necessary regulatory approvals, a Party ("Granting Party") shall furnish at the incremental cost to the other Party ("Access Party") any rights of use, licenses, rights of way and easements with respect to lands owned or controlled by the Granting Party or its agents (if allowed under the applicable agency agreement), that are necessary to enable the Access Party solely to obtain ingress and egress to construct, operate, maintain, repair, test (or witness testing), inspect, replace or remove facilities and equipment to: (i) interconnect the Facility with the PSNH Electric System; (ii) operate and maintain the Facility, the PSNH Interconnection Facilities, the Interconnector Interconnection Facilities and the PSNH Electric System; and (iii) disconnect or remove the Access Party's facilities and equipment upon termination of this Agreement; provided, however, that, notwithstanding any provision of this Agreement to the contrary, if PSNH is the Access Party and the Interconnector is the Granting Party, then any such rights of use, licenses, rights of way and easements requested by PSNH from the Interconnector shall be without cost to PSNH. In exercising such licenses, rights of way and easements, the Access Party shall not unreasonably disrupt or interfere with normal operation of the Granting Party's business and shall adhere to the safety rules and procedures established in advance, as may be changed from time to time, by the Granting Party and provided to the Access Party.

(g) Lands of Other Property Owners. If any part of the PSNH Interconnection Facilities is to be installed on property owned by persons other than Interconnector or PSNH, PSNH shall use reasonable efforts, including use of its eminent domain authority, and to the extent consistent with state law, to procure from such persons any rights of use, licenses, rights of way and easements that are necessary to construct, operate, maintain, test, inspect, replace or remove the PSNH Interconnection Facilities upon such property; provided, however, that (i) the Interconnector shall reimburse PSNH (within 30 days of the Interconnector's receipt of a request for reimbursement from PSNH) for all costs incurred by PSNH in connection with or arising out of PSNH's performance of its obligations under this subsection, including but not limited to any costs incurred by PSNH for surveying work, title searches, attorneys' fees, court costs, real estate acquisition costs, real estate appraisals, settlements paid to third party property owners and condemnation damage awards paid to third party property owners; and (ii) PSNH makes no representation, covenant or warranty to Interconnector concerning the outcome of, the success of, or the time table for the completion of, any such efforts to procure necessary rights of use, licenses, rights of way, or easements or of any eminent domain proceeding(s) contemplated by this subsection (h). Notwithstanding the foregoing, PSNH shall not be obligated to exercise eminent domain authority if PSNH reasonably determines that the exercise of the power of eminent domain would be inconsistent with, or unlikely to prevail under, Applicable Laws..

(h) Permits. PSNH and Interconnector shall cooperate with each other in good faith in obtaining all permits, licenses, and authorizations that are necessary to accomplish the interconnection of the Facility in compliance with Applicable Laws, provided that the cost of obtaining all such permits, licenses, and authorizations shall be borne by the Interconnector and provided further that the Interconnector shall be responsible for pursuing all such permits, licenses, and authorizations. With respect to this paragraph, PSNH shall provide permitting assistance to Interconnector comparable to that provided to PSNH's own, or an affiliate's, generation, provided that all costs incurred by PSNH in providing any such permitting assistance shall be reimbursed to PSNH from the Interconnector.

(i) Suspension. Interconnector reserves the right, upon written notice to PSNH, to suspend at any time all work by PSNH associated with the construction and installation of the PSNH Interconnection Facilities required under this Agreement with the condition that the PSNH Electric System shall be left in a safe and reliable condition in accordance with Good Utility Practice and PSNH's safety and reliability criteria. In such event, Interconnector shall be responsible for all reasonable and necessary costs which PSNH (i) has incurred pursuant to this Agreement prior to the suspension and (ii) incurs in suspending such work, including any costs incurred to perform such work as may be necessary to ensure the safety of persons and property and the integrity of the PSNH Electric System during such suspension and, if applicable, any actual costs incurred in connection with the cancellation or suspension of material, equipment and labor contracts which PSNH cannot avoid; provided, however, that prior to canceling or suspending any such material, equipment or labor contract, PSNH shall obtain Interconnector's authorization to do so. PSNH shall invoice Interconnector for any such costs and shall use reasonable efforts to minimize such costs.

(j) Pre-Commercial Operation Date Testing and Modifications. Prior to the Initial Synchronization Date, PSNH shall test (at the Interconnector's expense) the PSNH Interconnection Facilities and Interconnector shall test the Facility and the Interconnector Interconnection Facilities to ensure their safe and reliable operation. Each Party shall make any modifications to its facilities that are found to be necessary as a result of such testing, provided all costs incurred by PSNH in connection therewith shall be borne by the Interconnector.

2. **Construction Deposit and Invoicing for the PSNH Interconnection Facilities**.

(a) Deposit from Interconnector for the PSNH Interconnection Facilities. Notwithstanding any provision of this Agreement to the contrary, PSNH shall not commence construction of the PSNH Interconnection Facilities unless and until the Interconnector has provided PSNH with a cash deposit equal to one hundred percent (100%) of the payment entitled "Payment Due within five (5) Days following the Effective Date" in Section F of Attachment 2 to this Exhibit C. Thereafter, Interconnector agrees to deposit with PSNH amounts that are equal to the scheduled installments set forth in said Section F of Attachment 2 to this Exhibit C on or prior to the scheduled installment payment dates set forth in Section F of Attachment 2 to this Exhibit C. The amounts so deposited with PSNH shall be applied by PSNH to pay the costs to design and construct the PSNH Interconnection Facilities as and when incurred by PSNH.

(b) Final Invoice. Within ninety (90) days after the date on which PSNH determines that PSNH has received all of the necessary information PSNH has requested from its employees, agents, contractors and/or subcontractors working on, or providing services in connection with, the design and construction of the PSNH Interconnection Facilities, PSNH shall provide an invoice of the final cost of the construction of the PSNH Interconnection Facilities and shall set forth such costs in sufficient detail to enable Interconnector to compare the actual costs with PSNH's Estimated Design & Construction Costs in Attachment 2 to this Exhibit C and to ascertain deviations, if any, from such estimated costs, provided, however, that (i) if the amount reflected in PSNH's final construction invoice is greater than PSNH's Estimated Design &

Construction Costs, the Interconnector shall be responsible for reimbursing PSNH (within thirty (30) days of the issuance of a final construction invoice from PSNH to the Interconnector) for all actual costs incurred by PSNH in excess of PSNH's Estimated Design & Construction Costs and (ii) if any cost incurred by PSNH in connection with the design and construction of the PSNH Interconnection Facilities is not included in the above-mentioned final invoice, PSNH retains the continuing right to seek payment therefor from the Interconnector. PSNH shall refund to Interconnector any amount by which the actual payment by Interconnector for PSNH's Estimated Design & Construction Costs exceeds the actual costs of design and construction within thirty (30) days of the issuance of such final construction invoice. Interconnector shall pay to PSNH the amount by which the actual payment by Interconnector for PSNH's Estimated Design & Construction Costs falls short of the actual costs of design and construction of the PSNH Interconnection Facilities within thirty (30) days of the issuance of such final construction notice.

ATTACHMENT 1 TO EXHIBIT C

Estimated Construction Milestones for the PSNH Interconnection Facilities

Milestone	Estimated Milestone Date
Date on which PSNH selects Third Party Contractor to construct Dedicated Distribution Circuit:	February 1, 2008
NTP:	February 11, 2008
Notice to Verizon by PSNH of need for new poles to be constructed as part of Distribution Circuit Upgrade pursuant to Intercompany Operating Procedure #2 attached to Verizon Agreement	Not later than ten (10) days following NTP, provided the NTP must state in writing that Interconnector hereby directs PSNH to provide notice to Verizon in accordance with the terms of this Attachment 1 to Exhibit C
Initial contact by representative of PSNH to Verizon pursuant to paragraph 2 of Intercompany Operating Procedure #9 attached to Verizon Agreement	Not later than ten (10) days following election by Verizon that pole line to be constructed as part of Distribution Circuit Upgrade will be a joint pole line
Initiation by PSNH of Exchange of Notice pursuant to Intercompany Operating Procedure #9 attached to Verizon Agreement	Not later than five (5) days following initial contact described in immediately preceding milestone
Target Initial Synchronization Date:	August 1, 2008

ATTACHMENT 2 TO EXHIBIT C

Estimated Cost of and Payment Schedule for the PSNH Interconnection Facilities

A. **PSNH INTERCONNECTION FACILIITIES (EXCLUDING THE DISTRIBUTION CIRCUIT UPGRADES)*** – Work to be done by PSNH, including the electrical upgrades at PSNH's Newport and Northroad Substations necessary to interconnect the Facility. (The cost of the PSNH upgrades discussed in this subsection (A) does not include the cost of the Distribution Circuit Upgrades (as defined in Section (a)(ii) of Exhibit B to this Agreement) that will be constructed by Third Party Contractor(s)).

1. Engineering - System Protection – PSNH's review of control circuits, material specifications and development of PSNH required relay settings at the sites.

Labor:	$10,000

2. Newport Substation - (a.) Alteration of Newport Substation to include a three-phase recloser, recloser control, preparation for transfer trip capabilities and SCADA control.

Labor:	$50,000
Materials:	$100,000

(b.) The specification, application, drafting, purchase, installation and commissioning of the transfer trip equipment, RTU and the required telephone circuit interface at the Newport Substation.

Material:	$40,000
Labor:	$60,000

3. Northroad Substation - The specification, application, drafting, purchase, installation and commissioning of the transfer trip equipment and the required telephone circuit interface at the North Road Substation.

Material:	$25,000
Labor:	$45,000

4. ESCC, Manchester, NH - Labor and materials required for telemetry connection from Newport and Northroad to the PSNH SCADA computer system in Manchester.

Labor:	$ 3,000
Materials:	$ 1,000

5. Metering - Labor and material for System Metering.

Labor:	$ 3,500
Materials:	$15,000

***Note:** The actual costs for the work discussed in this subsection (A) are not available until the work is completely designed, bid and constructed. These estimates in this subsection (A) include only the estimated cost for equipment on the utility system. The costs shown in this subsection (A) do not include any costs associated with any upgrades, material and labor that is necessary or appropriate from the Interconnection Point inward to the Facility.

B. **OTHER PSNH COSTS** - Preliminary Engineering, Interconnection Study, Distribution System Upgrades Work and Contractor Supervision.

1. ISO System Impact Study – PSNH's share of the ISO-NE SIS is not reimbursed by ISO-NE.

Labor:	$28,500
Paid to Date:	0
Balance Due	$28,500

2. Interconnection Bid Package - The design, engineering and preparation of the Distribution Circuit Upgrades.

Labor:	$65,400
Paid to Date:	$75,000
Balance Due	$(9,600)

3. PSNH Interconnection Study and Report – PSNH's costs to conduct the study and prepare the Interconnection Report:

Labor:	$17,000

4. PSNH Interconnection Line Construction Supervision – **PSNH** Supervision of the construction of the Distribution Circuit Upgrades.

Labor:	$150,000

C. NHEC Interconnection Line Construction Supervision – NHEC Supervision of the construction of the Distribution Circuit Upgrades. The NHEC costs are for informational purposes only and this cost is not included in the summary of costs below.

Labor:	$60,000 (est.)

D. ESTIMATED DESIGN AND CONSTRUCTION SCHEDULE

1. Commit to Design – Estimated Start Date December 2007.

TRC North Road	$5,000
TRC Newport	$20,000
PLD	$20,000
Other PSNH Costs	$35,900
Total	$80,900

2. Material Order – Estimated Start Date February 2008.

North Road	$25,000
Newport RTU & TT	$40,000
Newport Recloser	$40,000
Metering	$15,000
PLD	$30,000
Associated labor	$35,000
Total	$195,000

3. Construction and Installation – Estimated Start Date April 2008.

North Road	$45,000
Newport RTU & TT	$20,000
Newport Recloser	$60,000
Metering	$3,500
PLD	$50,000
Associated labor	$28,000
Total	$182,500

4. Balance of Costs – Estimated Start Date July 2008.

North Road & Newport Labor		$30,000
PLD		$50,000
	Total	$80,000

5. Contingency – As required within 90 days of completion of work.

Contingency		$50,000
	Grand Total	**$588,400**

E. ESTIMATED THIRD PARTY CONTRACTOR COSTS FOR DISTRIBUTION CIRCUIT UPGRADES (to be supplied by each Third Party Contractor in its approved contract for the construction of the Distribution Circuit Upgrades).

This subsection (E) does not reflect the cost PSNH will incur for each Third Party Contractor to construct the Distribution Circuit Upgrades. Said amount is to be provided ("TBP"). Section 1(a)(ii) of Exhibit C to this Agreement provides the Interconnector with an opportunity to review, participate in the negotiation of and approve each contract between PSNH and each Third Party Contractor for the construction of the Distribution Circuit Upgrades. The Interconnector shall reimburse PSNH for all costs incurred by PSNH in connection with, or arising out of, each contract between PSNH and a Third Party Contractor for the construction of Distribution Circuit Upgrades.

Once PSNH has entered into final contract(s) with the Third Party Contractor(s) for the construction of the Distribution Circuit Upgrades, (i) PSNH shall prepare a payment schedule that will identify the specific dates on which Interconnector must provide PSNH with the payments that PSNH will use to pay Third Party Contractor(s) for such Distribution Circuit Upgrades and (ii) upon receipt of said payment schedule from PSNH, the Interconnector will be responsible for timely providing said payments to PSNH in accordance with the time frame set forth in, and the amounts set forth in, said payment schedule. If PSNH thereafter assumes responsibility for construction of any portion of the Distribution Circuit Upgrades that were originally expected by PSNH to be constructed by Verizon, then PSNH will promptly provide Interconnector with an updated payment schedule and

Interconnector shall thereafter make payments to PSNH in accordance with such updated schedule.

The Interconnector shall have the right, upon providing PSNH with 30 days prior notice, to review and audit all invoices submitted by each Third Party Contractor.

F. OVERALL PAYMENT SCHEDULE**

Payments Made to PSNH prior to 12/1/07	$ 75,000.

Additional Payments Due for	PSNH Work	Third Party Contractor Work	Total Due
Payment Due within five (5) Days following the Effective Date	$ 80,900	$0	$80,900
Payment Due on 2/1/08	$ 195,000	$0	$195,000
Payment Due on 3/1/08	$ 0	TBP	$0
Payment Due on 4/1/08	$ 182,500	TBP	$182,500
Payment Due on 5/1/08	$ 0.	TBP	$0
Payment Due on 6/1/08	$ 0	TBP	$0
Payment Due on 7/1/08	$ 80,000	TBP	$80,000
Payment Due on 8/1/08	$ 0	TBP	$0
Within 30 days of completion	$0	TBP	$0
Within 90 days of completion (See Notes)	$ 50,000	$0?	$50,000
Additional Payments as detailed above:	$ 588,400	TBP	TBP
Estimated Total Cost =	**$ 663,400**	TBP	TBP

**Notes: The estimated amounts shown in this subsection (F) are the estimated amounts owed by the Interconnector to PSNH as reimbursement for labor, material and work by PSNH and each Third Party Contractor for the PSNH Interconnection Facilities. As indicated in subsection (E) above, the amount Interconnector shall pay to Third Party Contractor(s) for the construction of the Distribution Circuit Upgrades has not yet been determined and such costs will be known when PSNH has entered into contract(s) with each Third Party Contractor for the construction of the Distribution Circuit Upgrades.

All of the estimates in subsections (A), (B), (C), (D), (E) and (F) of this Attachment 2 (i) are estimates, which are subject to true-up by PSNH based on the actual costs incurred by PSNH, and (ii) do not include any costs that Verizon may seek in connection with, arising out of, or to facilitate the construction of, the Distribution Circuit Upgrades, including but not limited to, any costs for work performed by Verizon to remove and/or relocate utility poles and/or utility facilities. Interconnector is responsible for, and Interconnector shall reimburse PSNH for, all such costs billed or requested by Verizon.

The final payment in subsection (F) above (i) contains the contingent amounts from the work detailed above, (ii) is due upon completion of the final accounting of construction costs, and (iii) is subject to true-up to reflect PSNH's actual costs.

Payments are due on the dates listed above and will not be separately billed to the Interconnector, except for the payment, if any, due upon the final accounting by PSNH within 90 days following completion of the work, which shall be paid as provided in Section 2(b) of Exhibit C to the Agreement.

EXHIBIT D

OPERATIONS AND MAINTENANCE

1. **Operations**.

(a) PSNH Obligations. PSNH shall cause the PSNH Electric System and the PSNH Interconnection Facilities to be operated, maintained and controlled in a safe and reliable manner and in accordance with this Agreement and applicable reliability standards.

(b) Interconnector Obligations. Interconnector shall at its own cost and expense operate, maintain and control the Facility and the Interconnector Interconnection Facilities in a safe and reliable manner and in accordance with this Agreement, Applicable Laws, the requirements of ISO-NE and applicable reliability standards. Interconnector shall also operate the Facility and Interconnector Interconnection Facilities (at its own cost and expense) in accordance with all applicable requirements set forth in the PSNH Interconnection Report.

(c) Outage Authority and Coordination. Each Party may in accordance with applicable reliability standards and in coordination with the other Party, remove from service any of its respective facilities that may impact the other Party's facilities as necessary to perform maintenance or testing or to install or replace equipment. If an outage on a Party's facilities adversely affects the other Party's operations or facilities, the Party that owns or controls the facility that is out of service shall promptly restore such facility(ies) to a normal operating condition consistent with the nature of the outage. The Party that owns or controls the facility that is out of service shall provide the other Party, to the extent such information is known, information on the nature of the conditions, an estimated time of restoration, and any corrective actions required. Initial verbal notice shall be followed up as soon as practicable with written notice explaining the nature of the outage.

(d) Interruption of Service. In accordance with applicable reliability standards, PSNH may require Interconnector to interrupt or reduce deliveries of Energy if such delivery of Energy materially adversely affects PSNH's ability to perform such activities as are necessary to safely and reliably operate and maintain the PSNH Electric System.

(e) Notice. PSNH shall notify Interconnector promptly when it becomes aware of an Emergency Condition that affects the PSNH Interconnection Facilities or the PSNH Electric System that may reasonably be expected to affect Interconnector's operation of the Facility or the Interconnector Interconnection Facilities. Interconnector shall notify PSNH promptly when it becomes aware of an Emergency Condition that affects the Facility or the Interconnector Interconnection Facilities that may reasonably be expected to affect the PSNH Electric System or the PSNH Interconnection Facilities.

To the extent information is known, the notification shall describe the Emergency Condition, the extent of the damage or deficiency, the expected effect on the operation of Interconnector's or PSNH's facilities and operations, its anticipated duration and the corrective action taken and/or to be taken. The initial notice shall be followed as soon as practicable with written notice. "Emergency Condition" means a condition or situation: (1) that in the reasonable judgment of the Party making the claim or ISO-NE is likely to endanger life or property; (2) that, in the case of PSNH or ISO-NE, is likely (as determined in a non-discriminatory manner and in accordance with Good Utility Practices) to cause a material adverse effect on the security of, or damage to, the PSNH Electric System or the PSNH Interconnection Facilities; (3) that, in the case of Interconnector, is likely (as determined in a non-discriminatory manner and in accordance with Good Utility Practices) to cause a material adverse effect on the security of, or damage to, the Facility or the Interconnector Interconnection Facilities; or (4) is designated by a Party, ESCC or ISO-NE as a condition or situation that is reasonably expected to lead to a condition or situation described in any of clauses (1) through (3) above.

(f) PSNH Authority. In accordance with applicable reliability standards and this Agreement, PSNH may take whatever actions or inactions with regard to the PSNH Electric System or the PSNH Interconnection Facilities it deems necessary during an Emergency Condition in order to (i) preserve public health and safety, (ii) preserve the reliability of the PSNH Electric System or the PSNH Interconnection Facilities, (iii) limit or prevent damage, and/or (iv) expedite restoration of service. PSNH shall use reasonable efforts to minimize the effect of such actions or inactions on the Facility and the Interconnector Interconnection Facilities.

(g) Interconnector Authority. In accordance with applicable reliability standards and this Agreement, Interconnector may take whatever actions or inactions with regard to the Facility and the Interconnector Interconnection Facilities during an Emergency Condition in order to (i) preserve public health and safety, (ii) preserve the reliability of the Facility or the Interconnector Interconnection Facilities, (iii) limit or prevent damage, and/or (iv) expedite restoration of service. Interconnector shall use reasonable efforts to minimize the effect of such actions or inactions on the PSNH Electric System and the PSNH Interconnection Facilities. PSNH shall use reasonable efforts to assist Interconnector in such actions.

(h) Limited Liability. Except as otherwise provided in Section 1(i) of this Exhibit D, neither Party shall be liable to the other for any action it takes in responding to an Emergency Condition so long as such action is made in good faith and in accordance with applicable reliability standards.

(i) Interconnector Compensation. Interconnector shall be compensated for its provision of real and reactive power or any other Emergency Condition services that Interconnector provides to support the PSNH Electric System during an Emergency Condition in accordance with applicable rules of ISO-NE.

2. **Maintenance**.

PSNH shall maintain, at its costs and expense, the PSNH Electric System and the PSNH Interconnection Facilities in a safe and reliable manner and in accordance with applicable reliability standards. Interconnector shall maintain, at its costs and expense, the Facility and the Interconnector Interconnection Facilities in a safe and reliable manner and in accordance with this Agreement.

3. **Third Party Users**.

If required by Applicable Laws or if the Parties mutually agree, such agreement not to be unreasonably withheld, to allow one or more third parties to use the PSNH Interconnection Facilities, or any part thereof, Interconnector will be entitled to compensation for the capital expenses it incurred in connection with the PSNH Interconnection Facilities based upon the pro rata use of the PSNH Interconnection Facilities by PSNH, all third party users, and Interconnector, in accordance with Applicable Laws or upon some other mutually-agreed upon methodology. If the issue of such compensation cannot be resolved through such negotiations, it shall be submitted to FERC for resolution.

ATTACHMENT 1 TO EXHIBIT B

ISO-NE SYSTEM IMPACT STUDY

Lempster Wind Project
System Impact Study

Final Report

November, 2006

Prepared by:

E·PRO

Engineering & Environmental Consulting, LLC

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Executive Summary

E/PRO Engineering & Environmental Consulting, LLC ("E/PRO") has conducted a System Impact Study ("Study") on behalf of ISO New England Inc. and Public Service Company of New Hampshire (PSNH) for Community Energy, Inc – New Hampshire, LLC (CEI) to develop a 24MW wind-farm (the "Project") in central New Hampshire (NH) with an Initial Synchronization Date of September 2007 and a proposed Commercial Operations Date of November 2007.

The Study was performed in accordance with the ISO New England Operating Documents and the ISO New England Planning Procedures 5-6, Minimum Interconnection Standard ("MIS").

This Study includes results: (i) assessing thermal overloads and voltage limit violations resulting from the interconnection (previously performed by PSNH); (ii) assessing circuit breaker short circuit capability limits exceeded as a result of the interconnection (which is contained within the "Lempster Wind Project – Assessment of Wind Turbine Technology and Review of Protection & Control Issues for the Public Service Company of New Hampshire", previously performed by E/PRO); and (iii) identifying any instability or inadequately damped response to system disturbances resulting from the interconnection. The Study has finalized these results and presents a conclusive response to the latter two aspects of the ISIS in respect to the Project.

The Project will consist of 12 Gamesa Eolica G87 2.0 MW wind turbines configured in a two collector string system in the vicinity of the Lempster Mountain ridge in the town of Lempster (Sullivan County), NH. As shown in Figure 1 on the next page, the Project will interconnect at PSNH's Newport 34.5kV Substation through two 34.5-kV line segments. The first segment is approximately 3 miles from the Project to NH Route 10 and connects to the second segment consisting of approximately 7 miles of overhead line to the PSNH Newport Substation. The Newport Substation is a 34.5 – 4.16 kV distribution substation which is fed via line 315 (approximately 4 miles) from PSNH's North Road 115kV – 34.5 kV substation located in Sunapee, NH.

Study Findings

The short-circuit analysis (performed by E/PRO in a separate study conducted for PSNH) concluded that the Project did not produce any adverse impact on local area protective switching devices that will require replacement. Fault current contribution from the Project did not cause any protective device to exceed its fault interrupting duty. A more detailed summary can be found in Appendix E.

The transient stability analysis was performed on a set of base cases representing a 2008 light load transmission system and included sensitivity to the Monadnock Project which has been studied and approved by the technical review task forces.

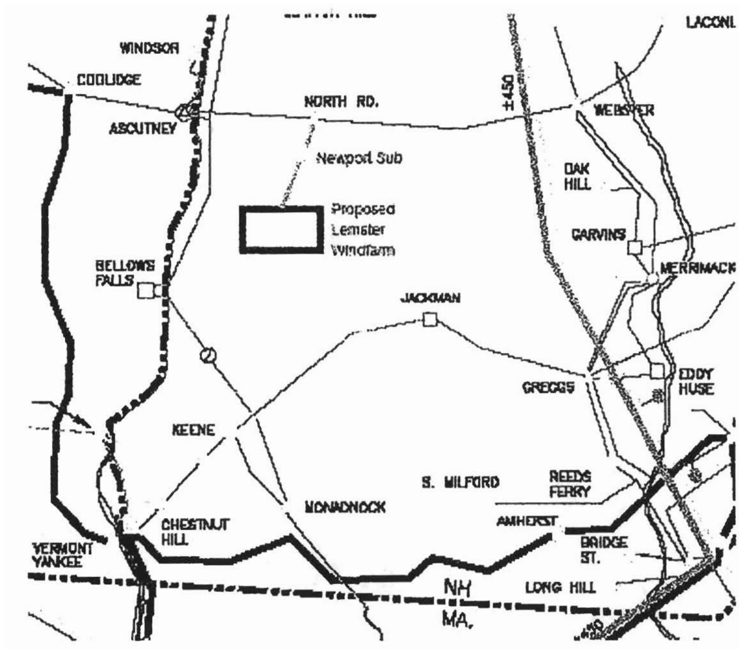


Figure 1 Proposed Project Study Area

Based on the existing network configuration and North Road Substation protective devices and voltage relaying scheme, transmission line faults involving the M-127 (Webster-North Road 115-kV Line) and K-174 (Ascutney-North Road 115-kV Line) lines will isolate the North Road S/S from the 115-kV bulk power transmission system and transfer trip the Hemp Hill generator units. The addition of the Lempster wind farm will not significantly affect the application of this protective relaying scheme. The Lempster Wind Farm will also be included with transfer trip initiated by this voltage protection scheme. For more detailed description, see Section 1.5 of this report.

Twenty-two stability simulations were performed.

BPS stability testing was performed on two 2008 light load base cases. A five second station test was performed on the North Road 115kV station. The results of this BPS testing showed no violations to the NPCC BPS testing criteria and no additional stations are to be classified as part of the Bulk Power System as a result of the Project.

In conclusion, the system impact study revealed that the addition of the Project has no significant system impact to the stability, reliability, and operating characteristics of the New England bulk power transmission system.

1 Introduction

1.1 Background

Community Energy, Inc. – New Hampshire, LLC (CEI) has proposed to construct a 24 MW wind farm in the vicinity of the Lempster Mountain ridge in the town of Lempster (Sullivan County), New Hampshire. The proposed Lempster Mountain Wind Power Project (the "Project") will interconnect to the Public Service Company of New Hampshire's 34.5 kV Newport Substation via an 10 mile, overhead 34.5 kV generator exit line.

E/PRO Engineering & Environmental Consulting, LLC (EPRO) has been engaged to perform an interconnection system impact study to assess the transient response resulting from the placement of 24MW of wind-generation onto the Public Service of New Hampshire (PSNH) distribution and ISO New England Bulk Power Transmission systems in central New Hampshire.

1.2 Project Description

CEI plans to install 12 Gamesa Eolica G87 2.0 MW wind turbine generators. The Gamesa G87 wind turbine generator employs a doubly fed induction generator technology to produce low voltage power (690V) that is stepped up to 34.5kV via a dry resin cast transformer located inside of the wind turbine nacelle.

The turbines will connect into an underground collector system consisting of two collector strings with six units on each string. The two underground collector strings will terminate in a three terminal pad-mounted switchgear arrangement and transition to an overhead line, as depicted in Appendix A. The overhead line will feed through a 34.5 kV distribution class recloser at the Lempster site and route some 10 miles to the PSNH 34.5 kV Newport Substation. The proposed generator exit line will be comprised of two line segments:

- Segment 1 - This segment will use an existing NHEC circuit built along public roads and private residence access for an approximate 3 mile 34.5kV line from the Project to PSNH' system on Route 10 at the Goshen - Lempster town lines. The existing line will be rebuilt as an express over-build or as an underground line. For the purpose of this study the over-build option will be used.

  Segment 2 – This section will replace an existing PSNH circuit along Rt. 10 and New Hampshire Electric Cooperative (NHEC) right-of-way for approximately 7 miles with a new overbuilt overhead express line to the PSNH Newport substation.

The Newport Substation is a 34.5 – 4.16 kV distribution substation that is fed via a 34.5kV line (Line 315) from PSNH's North Road 115 – 34.5 kV substation located in Sunapee, NH. Line 315 is a three phase, four wire circuit comprised of 336.4 kcmil ACSR conductor that extends from North Road Substation 34.5 kV Bus No. 1 approximately 3.87 miles to the Newport Substation 34.5 kV bus.

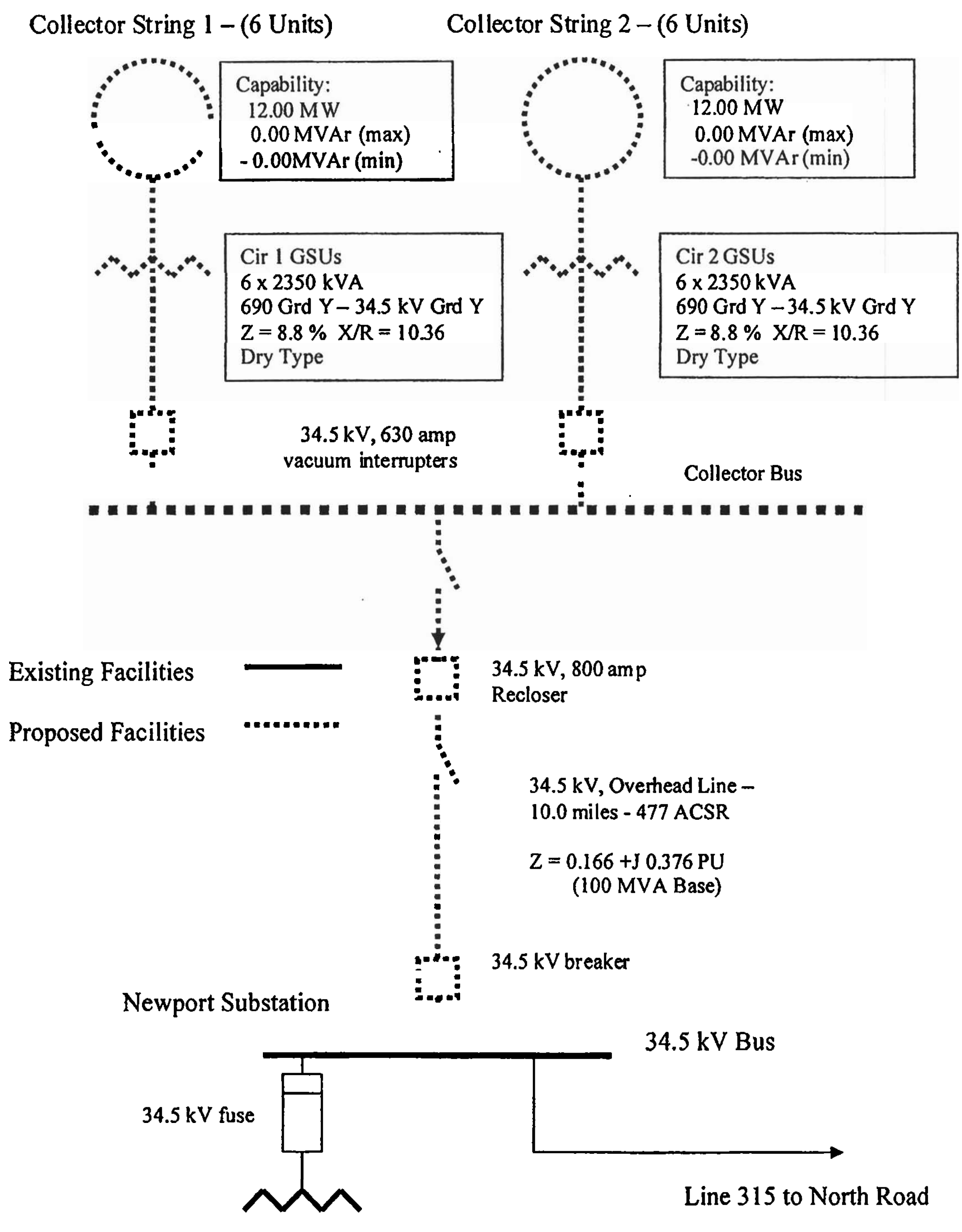


Figure 2 Simple One-Line

1.3 Technical Information

1.3.1 Gamesa G87 unit

Rated Power	2,000 kW
Rated Voltage	690 Volts
Rated Frequency	60 Hz.
Apparent Power	2,197 kVA
Power Factor	0.91 Inductive
Rated Speed	2,015 RPM
Synchronous Speed	1,800 RPM
Rated Current –	
Rotor	580 amps
Stator	1621 amps
Moment of Inertia –	
Generator	70.7 kg·m^2
Total	292.1 kg·m^2

Reactances (per unit) –		
Transient	0.196 (saturated)	0.214 (unsaturated)
Subtransient	0.149 (saturated)	0.152 (unsaturated)
Synchronous	3.4 (saturated)	4.63 (unsaturated)
Negative sequence	0.195 (saturated)	0.212 (unsaturated)
Zero Sequence	0.398 (saturated)	0.410 (unsaturated)

Time Constants –	
Open Circuit Transient	1.40 sec
Short Circuit Transient	0.0025 sec

1.3.2 Transformer data:

Type	Dry Cast Resin located in Nacelle
High Voltage Winding	34,500 volts
Low Voltage Winding	690 volts
Winding Configuration	Wye (grnd) /Wye (grnd)
MVA Rating	2.350 MVA
Impedance	8.80 % Z, X/R = 10.36
BIL	150 kV BIL
Taps	2 – 2.5% + and 2 – 2.5 % -

1.3.3 Wind Farm to Newport Line (New Generator Exit Line)

The proposed generator exit line will be comprised of two line segments:

Line Section	Distance (miles)	From	To	Construction	Conductor Type	MVA Rating (Sum/Win)	R (pu)*	X (pu)*
Segment 1	2	Project	Route 10	Overbuilt	477 ACSR	48.1/56.9	0.03325	0.07525
Segment 2	8	Route 10	Newport S/S	Overhead	477 ACSR	48.1/56.9	0.13300	0.30100
Total	10	Project	Newport S/S				0.16625	0.37625

Table 1-1 Generation Exit Line Data

1.3.4 Newport 34.5 kV to North Road 34.5 kV (Existing PSNH Line 315)

Line Section	Distance (miles)	From	To	Construction	Conductor Type	MVA Rating (Sum/Win)	R (pu)*	X (pu)*
315	1.73	Newport	Guild	Overhead	336 ACSR	38.4/45.3	0.0405	0.0989
315	2.14	Guild	North Rd	Overhead	336 ACSR	38.4/45.3	0.0501	0.1224
Total	3.87	Newport	North Rd				0.0906	0.2213

Table 1-2 Line 315 Conductor Data

1.3.5 North Road 115 kV to North Road 34.5 kV (PSNH Transformation)

Xformer Ident	Rating MVA	From	To North Rd	Winding Configuration	% Z Base Rating	R (pu)*	X (pu)*
TB38	24/32/40/44.8	Ascutney K174	34.5 Bus 1	Delta – wye(gmd)-Dy1	8.7	0.0144	0.3610
TB49	24/32/40/44.8	Webster M127	34.5 Bus 2	Delta – wye(gmd)-Dy1	8.6	0.0140	0.3589

Table 1-3 North Road Step-Down Transformers

1.4 Hemphill Dynamic Model

Hemphill Power and Light provided its' dynamics data to E/PRO for the purpose of this study. This data can be found in Appendix H of this report.

* On 100 MVA Base

1.5 North Road Protective Relaying

The North Road 115kV Substation has an existing 115kV transmission line fault protection at North Road substation that is implemented by voltage relaying. The sensing voltage is taken from the secondaries of CCVTs which are connected to the 115 kV substation bus. The protection scheme consists of the following functions:

1) Time undervoltage (27) relaying to detect three phase faults.
2) Negative sequence (47) time overvoltage protection to detect phase to phase and phase to phase to ground faults.
3) Zero sequence (59N) time overvoltage to detect line to ground faults
4) Zero sequence (59N) instantaneous overvoltage to detect line to ground faults where remote terminals have tripped, resulting in a full neutral displacement.

The existing voltage relaying detects faults on the M-127 / K-174 lines and trips the low side transformer breakers TB38 and TB49, and transfer trips Hemphill generation, which interconnects with the PSNH system via 34.5 kV circuit 316. After its installation, the Lempster Wind Farm will also be transfer tripped directly by this voltage protection scheme.

Time delays are typically on the order of 1-3 seconds depending on the nature of the fault. These time delays are determined with consideration for the 34.5 kV clearing times, the 115 kV reclosing time delays, and the through fault protection for the North Road transformers.

In addition, the Webster and Ascutney line terminals are equipped for automatic reclosing following fault clearing. The reclosing sequences are as follows:

1) Webster M127 – 1 Reclosure at 5s, Live Bus/Dead Line or Synch-Check
2) Ascutney K174 – 1 Reclosure at 10s Live Bus/Dead Line or Synch-Check.

The addition of the Lempster Wind Farm will not significantly affect the application of this scheme.

2 Steady State Assessment

PSNH's System Engineering group performed a Preliminary Voltage Profile Study in August 2004 to determine the feasibility of interconnecting a 25MW wind generation facility in Lempster, New Hampshire to the PSNH distribution system. The Study concluded that 25MW of generation may be interconnected at 34.5kV to Newport Substation in Newport, NH. The following construction and operating constraints must be met by the generating facility to interconnect 25MW:

1. For steady state operation at almost all load and generation levels, the generation system will have to operate absorbing VARs to maintain an acceptable voltage. 1.035 was modeled at the generator interconnection and delivery point modeled at the intersection of Bean Mountain Road and Nichols Road. Power factor ranges from Unity to -95%(absorbing VARs). This is required to hold the steady state voltage down on the line. The generation facility will not be allowed to provide VARs to the system because the resultant voltages are above acceptable limits for 34.5kV distribution.
2. Any generating facility will require machines with voltage control, remote fault ride-through, and equipment with state-of-the-art control capabilities.
3. An upgraded/new three-phase, 477ACSR, 34.5kV circuit is required.
4. NHEC must be in agreement on any system operating conditions on facilities in the NHEC franchise territory.

Construction requirements on the PSNH and NHEC system include:

- Approximately 10 miles of new 34.5kV, 3 phase line from Newport Substation to the site which is NH Electric Coop franchise territory (NHEC).
- Alteration of Newport Substation including a three-phase breaker, controls, transfer trip, and SCADA.

The budgetary estimate for the above line and substation work is $2,300,000.

3 Study Methodology

Stability and short-circuit analyses were used to evaluate the performance of the Project at the summer 2008 light load levels. A sensitivity study has also been evaluated with the Monadnock Project which includes a plan to install a 345-115-kV autotransformer at the new Fitzwilliams Substation. Stability analysis was preformed on a comprehensive set of fault contingencies according to standard stability simulation practices for New England.

3.1 Study Approach

The dynamic stability analysis was performed using Power Technologies Inc. PSS/E software package, version 28. Fault contingencies were simulated and analyzed using the criteria listed below with the project in-service to determine the project's impact on the stability, reliability, or operating characteristics of the interconnected bulk power system.

3.2 Bulk Power System Testing

Tests were performed to determine the impact of the project on the classification of facilities as part of the Bulk Power System (BPS). The Northeast Power Coordinating Council Criteria defines specific requirements applicable to design, operation, and protection of BPS facilities. BPS testing was initially conducted with NRI Project not included in the model. If a station is classified as BPS with NRI Project not modeled, its classification with the NRI Project included in the model will also be performed in order to determine the impact which the NRI Project has on BPS classification of the associated stations.

In this study, a permanent three-phase fault was applied at selected stations with 5 second (300 cycles) and actual (for failure of the 300 cycle test) remote-end clearing times at the station in question. If the simulation failed to meet the acceptance criteria discussed in Section 2.6 below, the station was classified as part of the BPS.

All non-BPS stations one bus away from a newly-classified BPS station was investigated. The classification of a station as BPS requires specific single failure proof protection system design. In addition, BPS facilities must be tested in accordance with NPCC Maintenance Criteria (Document A-4) as part of the NPCC Reliability Compliance and Enforcement Program.

3.3 Stability Performance Criteria

Stability analysis results were analyzed using the criteria in the *Reliability Standards for New England Power Pool, Transmission Reliability Standard for Northeast Utilities, January 2004*, and in the applicable ISO New England Planning Procedures i.e. PP#5-3 Guidelines for Conducting and Evaluating Proposed Plan Application Analyses, PP#5-5 Subordinate Proposed Plan Application Policy and PP#5-6 Scope of Study for System Impact Studies Under the Minimum Interconnection Standard. For the transient stability assessment, a set of design criteria faults, normal and extreme contingencies, were simulated with the following criteria applied for evaluation.

The ISO New England Planning Procedure PP #3, *Reliability Standards for New England Power Pool* specifically states that "The New England bulk power system shall remain stable during and following the most severe of the contingencies stated below with due regard to reclosing and before making any manual system adjustments."

3.4 Normal Contingencies

The following normal contingencies, as defined by ISO New England Planning Procedure #3, will be considered for this analysis.

a. Permanent 3-phase fault on any generator, transmission circuit, transformer or bus section, with normal fault clearing.
b. Simultaneous permanent phase-to-ground faults on different phases of each of two adjacent transmission circuits on a multiple circuit transmission tower, with normal fault clearing. If multiple circuit towers are used only for station entrance and exit purposes, and if they do not exceed five towers at each station, then this condition and other similar situations can be excluded on the basis of acceptable risk, provided that ISO New England specifically approves each request for exclusion. Similar approval must be granted by the NPCC Reliability Coordinating Committee.
c. Permanent phase-to-ground fault on any transmission circuit, transformer, or bus section with delayed fault clearing. This delayed fault clearing could be due to circuit breaker, relay system, or signal malfunction.
d. Loss of any element without a fault.
e. Permanent phase-to-ground fault in a circuit breaker, with normal fault clearing (Normal fault clearing time for this condition may not be high speed).
f. Simultaneous permanent loss of both poles of a direct current bipolar facility without an ac fault.
g. Failure of any Special Protection System (SPS) which is not functionally redundant following the contingencies listed in "a" through "f" above.
h. The failure of a circuit breaker associated with an SPS following: loss of any element without a fault; or a permanent phase to ground fault, with normal fault clearing, on any transmission circuit, transformer, or bus section.

The following criteria define stable transmission system performance for normal contingencies.

- All units transiently stable except for units tripped for fault clearing.
- A 50% reduction in the magnitude of system oscillations must be observed over the last four periods of the oscillation.
- Loss of source not greater than 1200 MW.
- No entry of the Keswick GCX SPS apparent impedance relay characteristic on Section 396/3001 line from Keswick to Orrington at Keswick S/S

3.5 Extreme Contingencies

The Reliability Standards also address extreme contingencies; the extreme contingencies are considered more severe relative to a normal contingency, but lower in probability of occurrence. The transmission bulk power system performance, in response to an extreme contingency, is intended to be a gauge of the system's robustness or a measure of the extent of the disturbance.

The following extreme contingencies, as defined by ISO New England Planning Procedure #3, will be considered for this analysis:

a. Loss of the entire capability of a generating station.
b. Loss of all lines emanating from a generating station, switching station or substation.
c. Loss of all transmission circuits on a common right-of-way.
d. Permanent three-phase fault on any generator, transmission circuit, transformer or bus section, with delayed fault clearing and with due regard to reclosing. This delayed fault clearing could be due to circuit breaker, relay system or signal channel malfunction.
e. Sudden dropping of a large load or major load center.
f. The effect of severe power swings arising from disturbances outside of New England
g. Operation or partial operation of a Special Protection System for an event or condition for which it was not intended to operate.

Of the seven types of extreme contingencies which were considered, the Stability Task Force (STF) typically focuses on permanent three-phase stuck breaker faults with delayed clearing, detailed in bullet d) above. The STF has indicated measures which should be used to determine acceptable and unacceptable system performance resulting from this type of fault.

The following responses are considered acceptable:

- A 50% reduction in the magnitude of system oscillations observed over four periods of the oscillation.
- Loss of source up to 1400 MW.
- A loss of source greater than 1400 MW is not immediately acceptable.
- A loss of source between 1400 MW and 2200 MW may be acceptable depending upon the likelihood of occurrence and other factors.

The following responses are considered unacceptable:

1. Transiently unstable, with wide spread system collapse.
2. Transiently stable, with undamped or sustained power system oscillations.
3. Loss of source greater than 2200 MW.

3.6 Bulk Power System Testing

Tests were performed to determine the impact the Project would have on the classification of facilities as part of the Bulk Power System (BPS). The Northeast Power Coordinating Council Criteria defines specific requirements applicable to design, operation, and protection of BPS facilities.

The following responses are considered unacceptable:

4. Transiently unstable, with wide spread system collapse.
5. Transiently stable, with undamped or sustained power system oscillations.
6. Loss of source greater than 1,200 MW.
7. Entry of the Keswick GCX SPS apparent impedance relay characteristic on Section 396/3001 line from Keswick to Orrington at Keswick S/S resulting in a 3001 line trip.

The following responses are considered acceptable:

8. A 50% reduction in the magnitude of system oscillations observed over four periods of the oscillation.
9. Loss of source up to 1,200 MW.
10. Entry of the Keswick GCX SPS apparent impedance relay characteristic on Section 396/3001 line from Keswick to Orrington at Keswick S/S where generation rejection is blocked by the frequency supervision
11. Entry of the Keswick GCX SPS apparent impedance relay characteristic on Section 396/3001 line from Keswick to Orrington at Keswick S/S resulting in generation rejection as long as the total loss of source does not exceed 1,200MW as stated above.

3.7 Oscillatory Response

All design contingencies, normal, extreme and BPS, shall meet the "ISO New England Damping Criteria", which states; "Acceptable damping with time domain analysis requires running a transient stability simulation for sufficient time (up to 30 seconds) that only a single mode of oscillation remains. A 50% reduction in the magnitude of the oscillation must then be observed over four periods of the oscillation. A sufficient number of system quantities including rotor angle, voltage, and interface transfers should be analyzed to ensure that adequate system damping is observed.", [ISO New England Stability Task Force submittal, Aug. 18, 1999].

3.8 Short-circuit Study

PSNH supplied E/PRO with the associated project data and transmission upgrades to conduct a short-circuit study to assess the impact of the project on fault current levels in their area. Substation breakers were evaluated to determine if the modifications create an over-duty condition. Further discussion of results can be found in Section 9 of this report.

4 Power Flow Base Case Development

4.1 Load

The stability analysis was performed on a set of power flow base cases representing a 2008 light load transmission system. Based on the NEPOOL Capacity, Energy, Load and Transmission (CELT) Report, issued in April 2005, a 2008 50/50 summer peak load plus losses for the New England control area is 27,750 MW making the summer light load case (45% of peak) 12,488MW.

Loads in the cases were modeled as prescribed in the ISO-NE Library conversion file for dynamic stability modeling. For New England, this file converts both real and reactive loads to 100% constant admittance for load modeling and where appropriate converts some generators to negative loads since they have no dynamic models to represent them.

4.2 Power Flow Case Modifications

The power flow cases were created from the peak load case, last revised November, 2005, available from the 2003 ISO-NE mid-year update. Cases in this library were modified to reflect several relevant system upgrades, listed in the 2003 Mid-Year Update Change Document, available from ISO-NE.

4.3 Dispatch Conditions

The power flow cases are intended to represent a stressed Northern New England (NNE) transmission system. No attempt has been made to observe the thermal limitations of the New England transmission system in the light load dispatch conditions.

Table 4-1 and Table 4-2 summarize the interface transfers and dispatch conditions for each base case used in the stability analyses. See Appendix C for a more detailed dispatch summary.

Interfaces	2008
	Light Load
NB-NE	702
ORRINGTON-SOUTH	1098
MEYANKEE-SOUTH	821
SUR-SO	1024
MAINE-NH	1509
NNE-SCOBIE+394	2904
SEABROOK-SOUTH	1549
NORTH-SOUTH	3625
EAST-WEST	1748
SNDYPOND-SOUTH	977
BOSTON IMPORT	1771
SEMA/RI EXPORT	961
CONN EXPORT	846
CONN IMPORT	-236
SW CONN IMPORT	488
NORWLK-STAMFORD	381
XSNDCABL TO NY	-346
CT-LI 1385 Line	0
NY-NE	-188

Table 4-1 Interface Transfer Summary

Generators	Capacity (MW)	2008 Baseline Case
Maine		
MIS	549	549
BUCKSPORT	191	72
WYMAN HYDRO	79	54
HARRIS	90	54
WILLIAMS	15	14
RUMFORD POWER	273	0
AEC	173	55
WYMAN	875	0
WESTBROOK	566	565
New Hampshire		
COMERFORD	164	0
MOORE	192	0
MERRIMACK	466	433
AES	824	0
SCHILLER	146	145
NEWINGTON	422	422
CONED-NEWINGTON	533	0
SEABROOK	1318	1315
BOSTON		
MYSTIC	2706	565
SALEM HARBOR	702	0
W. MASS / VT		
VERMONT YANKEE	667	667
BEARSWAMP	588	-560
NORTHFIELD	1080	-750
STONYBROOK	412	0
MILLENNIUM	390	0
MASSPWRR	307	0
BERKSHIRE	305	0
SEMA / RI		
NEA	301	301
CANAL	1143	576
PILGRIM	734	734
HOPE	545	0
SITHE FORE RIVER	881	0
DIGHTON	185	0
ANP BLACKSTONE	580	0
ANP BELLINGHAM	580	0
BRAYTON POINT	1084	945
MANCHESTER ST	495	0
OCEAN STATE POWER	524	0
Connecticut		
MILLSTONE	2200	2200
LAKE ROAD	915	305
SOUTH MEADOW	186	0
MIDDLETOWN	771	0
MONTVILLE	489	0
NORWALK HARBOR	330	168
KLEEN	635	0
WALLINGFORD	255	0
NEW HAVEN HARBOR	447	447
BRIDGEPORT HARBOR	567	0
BRIDGEPORT ENERGY	520	520
DEVON	382	80
MILFORD POWER	610	280
BRIDGEPORT_RESCO	59	0

Table 4-2 Major Generator Dispatch Conditions

5 Fault Contingency Descriptions

Descriptions of the faults used in the Study can be found in Table 5-1 below. This contingency list was used to analyze the impact of the Project on the local ISO New England Bulk Power System stability performance.

ID	Fault Location	Fault Type	Stuck Breaker	Fastest Group OOS	Fault Description	Local Clearing (cycles)	Remote Clearing (cycles)	Element(s) Removed	Note
FLAT		N/A		N/A	Flat Line Run	N/A	N/A	N/A	
Extreme Contingencies									
EC1	Vermont Yankee 345kV	3-phase	VY 379	N/A	Vermont Yankee 345 kV 3ph fault on the VY Bus #1 with a VY-379 stuck breaker	Vermont Yankee K1 = 5.5 Vermont Yankee 79-40 = 10.3 Vermont Yankee 381 = 4	Amherst 3971, 7985 = 11.3	1) Existing 379 Line - from VY to Amherst 2) VY Auto	Monadnock Project IOT in service
EC1-IPT	Vermont Yankee 345kV	3-phase	VY 379	N/A	Vermont Yankee 345 kV 3ph fault on the VY Bus #1 with a VY-379 stuck breaker with VY 379 IPT Breaker	Vermont Yankee K1 = 4 Vermont Yankee K1-IPT = 5.5 Vermont Yankee 79-40 = 10.3 Vermont Yankee 381 = 4	Amherst 3971, 7985 = 11.3	1) Existing 379 Line - from VY to Amherst 2) VY Auto	Monadnock Project IOT in service Single Phase Impedance 2.885 + j26.8557 Ohms
EC2	Vermont Yankee 345kV	3-phase	VY 379	N/A	Vermont Yankee 345 kV 3ph fault on the VY Bus #1 with a VY-379 stuck breaker	Vermont Yankee K1 = 5.5 Vermont Yankee 79-40 = 10.3 Vermont Yankee 381 = 4	Fitwilliams 3791, 7934 = 11.3	1) 379 Line- from VY to Fitzwilliams 2) VY Auto	
EC2-IPT	Vermont Yankee 345kV	3-phase	VY 379	N/A	Vermont Yankee 345 kV 3ph fault on the VY Bus #1 with a VY-379 stuck breaker with VY 379 IPT Breaker	Vermont Yankee K1 = 4 Vermont Yankee K1-IPT = 5.5 Vermont Yankee 79-40 = 10.3 Vermont Yankee 381 = 4	Fitwilliams 3791, 7834 = 11.3	1) 379 Line- from VY to Fitzwilliams 2) VY Auto	Single Phase Impedance 2.885 + j26.8557 Ohms
EC3	Coolidge 345kV	3-phase	Coolidge 340	N/A	Coolidge 345kV 3ph fault on the 340 Line with a Coolidge 340 stuck breaker	Coolidge 350 = 9.3 Coolidge 34-35 = 4 Coolidge K32-36, K36 = 10.5	Vermont Yankee 79-40, 1T = 4	1) 340 Line from Coolidge to VY 2) Coolidge Auto	
EC4	Fitzwilliams 345kV	3-phase	Fitzwilliams 7934	N/A	Fitzwilliams 345kV 3ph fault on the 379 Line with a 7934 stuck breaker	Fitzwilliams 3791 = 4 Fitzwilliams 367 = 9 Fitzwilliams F5, F6 = 10.3	Vermont Yankee 379, 79-40 = 4	1) 379 Line- from VY to Fitzwilliams 2) Fitzwilliams Auto	
Normal Contingencies									
NC1	Vermont Yankee 345kV	3-phase	No	Yes	Vermont Yankee 345 kV 3ph fault on the 379 Line	Vermont Yankee 379, 79-40 = 4	Fitzwilliams 7934, 3791 = 4	1) 379 Line- from VY to Fitzwilliams	
NC2	Vermont Yankee 345kV	3-phase	No	Yes	Vermont Yankee 345 kV 3ph fault on the 379 Line	Vermont Yankee 379, 79-40 = 4	Amherst 3971, 7985 = 4	1) Existing 379 Line - from VY to Amherst	Monadnock Project IOT in service
NC3	Vermont Yankee 345kV	3-phase	No	Yes	Vermont Yankee 345 kV 3ph fault on the 340 Line	Vermont Yankee 1T, 79-40 = 4	Coolidge 340, 34-35 = 4	1) 340 Line from Coolidge to VY	
NC4	Vermont Yankee	3-phase	No	Yes	3 ph fault on the Vermont Yankee 345kV/115kV Auto Transformer	Vermont Yankee 379, 381 = 4	Vermont Yankee 115kV-K1 = 5	1) VY Auto	
NC5	Coolidge 345kV	3-phase	No	Yes	Fault on the 350 line from Coolidge to West Rutland	Coolidge 350, 34-35 = 4	W.Rutland 350, 360 = 4	1) 350 Line from Coolidge to West Rutland	
NC6	Coolidge Auto	3-phase	No	Yes	3 ph fault on the Coolidge 345kV 115kV Auto Transformer	Coolidge 340, 350 = 4	Coolidge K32-36, K36 = 5	1) Coolidge Auto	
NC7	Granite Auto	3-phase	No	No	3 ph fault on the Granite 230kV/115kV Auto Transformer	Comerford 230kV = 4	Granite 115kV- K53, K51 = 5	1) Granite Auto 2) 230kV Line from Granite to Comerford	
NC8	North Road 115kV	3-phase	No	No	North Road 3 ph fault on the M-127 Line	North Road 34.5kV = 66.5	Webster = 57.5 Ascutney = 6.5	1) M127 Line 2) K174 Line	
NC9	Webster 115kV	3-phase	No	No	Webster 3ph fault on the M-127 Line	Webster = 4.0	North Road = 66.5 Ascutney = 6.5	1) M127 Line 2) K174 Line	
NC10	Ascutney 115kV	3-phase	No	No	Ascutney 3 ph fault on the K-174 Line	Ascutney = 5	Webster = 55 North Road = 65.5	1) M127 Line 2) K174 Line	
NC11	North Road 115kV	3-phase	No	Yes	North Road 3 ph fault on the M-127 Line	North Road 34.5kV = 65.75	Webster = 55.7 Ascutney = 6.5	1) M127 Line 2) K174 Line	
NC12	Webster 115kV	3-phase	No	Yes	Webster 3 ph fault on the M-127 Line	Webster = 4.0	North Road = 96.5 Ascutney = 36.5	1) M127 Line 2) K174 Line	
NC13	Ascutney 115kV	3-phase	No	Yes	Ascutney 3 ph fault on the K-174 Line	Ascutney = 6.5	Webster = 36.0 North Road = 96	1) M127 Line 2) K174 Line	
NC14	Ascutney 115kV	1-phase	No	Yes	1 ph fault on the K-174 Line	Ascutney = 6.5	North Road = 46 Webster = 41	1) M127 Line 2) K174 Line	Pos-Neg Seq = 1.17822 + j 6.72829 Zero Seq = 1.74808 + j 10.031 SLG IMP = 2.9263 + j 16.75929
NC15	Webster 115kV	1-phase	No	Yes	1 ph fault on the M-127 Line	Webster = 4.0	Ascutney = 63.5 North Road = 68.5	1) M127 Line 2) K174 Line	Pos-Neg Seq = 1.47433 + j 7.85805 Zero Seq = 7.04755 + j 17.2867 SLG IMP = 8.52168 + j 24.94476
NC16	Webster 115kV	3-phase	Yes	Yes	3 ph fault on the M-127 Line Stuck Breaker	Webster = 23.75	Ascutney = 36.5 North Road = 96.5	1) Bus Tie 40, 2) P145, 3) M127 4) A111, 5) J125, 6) T807	
NC17	Webster 115kV	3-phase	Yes	Yes	3 ph fault on the V-182 Line	Webster = 3	Garvins = 39	V-182 Line	
NC18	Garvins 115kV	3-phase	Yes	Yes	3 ph fault on the V-182 Line	Garvins = 3	Webster = 30	V-182 Line	

Table 5-1 Contingency Fault Descriptions

6 Dynamics Modeling

6.1 Model Set-up

Dynamics data and profiles for the G87 2MW wind turbines were provided by Gamesa. PSS/E library models were developed using the supplied Gamesa IPLAN. Data found in Section 1.3 was used along with a PSNH recommendation that required the wind turbine generators to operate in a leading 0.95 pf mode of operation. The Gamesa IPLAN produced two dynamics models along with a set of over and under voltage and frequency relay settings. The G8XDFG model was used for the G87 doubly fed induction generator and a G8XCNT model was used for the G87 machine control (exciter). Detailed dynamics data for these two models can be found in Appendix B.

6.2 Low Voltage Ride Through

The Federal Electric Reliability Council (FERC) has established standards for minimum low voltage ride through (LVRT) capabilities that wind turbines should exhibit (Docket No. RM05-4-000 – Order No.661, Issued June 2, 2005). These capabilities are represented in the graph contained in Figure 3 below. Two of the key features of this regulation are:

1. A wind generating plant must have low voltage ride-through capability down to 15 percent of the rated line voltage for 0.625 seconds;
2. A wind generating plant must be able to operate continuously at 90 percent of the rated line voltage, measures at the high voltage side of the wind plant substation transformer(s).

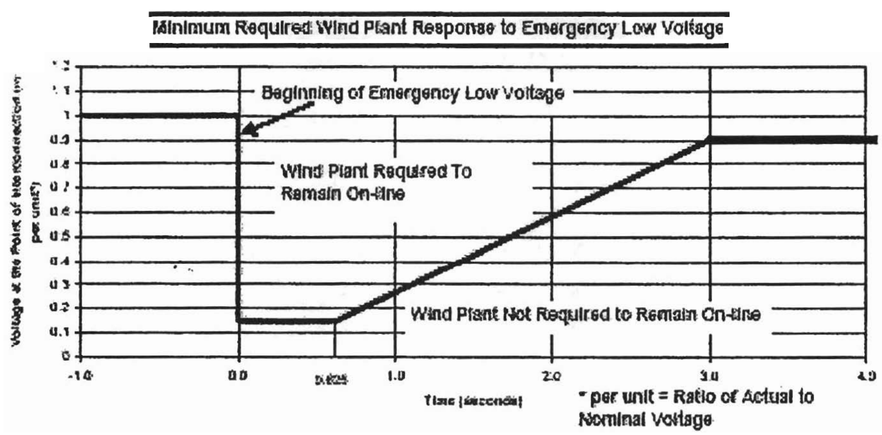


Figure 3 FERC LVRT Capabilities Graphical Representation

The Gamesa G87 standard voltage relay settings are defined in seven separate voltage levels which are found in Table 6-1. These settings are compliant with the FERC LVRT standards.

Gamesa G87 Voltage Relay Settings			
Lower Voltage Setting (pu)	Upper Voltage Setting (pu)	Relay Pickup Time (Seconds)	Breaker Time (Seconds)
0.15	5.00	0.040	0.05
0.30	5.00	0.625	0.05
0.45	5.00	1.100	0.05
0.60	5.00	1.575	0.05
0.75	5.00	2.050	0.05
0.90	5.00	2.550	0.05
0.00	1.10	0.060	0.05

Table 6-1 Gamesa G87 Voltage Relay Limits

6.3 Frequency limits

The Gamesa G87 has only one setting which is used for the over & under frequency relay. The standard frequency setting for the Gamesa G87 unit will trip instantaneously for a frequency that falls below 57Hz or spikes above 62Hz.

Gamesa G87 Frequency Relay Settings			
Lower Frequency Setting (Hz)	Upper Frequency Setting (Hz)	Relay Pickup Time (Seconds)	Breaker Time (Seconds)
57	62	0.000	0.05

Table 6-2 Gamesa G87 Frequency Relay Limits

7 Discussion of Stability Analysis Results

Transient stability simulations were conducted with PTI PSS/E dynamic simulation software, version 28. The analysis performed for the Project was based on the assumptions stated in the previous sections. Detailed results are summarized in Appendix D for the light load 2008 cases and system model representations along with a description of each fault. The spreadsheets presented in Appendix D contain links to all the simulation results in plotted format, based on the SSG/STF standard form. The CD-ROM accompanying this report contains the plot sets.

Stability fault simulations were conducted with four extreme and eighteen normal contingencies. These contingencies (as shown in Section 4 of this Study) were comprised of various three-phase, single-phase and stuck breaker faults within the surrounding bulk power transmission system of the Project. The analyses included a Monadnock Project sensitivity which has an approved proposed plan application analysis.

7.1 2008 Stability Analysis

All fault simulations in the 2008 light load cases resulted in a stable bulk power system response.

7.1.1 Extreme Contingencies

The Project was stable and did not trip due to LVRT for the four extreme contingencies that were simulated.

EC1 and EC2 contingencies (known as EC303 in past reports) were three-phase faults on the Vermont Yankee 345kV bus #1 with a Vermont Yankee-379 stuck breaker. Both simulations resulting in tripping Section 396, the New Brunswick – New England 345-kV tie line. The loss of source for both the EC01 and EC02 simulations was approximately 2121 MW. Similar results were found in the Northeast Utilities – Public Service of New Hampshire Monadnock Project Stability Report presented to the ISO New England Stability Study Group issued in December 2005. To mitigate the potential adverse impact, VELCO and Vermont Yankee substation owner Entergy will be replacing the existing Vermont Yankee 345kV 379 breaker with an Independent Pole Tripping (IPT) breaker in 2006.

The Vermont Yankee 345kV 379 IPT breaker upgrade was simulated for both contingencies EC1 and EC2. The resultant loss of source was reduced to 0MW with no activation of the Section 396 line protection.

7.1.2 Normal Contingencies

In all simulations that involved the loss of the M127 and K174 lines (contingencies that isolated North Road 115-kV bus from the 115-kV bulk power transmission system), the Lempster wind farm and the Hemp Hill generator unit (total of 38 MW loss of source) were isolated from the system and did not remain synchronized. At North Road, both 115-kV lines are equipped with circuit switchers for switching purposes only and do not have any associated protective switching capability. As discussed previously, both generators are equipped with a transfer trip scheme triggered by the voltage relaying scheme at North Road. No system reliability criteria were violated as a result of the simulations of the 3-phase and stuck breakers.

8 Bulk Power System Testing

The Northeast Power Coordinating Council Criteria defines specific requirements applicable to design, operation, and protection of bulk power system facilities. Tests were performed in accordance with Section 3.2 to determine whether classification of Bulk Power System (BPS) Facilities was impacted by the addition of the Lempster Wind Farm. Detailed results are summarized in Appendix F which contains links to the simulation results in plotted format.

In this study, initial fault simulations implemented a permanent, 5 second (300 cycle), a three-phase fault at North Road station. If the station passed this BPS test, no further testing was conducted. If the station failed, additional simulations were performed to narrow the possible clearing times that would permit the system to remain stable as contained in Section 3.6.

BPS testing of North Road caused no violations of NPCC criteria. Results of the 5-second testing are summarized in Table 8-1, below:

ID	Fault Location	Fault Type	Fault Description	Pre-Fitzwilliams		Post-williams	
				Results	Recorded LOS (MW)	Results	Recorded LOS (MW)
5 Second Bulk Power System Testing							
BPSNR	North Road	3-phase	5 Second Bus Fault	Stable	38	Stable	38

Table 8-1 BPS Testing Results

9 Discussion of Short Circuit Results

E/PRO performed a short-circuit study on the Lempster Wind Farm Project in a separate study for PSNH which was contained within a report "Lempster Wind Project – *Assessment of Wind Turbine Technology and Review of Protection & Control Issues for the Public Service Company of New Hampshire*", dated November 2005. The results from that report indicate that there were no adverse impacts from the addition of the Project (excerpts from that report regarding the short-circuit study are in Appendix E). Fault current contribution from the Project did not cause any protective device to exceed its fault interrupting duty. In addition, it should be noted that, in that report, E/PRO was assuming a 13 unit, 26MW wind farm, which would result in a slightly higher and a more conservative estimate of available fault currents.

10 Conclusions

PSNH performed a Preliminary Voltage Profile Study in August 2004 to determine the feasibility of interconnecting a 25MW wind generation facility in Lempster, New Hampshire to the PSNH distribution system. The following construction and operating constraints must be met by the generating facility to interconnect the Project:

1. For steady state operation at almost all load and generation levels, the generation system will have to operate absorbing VARs to maintain an acceptable voltage. 1.035 was modeled at the generator interconnection and delivery point modeled at the intersection of Bean Mountain Road and Nichols Road. Power factor ranges from Unity to -95%(absorbing VARs). This is required to hold the steady state voltage down on the line. The generation facility will not be allowed to provide VARs to the system because the resultant voltages are above acceptable limits for 34.5kV distribution.
2. Any generating facility will require machines with voltage control, remote fault ride-through, and equipment with state-of-the-art control capabilities.
3. An upgraded/new three-phase, 477ACSR, 34.5kV circuit is required.
4. NHEC must be in agreement on any system operating conditions on facilities in the NHEC franchise territory.

Construction requirements on the PSNH and NHEC system include:

- Approximately 10 miles of new 34.5kV, 3 phase line from Newport Substation to the site which is NH Electric Coop franchise territory (NHEC).
- Alteration of Newport Substation including a three-phase breaker, controls, transfer trip, and SCADA.

The budgetary estimate for the above line and substation work is $2,300,000.

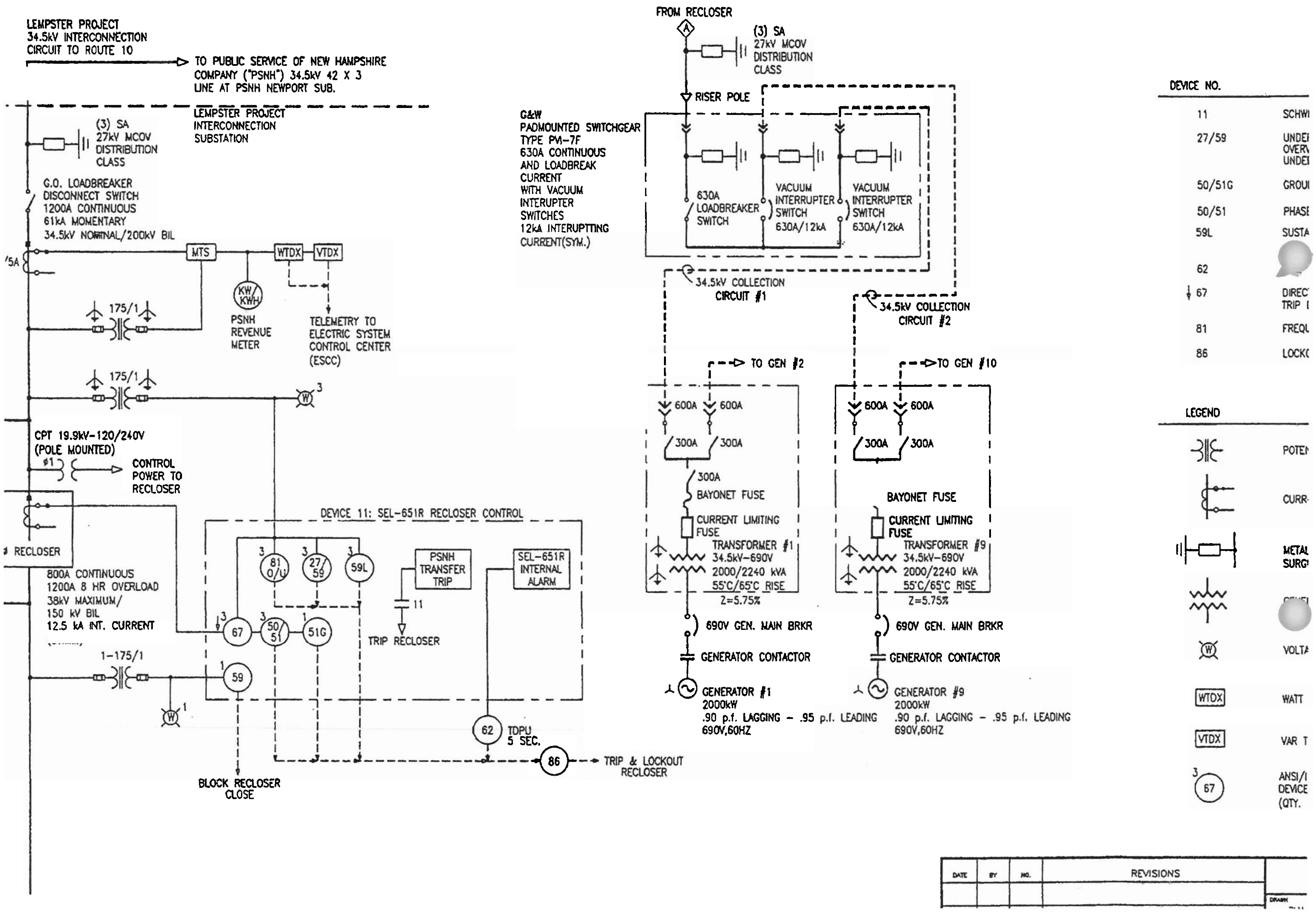
Based on the stability analysis, the Project was stable and did not trip due to LVRT for the four extreme contingencies and normal contingencies that did not involve the two 115-kV lines connected to North Road S/S. The normal contingency faults that involved the loss of the M127 and K174 lines (contingencies that isolated North Road 115kV bus from the 115kV bulk power transmission system) caused the Project and the Hemp Hill unit to lose synchronism. Both generating stations are equipped with a transfer trip scheme triggered by the voltage relaying scheme at North Road which detects faults on these two lines. The most severe extreme contingency revolved around a three-phase fault on the Vermont Yankee 345kV Bus #1 with a VY379 stuck breaker which resulted in a loss of source greater than 2200MW and a separation of the New Brunswick – New England tie line. This contingency was re-simulated with an IPT breaker upgrade and was stable without activating the Section 396 line protection.

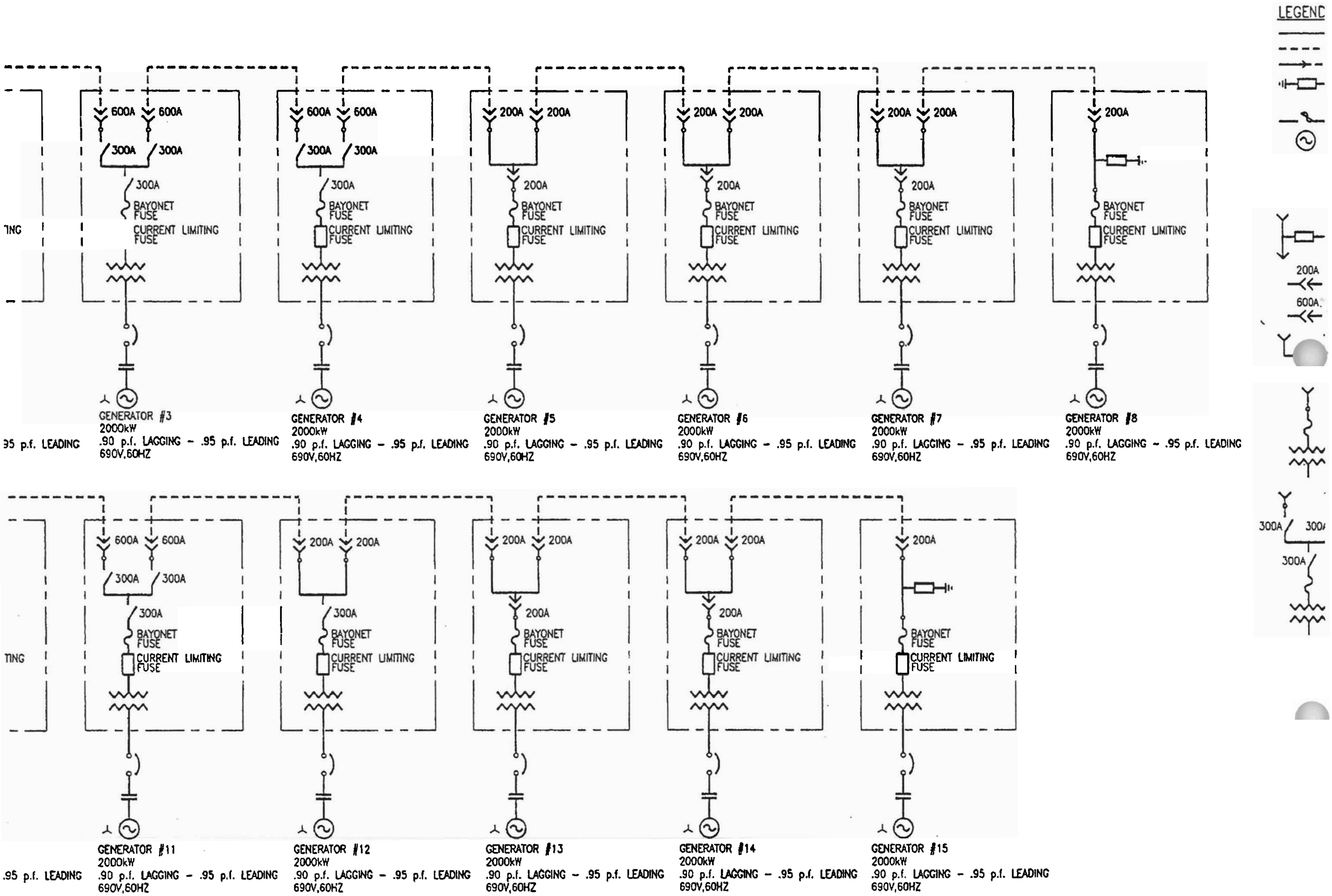
BPS stability testing was performed on two light load base cases. A five second station test was performed on the North Road 115kV station. The results of this BPS testing showed no violations to the NPCC BPS testing criteria and no additional stations to be classified as part of the Bulk Power System.

The short-circuit analysis (performed by E/PRO in a previous report) concluded that Project did not produce any adverse impact on local area breakers that will require breaker replacement. Fault current contribution from the Project did not cause any breaker to exceed its fault interrupting duty.

In conclusion, the system impact study revealed that the addition of the Project has no significant system impact to the stability, reliability, and operating characteristics of the New England bulk power transmission system.

Appendix A
Site Maps


LEMPSTER PROJECT
34.5kV INTERCONNECTION
CIRCUIT TO ROUTE 10
TO PUBLIC SERVICE OF NEW HAMPSHIRE
COMPANY ("PSNH") 34.5kV 42 X 3
LINE AT PSNH NEWPORT SUB.
LEMPSTER PROJECT
INTERCONNECTION
SUBSTATION
(3) SA
27kV MCOV
DISTRIBUTION
CLASS
G.O. LOADBREAKER
DISCONNECT SWITCH
1200A CONTINUOUS
61kA MOMENTARY
34.5kV NOMINAL/200kV BIL
MTS
WTDX
VTDX
KW/KWH
PSNH
REVENUE
METER
TELEMETRY TO
ELECTRIC SYSTEM
CONTROL CENTER
(ESCC)
175/1
175/1
CPT 19.9kV-120/240V
(POLE MOUNTED)
CONTROL
POWER TO
RECLOSER
RECLOSER
800A CONTINUOUS
1200A 8 HR OVERLOAD
38kV MAXIMUM/
150 kV BIL
12.5 kA INT. CURRENT
1-175/1
DEVICE 11: SEL-651R RECLOSER CONTROL
81 O/U
27/59
59L
67
50/51
51G
59
PSNH
TRANSFER
TRIP
11
TRIP RECLOSER
SEL-651R
INTERNAL
ALARM
62
TDPU
5 SEC.
86
TRIP & LOCKOUT
RECLOSER
BLOCK RECLOSER
CLOSE
FROM RECLOSER
(3) SA
27kV MCOV
DISTRIBUTION
CLASS
RISER POLE
G&W
PADMOUNTED SWITCHGEAR
TYPE PVI-7F
630A CONTINUOUS
AND LOADBREAK
CURRENT
WITH VACUUM
INTERRUPTER
SWITCHES
12kA INTERUPTING
CURRENT(SYM.)
630A
LOADBREAKER
SWITCH
VACUUM
INTERRUPTER
SWITCH
630A/12kA
VACUUM
INTERRUPTER
SWITCH
630A/12kA
34.5kV COLLECTION
CIRCUIT #1
34.5kV COLLECTION
CIRCUIT #2
TO GEN #2
TO GEN #10
600A
600A
300A
300A
300A
BAYONET FUSE
CURRENT LIMITING
FUSE
TRANSFORMER #1
34.5kV-690V
2000/2240 kVA
55°C/65°C RISE
Z=5.75%
690V GEN. MAIN BRKR
GENERATOR CONTACTOR
GENERATOR #1
2000kW
.90 p.f. LAGGING - .95 p.f. LEADING
690V,60HZ
600A
600A
300A
300A
BAYONET FUSE
CURRENT LIMITING
FUSE
TRANSFORMER #9
34.5kV-690V
2000/2240 kVA
55°C/65°C RISE
Z=5.75%
690V GEN. MAIN BRKR
GENERATOR CONTACTOR
GENERATOR #9
2000kW
.90 p.f. LAGGING - .95 p.f. LEADING
690V,60HZ
DEVICE NO.
11
27/59
50/51G
50/51
59L
62
67
81
86
LEGEND
WTDX
VTDX
67
DATE
BY
NO.
REVISIONS



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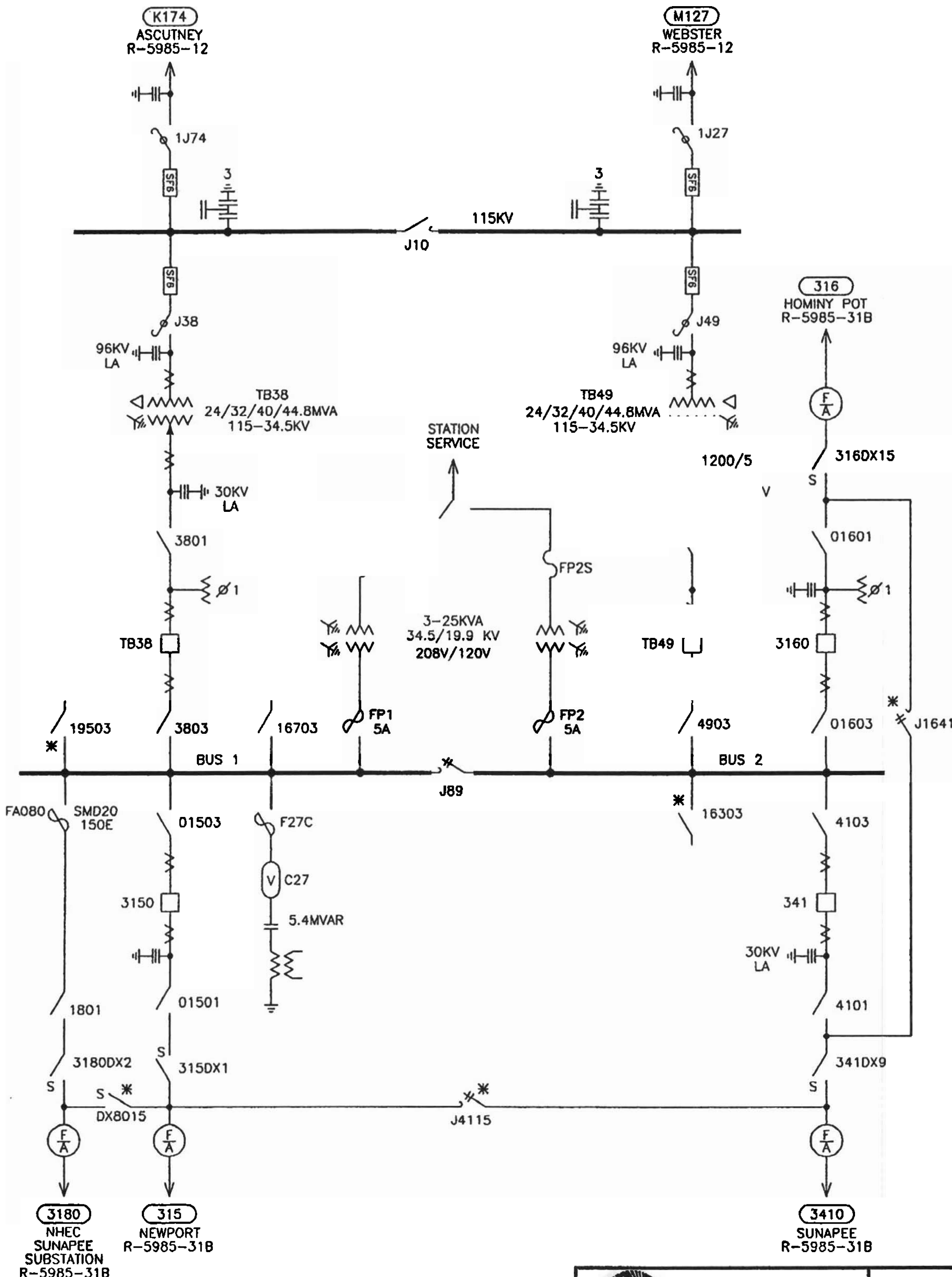

LAST REVISION DETAIL
REMOVE TIE BETWEEN 3180 AND BUS 1.
REMOVE 19509 AND ASSOCIATED LINE.
ADD TRANSFORMER NAMES.

Public Service of New Hampshire

WESTERN/ CENTRAL

NORTH ROAD

NORTH ROAD, SUNAPEE, NH

763-5821

DRN.	CHKD.	APPR.		
WRC	JRM	SD	12/01/04	D-5748-3

/d/021002/038129211

Appendix B
Machine Data

The description of the IPLAN program

This program adds equivalent wind turbine generators (WTG), along with their step-up transformers, to a number of collector buses that exist in the load flow case.

Equivalent wind turbine generators will be dispatched based on the given wind speed and control mode. The corresponding curve of the power output versus the wind speed and the generator speed is embedded in the code.

With the iplan file are enclosed examples of the data file necessary for the execution of this program:

1. Collector_bus.dat
2. Machine_param.dat
3. Wind_speed.dat

The first called input file listing collector buses must be prepared in the following format: The first line indicates the number of collector buses (NB). Following NB lines of inputs containing two numbers: the collector bus number, and the number of WTG units connected to this bus. The MW generation is calculated by either of the two methods, chosen by the user: wind speed or direct dispatch. The generator speed will be calculated internally in the program.

There are two modes for entering the wind speed: terminal input of through a prepared file. Should the user choose to prepare the file first, the file should contain the following: collector bus number, base wind speed, displacement factor, and the azimuth angle. The sequence of collector bus number has to be exactly the same as in the first input file. Also, each collector bus has to be listed in this file.

The MVAR generation will be calculated by power factor control mode, the user being asked to input the desired power factor at each collector bus.

The bus number for the new wind turbine generators will be 90000+the original collector bus number. It is the user's responsibility to avoid overlapping of bus numbers.

The program will then add the corresponding dispatched generator to the load flow case. During the process, the user can use generic machine data, which is embedded in the program, or input user-specified data.

Should the user choose to enter user-specified machine data, the third input file should be prepared. The input file listing wind turbine generator parameters will be called in sequence. Format of input files containing 10 parameters is as follows: Base kV, MBASE, transformer MVA Base, transformer R, X, and GTAP, PMAX, PMIN, machine parameters in pu on MBASE: Ra, La, Lm, Rl, Ll, Inertia constant, Damping factor, conventional four saturation parameters, and the values of the crowbar rotor resistance system: REXT0 ,REXT1 , REXT2 ,T1 , T2 , T0, KS and KI.

The IPLAN program then writes out to the dyre-file the dynamic data for the doubly fed induction generator and for all the rest of dynamic models, namely:

- G8XDFG doubly-fed induction generator model
- G8XCNT machine control
- TWIND1 wind gusts and ramps
- G8XAER the aerodynamic energy conversion
- G8XPTC pitch control

It is the user's responsibility to solve the load flow case after the IPLAN program execution is completed.

```
2                       / NUMBER OF COLLECTOR BUSES
850     6               / 6 UNITS AGGREGATED ON BUS 90850
851     6               / 6 UNITS AGGREGATED ON BUS 90851
```

```
0.690       / BASE KV
2.000       / WTG MBASE
2.350         / TRANSFORMER MBASE
0.008457      / TRANSFORMER R ON TRANSFORMER BASE
0.087622      / TRANSFORMER X ON TRANSFORMER BASE
1.0         / GTAP
2.0         / PMAX
0.0         / PMIN
0.01022     / RA
0.14283     / LA
7.21137     / LM DELTA
6.94532     / LM Y
0.01008     / RMACH
0.17503     / L1
```

Título: **FT Características y funcionamiento general del aerogenerador G87-2.0 MW 50/60Hz**	Confidencialidad: 3
	Doc VWS:
	AUTOR/ AUTHOR: DGF
Title: **FT Characteristics and general operation of G87-2.0 MW 50/60Hz Wind-turbine**	*REVISADO/CHECKED:* CLP/MBU/CDC/DSS/JGS
	APROBADO/APPROVED: JMY

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REGISTRO DE CAMBIOS/ RECORD OF CHANGES

Rev.	Fecha/ Date	Autor/ Author	Descripción	Description
0	16/02/04	MPM	Primera versión	First issue
	26/01/2004	DGF	Actualizadas las condiciones climáticas (Temperaturas y tipo de protección contra corrosión). Añadido material alternativo para eje principal. Actualizadas especificaciones técnicas del sistema de giro. Cambiado el material del disco del freno. Actualizadas presiones del grupo hidráulico. Modificados pesos de torres, rotor y Nacelle	Climatic conditions updated (Temperatures and corrosion protection level). Alternative material added for the main shaft. Yaw system technical specifications updated. Brake disk material changed. Hydraulic power unit pressures updated. Tower, rotor and Nacelle weights modified.

1 DESCRIPCIÓN DEL AEROGENERADOR

El aerogenerador G87 – 2.0 MW de GAMESA EOLICA, S.A. es un aerogenerador de rotor tripala a barlovento, regulado por sistema de cambio de paso y con sistema de orientación activo. Tiene un rotor de 87m de diámetro y utiliza el sistema de control capaz de adaptar el aerogenerador para operar en grandes intervalos de velocidad de rotor.

El rotor consiste en tres palas con cambio de paso en la envergadura completa de la pala, rodamiento de pala y buje en fundición nodular.

Las palas son de 42,5m de longitud y están realizadas en fibra de carbono y fibra de vidrio utilizando tecnología prepreg. Cada pala consiste en dos conchas pegadas a una viga soporte. Insertos especiales de acero conectan la pala al rodamiento de la pala, que es un rodamiento de bolas de 4–puntos, atornillado al buje.

El sistema de cambio de paso del rotor proporciona una regulación constante del ángulo de operación de la pala con respecto a las condiciones de viento del momento optimizando la producción de potencia y minimizando la emisión de ruido.

A altas velocidades de viento, el sistema de control y el sistema de cambio de paso mantienen la potencia en su valor nominal, independientemente de la temperatura del aire y su densidad. En vientos de velocidades bajas el sistema de cambio de paso variable y el sistema de control optimizan la producción de energía seleccionando la combinación óptima de revoluciones y ángulo de paso.

El eje principal transmite la potencia al generador a través de la multiplicadora. La multiplicadora se compone de 3 etapas combinadas, una planetaria y dos de ejes helicoidales paralelos. Desde la multiplicadora la potencia se transmite al generador a través de una junta de composite.

El generador eléctrico es altamente eficiente, de 4 polos, doblemente alimentado con rotor devanado y anillos rozantes.

El freno primario del aerogenerador es aerodinámico por puesta en bandera de las palas. El sistema de cambio de paso independiente proporciona un sistema de seguridad con triple redundancia. El freno mecánico de aparcamiento es un freno de disco, hidráulicamente activado que se monta en la salida del eje de alta velocidad de la multiplicadora.

1 WIND-TURBINE DESCRIPTION

The Gamesa Eólica's G87–2.0 MW wind-turbine is a three bladed, upwind, pitch regulated and active yaw wind-turbine. It has a rotor diameter of 87 m and uses the control system concept that enables the wind-turbine to operate in a broad range of variation of rotor speed.

The rotor has three-blades with full span control, pitch bearings and the nodular cast iron hub.

The blades are 42,5m span and are made of carbon and glass fibre reinforced epoxy using the pre-preg moulding technology. Each blade consists of two blade shells, bonded to a supporting beam. Special steel inserts connect the blade to the blade bearing. This bearing is a 4– point ball type bolted to the hub.

The rotor pitch is variable. This feature provides fine adjustment of the blade-operating angle all the time with respect to the wind conditions each moment. This provides a better power production and a noise emission reduction.

At high wind speeds the control system and the pitch system keep the power output at its nominal value, independently of air temperature and air density. At lower wind speeds the variable pitch system and the control system maximise the power output by choosing the combination of rotor speed and pitch angle which give maximum power coefficient.

The main shaft transmits the power to the generator through the gearbox. The gearbox is a 3-combined-stages, one planetary and two helical parallel shafts, gearbox. From it the power is transmitted via a composite coupling to the generator.

The generator is a high efficiency 4 – pole doubly fed generator with wound rotor and slip rings.

The wind-turbine primary brake is given by full feathering the blades. The individual pitch system gives a triple redundant safety system. The mechanical brake is a parking disc brake system hydraulically activated and mounted on the gearbox high-speed shaft.

Todas las funciones del aerogenerador son monitorizadas y controladas por varias unidades de control basadas en microprocesadores. El sistema de control va instalado en la góndola. Las variaciones del ángulo de paso de la pala son activadas por un sistema hidráulico que deja que la pala rote 95°. Este sistema también proporciona presión al sistema de frenado mecánico.

All functions of the wind turbine are monitored and controlled by several microprocessor based control units. The controller system is placed in the nacelle. Blade pitch angle variation is regulated by a hydraulic system actuator which enables the blade to rotate 95°. This system also supplies pressure to the brake system.

El sistema de orientación consiste en cuatro motores operados eléctricamente y controlados por el sistema de control del aerogenerador de acuerdo a la información recibida de los dos anemómetros sónicos colocados en la parte superior de la góndola. El motor del sistema de orientación hace girar los piñones del sistema de giro, los cuales engranan con los dientes de la corona de orientación montada en la parte superior de la torre. El bastidor con las motorreductoras puede girar respecto a la corona de orientación en la torre mediante un cojinete de fricción, el cual posee dispositivos hidráulicos y mecánicos para proveer par de retención.

The yaw system consists of four gears electrically operated and controlled by the wind turbine controller based on information received from the sonic anemometers mounted on top of the nacelle. The yaw gears rotate the yaw pinions, which mesh with a large toothed yaw ring mounted on the top of the tower. The yaw bearing is a plain bearing system with hydraulic and mechanical devices to provide retention torque.

La cubierta de la góndola es de fibra de vidrio con poliéster, la cual protege todos los componentes de la góndola frente a lluvias, nieve, polvo, rayos solares, etc. El acceso a la góndola desde la torre se realiza a través de la abertura central. La góndola contiene en su interior una grúa de servicio de 800 kg, que puede ser ampliada para elevar los componentes principales (8000 kg).

The nacelle cover -made of glass fibre reinforced polyester- protects all the components inside against rain, snow, dust, sun, etc. Access to the nacelle from the tower is through a central opening. The nacelle houses the internal 800 kg service crane, which can be enlarged to hoist the main components (8000 kg).

La torre del aerogenerador es tubular y de acero y se suministra pintada con pintura de protección especial anti-corrosión. (ver Sección 4.13 para detalles). Gamesa Eólica ofrece un ascensor opcional.

The steel tubular tower is delivered painted (see Section 4.13 for more details). Gamesa Eólica S. A. offers a service lift in the tubular tower.

1.1 SISTEMA DE CONTROL

El sistema de control asegura que las rpm y el par motor del aerogenerador siempre suministren una potencia eléctrica estable a la red. Este sistema de control además suministra la energía con un factor de potencia deseado a la red eléctrica.

El sistema de control consiste en un generador asíncrono de rotor devanado, anillos deslizantes, dos convertidores de 4- cuadrantes de tecnología IGBT, contactores y protección eléctrica. Debido a la forma de funcionamiento que tiene el generador y como se controla, desde la red (es decir, desde el estátor) éste es visto como un generador síncrono.

1.1 CONTROL SYSTEM

The control system ensures that both the rotor speed and the drive torque of the wind turbine always transform into a steady and stable electric power eventually injected into the grid. This control system also obtains an optimum power factor to the grid.

The control system consists of an effective asynchronous generator with wound rotor, slip rings, two 4-quadrant converters with IGBT switches, contactors and protection. Because the way this generator is controlled it is seen from the grid (i.e., from the stator) as a synchronous generator.

El generador está protegido frente a corto-circuitos y sobrecargas. La temperatura es también continuamente monitorizada mediante PT100 en puntos del estator, de rodamientos y de cajón de anillos.

The generator is protected against short-circuits and overloading. The temperatures are also continuously monitored by PT100's in stator hotspot points, bearings and in slip ring unit.

El generador con sistema de control es un generador asíncrono especial el cual es capaz de trabajar con velocidad variable y mantener la potencia constante simultáneamente. Esta mejora es ejecutada por control de las intensidades en el rotor. Por medio del control de las corrientes en el rotor, el factor potencia se puede ver como un parámetro definible por el sistema de control. Como resultado las pérdidas en la red eléctrica decrecen.

The generator in the control system is a special synchronous generator which is able to run with variable speed and simultaneously keep the power constant. This feature is achieved by control of the rotor currents. By means of controlling of the these currents, the power factor can be viewed as a configurable parameter of the control system. As a result the losses in the electrical grid decrease.

Otro resultado de la generación síncrona que caracteriza al sistema de control es la "suave" conexión a la red eléctrica. Por lo tanto, conexiones y desconexiones suaves a la red eléctrica se obtienen fácilmente.

Another result of the synchronous generation that characterizes the control system is the 'soft' connection to the grid which means a smooth connection/disconnection to grid.

La turbina G87 – 2.0 MW es capaz de operar a una velocidad variable entre 900 rpm. y 1900 rpm. para 50Hz y entre 1080 y 2280 rpm para 60Hz. El sistema de control tiene flexibilidad intrínseca respecto a optimización de energía, mínimo ruido durante el funcionamiento y reducción de cargas en la multiplicadora y en otros componentes.

Wind-turbine G87 – 2.0 MW operates with a variable speed range of 900 - 1900 rpm. 50Hz (1080-2280 rpm for 60Hz) The control system has built in flexibility regarding energy optimisation, low noise during operation and reduction in loads on gearbox and other components.

1.2 APROBACIÓN DE TIPO

El diseño del aerogenerador G87 – 2.0 MW está certificado de acuerdo con la norma IEC 61400–1, Ed. 2 como Clase IIA (67m y 78m).
Se están monitorizando varios prototipos para medir Curva de Potencia, Ruido, Cargas y Calidad de Energía y obtener el Certificado de Tipo en 2005.
Asimismo se está en proceso de certificación de diseño bajo la norma DIBt WZII (Typenpüfung).

1.2 TYPE APPROVAL

The G87–2.0 MW wind turbine's design has been certified according to the IEC 61400 – 1, Ed. 2, Standard as Class II_A (67m and 78m).
Several prototypes are being monitorized in order to measure Power Curve, Loads, Noise emission and Power Quality on 2005.
Also, the design assessment following DIBt WZII regulations is being carried out.

1.3 CONDICIONES CLIMÁTICAS

El aerogenerador está diseñado para temperaturas ambiente exteriores entre –20° C y +30° C. Bajo petición expresa del cliente, se suministrarán aerogeneradores en versiones de alta y baja temperatura.

- El rango de funcionamiento de la versión de altas temperatura es de -20°+40°
- El rango de funcionamiento de la versión de bajas temperatura es de -30°+30°

1.3 CLIMATIC CONDITIONS

The wind turbine is designed for ambient temperatures ranging from –20° C to +30° C. Under explicit request of the customer, the wind turbine can be supplied in High and Low temperature versions.

- The operating rank of the High Temperature version increases temperature to -20°+40°
- The operating rank of the Low Temperature version is -30°+30°.

El aerogenerador se puede colocar en parques con

The wind turbines should be placed in wind farms una distancia de al menos 5 diámetros de rotor (400 m) entre aerogeneradores en la dirección predominante del viento. Si los aerogeneradores se sitúan en fila, perpendicularmente a la dirección predominante del viento, la distancia entre los mismos deberá ser de al menos 3 diámetros de rotor (240 m).

with a distance of at least 5 rotor diameters (400 m) between each other measured along the predominant wind direction. If wind turbines are placed along a row, perpendicularly to the predominant wind direction, the distance between them should be of at least 3 rotor diameters (240 m).

La humedad relativa puede ser de 100% (máximo el 10% del tiempo). Se proporciona protección contra corrosión conforme a ISO 12944-2 para corrosión de tipo C5-M (fuera) y C3-H (dentro). A petición del cliente se puede suministrar una máquina para ambientes corrosivos que cumple con C4-H en el interior de la Nacelle

The relative humidity can be 100 % (10% of time maximum). Corrosion protection for corrosion class C5-M (outside) and C3-H (inside) are provided according to ISO 12944-2. Under request of the customer a corrosive ambient version can be supplied, this machine has a C4-H corrosion class inside the Nacelle.

1.4 CONEXIÓN CON LA RED ELÉCTRICA

1.4 GRID CONNECTION

El aerogenerador debe conectarse a una red de media tensión a 10-33 kV. El aerogenerador estándar se conecta a una red de 20 kV, otros niveles de tensión dentro del intervalo indicado pueden ser desarrollados a petición del cliente. El voltaje máximo del equipamiento es 36 kV (U_m). La conexión del cable de media tensión se realiza en la parte inferior de la torre.

The wind turbines must be connected to medium-voltage grid at 10-33 kV. The standard wind turbines is connected to a 20 kV grid, other voltage levels inside the indicated range can be developed when asked by the customer. The maximum voltage of the equipment is 36 kV (Um). The MV-cable connection is made in the bottom of the tower.

El transformador de la turbina debe estar ajustado a la tensión de la red eléctrica. Al realizar el pedido, Gamesa Eólica necesitará información precisa sobre la tensión de la red para elegir la tensión nominal del transformador y el tipo de conexión del devanado. Gamesa Eólica ofrece como opción las celdas de conexión.

The transformer in the turbine must be adjusted to the grid voltage. When ordering GAMESA EÓLICA S.A. will need precise information about grid voltage, as to choice the transformer's nominal voltage as well as the type of winding connection. GAMESA EÓLICA S.A. offers the switch gear as an option.

El aerogenerador puede generar energía reactiva. No obstante, en algunas ocasiones, el aerogenerador limitará la potencia reactiva para preservar su funcionamiento.

The wind-turbine may generate reactive. Nevertheless, in some occasions, the wind-turbine will limit the reactive power so as to preserve its operation.

El voltaje de la red de media tensión estará dentro del intervalo ± 5%. Variaciones entre +1/-3 Hz (50 Hz) son aceptables. Intermitentes o rápidas fluctuaciones de la frecuencia de la red eléctrica pueden causar serios problemas al aerogenerador.

The voltage of the medium voltage grid shall be within the range ± 5%. Variations within +1/-3 Hz (50 Hz) are acceptable. Intermittent or rapid grid frequency fluctuations may cause serious damage to the turbine.

Caídas de la red eléctrica solamente deberían ocurrir una vez por semana como promedio durante la vida del aerogenerador.

Grid dropouts must, as an average over the entire lifetime of the wind-turbine, only take place once a week.

Debe existir una conexión de tierra de máx. 10 Ω. El sistema de tierra se deberá acomodar a las condiciones del terreno. La resistencia al neutro de la conexión a tierra deberá ser conforme a los requisitos de las autoridades locales.

A ground connection of maximum 10 Ω must be present. The earthing system must be accommodated to local soil conditions. The resistance to neutral earth must be according to the requirements of the local authorities.

1.5 RESTRICCIONES GENERALES

Durante los periodos de vientos bajos, es de esperar un aumento del consumo de potencia para el calentamiento y la deshumidificación de la góndola.

Respecto a la acumulación de fuertes hielos, es de esperar interrupciones en la operación. En algunas combinaciones de vientos altos, altas temperaturas, temperatura baja del viento, baja densidad y/o bajo voltaje, puede ocurrir una disminución de la potencia nominal para asegurar que las condiciones térmicas de algunos componentes principales como la multiplicadora, generador, transformador, cables de potencia, etc. se mantengan dentro de los límites.

Generalmente se recomienda que el voltaje de red eléctrica se mantenga tan cerca del nominal como sea posible. En caso de caída de la red eléctrica y muy bajas temperaturas, se debe esperar un cierto tiempo para el calentamiento antes de que el aerogenerador comience a operar.

Si el terreno, dentro de un radio de 100 m a partir de un aerogenerador, tiene una pendiente de más de 10°, pudieran ser necesarias consideraciones particulares.

Si el aerogenerador se sitúa a más de 1000 m sobre el nivel del mar, podría ocurrir una subida de temperatura mayor de lo normal en el generador, el transformador y otros componentes eléctricos. En dicho caso, podría suceder una reducción periódica de la potencia nominal, incluso si la temperatura ambiente está dentro de los límites especificados. Además en los emplazamientos situados a más de 1000 m sobre el nivel del mar el riesgo de congelación se verá aumentado.

Debido a los cambios y actualizaciones en nuestros productos, Gamesa Eólica S.A. se reserva el derecho a cambiar las especificaciones.

1.5 GENERAL RESERVATIONS

During periods of low wind, an increased own consumption of power for heating and dehumidification of the nacelle must be expected.

Regarding heavy icing up, interruptions in operation may be expected. In certain combinations of high wind speeds, high temperature, low air temperature, low air density and/or low voltage, power derating may happen to ensure that the thermal conditions of the main components such as gearbox, generator, transformer, power cables, etc, are kept within limits.

It is generally recommended that the grid voltage is as close to nominal as possible. In case of grid dropout and very low temperatures, a certain time for heating must be expected before the wind turbine can start to operate.

If the terrain within a 100 m radius of the turbine has a slope of more than 10°, particular considerations may be necessary.

If the wind-turbine is placed in more that 1000 m above the sea level, a higher temperature rise than usual might occur in the generator, transformer and other electrical components. In this case a periodic reduction of rated power might occur, even if the ambient temperature is within the specified limits. Furthermore, also at sites in more than 1000 m above sea level, there will be an increased risk of icing-up.

Due to continuous updating of our products, Gamesa Eolica S.A. reserves the right to change these specifications.

2 ELEMENTOS DEL AEROGENERADOR

La **Figura 1** muestra la disposición de los diferentes elementos en la góndola del aerogenerador G87 – 2.0 MW.

2 WIND-TURBINE ELEMENTS

Figure 1 shows the location of the different elements in the nacelle of the G87 – 2.0 MW wind-turbine.

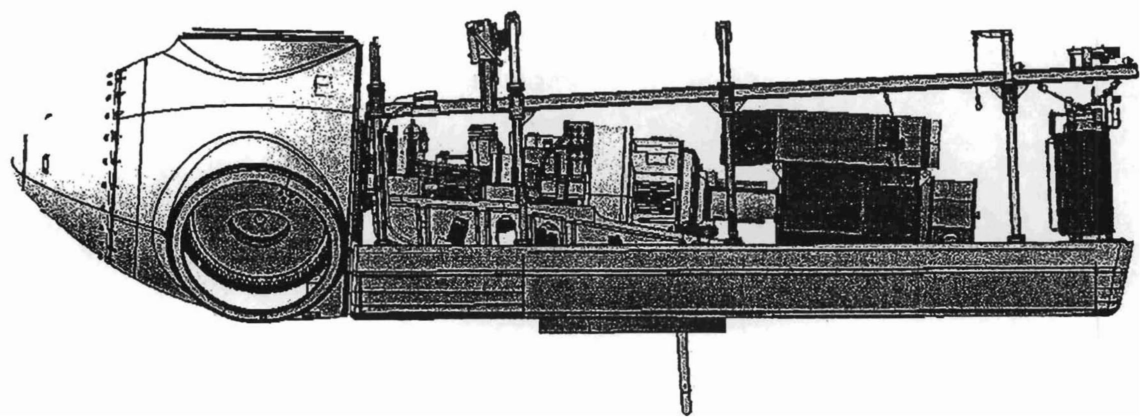


***Figura 1** Vista lateral de la del aerogenerador G87-2.0 MW.*

***Figure 1** Side view of G87-2.0 MW wind-turbine.*

2.1 ROTOR

2.1.1 General

El rotor del aerogenerador G87-2.0 MW es un rotor de tres palas unidas a un buje esférico mediante los rodamientos de pala. El rotor está dotado de un ángulo de conicidad de 2°, que aleja la punta de las palas de la torre.

2.1.2 Palas

Las palas del aerogenerador G87-2.0 MW son de 42,5m de longitud y un peso nominal de 5981kg. La distancia de la raíz de las palas hasta el centro del buje es de 1m, con lo que se alcanzan los 87m de diámetro del rotor.

Cada pala lleva un sistema pararrayos que recoge las descargas eléctricas mediante un receptor en punta de pala. Dicha descarga es transmitida, vía un cable de cobre que recorre la pala longitudinalmente, hasta el buje.

Las palas del aerogenerador G87-2.0 MW están fabricadas en material compuesto de resina epoxy, fibra de carbono y fibra de vidrio. En su fabricación se emplea la tecnología de los preimpregnados ("prepreg"). El método de fabricación está automatizado mediante la combinación de las

2.1 ROTOR

2.1.1 General

The rotor of G87-2.0 MW consists of three blades attached to a cast iron hub through the blade bearings and the pitch regulation system. The blade coning is 2° so that, the blade tip is kept away from the tower

2.1.2 Blades

The blades are 42,5m span and a nominal weight of 5981kg. Each blade is fitted with a anti-lightning system that receive lightning discharges by a receptor at the tip. The discharge is conducted via a copper cable through the blade to the hub.

The distance between the blade root and the centre of the hub is 1m and, as a result, the diameter of the rotor is 87m.

The blades are made of carbon fiber and glass fiber reinforced epoxy. Their manufacture is based on the pre-preg moulding technology. The manufacturing method is automated by the combination of tape Placement and Tape Winding techniques. This assures that the required mechanical properties are técnicas de Tape Placement y Tape Winding. Esto repercute en la repetitividad de sus características mecánicas y por tanto aumenta la calidad respecto a otras tecnologías.

obtained each time the process is repeated and improves the quality in relation to others technologies.

La estructura de las palas del aerogenerador G87-2.0 MW está formada por un larguero interior alrededor del cual va pegado el revestimiento, formado por dos conchas fabricadas por separado. La misión del larguero es aportar resistencia estructural al conjunto, resistir las cargas propias de la pala y transmitir esfuerzos al buje. El revestimiento no posee misión estructural, sino que tiene la forma aerodinámica adecuada para convertir la energía cinética del viento en par motor para la generación de electricidad.

Each blade consists of two shells –made separately-, bonded to a supporting internal spar. The role of this spar is to provide structural resistance to the whole system, bear the own blade loads and transmit the stresses to the hub. On the other hand, the shells have no structural mission but possess the adequate aero-dynamical shape to convert the kinetic energy of the wind into drive torque to generate electricity.

El larguero es en sí mismo una viga de sección tubular cerrada con una geometría adaptada a la forma aerodinámica de los perfiles de la pala. Es en el larguero donde se introduce fibra de carbono. Esto provoca un aumento de rigidez y una disminución de peso respecto a las palas de fibra de vidrio. Las palas de fibra de vidrio están dimensionadas por deflexión máxima. En palas de gran longitud esto provocaría un gran aumento de peso. La introducción de fibra de carbono permite dimensionar las palas por tensión, quedando por tanto la cantidad de material optimizada. Este hecho, unido a la sensiblemente mayor relación rigidez/peso de la fibra de carbono respecto de la fibra de vidrio, reduce considerablemente el peso final de la pala y, a la postre, las cargas del resto de componentes del aerogenerador.

The internal spar is essentially a closed beam of tubular cross-section and its geometry is adapted to the aero-dynamic profile of the blade at each station. The carbon fiber is located in this spar. That means a higher stiffness with a less weight compared with glass fiber blades. The glass fiber blades are dimensioned by maximum deflection; in long blades this would mean an important increase in weight. The carbon fiber introduction let the blades be dimensioned by stress, optimizing the quantity of material. This fact, together with the important stiffness/weight relation compared to the glass fiber, reduces considerably the final weight of the blade and, consecuently, the loads of the rest of wind turbine components.

La mezcla de fibra de vidrio y fibra de carbono es un compromiso entre rigidez estructural y coste. Si se hiciera la pala íntegramente de fibra de carbono, el coste sería muy elevado. El diseño de una pala híbrida supone el uso de las tecnologías más avanzadas del sector, tanto a nivel de diseño como de fabricación, resultando una pala con óptima relación calidad/precio.

The carbon and glass fiber combination is an agreement between structural stiffness and cost. If the blade was all in carbon fiber, its cost would be very high. The hybrid blade design means the use of the most advanced technologies in the sector, not only in design but also in manufacture, with the result of an optimum quality/price relation blade.

El revestimiento es una estructura "sandwich" con núcleo de PVC y laminados de fibra de vidrio en resina epoxy.

The outer part (shells) is a sandwich-like construction formed by a PVC core and glass fibre-*epoxy* laminates.

La unión de la pala al rodamiento es atornillada. Se practican 90 taladros en la sección de raíz del larguero en los que se introducen insertos metálicos roscados, para facilitar la unión atornillada

The attachment of the blade to the blade bearing is bolted. This is attained by means of 90 steel threaded inserts embedded in the laminate of the blade root.

2.1.3 Buje

El buje es de forma esférica y está fabricado en fundición nodular. Está montado directamente en el eje principal. Posee una abertura en la parte frontal que permite el acceso al interior para realizar inspecciones.

2.1.3 Hub

The hub is spherical and manufactured in nodular cast iron. It is directly mounted on the main shaft and has an frontal opening for internal inspections.

2.1.4 Cono de la nariz

El cono de la nariz protege el buje y los rodamientos de pala del ambiente. El cono se atornilla a la parte frontal del buje.

2.1.4 Nose cone

The hub and the blade bearings are entirely enclosed and protected from the outside environmental conditions by the nose cone. It is bolted on front of the hub and supported by the blade bearings.

2.1.5 Rodamientos de pala

Los rodamientos de la pala son la interfaz entre la pala y el buje y permiten el movimiento de cambio de paso. Son rodamientos de bolas con doble hilera con juntas sellantes y agujeros pasantes en la pista exterior para la unión con el buje y en la pista interior para la unión a la pala.

2.1.5 Blade bearings

The blade bearings fasten the blade with a rotating connection to the hub. The bearing is a double row 4-point contact ball bearing with seals. It has threaded holes in the outer ring for connecting with the hub and in the inner ring for connecting with the blade.

2.2 SISTEMA DE CAMBIO DE PASO

El sistema de cambio de paso actúa durante todo el tiempo de funcionamiento del aerogenerador: (i) Cuando la velocidad del viento es inferior a la nominal el ángulo de paso seleccionado es aquél que maximiza la potencia eléctrica obtenida para cada velocidad del viento; (ii) Cuando la velocidad del viento es superior a la nominal el ángulo de paso es aquél que proporciona la potencia nominal de la máquina.

El movimiento de cambio de paso de la pala es un giro alrededor de su eje longitudinal. Para conseguir este movimiento en el aerogenerador G87-2.0 MW se utiliza un sistema hidráulico, que a través de un cilindro independiente por pala, coloca las tres palas al mismo ángulo de paso en cada instante.

2.2 PITCH SYSTEM

The pitch system is working all the times of operation of the wind turbine: (i) When the wind speed is below the rated one the pitch angle is chosen so the electrical power output is maximised for each wind speed; (ii) When the wind speed is above the rated one the pitch angle is adjusted to yield the rated power.

The pitch movement of the blade is a rotation around its longitudinal axis. This movement in G87-2.0 MW wind-turbine is attained by an hydraulic system, which set the three blades at the same pitch angle every time by means of an independent cylinder for each blade.

2.3 EJE PRINCIPAL

La transmisión del par motor que provoca el viento sobre el rotor hasta la multiplicadora se realiza a través del eje principal. El eje se une al buje con una brida atornillada y está apoyado sobre rodamientos alojados en soportes fundidos. Todas las cargas, excepto el par torsor, son transmitidas al bastidor a través de estos soportes. La unión con la entrada de baja velocidad de la multiplicadora se consigue con un disco cónico de apriete que transmite el par por

2.3 MAIN SHAFT

The main shaft transmits the drive torque from the rotor to the gearbox. The shaft is joined to the hub through a bolted flange and is supported by two bearings in cast main bearing houses. All loads, except the driving torque, are transmitted to the main frame through the supports. The main shaft is fixed to the low speed hollow shaft of the gearbox with a conical joint that transmits the torque by friction.

fricción.

El eje está fabricado en acero forjado y tiene un orificio central longitudinal para alojar los elementos hidráulicos y de control del sistema de cambio de paso de las palas.

The main shaft is manufactured in forged alloy steel. It features a hole to house the hoses for hydraulic oil and cables for pitch control system.

2.4 BASTIDOR

El bastidor del aerogenerador G87-2.0 MW se ha diseñado bajo los criterios de simpleza mecánica y robustez adecuada para soportar los elementos de la góndola y transmitir las cargas hasta la torre. La transmisión de estas cargas se realiza a través del cojinete de la corona de orientación.

El bastidor se divide en dos partes:

(i) El bastidor delantero es una pieza de fundición donde se fijan los soportes del eje principal y la corona de orientación.
(ii) El bastidor trasero está formado por dos vigas unidas por su parte delantera y trasera. Esta parte ha sido diseñada para soportar al generador (derecha), el controlador del *Top* (izquierda) y el transformador. Entre ellas el suelo de la góndola permite el acceso para la realización de tareas de reparación y mantenimiento.

2.4 MAIN FRAME

The machine main frame has been designed to result in a simple and robust foundation suitable for the nacelle components and machinery. It transmits the loads from these elements to the tower through the yaw bearing system.

The nacelle main frame is divided in two parts:

(i) The front foundation is a cast piece where the supports of the main shaft and the yaw ring are fixed.
(ii) The rear frame is composed by two beams joined both at their rear and front ends. This part has been designed as to support the generator (right), controller (left) and the transformer. Between them, the nacelle floor allows both repair and maintenance tasks to be done.

2.5 CAPOTA

La capota es la cubierta que protege los componentes del aerogenerador que se encuentran en la góndola. Está fabricada en resina poliéster con fibra de vidrio.

En el interior de la góndola hay suficiente espacio para realizar las operaciones de reparación y mantenimiento del aerogenerador. Una trampilla en la parte frontal permite el acceso al interior del cono, y una trampilla en el suelo de la parte trasera permite operar con la grúa. Las 2 claraboyas del techo proporciona luz solar por el día, ventilación adicional y acceso al exterior, donde se encuentran los instrumentos de medida de viento y el pararrayos.

Las partes giratorias están debidamente protegidas para garantizar la seguridad del personal de mantenimiento.

2.5 NACELLE COVER

The nacelle housing is the cover for the protection of the mechanical components from the actions of the environment. This cover is manufactured in glass fibre reinforced polyester. Sufficient standing and working area is provided in the inner of the nacelle for service and maintenance work.

A hatch at the front of the cabin gives access to the inside of the nose cone and the hub. A hatch in the ground of the rear part of the nacelle cover can be opened to operate the service crane. The 2 skylight hatches provide diurnal lighting and additional ventilation and enables easy access to the nacelle roof where the wind sensors and the lightning rods are placed.

High-speed rotating parts are conveniently covered by protective screens providing adequate safety for maintenance personnel.

2.6 MEDIDA DE VIENTO

En el exterior de la capota, en la parte trasera, dos mástiles verticales sirven de soporte de los anemómetros sónicos para medida del viento.

2.7 SISTEMA DE CONTROL

El sistema de control monitoriza y gobierna todas las funciones del aerogenerador G87-2.0 MW de manera que las actuaciones sean óptimas en todo momento. El sistema de control registra continuamente las señales de los distintos sensores del aerogenerador, y cuando detecta algún error realiza las acciones oportunas para subsanarlo. El sistema de control detiene el aerogenerador si el error detectado así lo requiere.

Existe una pantalla táctil en la que se presentan datos de operación y que permite la interacción del usuario con el aerogenerador, y un sistema de control que está preparado para la monitorización y el control remoto si es necesario.

2.7.1 Disposición del sistema de control

El soporte físico del sistema de control se reparte en tres armarios:

1. Controlador de la "nacelle" situado en la nacelle.
2. Controlador "ground" situado en la base de la torre.
3. Controlador del buje situado en la parte giratoria del aerogenerador.

A su vez, el controlador de la "nacelle" se divide en tres partes:

1. Sección de control: se encarga de las tareas propias del gobierno de la góndola, i.e. monitorización del viento, cambio del ángulo de paso, orientación, control de la temperatura interior.
2. Convertidor de frecuencia: se encarga del control de potencia y de gestionar la conexión y desconexión del generador de la red.
3. Sección de embarrados y protecciones: en esta parte se encuentra la salida de la potencia producida con las protecciones eléctricas necesarias.

2.6 WIND MEASUREMENT

Outside the nacelle, in the rear part, two vertical mast support the sonic anemometers for measuring the wind speed and direction.

2.7 CONTROL SYSTEM

The controller monitors and controls all functions in the G87 wind-turbine to ensure that its performance is optimal at any wind speed. It continuously scans the signals from the sensors in the wind turbine so that as soon as an error is detected, the appropriate handling takes place. The controller will stop the turbine if the detected error requires so.

There exists a touch screen in which operational data are displayed. The controller is designed as to allow remote monitoring and control in case these features are required. It is also supervised by the system watchdog so that, its correct operation is permanently guaranteed

2.7.1 Layout of the controller

The control system hardware is placed in three parts:

1. "Nacelle" controller, located at the nacelle.
2. "Ground" controller, located at the bottom of the tower.
3. "Hub" controller, located at the rotating element of the wind-turbine (inside the hub).

The "nacelle" controller is divided into three parts further:

1. Control section: It in charged of the proper tasks of govern of the nacelle, i. e. wind monitoring, pitch angle change, orientation, inside temperature control.
2. Frequency converter: It is charged of the power control and generator-grid connection/disconnection management.
3. Bars and protection section: This is in charge of the power output yield with the necessary electrical protections.

2.7.2 Pantalla de control

Desde la pantalla táctil del "ground" se puede tanto observar algunos datos de la operación del aerogenerador como detener y arrancar la máquina, entre otras acciones. También se puede conectar una pantalla portátil al controlador de la "nacelle" para realizar estas tareas.

2.7.2 Control touch terminal

When an operator wants to look at operational data from the turbine, or to start or stop the turbine, he can use the operating panel in the "ground" controller or connect a service panel to the "nacelle" controller. Figure 2 shows different operating panel modes.

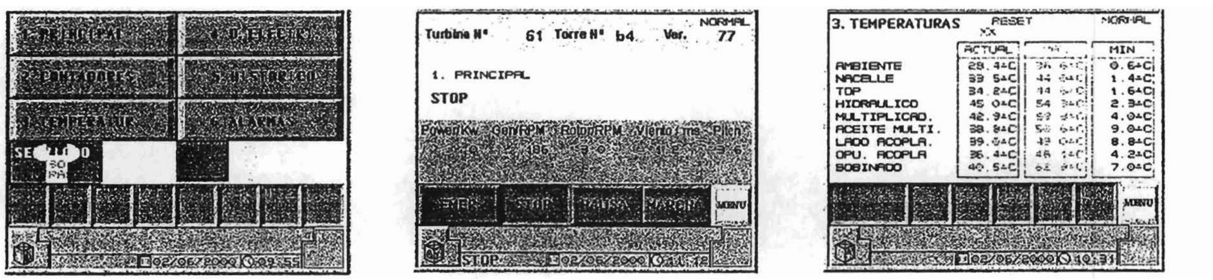


Figura 2. *Distintos modos de la pantalla de control.*

Figure 2. *Different operating panel modes.*

2.7.3 Control del aerogenerador

La velocidad de giro del aerogenerador y el ángulo de paso de las palas se modifican en cada instante dependiendo de la velocidad de viento que llega a la máquina. El sistema de control se encarga de elegir los valores adecuados de estas variables.

Atendiendo a la velocidad de viento se pueden establecer cuatro fases

1. *Viento bajo*, con el generador desconectado de la red.
2. *Viento medio*, con el generador conectado, pero sin llegar a generar potencia nominal.
3. *Viento alto*, el generador produce potencia nominal.
4. *Viento muy alto*, el generador está desconectado y la turbina parada.

Viento bajo

Cuando la velocidad del viento es inferior a la velocidad de arranque de la máquina pero próxima a ésta, el sistema de control coloca las palas a un ángulo de paso cercano a 45°, que proporciona un par de arranque suficientemente alto.

A medida que la velocidad de viento aumenta la

2.7.3 Wind-turbine control

The rotational speed and the pitch angle of the wind-turbine are modified at every instant depending on the existing wind-speed. The control system chooses the adequate values of these variables.

Depending on the wind-speed 4 stages can be established:

1. *Low wind*, with the generator disconnected from the grid.
2. *Medium wind*, with the generator connected to the grid, but rated power is not accomplished.
3. *High wind*, the turbine produces rated power.
4. *Very high wind (stop wind)*, the generator is disconnected and the wind-turbine stopped.

Low wind

When the wind-speed is below, but close to, the start-wind-speed, the pitch angle will be approximately set equal to 45 degrees. This situation will give a sufficiently high start moment to the rotor.

As the wind-speed increases the rotational speed -rotor and generator- also increases, and the pitch velocidad de rotación del rotor también aumenta, y el ángulo de paso se hace disminuir hasta que se alcanzan las condiciones adecuadas para que el generador se conecte.

angle is shifted down to small angles by the controller till the conditions to generator connection are achieved.

Viento medio

A velocidades de viento por encima de la velocidad de arranque y por debajo de la velocidad nominal el sistema de control elige la velocidad de rotación y el ángulo de paso que proporcionan la máxima potencia para cada velocidad de viento.

Medium wind

For wind speeds above the start-wind-speed and below the rated-wind-speed the control system works out the most suitable rotor speed -within a certain range of available operating speeds- and pitch angle so that the electrical power yield is maximum for each wind speed.

Viento alto

Cuando la velocidad de viento es superior a la nominal, la energía contenida en el viento es suficiente para producir potencia nominal, y el ángulo de paso se incrementa para regular la potencia a su valor nominal.

High wind

When the wind-speed exceeds the rated wind speed, the wind kinetic energy is sufficient for the turbine to produce rated power, and the pitch angle is increased to regulate the power to its rated value.

Viento muy alto

Si la velocidad del viento es superior a la velocidad de parada, el generador se desconecta y el sistema de control lleva las palas a la posición de bandera (cercana a 90º) hasta que la velocidad de viento desciende por debajo de la velocidad de re-arranque y la máquina reanuda la generación de potencia.

Very high wind

If the wind-speed is greater than the stop value the generator is disconnected and the control system pitches the blades to full feathered position (~ 90º). Then, the system will wait until the wind-speed has decreased below the re-start wind-speed to re-start the power generation.

2.8 COMUNICACIÓN DE TRANSFORMADOR, ARMARIO DE CONTROL Y CELDA

2.8 COMMUNICATION OF TRANSFORMER, CONTROL SYSTEM AND MEDIUM VOLTAJE SWITCH GEAR

2.8.1 Alimentación del rotor del generador

La alimentación del rotor del generador se realiza a través de una salida del transformador principal a 480 V.

2.8.1 Generator rotor supply

The power supply of the rotor of the generator is performed by means of an 480 V output of the main transformer.

2.8.2 Características de los cables del generador.

Estator: Los cables que unen tanto el estator del generador con el armario de control de potencia situado en la nacelle son cables DN-K 0.6/1kV 3x240 mm^2 y diseñados de acuerdo a la norma UNE 21150. Se utilizan 4 cables en paralelo para alimentar al estator.
Rotor: Se utilizan 4 cables DN-K 0.6/1kV 3x70 mm^2

Los cables que unen el armario de control de potencia con el transformador son cables de tipo DN-K 0.6/1kV 1x240 mm^2. Se utilizan 4 cables en paralelo para el estator y 1 para el rotor.

2.8.2 Generator cables characteristics.

Stator: The generator stator and the power control board located in the nacelle are connected by means of DN-K 0.6/1kV 3 x 240 mm^2 cables which are designed according to the normative UNE 21150. 4 cables (in parallel) are used to supply the stator.
Rotor: As in the stator but with a section of 3 x 70 mm^2.

The power control board and the transformer are connected by means of DN-K 0.6/1kV 240 mm^2 cables. 4 cables are used in parallel for the stator and 1 for the rotor.

2.8.3 Fibra óptica

La fibra óptica utilizada para comunicaciones en el interior del aerogenerador es de diámetro 200/230 µm, 4 hilos por manguera. Esta fibra está protegida contra humedad y roedores.

Esta fibra óptica se utiliza para comunicaciones entre los distintos procesadores del aerogenerador o entre estos procesadores y el usuario que se conecta a través de un terminal de operación.

El sistema de telemando utiliza fibra de diámetro 62.5/125 µm, igualmente protegida contra la humedad y los roedores, para comunicar los distintos aerogeneradores.

2.8.3 Optical fibre

The optical fibre used for communications inside the turbine has a diameter of 200/230 µm, 4 wires per cable. This fibre is protected against humidity and rodents action.

This fibre is used for the communication between the different processors or between these processors and the user that log in through a operating terminal.

The remote control uses fibre of diameter 62.5/125 µm to communicate different wind-turbines. This fibre is also protected against the humidity and rodents action.

2.9 CIMENTACIONES

A continuación se definen los datos principales de las cimentaciones estándar para el aerogenerador G87– 2.0 MW con torres IEC IIA de 67 y 78m.

Estas cimentaciones se han calculado suponiendo cargas certificadas o en proceso de certificación y un terreno estándar.

En el caso de que las hipótesis manejadas sufran variaciones, los valores definidos no tendrán valor y será necesario un recálculo de la cimentaciones.

Para cada emplazamiento, será necesario revisar las características del terreno junto con los datos de viento para seleccionar la cimentación más adecuada.

2.9 FOUNDATIONS

Below the main data of standard foundations of the G87 – 2.0 MW wind-turbine with 67m and 78m IEC IIA towers.

These foundations have been calculated using certified loads (or in certification process) and supposing a standard terrain.

In case these hypothesis change, the defined values will not be valid and a new calculation will be necessary.

It will be necessary to revise the characteristics of the terrain and wind data to select the most convenient foundation for each site.

2.9.1 Datos principales:

- Dimensiones de las zapatas para torres IEC IIA:

2.9.1 Main data

- Dimensions of foundations of IEC IIA towers:

Dimensión	Dimensions	T67m	T78m	Unit
Lado zapata, L	Foundation length, L	12.8	13.8	m
Canto exterior, h_e	Exterior height, h_e	1.5	1.5	m
Canto central, h_c	Central height, h_c	1.5	1.5	m
Diámetro virola cimentación	Foundation belt diameter	4.034	4.038	m

- Mediciones de materiales para zapatas de torres IEC IIA:

- Materials of foundations of IEC IIA towers::

Material	Material	T67m	T78m	Unit
Hormigón limpieza HM-15	HM-15 concrete	16.4	19.1	m^3
Hormigón estructural HA-30	HA-30 structural concrete	254.2	294.1	m^3
Acero armaduras B 500 S	Steel reinforcement B 500 S	22300	27100	kg

3 PARÁMETROS DE DISEÑO

3.1 CONDICIONES DEL VIENTO.

Las condiciones de viento para un emplazamiento se especifican normalmente por una distribución de Weibull. Esta distribución viene descrita por el factor de escala *A* y el factor de forma *k*. El factor *A* es proporcional a la velocidad media del viento y el factor *k* define la forma de la distribución para diferentes velocidades de viento. La turbulencia es el parámetro que describe las variaciones / fluctuaciones a corto plazo del viento.

Las condiciones de diseño de la máquina G87-2.0 MW se indican a continuación:

3 DESIGN PARAMETERS

3.1 WIND CONDITIONS.

The wind climate for a given site is normally specified by a Weibull distribution. The Weibull distribution is described by the scale factor A and the shape factor K. The A factor is proportional to the mean wind speed and the K factor defines the shape of the Weibull distribution for different wind speeds. Turbulence is the factor, which describes short-term wind variation/fluctuations.

The design conditions of G87-2.0 MW are given below:

Tabla 4 Parámetros de diseño del aerogenerador G87 – 2.0 MW. Table 4 Design parameters of G87 – 2.0 MW wind-turbine.							Unidad/Unit	Comentarios Comments
Class IEC	DIBT II 67m	DIBT II 78m	DIBT III 67m	DIBT III 78m	II_A	I_A		IEC 61400-1 Ed. 2
Annual mean wind speed	6	6.2	8.4	8.6	8.5	10	m/s	Referido a altura del buje
Weibull shape parameter, *K*				2	2	2		
Turbulence intensity at 15 m/s, I_{15}	18	18	18	18	18	18		
Reference wind 10 min. averaged	37.4	38.3	43.4	44.5	42.5	50	m/s	Periodo recurrencia 50 años
Reference wind 3 sec. averaged	-	-		-	59.5	70	m/s	Periodo recurrencia 50 años
Stop / restart wind speed	25 / 20	25 / 20	25 / 20	25 / 20	25 / 20	25 / 20	m/s	

La curva de potencia (calculada para una turbulencia del 10 %) junto con las curvas C_p y C_t y la producción anual del aerogenerador G87 – 2.0 MW se incluyen en el documento **FT002404**.

The power curve (calculated for a turbulence of 10 %) together with the C_p and C_t curves and the annual production of G87 – 2.0 MW wind-turbine are included in the **FT002404** document.

3.2 VERIFICACIÓN DE LAS CONDICIONES DE VIENTO.

Los aerogeneradores se pueden colocar bajo diferentes y variadas condiciones climáticas: donde la densidad del aire, la intensidad de turbulencia, la velocidad media del viento y el parámetro de forma *k* son los parámetros a considerar. Si la intensidad de turbulencia es alta las cargas en el aerogenerador aumentan y su tiempo de vida disminuye. Por el contrario, las cargas se reducirán y su tiempo de vida aumentará si la velocidad media del viento o la intensidad de turbulencia o ambas son bajas. Por lo tanto, los aerogeneradores pueden colocarse en emplazamientos con alta intensidad de turbulencia si la velocidad media del viento es adecuadamente baja. Las condiciones climáticas han de examinarse si lo prescrito es excedido.

El valor característico, a altura de buje, de la intensidad de turbulencia I_{15} a la velocidad de viento media *diez-minutal* de 15 m/s se calcula sumando la desviación estándar medida de la intensidad de turbulencia a su valor medio medido o estimado.

En terreno complejo las condiciones de viento serán verificadas sobre la base de medidas realizadas en el emplazamiento. Además, habrá que considerar el efecto de la topografía en la velocidad y perfil del viento, la intensidad de turbulencia y la inclinación del flujo de viento sobre cada aerogenerador.

3.2 WIND CONDITION ASSESSMENT.

The turbines can be placed under various climatic conditions: where the air density, the turbulence intensity, the mean wind speed and the shape factor K are the parameters to be considered. If the turbulence intensity is high the turbine loading increases and the turbine lifetime decreases. On the contrary, the loading will be reduced and the lifetime extended if the mean wind speed or the turbulence intensity, or both, are low. Therefore, the wind-turbines can be placed on sites with high turbulence intensity if the mean wind speed is appropriately low. The climatic conditions have to be examined if the prescribed is exceeded

The characteristic value of hub-height turbulence intensity, I_{15}, at a min. average wind speed of 15 m/s is calculated by adding the measured standard deviation of the turbulence intensity to the measured or estimated mean value.

For complex terrain, the wind conditions shall be assessed from measurements made at the site. In addition, consideration shall be given to the effect of topography on the wind speed, wind profile, turbulence intensity and flow inclination at each turbine location.

4 ESPECIFICACIONES TÉCNICAS

A continuación se detallan las especificaciones técnicas de los diferentes componentes del aerogenerador G87 – 2.0 MW.

4 TECHNICAL SPECIFICATIONS

The technical specifications of the different components of the G87 – 2.0 MW wind-turbine are listed below:

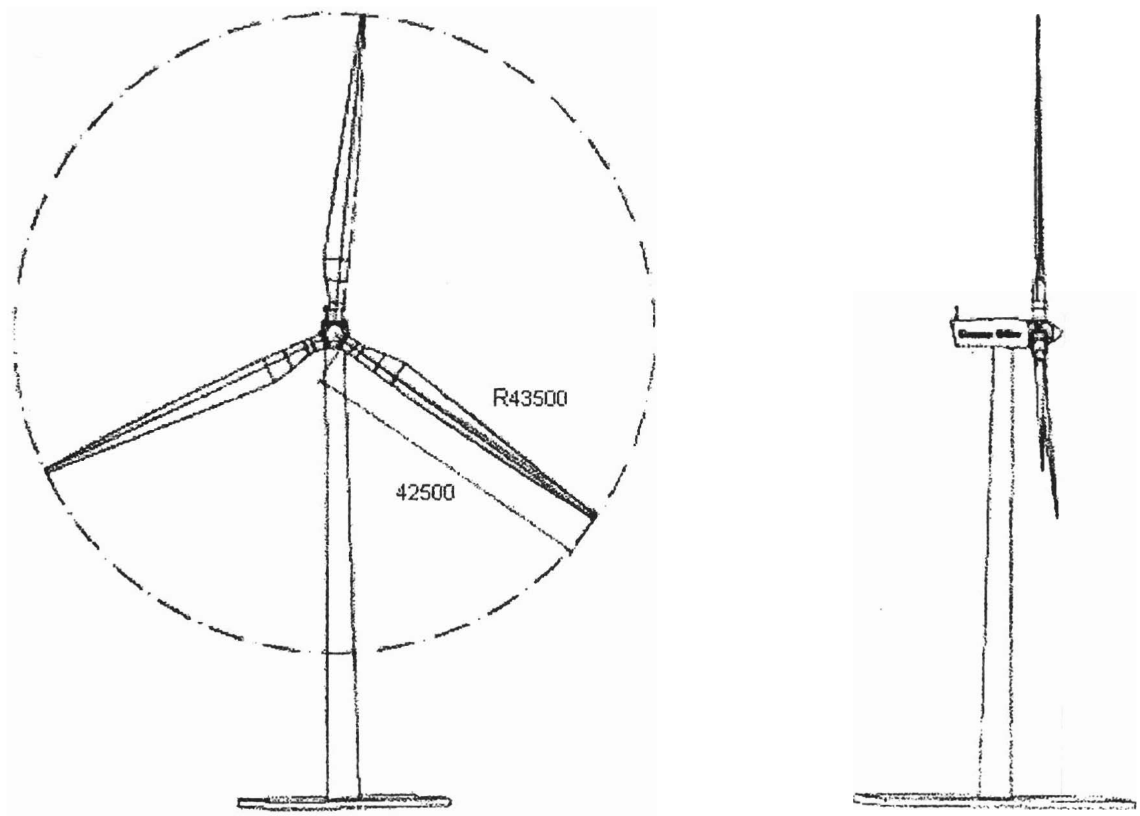


Figure 3 *Main dimensions of G87-2.0 MW rotor*

4.1 CONO / NOSE CONE

Dimensiones	Distancia punta-base: 4237 mm Ø max. 3957 mm / Ø base 3300 mm
Material	Fibra de vidrio y resina de poliéster
Peso	310 kg

Dimensions	Tip-base distance: 4237 mm Ø max. 3957 mm; Ø base 3300 mm
Material	Glass fibre and polyester resin
Weight	310 kg

4.2 ROTOR / ROTOR

Diámetro	87m
Área barrida	5944,68m^2
Velocidad de rotación de operación	9.0 : 19.0 rpm
Sentido de rotación	Sentido agujas de reloj (vista frontal)
Orientación	Barlovento
Ángulo de inclinación	6°
Conicidad del rotor	2°
Número de palas	3
Freno aerodinámico	Puesta en bandera de palas

Diameter	87m
Swept Area	5944,68m^2
Rotational Speed Operation Interval	9,0:19,0 rpm
Sense of Rotation	Clockwise (front view)
Rotor Orientation	Upwind
Tilt angle	6°
Blade coning	2°
Number of blades	3
Aero-dynamic brake	Full feathering

4.3 PALAS / BLADES

Concepto estructural	Conchas pegadas a viga soporte
Material	Pre-impregnados de fibra de carbono - epoxy y fibra de vidrio - epoxy
Conexión de palas	Insertos de acero en raíz
Perfiles aerodinámicos	DU-WX + FFA – W3
Longitud	42,5 m
Cuerda de la pala (raíz / punta)	3,357m (en R=8,0m) / 0,013m (en R=43,5m)
Torsión	15,74°
Peso	5981kg

Principle	Shells bonded to supporting beam
Material	Carbon and glass fibre reinforced epoxy
Blade connection	Steel root inserts
Airfoils	DU-WX + FFA – W3
Length	42,5 m
Chord (root/ tip)	3,357m (at R=8,0m) / 0,013m (at R=43,5m)
Max. Twist	15,74°
Weight	5981kg

4.4 RODAMIENTO DE PALA / BLADE BEARING

Tipo	Rodamientos de bola 4 – puntos, doble fila.

Type	4 - point ball bearing, double line.

4.5 CARCASA / NACELLE COVER

Dimensiones	10050 x 4050 x 3300 mm
Material	Fibra de vidrio y resina de poliéster
Peso	2000 kg

Dimensions	10050 x 4050 x 3300 mm^3
Material	Glass fibre and polyester resin
Weight	2000 kg

4.6 BUJE DE PALA / ROTOR HUB

Tipo	Esférico
Material	Fundición nodular
Material espec.	EN-GJS-400-18U-LT según EN 1563

Type	Spherical
Material	Nodular Cast Iron
Material specifications	EN-GJS-400-18U-LT per EN 1563

4.7 EJE PRINCIPAL / MAIN SHAFT

Tipo	Eje forjado
Material	Acero templado y revenido
Especificación de material	42CrMo4 ó 34CrNiMo6 EN10083

Type	Forged shaft
Material	Quenched and tempered steel
Material specification	42CrMo4 or 34CrNiMo6 EN10083

4.8 SOPORTE DEL EJE / MAIN SHAFT SUPPORT

Tipo	Soporte de fundición
Material	Fundición nodular
Especificación de material	EN-GJS-400-18U-LT según EN 1563

Type	Cast
Material	Nodular Cast Iron
Material specification	EN-GJS-400-18U-LT per EN 1563

4.9 RODAMIENTOS DEL EJE / MAIN SHAFT BEARING

Tipo	Rodamientos de rodillos a rótula

Type	Spherical Roller Bearings

4.10 BASTIDOR DELANTERO / FRONT MAIN FRAME

Material	Fundición nodular
Especificación de material	EN-GJS-400-18U-LT según EN 1563

Material	Nodular Cast Iron
Material specification	EN-GJS-400-18U-LT per EN 1563

4.11 SISTEMA DE GIRO / YAW SYSTEM

Tipo	Corona de orientación con cojinete de fricción
Materiales	
Corona de orientación	Forjado. 34CrNiMo 6 / 42CrMo4 EN10083
Elemento de fricción	PETP
Velocidad de orientación	< 0.5°/s
Freno de yaw	Activo hidráulico + Pasivo

Type	Plain bearing system with built-in friction
Materials	
Yaw ring	Forged. 34CrNiMo 6 / 42CrMo4 EN10083
Plain bearing	PETP
Yawing speed	< 0.5°/s.
Yaw brake	Hydraulic active + Passive

4.12 MECANISMO DE GIRO. MOTORREDUCTORAS / YAW GEARS

Tipo	3 etapas epicicloidales
	1 etapa sinfín (ratio máximo 1:10)
Motor	2.2 kW, motor asíncrono de 6 polos con freno

Type	3 planetary stages
	1 worm gear non – locking stage (maximum ratio 1:10)
Motor	2.2 kW, 6 pole asynchronous motor with brake.

4.13 TORRE / TOWER

Tipo	Tronco-cónica tubular	
Material	Acero al carbono estructural	
Especificación material		
Virolas	S235 JO / S235 JRG2 / S275J2G3/ S355J2G3	
Bridas	S355 NL	
Tratamiento superficial	Pintada	
Tipo de corrosión, exterior / interior	C5-M (ISO 12944-2) / C3 (ISO 12944-2)	
Diámetro en parte superior	2.3 m (todas las alturas)	
Diámetro en parte inferior	4.0 m (todas las alturas)	
Altura del buje		
Torre modular de 3 tramos IEC (67 m)		67 m
Torre modular de 4 tramos IEC (78 m)		78 m

Características de los tramos de torres IEC IIA / DIBT II	Longitud [mm]	Ø Inferior Externo [mm]	Ø Superior Externo [mm]	Peso [kg]
Torre IEC IIA/ DIBT II 67 m				
Inferior	16665	4034	3492	53200
Intermedio	23822	3492	2781	54700
Superior	24367	2781	2314	42000
Torre IEC IIA / DIBT II 78 m				
Inferior	11100	4038	3810	45500
Intermedio 1	16980	3810	3494	55300
Intermedio 2	23847	3494	2781	56200
Superior	24392	2781	2314	41600

(*) La altura exacta del buje incluye 0.60 m de distancia desde la brida de cimentación al suelo y 1.7 m desde la parte más alta de la torre hasta el centro del buje.

Type	Trunk-conical Tubular	
Material	Non-alloy structural steel	
Material specification		
Shells	S235 JO / S235 JRG2 / S275J2G3 / S355J2G3	
Flanges	S355 NL	
Surface treatment	Painted	
Corrosion class, outside / inside	C5-M (ISO 12944-2) / C3 (ISO 12944-2)	
Top diameter	2.3 m (all heights)	
Bottom diameter	4.0 m (all heights)	
Hub height		
3 parted modular tower IEC (67 m)		67 m
4 parted modular tower IEC (78 m)		78 m

Characteristics of the IEC IIA / DIBT II tower sections				
	Length [mm]	**Outer Ø at Bottom [mm]**	**Outer Ø at Top [mm]**	**Weight [kg]**
Tower IEC IIA/ DIBT II 67 m				
Bottom	16665	4034	3492	53200
Intermediate	23822	3492	2781	54700
Top	24367	2781	2314	42000
Tower IEC IIA / DIBT II 78 m				
Bottom	11100	4038	3810	45500
Intermediate 1	16980	3810	3494	55300
Intermediate 2	23847	3494	2781	56200
Top	24392	2781	2314	41600

(*) The exact hub height includes 0.7 m (distance from the foundation section to ground level) and 1.7 m (distance from top flange to hub).

4.14 MULTIPLICADORA / GEARBOX

Tipo	1 etapa planetaria / 2 paralelas
Ratio	1 : 100.5 (50 Hz) 1 : 120,5 (60Hz)
Refrigeración	Bomba de aceite con intercambiador.
Calentador de aceite	2.25 kW a 690V
Filtro de aceite	3 µm / 10 µm
Proveedor	Varios.
Dimensiones (aprox.)	2 x 2.2 x 2.2 m^3
Peso (aprox.)	16500 kg

Type	1 planetary stage / 2 parallel stages
Ratio	1 : 100.5 (50 Hz) 1 : 120,5 (60Hz)
Cooling system	Oil pump with oil cooler; Aux. pump
Oil heater power	2.25 kW, 690V
Oil filter	3 µm / 10 µm
Supplier	Several
Dimensions (approx.)	2 x 2.2 x 2.2 m^3
Weight (approx.)	16500 kg

4.15 ACOPLAMIENTOS / COUPLINGS

Eje principal – multiplicadora	Disco cónico de apriete
Multiplicadora – generador	Acoplamiento flexible

Main shaft – gearbox	Shrink Disc Conical
Gearbox – generator	Flexible joint

4.16 GENERADOR / GENERATOR

Tipo	Doblemente alimentado con rotor devanado y anillos deslizantes
Potencia nominal	2000 kW (estátor + rotor)
Voltaje	690 Vac
Frecuencia	50 Hz
Nº de polos	4
Clase de protección	IP54
Velocidad nominal de rotación	1680 rpm
Intensidad nominal	
Estator	1500 A @ 690 V
Rotor	260 A @ 480 V
Factor de potencia	1.0
Intervalo de factor de potencia (*)	$0.98_{CAP} – 0.96_{IND}$ (opción)
	Ver sección 1.5

Type	Doubly fed machine with wound rotor and slip-rings
Rated power	2000 kW (stator + rotor)
Voltage	690 Vac
Frequency	50 Hz
Number of poles	4
Class of protection	IP54
Rated speed	1680 rpm
Nominal current	
Stator	1500 A @ 690 V
Rotor	260 A @ 480 V
Default power factor	1.0
Power factor range (*)	$0.98_{CAP} - 0.96_{IND}$ (option)
	Ver sección 1.5

4.17 FRENO DE APARCAMIENTO / PARKING BRAKE

Tipo	Freno de disco
Diámetro	600 mm
Material	EN-GJV-300-LT

Type	Disc brake
Diameter	600 mm
Material	EN-GJV-300-LT

4.18 GRUPO HIDRÁULICO / HYDRAULIC UNIT

Capacidad de la bomba	44 l/min
Presión máxima	200 bar
Presión de frenado	25,5 bar (50Hz); 19,5 bar (60Hz)
Contenido de aceite	300 l
Motor	18.5 kW (50Hz); 22kW (60Hz)
Presión de frenado yaw	180 bar-200bar

Pump capacity	44 l/min
Maximum pressure	200 bar
Brake pressure	25,5 bar (50Hz); 19,5 bar (60Hz)
Oil quantity	300 l
Motor	18.5 kW (50Hz); 22kW (60Hz)
Yaw brake pressure	180-200 bar

4.19 SENSORES DE VIENTO / WIND SENSORS

Tipo	Anemómetro sónico 2D con medida de velocidad y dirección simultánea.
Número	2

Type	2D sonic anemometer with simultaneous measurement of wind speed and direction.
Number	2

4.20 UNIDAD DE CONTROL / CONTROL UNIT

Alimentación		
Frecuencia	50 Hz	
Voltaje	3 x 690 Vca + 3 x 480 Vca	
Intensidad de cortocircuito	1500 A (estator); 260 A (rotor)	
Potencia para iluminación	1 x 10 A, 230 Vac/ (1 x 10 A, 110 Vca)	
Ordenador	Sisteam A	
Comunicación	CAN	
Memoria de programa	EPROM (flash)	
Lenguaje de programación	ST (IEC-1131)	
Configuración	Módulos a un rack frontal	
Operación	Pantalla táctil	
Pantallas	Terminales táctiles, 320 x 240 pixells, 5,7 pulg.	
Supervisión / control		
	Potencia activa	Ambiente (temperatura del aire)
	Potencia reactiva	Rotación
	Orientación	Generador
	Hidráulicos	Sistema de cambio de paso
	Red eléctrica	Monitorización remota
Información		
		Datos de operación
		Producción
		Listado de operación
		Listado de alarmas
Órdenes		
	Arranque / pausa	
	Inicio / parada de orientación manual	
	Tests de mantenimiento	
Supervisión remota		
	Posibilidad de conexión a comunicación serie	

Datos de controladores Nacelle, Buje, Ground			
Grado de protección			
		Nacelle	IP-43
		Buje	IP-54
		Ground	IP-54
Dimensiones		Nacelle	4000 x 2200 x 500 mm^3
		Buje	800 x 800 x 400 mm^3
		Ground	800 x 1600 x 400 mm^3
Tipo de alojamiento	Acero: chapa de 3 mm (armario y pedestal) y de 1,5 mm (puerta)		
Protección personas		UNE 60439-1; UNE 60204	

Power supply		
Frequency	50 Hz	
Voltage	3 x 690 Vac + 3 x 480 Vac	
Lockable circuit breaker	1500 A (stator); 260 A (rotor)	
Illumination	1 x 10 A, 230 Vac/ (1 x 10 A, 110 Vca)	
Computer	Sisteam A	
Communication	CAN	
Program memory	EPROM (flash)	
Programming language	ST (IEC-1131)	
Configuration	Modules to a front rack	
Operation	Touch terminal	
Display	Touch terminal, 320 x 240 pixells, 5,7 inch	
Supervision / control		
	Active power	Ambient (air temperature)
	Reactive power	Rotation
	Yawing	Generator
	Hydraulics	Pitch system
	Grid	Remote monitoring
Information		
	Operating data	Operation log
	Production	Alarm log
Commands		
	Run /pause	
	Start / Stop. Manual yaw	
	Maintenance tests	
Remote supervision		
	Possibility of connection of serial communication	

Nacelle, hub and ground controller data		
Protection level		
	Nacelle	IP-43
	Hub	IP-54
	Ground	IP-54
Dimensions		
	Nacelle	4000 x 2200 x 500 mm^3
	Hub	800 x 800 x 400 mm^3
	Ground	800 x 1600 x 400 mm^3
Type of enclosure	Steel. Thickness 3 mm (cabinet, pedestal); 1,5 mm (door)	
Method of protection of persons	UNE 60439-1; UNE 60204	

4.21 CELDA DE MEDIA TENSIÓN / MEDIUM VOLTAGE SWITCH GEAR

La celda de conexión del aerogenerador a la red eléctrica en Media Tensión se incluye en el suministro de Gamesa Eólica de forma opcional. La elección de esta celda debe ser realizada de acuerdo a las características eléctricas de la red de conexión, a continuación se muestran las características básicas de una celda-tipo.
Esta celda corresponde al aerogenerador G87 2MW estándar para una red de conexión de 20kV. Para otros niveles de tensión de la red de conexión, es necesario consultar con Gamesa Eólica.

Tipo	Aparamenta Blindada aislada SF6
Servicio	Continuo
Instalación	Interior
Nº de fases	3
Nº embarrados	1
Tensión nominal asignada	24 kV
Tensión del servicio	20 kV
Frecuencia nominal	50 Hz
Intensidad nominal	
Función de protección (P)	200 A
Función de conexión a red (L)	400 A
Nivel de aislamiento	
A tierra, entre polos y entre bornas (frecuencia industrial / tipo rayo))	50 kV / 125 kV
Intensidad de cortocircuito	
Admisible de corta duración (1 s)	16 kA
Nominal cresta	40 kA
Resistencia arcos internos	
Intensidad	16 kA-0,5 s (UNE 20099-CEI 298
Voltaje	24 kV
Dimensiones (aprox.) (*)	1200 x 800 x 2090 (alto) mm^3
Peso (aprox.) (*)	415 kg

(*) Celda mayor

(**) El tipo de celda depende de las características del puerto de conexión del aerogenerador. Los datos indicados corresponden a una de las situaciones posibles.
The switch gear of the windturbine is included in the supply of Gamesa Eólica, S. A. as an option. This gear has to be chosen according to the electrical characteristics of the grid connection. Below, characteristics of one type of gear are shown. This gear corresponds to the G87-2.0 MW standard for a grid connection of 20 kV. For other voltage levels, it is necessary to contact Gamesa Eólica, S. A.

Type	Armored isolated SF6
Service	Continuous
Installation	Inside
Number of phases	3
Busbar number	1
Assigned nominal voltage	24 kV
Service voltage	20 kV
Nominal frequency	50 Hz
Nom. Intensity, Protection function (P)	200 A
Nom. Intensity, Grid connection function (L)	400 A
Insulation level	
Ground, between poles and between terminals	50 kV (industrial freq.) / 125 kV (peak freq.)
Short-circuit intensity	
Permissible of short duration (1 s)	16 kA
Nominal pulse	40 kA
Resistance	
Intensity	16 kA-0.5 s (UNE 20099-CEI 298)
Voltage	24 kV
Dimensions (approx. for larger unit)	1200 x 800 x 2090 (height) mm^3
Weight (approx. for larger unit)	415 kg

(*) Biggest gear
(**) The switch gear depends on the characteristics of the connection port of the generator. The indicated data correspond to one of the possible situations.

4.22 TRANSFORMADOR / TRANSFORMER

Tipo	Trifásico, seco encapsulado
Relación	20 / 690 V
Potencia nominal	2100 kVA
Frecuencia	50 Hz
Grupo de conexión	Dyn11
Clase de aislamiento	F
Nivel de aislamiento (kV)	24 kV.
Peso (aprox.)	< 5000 kg

Type	3 phase, dry-encapsulated
Transformation relation	20 kV / 690 V
Nominal power	2100 kVA
Frequency	50 Hz
Connection group	Dyn11
Insulation class	F
Insulation level (kV)	24 kV.
Weight (approx.)	< 5000 kg

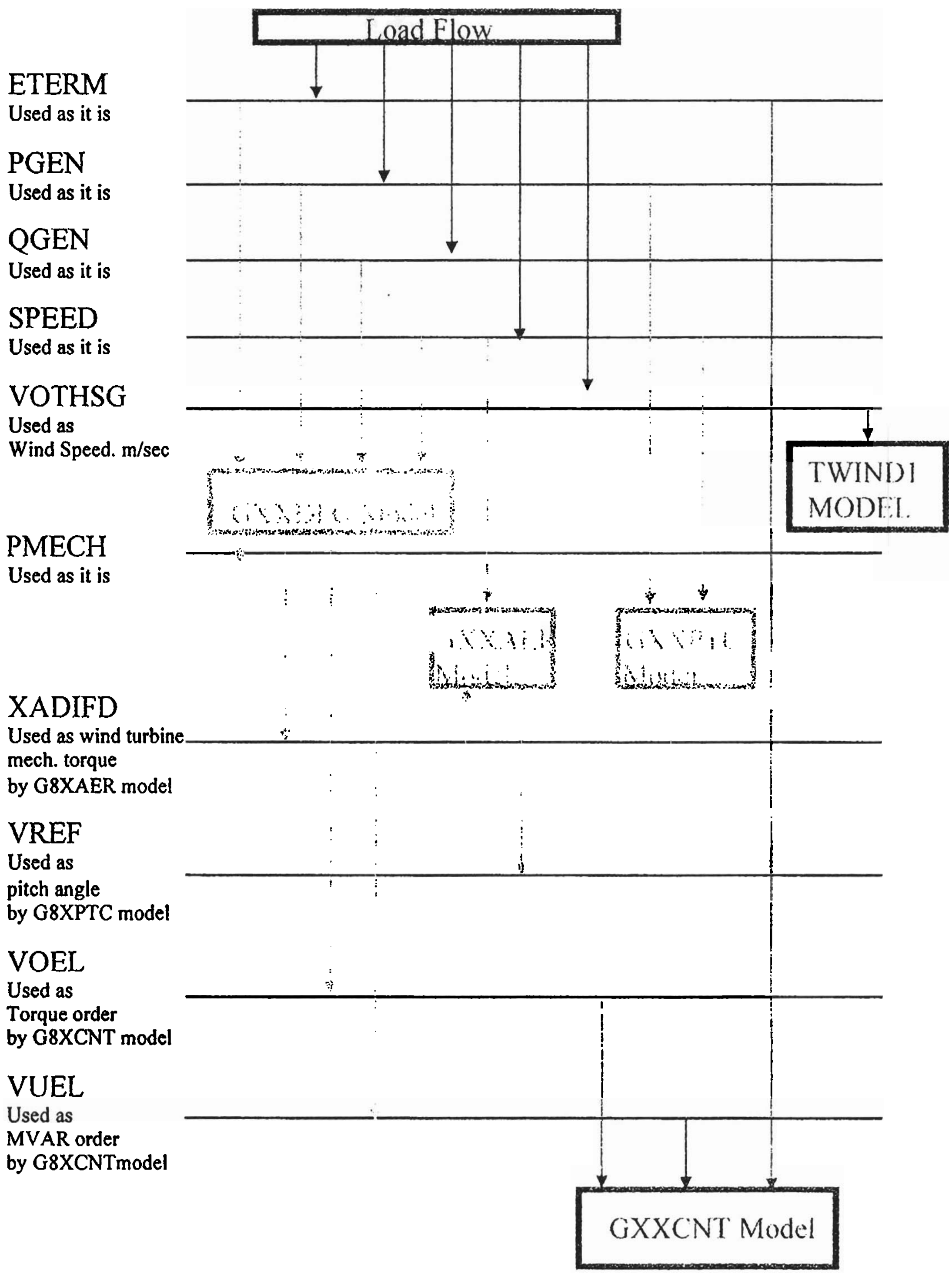
4.23 PESOS / WEIGHTS

Torres IEC II_A / DIBt WZII	**67 m**	**78 m**
Torre (*)	149,9 t	198,7 t
Góndola	70 t	70 t
Rotor	36,4 t	36,4 t
Total	**256,3 t**	**305,1 t**

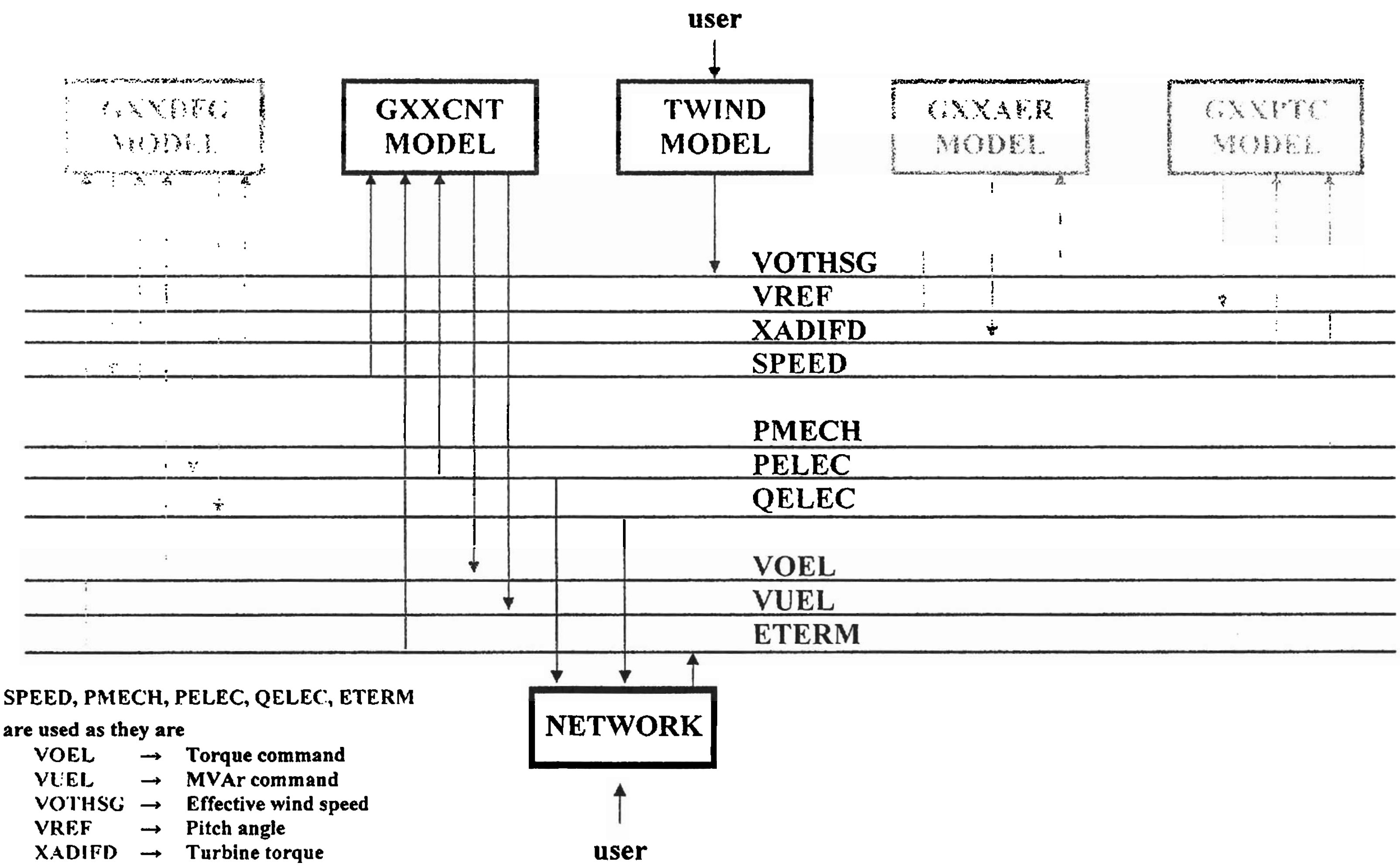
Towers IEC II_A / DIBt WZII	**67 m**	**78 m**
Tower (*)	149,9 t	198,7 t
Nacelle	70 t	70 t
Rotor	36,4 t	36,4 t
Total	**256,3 t**	**305,1 t**

Universidad de Zaragoza
Gisep Group

G5X 0.85 MW and G8X 2.0 MW Software Package Initialization Flow

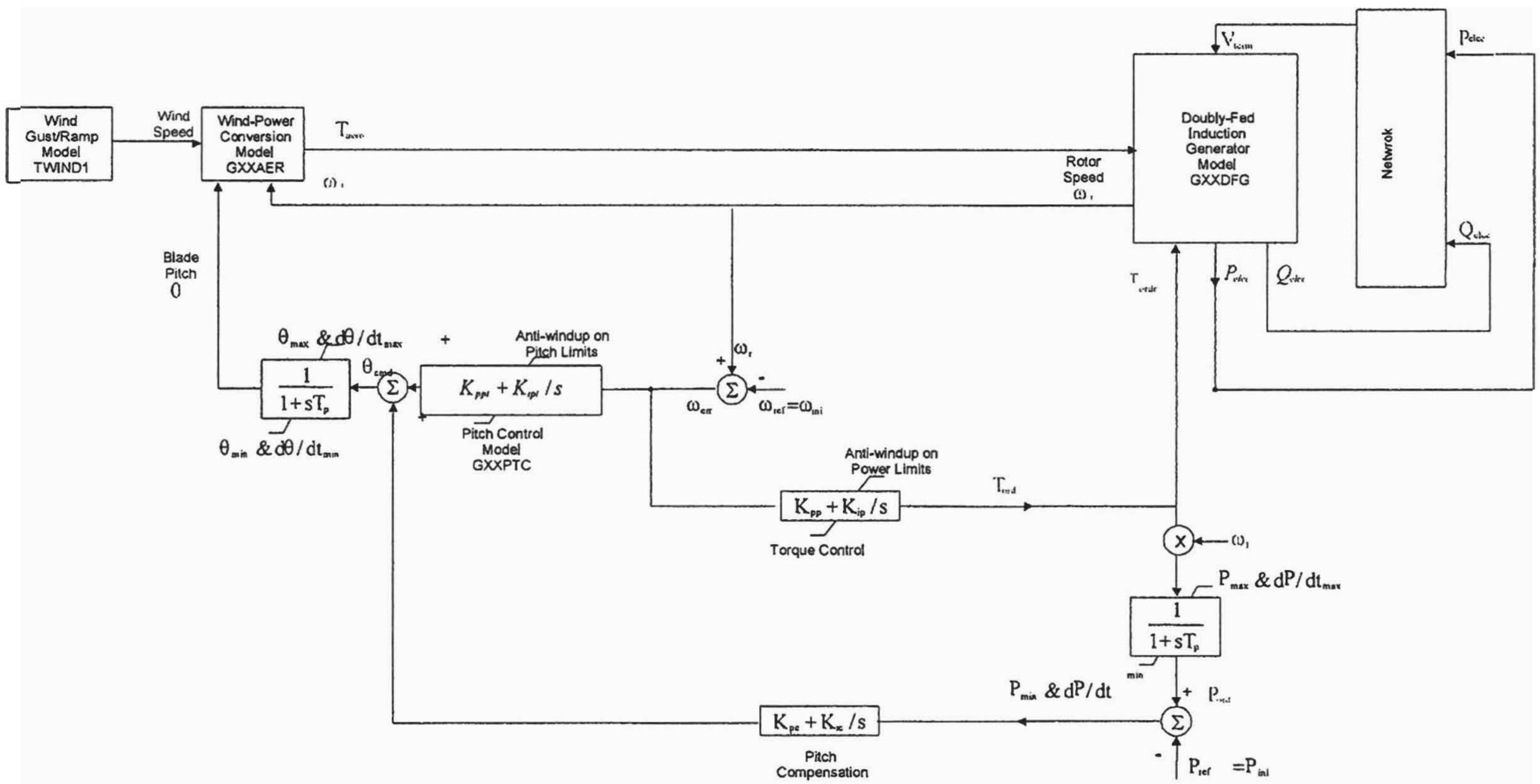


G5X 0.85 MW and G8X 2.0 MW Software Package
Dynamic Simulation Flow



SPEED, PMECH, PELEC, QELEC, ETERM are used as they are

VOEL	→	Torque command
VUEL	→	MVAr command
VOTHSG	→	Effective wind speed
VREF	→	Pitch angle
XADIFD	→	Turbine torque


Wind Gust/Ramp Model TWIND1
Wind Speed
Wind-Power Conversion Model GXXAER
Blade Pitch
Anti-windup on Pitch Limits
Pitch Control Model GXXPTC
Anti-windup on Power Limits
Torque Control
Pitch Compensation
Rotor Speed
Doubly-Fed Induction Generator Model GXXDFG
Netwrok

GXX WIND TURBINE DOUBLY-FED (WOUND ROTOR) INDUCTION GENERATOR

This model is located at system bus	#_______IBUS
Machine	#_______I
This model uses CONs starting with	#_______J
and STATEs starting with	#_______K
and VARs starting with	#_______L
and ICONs starting with	#_______M

CONs	#	Value	Description
J			Ra, Stator resistance, pu
J+1			La, Stator Inductance, pu
J+2			Lm_D, Mutual Inductance Delta connection, pu
J+3			Lm_Y, Mutual Inductance Star connection, pu
J+4			R1, Rotor Resistance, pu
J+5			L1, Rotor Inductance, pu
J+6			cosφ reference

STATEs	#	Description
K		Rotor Speed Deviation, pu
K+1		Transient Flux Linkage, pu λ_{dr}
K+2		Transient Flux Linkage, pu λ_{qr}
K+3		Rotor voltage control integral V_{qr}
K+4		Rotor voltage control integral V_{dr}

VARs	#	Description
L		V_{ds}, Stator Voltage (p.u. on MBASE)
L+1		V_{qs}, Stator Voltage (p.u. on MBASE)
L+2		Rotor resistance (p.u.)
L+3		Rotor Slip (p.u.)
L+4		I_{ds}, Stator Current (p.u. on MBASE)
L+5		I_{qs}, Stator Current (p.u. on MBASE)
L+6		P_r, Rotor Real Power (p.u. on MBASE)
L+7		I_{dr}, Rotor Current (p.u. on MBASE)
L+8		I_{qr}, Rotor Current (p.u. on MBASE)
L+9		Initial Machine internal Angle(rads)
L+10		Q_r, pu
L+11		I_s, Stator current (p.u. on MBASE)
L+12		V_{dr}, Rotor Voltage (p.u. on MBASE)
L+13		V_{qr}, Rotor Voltage (p.u. on MBASE)
L+14		ψ_{ds}, Stator Flux Linkage, pu
L+15		ψ_{qs}, Stator Flux Linkage, pu
L+16		Stator active power (p.u. on MBASE)
L+17		Stator reactive power (p.u. on MBASE)
L+18		Crowbar protection activation time
L+19		Second crowbar protection activation time
L+20		Reactive control activation time
L+21		I_{dref} Reference of I_{qr}
L+22		I_{qref} Reference of I_{dr}
L+23		D-Y Factor
L+24		Lm Mutual Inductance, pu
L+25		Reactive control activation time
L+26		Active power corrector factor, pu
L+27		Reactive power corrector factor,pu

ICONs	#	Description
M		Memory

G8X 2 MW MODEL:

IBUS 'USRMDL' ID 'G8XDFG' 1 1 1 7 5 28 0 CONs from (J) to (J+20) /

G5X 0.85 MW MODEL:

IBUS 'USRMDL' ID 'G5XDFG' 1 1 1 7 5 28 0 CONs from (J) to (J+20) /

Note: input data to a dyre file are to be prepared by the IPLAN program.

GXX WIND TURBINE GENERATOR CONTROL

This model is located at system bus #_______IBUS
Machine #_______I
This model uses CONs starting with #_______J
and STATEs starting with #_______K
and VARs starting with #_______L
and ICONs starting with #_______M

CONs	#	Value	Description
			No constants

STATEs	#	Description
K		Filter in Voltage regulator
K+1		Integrator in Voltage regulator
K+2		Filter in Torque regulator
K+3		Integrator in Torque regulator
K+4		Voltage sensor
K+5		Generator Power (System base)

VARs	#	Description
L		Initial rotor speed deviation, pu
L+1		Initial Q
L+2		Initial value of Power Order
L+3		Initial terminal voltage
L+4		Rotor PI-controller output
L+5		Notch Filter
L+6		Notch Filter
L+7		Notch Filter
L+8		Notch Filter
L+9		Notch Filter
L+10		Notch Filter

ICONs	#	Description
M		Remote bus # for voltage control
M+1		Memory
M+2		1 if power factor control enabled

G8X 2 MW MODEL:

IBUS 'USRMDL' ID 'G8XCNT' 4 0 3 0 6 11 ICONs from (M) to (M+2) /

G5X 0.85 MW MODEL:

IBUS 'USRMDL' ID 'G5XCNT' 4 0 3 0 6 11 ICONs from (M) to (M+2 /

Note: input data to a dyre file are to be prepared by the IPLAN program.

Nonstandard Model Data Sheet
G_VTRP

UNDERVOLTAGE/OVERVOLTAGE GENERATOR RELAY MODEL

This model is located at system bus #______IBUS
Machine #______IM
This model uses CONs starting with #______J
and VARs starting with #______K
and ICONs starting with #______I

CONs	#	Value	Description
J			VL, lower voltage threshold (pu)
J+1			VU, upper voltage threshold (pu)
J+2			TP, relay pickup time (sec)
J+3			TB, breaker time (sec)

VARs	#	Description
L		Timer memory

ICONs	#	Description
I		Bus number where voltage is monitored
I+1		Bus number of generator bus where relay is located
I+2		Delay flag
I+3		Time-out flag
I+4		Timer status

Note: ICONs (I+2) through (I+4) are control flags that are not to be changed by the user

0 'USRMDL' 0 'G_VTRP' 0 2 5 4 0 1 ICON(M) ICON(M+1) 0 0 0 CONs from (J) to (J+3) /

Note: input data to a dyre file are to be prepared by the IPLAN program which is a part of the same PSS/E software package.

Nonstandard Model Data Sheet
G_FRTP

UNDERFREQUENCY/OVERFREQUENCY GENERATOR RELAY MODEL

This model is located at system bus #_______IBUS
Machine #_______IM
This model uses CONs starting with #_______J
and VARs starting with #_______K
and ICONs starting with #_______I

CONs	#	Value	Description
J			FL, lower frequency threshold (pu)
J+1			FU, upper frequency threshold (pu)
J+2			TP, relay pickup time (sec)
J+3			TB, breaker time (sec)

VARs	#	Description
L		Timer memory

ICONs	#	Description
I		Bus number where frequency is monitored
I+1		Bus number of generator bus where relay is located
I+2		Generator ID
I+3		Delay flag
I+4		Time-out flag
I+5		Timer status

Note: ICONs (I+3) through (I+5) are control flags that are not to be changed by the user

0 'USRMDL' 0 'G_FRTP' 0 2 6 4 0 1 ICON(I) ICON(I+1) 'ICON(I+2)' 0 0 0 CONs from (J) to (J+3) /

Note: input data to a dyre file are to be prepared by the IPLAN program which is a part of the same PSS/E software package.

TWO-MASS SHAFT

This model is located at system bus #_______IBUS
Machine #_______I
This model uses CONs starting with #_______J
and STATEs starting with #_______K
and VARs starting with #_______L
and ICONs starting with #_______M

CONs	#	Value	Description
			No constants

STATEs	#	Description
K		Shaft twist angle, rad.
K+1		Turbine rotor speed deviation, pu

VARs	#	Description
L		Initial generator mechanical torque, pu
L+1		Initial generator rotor speed deviation, pu
L+2		Initial turbine rotor mechanical torque, pu

ICONs	#	Description
M		Machine bus #
M+1		Machine ID
M+2		Memory

0 'USRMDL' 0 'GTSHAF' 8 0 3 0 2 3 ICON(M) 'ICON(M+1)' 0 /

Note: input data to a dyre file are to be prepared by the IPLAN program.

WIND GUST AND RAMP

This model is located at system bus #______IBUS
Machine #______I
This model uses CONs starting with #______J
and VARs starting with #______L
and ICONs starting with #______M

CONs	#	Value	Description
J			Vwb, Base wind speed from load flow, m/sec
J+1			T1g, Gust start time, sec.
J+2			Tg, Gust duration, sec.
J+3			MAXG, Gust peak over Vwb, m/sec
J+4			T1r, Ramp start time, sec.
J+5			T2r, Ramp Max time, sec.
J+6			MAXR, Ramp maximum over Vwb, m/sec.

VARs	#	Description
L		Vw, Actual wind speed, m/sec
L+1		Vwg, Gust component, m/sec
L+2		Vwr, Ramp component, m/sec

ICONs	#	Description
M		Generator bus #
M+1		Generator ID

0 'USRMDL' 0 'GTWIND' 8 0 2 7 0 3 ICON(M) 'ICON(M+1)' CONs from (J) to (J+6) /

Note: input data to a dyre file are to be prepared by the IPLAN program.

GXX WIND TURBINE AERODYNAMICS

This model is located at system bus	#______IBUS
Machine	#______I
This model uses CONs starting with	#______J
and VARs starting with	#______L
and ICONs starting with	#______M

CONs	#	Value	Description
J			Vwinit, Initial eff. wind speed from load flow, m/sec
J+1			Lambda_Max, Max. Lambda from Cp curves
J+2			Lambda_Min, Min. Lambda from Cp curves
J+3			PITCH_MAX, Upper limit of pitch angle
J+4			PITCH_MIN, Lower Limit of pitch angle
J+5			Ta, time constant of the conversion smoothing

STATEs	#	Description
K		Conversion smoothing lag

V		Description
		K_ADJ from initialization
		PITCH)INIT, Initial pitch angle
L+2		Lambda, current lambda
L+3		Cp, Current Cp

ICONs	#	Description
M		Machine Bus #
M+1		Machine ID
M+2		Memory

G8X 2 MW MODEL:

0 'USRMDL' 0 'G8XAER' 8 0 3 6 1 4 ICON(M) 'ICON(M+1)' 0 CONs from (J) to (J+5) /

G5X 0.85 MW MODEL:

0 'USRMDL' 0 'G5XAER' 8 0 3 6 1 4 ICON(M) 'ICON(M+1)' 0 CONs from (J) to (J+5) /

Note: input data to a dyre file are to be prepared by the IPLAN program.

GXX PITCH CONTROL

This model is located at system bus	#______IBUS
Machine	#______I
This model uses CONs starting with	#______J
and STATEs starting with	#______K
and VARs starting with	#______L
and ICONs starting with	#______M

CONs	#	Value	Description
			No constants

STATEs	#	Description
K		Output Lag
K+1		Pitch Control Integral 1
K+2		Pitch.Control Integral 2
K+3		Pitch compensator
K+4		Generator Power (System base)

VARs	#	Description
L		Initial machine rotor speed, pu
L+1		Initial pitch angle, degrees
L+2		Initial power reference
L+3		Pitch compensator
L+4		Notch filter
L+5		Notch filter
L+6		Notch filter
L+7		Notch filter
L+8		Notch filter
L+9		Notch filter
L+10		Wind speed (m/s)

ICONs	#	Description
M		Machine bus #
M+1		Machine ID
M+2		Memory

G8X 2 MW MODEL:

0 'USRMDL' 0 'G8XPTC' 8 0 3 0 5 11 ICON(M) 'ICON(M+1)' 0 /

G5X 0.85 MW MODEL:

0 'USRMDL' 0 'G5XPTC' 8 0 3 0 5 11 ICON(M) 'ICON(M+1)' 0 /

Note: input data to a dyre file are to be prepared by the IPLAN program.

Appendix C
Distribution Summaries

Lempster Wind Farm Stability Testing
2008 SUMMER LIGHT LOAD WITH FITZWILLIAMS OUT OF SERVICE
W/ 2004L DYN OF NERC/MMWG 2003 SERIES

GENERATION

---MAINE---

#		V	MW	MX	PMAX	#		V	MW	MX	PMAX	#		V	MW	MX	PMAX
70060	MIS GT1	1.047	179	55	179	70061	MIS GT2	1.047	179	55	179	70062	MIS ST	1.047	191	55	191
70426	CHAMP G2	1.002	0	0	21	70424	CHAMP G3	1.029	72	20*	72	70389	BUCKS G4	1.004	0	0	191
70067	U P 5 PF	1.027	0	0	25	70070	U P 6 PP	1.023	0	0*	25	70069	WENFD PH	1.015	0	0	20
70372	SEA STRN	0.972	0	0	47	70360	WYMAN #1	0.979	27	2	27	70361	WYMAN #2	0.980	27	2	27
70362	WYMAN #3	0.974	0	0	25	70363	WILLM #1	1.035	8	1*	8	70364	WILLM #2	1.039	6	1*	7
70356	HARRIS#1	0.965	17	2	17	70357	HARRIS#2	0.966	37	3	37	70358	HARRIS#3	0.957	0	0	36
70381	RPA CG1	0.986	0	0	179	70382	RPA SG2	0.994	0	0	93	70377	AEC G1	1.057	55	19	55
70378	AEC G2	1.020	0	0	55	70379	AEC G3	1.020	0	0	55	70370	AEI GEN	1.013	0	0	39
70365	WF WY #1	0.989	0	0	57	70366	WF WY #2	0.985	0	0	57	70367	WF WY #3	0.991	0	0	125
70368	WF WY #4	0.995	0	0	636	70386	WBK G1	1.037	185	72	185	70387	WBK G2	1.037	185	72	185
70388	WBK G3	1.036	196	72	196	70140	CAPE	1.037	0	0*	24	70420	J/MILL A	1.003	35	20*	35
70421	J/MILL B	1.004	20	27	35	70432	J/MILL C	0.995	32	16*	40	70425	MEADCOGN	0.982	93	22*	110
70422	WARRN G1	1.000	51	4	51	70423	WARRN G2	0.996	0	0	62	70129	LOUDEN	1.028	37	0*	37
70160	W.BUXTON	1.027	37	0*	37	70223	TOPSM GN	1.040	0	0*	49	70118	GULF ISL	1.027	0	0*	34
70104	LEW LWR	1.027	30	0	30	70222	TOPSHAM	1.040	0	0	20	70371	GORBELL	0.996	0	0	16
70177	LWSTN GN	1.027	0	0*	17	70147	LAKEWOOD	1.005	0	0	15	70410	HYDRO KN	1.033	0	0*	17
70330	WINSLOW	1.033	13	0*	22												

---NEW HAMPSHIRE / VERMONT---

#		V	MW	MX	PMAX	#		V	MW	MX	PMAX	#		V	MW	MX	PMAX
72869	SBRK G1	1.007	1315	310	1318	72868	NWNGT G1	1.009	422	112	422	72702	CONEDG1	0.983	0	0	169
72703	CONEDG2	0.983	0	0	169	72704	CONEDG3	0.983	0	0	195	72866	MERMK G1	1.020	113	6	113
72867	MERMK G2	1.020	320	17	320	72870	SCHILLER	1.013	48	14	48	72871	SCHILLER	1.013	50	14	50
72872	SCHILLER	1.013	48	14	48	71950	GRANRDG1	1.032	0	0	280	71951	GRANRDG2	1.027	0	0	280
72701	AESSTG	1.035	0	0	250	71857	COMRF G1	1.007	0	0	41	71858	COMRF G2	1.007	0	0	41
71859	COMRF G3	1.007	0	0	41	71860	COMRF G4	1.007	0	0	41	71861	MOORE G1	0.998	0	0	48
71862	MOORE G2	1.007	0	0	48	71863	MOORE G3	0.993	0	0	48	71864	MOORE G4	1.005	0	0	48
72756	TAMW PF	1.021	20	0*	20	72918	L NATION	1.033	13	0*	13	72843	WHFDA PF	1.029	14	0*	14
72847	PINET PF	1.029	15	0*	15	72760	POTOK PH	1.030	10	1	10	72758	SMITH HY	1.029	16	0*	16
72848	JAMES	0.000	0	0*	0	70705	VTYAK G	0.973	667	150*	667						

---WESTERN MASSACHUSETTS---

#		V	MW	MX	PMAX	#		V	MW	MX	PMAX	#		V	MW	MX	PMAX
72512	BRSWP G1	0.935	-280	30	294	72513	BRSWP G2	0.935	-280	30	294	73083	NRTHFD12	0.970	-500	53	540
73084	NRTHFD34	0.979	-250	53	540	72243	MILLENCT	1.004	0	0	273	72244	MILLENST	1.004	0	0	117
72930	STNYBK1A	1.020	0	0	65	72931	STNYBK1B	1.020	0	0	65	72932	STNYBK1C	1.020	0	0	65
72933	STNYBK 1	1.020	0	0	87	72934	STNYBK2A	1.020	0	0	65	72935	STNYBK2B	1.020	0	0	65
72986	BERKPWR	1.019	0	0	305	73069	MAPR1 PF	0.984	0	0	106	73070	MAPR2 PF	0.984	0	0	106
73071	MAPR3 PF	0.984	0	0	95	73072	ALT12 PF	1.002	0	0	65	73073	ALT34 PF	1.002	0	0	81
73080	WSPFLD 3	0.996	0	0	107	73085	MT.TOM	0.999	0	0	146						

---NEMA / BOSTON---

#		V	MW	MX	PMAX	#		V	MW	MX	PMAX	#		V	MW	MX	PMAX
71060	MYST G4	1.009	0	0	133	71061	MYST 5G	1.020	0	0	129	71062	MYST G6	1.020	0	0	136
71063	MYST G7	0.987	565	-150	565	71067	MYS8 GTS	1.014	0	0	554	71068	MYS8 ST	1.014	0	0	312
71069	MYS9 GTS	1.019	0	0	554	71070	MYS9 ST	0.998	0	0	312	71073	N.BOST 1	1.002	0	0	380
71074	N.BOST 2	0.994	0	0	380	71946	SALEM G1	1.009	0	0	81	71947	SALEM G2	1.010	0	0	78
71948	SALEM G3	1.005	0	0	143	71949	SALEM G4	1.005	0	0	360						

---SEMA, SEMA / RHODE ISLAND---

#		V	MW	MX	PMAX	#		V	MW	MX	PMAX	#		V	MW	MX	PMAX
72372	BP #1 GN	0.980	238	19	241	72375	BP #2 GN	0.982	138	19	241	72370	BP #3 GN	0.974	569	-130	605
72371	BP #4 GN	0.995	0	0	425	71743	TAU 9A,8	0.916	0	0	55	71744	TAUNT G9	0.992	0	0	85
72669	TIVER G1	1.025	0	0	189	72670	TIVER G2	1.025	0	0	92	71394	BELLWEST	0.000	0	0	0
71316	DPA PF	1.009	65	-10	68	71521	SOM G5	1.006	0	0	69	71522	SOM G6	0.952	0	0	105
71523	SOMST JT	0.995	0	0	34	72661	MANCH09A	0.978	0	0	119	72662	MANCH10A	0.978	0	0	119
72663	MANCH11A	0.978	0	0	119	72666	FRSQ SC1	0.992	0	0	46	72667	FRSQ SC2	0.993	0	0	46
72668	FRSQ SC3	0.993	0	0	46	71531	OSP1 PF	1.003	0	0	77	71532	OSP2 PF	1.003	0	0	77
71533	OSP3 PF	1.003	0	0	108	71534	OSP4 PF	1.003	0	0	77	71535	OSP5 PF	1.003	0	0	77
71536	OSP6 PF	1.003	0	0	108	71084	NEA GTPF	0.997	111	0	111	71085	NEA GTPF	0.997	110	0	110
71086	NEA STPF	1.000	80	0	80	71251	CANAL G1	0.978	0	0	566	71252	CANAL G2	1.002	576	76	576
71094	PLGRM G1	1.016	734	55	734	72373	MPLP 1PF	1.025	0	0	109	72374	MPLP 2PF	1.025	0	0	45
71095	ANPBLCK1	1.027	0	0	9999	71096	ANPBLCK2	1.027	0	0	9999	72377	BELL #1	1.026	0	0	290
72378	BELL #2	1.026	0	0	290	72671	RISE G1	0.997	0	0	176	72672	RISE G2	0.997	0	0	176
72673	RISE G3	0.997	0	0	196	71092	EDG ST	1.043	0	0	311	71093	EDG GTS	1.043	0	0	552

---CONNECTICUT---

#		V	MW	MX	PMAX	#		V	MW	MX	PMAX	#		V	MW	MX	PMAX
73501	KLEENGT1	0.977	0	0	187	73502	KLEENGT2	0.977	0	0	187	73503	KLEEN ST	0.977	0	0	358
73538	AESTH PF	0.972	0	0	180	73549	SMD1112J	1.052	0	0	93	73550	SMD1314J	1.052	0	0	93
73551	NORHAR#1	0.983	0	0	162	73552	NORHAR#2	0.973	168	-16	168	73553	DEVON#7	0.976	0	0	107
73554	DEVON#8	0.976	0	0	107	73555	MIDDTN#2	0.973	0	0	117	73556	MIDDTN#3	0.965	0	0	233
73557	MIDDTN#4	0.973	0	0	400	73558	MONTV#5	0.970	0	0	81	73559	MONTV#6	0.981	0	0	402
73562	MILL#2	0.997	940	175	940	73563	MILL#3	0.997	1260	232	1260	73565	LAKERD#1	1.015	305	81	310
73566	LAKERD#2	1.015	305	81	310	73567	LAKERD#3	0.986	0	0	310	73570	DEVGAS11	1.018	0	0	42
73571	DEVGAS12	1.018	0	0	42	73572	DEVGAS13	1.018	0	0	42	73573	DEVGAS14	1.018	0	0	42
73574	MILFD#1	0.984	280	-5	280	73575	MILFD#2	0.993	0	0	280	73588	MERIDEN1	0.987	0	0	172
73589	MERIDEN2	0.987	0	0	172	73590	MERIDEN3	0.987	0	0	196	73594	WALL LV1	0.999	0	0	102
73595	WALL LV2	0.999	0	0	102	73596	WALL LV3	0.999	0	0	51	73647	BPTHBR#2	0.936	0	0	170
73648	BPTHBR#3	0.957	0	0	375	73651	NH HARBR	0.955	447	0	447	73654	BE 10 ST	0.949	180	-5	180
73652	BE 11	0.955	170	-5	170	73653	BE 12	0.955	170	-5	170						

-GENERATION TOTALS---

	MW	MX		MW	MX		MW	MX
MIS	549	165	BUCKSPORT	72	20	WYMAN	54	4
HARRIS	54	5	WILLIAMS	14	2	RUMFORD PWR	0	0
AEC	55	19	WYMAN	0	0	WESTBROOK	565	215
COMERFORD	0	0	MOORE	0	0	SEABROOK	1315	310
MERRIMACK	433	23	AES	0	0	SCHILLER	145	41
NEWINGTON	422	112	CONED-NEW	0	0	MYSTIC	565	-150
NEWBOSTON	0	0	SALEMHBR	0	0	MASSPWRR	0	0
ANPBLK	0	0	ANPBELL	0	0	BRAYTONPT	945	-92
MANCHSTRST	0	0	OSP	0	0	NEA	301	0
CANAL	576	76	PILGRIM	734	55	HOPE	0	0
EDGER	0	0	DGHTN	0	0	VTYANKEE	667	150
BEARSWAMP	-560	61	NORTHFIELD	-750	105	STONYBROOK	0	0
MASSPWRR	0	0	BERKSHIRE	0	0	MILLSTONE	2200	408
LAKERD	610	162	S MEADOW	0	0	MIDDLETOWN	0	0
MONTVILLE	0	0	NORWALK HBR	168	-16	Meriden	0	0
NHHARBOR	447	0	BRIDGEPORT	520	-14	DEVON	0	0
MLFDPWR	280	-5	BPT_RESCO	0	0	NORWALK	168	-16
COS_COB	0	0	CT	3744	381	SWCT	1054	-21
NOR-STAM-PLA	168	-16						

CAPACITORS

#		V	MVAR	MAX	#		V	MVAR	MAX	#		V	MVAR	MAX
70001	CHESTER	0.995	27	450.0	70024	ORR CAP1	1.045	73	67.0	70025	ORR CAP2	1.045	73	67.0
70026	ORR CAP3	1.045	73	67.0	70036	MAX CAP1	1.037	54	50.0	70037	MAX CAP2	1.037	54	50.0
70043	MAS CAP1	1.038	54	50.0	70044	MAS CAP2	1.038	54	50.0	70050	SUR CAP1	1.032	0	50.0
70051	SUR CAP2	1.032	0	50.0	70052	SUR CAP3	1.032	0	50.0	70056	SGR CAP1	1.030	0	50.0
70057	SGR CAP2	1.030	0	50.0	70162	SANFORD	1.025	0	31.0	70136	CROWLEYS	1.028	0	50.0
72712	BEEBE	1.018	0	20.0	72738	OCEAN ER	1.025	0	25.0	72739	OCEAN UH	1.038	0	25.0
72770	3 RIV 2	1.026	0	61.0	72732	MADBURY	1.030	0	48.8	72717	CHSNT HL	1.046	0	50.0
72734	MERRMACK	1.035	0	72.0	71996	TEWKSBRY	1.023	0	126.0	72102	PRATTS J	1.025	66	63.0
72265	NBORO RD	1.024	0	54.0	72096	MILLBURY	1.034	135	63.0	70507	GEORG TP	1.005	0	24.8
70546	BERLIN	1.009	0	24.8	70519	MIDDLBRY	1.018	0	22.9	70512	ESX B-2	1.010	50	99.2
70529	WILLISTN	1.010	0	24.8	70521	RUTLAND	1.022	0	24.8	70508	SANDB115	1.011	0	24.8
70504	SBRAT 69	1.034	0	50.0	70547	HIGHGATE	1.005	0	140.0	70870	FRMNGHAM	1.035	0	53.6
70888	BAKER ST	1.044	0	107.2	70806	LEXINGTN	1.034	0	53.6	73177	MYSTICCT	1.005	0	53.6
70836	K-ST-1	1.049	0	53.6	70837	K-ST-2	1.047	-88	53.6	70893	NEEDHAM	1.042	0	53.6
72569	FRSO	1.021	0	63.0	72565	KENT CO	1.022	66	63.0	72962	AGAWM PF	1.020	0	104.8
73243	BERLIN	1.012	0	132.0	73262	CANTON	1.009	0	50.4	73267	DARIEN	1.032	0	39.6
73668	E.SHORE	1.025	0	84.0	73260	FRKLN DR	1.012	0	37.8	73202	FROST BR	1.021	0	262.0
73168	GLNBROOK	1.035	0	348.0	73242	MANCHSTR	1.008	53	3.0	73210	MONTVLLE	1.014	0	104.8
73177	MYSTICCT	1.005	0	50.4	73244	N.BLMFLD	1.011	0	157.2	73671	NO.HAVEN	1.025	0	42.0
73172	NORWALK	1.030	0	0.0	73170	PLUMTREE	1.010	0	92.2	73190	ROCK RIV	1.013	0	25.2
73672	SACKETT	1.024	0	42.0	73154	SGTN B	1.026	55	314.4	73165	STONY HL	1.012	0	100.8

REACTORS

#		V	MVAR	MAX	#		V	MVAR	MAX	#		V	MVAR	MAX
87004	KESWICK	1.026	0	37.5	70001	CHESTER	0.995	-27	125.0	70027	ORRINGTN	1.045	0	80.0
70125	SUROWIEC	1.032	0	80.0	72766	SCOBIE1	1.037	0	40.0	72746	SCOBIE2	1.037	0	40.0
71786	SANDY PD	1.031	-181	480.0	70837	K-ST-2	1.047	88	80.0	70799	WOBURN	1.020	83	240.0
70818	MYSTC MA	1.046	84	80.0	70815	N.CAMB	1.042	174	160.0	73132	PLUMREAC	1.009	153	150.0
73135	NOROH	1.009	305	300.0										

INTERFACE FLOWS

NB-NE	702	-5*	ORRING-SOUTH	1098	6	SUROWIEC-SOUTH	1024	-132
MEYANKEE-SOUTH	821	-170	MAINE-NH	1509	-89	NNE-SCOBIE+394	2904	80
SEABROOK-SOUTH	1549	122	NORTH-SOUTH	3625	-53	CMFD/MOORE-SO	54	-28
SNDYPOND-SOUTH	977	-43	CONN-IMPORT	-236	57	SWCT	488	-3
NE-NRWLK-STFD	381	-95	BOSTON IMPORT	1771	-654	SEMA/RI EXPORT	961	-668
SEMA EXPORT	231	-669	EAST-WEST	1748	-19	NY-NE 2200(170	-188	92
NW VT	99	-2	PLAT PAR	109	-7	BLISS PAR	0	-3
UPNY-CONED	2064	-30	CENTRAL_EAST	2156	-103	CROSS-SOUND	-346	92
CONN-EXPORT	846	-74	LILCO	0	-44			

HVDC TRANSFERS FROM H-Q

CHAT-1 = 0		HIGHGATE = 150
MADAWASK = 0	PHII-P1 = 0	PHII-P2 = 0
EEL = 0		

BUS VOLTAGES

			V	LMT				V	LMT				V	LMT
70001	CHESTER	345	343.		70002	ORRINGTN	345	347.		70003	MAXCYS	345	347.	
70086	ME YANK	345	350.		70087	SUROWIEC	345	350.		70090	BUXTON	345	351.	
70089	S.GORHAM	345	353.		70088	WYMAN	345	353.		72754	3 RIVERS	115	118.	
70144	BOLT HL	115	119.		72745	SCHILLER	115	119.		72732	MADBURY	115	118.	
72691	DRFLD345	345	353.		72692	NWGTN345	345	357.		72694	SEBRK345	345	357.	
71789	TEWKS	345	357.		71786	SANDY PD	345	356.		71801	BRAYTN P	345	352.	
71336	SHERMAN	345	355.		70783	PILGRIM	345	355.		71193	CANAL	345	355.	
70818	MYSTC MA	115	120.		72926	NRTHFLD	345	351.		73111	NOBLMFLD	345	354.	
73108	CARD	345	356.		73119	LAKEROAD	345	357.		73109	MONTVILE	345	354.	
73110	MILLSTNE	345	357.		73116	MIDDLTWN	345	354.		73107	SCOVL RK	345	354.	
73663	E.SHORE	345	355.		73106	SOUTHGTN	345	349.		73105	LONG MTN	345	349.	
73115	PLUMTREE	345	348.		73293	NORWALK	345	348.		71801	BRAYTN P	345	352.	
71326	BRIDGWTR	345	354.		71336	SHERMAN	345	355.		71337	WFARNUM	345	354.	
70780	WWALP345	345	354.		70783	PILGRIM	345	355.		71193	CANAL	345	355.	
71133	CARVER	345	355.		73244	N.BLMFLD	115	116.		73242	MANCHSTR	115	116.	
73215	CARD	115	115.		73241	MIDDLTWN	115	117.		72590	TIVERTON	115	118.	
71377	SOMERSET	115	117.		71378	BELLROCK	115	118.		71347	BRIDGWTR	115	118.	
71202	BRNSTBL	115	119.		72569	FRSQ	115	117.		73668	E.SHORE	115	118.	
73195	DEVON	115	117.		73125	MILFORD	115	117.		73700	PEQUONIC	115	117.	
73172	NORWALK	115	119.		73171	NWLK HAR	115	119.		73168	GLNBROOK	115	119.	
73198	SOUTHGTN	115	118.		73202	FROST BR	115	117.		73170	PLUMTREE	115	116.	
73153	BRANFORD	115	118.	H	73230	HADDAM	115	118.						

AREA/ZONE TOTALS

NEPOOL GEN	11831	NEPOOL_LOAD	12110	NEPOOL_LOSS	368
NEPOOL_INT	-667				

Lempster Wind Farm Stability Testing
2008 SUMMER LIGHT LOAD WITH FITZWILLIAMS IN SERVICE
W/ 2004L DYN OF NERC/MMWG 2003 SERIES

GENERATION

---MAINE---

#	V	MW	MX	PMAX	#	V	MW	MX	PMAX	#	V	MW	MX	PMAX
70060 MIS GT1	1.047	179	55	179	70061 MIS GT2	1.047	179	55	179	70062 MIS ST	1.047	191	55	191
70426 CHAMP G2	1.002	0	0	21	70424 CHAMP G3	1.029	72	20*	72	70389 BUCKS G4	1.004	0	0	191
70067 U P 5 PF	1.027	0	0	25	70070 U P 6 PF	1.023	0	0*	25	70069 WENFD PH	1.015	0	0	20
70372 SEA STRN	0.972	0	0	47	70360 WYMAN #1	0.979	27	2	27	70361 WYMAN #2	0.980	27	2	27
70362 WYMAN #3	0.974	0	0	25	70363 WILLM #1	1.035	8	1*	8	70364 WILLM #2	1.039	6	1*	7
70356 HARRIS#1	0.965	17	2	17	70357 HARRIS#2	0.966	37	3	37	70358 HARRIS#3	0.957	0	0	36
70381 RPA CG1	0.986	0	0	179	70382 RPA SG2	0.994	0	0	93	70377 AEC G1	1.057	55	19	55
70378 AEC G2	1.020	0	0	55	70379 AEC G3	1.020	0	0	55	70370 AEI GEN	1.013	0	0	39
70365 WF WY #1	0.989	0	0	57	70366 WF WY #2	0.985	0	0	57	70367 WF WY #3	0.991	0	0	125
70368 WF WY #4	0.995	0	0	636	70386 WBK G1	1.037	185	72	185	70387 WBK G2	1.037	185	72	185
70388 WBK G3	1.036	196	72	196	70140 CAPE	1.037	0	0*	24	70420 J/MILL A	1.003	35	20*	35
70421 J/MILL B	1.004	20	27	35	70432 J/MILL C	0.995	32	16*	40	70425 MEADCOGN	0.982	93	22*	110
70422 WARRN G1	1.000	51	4	51	70423 WARRN G2	0.996	0	0	62	70129 LOUDEN	1.028	37	0*	37
70160 W.BUXTON	1.027	37	0*	37	70223 TOPSM GN	1.040	0	0*	49	70118 GULF ISL	1.027	0	0*	34
70104 LEW LWR	1.027	30	0	30	70222 TOPSHAM	1.040	0	0	20	70371 GORBELL	0.996	0	0	16
70177 LWSTN GN	1.027	0	0*	17	70147 LAKEWOOD	1.005	0	0	15	70410 HYDRO KN	1.033	0	0*	17
70330 WINSLOW	1.033	13	0*	22										

---NEW HAMPSHIRE / VERMONT---

#	V	MW	MX	PMAX	#	V	MW	MX	PMAX	#	V	MW	MX	PMAX
72869 SBRK G1	1.007	1315	307	1318	72868 NWNGT G1	1.009	422	112	422	72702 CONEDG1	0.983	0	0	169
72703 CONEDG2	0.983	0	0	169	72704 CONEDG3	0.983	0	0	195	72866 MERMK G1	1.019	113	6	113
72867 MERMK G2	1.020	320	16	320	72870 SCHILLER	1.013	48	14	48	72871 SCHILLER	1.013	50	14	50
72872 SCHILLER	1.013	48	14	48	71950 GRANRDG1	1.033	0	0	280	71951 GRANRDG2	1.027	0	0	280
72701 AESSTG	1.035	0	0	250	71857 COMRF G1	1.007	0	0	41	71858 COMRF G2	1.007	0	0	41
71859 COMRF G3	1.007	0	0	41	71860 COMRF G4	1.007	0	0	41	71861 MOORE G1	0.998	0	0	48
71862 MOORE G2	1.007	0	0	48	71863 MOORE G3	0.994	0	0	48	71864 MOORE G4	1.005	0	0	48
72756 TAMW PF	1.023	20	0*	20	72918 L NATION	1.033	13	0*	13	72843 WHFDA PF	1.029	14	0*	14
72847 PINET PF	1.029	15	0*	15	72760 POTOK PH	1.030	10	1	10	72758 SMITH HY	1.029	16	0*	16
72848 JAMES	0.000	0	0*	0	70705 VTYAK G	0.973	667	150*	667					

---WESTERN MASSACHUSETTS---

#	V	MW	MX	PMAX	#	V	MW	MX	PMAX	#	V	MW	MX	PMAX
72512 BRSWP G1	0.935	-280	31	294	72513 BRSWP G2	0.935	-280	31	294	73083 NRTHFD12	0.969	-500	52	540
73084 NRTHFD34	0.979	-250	52	540	72243 MILLENCT	1.004	0	0	273	72244 MILLENST	1.004	0	0	117
72930 STNYBK1A	1.020	0	0	65	72931 STNYBK1B	1.020	0	0	65	72932 STNYBK1C	1.020	0	0	65
72933 STNYBK 1	1.020	0	0	87	72934 STNYBK2A	1.020	0	0	65	72935 STNYBK2B	1.020	0	0	65
72986 BERKPWR	1.019	0	0	305	73069 MAPR1 PF	0.984	0	0	106	73070 MAPR2 PF	0.984	0	0	106
73071 MAPR3 PF	0.984	0	0	95	73072 ALT12 PF	1.002	0	0	65	73073 ALT34 PF	1.002	0	0	81
73080 WSPFLD 3	0.996	0	0	107	73085 MT.TOM	0.999	0	0	146					

---NEMA / BOSTON---

#	V	MW	MX	PMAX	#	V	MW	MX	PMAX	#	V	MW	MX	PMAX
71060 MYST G4	1.009	0	0	133	71061 MYST 5G	1.020	0	0	129	71062 MYST G6	1.020	0	0	136
71063 MYST G7	0.988	565	-150	565	71067 MYS8 GTS	1.014	0	0	554	71068 MYS8 ST	1.014	0	0	312
71069 MYS9 GTS	1.019	0	0	554	71070 MYS9 ST	0.998	0	0	312	71073 N.BOST 1	1.002	0	0	380
71074 N.BOST 2	0.994	0	0	380	71946 SALEM G1	1.010	0	0	81	71947 SALEM G2	1.010	0	0	78
71948 SALEM G3	1.006	0	0	143	71949 SALEM G4	1.006	0	0	360					

---SEMA, SEMA / RHODE ISLAND---

#	V	MW	MX	PMAX	#	V	MW	MX	PMAX	#	V	MW	MX	PMAX
72372 BP #1 GN	0.980	238	19	241	72375 BP #2 GN	0.982	138	19	241	72370 BP #3 GN	0.974	569	-130	605
72371 BP #4 GN	0.995	0	0	425	71743 TAU 9A,8	0.916	0	0	55	71744 TAUNT G9	0.992	0	0	85
72669 TIVER G1	1.025	0	0	189	72670 TIVER G2	1.025	0	0	92	71394 BELLWEST	0.000	0	0	0
71316 DPA PF	1.009	65	-10	68	71521 SOM G5	1.006	0	0	69	71522 SOM G6	0.952	0	0	105
71523 SOMST JT	0.995	0	0	34	72661 MANCH09A	0.978	0	0	119	72662 MANCH10A	0.978	0	0	119
72663 MANCH11A	0.978	0	0	119	72666 FRSQ SC1	0.992	0	0	46	72667 FRSQ SC2	0.993	0	0	46
72668 FRSQ SC3	0.993	0	0	46	71531 OSP1 PF	1.003	0	0	77	71532 OSP2 PF	1.003	0	0	77
71533 OSP3 PF	1.003	0	0	108	71534 OSP4 PF	1.003	0	0	77	71535 OSP5 PF	1.003	0	0	77
71536 OSP6 PF	1.003	0	0	108	71084 NEA GTPF	0.997	111	0	111	71085 NEA GTPF	0.997	110	0	110
71086 NEA STPF	1.000	80	0	80	71251 CANAL G1	0.978	0	0	566	71252 CANAL G2	1.002	576	76	576
71094 PLGRM G1	1.016	734	54	734	72373 MPLP 1PF	1.025	0	0	109	72374 MPLP 2PF	1.025	0	0	45
71095 ANPBLCK1	1.027	0	0	9999	71096 ANPBLCK2	1.027	0	0	9999	72377 BELL #1	1.026	0	0	290
72378 BELL #2	1.026	0	0	290	72671 RISE G1	0.997	0	0	176	72672 RISE G2	0.997	0	0	176
72673 RISE G3	0.997	0	0	196	71092 EDG ST	1.043	0	0	311	71093 EDG GTS	1.043	0	0	552

---CONNECTICUT---

#	V	MW	MX	PMAX	#	V	MW	MX	PMAX	#	V	MW	MX	PMAX
73501 KLEENGT1	0.977	0	0	187	73502 KLEENGT2	0.977	0	0	187	73503 KLEEN ST	0.977	0	0	358
73538 AESTH PF	0.971	0	0	180	73549 SMD1112J	1.052	0	0	93	73550 SMD1314J	1.052	0	0	93
73551 NORHAR#1	0.983	0	0	162	73552 NORHAR#2	0.973	168	-16	168	73553 DEVON#7	0.976	0	0	107
73554 DEVON#8	0.976	0	0	107	73555 MIDDTN#2	0.973	0	0	117	73556 MIDDTN#3	0.965	0	0	233
73557 MIDDTN#4	0.973	0	0	400	73558 MONTV#5	0.970	0	0	81	73559 MONTV#6	0.981	0	0	402
73562 MILL#2	0.997	940	175	940	73563 MILL#3	0.997	1260	233	1260	73565 LAKERD#1	1.015	305	81	310
73566 LAKERD#2	1.015	305	81	310	73567 LAKERD#3	0.986	0	0	310	73570 DEVGAS11	1.018	0	0	42
73571 DEVGAS12	1.018	0	0	42	73572 DEVGAS13	1.018	0	0	42	73573 DEVGAS14	1.018	0	0	42
73574 MILFD#1	0.984	280	-5	280	73575 MILFD#2	0.993	0	0	280	73588 MERIDEN1	0.987	0	0	172
73589 MERIDEN2	0.987	0	0	172	73590 MERIDEN3	0.987	0	0	196	73594 WALL LV1	0.999	0	0	102
73595 WALL LV2	0.999	0	0	102	73596 WALL LV3	0.999	0	0	51	73647 BPTHBR#2	0.936	0	0	170
73648 BPTHBR#3	0.957	0	0	375	73651 NH HARBR	0.955	447	0	447	73654 BE 10 ST	0.949	180	-5	180
73652 BE 11	0.955	170	-5	170	73653 BE 12	0.955	170	-5	170					

---GENERATION TOTALS---

	MW	MX		MW	MX		MW	MX
MIS	549	165	BUCKSPORT	72	20	WYMAN	54	4
HARRIS	54	5	WILLIAMS	14	2	RUMFORD PWR	0	0
AEC	55	19	WYMAN	0	0	WESTBROOK	565	215
COMERFORD	0	0	MOORE	0	0	SEABROOK	1315	307
MERRIMACK	433	22	AES	0	0	SCHILLER	145	41
NEWINGTON	422	112	CONED-NEW	0	0	MYSTIC	565	-150
NEWBOSTON	0	0	SALEMHBR	0	0	MASSPWRR	0	0
ANPBLK	0	0	ANPBELL	0	0	BRAYTONPT	945	-93
MANCHSTRST	0	0	OSP	0	0	NEA	301	0
CANAL	576	76	PILGRIM	734	54	HOPE	0	0
EDGER	0	0	DGHTN	0	0	VTYANKEE	667	150
BEARSWAMP	-560	61	NORTHFIELD	-750	103	STONYBROOK	0	0
MASSPWRR	0	0	BERKSHIRE	0	0	MILLSTONE	2200	408
LAKERD	610	162	S MEADOW	0	0	MIDDLETOWN	0	0
MONTVILLE	0	0	NORWALK HBR	168	-16	Meriden	0	0
NHHARBOR	447	0	BRIDGEPORT	520	-14	DEVON	0	0
MLFDPWR	280	-5	BPT_RESCO	0	0	NORWALK	168	-16
COS_COB	0	0	CT	3744	381	SWCT	1054	-21
NOR-STAM-PLA	168	-16						

CAPACITORS

#		V	MVAR	MAX	#		V	MVAR	MAX	#		V	MVAR	MAX
70001	CHESTER	0.995	27	450.0	70024	ORR CAP1	1.045	73	67.0	70025	ORR CAP2	1.045	73	67.0
70026	ORR CAP3	1.045	73	67.0	70036	MAX CAP1	1.037	54	50.0	70037	MAX CAP2	1.037	54	50.0
70043	MAS CAP1	1.038	54	50.0	70044	MAS CAP2	1.038	54	50.0	70050	SUR CAP1	1.032	0	50.0
70051	SUR CAP2	1.032	0	50.0	70052	SUR CAP3	1.032	0	50.0	70056	SGR CAP1	1.030	0	50.0
70057	SGR CAP2	1.030	0	50.0	70162	SANFORD	1.025	0	31.0	70136	CROWLEYS	1.028	0	50.0
72712	BEEBE	1.020	0	20.0	72738	OCEAN ER	1.025	0	25.0	72739	OCEAN UH	1.038	0	25.0
72770	3 RIV 2	1.026	0	61.0	72732	MADBURY	1.030	0	48.8	72717	CHSNT HL	1.045	0	50.0
72734	MERRMACK	1.035	0	72.0	71996	TEWKSBRY	1.023	0	126.0	72102	PRATTS J	1.024	66	63.0
72265	NBORO RD	1.024	0	54.0	72096	MILLBURY	1.034	135	63.0	70507	GEORG TP	1.005	0	24.8
70546	BERLIN	1.009	0	24.8	70519	MIDDLBRY	1.018	0	22.9	70512	ESX B-2	1.010	50	99.2
70529	WILLISTN	1.010	0	24.8	70521	RUTLAND	1.023	0	24.8	70508	SANDB115	1.011	0	24.8
70504	SBRAT 69	1.033	0	50.0	70547	HIGHGATE	1.005	0	140.0	70870	FRMNGHAM	1.035	0	53.6
70888	BAKER ST	1.044	0	107.2	70806	LEXINGTN	1.035	0	53.6	73177	MYSTICCT	1.005	0	53.6
70836	K-ST-1	1.049	0	53.6	70837	K-ST-2	1.047	-88	53.6	70893	NEEDHAM	1.042	0	53.6
72569	FRSQ	1.021	0	63.0	72565	KENT CO	1.022	66	63.0	72962	AGAWM PF	1.020	0	104.8
73243	BERLIN	1.012	0	132.0	73262	CANTON	1.009	0	50.4	73267	DARIEN	1.032	0	39.6
73668	E.SHORE	1.025	0	84.0	73260	FRKLN DR	1.012	0	37.8	73202	FROST BR	1.021	0	262.0
73168	GLNBROOK	1.035	0	348.0	73242	MANCHSTR	1.008	53	3.0	73210	MONTVLLE	1.014	0	104.8
73177	MYSTICCT	1.005	0	50.4	73244	N.BLMFLD	1.010	0	157.2	73671	NO.HAVEN	1.025	0	42.0
73172	NORWALK	1.030	0	0.0	73170	PLUMTREE	1.010	0	92.2	73190	ROCK RIV	1.013	0	25.2
73672	SACKETT	1.024	0	42.0	73154	SGTN B	1.026	55	314.4	73165	STONY HL	1.012	0	100.8

REACTORS

#		V	MVAR	MAX	#		V	MVAR	MAX	#		V	MVAR	MAX
87004	KESWICK	1.026	0	37.5	70001	CHESTER	0.995	-27	125.0	70027	ORRINGTN	1.045	0	80.0
70125	SUROWIEC	1.032	0	80.0	72766	SCOBIE1	1.037	0	40.0	72746	SCOBIE2	1.037	0	40.0
71786	SANDY PD	1.031	-181	480.0	70837	K-ST-2	1.047	88	80.0	70799	WOBURN	1.020	83	240.0
70818	MYSTC MA	1.046	84	80.0	70815	N.CAMB	1.042	174	160.0	73132	PLUMREAC	1.009	153	150.0
73135	NOROH	1.009	305	300.0										

INTERFACE FLOWS

NB-NE	702	-5*	ORRING-SOUTH	1098	6	SUROWIEC-SOUTH	1024	-132
MEYANKEE-SOUTH	821	-170	MAINE-NH	1509	-89	NNE-SCOBIE+394	2909	77
SEABROOK-SOUTH	1547	119	NORTH-SOUTH	3541	-48	CMFD/MOORE-SO	54	-28
SNDYPOND-SOUTH	961	-40	CONN-IMPORT	-236	57	SWCT	488	-3
NE-NRWLK-STFD	381	-95	BOSTON IMPORT	1770	-658	SEMA/RI EXPORT	961	-669
SEMA EXPORT	231	-670	EAST-WEST	1749	-12	NY-NE 2200(170	-189	92
NW VT	99	-2	PLAT PAR	109	-7	BLISS PAR	0	-3
UPNY-CONED	2064	-30	CENTRAL_EAST	2156	-103	CROSS-SOUND	-346	92
CONN-EXPORT	846	-75	LILCO	0	-44			

HVDC TRANSFERS FROM H-Q

CHAT-1 = 0
MADAWASK = 0
EEL = 0

PHII-P1 = 0

HIGHGATE = 150
PHII-P2 = 0

BUS VOLTAGES

			V	LMT				V	LMT				V	LMT
70001	CHESTER	345	343.		70002	ORRINGTN	345	347.		70003	MAXCYS	345	347.	
70086	ME YANK	345	350.		70087	SUROWIEC	345	350.		70090	BUXTON	345	351.	
70089	S.GORHAM	345	353.		70088	WYMAN	345	353.		72754	3 RIVERS	115	118.	
70144	BOLT HL	115	119.		72745	SCHILLER	115	119.		72732	MADBURY	115	118.	
72691	DRFLD345	345	353.		72692	NWGTN345	345	357.		72694	SEBRK345	345	357.	
71789	TEWKS	345	357.		71786	SANDY PD	345	356.		71801	BRAYTN P	345	352.	
71336	SHERMAN	345	355.		70783	PILGRIM	345	355.		71193	CANAL	345	355.	
70818	MYSTC MA	115	120.		72926	NRTHFLD	345	351.		73111	NOBLMFLD	345	354.	
73108	CARD	345	356.		73119	LAKEROAD	345	357.		73109	MONTVILE	345	354.	
73110	MILLSTNE	345	357.		73116	MIDDLTWN	345	354.		73107	SCOVL RK	345	354.	
73663	E.SHORE	345	355.		73106	SOUTHGTN	345	349.		73105	LONG MTN	345	349.	
73115	PLUMTREE	345	348.		73293	NORWALK	345	348.		71801	BRAYTN P	345	352.	
71326	BRIDGWTR	345	354.		71336	SHERMAN	345	355.		71337	WFARNUM	345	354.	
70780	WWALP345	345	354.		70783	PILGRIM	345	355.		71193	CANAL	345	355.	
71133	CARVER	345	355.		73244	N.BLMFLD	115	116.		73242	MANCHSTR	115	116.	
73215	CARD	115	115.		73241	MIDDLTWN	115	117.		72590	TIVERTON	115	118.	
71377	SOMERSET	115	117.		71378	BELLROCK	115	118.		71347	BRIDGWTR	115	118.	
71202	BRNSTBL	115	119.		72569	FRSQ	115	117.		73668	E.SHORE	115	118.	
73195	DEVON	115	117.		73125	MILFORD	115	117.		73700	PEQUONIC	115	117.	
73172	NORWALK	115	119.		73171	NWLK HAR	115	119.		73168	GLNBROOK	115	119.	
73198	SOUTHGTN	115	118.		73202	FROST BR	115	117.		73170	PLUMTREE	115	116.	
73153	BRANFORD	115	118.	H	73230	HADDAM	115	118.						

AREA/ZONE TOTALS

NEPOOL GEN	11831	NEPOOL_LOAD	12110	NEPOOL_LOSS	368
NEPOOL_INT	-667				

Appendix D
Stability Results

	Stuck Breaker	Fastest Group OOS	Fault Description	Local Clearing (cycles)	Remote Clearing (cycles)	Element(s) Removed	Note	Pre-Fitzwillian Results	Rec LOS
		N/A	Flat Line Run	N/A	N/A	N/A		Stable	
				Extreme Contingencies					
e	VY 379	N/A	Vermont Yankee 345kV 3ph fault on the VY Bus #1 with a VY-379 stuck breaker	Vermont Yankee K1 = 5.5 Vermont Yankee 79-40 = 10.3 Vermont Yankee 381 = 4	Amherst 3971, 7985 = 11.3	1) Existing 379 Line- from VY to Amherst 2) VY Auto	Monadnock Project NOT in service	Stable GCX / NB-NE Tie Trip	22
e	VY 379	N/A	Vermont Yankee 345kV 3ph fault on the VY Bus #1 with a VY-379 stuck breaker with VY-379 IPT Breaker	Vermont Yankee K1 = K1-IPT = 5.5 79-40 = 10.3 Vermont Yankee 381 = 4	Amherst 3971, 7985 = 11.3	1) Existing 379 Line- from VY to Amherst 2) VY Auto	Monadnock Project NOT in service Single Phase Impedance: 2.885 + j 26.8557 Ohms	Stable	
e	VY 379	N/A	Vermont Yankee 345kV 3ph fault on the VY Bus #1 with a VY-379 stuck breaker	Vermont Yankee K1 = 5.5 Vermont Yankee 79-40 = 10.3 Vermont Yankee 381 = 4	Fitwilliams 3791, 7934 = 11.3	1) 379 Line- from VY to Fitzwilliams 2) VY Auto		N/A	N
e	VY 379	N/A	Vermont Yankee 345kV 3ph fault on the VY Bus #1 with a VY-379 stuck breaker with VY-379 IPT Breaker	Vermont Yankee K1 = 4 Vermont Yankee K1-IPT = 5.5 Vermont Yankee 79-40 = 10.3 Vermont Yankee 381 = 4	Fitwilliams 3791, 7934 = 11.3	1) 379 Line- from VY to Fitzwilliams 2) VY Auto	Single Phase Impedance: 2.885 + j 26.8557 Ohms	N/A	N
	Coolidge 340	N/A	Coolidge 345kV 3ph fault on the 340 Line with a Coolidge 340 stuck breaker	Coolidge 350 = 9.3 Coolidge 34-35 = 4 Coolidge K32-36, K36 = 10.5	Vermont Yankee 79-40, 1T = 4	1) 340 Line from Coolidge to VY 2) Coolidge Auto		Stable	
	Fitzwilliams 7934	N/A	Fitzwilliams 345kV 3ph fault on the 379 Line with a 7934 stuck breaker	Fitzwilliams 3791 = 4 Fitzwilliams 367 = 9 Fitzwilliams F5, F6 = 10.3	Vermont Yankee 379, 79-40 = 4	1) 379 Line- from VY to Fitzwilliams 2) Fitzwilliams Auto.		N/A	N
				Normal Contingencies					
e	No	Yes	Vermont Yankee 345kV 3ph fault on the 379 Line	Vermont Yankee 379, 79-40 =4	Fitzwilliams7934, 3791 = 4	1) 379 Line- from VY to Fitzwilliams		N/A	N
e	No	Yes	Vermont Yankee 345kV 3ph fault on the 379 Line	Vermont Yankee 379, 79-40 = 4	Amherst 3971, 7985 = 4	1) Existing 379 Line- from VY to Amherst	Monadnock Project NOT in service	Stable	
e	No	Yes	Vermont Yankee 345kV 3ph fault on the 340 Line	Vermont Yankee 1T, 79-40 = 4	Coolidge 340, 34-35 = 4	1) 340 Line from Coolidge to VY		Stable	
e	No	Yes	3 ph fault on the Vermont Yankee 345kV/115kV Auto Transformer	Vermont Yankee 379, 381 = 4	Vermont Yankee 115kV- K1 = 5	1) VY Auto		Stable	
e	No		Fault on the 350 line from Coolidge to West Rutland	Coolidge350, 34-35 = 4	W.Rutland 350, 360 = 4	1) 350 Line from Coolidge to West Rutland		Stable	
e	No	Yes	3 ph fault on the Coolidge 345kV/115kV Auto Transformer	Coolidge 340, 350 = 4	Coolidge K32-36, K36 = 5	1) Coolidge Auto		Stable	
e	No	No	3 ph fault on the Granite 230kV/115kV Auto Transformer	Comerford 230kV = 4	Granite 115kV- K53, K51 = 5	1) Granite Auto 2) 230kV Line from Granite to Comerford		Stable	
e	No	No	North Road 3 ph fault on the M-127 Line	North Road 34.5kV =66.5	Webster = 5.75 Ascutney = 6.5	1) M127 Line 2) K174 Line		Stable	
e	No	No	Webster 3 ph fault on the M-127 Line	Webster = 4.0	North Road = 66.5 Ascutney = 6.5	1) M127 Line 2) K174 Line		Stable	
e	No	No	Ascutney 3 ph fault on the K-174 Line	Ascutney = 5	Webster = 5.5 North Road = 65.5	1) M127 Line 2) K174 Line		Stable	
e	No	Yes	North Road 3 ph fault on the M-127 Line	North Road 34.5kV = 65.75	Webster = 5.57 Ascutney = 6.5	1) M127 Line 2) K174 Line		Stable	
e	No	Yes	Webster 3 ph fault on the M-127 Line	Webster = 4.0	North Road = 96.5 Ascutney = 36.5	1) M127 Line 2) K174 Line		Stable	
e	No	Yes	Ascutney 3 ph fault on the K-174 Line	Ascutney = 6.5	Webster = 36.0 North Road = 96	1) M127 Line 2) K174 Line		Stable	
e	No	Yes	1 ph fault on the K-174 Line	Ascutney = 6.5	North Road = 46 Webster = 41	1) M127 Line 2) K174 Line	Pos-Neg Seq = 1.17822 + j 6.72829 Zero Seq = 1.74808 + j 10.031 SLG IMP =2.9263 + j 16.75929	Stable	
e	No	Yes	1 ph fault on the M-127 Line	Webster = 4.0	Ascutney = 63.5 North Road = 68.5	1) M127 Line 2) K174 Line	Pos-Neg Seq = 1.47433 + j 7.65806 Zero Seq = 7.04755 + j 17.2867 SLG IMP = 8.52188 + j 24.94476	Stable	
e	Yes	Yes	3 ph fault on the M-127 Line Stuck Breaker	Webster = 23.75	Ascutney = 36.5 North Road = 96.5	1) Bus Tie 40, 2) P145, 3) M127 4) A111, 5) J125, 6) TB37		Stable	

Appendix E
Short-Circuit Results

0Lempster / PSNH Protection Issues

Short Circuit Impacts

Based upon the Aspen Model provided by PSNH to E/PRO representing the project area, short circuit estimates were developed for the Newport 34.5 kV bus and the North Road 34.5 kV bus (Appendix F). These estimates are included in Appendix G. Assuming a 13 unit, 26 MW Wind Project at Lempster, the estimated pre and post project maximum available bus fault currents are projected to be:

	Newport 34		North Road 34	
	Pre Project (amperes)	Post Project (amperes)	Pre Project (amperes)	Post Project (amperes)
Three Phase Fault	3,646	4,923	7,361	8,442
Double Line to Grd Fault	3,393	4,444	7,641	8,803
Single Line to Grd Fault	2,932	3,377	8,031	8,816

The magnitude of the fault currents do not appear to be in excess of any circuit breaker ratings. The 315 line from North Road to Newport experiences the following shift in fault contributions:

	Fault at Newport 34		Fault at North Road 34	
	Pre Project (amperes)	Post Project (amperes)	Pre Project (amperes)	Post Project (amperes)
Three Phase Fault	3,646	3,646	0	1,086
Double Line to Grd Fault	3,393	3,380	0	939
Single Line to Grd Fault	2,932	2,824	0	721

The only protection on the radial circuit 315 appears to be the breaker at North Road and a set of 100 E fuses at Newport for the 4 kV transformer. Based on information in the Aspen model, the line 315 breaker is equipped with non-directional phase and ground overcurrent relays with a current transformer ratio of 100:1. The relays are reportedly C-09 relays with a pick up of 4 amps on the ground relay and 5 amps on the phase relay. These relays do not appear to be adversely affected by the addition of the Lempster Wind Project.

Lempster Wind Project
Summary of Fault Contribution at North Road 34.5 kV Bus
without Lempster Wind in Service

Summary of fault being displayed:

---

1. 3LG Bus fault on:
N ROAD 34.5 kV

FAULT CURRENT (A @ DEG)

+ SEQ	- SEQ	0 SEQ	A PHASE	B PHASE	C PHASE
7360.7@-114.6	0.0@ 0.0	0.0@ 0.0	7360.7@-114.6	7360.7@ 125.4	7360.7@ 5.4

THEVENIN IMPEDANCE (OHM)

+ SEQ	- SEQ	0 SEQ
0.25776+j2.72263	0.25778+j2.72269	0.08679+j2.04931

SHORT CIRCUIT MVA= 444.5 X/R RATIO= 10.5626 R0/X1= 0.03188 X0/X1= 0.75269

BUS 0 N ROAD 34.5KV AREA 1 ZONE 1 TIER 0 (PREFAULT V=1.011@ -30.0 PU)

	+ SEQ	- SEQ	0 SEQ	A PHASE	B PHASE	C PHASE
VOLTAGE (KV, L-G) >	0.000@ 0.0	0.000@ 0.0	0.000@ 0.0	0.000@ 0.0	0.000@ 0.0	0.000@ 0.0
BRANCH CURRENT (A) TO >						
9120 SUNAPEE NHE 34.5 L	0.0@ 0.0	0.0@ 0.0	0.0@ 0.0	0.0@ 0.0	0.0@ 0.0	0.0@ 0.0
0 SUNAPEE 34.5 1L	0.0@ 0.0	0.0@ 0.0	0.0@ 0.0	0.0@ 0.0	0.0@ 0.0	0.0@ 0.0
0 GEORGS MILLS 34.5 1L	1175.8@ 68.9	0.0@ 0.0	0.0@ 0.0	1175.8@ 68.9	1175.8@ -51.1	1175.8@-171.1
0 GUILD 34.5 1L	0.0@ 0.0	0.0@ 0.0	0.0@ 0.0	0.0@ 0.0	0.0@ 0.0	0.0@ 0.0
0 N ROAD 115. 2T	3084.7@ 64.7	0.0@ 0.0	0.0@ 0.0	3084.7@ 64.7	3084.7@ -55.3	3084.7@-175.3
0 N ROAD 115. 1T	3102.9@ 64.7	0.0@ 0.0	0.0@ 0.0	3102.9@ 64.7	3102.9@ -55.3	3102.9@-175.3
CURRENT TO FAULT (A) >	7360.7@-114.6	0.0@ 0.0	0.0@ 0.0	7360.7@-114.6	7360.7@ 125.4	7360.7@ 5.4
THEVENIN IMPEDANCE (OHM) >	2.7348@ 84.6	2.7348@ 84.6	2.05114@ 87.6			

Lempster Wind Project
Summary of Fault Contribution at North Road 34.5 kV Bus
without Lempster Wind in Service

Summary of fault being displayed:

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 2. 2LG Bus fault on:
   N ROAD      34.5 kV
                              FAULT CURRENT (A @ DEG)
        + SEQ         - SEQ         0 SEQ         A PHASE        B PHASE        C PHASE
      5152.4@-115.1   2208.9@ 66.6   2945.2@ 63.6      0.0@  0.0    7641.4@ 120.1    7868.3@  9.5
                              THEVENIN IMPEDANCE (OHM)
     0.25776+j2.72263  0.25778+j2.72269  0.08679+j2.04931

        SHORT CIRCUIT MVA= 461.5      X/R RATIO= 11.6722    R0/X1= 0.03188   X0/X1= 0.75269
-------------------------------------------------------------------------------------
BUS    0 N ROAD       34.5KV  AREA  1  ZONE  1  TIER  0     (PREFAULT V=1.011@ -30.0 PU)
                    + SEQ         - SEQ         0 SEQ         A PHASE        B PHASE        C PHASE
VOLTAGE (KV, L-G)       >   6.041@ -28.9   6.041@ -28.9   6.041@ -28.9   18.123@ -28.9    0.000@  0.0    0.000@  0.0
BRANCH CURRENT (A) TO    >
 9120 SUNAPEE NHE  34.5   L      0.0@  0.0      0.0@  0.0      0.0@  0.0      0.1@  61.1      0.0@  0.0      0.0@  0.0
   0 SUNAPEE      34.5  1L     0.9@  61.1      0.9@  61.1      0.9@  61.1      2.7@  61.1      0.0@  0.0      0.0@  0.0
   0 GEORGS MILLS 34.5  1L    820.1@  68.4    355.8@-109.9    128.5@-112.8    336.0@  67.1   1069.8@ -40.8   1090.7@
178.2
   0 GUILD        34.5  1L     0.0@  0.0      0.0@  0.0      0.0@  0.0      0.1@  61.1      0.0@  0.0      0.0@  0.0
   0 N ROAD       115.  2T   2160.3@  64.2    924.7@-114.1   1404.8@-116.6    168.9@-112.9   3310.4@ -62.9   3391.0@-168.7
   0 N ROAD       115.  1T   2173.0@  64.2    930.1@-114.1   1413.1@-116.6    169.9@-113.0   3329.9@ -63.0   3411.0@-168.7

CURRENT TO FAULT (A)     >   5152.4@-115.1   2208.9@ 66.6   2945.2@ 63.6      0.0@  0.0   7641.4@ 120.1    7868.3@
9.5
THEVENIN IMPEDANCE (OHM)  >   2.7348@  84.6   2.7348@  84.6   2.05114@  87.6
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Lempster Wind Project
Summary of Fault Contribution at North Road 34.5 kV Bus
without Lempster Wind in Service

Summary of fault being displayed:

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 3. 1LG Bus fault on:
   N ROAD      34.5 kV
                              FAULT CURRENT (A @ DEG)
          + SEQ          - SEQ          0 SEQ          A PHASE          B PHASE          C PHASE
       2677.3@-115.4   2677.3@-115.4   2677.3@-115.4   8031.9@-115.4      0.0@   0.0       0.0@   0.0
                              THEVENIN IMPEDANCE (OHM)
     0.25776+j2.72263   0.25778+j2.72269   0.08679+j2.04931

          SHORT CIRCUIT MVA= 485.0      X/R RATIO= 12.4427    R0/X1= 0.03188    X0/X1= 0.75269
--------------------------------------------------------------------------------------------
BUS     0 N ROAD       34.5KV  AREA   1  ZONE   1  TIER  0     (PREFAULT V=1.011@ -30.0 PU)
                         + SEQ          - SEQ          0 SEQ          A PHASE          B PHASE          C PHASE
VOLTAGE (KV, L-G)       >  12.809@ -29.6   7.322@ 149.1   5.492@ 152.1   0.000@   0.0   19.561@-144.9   18.997@  85.6
BRANCH CURRENT (A) TO     >
 9120 SUNAPEE NHE  34.5  L     0.0@   0.0     0.0@   0.0     0.0@   0.0     0.0@   0.0     0.1@ -47.8     0.1@ 168.2
   0 SUNAPEE       34.5  1L    1.9@  60.4     1.1@-120.9     0.8@-117.9     0.0@   0.0     2.9@ -55.0     2.8@ 175.6
   0 GEORGS MILLS  34.5  1L  421.3@  68.1   431.3@  68.1   116.8@  68.2   969.4@  68.1   309.2@-113.5   310.0@-110.3
   0 GUILD         34.5  1L    0.0@   0.0     0.0@   0.0     0.0@   0.0     0.0@   0.0     0.1@ -58.6     0.1@ 179.6
   0 N ROAD        115.  2T 1124.2@  63.9  1120.8@  63.9  1277.0@  64.4  3521.9@  64.1   154.9@  67.0   155.0@  69.2
   0 N ROAD        115.  1T 1130.8@  63.9  1127.3@  63.8  1284.5@  64.4  3542.7@  64.0   155.9@  66.9   155.9@  69.1

CURRENT TO FAULT (A)      >  2677.3@-115.4  2677.3@-115.4  2677.3@-115.4  8031.9@-115.4     0.0@   0.0     0.0@
0.0
THEVENIN IMPEDANCE (OHM)  >  2.7348@  84.6   2.7348@  84.6   2.05114@  87.6
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Lempster Wind Project
Summary of Fault Contribution at North Road 34.5 kV Bus
with Lempster Wind in Service

Summary of fault being displayed:

===

1. 3LG Bus fault on:
N ROAD 34.5 kV

FAULT CURRENT (A @ DEG)

+ SEQ	- SEQ	0 SEQ	A PHASE	B PHASE	C PHASE
8442.3@-113.9	0.0@ 0.0	0.0@ 0.0	8442.3@-113.9	8442.3@ 126.1	8442.3@ 6.1

THEVENIN IMPEDANCE (OHM)

0.25406+j2.36758 0.24942+j2.39787 0.08679+j2.04932

SHORT CIRCUIT MVA= 509.1 X/R RATIO= 9.31916 R0/X1= 0.03666 X0/X1= 0.86557

BUS 0 N ROAD 34.5KV AREA 1 ZONE 1 TIER 0 (PREFAULT V=1.009@ -30.0 PU)

	+ SEQ	- SEQ	0 SEQ	A PHASE	B PHASE	C PHASE
VOLTAGE (KV, L-G) >	0.000@ 0.0	0.000@ 0.0	0.000@ 0.0	0.000@ 0.0	0.000@ 0.0	0.000@ 0.0
BRANCH CURRENT (A) TO >						
9120 SUNAPEE NHE 34.5 L	0.0@ 0.0	0.0@ 0.0	0.0@ 0.0	0.0@ 0.0	0.0@ 0.0	0.0@ 0.0
0 SUNAPEE 34.5 1L	0.0@ 0.0	0.0@ 0.0	0.0@ 0.0	0.0@ 0.0	0.0@ 0.0	0.0@ 0.0
0 GEORGS MILLS 34.5 1L	1175.8@ 68.9	0.0@ 0.0	0.0@ 0.0	1175.8@ 68.9	1175.8@ -51.1	1175.8@-171.1
0 GUILD 34.5 1L	1086.1@ 70.9	0.0@ 0.0	0.0@ 0.0	1086.1@ 70.9	1086.1@ -49.1	1086.1@-169.1
0 N ROAD 115. 2T	3084.7@ 64.7	0.0@ 0.0	0.0@ 0.0	3084.7@ 64.7	3084.7@ -55.3	3084.7@-175.3
0 N ROAD 115. 1T	3102.9@ 64.7	0.0@ 0.0	0.0@ 0.0	3102.9@ 64.7	3102.9@ -55.3	3102.9@-175.3
CURRENT TO FAULT (A) >	8442.3@-113.9	0.0@ 0.0	0.0@ 0.0	8442.3@-113.9	8442.3@ 126.1	8442.3@ 6.1
THEVENIN IMPEDANCE (OHM) >	2.38118@ 83.9	2.38118@ 84.1	2.05116@ 87.6			

Summary of fault being displayed:

Lempster Wind Project
Summary of Fault Contribution at North Road 34.5 kV Bus
with Lempster Wind in Service

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2. 2LG Bus fault on:
N ROAD 34.5 kV

FAULT CURRENT (A @ DEG)

+ SEQ	- SEQ	0 SEQ	A PHASE	B PHASE	C PHASE
5761.0@-114.6	2649.5@ 67.3	3114.1@ 63.8	0.0@ 0.0	8499.0@ 122.7	8802.7@ 8.0

THEVENIN IMPEDANCE (OHM)

0.25406+j2.36758 0.24942+j2.39787 0.08679+j2.04932

SHORT CIRCUIT MVA= 512.6 X/R RATIO= 10.4572 R0/X1= 0.03666 X0/X1= 0.86557

BUS 0 N ROAD 34.5KV AREA 1 ZONE 1 TIER 0 (PREFAULT V=1.009@ -30.0 PU)

	+ SEQ	- SEQ	0 SEQ	A PHASE	B PHASE	C PHASE
VOLTAGE (KV, L-G) >	6.388@ -28.6	6.388@ -28.6	6.388@ -28.6	19.163@ -28.6	0.000@ 0.0	0.000@ 0.0
BRANCH CURRENT (A) TO >						
9120 SUNAPEE NHE 34.5 L	0.0@ 0.0	0.0@ 0.0	0.0@ 0.0	0.1@ 61.4	0.0@ 0.0	0.0@ 0.0
0 SUNAPEE 34.5 1L	0.9@ 61.4	0.9@ 61.4	0.9@ 61.3	2.8@ 61.3	0.0@ 0.0	0.0@ 0.0
0 GEORGS MILLS 34.5 1L	799.7@ 68.3	376.2@-109.7	135.9@-112.6	288.1@ 66.0	1063.9@ -40.1	1088.0@ 177.6
0 GUILD 34.5 1L	738.0@ 70.3	314.8@-108.8	0.0@ 0.0	423.3@ 69.6	932.3@ -32.5	939.5@ 173.6
0 N ROAD 115. 2T	2107.4@ 64.1	977.7@-113.9	1485.4@-116.3	355.9@-111.9	3326.7@ -63.3	3408.3@-168.3
0 N ROAD 115. 1T	2119.8@ 64.0	983.5@-113.9	1494.1@-116.4	358.0@-111.9	3346.3@ -63.4	3428.4@-168.4
CURRENT TO FAULT (A) >	5761.0@-114.6	2649.5@ 67.3	3114.1@ 63.8	0.0@ 0.0	8499.0@ 122.7	8802.7@ 8.0
THEVENIN IMPEDANCE (OHM) >	2.38118@ 83.9	2.38118@ 84.1	2.05116@ 87.6			

Summary of fault being displayed:

Lempster Wind Project
Summary of Fault Contribution at North Road 34.5 kV Bus
with Lempster Wind in Service

3. 1LG Bus fault on:
N ROAD 34.5 kV

FAULT CURRENT (A @ DEG)

+ SEQ	- SEQ	0 SEQ	A PHASE	B PHASE	C PHASE
2938.8@-115.1	2938.8@-115.1	2938.8@-115.1	8816.5@-115.1	0.0@ 0.0	0.0@ 0.0

THEVENIN IMPEDANCE (OHM)
0.25406+j2.36758 0.24942+j2.39787 0.08679+j2.04932

SHORT CIRCUIT MVA= 531.7 X/R RATIO= 11.5453 R0/X1= 0.03666 X0/X1= 0.86557

BUS 0 N ROAD 34.5KV AREA 1 ZONE 1 TIER 0 (PREFAULT V=1.009@ -30.0 PU)

	+ SEQ	- SEQ	0 SEQ	A PHASE	B PHASE	C PHASE
VOLTAGE (KV, L-G) >	13.107@ -29.4	7.085@ 149.0	6.028@ 152.5	0.000@ 0.0	20.027@-146.8	19.336@ 87.9
BRANCH CURRENT (A) TO >						
9120 SUNAPEE NHE 34.5 L	0.0@ 0.0	0.0@ 0.0	0.0@ 0.0	0.0@ 0.0	0.1@ -49.3	0.1@ 169.9
0 SUNAPEE 34.5 1L	1.9@ 60.6	1.0@-121.1	0.9@-117.6	0.0@ 0.0	2.9@ -56.9	2.8@ 177.9
0 GEORGS MILLS 34.5 1L	403.9@ 67.8	417.3@ 67.9	128.2@ 68.5	949.4@ 67.9	283.5@-114.8	281.8@-110.1
0 GUILD 34.5 1L	371.6@ 69.8	349.1@ 68.8	0.0@ 0.0	720.7@ 69.3	355.6@-107.5	366.2@-113.7
0 N ROAD 115. 2T	1078.8@ 63.6	1084.5@ 63.7	1401.8@ 64.8	3564.9@ 64.1	318.8@ 69.5	323.4@ 67.7
0 N ROAD 115. 1T	1085.1@ 63.5	1090.9@ 63.7	1410.0@ 64.7	3585.9@ 64.0	320.7@ 69.4	325.3@ 67.6
CURRENT TO FAULT (A) >	2938.8@-115.1	2938.8@-115.1	2938.8@-115.1	8816.5@-115.1	0.0@ 0.0	0.0@ 0.0
THEVENIN IMPEDANCE (OHM) >	2.38118@ 83.9	2.38118@ 84.1	2.05116@ 87.6			

Lempster Wind Project
Summary of Fault Contribution at Newport 34.5 kV Bus
with Lempster Wind in Service

Summary of fault being displayed:

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==========================================================================================
==================================
 1. 3LG Bus fault on:
   NEWPORT      34.5 kV
                                    FAULT CURRENT (A @ DEG)
         + SEQ          - SEQ         0 SEQ        A PHASE        B PHASE        C PHASE
       4922.7@-107.4      0.0@  0.0      0.0@  0.0   4922.7@-107.4   4922.7@ 132.6    4922.7@  12.6
                                    THEVENIN IMPEDANCE (OHM)
      0.89399+j3.97893  0.91232+j4.10231  2.37585+j9.25427

         SHORT CIRCUIT MVA= 296.5       X/R RATIO= 4.45077    R0/X1= 0.59711    X0/X1= 2.32582
---------------------------------------------------------------------------------------------
BUS     0 NEWPORT      34.5KV  AREA   1  ZONE   1   TIER  0     (PREFAULT V=1.008@ -30.0 PU)
                         + SEQ         - SEQ          0 SEQ        A PHASE        B PHASE        C PHASE
VOLTAGE (KV, L-G)       >    0.000@  0.0    0.000@  0.0    0.000@  0.0    0.000@  0.0    0.000@  0.0    0.000@  0.0
BRANCH CURRENT (A) TO       >
  0 LEMPSTER WND  34.5  2L   1280.2@  68.9     0.0@  0.0      0.0@  0.0   1280.2@  68.9   1280.2@ -51.1   1280.2@-171.1
  0 GUILD        34.5  1L   3646.2@  74.0      0.0@  0.0      0.0@  0.0   3646.2@  74.0   3646.2@ -46.0   3646.2@-166.0
  0 NEWPORT       4.16  1T      0.0@  0.0      0.0@  0.0      0.0@  0.0      0.0@  0.0      0.0@  0.0      0.0@  0.0

CURRENT TO FAULT (A)      >  4922.7@-107.4      0.0@  0.0      0.0@  0.0   4922.7@-107.4   4922.7@ 132.6   4922.7@
12.6
THEVENIN IMPEDANCE (OHM)  >  4.07812@  77.3  4.07812@  77.5  9.55438@  75.6
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Lempster Wind Project
Summary of Fault Contribution at Newport 34.5 kV Bus
with Lempster Wind in Service

Summary of fault being displayed:

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2. 2LG Bus fault on:
NEWPORT 34.5 kV

FAULT CURRENT (A @ DEG)

+ SEQ	- SEQ	0 SEQ	A PHASE	B PHASE	C PHASE
2869.1@-107.2	1992.8@ 72.3	876.6@ 74.1	0.0@ 0.0	4444.3@ 145.4	4377.5@ 0.1

THEVENIN IMPEDANCE (OHM)

0.89399+j3.97893 0.91232+j4.10231 2.37585+j9.25427

SHORT CIRCUIT MVA= 267.7 X/R RATIO= 4.38454 R0/X1= 0.59711 X0/X1= 2.32582

BUS 0 NEWPORT 34.5KV AREA 1 ZONE 1 TIER 0 (PREFAULT V=1.008@ -30.0 PU)

	+ SEQ	- SEQ	0 SEQ	A PHASE	B PHASE	C PHASE
VOLTAGE (KV, L-G) >	8.375@ -30.3	8.375@ -30.3	8.375@ -30.3	25.125@ -30.3	0.000@ 0.0	0.000@ 0.0
BRANCH CURRENT (A) TO >						
0 LEMPSTER WND 34.5 2L	741.9@ 69.1	477.9@-112.4	0.0@ 0.0	264.5@ 71.8	1072.1@ -28.6	1057.1@ 165.7
0 GUILD 34.5 1L	2129.3@ 74.1	1517.0@-106.3	876.6@-105.9	264.5@-108.2	3380.0@ -36.5	3363.8@-175.5
0 NEWPORT 4.16 1T	0.0@ 0.0	0.0@ 0.0	0.0@ 0.0	0.0@ 0.0	0.0@ 0.0	0.0@ 0.0

CURRENT TO FAULT (A) > 2869.1@-107.2 1992.8@ 72.3 876.6@ 74.1 0.0@ 0.0 4444.3@ 145.4 4377.5@
0.1
THEVENIN IMPEDANCE (OHM) > 4.07812@ 77.3 4.07812@ 77.5 9.55438@ 75.6

Lempster Wind Project
Summary of Fault Contribution at Newport 34.5 kV Bus
with Lempster Wind in Service

Summary of fault being displayed:

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 3. 1LG Bus fault on:
   NEWPORT      34.5 kV
                                   FAULT CURRENT (A @ DEG)
          + SEQ          - SEQ           0 SEQ          A PHASE          B PHASE          C PHASE
        1125.7@-106.5    1125.7@-106.5    1125.7@-106.5    3377.2@-106.5       0.0@  0.0        0.0@  0.0
                                   THEVENIN IMPEDANCE (OHM)
      0.89399+j3.97893   0.91232+j4.10231   2.37585+j9.25427

          SHORT CIRCUIT MVA= 203.4        X/R RATIO= 4.14511     R0/X1= 0.59711    X0/X1= 2.32582
----------------------------------------------------------------------------------------------------
BUS    0 NEWPORT       34.5KV  AREA   1  ZONE   1   TIER  0      (PREFAULT V=1.008@ -30.0 PU)
                            + SEQ         - SEQ        0 SEQ        A PHASE       B PHASE       C PHASE
VOLTAGE (KV, L-G)        >   15.485@ -30.3    4.731@ 151.0   10.756@ 149.1    0.000@  0.0   23.626@-163.0   23.987@
102.3
BRANCH CURRENT (A) TO      >
   0 LEMPSTER WND  34.5  2L    285.0@  69.9    270.0@  68.9      0.0@  0.0    555.0@  69.4    273.6@-107.9    282.1@-113.3
   0 GUILD         34.5  1L    841.5@  74.8    856.9@  75.0   1125.8@  73.5   2824.0@  74.4    273.6@  72.1    282.1@  66.7
   0 NEWPORT       4.16  1T      0.0@   0.0      0.0@   0.0      0.0@   0.0      0.0@   0.0      0.0@   0.0      0.0@   0.0

CURRENT TO FAULT (A)      >   1125.7@-106.5   1125.7@-106.5   1125.7@-106.5   3377.2@-106.5      0.0@  0.0      0.0@
0.0
THEVENIN IMPEDANCE (OHM)  >   4.07812@  77.3   4.07812@  77.5   9.55438@  75.6
----------------------------------------------------------------------------------------------------
```

Lempster Wind Project
Summary of Fault Contribution at Newport 34.5 kV Bus
with Lempster Wind out of Service

Summary of fault being displayed:

==

1. 3LG Bus fault on:
NEWPORT 34.5 kV

FAULT CURRENT (A @ DEG)

+ SEQ	- SEQ	0 SEQ	A PHASE	B PHASE	C PHASE
3646.2@-106.0	0.0@ 0.0	0.0@ 0.0	3646.2@-106.0	3646.2@ 134.0	3646.2@ 14.0

THEVENIN IMPEDANCE (OHM)

1.33614+j5.35667 1.33616+j5.35673 2.37572+j9.25403

SHORT CIRCUIT MVA= 220.2 X/R RATIO= 4.00906 R0/X1= 0.44351 X0/X1= 1.72757

BUS 0 NEWPORT 34.5KV AREA 1 ZONE 1 TIER 0 (PREFAULT V=1.011@ -30.0 PU)

	+ SEQ	- SEQ	0 SEQ	A PHASE	B PHASE	C PHASE
VOLTAGE (KV, L-G) >	0.000@ 0.0	0.000@ 0.0	0.000@ 0.0	0.000@ 0.0	0.000@ 0.0	0.000@ 0.0
BRANCH CURRENT (A) TO >						
0 GUILD 34.5 1L	3646.2@ 74.0	0.0@ 0.0	0.0@ 0.0	3646.2@ 74.0	3646.2@ -46.0	3646.2@-166.0
0 NEWPORT 4.16 1T	0.0@ 0.0	0.0@ 0.0	0.0@ 0.0	0.0@ 0.0	0.0@ 0.0	0.0@ 0.0

CURRENT TO FAULT (A) > 3646.2@-106.0 0.0@ 0.0 0.0@ 0.0 3646.2@-106.0 3646.2@ 134.0 3646.2@ 14.0
THEVENIN IMPEDANCE (OHM) > 5.5208@ 76.0 5.5208@ 76.0 9.55411@ 75.6

Lempster Wind Project
Summary of Fault Contribution at Newport 34.5 kV Bus
with Lempster Wind out of Service

Summary of fault being displayed:

==

2. 2LG Bus fault on:
NEWPORT 34.5 kV

FAULT CURRENT (A @ DEG)

+ SEQ	- SEQ	0 SEQ	A PHASE	B PHASE	C PHASE
2231.8@-106.0	1414.4@ 73.9	817.3@ 74.3	0.0@ 0.0	3393.4@ 142.8	3381.3@ 5.2

THEVENIN IMPEDANCE (OHM)

1.33614+j5.35667 1.33616+j5.35673 2.37572+j9.25403

SHORT CIRCUIT MVA= 204.9 X/R RATIO= 3.99251 R0/X1= 0.44351 X0/X1= 1.72757

BUS 0 NEWPORT 34.5KV AREA 1 ZONE 1 TIER 0 (PREFAULT V=1.011@ -30.0 PU)

	+ SEQ	- SEQ	0 SEQ	A PHASE	B PHASE	C PHASE
VOLTAGE (KV, L-G) >	7.809@ -30.1	7.809@ -30.1	7.809@ -30.1	23.427@ -30.1	0.000@ 0.0	0.000@ 0.0
BRANCH CURRENT (A) TO >						
0 GUILD 34.5 1L	2231.8@ 74.0	1414.4@-106.1	817.3@-105.7	0.0@ 0.0	3393.4@ -37.2	3381.3@-174.8
0 NEWPORT 4.16 1T	0.0@ 0.0	0.0@ 0.0	0.0@ 0.0	0.0@ 0.0	0.0@ 0.0	0.0@ 0.0
CURRENT TO FAULT (A) >	2231.8@-106.0	1414.4@ 73.9	817.3@ 74.3	0.0@ 0.0	3393.4@ 142.8	3381.3@ 5.2
THEVENIN IMPEDANCE (OHM) >	5.5208@ 76.0	5.5208@ 76.0	9.55411@ 75.6			

Lempster Wind Project
Summary of Fault Contribution at Newport 34.5 kV Bus
with Lempster Wind out of Service

Summary of fault being displayed:

==

3. 1LG Bus fault on:
NEWPORT 34.5 kV

FAULT CURRENT (A @ DEG)

+ SEQ	- SEQ	0 SEQ	A PHASE	B PHASE	C PHASE
977.4@-105.9	977.4@-105.9	977.4@-105.9	2932.2@-105.9	0.0@ 0.0	0.0@ 0.0

THEVENIN IMPEDANCE (OHM)

1.33614+j5.35667 1.33616+j5.35673 2.37572+j9.25403

SHORT CIRCUIT MVA= 177.1 X/R RATIO= 3.9555 R0/X1= 0.44351 X0/X1= 1.72757

BUS 0 NEWPORT 34.5KV AREA 1 ZONE 1 TIER 0 (PREFAULT V=1.011@ -30.0 PU)

	+ SEQ	- SEQ	0 SEQ	A PHASE	B PHASE	C PHASE
VOLTAGE (KV, L-G) >	14.734@ -30.1	5.396@ 150.1	9.338@ 149.7	0.000@ 0.0	22.323@-158.9	22.403@ 98.7
BRANCH CURRENT (A) TO >						
0 GUILD 34.5 1L	977.4@ 74.1	977.4@ 74.1	977.4@ 74.1	2932.2@ 74.1	0.0@ 0.0	0.0@ 0.0
0 NEWPORT 4.16 1T	0.0@ 0.0	0.0@ 0.0	0.0@ 0.0	0.0@ 0.0	0.0@ 0.0	0.0@ 0.0
CURRENT TO FAULT (A) >	977.4@-105.9	977.4@-105.9	977.4@-105.9	2932.2@-105.9	0.0@ 0.0	0.0@ 0.0
THEVENIN IMPEDANCE (OHM) >	5.5208@ 76.0	5.5208@ 76.0	9.55411@ 75.6			

Appendix F
Bulk Power System Testing Results

Lempster Wind Farm Interconnection System Impact Study

Bulk Power System Testing Stability Results

ID	Fault Location	Fault Type	Fault Description	2008 CELT Light Load			
				Pre-Fitzwilliams		Post-williams	
				Results	Recorded LOS (MW)	Results	Recorded LOS (MW)
5 Second Bulk Power System Testing							
BPSNR	North Road	3-phase	5 Second Bus Fault	Stable	38	Stable	38

Appendix G
PSNH Voltage Report Summary

October 13, 2005

Jeff Keeler
New England Director
Community Energy, Inc.
22 Stanton Court
Madison, CT 06443

Dear Jeff,

System Engineering performed a Preliminary Voltage Profile Study in August 2004 to determine the feasibility of interconnecting a 25MW wind generation facility in Lempster, New Hampshire to the PSNH distribution system. The Study concluded that 25MW of generation may be interconnected at 34.5kV to Newport Substation in Newport, NH.

The 2004 Study has been reviewed. The results of the Preliminary Voltage Profile Study are confirmed and will be incorporated in the PSNH Distribution Interconnection Study.

The following construction and operating constraints must be met by the generating facility to interconnect 25MW:

1. For steady state operation at almost all load and generation levels, the generation system will have to operate absorbing VARs to maintain an acceptable voltage. 1.035 was modeled at the generator interconnection and delivery point modeled at the intersection of Bean Mountain Road and Nichols Road. Power factor ranges from Unity to -95%(absorbing VARs). This is required to hold the steady state voltage down on the line. The generation facility will not be allowed to provide VARs to the system because the resultant voltages are above acceptable limits for 34.5kV distribution.
2. Any generating facility will require machines with voltage control, remote fault ride-through, and equipment with state-of-the-art control capabilities.
3. An upgraded/new three-phase, 477ACSR, 34.5kV circuit is required.
4. NHEC must be in agreement on any system operating conditions on facilities in the NHEC franchise territory.

Construction requirements on the PSNH and NHEC system include:

1. Approximately 10 miles of new 34.5kV, 3 phase line from Newport Substation to the site which is NH Electric Coop franchise territory (NHEC).
2. Alteration of Newport Substation including a three-phase breaker, controls, transfer trip, and SCADA.

The budgetary estimate for the above line and substation work is $2,300,000. The budgetary estimate is based on historical data and knowledge of the PSNH and NHEC system costs. Actual costs are not available until the work is completely designed, bid and constructed. This estimate includes only the cost for equipment on the utility system. The developer will have additional costs associated with equipment required from the utility interconnection point to the generator(s).

If you require additional information or clarification, please contact me at (603) 634-2944

Very truly yours,

Thelma J. Brown
Supervisor, System Engineering

cc: Tod Wicker, Manager of Supplemental Energy Sources Department, PSNH

Appendix H
Hemphill Power and Light Dynamics Data

GENERATOR DATA

GENERATOR NO. 316X662

NAMEPLATE DATA

2 Poles, 3 Phase, Wye Connected, 60 Hertz, 3600 RPM
Total temperature at rating guaranteed not to exceed:
100 C on armature by detector, 145 C on field by resistance

Inlet Water Temperature	70	95
Cold Air Temperature	26	40
KVA	22,100	19,900
Armature Amps	925	833
Armature Volts	13,800	13,800
Field Amps	215	201
Exciter Volts	250	250
Power Factor	0.80	0.80

DESIGN DATA

Maximum KVA With One Cooler Out of Service (70F Cold Water)	17,680
Maximum KVA With One Cooler Out of Service (95F Cold Water)	15,920
No-Load Field Current	2.4 Amperes
Three Phase Armature Winding Capacitance	0.199 Microfarads
Armature Winding DC Resistance (per phase)	0.01913 Ohms at 100 C
Field Winding DC Resistance	1.057 Ohms at 125 C

GAS COOLER DATA

Inlet water temperature: 95 F
Head loss through cooler: 6 feet
Gas space in generator: 580 cubic feet

Water flow at rated load: 412 gpm
Gas flow through generator: 22,590 cfm

AIR FILTER

Type of Air Filter	Farr
Size of Air Filter	10 x 20 x 2
Number of Air Filters	1

RAP-12 (4-72)

GENERATOR DATA

DESIGN NO. E145U24

DATED 24 Jan. 86

ATB-2-22100 KVA-0.80 PF-3600 RPM-13800 V-925 AMPS- WYE CONNECTED
250 FIELD VOLTS-

REACTANCE DATA: (PER UNIT)

		DIRECT AXIS		QUADRATURE AXIS
Saturated Synchronous	(Xdv)	1.846	(Xqv)	1.733
Unsaturated Synchronous	(Xdi)	1.846	(Xqi)	1.733
Saturated Transient .7738pu 100 —	(X'dv)	0.171	(X'q)	0.452
Unsaturated Transient 1.0362pu 100	(X'di)	0.229 — from SW cases w/higher x' value j1.0362 from 100		
Saturated Subtransient .5023pu 100	(X"dv)	0.111	(X"qv)	0.106
Unsaturated Subtransient .7104pu 100	(X"di)	0.1[illegible]7	(X"qi)	0.152
Saturated Negative Sequence [illegible]	(X2v)	0.103 →		
Unsaturated Negative Sequence [illegible]	(X2i)	0.145		
Saturated Zero Sequence	(Xov)	0.063		
Unsaturated Zero Sequence	(Xoi)	0.075		
Leakage Reactance	(XLM,OEX)	0.124	(XLM,UEX)	0.124

FIELD TIME CONSTANT DATA: (Sec. @ 125°C)

Open Circuit	(T'do)	4.824	(T'qo)	0.392
Three Phase Short Circuit Transient	(T'd3)	0.447	(T'q)	0.392
Line to Line Short Circuit Transient	(T'd2)	0.679		
Line to Neutral Short Circuit Transient	(T'd1)	0.909		
Short Circuit Subtransient	(T"d)	0.015	(T"q)	0.015
Open Circuit Subtransient	(T"do)	0.022	(T"qo)	0.054

ARMATURE DC COMPONENT TIME CONSTANT DATA: (Sec. @ 100°C)

Three Phase Short Circuit	(Ta3)	0.119
Line to Line Short Circuit	(Ta2)	0.119
Line to Neutral Short Circuit	(Ta1)	0.103

PER UNIT ARMATURE WINDING SEQUENCE RESISTANCE DATA:

Positive	(R1)	0.005
Negative	(R2)	0.018
Zero	(Ro)	0.009

Rotor Short-Time Thermal Capacity $(I_2)^2t$	30	
Turbine and Generator Combined Inertia Constant (H)	3.43	KW SEC./KVA
Three Phase Armature Winding Capacitance	0.199	MICROFARADS
Armature Winding DC Resistance (per phase)	0.01987	OHMS (100°C)
Field Winding DC Resistance	1.057	OHMS (125°C)
Field Current at Rated KVA, Rated Arm. Voltage, Rated PF	[illegible]	AMPS.
Field Current at Rated KVA, Rated Arm. Voltage, 0 PF Lagging	243	AMPS.*

*This is not an allowable operating point for the generator. Value is supplied for systems study only.

FEB 04 1986

TECO DRAWING CONTROL NO.

5580-202-01008

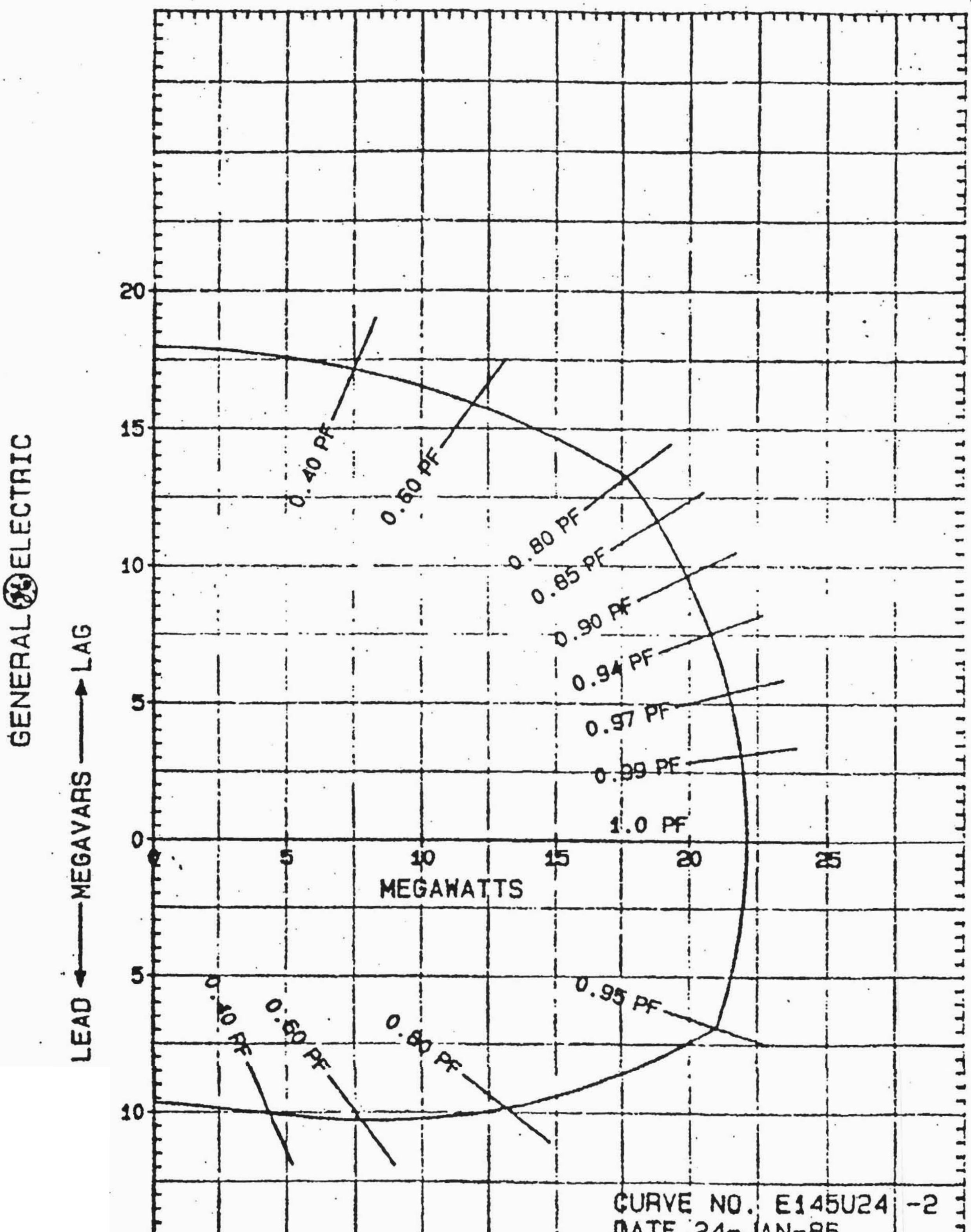
MEDIUM STEAM TURBINE
GENERATOR DEPARTMENT
GENERAL ELECTRIC
WEST LYNN, MASS.

Customer Name Hemphill P & L
G. E. Req'n No. 2[illegible]-77313
G. E. Serial No. 198030
Turbine No. 573L916
Generator No. 313X3[illegible]2
Controls No. 717L2[illegible]5

ESTIMATED REACTIVE CAPABILITY CURVES

22100 KVA - 3600 RPM - 13800 VOLTS - 0.80 PF

.58.00SCR - 3300 FT ALT - 250 FLD VOLTS



POWER TECHNOLOGIES INC.®

2006 SUMMER LIGHT LOAD
W/ 2004L DYN OF NERC/MMWG 2003 SERIES

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