DYKMAN ELECTRICAL, INC.

VFD'S AND LONG MOTOR LEADS

Put on by Bruce Reeves

Covering the Western US

For all of your VFD and Soft Start and Motor Needs

NEW LOCATION

- 5481 SWANSON ROAD
- UNIT C
- GILLETTE, WY

How To Specify a Variable Frequency Drive

- What is the FLA of the Motor?
- What is the application?
- How will the drive be controlled
- Enclosure needs
- Communications needs
- Elevation

YASKAWA
The Drive for Quality™

AC DRIVE
MOTOR LEAD LENGTH ISSUES

for

WESTERN MINING ENGINEERS ASSOCIATION

Presented by

Jim Wilson

Regional Drive Specialist

Why Use VFDs ???

Increased Energy Savings

Reduced Inrush Current

Improved Power Factor

80% Speed = 50% Energy Consumption (VT)

Improved Process Control

Match speed to process requirements

System Connectivity

Automate via the AC Drive

Increased Mechanical Equipment Life

Precisely Controlled Motor Output Torque

Improved Motor Protection

Electronic Overload Parallels Motor Insulation Breakdown

Suspicious Motor Failures

Some Motors Suddenly Fail when VFDs are Applied

Failure Characteristics

First Turn of the Motor Winding

Phase to Phase Short

Phase to Stator Short

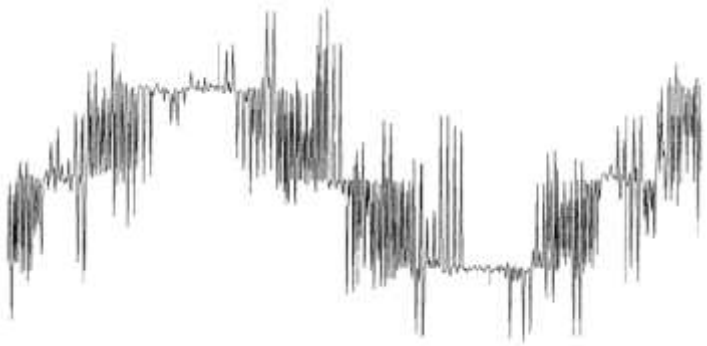
Failures Caused by Combination of Factors

Fast Switching IGBTs

Long Motor Lead Lengths

Root Cause Phenomenon

Reflected *or* Standing Wave

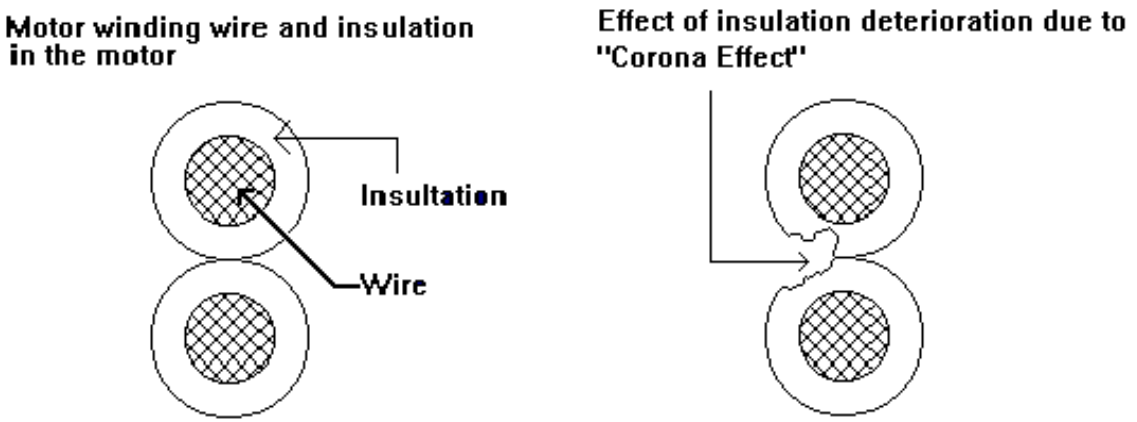


resulting in

Voltage Overshoot

which causes

Corona Effect

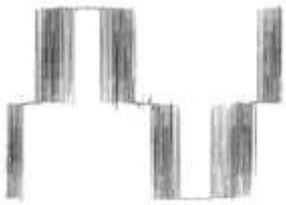


Reflected Wave / Voltage Overshoot

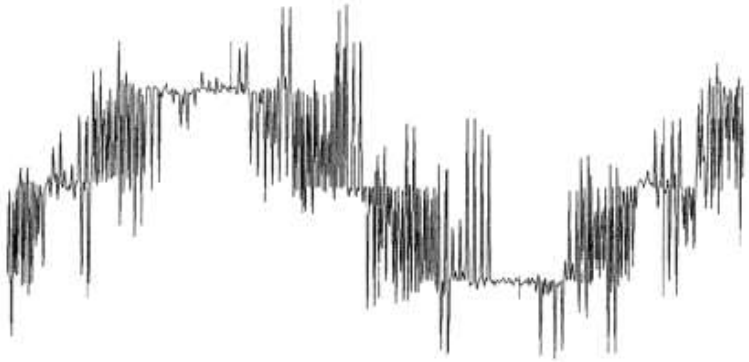
Long Motor Leads behave as a Capacitive Tank Circuit, charging and discharging

IGBT Fast Switching fires into the Motor Leads before the Voltage is Completely Dissipated

Results in Voltage Spikes throughout the Waveshape



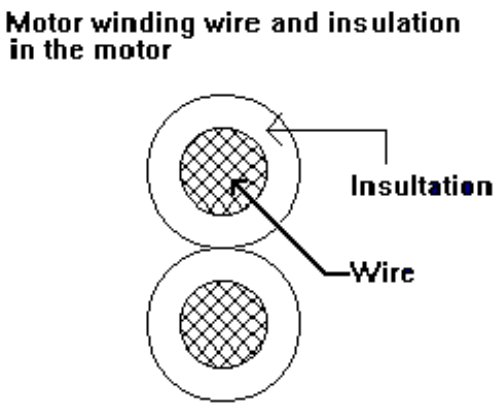
Waveform at 30 Feet

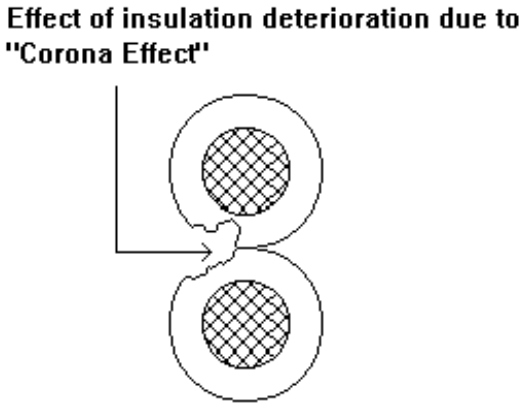


Waveform at 1000 Feet

Corona Effect

- Voltage Spikes cause Magnetic Field of Conductors to Heat Air Trapped between Motor Windings
- Ionized Oxygen (O_2) becomes Ozone (O_3)
- Ozone Attacks Insulating Motor Resins
- Failure on First Turn of Motor Winding





Solution Summary

Minimize Conductor Length

NEMA MG1-31 Inverter Duty Motor

Output Line Reactor

Reactor at the Motor

Motor Protecting Output Filter

Minimize Conductor Length

PWM Voltage Rise Times generally from .1 to .3ms

referencing the formula

$$v = c_o / \sqrt{\varepsilon}$$

$$t = L / v$$

Surge Voltage can Appear at 52 to 156 feet*

Keep Motor Lead Lengths under 150 feet

** Yaskawa VFDs publish 164' Lead Lengths with Standard Motors*

Inverter Duty Motor

Simplest and Most Cost Effective Solution:

NEMA Standard MG1-31.4

"Inverter Duty Motors shall be designed to withstand 1600 Volts Peak and Rise Times of Greater or Equal to .1ms on Motors Rated less than 600 Volts RMS."

Applying Motors that meet this standard will afford the user years of error free operation at virtually any motor lead length.

Output Line Reactor

Cost Effective Solution when applying VFD to an existing non MG1-31.4 Motor

Reliable Operation to 300 feet Lead Length

Installed at VFD Output Terminals, also protects 600V Motor Leads

Be Aware of Voltage Drop Over Linear Distance

Reactor at the Motor

Positives:

Allows Lead Lengths to 650 feet

Negatives:

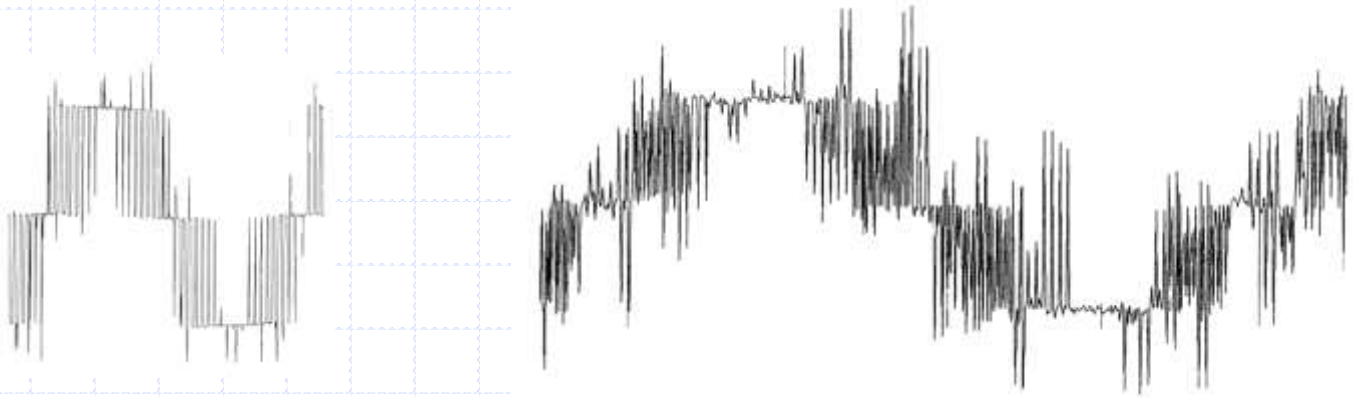
Does not protect 600V Wire

Motor Protecting Output Filter

Designed to Strip High Frequency Component from the PWM Output

Reduces Voltage Rise Time to approx 1.2ms

Insures Error Free Operation to 2000 feet



Waveform at 1000’ with dV/dT Filter… And at 1000’ Without Filter

YASKAWA

The Drive for Quality™

Thank You for taking time to participate…

We hope the information conveyed to you today will help you get the most from your Motor and Drive Applications.

Additional Technical Information on this and other drive related issues can be obtained from our Web Site at:

www.drives.com