INFRARED THERMOGRAPHIC SURVEY

For

ABC Company, Inc.
123 Any Street
Any Town, US 12345

Survey Performed
March 24, 2020

By
JR Smith
AVP / Level III Thermographer
HSB Thermography Services
Ronald_Smith_Jr@hsb.com
(216) 588-1381

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Dear Mr. Johnson,

Thank you for allowing HSB Thermography Services to provide this service. We trust that this report proves helpful and is of assistance to you.

The scope of work included the following areas:

Outside Substation, Load Centers, Motor Control Centers, Control Panels, Breaker Panels, and Disconnects.

Equipment not surveyed during this visit includes de-energized, lightly loaded, inaccessible and/or deemed by facility personnel to be non-critical.

As a result of this service the following Findings are presented for your review:

1 CRITICAL
1 SEVERE
2 ALERT
0 ADVISORY

Should you have any questions or comments concerning this report or our services, we are here to assist you. Please feel free to call me at (216) 588-1381 or email Ronald_Smith_Jr@hsb.com

Sincerely,

JR Smith

AVP / Level III Thermographer
HSB Thermography Services
COMMENTS

The criteria used to categorize findings in this report are based on the potential effect that a failure will have on operations and/or production.

**ADVISORY** - The following is helpful information based on HSB’s experience and engineering judgement.

**ALERT** - The noted condition is routine in nature and is easily repairable. Cost is often limited to labor and a few minor parts.

**SEVERE** - The noted condition presents a risk of personnel injury, contained property damage and fire may be possible, and/or localized equipment damage and business interruption may result.

**CRITICAL** - The noted condition presents a significant risk of personnel injury, property or fire damage, exhibits signs of advanced degradation and imminent failure, and/or may subject the facility to an extended business interruption.

Infrared thermographic surveys are non-contact, non-destructive examinations used to find abnormal or unexpected thermal patterns or temperature differentials. These thermal patterns may indicate such conditions as loose connections, overloaded circuits or phases, deteriorated or damaged insulation or refractory, or excessive or unwanted friction, among others.

To perform the thermographic survey of your facility, HSB Thermography Services used the FLIR Thermacam infrared imaging system. This system utilizes the latest developments in un-cooled technology to generate the most accurate data available.

The calibration for this system is certified traceable to The National Institute of Standards and Technology, NIST, USA and the Swedish National Testing and Research Institute, SP. This calibration is based on the International Temperature Scale (ITS-90).

The Findings of this survey are in the following pages. These conditions warrant your attention.
### Finding Summary

<table>
<thead>
<tr>
<th>Finding No.</th>
<th>CATEGORY</th>
<th>Location Area</th>
<th>Equipment Location</th>
<th>Equipment ID</th>
<th>Est. Repair Cost Before Failure</th>
<th>Est. Repair Cost After Failure</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>CRITICAL</td>
<td>Outside Substation</td>
<td>Main Transformer</td>
<td>East Secondary Bushing</td>
<td>$5,000</td>
<td>$78,000</td>
</tr>
<tr>
<td>2</td>
<td>SEVERE</td>
<td>Raw Materials</td>
<td>Pellet Feeder</td>
<td>Main Breaker</td>
<td>$100</td>
<td>$4,000</td>
</tr>
<tr>
<td>3</td>
<td>ALERT</td>
<td>Packaging Dept.</td>
<td>Palletizer No.3</td>
<td>Fuse No.1673</td>
<td>$25</td>
<td>$40</td>
</tr>
<tr>
<td>4</td>
<td>ALERT</td>
<td>Press Dept.</td>
<td>Press No.22</td>
<td>Disconnect</td>
<td>$50</td>
<td>$475</td>
</tr>
</tbody>
</table>

**Total Estimated Repair Costs Before Failure**  
$5,175

**Total Estimated Repair Costs After Failure**  
$82,515

**Cost Avoidance =**  
$77,340

*Before and After costs - This estimate is based only on direct damage to the equipment and does not include the costs of business interruption, extra expenses, spoilage, etc.*
Finding No. 1  

<table>
<thead>
<tr>
<th>Location Area</th>
<th>Outside Substation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Equipment Location</td>
<td>Main Transformer</td>
</tr>
<tr>
<td>Equipment ID</td>
<td>East Secondary Bushing</td>
</tr>
<tr>
<td>Est. Repair Cost Before Failure</td>
<td>$5,000</td>
</tr>
<tr>
<td>Est. Repair Cost After Failure</td>
<td>$78,000</td>
</tr>
<tr>
<td>Est. % of Production</td>
<td>90%</td>
</tr>
<tr>
<td>Est. Down Time</td>
<td>10-14 Days</td>
</tr>
</tbody>
</table>

**Recommendation/Comments:**

The thermal pattern indicates the transformer has an internal problem conducting heat out to the surface of the bushing. This should be investigated and repaired by a qualified HV electrical contractor.

*This is rated as “CRITICAL” due to the high replacement cost of the transformer and potential business interruption should a failure occur.

<table>
<thead>
<tr>
<th>Ref. Temperature</th>
<th>76.2 °F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Area 1 Max. Temperature</td>
<td>176.0 °F</td>
</tr>
</tbody>
</table>

**Area 1: Rise** 99.8 °F

**Repair notes:**

Signature:……………………………………..Date:

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**Finding No. 2**

**Category:** SEVERE

<table>
<thead>
<tr>
<th>Location Area</th>
<th>Raw Materials</th>
</tr>
</thead>
<tbody>
<tr>
<td>Equipment Location</td>
<td>Pellet Feeder</td>
</tr>
<tr>
<td>Equipment ID</td>
<td>Main Breaker</td>
</tr>
<tr>
<td>Est. Repair Cost Before Failure</td>
<td>$100</td>
</tr>
<tr>
<td>Est. Repair Cost After Failure</td>
<td>$4,000</td>
</tr>
<tr>
<td>Est. % of Production</td>
<td>50%</td>
</tr>
<tr>
<td>Est. Down Time</td>
<td>2 Days</td>
</tr>
</tbody>
</table>

**Recommendation/Comments:**

The lug connection should be disassembled, cleaned, inspected for damage and repaired as necessary. Replace any discolored or damaged hardware and cut back the wire to sound conductor. Reassemble and torque the fastener according to the manufacturer’s specifications.

*This is rated as “SEVERE” due to the very high temperature and potential business interruption.*

**Repair notes:**

Signature: _______________________________ Date: _______________________________

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Finding No. 3

Category: ALERT

<table>
<thead>
<tr>
<th>Location Area</th>
<th>Packaging Dept.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Equipment Location</td>
<td>Palletizer No.3</td>
</tr>
<tr>
<td>Equipment ID</td>
<td>Fuse No.1673</td>
</tr>
<tr>
<td>Est. Repair Cost Before Failure</td>
<td>$25</td>
</tr>
<tr>
<td>Est. Repair Cost After Failure</td>
<td>$40</td>
</tr>
<tr>
<td>Est. % of Production</td>
<td>0%</td>
</tr>
<tr>
<td>Est. Down Time</td>
<td>0</td>
</tr>
</tbody>
</table>

**Recommendation/Comments:**

Remove the fuse and clean the fuse and fuse clip. Reinsert the fuse ensuring the fuse clip is providing adequate tension and making good contact with the fuse. Also, all three fuses (yellow arrow) should be the same size, style, and type from the same manufacturer.

**Repair notes:**

Signature: .................................................. Date:
Finding No. 4

**Location Area**: Press Dept.

**Equipment Location**: Press No.22

**Equipment ID**: Disconnect

**Est. Repair Cost Before Failure**: $50

**Est. Repair Cost After Failure**: $475

**Est. % of Production**: 10%

**Est. Down Time**: 1 Day

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**Ref. Temperature**: 91.4 °F

**Area 1 Max. Temperature**: 132.3 °F

**Area 2 Max. Temperature**: 139.1 °F

**Area 1: Rise**: 40.9 °F

**Area 2: Rise**: 47.7 °F

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**Recommendation/Comments:**

The connections should be disassembled, cleaned, inspected for damage and repaired as necessary. Reassemble and torque fasteners according to the manufacturer's specifications using new hardware as required.

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**Repair notes:**

Signature: ________________________________ Date:
For more information or comments contact:

JR Smith- AVP/ HSB Thermography Services
Cleveland, OH
216-588-1381
Ronald_Smith_Jr@hsb.com

<table>
<thead>
<tr>
<th>Western Region</th>
<th>Eastern Region</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dennis DeGerald LVL II Thermographer</td>
<td>Bill Viot LVL II Thermographer</td>
</tr>
<tr>
<td>Madison, WI</td>
<td>Hartford, CT</td>
</tr>
<tr>
<td>904-214-5201</td>
<td>860-281-2541</td>
</tr>
<tr>
<td><a href="mailto:Dennis_DeGerald@hsb.com">Dennis_DeGerald@hsb.com</a></td>
<td><a href="mailto:William_Viot@hsb.com">William_Viot@hsb.com</a></td>
</tr>
<tr>
<td>Steve Woods LVL II Thermographer</td>
<td>Charles Johnson LVL II Thermographer</td>
</tr>
<tr>
<td>St. Louis, MO</td>
<td>Richmond, VA</td>
</tr>
<tr>
<td>618-973-7835</td>
<td>804-691-3082</td>
</tr>
<tr>
<td><a href="mailto:Steven_Woods@hsb.com">Steven_Woods@hsb.com</a></td>
<td><a href="mailto:Charles_Johnson@hsb.com">Charles_Johnson@hsb.com</a></td>
</tr>
<tr>
<td>Jim Nelson LVL II Thermographer</td>
<td>Norm Gaver LVL II Thermographer</td>
</tr>
<tr>
<td>Dallas, TX</td>
<td>Charlotte, NC</td>
</tr>
<tr>
<td>903-217-7016</td>
<td>704-892-33947</td>
</tr>
<tr>
<td><a href="mailto:Jimmy_Nelson@hsb.com">Jimmy_Nelson@hsb.com</a></td>
<td><a href="mailto:Norman_Gaver@hsb.com">Norman_Gaver@hsb.com</a></td>
</tr>
<tr>
<td>Richard Toth LVL III Thermographer</td>
<td>Ron Griggs LVL II Thermographer</td>
</tr>
<tr>
<td>Yuma, AZ</td>
<td>Lakeland, FL</td>
</tr>
<tr>
<td>916-995-2267</td>
<td>863-413-6251</td>
</tr>
<tr>
<td><a href="mailto:Richard_Toth@hsb.com">Richard_Toth@hsb.com</a></td>
<td><a href="mailto:Ronald_Griggs@hsb.com">Ronald_Griggs@hsb.com</a></td>
</tr>
<tr>
<td>Rick Stafford LVL II Thermographer</td>
<td></td>
</tr>
<tr>
<td>Los Angeles, CA</td>
<td></td>
</tr>
<tr>
<td>951-457-1229</td>
<td></td>
</tr>
<tr>
<td><a href="mailto:Rick_Stafford@hsb.com">Rick_Stafford@hsb.com</a></td>
<td></td>
</tr>
</tbody>
</table>

If you would like to learn more about electrical risk management, please click on the following link:

http://www.hsb.com/hsbext/Electrical_Risk_Management/
VIBRATION ANALYSIS SURVEY

For

ABC Company, Inc.
123 Any Street
Any Town, US 12345

Survey Performed

March 24, 2020

By

JR Smith
AVP / Level III Thermographer
HSB Thermography Services
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I. ANALYSIS BACKGROUND

The vibration measurements were collected on the machine casing at bearing locations in a vertical, horizontal, and axial direction using an accelerometer and vibration data collector. The vibration levels were compared to a database of vibration severity levels. The vibration severity levels are based on the vibration characteristics of machines with similar mechanical configurations and on ISO Standard 10816. The vibration levels were compared to previous measurements to establish the trend and determine the final severity.

CONDITION DEFINITIONS

<table>
<thead>
<tr>
<th>Condition Level</th>
<th>Vibration Analysis Indicates</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acceptable</td>
<td>Little or no deterioration in equipment condition.</td>
<td>There is no cause for concern. Note for future analysis.</td>
</tr>
<tr>
<td>Monitor</td>
<td>Developing Problems.</td>
<td>Monitor the vibration levels more frequently to establish a trend and to determine if repairs should be made during next shutdown.</td>
</tr>
<tr>
<td>Alarm</td>
<td>The machine is running rough.</td>
<td>Plan for a repair outage at the nearest opportunity. Until repaired, monitor closely.</td>
</tr>
<tr>
<td>Danger</td>
<td>A severe problem.</td>
<td>Correct problems immediately or at the first opportunity to avoid machine failure, unscheduled downtime, and secondary damage.</td>
</tr>
</tbody>
</table>

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II. EQUIPMENT SUMMARY

The overall condition of equipment can have a large impact on the operation of any facility. As the condition of the equipment improves, there are several factors that are affected:

- Operating Costs will decrease.
- Reliability will increase.
- Building Environment quality will increase.

### ABC Company
1234 Any Street, Any Town, US

<table>
<thead>
<tr>
<th>Health</th>
<th>Machine</th>
<th>Last Recorded</th>
<th>Faults</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Alarm</strong></td>
<td>84-Fan Mold -10</td>
<td>Nov 12, 2019 GMT</td>
<td>Radial unbalance - Driven Fan</td>
<td>🌱</td>
</tr>
<tr>
<td><strong>Monitor</strong></td>
<td>Shop 31 Mold Cooling Fan</td>
<td>Nov 12, 2019 GMT</td>
<td>Misalignment - Motor</td>
<td>🌱</td>
</tr>
<tr>
<td><strong>Acceptable</strong></td>
<td>84-Fan Mold-12</td>
<td>Nov 12, 2019 GMT</td>
<td></td>
<td>🌱</td>
</tr>
<tr>
<td><strong>Acceptable</strong></td>
<td>84-Fan Mold-7</td>
<td>Nov 12, 2019 GMT</td>
<td></td>
<td>🌱</td>
</tr>
<tr>
<td><strong>Acceptable</strong></td>
<td>Shop 32 Mold Cooling Fan</td>
<td>Nov 12, 2019 GMT</td>
<td></td>
<td>🌱</td>
</tr>
</tbody>
</table>
III. DETAILED ANALYSIS AND DATA

84-Fan Mold -10 - Fan
Last Recorded Nov 12, 2019 4:05:45 PM GMT by Charlie Johnson

Overview
Schedule the recommended activities in the next quarter and monitor the machine frequently until repaired.

alarm
Radial unbalance - Driven Fan

The vibration levels at the fan running speed indicate a possible fan imbalance.

Possible Cause
- Heavy spot.
- Dirt build-up.
- Erosion of fan blades.

Maintenance Practices
- Wash and clean as access permits.
- Balance the fan.

Bearing2 - 2H

RMS | Measurement: vibration | Domain: frequency | Vector: velocity

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**Overview**
Monitor the machine more frequently.

**Misalignment - Motor**
Misalignment between the motor and the machine.

**Possible Cause**
- Damaged or worn shaft or coupling.
- Pipe strain
- Soft foot
- Incorrect thermal growth offset
- Imprecise installation / maintenance practices

**Maintenance Practices**
- Inspect coupling for wear.
- Consider performing a precision shaft alignment.
- Continue to monitor.

**Bearing1 - 1H**
RMS | Measurement: vibration | Domain: frequency | Vector: velocity

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Overview
Continue with usual maintenance activities and monitoring on a regular basis.

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**Scope**

Continue with usual maintenance activities and monitoring on a regular basis.

**Overview**

Continue with usual maintenance activities and monitoring on a regular basis.

**Bearing1 - 1H**

RMS | Measurement: vibration | Domain: frequency | Vector: velocity

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Overview

Continue with usual maintenance activities and monitoring on a regular basis.