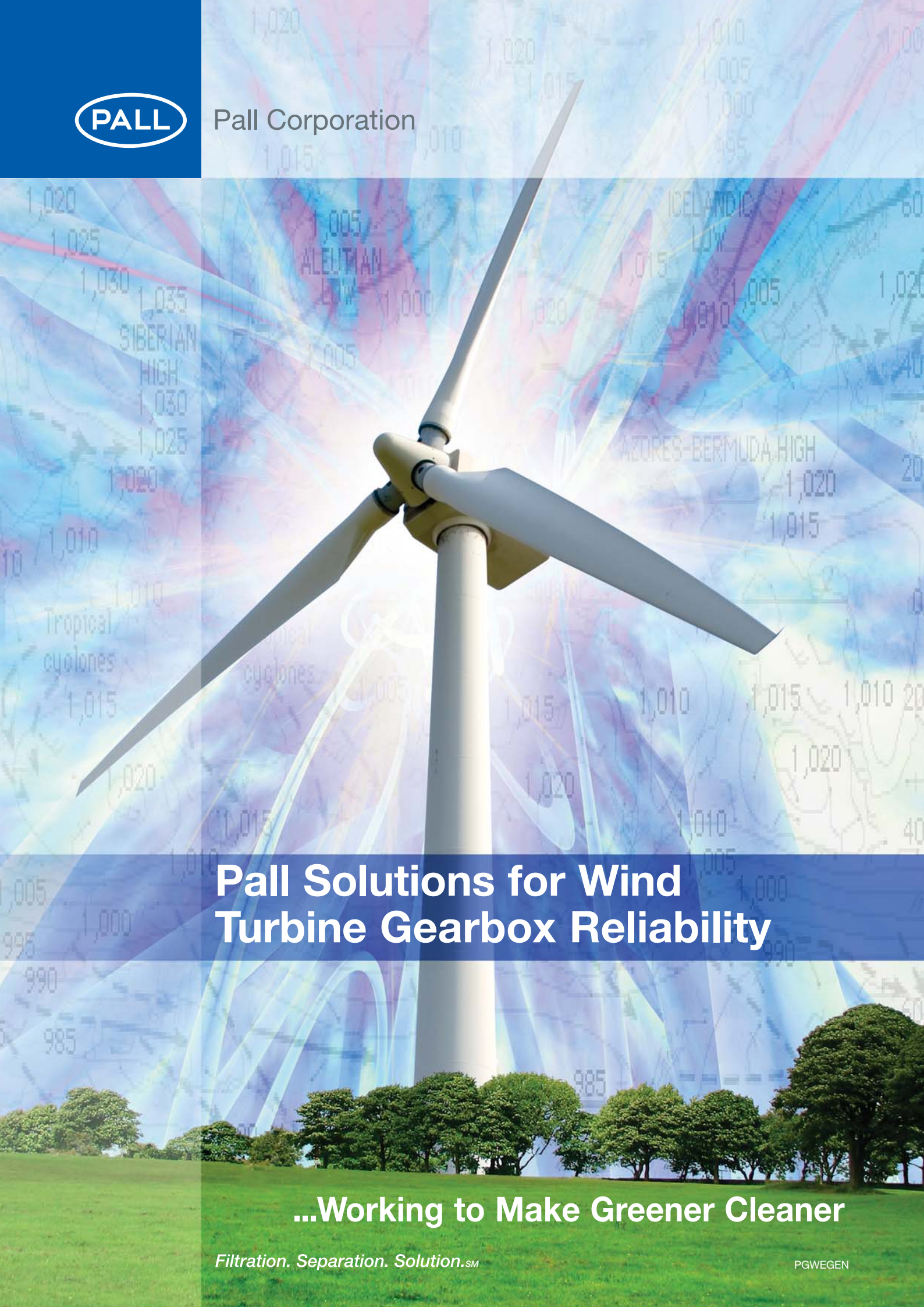
Pall Corporation



Pall Solutions for Wind Turbine Gearbox Reliability

...Working to Make Greener Cleaner

*Filtration. Separation. Solution.*SM

PGWEGEN

Pall Solutions for Wind Turbine Gearbox Reliability

For manufacturers and operators of wind energy generating turbines, reliability, remote monitoring and ease of component maintenance are critical factors in their successful and viable operation.

Clean, efficient, plentiful….

The promise of clean, unlimited wind energy presents many technical challenges for the components in the windmill nacelle. Often located in extremely remote locations and tens of meters in the air, reliability is paramount and failure not an option. Components need to be compact and lightweight yet provide exceptional service life in the most demanding of operating environments.

Among the most critical components, the gearbox has to operate under extreme stresses and operating conditions. Its critical parts, bearings and gears must be protected by a lubrication fluid free of particulate and water. Only with the best filtration available can the gearbox sustain years of operation under some of the most demanding conditions anywhere, including:

- Wide variations in rotor loads transferring to the gearbox
- Potentially high ingression of contaminants, either solid (dust), liquid (aerosols or rain), or gaseous (moist air)
- Limited access for unscheduled maintenance: This is especially true in the case of offshore windfarms, or large capacity onshore generators
- Vibration
- Wide variation in temperatures

All these factors contribute to increased levels or wear in the gearbox and bearings unless suitably protected using a high performance, high efficiency filtration.

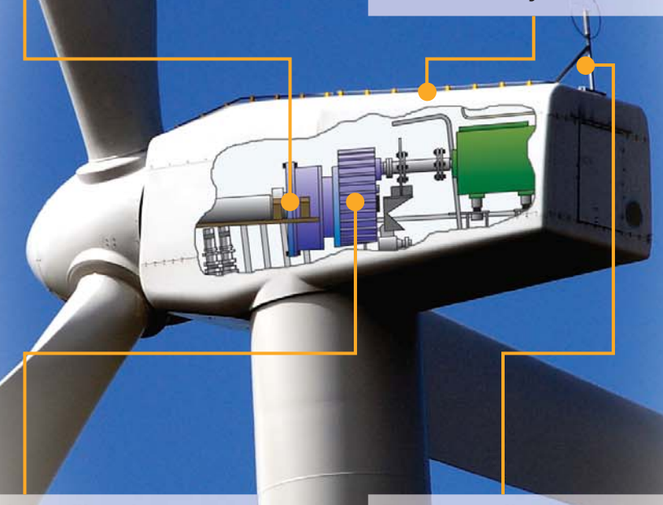
‘Components need to be compact and lightweight yet provide exceptional service life in the most demanding of operating environments’

Hydraulic system filtration

- Protection of valves against wear, stiction and jamming
- Better response of pitch and stall system
- Light weight filter systems

Protection against airbourne contaminants

- Air filtration for nacelle protection against moisture and salt in offshore WEGs
- Reservoir-mounted air breather against airborne contaminants and moisture
- Ultipleat® SRT oil filter technology for high resistance to stress, cold start and cyclic conditions



Gearbox lube filtration

- Protection against gear and bearing wear with inline and off-loop filtration options
- Long element life with innovative media and pleat design
- Consistent performance and resistance to extreme conditions
- Lightweight, metal-free element for ease of service

Remote oil condition monitoring

- Combined water and particulate monitoring
- Rugged, simple, accurate
- Proven in extreme industrial applications
- Ferrous and non ferrous particle detection

The Pall Solution

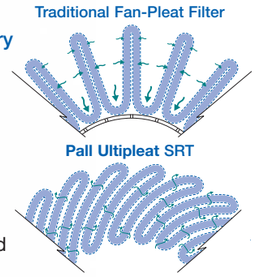
Inline Protection

The **Pall Ultipleat®** SRT oil filter range is the perfect fit for windmill gearbox applications.

- The high performance, highly efficient **Ultipleat** SRT filter media (beta x = 1000) will remove critically sized 5-10µm particulate from lube oils reliably and consistently throughout the full life of the filter.
- Filter life is optimized by the innovative wave shaped laid over pleat design, allowing more media to be packed into a small space.

The optimized fan-pleat geometry of SRT filtration provides:

- Uniform flow distribution and increased capacity
- Maximum filter surface area and element life



- The SRT (stress resistance technology) allows the filter to retain the captured contaminants in arduous operating conditions. **Pall** SRT filter elements are designed to sustain wide variations in flow conditions, viscosity, temperature and pressures across the element without degrading the removal efficiency necessary in today’s wind turbines.
- The compact filter housings are manufactured in aluminium alloy to reduce weight and painted for corrosion resistance.
- When scheduled maintenance can be made, the filter assembly cap service and ‘Autopull’ feature makes maintenance quick and simple – no bowl removal is required and the filter element is removed with the action of unscrewing the cap.

Up and Downstream Mesh Layers: Create flow channels for uniform flow through the filter.

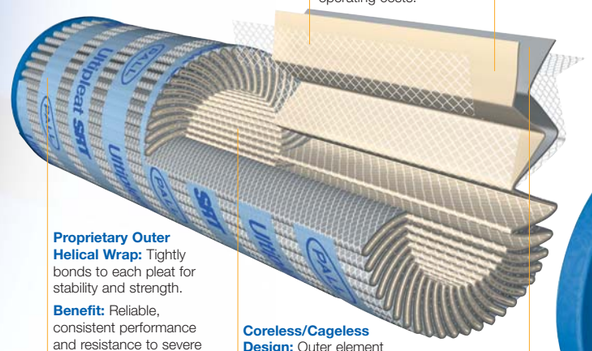
Benefit: Extended element life for lower operating costs.

Proprietary Cushion Layer: Provides support for the media and protection from handling.

Benefit: Reliable, consistent performance

O-ring Seal: Prevents contaminant bypassing the filtration medium under normal operation.

Benefit: Reliable, consistent filtration performance.

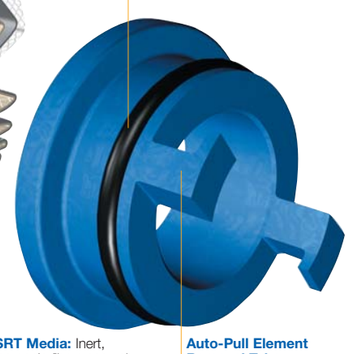


Proprietary Outer Helical Wrap: Tightly bonds to each pleat for stability and strength.

Benefit: Reliable, consistent performance and resistance to severe operating conditions

Coreless/Cageless Design: Outer element cage is a permanent part of the filter housing

Benefit: Lighter, environmentally friendly element for reduced disposal costs and ease of element change-out.



SRT Media: Inert, inorganic fibers securely bonded in a fixed, tapered pore structure with increased resistance to system stresses such as cyclic flow and dirt loading.

Benefit: Improved performance over the life of the filter and more consistent fluid cleanliness.

Auto-Pull Element Removal Tabs: Auto-Pull tabs for automatic element extraction upon opening the housing.

Benefit: Ease of element change-out.

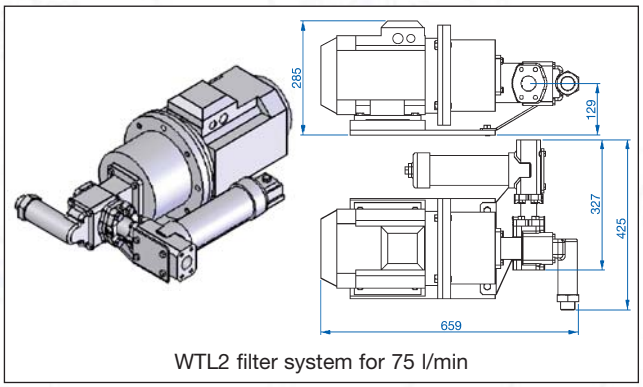
PALL
Ultipleat® SRT
FILTRATION

WTL series off-loop filtration system

Pall Ultipleat SRT off-loop filter and pump set

Pall's WTL series recirculation system for gearbox lubrication oil is a self contained, compact and very efficient solution to keep the lubricating oil in optimum conditions, while the inline filter concentrates on direct component protection. The WTL series filter system is designed to:

- Connect easily on the lube oil reservoir, with its own pump
- Be available in three flowrates: 12, 75 and 120 l/min
- Provide continuous cleaning of the oil with **Ultipleat** SRT filtration to remove particles smaller than 10 microns, in any operating conditions, including cold start
- Extend the life of the inline filters by maintaining overall system cleanliness
- Combine with **Pall** monitoring equipment to provide total cleanliness control of the gearbox



WTL2 filter system for 75 l/min

Pall Monitoring solutions

Continuous monitoring and early detection of bearings mechanical wear are critical in operating wind turbines efficiently and cost effectively. **Pall** monitoring solutions are designed to be complete, rugged, and reliable. They are the eyes and ears of the wind turbine operators looking to improve the operation and reliability of gearboxes.

Particle Monitoring

Pall PCM400W

Pall Contamination Monitors (PCM)
The **Pall** PCM series contamination monitors can operate accross a wide large viscosity range and being based on mesh blockage mechanisms are not susceptible to the presence of air bubbles, free water, and opaque fluids. Easily connected to central control systems, they form the first line of defense against gearbox failures.

Pall Chip Detectors
Capable of full flow inline detection of contamination spikes, in all operating conditions, chip detectors can detect surges in particles over 50 microns in the fluids. Specifically designed as contamination alert systems, they combine responsiveness with ruggedness.

Water sensors

Pall water sensors continuously measure inline water content of the lube oil. The water sensor's ability to track relative humidity allows turbine operators to detect a rise in water content long before the formation of free water.

Filter Life indicators

Pall Deltalog™ filter life indicators monitor element pressure drop, fluid temperature and remaining life of the hydraulic and lube filters. With early information on expected replacements, **Pall Deltalog** facilitates maintenance planning and filter parts management.

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