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Case Study

Installation of AEGIS SGR™ Bearing Protection Ring at Time Life Building

Date: March 9, 2009

AEGIS SGR™ Bearing Protection Ring:

Purpose: To protect VFD/AC Motor Systems from VFD induced electrical bearing failure.

Objective: To measure shaft voltages before and after AEGIS Bearing Protection Ring installation and 12 months after installation.

Location: Time Life Building
1271 6th Avenue
Rockefeller Center
New York City, NY

Equipment: 36 S 4 Supply Fan
Baldor 50 HP motor
Magnatek drive
Trane Air Handler

Installation Date: 6-Feb-2008

12 Month Check: 9-Mar-2009

Installation By:

AKF Analysis and Testing
and
Electro Static Technology-ITW

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Test Measurement Objective:

(1) Measure ground reference for baseline comparison

(2) Measure VFD induced shaft voltage with no AEGIS SRG™ protection

(3) Measure shaft voltage with AEGIS SGR™ Bearing Protection Ring installed

(4) Measure shaft voltage with AEGIS SGR™ after 12 months operation

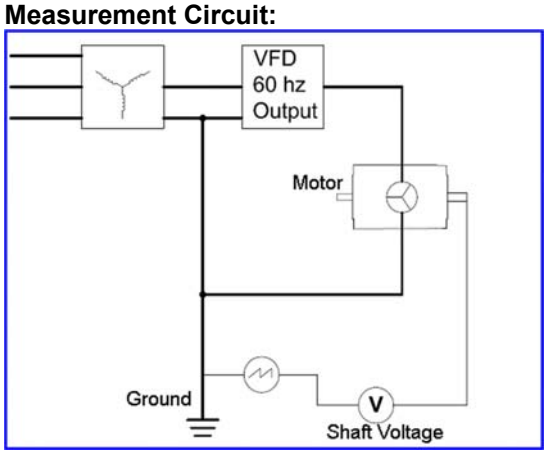
Field Measurement:

Date: Feb 6, 2008 (before)
Feb 20, 2008 (after)

Motor: Baldor 50hp

DE Shaft "U" Dimension: 2.125"

Measurement Circuit:



Test Equipment:

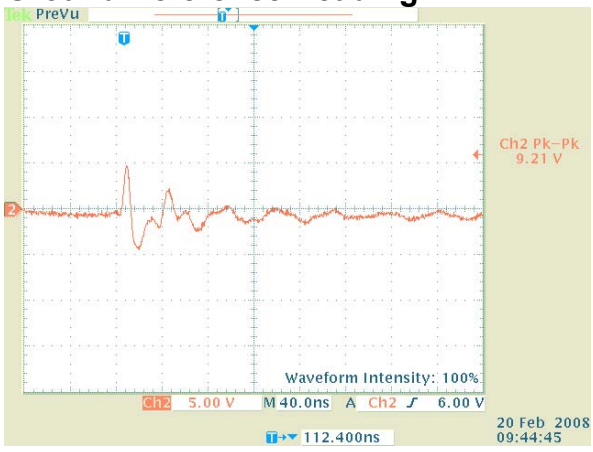
Oscilloscope: Tektronix TDS 3064B
600 MHz 5GS/s

Oscilloscope Voltage Probe: Tek P5100
100x2500 V pk

Microfiber Shaft Voltage Probe

36th Floor, Motor 36 S 4

Ground Reference Reading



Observation:

Volts: 9.21 V pk-pk
Oscilloscope setting: 40.0ns/div
Date: 20-Feb-08
Time: 9.44 am

Ground reference reading was taken with oscilloscope touching the motor frame.

Voltage measured is ground noise produced by radiated stray voltages

Ground reference voltage may be subtracted from the grounded shaft voltage measured after AEGIS was installed.

Electro Static Technology™
An ITW Company

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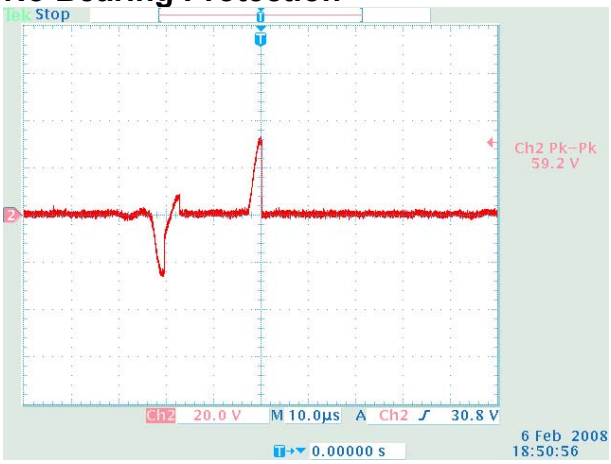
Shaft Voltage Reading
Prior to AEGIS SGR Installation
Series 1: 6-Feb-2008

Reading #1

Voltage 59.2

No Bearing Protection



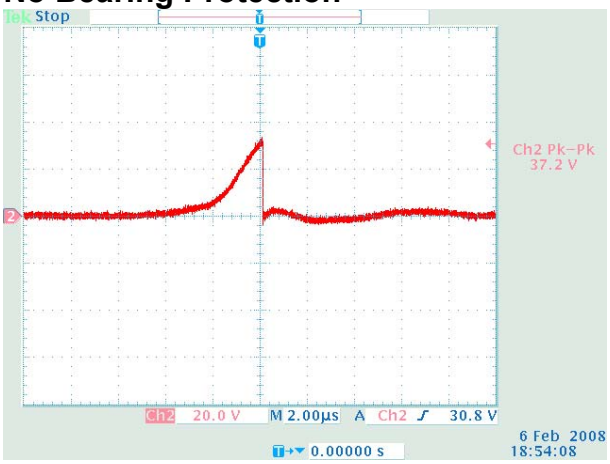
Observation:

Volts: 59.2 V pk-pk
Oscilloscope setting: 10.0µsec/div
Date: 6-Feb-08
Time: 18:50 pm

Reading #2

Voltage 37.2

No Bearing Protection



Observation:

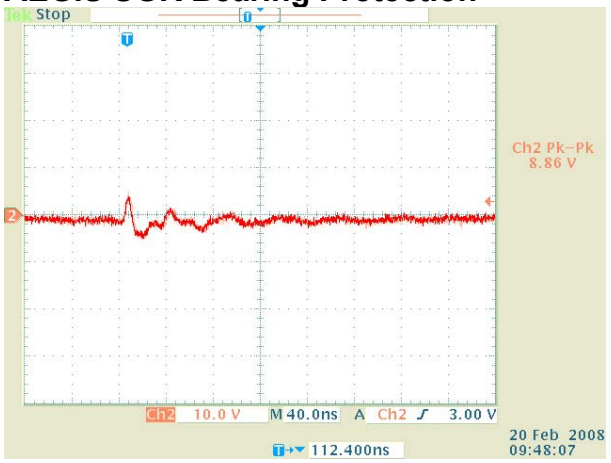
Volts: 37.2 V pk-pk
Oscilloscope setting: 2.00µsec/div
Date: 6-Feb-08
Time: 18:54 pm

Shaft Voltage Reading
After AEGIS SGR Installed
Series 2: 20-Feb-2008

Reading #1

Voltage 8.86

AEGIS SGR Bearing Protection



Observation:

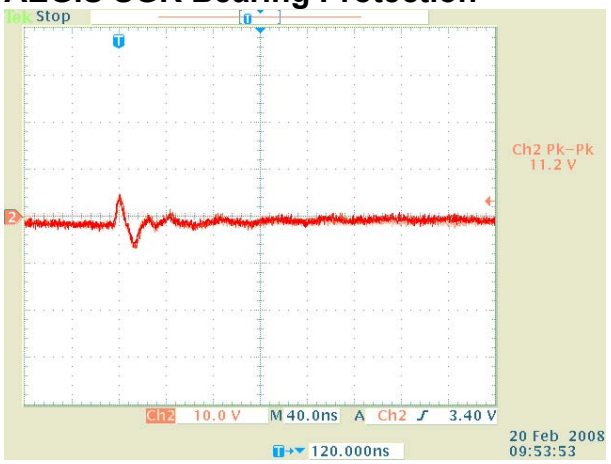
Volts: 8.86 V pk-pk
Oscilloscope setting: 40.0ns/div
Date: 20-Feb-08
Time: 9.48 am

Same as ground reference reading

Reading #2

Voltage 11.2

AEGIS SGR Bearing Protection



Observation:

Volts: 11.2 V pk-pk
Oscilloscope setting: 40.0ns/div
Date: 20-Feb-08
Time: 9:53 am

Same as ground reference reading

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Field Installation:

Date: Feb 6, 2008
Motor: Baldor 50hp
DE Shaft "U" Dimension: 2.125"

Parts Installed:

AEGIS SGR PN: **SGR-71.5-3FH**
ETE Collar PN: **ETE75-2.125-K-1**
Mounting Kit: **SGR-M330-1 (custom 13" diameter plate with spacers)**

1. Attached equipment was disassembled for AEGIS SGR installation.
2. Shaft was cleaned and free of any coatings, paint, or other nonconductive material. Shaft was lightly sanded to remove any oxide coating.
3. DE shaft has a shaft step. Step was not long enough to mount SGR direct to step diameter. A mounting kit was needed for installation.
4. Installed ETE Collar onto the shaft and secured with set screw.
5. AEGIS SGR and attached mounting plate was placed onto the ETE Collar. SGR was evenly spaced around the ETE Collar. Drill points were marked on the end bell of the motor. SGR and mounting plate was removed.
6. Drilled 3 holes using a #29 drill. Depth of ¼". Tapped each hole with a #8-32 tap.
7. AEGIS SGR and attached mounting plate was installed and secured to the motor with spacers and screws.

Note: Mounting plate OD dimensions were established before attached equipment was removed. Once the attached equipment was removed, a more qualified measurement was taken. The plate could have been only 7" in diameter.

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12 Month Voltage Measurement – 9-Mar-2009

Field Measurement after installation:

Date of Measurement: Mar 9, 2009

Motor: Baldor 50hp Super E

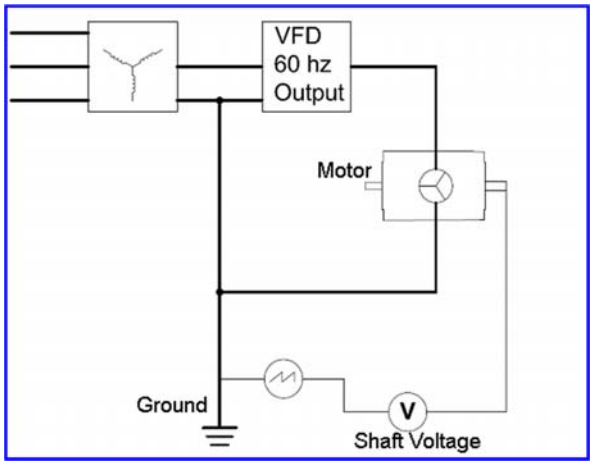
DE Shaft "U" Dimension: 2.125"

Test Equipment:

Oscilloscope: Fluke 199C Scope Meter 200 MHz 2.5GS/s

Probe: Fluke VPS200-R with AEGIS SVP Shaft Voltage Probe

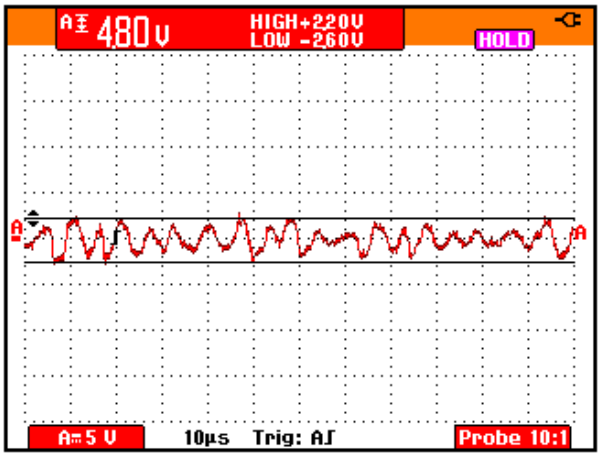
Measurement Circuit after installing AEGIS SGR:



Reading #1

Voltage 4.80

AEGIS SGR Bearing Protection



Observation:

Volts: 4.80 V pk-pk
Oscilloscope setting: 10.0us/div
Date: 09-Mar-09

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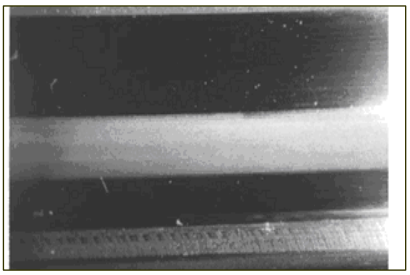
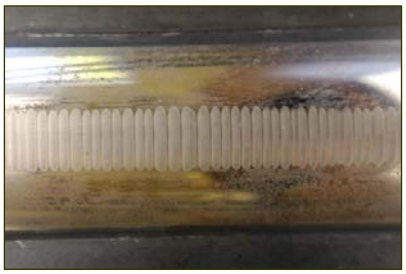
Background:

36 S 4 Supply Fan Motor in Time and Life Building, Rockefeller Center, NYC: This Baldor 50 HP motor is operated on a Magnatek VFD and supplies air from the 36th floor mechanical room. The motor had a history of repeated bearing failures and vibration analysis determined the failure mode to be from electrical bearing current discharges.

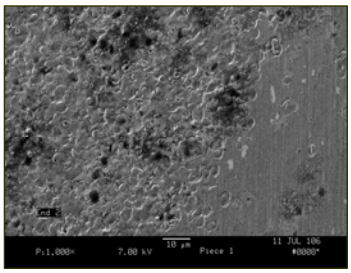
Root cause of VFD induced bearing's failure: Electrical voltages are induced onto the shaft of the motor through parasitic capacitive coupling between the stator and rotor. The high frequency voltage changes in the pulse width modulation (PWM) drives cause electrical discharge machining (EDM) when the currents arc through the dielectric oil film in the bearing. These bearing current discharges result in pitting and fluting of the bearing race and catastrophic bearing failure.



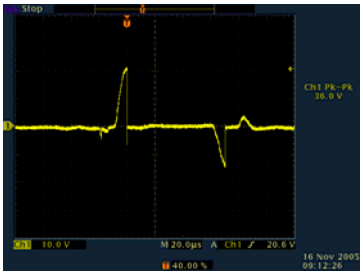
EDM pitting (frosting line) on bearing race from electrical bearing currents



Fluting on bearing race results from continuous electrical discharges



Scanning Electron Microscope of pitted/fluted surface



Typical Shaft Voltage Reading of VFD induced EDM effect

Reference Information:

- Shaft voltages will vary depending on motor and system. Typical peak to peak voltages are 20 to over 60 volts and may be measured on the motor shaft while rotating.
- Shaft voltages will rise until they overcome the bearing lubricant and will then rapidly discharge through the motor bearing which is seen in the rapid collapse from the peak to ground.

Objective:

To reduce down time, repair and maintenance costs associated with VFD controlled motor systems by:

- Minimizing electrical bearing currents in motors
- Providing safe discharge path for shaft voltages
- Channel destructive bearing currents away from motor bearings to ground

Field Test Trial: Application/configuration: Install AEGIS SGR™ Bearing Protection Ring with Electron Transport Enhancement technology and test/monitor for 12 month period.

Test measurements: (1) Measure ground reference for baseline comparison; (2) Measure VFD induced shaft voltage with no AEGIS SRG™ protection; (3) Measure shaft voltage directly after AEGIS SGR™ Bearing Protection Ring was installed, (4) Measure shaft voltage after 12 months operation.

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Analysis/Comparison: Confirm AEGIS SGR™ Bearing Protection Ring functionality with real time documented shaft voltage before and after bearing protection ring is installed on the motor and compare to voltage readings. Compare ground readings to compare ground noise readings with grounded shaft voltage readings.

After minimum 12 months operation re-measure the shaft voltage and compare to shaft voltage measurements taken directly after installation of AEGIS Bearing Protection Ring™

Test results:

Three series of shaft voltage readings were recorded on February 6th 2008 prior to AEGIS SGR installation and on February 20th 2008 after AEGIS was installed on VFD controlled motor then again after 12 months operation on March 9th 2009.

Series 1: Motor with no bearing protection ring installed: **Average 48.2 V pk-pk**

Series 2: Motor with AEGIS SGR: **Average 10.03 V pk-pk**

Series 3: Motor with AEGIS SGR after 12 months operation: **4.80 V pk-pk**

Conclusions:

(1) Unprotected motor has high shaft voltage readings with bearing discharge pattern in wave form. Readings varied between 37.2 V pk-pk and 59.2 V pk-pk.

(2) Rapid dv/dt Voltage collapse at training edge of wave form is typical of bearing EDM discharge which causes pitting and fluting damage//electrical bearing failure.

(3) Adding AEGIS SGR™ to motor reduced voltage initially to **10.03 V pk-pk**

(4) **After 12 months operation the shaft voltage measured 4.80 V pk-pk.**

(5) Motor bearings are protected from VFD induced bearing currents by grounding motor shaft with AEGIS SGR Bearing Protection Ring. This provides an alternate discharge path for induced shaft voltage, away from the motor bearings to ground.

(6) There was a dramatic reduction in voltage before AEGIS SGR was installed from 48 V pk-pk down to 10 V pk-pk which is a normal observed reading with the micro fiber shaft grounding ring installed.

(7) The reading observed after 12 months was also a greatly reduced peak-peak reading of 4.8 volts indicating continued effective operation of the AEGIS SGR.

Note that the voltage reading after 12 months was actually less than the initial voltage reading on 20-Feb-2008. Normal shaft voltage discharges with conductive micro fiber shaft grounding ring installed on a VFD driven motor will vary based on the operation of the motor at the time that measurements are taken.

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Recommendations:

- Install AEGIS SGR™ on all VFD driven motors per manufacturer application recommendations.
- Install new motor bearing prior to installation of AEGIS SGR.
- AEGIS SGR may be installed prior to bearing changes to reduce the impact of bearing currents if damage is not already indicated.

For more information please contact:

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