

## Mid-South Engineering Company

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### VFD Caused Induction Motor Bearing Failures

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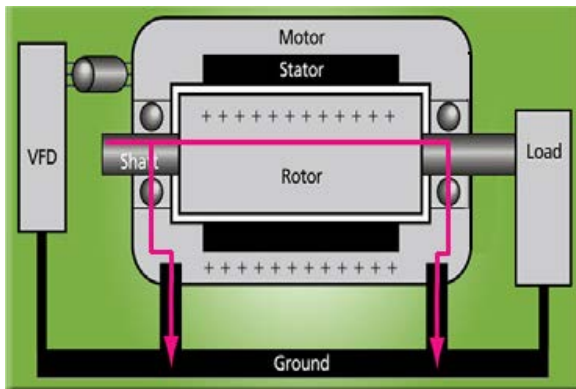
First, let us provide an explanation of what a VFD represents. Basically a Variable Frequency Drive (VFD) converts or rectifies the incoming 50/60 Hz power to D.C. Then it re-converts or inverts this D.C. back into an A.C. output but with a variable or adjustable fundamental frequency. This A.C. output (to the motor) is through Pulse Width Modulation (PWM) in the VFD's inverter section. This is accomplished by using solid state switching devices such as insulated gate bipolar transistors (IGBT's), gate turn off (GTO's), or bipolar junction transistors (BJT's). These devices enable the VFD to produce an output with PWM. The PWM output is simply a series of D.C. voltage pulses of constant amplitude but with varying pulse width. This happens for both the positive and negative half cycles of the original incoming 50/60 Hz power supply. The newer VFD's with IGBT's produce D.C. pulses with very fast voltage rise times. This is good since it provides more precise speed control but it can also cause problems in motors or in a cable system between a drive and motor.



Figure 1

**Fluting:** In a phenomenon known as fluting, the operational frequency of the VFD causes concentrated pitting at regular intervals along the bearing race wall, forming a "washboard" pattern. This pattern results in vibration and noise.

### Bearing Failure



The use of VFDs to control AC motors has increased dramatically in recent years. In addition to lower operating cost and high performance, they save energy. Today, the challenge facing system designers and engineers is to minimize damage to AC motors from shaft current.

Electrical damage to VFD/AC motor bearings begins at startup and is caused by the discharge of capacitively coupled currents from the shaft of the motor through the bearings to the frame of the motor. These currents are due to the capacitive relationship between the stator and the rotor during high frequency PWM control. Due to high frequency PWM control, currents can flow through the wire insulation, stator slot liners, motor air gap, bearings and stator slot top sticks.

The discharge of current through the bearings usually results in something called **Fluting**, see Figure 1. To prevent such damage, the induced shaft current must be diverted from the bearings by insulation and/or an alternate path to ground.



"The Barn" built in the 1930's to house Welsh ponies, serves as Mid-South's offices.

## VFD Motor Bearing Failures - Continued

## Document Control: More than Filing

By: Bill Pflieger

Insulation: Insulating motor bearings is a solution that tends to shift the problem elsewhere as shaft current looks for another path to ground. Sometimes, because of the capacitive effect of the ceramic insulation, high-frequency VFD induced currents actually pass through the insulating layer and cause bearing failure. If attached equipment, such as a pump, provides this path to ground, the other equipment often winds up with bearing damage of its own.

Alternate discharge paths: When properly implemented, these strategies are preferable to insulation because they neutralize shaft current. Techniques range in cost and sometimes can only be applied selectively, depending on motor size or application. The ideal solution would provide a very-low-resistance path from shaft to frame, be low-cost, and could be applied across all VFD/AC motor applications.

To be continued...

Part 2 includes discussions on motor Protection and Testing. If there are any questions I can be contacted via email at [bsparks@mseco.com](mailto:bsparks@mseco.com)

### Adapted from:

IEEE-112-2004, "IEEE Standard Test Procedure for Polyphase Induction Motors and Generators,"

<http://www.nasatech.com>

<http://ecmweb.com>

<http://www.greenheck.com>

<http://www.emisymposium.org/13th.papers/docs/EML087.pdf>

[www.est-aegis.com](http://www.est-aegis.com)

<http://www.egr.msu.edu/~jurkovi4/bearingcurrent.pdf>

Projects rely heavily on the availability of information surrounding the scope or the breadth and depth of each component making up the operation. This information can come from a dynamic range of sources and in many different types of media and should be managed appropriately. Additionally, people who work together on a project need a method for sharing their work while minimizing or eliminating the opportunities for misunderstandings and confusion which waste time and money. Creating a uniform, consistent, and transparent method of document control can have great implications on a project's success.

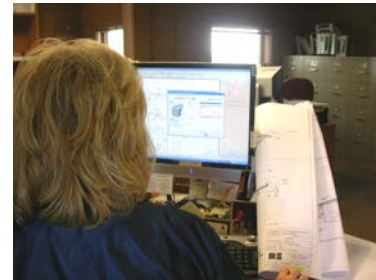
Today, projects require a high level of document control in order to deal with the large volume of incoming and outgoing information and to facilitate the design and execution processes. Much of this information is conveyed electronically along with more traditional methods, for example, hard copies of drawings. Creating a process for indexing, creating, approving, publishing, and accessing information has benefits on several levels:

First, it provides a system for incoming information to be stored and utilized later.

Second, it facilitates a higher level of reliability and insight during the design phase.

Third, it allows for the conveyance of ideas to clients, contractors and involved agencies much more easily and readily.

Fourth, it provides a forum upon which shared work can be evaluated and progress can be mapped as the project moves forward.



Moreover, these benefits can streamline all processes of a project and reduce costs to clients by eliminating waste created by misunderstanding, improper information, confusion, and wasted time.

Finally, a project which has implemented proper document control will produce a complete record to be utilized again and facilitate future projects, maintenance or upgrades.

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"You must manage a business, but you have to lead people."

Norman Schwartzkoff



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