Current Affairs
Maintaining Your Generator Investment

Small Hydro and Technical Workshop
Bend, Oregon | August 21st, 2019
INTRODUCTION

• Many forms, similar concepts
• Our imperfect world
• Maintaining your generator
• Select focal points for protecting uptime
Generators: many forms, similar concepts
Preventative Generator Maintenance

Many forms, similar concepts.
Maintaining Your Generator Investment

It’s not a perfect world...
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Preventative Generator Maintenance

The **rivals of industrial equipment** are everywhere.
Preventative Generator Maintenance

Operation involves PRACTICAL REALITIES

- Emergency stops / starts
- Operation outside of design conditions
- Missing / unused protection…

Balancing operation with proper maintenance:

- **maximizes availability**
- **contributes to safe operation**
- **minimizes unplanned outages**

Presented by: Jason Kapelina, WEG | Electric Machinery
Your particular site conditions affect all major generator components.

Your operational practices affect all major generator components.
Preventative Generator Maintenance

Regularly:

• Record/observe stator and exciter current
  o Compare to last record

• Record/observe stator and bearing temperatures
  o Compare to last record

• Inspect filters and clean if required

• Visually inspect the operating generator
  o Take photos – your memory is not perfect
Presented by: Jason Kapelina, WEG | Electric Machinery

Preventative Generator Maintenance

Periodically:

• Identify suitable electrical testing to perform on major windings, based on performance / time in service / future objectives

• Inspect:
  o The bearings / take an oil sample
  o The collector ring / diode wheel inspection and testing
  o The electrical connections
  o Critical fasteners
  o Cooling systems

• Remove covers and visually inspect rotor and stator

• Record what’s different!

• Clean, as necessary
Focal Points: Stay Dry

Electric machines don’t like saunas.

So, the Lamborghini sunroof was left open. Depending on the characteristics of the generator and the exposure to humidity, a safe dry-out may be necessary to return to service.

Maximize your uptime

Ensure your generator space heaters are connected to the 52-A contactor.
Collector rings

- Collector rings transfer power to the generator rotor
- They are designed to be self-cleaning for operation
- They are NOT resistant to contamination
Protecting collector rings

- Rings should be cleaned and returned to service with no oil / fingerprints.
- Switch polarity regularly
- Check brush installation, holders, and ring wear – and record your findings.
- The risk of contaminating other generator components can be mitigated by a switch to brushless excitation.

Maximize your uptime
After cleaning / touching collector rings, wipe with a denatured alcohol.
Focal Points: **Exciters**

**Brushless exciters**

- **Exciter Stator (DC Input)**
- **Exciter stator induces current in the exciter rotor**
- **Exciter Power Supply (Variable DC Output)**
- **2-phase AC output**
- **Diode Wheel (AC Input - DC Output)**
- **Exciter Rotor (AC Output)**
- **Main Rotor (DC Input)**

*Presented by: Jason Kapelina, WEG | Electric Machinery*
Protecting brushless exciters

- The exciter rotor and stator make an AC generator, and should be maintained on the same intervals as the main windings.
- Electrically test exciter windings and exciter components. Resistance across leads checks continuity; resistance to ground tests insulation.
- Keep IEEE 43 handy

Maximize your uptime
Keep spare diode wheel components in stock.
Focal Points: Fasteners

Protecting bolted connections

- **Reminder:** torque indicated on bolt head markings applies when the nut or female part has the same strength

- Typical generator frames are made from ASTM A36 (ASTM A48 cast iron for NEMA / small machines), both much softer than Grade 5

<table>
<thead>
<tr>
<th>Component</th>
<th>Material</th>
<th>Yield Stress (psi)</th>
<th>Ultimate Stress (psi)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grade 5 Bolt</td>
<td>SAE J429 Grade 5</td>
<td>92,000</td>
<td>120,000</td>
</tr>
<tr>
<td>Grade 8 Bolt</td>
<td>SAE J429 Grade 8</td>
<td>130,000</td>
<td>150,000</td>
</tr>
<tr>
<td>Silicon Bronze Bolt</td>
<td>UNS65500 H06</td>
<td>60,000</td>
<td>108,000</td>
</tr>
<tr>
<td>Welded Frame or Soleplate</td>
<td>ASTM A36</td>
<td>36,000</td>
<td>60,000</td>
</tr>
<tr>
<td>Cast Motor Frame</td>
<td>ASTM A48 No 30B</td>
<td>N/A</td>
<td>30,000</td>
</tr>
</tbody>
</table>

Maximize your uptime

ASTM A307 Grade A torque is typically appropriate for frame/soleplate bolts

Presented by: Jason Kapelina, WEG | Electric Machinery
Focal Points: **Bearings**

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Focal Points: **Bearings**

Protecting sleeve bearings

- Ensure sufficient oil level, verify oil cleanliness regularly and change oil as necessary
- Use bearing RTD’s and ensure the high temperature trip is in place
- Have oil rings? Ensure they are smooth and tightly assembled and they rotate at startup

**Maximize your uptime**

Spare bearing sleeves / pads can get you back online quickly. How much is that worth to your operations?
Expert \(<-\) Experiri

1. To test / put to the test
2. To try, to attempt, to prove
3. To **find out**
Closing

• Be an expert in your site conditions and generator operation

• **Guide maintenance rhythm** by the reality of site conditions and operational practices; it is *always* motivated by observable changes

• Stop, look, listen, and record. **Maintenance starts when the unit is running!**

• Test whenever there is a significant change.

• Know your equipment supplier and call for support before the failure: hindsight can be 20 : 20,000