



Facts & Specifications

LIBERTY[®] 2.5 MW
WINDTURBINE



LIBERTY

WIND TURBINE DESIGN

The Liberty 2.5 MW wind turbine brings the wind industry's most valued design standards together with Clipper's purpose-engineered technologies to tackle the industry's most critical technology limitations – namely, the recognized drivers of unscheduled maintenance expense – downtime associated with gearbox stresses, large component change-outs and unscheduled crane call-outs.

Beginning with a horizontal-axis, 3-blade, upwind, pitch-regulated, variable-speed architecture, Clipper integrated its Quantum Drive® distributed drive train, a two-stage, helical load-splitting gearbox, four separate MegaFlux® permanent magnet synchronous generators, and controls optimized for variable-speed operation with full power conversion.

A number of innovative features were also added to increase worker safety, and provide ease of machine serviceability

The Liberty turbine was designed by Clipper in partnership with the U.S. Department of Energy ("DOE") and its National Renewable Energy Laboratory ("NREL"), which provided funding for development as well as facilities and support for extensive drivetrain and blade testing. As a result, an 'Outstanding Research and Development Partnership Award' was issued to Clipper by DOE in 2007, highlighting Clipper's "outstanding contribution toward industry advancements," and recognizing "the Liberty wind turbine, which attained unparalleled levels of efficiency and reliability and reduced cost of energy."

In March 2009, an independent due diligence review of the Liberty wind turbine technology was conducted by Garrad Hassan America, Inc. ("GH") on behalf of Clipper. The GH Report concluded: "Overall, GH considers the Clipper turbine design to be reasonable though novel, and the technology to be sound."

"GH understands the reasons for these [Clipper's] core design objectives. Given the industry's history with gearbox bearing failures, the desire to reduce the potential for failures of this type through a novel drive train concept is commendable. Likewise, the [Clipper's] other design criteria are all reasonable and, to a large extent, are consistent with trends in the industry towards the next generation of turbine."

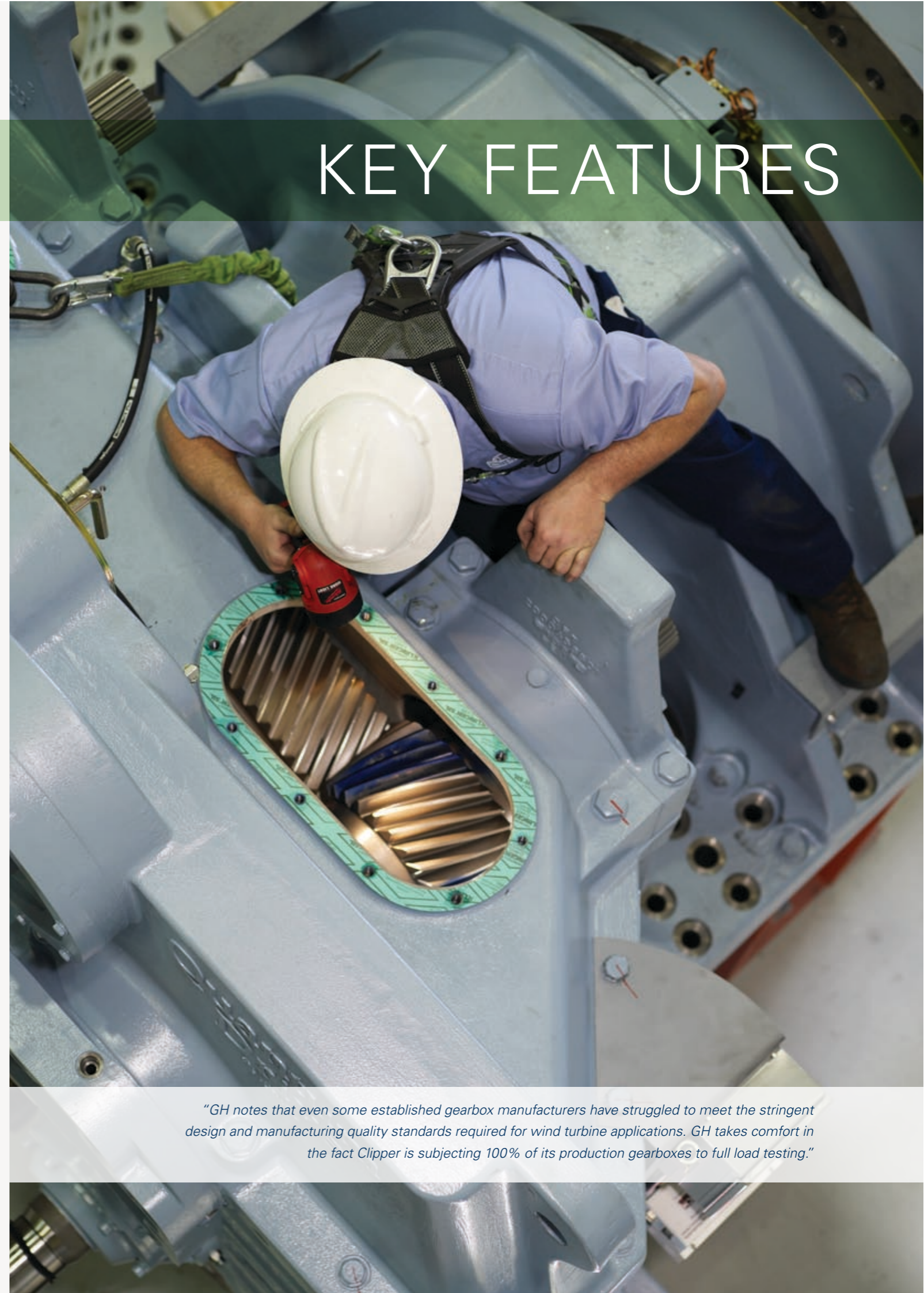
LIBERTY

KEY FEATURES

LIBERTY 2.5 MW WIND TURBINE – KEY FEATURES

Reduced Cost of Unscheduled Maintenance
 Greater Efficiency, Increased Production
 Improved Ownership Return
 Ease of Maintenance
 Grid Friendliness
 Lifetime Cost
 Versatility

Quantum Drive® distributed powertrain	•	•	•	•	•	•	•
Four MegaFlux® permanent magnet generators	•	•	•	•	•	•	•
Variable speed technology	•	•	•	•	•	•	•
IEEE 519 power quality, exceeds standards	•	•	•	•	•	•	•
Extended low voltage ride-through capability	•	•	•	•	•	•	•
Design architecture accommodates 50 or 60 Hz	•	•	•	•	•	•	•
SCADA monitoring & control system	•	•	•	•	•	•	•
CBMS predictive maintenance system	•	•	•	•	•	•	•
Multiple gear inspection ports in powertrain	•	•	•	•	•	•	•
Two-person service lift	•	•	•	•	•	•	•
Service platform with safe and ample work area	•	•	•	•	•	•	•
Internal 2-ton hoist	•	•	•	•	•	•	•
Hub accessibility from inside the nacelle	•	•	•	•	•	•	•
Comprehensive lightning protection	•	•	•	•	•	•	•
Crane size requirement for installation similar to 1.5 MW unit	•	•	•	•	•	•	•
GL certified cold weather capability	•	•	•	•	•	•	•
Rotor diameter choices for optimized power generation	•	•	•	•	•	•	•
Full Power Conversion	•	•	•	•	•	•	•
Generator cooling: Water-to-air or air-to-air configurations	•	•	•	•	•	•	•



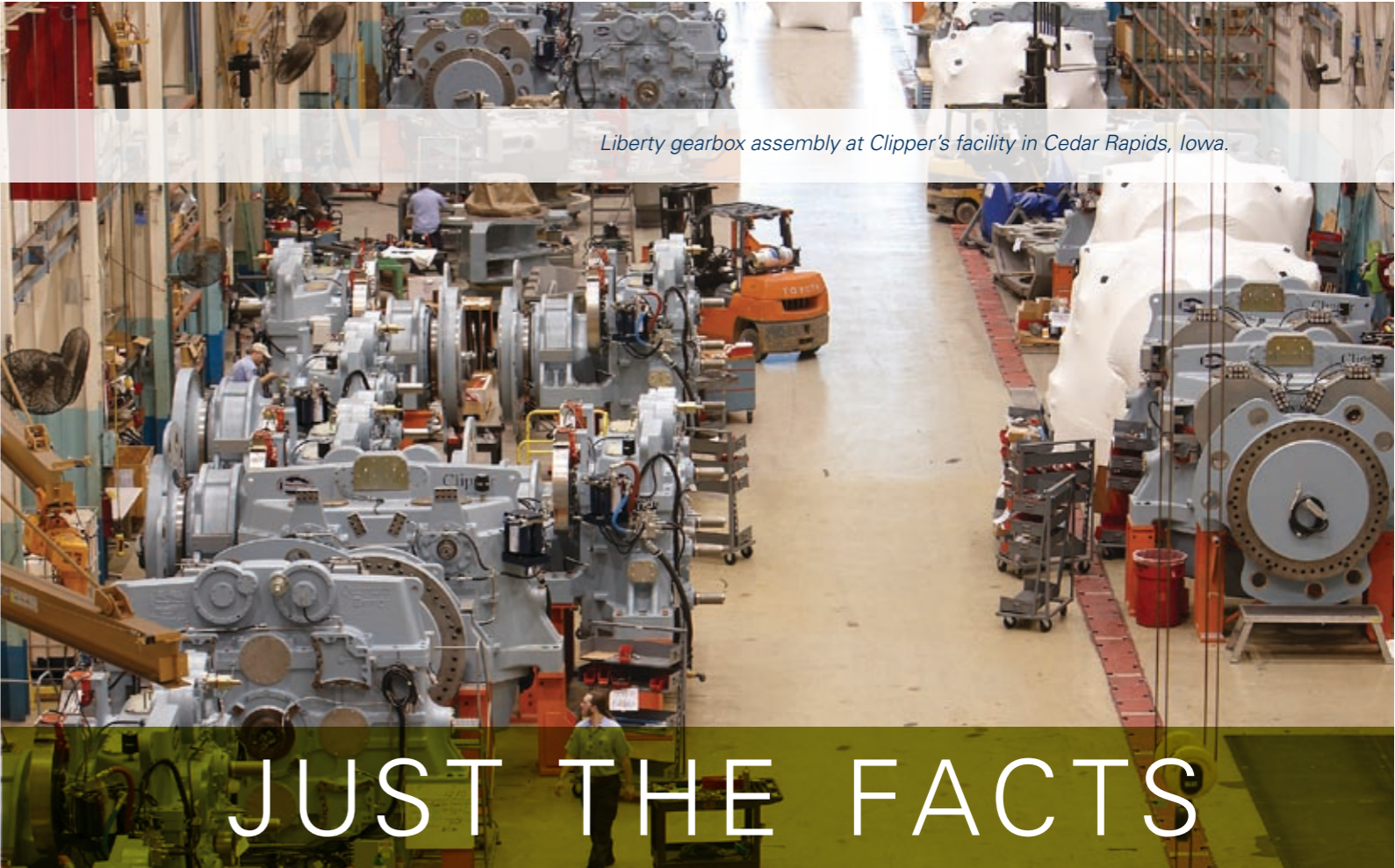
"GH notes that even some established gearbox manufacturers have struggled to meet the stringent design and manufacturing quality standards required for wind turbine applications. GH takes comfort in the fact Clipper is subjecting 100% of its production gearboxes to full load testing."

JUST THE FACTS

FEATURE	DETAIL	BENEFIT
Quantum Drive™ Distributed Powertrain	Liberty utilizes a compact, two-stage helical, distributed load path powertrain.	Increased reliability and durability. Higher efficiency in comparison to three-stage powertrain designs
	Four smaller high speed shafts distribute the output to four generators, reducing the potential for premature bearing failure and decreasing time and cost associated with generator service and repair.	Increased reliability and productivity.
	Two pre-loaded, low-speed taper-roller main bearings absorb thrust loads and mitigate problematic axial motion and mainshaft misalignment associated with low speed bearing failures.	Increased reliability, reduced downtime and extended turbine life.
	High-speed gear sets are in "cartridge" form. Replacement is conducted by way of an onboard hoist without removal of the gearbox, eliminating the need for expensive crane mobilization.	Reduced downtime, increased energy production, and substantially reduced long-term operating costs.
	Multiple inspection ports facilitate simple access for visual observation of the gears, enabling a more rigorous operations and maintenance protocol and earlier detection of abnormal wear.	Reduced unscheduled maintenance cost and increased energy production.
MegaFlux™ Permanent Magnet Generators	Permanent magnet generators offer advantages over induction generators in terms of increased power density, increased efficiencies at lower wind speeds, improved low-voltage ride-through capability when combined with full power conversion, and simplicity of design.	Nearly maintenance-free operation with higher efficiency, increased energy production, and a lower VAR requirement.
	Does not utilize slip rings or brushes. Historically, slip rings have been a maintenance issue requiring replacement more frequently than anticipated.	Higher efficiency.
	Stray current-induced pitting and bearing failures inherent in doubly-fed generators is eliminated, substantially extending bearing life.	Reduced unscheduled maintenance cost.
	There are no moving parts on the rotor in the rotating frame, thus the need for complex replacements of brushes, rotating rectifiers and exciters typical of doubly-fed generators is eliminated.	Reduced maintenance cost, increased reliability.
	Low short-circuit current reduces torque overload on the drivetrain due to electrical short circuit.	Extended gearbox life.
	Effective generator cooling design maintains temperature at less than Class F rise under all conditions. Form-wound Class H stator winding insulation.	Lower operating temperature provides for increased reliability, and longer life due to greater thermal margin.

FEATURE	DETAIL	BENEFIT
	The four-generator configuration and control capability can enable continued wind turbine operation with one or more generators removed until replacement is performed.	Reduced downtime, and greater productivity.
	Small, compact generators enable removal and replacement utilizing the onboard hoist, eliminating the need for expensive large crane mobilization.	Reduced downtime and long-term operating costs.
	Two IP54 configurations: "water-to-air" and "air-to-air" cooling configurations offer solutions for both mild and harsh operating environments.	Increased reliability and productivity and decreased downtime.
Variable Speed System	System is based on larger capacity IGBT's and proprietary permanent magnet generator technology which provides simpler, more reliable, more cost effective variable speed operation.	Higher energy capture. Increased productivity.
Full Power Conversion	Grid Isolation. Clipper's variable speed generator and inverter system completely decouples the generator from the grid, eliminating grid induced drivetrain torque excursions. Power Factor Control. Enables the operation with selectable power factor to near unity and as low as five percent load which minimizes or eliminates the need for VAR correction. Passive Rectifier. Conversion of the generator alternating current output to direct current for the input to the variable speed inverter offers a simpler variable speed system compared to other wind turbine designs. Unidirectional Power Flow. Clipper's variable speed inverter system is simpler, utilizes fewer parts, and delivers power exclusively from the generator's stator. In contrast, doubly-fed generator systems require power flow to and from the generator's rotor requiring high-power slip rings and brushes. Meets or exceeds IEEE 519 high quality power requirements worldwide now common in all major electricity power markets.	Improved gearbox reliability. Reduced overall system cost. Higher reliability and less downtime Lower operating and maintenance costs. Siting versatility. Increased productivity.
Low Voltage Ride-Through	The Clipper system stays online, helping to stabilize weak grid systems. The system provides low voltage ride-through capability of up to 3 seconds down to 10% of nominal voltage and for 150 msec down to zero percent, exceeding all low voltage ride-through requirements. Clipper's system exceeds the most stringent of grid requirements now in planning, enabling integration into the strictest regulatory environments.	Provides siting versatility and enables greater wind penetration on a given grid system.

Liberty gearbox assembly at Clipper's facility in Cedar Rapids, Iowa.



JUST THE FACTS

FEATURE	DETAIL	BENEFIT
Blades	Rotor sizes available for all wind regimes, including 89m, 93m, 96m and 99m.	Provides siting optimization benefits.
Blade Pitch System	Each blade has an independent electromechanical pitch system with battery back-up for power control and primary braking.	Increased reliability, higher availability.
Lightning Protection	Blade tip lightning receptors connect through brushes on the blade pitch bearings and main shaft, transmitting lightning strike current down the tower to ground. A steel mesh Faraday Cage is embedded within the structure of the nacelle providing an added lightning protection for service crews and machine safety, and immunity to radio frequency interference.	Reduced downtime, reduced cost, and greater productivity.
Advanced Cold Weather Package	Operates at temperatures down to -30 degrees Centigrade, survives to -40 degrees.	Greater energy capture and reduced downtime.
Installation Requirements	Crane size and duration requirements for the installation of the Liberty turbine are similar to that of a typical 1.5 MW machine.	Improved installation value on a cost-per-megawatt basis.
Service Lift	A two-person service lift facilitates timely and efficient service calls enabling crews to service more turbines per day. In addition, experienced service personnel can extend their careers without the limitation of stringent climbing requirements.	Higher turbine operating availability. Increased worker safety.
Interior Work Platform	Provides full stand-up workspace for several technicians as well as near obstacle-free walkways, facilitating ergonomic comfort, safety and ease of service for organized, efficient work performance.	Ease of maintenance. Increased worker safety.
EHS Equipment	Personnel evacuation equipment, including a self-rescue system.	Provides greater safety levels for service technicians. Increased worker safety.
Containment Deck	The nacelle includes a 125-gallon containment deck below the powertrain, preventing tower contamination and providing increased service crew safety.	Reduced downtime associated with spills. Increased worker safety.
Hub Access	The hub can be accessed through three entry ports from inside the nacelle, eliminating the need to exit to the nacelle topside to enter the hub, facilitating quick, simple and safe hub access, particularly in extreme weather conditions. Hub components, including pitch drives, can be lowered to the ground with a small, portable 2-ton hoist that attaches to lifting eyes inside the hub.	Decreased downtime associated with performing hub maintenance in severe weather. Increased worker safety. Reduced downtime for component change out. Ease of replacement and maintenance of components in the hub.

MANUFACTURING	BENEFIT
Quality	Clipper operates with 6 Sigma quality assurance practices, including tools and training for manufacturing practices, personnel training and quality assurance of suppliers. Clipper's ISO 9001:2000 compliant Quality Management System "QMS" manages the full life cycle of the product from design through ongoing operation and maintenance. Our fleet of professional QC staff is on-site at Clipper's Iowa facility as well as at the plants of our key component suppliers to ensure production to the highest standards. This proactive hands-on approach includes mandatory hold and inspection points within all of our production processes.
In-House Manufacturing Cedar Rapids, Iowa	Located in the middle of North America near major road, rail and river barge services. Clipper has invested significantly to ensure state-of-the-art operations. Affording over 330,000 square feet of manufacturing and assembly space, Clipper's facility includes full-scale wind turbine machine base, hub and gearbox assembly lines for the highest level of quality control and supply surety.
In-House Testing	Clipper built and operates two fully rated gearbox test stands as well as a generator test stand. Gearboxes and generators undergo a rigorous fatigue testing protocol prior to final sign-off and shipment.
Purpose-Engineered Component Manufacturing	Outsourced to select, reliable, well-established companies with specialized industrial expertise, and precision-made to Clipper's strict specifications for quality assurance, Clipper's component manufacturing is purpose engineered to the highest standards.
Safety	At Clipper, we're dedicated to the safe operation of our facilities and to the protection of our employees, the public and the environment. Our experienced staff includes a ratio of full-time EHS officers to employees that is among the highest in the wind energy industry. Our practices meet or exceed local, state and federal agency standards.
Operation, Maintenance & Remote Monitoring	Clipper provides service support, covering both scheduled and unscheduled maintenance, and maintains a 24/7 Remote Monitoring and Diagnostics Center (RMDC) at its Cedar Rapids plant. The RMDC interfaces with project sites to shut down and bring on-line turbines that are going into or coming out of a maintenance cycle. The RMDC is also active throughout the turbine commissioning process. Clipper's Fleet Service team is among the wind industry's most skilled, with decades of experience providing a highly qualified professional base.
Warranty	Warranties are available to suit our customer's needs similar to other industry standard packages.
Our People	Clipper's team represents one of the broadest and deepest levels of experienced wind industry professionals. The global staff includes a strong ratio of professionals with 10 to 20 years of proven wind energy expertise throughout the full range of key staffing roles – experience gained through prior employment within the industry's top wind energy companies.

TECHNICAL SPECIFICATIONS - LIBERTY 2.5 MW WIND TURBINE

Power Output 2500 kW
 Operation Variable Speed: 9.6 - 15.5 rpm

Model	C89	C93	C96	C99
Wind Class	Ia*	IIa	IIb	S
Rotor Diameter	89m	93m	96m	99m
Swept Area	6221m ²	6793m ²	7238m ²	7698m ²
Blades	43.2m	45.2m	46.7m	48.2m

*Class Ia - All parameters same as IEC Class Ia except 50-year return gust value is 64.5 m/s instead of 70 m/s

Cut-in Wind Velocity 4 m/s - 10 min. Average
 Cut-out Wind Velocity 25 m/s - 10 min. Average

Pitch System 3X DC Electric-Mechanical Gear-motor, Servo Drives and Batteries

Generator Type Synchronous Permanent Magnet
 Rated Power Each 660 kW at 1133 rpm
 Number of Units 4
 Voltage 1320 VDC at Rated Power

Controller Type Embedded Motorola Power PC
 Voltage 3 Phase 480 VAC

Power Converter Type 4X, Voltage Sourced, IGBT Based
 6 Pulse, Inverters
 Voltage 690 VAC, 50Hz or 60Hz + 3Hz

Grid Compatibility Frequency-Continuous 50Hz or 60Hz + 3Hz

Line Voltage 690 VAC + 10% Continuous

Line Fault Ride-Thru -90% of Nominal Line for 3 sec.

Line Phase Imbalance Rated Power + 5%, Cut-in + 10%

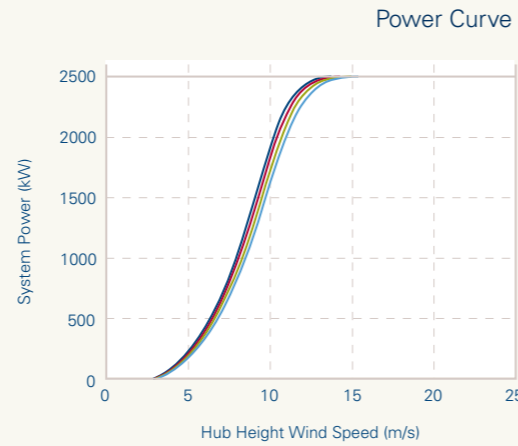
Yaw System 4 Electro-Mechanical Motors with Planetary Drives
 Yaw Bearing Internal Gear, Ball Bearing
 Yaw Brake System Disc, 4 Active Hydraulic Brake Calipers

Parking Brake System Dual Disc with Active Hydraulic Brake Calipers
 Parking Brake Location Intermediate Stage of Gearbox

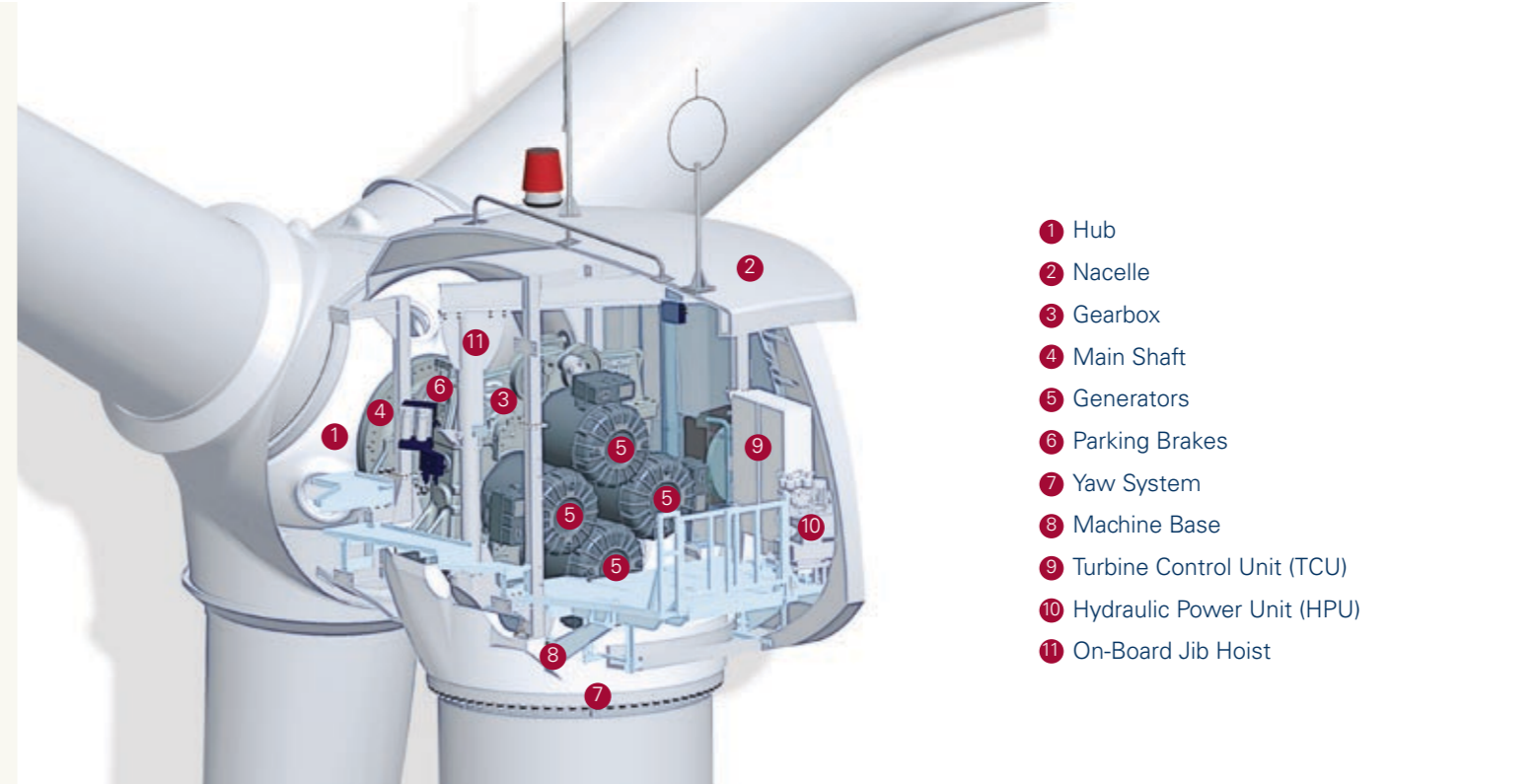
Tower Partial Conical - Tubular Steel, 4 Steel Plate Sections
 Hub Height 80m Standard / Other Options Available

Service Hoist On-Board, 2 Metric-ton Hoist

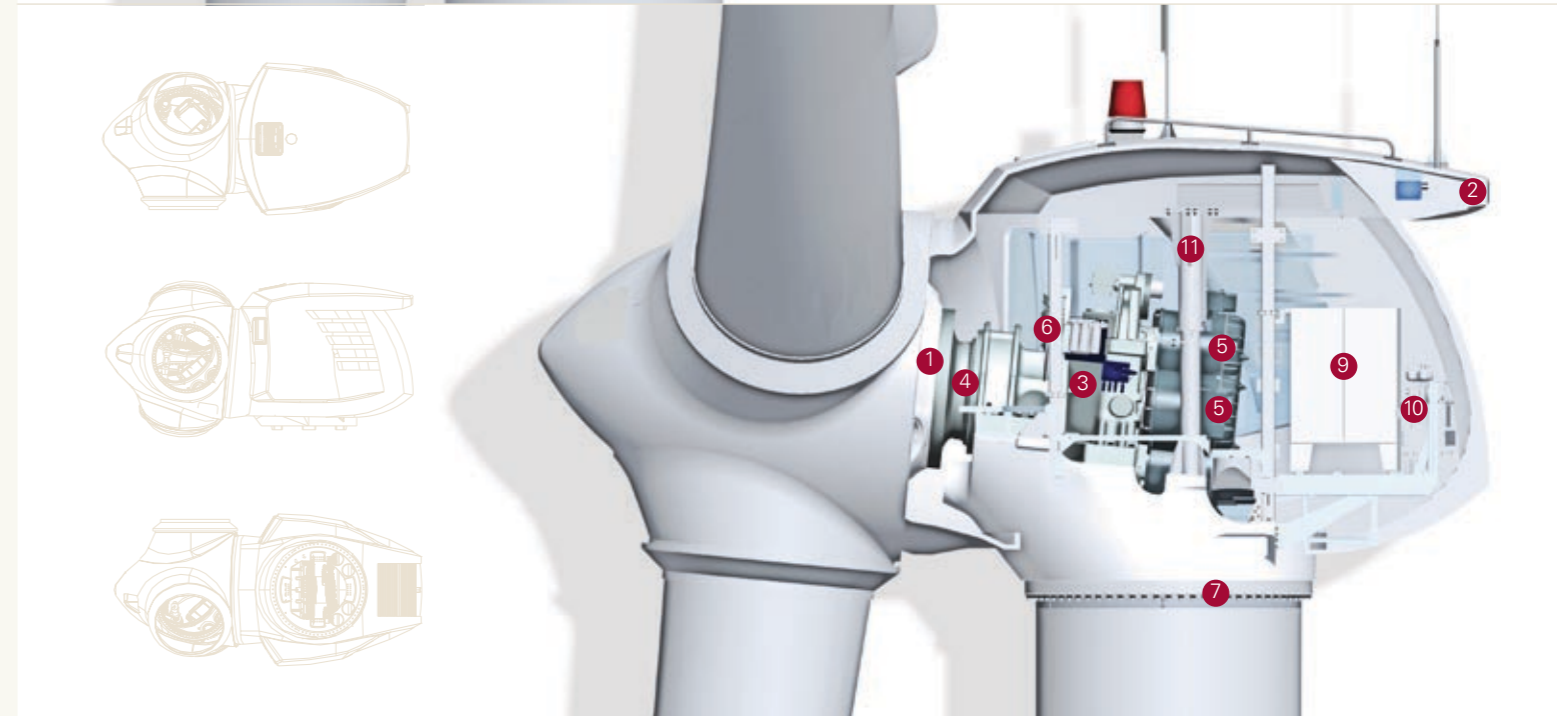
Maintenance Post Commissioning Once at 700 Hours, Every 6 Months Thereafter



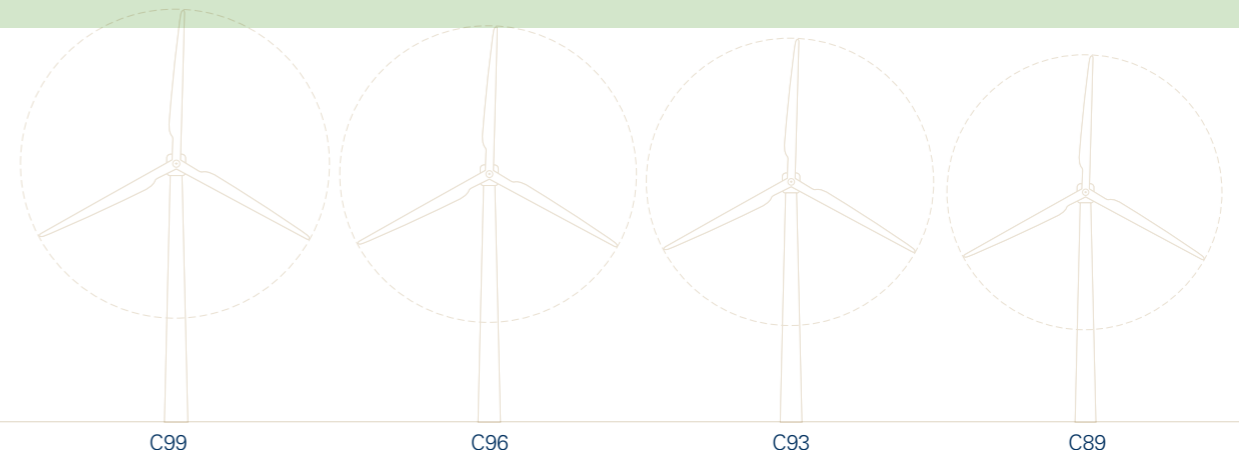
— C99, class S
 — C96, class IIb
 — C93, class IIa
 — C89, class Ia*



- 1 Hub
- 2 Nacelle
- 3 Gearbox
- 4 Main Shaft
- 5 Generators
- 6 Parking Brakes
- 7 Yaw System
- 8 Machine Base
- 9 Turbine Control Unit (TCU)
- 10 Hydraulic Power Unit (HPU)
- 11 On-Board Jib Hoist



SPECIFICATIONS



C99

C96

C93

C89



Clipper Windpower is a rapidly growing company engaged in wind energy technology, turbine manufacturing, and wind project development. With offices in the USA (California, Colorado, Iowa and Maryland), Mexico, Denmark and the United Kingdom, and a ISO9001:2000 QMS Certified, 330,000 square foot manufacturing and assembly facility located in Cedar Rapids, Iowa, the company designs advanced wind turbines, manufactures its 2.5-MW Liberty wind turbine and actively develops wind power generating projects in the Americas and Europe. Clipper is a public company listed on the London Stock Exchange's Alternative Investment Market (AIM). Clipper's ticker symbol is CWP.

The ordinary shares of Clipper Windpower Plc are traded on the Alternative Investment Market of the London Stock Exchange and are not registered under the U.S. Securities Act of 1933, as amended. Such shares may not be offered or sold to residents of the United States or to persons acting on their behalf, or to other persons who are "United States Persons" within the meaning of Regulation S as promulgated under the Securities Act of 1933, unless such shares have been registered under the Securities Act or there is an available exemption from registration.

Clipper Windpower Plc

United States of America
6305 Carpinteria Ave., Suite 300
Carpinteria, California 93013
Tel: +1-805-690-3275
Fax: +1-805-899-1115
Web: www.clipperwind.com

Clipper Windpower Marine Limited

United Kingdom
CPTC
High Quay
Blyth
NE24 2AZ
Tel: +44-20-7820-1078
Fax: +44-20-7820-7078

