WASATCH WIND
Tower Systems and Wind Development

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# Bringing the Space Frame Wind Tower Technology to the Caribbean

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## ABSTRACT

*Wasatch Wind is developing the Space Frame Wind Turbine Tower in partnership with several major turbine manufacturers. The turbines are commercially available and packaged with tubular steel towers and have completed rigorous certification standards. However, with the advent of the lighter weight and structurally less stiff Space Frame Tower, a collaborative engineering effort with the our turbine partners is required to verify that the structural limit and fatigue driven loads on the tower and on the critical turbine components are within acceptable requirements. Further, in order for the finance and insurance sectors to provide full coverage for the tower, and for the turbine suppliers to include full warranties, the towers must be certified to Germanischer Lloyd Wind Energy (GL Wind) standards.*

## General Description

Space Frame Wind Towers (SFWT) designed by Wasatch Wind are intended to be used for multi-megawatt wind turbines ranging from 1 to 3 megawatts and at heights of 80 or 100 meters. Although a single tower design may be suitable for more than one generator/rotor combination, certifications of turbine/tower/control combinations forming unique systems are demanded by the industry. This certification to date is largely done through Germanischer Lloyd Wind Energy (GL Wind) as a subsidiary of Germanischer Lloyd AG, and is the world market leader in wind turbine certification. They are accredited to certify turbines according to international and national regulations and standards. Germanischer Lloyd Wind Energy (GL Wind) is an internationally operating certification body for wind turbines and leads the world in this field. GL Wind carries out examinations, certifications and expertise's and is actively involved in the development of national and international standards. Certification of wind turbines is carried out on the basis of the GL Wind Guideline for the Certification of Wind Turbines (Edition 2003 with Supplement 2004). Furthermore, GL Wind is accredited to certify in accordance with all relevant standards in the field of wind energy.

Wasatch Wind works with the turbine manufactures ensuring the tower portion of the turbine/tower/control system is designed to meet the stringent code demanded by a GL Wind certification. By the time a turbine system utilizing a SFWT is delivered to a site it has received the design certification from GL Wind that provides assurance the turbine meets safety and performance criteria.

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**Behind The Scene View of Certification:**

There are 2 main business models for certifying turbine systems utilizing a Wasatch Wind SFWT:

1. Wasatch Wind works with turbine manufactures in selecting systems that will be developed and certified. Once certified these selected systems are available.
2. Developers request a turbine manufacture to provide a selected turbine to be offered with a SFWT. This system is then developed and certified for sell to the Developer.

In both cases, the turbine and blades being used with SFWT have already passed through the rigorous certification process and are currently commercial products. The first three SFWT turbine systems Wasatch Wind is developing in partnership with a turbine manufacturer have long been commercial products and are now being developed into systems which utilize the SFWT.

**Certification for the Islands:**

Wasatch Wind in partnership with the California Energy Commission and Clipper Windpower, a turbine manufacturer, is in the process of installing and testing a turbine system utilizing a SFWT. This class of turbine at 2.5 MW would be very useful on the islands to maximize capacity factor and minimize cost per kwh produced due to energy extraction efficiencies and economies of scale. Like most of the SFWT turbine systems that are being engineered by Wasatch Wind, the Clipper turbine and blade combination have already been certified and are being installed commercially in many locations in 2007 and beyond. The first installation was the Steel Winds project near Buffalo NY. Because the SFWT is a sub-component to the full system, additional certification will be performed on the tower design and does not require a “re-certification” of the entire turbine. The process for certification is ongoing and includes the following:

a. The turbine, blade, hub height, and control system are selected and then an initial SFWT design is created. The full system is analyzed by GL with all subcomponents. Subcomponents such as the turbine or blade that have previously received certification from GL will not require the same level of scrutiny as the tower component.
b. After the initial tower design is created, the ADAMS aero-elastic modeling program is used to determine the system loads. Using the global allowable load criteria defined by GL Wind and international standards, the SFWT turbine system is designed to comply. If modifications need to be made they are typically done to the tower design and/or the control system until the ADAMS load output shows compliance to the GL Wind criteria. The SFWT Clipper 2.5MW turbine

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system required multiple iterations and some adjustments to the ECD control sequence for proper GL Wind criteria compliance and this process is complete.

c. Once the full system loads comply to industry standards the tower components are individually analyzed and designed to confirm compliance. The two main areas of concern are structural strength and fatigue life. After all subcomponents of the tower have been analyzed using hand calculations, COSMOSWorks Designer FEA software, and the Algor FEA software, final full system loads are confirmed.

d. A complete tower engineering design package is compiled and then added to the turbine, blade, and control system design data. This complete document package is then submitted to GL Wind for design certification. Once GL Wind gives design certification the turbine system utilizing the SFWT is stamped as a Certified system.

e. In the first installation of the unique combination of turbine/tower/control system, there is also some field certification that takes place as a follow on to the design certification. This field certification is done during the installation and first few months of the tower in the wind farm. This is to help ensure that correct procedures have been documented and can be clearly followed. This field certification is performed on the tower being installed in California. It includes:

    a. Tower component fabrication quality documentation is checked.

    b. Installation manuals are reviewed and checked against the installation process. If changes need to be made to either the manual or the installation process they are done to ensure certification compliance.

    c. For the first tower only, strain gauges are mounted on areas of select tower members to allow comparison of actual load data to design load data. This field data is checked against the certification design process to ensure certification compliance of the design.

The certification process is on-going and is expected to complete by Spring 2008. Upon certification, the turbines will be delivered thereafter to projects and will include full warranties consistent with offerings for turbines with tubular towers. Since GL certification will have been completed prior to installation in the islands, all the projects slated for the islands are debt and equity financiable and insurable. In anticipation of project construction, Wasatch Wind is in process of securing production turbines for long term delivery schedules.

**Hi-Jack Program:**

Separate from the SFWT turbine system design certification but an important component of success in the islands is the Hi-Jack lift system. The Hi-Jack system is enabled by the lighter weight SFWT and allows for turbine installation and recurring maintenance without the use of crawler cranes.

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The Hi-Jack is being tested and certified to crane industry standards in 2007. These standards are:

1. Guides for the Analysis of Guy and Stiffleg Derricks (AISC-1974) [Guide]
2. AISC – ASD – 9th Edition [Manual]
3. AISC – LRFD/ASD – 13th Edition [Manual]
4. API Specification 2C, 1995 [Specification]
5. ASME B30.6-1995 [ANSI Standard]
6. ANSI\TIA-1019, 2004 [ANSI Standard]
7. Cranes and Derricks – 3rd Edition – McGraw-Hill, 1999 (ISBN 0-07-057889-3) [Text Book]

The Hi-Jack is being tested to both static and dynamic loads. The static load test will be done to verify the maximum allowable design load to be handled by the Hi-Jack system. Because it is a hydraulic system, the test also includes safety testing of the hydraulic control system. The dynamic load test is performed on a tower top to confirm system adherence to the Lifting industry standards. The dynamic test further tests the overload and safety systems of the hydraulic control system.

Each of these tests will be finalized several months prior to the Hi-Jack being utilized on the first SFWT turbine installation. Beyond just testing industry compliance to standards for the Hi-Jack, the tests are also designed to create opportunity to prove out the ability of the Hi-Jack and further refine the cost and usage metrics.