

Technical Disclosure¹

1. Title

Wind Turbine Blade Hardware Retention Plate with Magnetic Attachment to the Rotor Hub

2. Publication date

21st May 2026

3. Publication venue

<https://prev-www.gepower.com/wind-power/about/technical-disclosures>

4. Publication type

Technical Disclosure

5. Abstract

A hardware retention system is disclosed for use in a wind turbine blade-to-hub bolted joint. The system includes a retention plate configured to span multiple blade bolts along the bolt circle diameter and to be positioned over the protruding ends of the blade bolts on the hub side of the joint. The plate includes holes aligned with the respective bolts such that the plate can be slotted over the bolt ends and rest on the joint hardware, such as the nuts. The retention plate is secured to a hub-side surface, such as the inner ring of a pitch bearing, by magnetic attachment. In the event of bolt failure, the retention plate restrains broken bolts, nuts, washers, or other hardware from becoming liberated and falling into the rotor hub. The system is particularly suited for retrofit installation on existing wind turbines and can be removed quickly to permit inspection and maintenance of the blade bolted joint.

6. Technical field

The present disclosure relates generally to wind turbine rotor assemblies and, more particularly, to hardware retention systems for blade-to-hub bolted joints. More specifically, the disclosure concerns a retention plate assembly configured to prevent failed blade joint hardware from detaching into the rotor hub.

7. Background

Wind turbine blades are commonly attached to a central rotor hub by a circular bolted joint. In service, one or more bolts in this joint may fail due to fatigue, overload, loosening, or other operating conditions. When such failure occurs, the associated broken hardware, including bolts, nuts, and washers, may become detached from the joint and fall into the interior of the rotor hub.

Detached hardware within the rotating hub can strike structural and functional components, including pitch system equipment such as motors, cabinets, switches, and other control hardware. In certain circumstances, such damage may impair blade pitch functionality, causing the blades to remain at an undesirable angle and thereby threatening turbine performance and structural integrity.

¹ GE and the GE Monogram are trademarks of General Electric Company used under trademark license. © 2026 GE Vernova and/or its affiliates. All rights reserved.

Detached hardware may also exit through hatches or openings and fall down the tower, creating a significant safety risk for personnel and surrounding property.

A practical solution is needed to retain failed blade-joint hardware before it becomes liberated. Such a solution should be compatible with existing turbine architectures, should preferably avoid requiring permanent modification of the hub structure or blade joint, and should allow convenient removal or access during routine maintenance operations, including periodic torque checks of blade bolts.

8. Summary of the disclosure

The disclosure provides a retention plate system that spans multiple blade bolts of a blade root bolted joint and physically blocks failed hardware from falling into the rotor hub. The retention plate includes a series of holes arranged to align with corresponding blade bolts, allowing the plate to be installed by passing it over the protruding bolt ends on the hub side of the joint. Once positioned, the plate may rest on the nuts or other existing hardware of the bolted joint.

In a preferred embodiment, the retention plate is secured to a hub-side structure, such as the inner ring of a pitch bearing, by one or more magnets. The magnetic attachment resists circumferential, radial, and other unwanted movement of the plate while avoiding the need for additional anchoring features or modifications to the hub. Because the plate is not primarily retained by the bolts themselves, the system can continue to restrain broken hardware even if one or more of the spanned bolts fail.

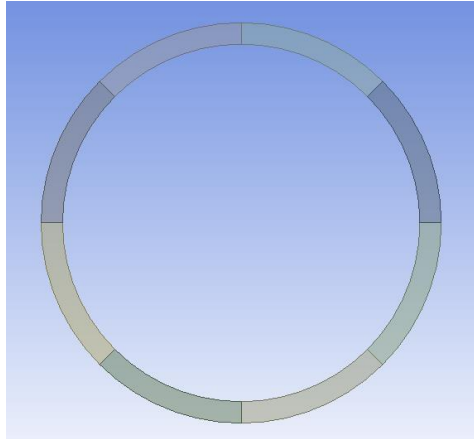
The disclosure also encompasses embodiments in which the retention plate spans selected portions of the bolt circle rather than the full circumference, as well as embodiments using alternative securement methods, including nuts, clamps, snap rings, retaining caps, tie-offs, or other attachment arrangements. The system is suitable for new installations and retrofit use.

9. Brief description of drawings

- A perspective or sectional view of a wind turbine blade-to-hub bolted joint showing a retention plate installed over protruding blade bolt ends.



- Illustrations of plate geometries having different numbers of bolt holes, such as 11-hole and 12-hole plate embodiments.



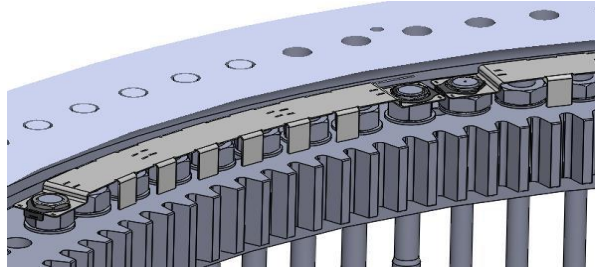
- A view showing a preferred embodiment in which the retention plate is secured by magnets to the pitch-bearing inner ring.



- Views showing alternative embodiments in which retention plates are installed only at selected circumferential locations rather than around the entire blade root circumference.



- Views showing alternative embodiments including radial walls with methods other than magnetic attachment.



10. Detail description

In one implementation, a wind turbine blade is connected to a rotor hub through a bolted joint arranged about a bolt circle. On the hub side of the joint, ends of the blade bolts extend beyond corresponding nuts. A retention plate is configured with a pattern of holes matching the bolt pattern for a selected set of adjacent bolts. The retention plate is placed over the protruding bolt ends so that the bolt ends pass through the holes and the plate comes to rest against the outer faces of the nuts or other existing joint hardware.

The retention plate may be formed as an arcuate segment corresponding to a portion of the bolt circle. Multiple plates may be used together to cover a larger circumferential extent, including substantially the full inner ring circumference if desired. In some examples, two or more plates having different hole counts may be combined to suit a particular hub geometry or bolt distribution.

In a preferred embodiment, one or more magnets are coupled to the retention plate and engage a ferromagnetic hub-side surface, such as the inner ring of the pitch bearing. The magnetic force secures the plate against unintended movement and holds the plate in position during operation. The magnetic securement allows the plate to be installed and removed without special tools and without requiring additional modifications to the existing turbine structure.

The retention plate is dimensioned such that, during normal operation, it does not interfere with pitch-bearing rotation or adjacent hub components. Plate thickness, inner radius, outer radius, and hole dimensions may be selected according to the geometry of the specific turbine platform and the amount of bolt extension beyond the nuts after assembly. Examples include plate configurations with inner and outer radii sized to fit the inner ring region and hole patterns selected for specific bolt-circle arrangements.

During a bolt failure event, any broken bolt, nut, washer, or associated hardware that would otherwise detach into the hub is intercepted and retained by the plate. Because the plate is slotted over multiple bolt ends and held in place relative to the hub structure, the failed hardware remains captured locally near the failed joint position rather than being released into the rotating hub cavity.

The disclosed system is particularly advantageous for retrofit installation. A technician may carry the assembled plate and magnetic securement components into the hub and position the assembly over the selected blade bolts. The plate may then be attached directly to the pitch-bearing inner ring or another suitable surface. During scheduled maintenance, the technician may detach the magnetic attachment by hand, remove the plate, perform torque checks or other inspection tasks, and reinstall the plate with minimal additional maintenance time.

The disclosure also contemplates embodiments in which the retention plate is secured by other means. For example, one or more end holes of the plate may be retained using low-profile nuts, washers, clamps, snap rings, retaining caps, wire tie-offs, or dedicated anchor points. In some embodiments, the retention plate may include radial walls or other raised features that further improve hardware capture or stiffness. In other embodiments, plate segments may be located only at selected high-risk regions of the joint instead of being distributed around the full circumference.

11. Advantages

The disclosed system provides several technical and practical advantages, including:

- Prevents broken blade-joint hardware from falling into the rotor hub.
- Reduces the risk of damage to hub structures and internal pitch-system components.
- Reduces safety risks associated with detached hardware exiting the hub or falling down the tower.
- Can be retrofitted to existing wind turbines without substantial modification to the hub structure or existing blade bolted joint.
- Allows quick installation and removal, including manual removal in embodiments using appropriately sized magnets.
- Supports routine maintenance access, including torque checks on blade bolts.
- Uses a relatively simple design that may be manufactured using conventional processes and off-the-shelf components.
- Can be adapted to different turbine platforms by varying plate size, hole count, thickness, and segment arrangement.
- Minimizes installation error because the plate holes align directly with the protruding bolt ends.
- May be lightweight enough for technicians to transport and install within the hub environment.

12. Example Embodiments

Example Embodiment 1: Magnetic segmented retention plate

A retention plate spans a plurality of adjacent blade bolts and includes holes aligned with the protruding ends of those bolts. The plate is installed over the bolt ends and rests against the nuts. One or more magnets secure the plate to the inner ring of the pitch bearing. If one of the spanned bolts fails, the plate prevents the failed hardware from falling into the hub.

Example Embodiment 2: Multi-segment circumferential coverage

A plurality of arcuate retention plates are arranged around the blade root circumference. Each plate spans a subset of the total blade bolts. Together, the plates provide broad or full circumferential hardware retention coverage while still allowing segmented installation and removal.

Example Embodiment 3: Platform-specific plate geometry

For a selected turbine platform, an 11-hole plate and a 12-hole plate are used to cover portions of the inner ring region. Plate inner radius, outer radius, thickness, and hole diameter are chosen based on the bolt circle radius, total number of joint holes, and bolt extension length after assembly.

Example Embodiment 4: Partial-location retention system

Retention plates are installed only at selected circumferential positions judged to present elevated risk or to correspond to specific maintenance or design criteria, rather than around the entire blade root circumference.

Example Embodiment 5: Retention plate with radial walls

A retention plate includes one or more radial wall structures or raised containment features to provide additional physical restraint of failed hardware or to increase stiffness of the plate.

Example Embodiment 6: Alternative securement embodiment

Instead of magnetic attachment, the retention plate is secured using low-profile nuts, clamps, snap rings, retaining caps, wire tie-offs, or another attachment mechanism that restrains plate movement while still permitting installation and removal.

13. Industrial Applicability

The disclosed system is applicable to utility-scale wind turbines and other rotor systems using large, bolted joints where detached hardware presents operational or safety concerns. The retention plate may be used in manufactured original equipment, field retrofit programs, maintenance upgrades, and service campaigns. The invention is particularly relevant to wind turbine operators, manufacturers, and maintenance providers seeking to improve turbine safety, reduce secondary damage from bolt failures, and simplify field implementation without major redesign of existing hardware.

14. Variations and Alternatives

Numerous variations and alternatives may be implemented without departing from the general principles of the disclosure. For example:

- The retention plate may span any suitable number of bolts.
- The plate may cover selected regions or substantially the entire circumference of the blade root joint.
- The plate may be formed from steel, stainless steel, aluminum, composite materials, or other suitable structural materials.
- Magnetic attachment may be replaced or supplemented by mechanical fasteners, clamps, straps, wires, anchors, retaining rings, or custom brackets.
- The holes in the plate may be circular, slotted, keyed, or otherwise shaped to facilitate installation and retention.
- The plate may rest directly on nuts, washers, spacers, standoffs, or other surfaces.
- Raised walls, lips, pockets, cages, or enclosures may be added to improve capture of failed hardware.
- Multiple smaller plates may be used instead of one larger plate, or vice versa.
- The system may be adapted for different blade bolt diameters, bolt circle radii, and turbine platform geometries.
- Additional features such as coatings, corrosion protection, identification markings, or inspection indicators may be incorporated.

Alternative approaches to solving the same general problem may include safety wires attached to individual bolts, netting, retaining rings joining multiple bolts, or enclosures positioned to catch liberated hardware. Such approaches are recognized as alternatives, but the present disclosure particularly emphasizes a plate-based retention concept, preferably with magnetic attachment.

15. Conclusion

The present disclosure describes a practical and effective system for retaining failed hardware from a wind turbine blade-to-hub bolted joint. By using a retention plate positioned over protruding blade bolt ends and secured to a hub-side structure, preferably by magnetic attachment, the system prevents broken hardware from entering the rotor hub and causing secondary damage or safety hazards. The disclosed design is simple, adaptable, retrofit-friendly, and compatible with routine turbine maintenance practices, making it well suited for implementation across a range of wind turbine platforms.

/// END OF PUBLICATION ///