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PROPER IDENTIFICATION AND UNDERSTANDING OF FASTENERS IS CRITICAL IN WIND INDUSTRY APPLICATIONS

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> *"The number of hash marks on the top of the bolt determines the grade of the bolt."*

In the U.S. there are two distinct types of fasteners (bolts) used in wind turbines. One is of metric sizing and the other is a U.S. standard. Metric fasteners tend to cost more in the U.S. as they are still not the norm for our American society.

If a fastener needs to be replaced and you have to call in an order to make the replacement, you may have to determine what type of fastener it is.

In order for a tech to select the correct fastener, he needs to be able to first determine if the fastener that is to be replaced is a standard bolt or a metric bolt.

For bolts this is usually pretty easy. Metric bolts have numbers marking the top of the bolts; while standard bolts typically have hash marks.

The number of hash marks on the top of the bolt determines the grade of the bolt. Metric bolts used in wind have markings such as 8.8, 9.8, 10.9 and 12.9. If you see markings like that, you know it is a metric fastener.

Standard bolts used in wind typically have: no markings; three hash marks; five hash marks; or six or more hash marks. Unfortunately, these hash marks do not directly state the grade of the bolt. You have to add two to the total of the hash marks to get the bolt grade. For a bolt with: no marking, add two, which is a "grade 2;" three hash marks, add two, so it is a "grade 5;" six hash marks is a "grade 8." What if a bolt has more than six hash marks? It is called "better than grade 8."

Confused yet? Okay, well just so you know: the larger the number, the better the grade of the bolt.

But there is still more to know. Sometimes you can replace a metric fastener with a standard fastener to save time or money, or in cases when the metric bolt isn't readily available and you need to quickly get a turbine back online.

When you need to substitute a standard bolt for a metric bolt, you can use the following comparison: A grade 8.8 metric bolt is about the same as a grade 5 standard; a grade 10.9 metric is about the same as a grade 8 standard; and a grade 12.9 is about the same as a "better than grade 8" standard bolt.

Other important factors in identifying fasteners are size and length. Bolt sizes are determined by the diameter of the shank of the bolt, not the head of the bolt. Bolt lengths are determined by measuring the length of the shank of the bolt, excluding the head, in millimeters for metric bolts, and in inches for standard bolts.

The nuts that are used on the bolts are not typically identified and if you had a mixed bag of standard and metric of similar size you would have to test-fit them on the threads to see if they are metric or standard. There is much more, but let's move on.

It pays to know your washers too. There are a few different types of washers used in wind. Without going into all the different types of washers, let me give you one hint on using washers on critical connections: Always use "hardened" washers. This is because you don't want

to use a soft washer in a critical load path in which the washer can be squeezed, squished out, and thinned. If it thins out, the bolt will loosen and the connection can fail. This can make you think that you didn't properly tension your bolt! Using hardened washers will help prevent the washer from causing a failed connection. If you don't know if the washers are hardened, don't use them.

Let's discuss tensioning fasteners a little bit further. Have you ever taken a spring and placed it in tension? Take, for example, the spring from a retractable ball-point pen. At some point, most anyone who works with machinery has disassembled a ball-point pen. If you pull the spring in tension a little bit and then let it go, the spring returns to its original shape. You can pull harder on this spring and it will continue to return to its original shape when you let go. At some point, however, if you pull it hard enough, the spring will reach its "yield point," and will not return to its original shape when released. This is very similar to a bolt that is being tensioned. We typically are instructed to tension a bolt to within 75 percent or greater of its yield strength. If we over-tension the bolt, it will exceed its yield point. An over-tensioned bolt is just like that over-stretched spring. The bolt becomes damaged and will not function correctly to maintain its tension.

Notice that I said "tension" and not "torque." When we torque a bolt, we are basically trying to achieve the proper tension. Many things can affect the resulting tension while torquing a bolt. Dirty bolt threads will cause increased friction and can result in a lower tension than expected. The same size bolt with clean and oiled threads will result in more tension while applying the same torque Did you know that if you handle the threaded portion of a bolt with your hands, that the oil from your skin is enough to affect the friction of the bolt and can result in a tension higher than expected? I find it much easier to use lubricated torques for consistent results and it takes less physical effort to achieve the target tension.

There is much more to cover but hopefully this has raised some curiosity and improved your understanding of fasteners used in the wind industry.

As always, work as safe as possible, and work to prevent surprises.

HEADLINES

GE lab to focus on innovation in wind turbine drivetrain repair

GE recently announced the opening of its Global Wind Turbine Drivetrain Repair Innovation Lab at the site of GE's Power Generation Repair Technology Center in Albany, N.Y.

The facility is equipped with advanced technologies to support fast development and innovation for repairs to the wind turbine's gearbox and rotor, creating a lab environment to simulate and solve problems that previously had to be worked on more than 100 meters in the air and at remote sites.

Technical capabilities of the Innovation Lab include:

- Rapid prototyping tools such as 3D printers and computer numerical control machines.
- Robotic welding and advanced machining tools.
- Repair of various gearbox models.
- Turbine generator repair.

Andy Holt, general manager of global wind projects and services, said: "This is the first facility of its kind dedicated to developing repair technologies and capabilities that reduce the life cycle cost of wind turbines. Albany was an ideal location for the facility with its close proximity to GE's renewable energy headquarters, the GE Energy Learning Center as well as the existing Repair Technologies Center. It is uniquely positioned for collaboration with the field, design engineering, training and product service teams."

The Innovation Lab aligns GE with customer needs by helping reduce maintenance and operating costs. GE engineers will have the space and resources to rapidly prototype and develop new technologies to apply to field service repairs. The team will focus on innovative approaches while fully vetting tooling and processes, keeping in mind safety, cost and the ability to address multi-unit configurations. With proximity to GE's renewable energy headquarters in Schenectady, the team at the Innovation Lab also will work closely with product engineering to improve serviceability.