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A Wind Turbine Burns Down – Did it Have to Happen?

Reliable Technology Protects Against Irreparable Damage

There are many wind turbines installed throughout the world already, and experience has shown that they are prone to severe damage. In fact, it is not unusual for wind turbines to catch fire. Once this happens, a flaming, 30-m long rotor blade may crash to the ground from a height of 100 m. In extreme cases, the towers threaten to break or topple over. In many countries the fire department cannot extinguish fires at such a height. Instead, they can only cordon off the area and let the system burn in a controlled manner. As a result, the damage can quickly reach into the millions of dollars under certain circumstances, depending on the size of the turbine. This raises the question: how can we make wind turbines safer?

To answer this question, manufacturers have defined key areas to eliminate every source of error in advance. This is why Vishay investigated the connection of capacitors in particular. It was possible to trace some of the faults causing fires to defective electrical connections. The most important requirements placed on an electrical connection include contact pressure that is adequate over the long term and a low contact resistance. If the contact pressure is too low or if the contact resistance is too high such as happens in an intermittent contact, the power dissipation, converted to heat, increases when current flows at the connection point.
As electrical connections are made of metal, the resistance increases with increasing temperature and may generate temperatures of up to 600°C at the defective connection point depending on the magnitude of the contact resistance and of the current flowing ($P = R * I^2$). A technician considers a power dissipation of 50 watts or more combustible. Processes that change the current load can increase a contact resistance that is already too high even further because they subject the electrical connection to expansion and contraction due to pronounced thermal stress. This results in a further degradation of the contact pressure. In addition, the thermal stress usually causes a further degradation in the conductivity of the conducting material leading to even higher contact resistance. Aggravating factors also include the following: It is almost impossible to detect defective electrical connections with a contact resistance that is too high all the time even using regular, comprehensive inspections. This is because the resistance of these connections can change depending on the operating state of the turbine. These conditions may also develop slowly over years.

Using Obsolete Technology

The investigations yielded the following: Electronic circuit boards used in the nacelle today predominantly use spring connections to handle the aforementioned problem of increased contact resistance. Even if these spring connections are a recognized and proven connection technology in terms of cost-effectiveness and flexibility, many manufacturers of power capacitors still rely on screw connections. The greatest disadvantage of these is that, despite the cable making contact, installers cannot determine visually whether they tightened all screws reliably with the correct torque. With several capacitors connected in parallel with a battery, the situation becomes virtually unmanageable.

Figure caption: ESTAspring protects valuable investments against irreparable damage without any screws at all using springs and lever action. (Photo: Vishay)

Capacitor with Spring Connection

To solve this problem arising from loose connections especially in environments undergoing permanent vibrations over the long term, Vishay developed the ESTAspring, a new generation of LVAC power capacitors that do not use any screws and have lever-action spring contacts. The capacitors of the PhMKP Series are available with rated voltages of 230 V to 1000 V, maximum reactive powers ranging from 2 KVAR to 37.1 KVAR and maximum connection currents of up to 90 A. They have stainless-steel springs, are corrosion resistant and are available in designs with an oil filling or dry with a gas filling. These are the first capacitors of this type worldwide using the ESTAspring technology. They use a lever-lock spring connection for premade flexible conductors from 2.5 to 25 mm² with bootlace ferrules. The maximum rectangular crimp geometry is 6.0 x 7.6 mm. The spring used is made of stainless steel. The conductor material is a copper alloy. It can carry currents of up to 90 A. No tools are needed to insert the conductor directly into the clamping unit. With the orange, offset lever, operation is intuitive and easy using force that is user-friendly. The unit itself, without any torque specifications, provides the connection force needed. A simple visual check is possible for completeness of the connections using the lever position. The lever being closed assures reliable contact. This also eliminates the potential source of error in industrial series production of simply overlooking the clamping units.

Figure caption: Quick and easy – ESTAspring reduces assembly time by 60 percent

The UL/ULC has approved the polypropylene foil capacitors, in combination with ESTAspring, as a complete system. They provide a completely maintenance-free connection for applications such as low-voltage power-factor improvement or harmonic filters in wind turbines as well as other applications subject to high vibration stress. The always-constant contact force assures reliable connection over the entire service life of the capacitor. This makes them ideal for applications where there is the risk that a screw connection might come loose. This renders fires caused by defective capacitor contacts in the nacelle virtually impossible.

Figure caption: For reactive power compensation, a discharge resistor can be inserted on the back using the push-in feature. The resistor can be released again at the press of a button.

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Vishay Intertechnology, Inc., a Fortune 1000 Company listed on the NYSE (VSH), is one of the world's largest manufacturers of discrete semiconductors (diodes, MOSFETs, and infrared optoelectronics) and passive electronic components (resistors, inductors, and capacitors). These components are used in virtually all types of electronic devices and equipment, in the industrial, computing, automotive, consumer, telecommunications, military, aerospace, power supplies, and medical markets. Vishay's product innovations, successful acquisition strategy, and "one-stop shop" service have made it a global industry leader. Vishay can be found on the Internet at www.vishay.com.