Owner Assistance / HVAC Evaluations

for

Beecher Road Elementary School
40 Beecher Road - South
Woodbridge, CT 06525

Prepared for:

Robert F. Gilbert

Superintendent

Woodbridge School District

Prepared by:

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Van Zelm Project #: 2018137.00

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Executive Summary

Introduction

In September of 2018, van Zelm Heywood & Shadford, Inc. (van Zelm) was hired to provide Engineering Consultation Services for evaluating and troubleshooting the cause of ongoing humidity issues within the classrooms of the school.

This report describes the work performed by van Zelm during this evaluation and outlines our findings and recommendations.

Goals and Objectives

It is our understanding that the Beecher Road Elementary School has been suffering with various comfort control issues since the building was renovated in 2014, particularly with excessive humidity. Note: the classroom wings with Unit Ventilators did not have cooling prior to 2014. It is our understanding that window air conditioners were used.

The primary focus of our HVAC evaluation was as follows:

1. Determine the cause of these high humidity levels within the school, especially in the classrooms that have unit ventilators.
2. Determine the cause of coil freeze ups associated with the fan coil units in the classrooms.
3. Assist in determining the cause of bearing failures on the Dectron unit that serves the pool area.

Evaluation Process

The evaluation process that was followed for the project consisted of the following phases of work:

1. Planning and Organization

Prior to making a site visit, van Zelm reviewed all available as-built documentation, which included the Building Automation System (BAS) Mechanical drawings and Operation and Maintenance (O&M) Manuals. This documentation was used to familiarize ourselves with the layout of the building and the various systems within it. A Testing, Adjusting, and Balancing (TAB) Report was also provided to us and was useful in understanding how the systems were originally balanced.

2. BAS Remote Monitoring

Prior to our site visits, we were able to monitor the Building Automation System remotely to see for ourselves the performance of the various Heating, Ventilating, and Air Conditioning Units and their effect on the spaces they served. This included monitoring of the space conditions and equipment operation during both the occupied and unoccupied periods.

Please note: since this evaluation did not start until mid-September, we had a limited amount of days in which to evaluate the building while we had high outside air temperatures and humidity.

3. Field Evaluations

The next phase of the process consisted of a physical inspection and testing of the sampling of some of the systems. This included the following tasks:

1. Visual inspection of the various units (inspection of the coils, piping, valves, etc.).
2. Testing of the Unit Ventilators (UV's), Energy Recovery Units (ERU's) and Fan Coil Units (FCU's) in sample areas.
3. Worked with Building Automation System (BAS) technician from United Control Solutions to confirm sequences of operation and current programming for various systems that were evaluated.
4. Worked with local Dectron Factory Representative and Vibration Analysis Technician from Integrated Diagnostic Service to evaluate the bearings, fan, and shaft associated with the supply fan on the Pool unit.

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Participants and Contributors

We wish to acknowledge and thank the Beecher Road Elementary School Personnel and the Sub-Contractors for their assistance in this effort. The parties involved were:

Woodbridge School District

- Robert F. Gilbert (Superintendent)
- Al Pullo (Business Manager)

Beecher Road Elementary School Facilities

- Vito Esparo (Facilities Manager)

Outside Consultant

- Jim Saisa (Consultant)

Integrated Diagnostic Services, Inc.

- John Tecchio (President)

United Control Solutions Inc.

- Eric Beach (Technician)

EMCOR

- Anthony Daros (Field Service Supervisor)
- Tom Lapoint (Service Manager)

van Zelm Engineers

- Joe McCarthy (Senior Commissioning Consultant)
- Bill Donald (Manager of Commissioning Services)

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Basic HVAC System Overview

The building currently has three (3) boilers and one (1) chiller that feed a two-pipe hot and chilled water system. Since its two-pipe, the whole building will need to be either in heating or cooling mode. There isn't an option to have some areas in heating and some areas in cooling. The listing below does not capture all the HVAC systems within the building, just the ones that are relevant to our evaluation of the high relative humidity conditions.

1. <u>Unit Ventilators</u> - Console type Unit Ventilators are provided in many of the classrooms. UV's are Daikin (McQuay), two-pipe with "face and bypass" and three speed fans. Heating and cooling changeover is by local pipe temp sensors. Units have 2-way modulating control valves. Room occupancy sensors allow for standby relaxation of the daytime occupied heating/cooling setpoints.

   There are two sizes of UV's (UV-A & UV-B) which provide the heating and cooling capacities required to meet the indoor design conditions with hot or chilled water provided by the boilers and chiller. An outdoor air intake louver and damper is in the outside wall directly behind the console to provide code required minimum ventilation air requirements. Outdoor air quantities can be automatically increased by modulating the damper behind the louver during favorable outdoor air conditions to provide "free cooling", also called outside air economizer mode, to the spaces.

   The existing UV operating sequence, initiated by the BAS, calls for the UV outdoor air damper to open to its minimum position, balanced to 450 cfm for most rooms, and then for the unit fan to start and run continuously. During peak summer cooling conditions, the cooling coil control valve controls the flow of chilled water to the unit cooling coil based on a signal from the room temperature sensor. If the room setpoint is 72 degrees F, an acceptable temperature range would be between a low of 70 and a high of 74 degrees F.

   The classrooms that are served by the UV's have an exhaust grill that is used to prevent over-pressurization of the space. The original design documents for the renovation project indicate that most of the classrooms are designed to exhaust 350 CFM through the exhaust grill in the room. These airflow quantities change based on the size of the rooms that are served by the UV's.

2. Energy Recovery Units - There are four (4) Xetex Energy Recovery Units located on the roof of the building that provide ventilation air to various FCU's, which are located above the suspended ceilings in the classrooms. The ERU has a supply fan that delivers outside air to the FCU's and an exhaust fan to exhaust the air from the rooms with FCU's. The ERU has a heat exchanger that transfers heat from one airstream to the other. As the name implies, energy recovery is recovering heat from the warm exhaust air from the building and transferring some of that heat to the entering outside air. This process is now using what would have been wasted energy to pre-heat the incoming outside air. In the summer this process is reversed, and the cool exhaust air is used to pre-cool the incoming outside air.

3. Fan Coil Units - Some rooms are heated and cooled with FCU's instead of UV's. Unlike UV's, FCU's do not have a means of ventilating the room. ERU's are used to supply the ventilation air to the FCU's in these areas. The ERU's are located on the roof and supply the ventilation air to the FCU's through a distribution duct connected from the ERU supply to several FCU's. The ERU and duct is sized to supply only the minimum amount of fresh air required for ventilation or room pressurization. There is also a duct for exhaust air from the FCU's to the ERU. Each FCU has a motorized damper for both the supply and exhaust ducts from each room. These dampers are supposed to be open when the FCU fan is on and be closed when the FCU fan is off.

4. Air Handling Units (AHU's and RTU's) - There are a total of six (6) AHU's and five (5) RTU's that serve dedicated areas such as the Cafeteria, Gym, District Offices, etc. These units were not in our scope of work, so they have not been included in our overall evaluation of the Building.

5. Pool Unit - There is one dedicated Dectron Air Handing unit that serves the pool area. Our evaluation of this unit consisted of reviewing the cause of recent bearing failures and making recommendations for corrective actions.

6. The Building Automation System - The existing BAS is a Honeywell system with Spyder controllers. BAS controls the HVAC system equipment operation and space temperature setpoints automatically based on an occupied/unoccupied time of day schedule and outdoor air conditions.

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Findings

The findings identified below are the result of inspections and testing of a small sampling of the systems that feed the classrooms. Our findings are as follows:

1. **<u>Classrooms with Unit Ventilators</u>**
   a. When the room temperature setpoint is satisfied, no cooling or dehumidification is taking place, causing a cool but humid condition. Dehumidification takes place only during the period when the cooling coil is active (control valve is open). If the control valve is closed and there is no chilled water flow because the room temperature setpoint is satisfied, no dehumidification can happen. Staggered daytime occupancy of the classrooms exasperates the situation by decreasing the cooling load and, therefore, increasing the time when no cooling or dehumidification is taking place.
   b. We performed a sample load calculation in the sample rooms and the initial findings were that the unit size closely matched the original design documents. However, we know that once the internal heat loads in the space drop off, the unit then becomes oversized during that period.
   c. The coils on the UV and FCU in the sample rooms were verified to be piped correctly (counter-flow fashion).
   d. Some of the condensate pumps in the UV's were found to be unplugged.
   e. We tested the condensate overflow switches and they did not alarm or close the chilled water valve as expected. The overflow switches were not mounted properly within the enclosure.
2. **<u>Classrooms with Fan Coil Units</u>**
   a. We discovered that all the outdoor air dampers that serve the FCU's had been over-ridden to 100% open. When room temperature is satisfied, the supply fan on the FCU shuts off but OA damper remained open. If the fans on the FCU's are not running at the same time as the ERU's, untreated outside air will be delivered to the spaces if the OA damper is left open. This condition may have caused the coil freeze up that has occurred on one of the FCU's in the past.
   b. In the sampled rooms, we discovered a significant amount of duct leakage on the OA ductwork. This leakage could result in untreated air being delivered to the ceiling spaces of the classrooms and will also cause the ERU to run faster than it needs to run.

3. **Energy Recovery Units**
   a. We discovered that the local controls on the ERV's were not setup properly. The local sensors are meant to control frost mode, economizer mode, and summer recovery. The manufacturer supplied controls for the heat exchanger bypass damper control had been adjusted to prevent the unit from entering "summer recovery" mode. With this as-found condition, the heat exchanger would be bypassed in the summer months, thereby delivering completely untreated, hot and humid air into the building.
4. **Chilled Water System**
   a. During our monitoring of the systems, we observed that the chilled water bypass valve was very erratic and was modulating open and closed excessively and rapidly. This could result in unstable flow to the chilled water system. Given the limited amount of time we had to review the system, further investigation will be recommended to refine the variable flow chilled water loop.
5. **Dectron Pool Unit**

van Zelm has been made aware of several bearing failures that have occurred on the supply fan section of the Dectron Unit that serves the Pool Area. We agreed to review the situation related to the bearing failures and provide recommendations for future bearing maintenance. Below is a summary of the steps that were taken related to this issue.

a. When we first arrived at the School on October 25, 2018, we observed that the Dectron unit was off. When it was turned on, a very loud noise was observed coming from the supply fan motor bearings. We contacted the Manufacturer Rep (Aercon Corporation) to make them aware of the ongoing issues that we are having with the current bearing failure, along with past bearing failures that occurred. As part of the discussions, we had asked them to advise on a company that we could use to test the existing bearings and existing supply fan motor to determine how much damage may have been done to the unit. They recommended Integrated Diagnostic Services, Inc (John Tecchio). The School then hired IDS to perform vibration testing on the Unit.
b. We met with IDS onsite on October 5, 2018 to conduct the first test on the Unit. It was observed that the pulleys were misaligned and both inner and outer bearings were bad and needed to be replaced. IDS test reports have been included in Appendix C.
c. EMCOR purchased new bearings directly from Dectron. These new bearings were installed, and IDS went to the School on November 9, 2018 to perform the vibration test

on the new bearings. Based on the testing, it was determined that additional grease would be needed in the new bearings. IDS would need to return once the bearings were properly greased by EMCOR.

d. van Zelm, EMCOR and IDS met onsite on November 19, 2018 to conclude the testing. Anthony from EMCOR changed the supply fan drive sheave and the motor pulley. EMCOR used a laser alignment kit to align the two pulleys and worked on getting the belts properly tensioned. IDS ran a vibration analysis and found the vibration had been reduced from the previous testing. However, the bearing readings had gotten worse. After running the unit for a longer period of time, the bearing readings did improve to the point where IDS thought it was safe to run the unit. IDS did recommend that the bearings be tested again in six months. The unit has been left running and IDS has sent a revised report, dated 11/19/18, which is included in Appendix C.

e. The literature from the bearing manufacturer indicated a lubrication frequency of every two weeks or more. This is in direct conflict with the Dectron unit literature which calls for once every twelve months. van Zelm and EMCOR both tried to get this clarified through Dectron. EMCOR was able to get information from Dectron Service Manager (Gary Jones) that the bearings should be greased every 4 months. A table that Dectron sent to EMCOR showing the greasing schedule has been included in Appendix B. van Zelm responded to EMCOR to let them know that the greasing schedule sent by Dectron mentions ball bearings, but we have roller bearings. **On 12/18/18, Dectron provided new documentation that now states that the bearings should be greased every 2-3 months. Gary Jones from Dectron obtained this information directly from the Blower Supplier. The quantity of grease per interval was also indicated in the new greasing schedule (see Appendix B for this documentation).**

f. Because the Unit should be lubricated while in operation, EMCOR was going to provide a proposal to install tubing to allow for remote greasing of the bearings. This will allow the lubrication to be done in a safe manner. During a conference call on December 13, 2018, Vito Esparo from Beecher School conveyed to EMCOR that the School would be accepting the proposal to install the tubing.

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Recommendations

The recommendations identified below are the result of inspections and testing a small sampling of the systems that feed the classrooms. Our recommendations are as follows:

1. **Classrooms with Unit Ventilators (Humidity Corrections-Option 1)**

The following steps are generally in order of simplicity and cost to implement.

Step 1. Fan Speed - Recommend air flow reduction as a first step. Since the fan motors are PSC 3 speed motors, set the motors to low speed. Ensure the speed cannot be changed during this test period.

Step 2. Reset Chilled Water Temperature - Confirm the chilled water temperature setpoint. Try increasing the setpoint to 48˚F and monitor the results for not only the UV rooms, but the entire school to make sure other units like AHU's and RTU's are not negatively impacted.

These steps should be the first steps taken. If the elevated chilled water setpoint is problematic for other areas of the building, or the chilled water valve still modulates toward the closed position quickly, proceed to step 3.

Step 3. Limit travel of control valve - Through the Honeywell BAS, limit the maximum opening position of the valves. This will de-rate the cooling capacity of the chilled water coil. By de-rating the capacity of the coil, the control valve will be required to remain open longer to provide cooling to the room. This added time of opening will allow the cooling coil to remain "saturated" longer to provide increased dehumidification. The amount each valve will need to be limited will need to be determined by monitoring the results. **Note: The limitation must only be applied to the control valve while in the cooling mode. The valve must be allowed to open fully in the heating mode.**

The above steps are relatively simple, quick and inexpensive to try. Additional steps that may be required, but are more costly, invasive and time consuming are as follows.

Step 4. Outside Air Quantity Reduction / CO2 Control - This step is intended to reduce the amount of outside air brought into the building. The outside air required for ventilation and pressurization is the single largest contributor to introducing humidity into the building. Any outside air introduced to the building needs to be effectively dehumidified to remove moisture if the building is going to be comfortable. Therefore, any reductions in the amount of outside air will reduce the amount of moisture that needs to be removed from the air to make the building comfortable.

There are two methods of determining the required amount of outside air. The Ventilation Rate Procedure (VRP) utilizes a prescriptive method of calculating the code required values for various types of spaces. An alternative to the VRP method, allows for an Engineered Solution, which is a design that would prevent the concentration of contaminants from exceeding the amount obtainable by using the VRP method. An example of an engineered solution would be Bi Polar Ionization purification technology. Air purification would be an effective way to reduce the amount of outside air. An engineered alternative to airflow reduction may reduce the amount of outside air, but not reduce the humidity as well as a more traditional method. The use of the VRP allows for the implementation a CO2 based demand-controlled ventilation routine. CO2 is used as an indication of the level of occupancy or the number of people in the room. The amount of fresh air can be varied to maintain the required amount of ventilation air per person. While this will allow for a reduction of the outside air amount while the unit ventilator is running, the use of a CO2 sensor would also allow the UV fan to be cycled off when the room temperature is satisfied. This would eliminate the current scenario where the room temperature is satisfied and the cooling valve closes stopping any dehumidification, but the unit continues to introduce, now unconditioned outside air. Once the room calls for cooling or the new CO2 sensor calls for ventilation, the fan will start up. While the UV fan is off, no unconditioned moisture laden outside air is introduced into the room, which will result in lower relative humidity levels.

Classroom Exhaust - Now that the quantity of outside air has been reduced and UV fans are cycling on and off, the exhaust air quantity must be considered and addressed. This is important so that the building pressure remains under control and maintains a slight positive pressure. Options for exhaust control in the rooms is as follows:

Option 1 - Install a motorized damper ahead of the exhaust fan and open the damper when building pressure requires. This will act as a building relief to control classroom pressurization. This first option assumes that the fan is off.

Option 2 - If it is determined that the building pressure is negatively affected by keeping the exhaust fan off, a variable frequency drive (VFD) should be installed on the fans to allow for control of the exhaust airflow from the classrooms. This would require the installation of the motorized damper detailed in option #1 above.

Option 3 - An expensive, but very costly option to control the room exhaust would be to install a motorized control damper. The dampers would be installed in each room and opened when the UV fans turn on. The exhaust fan speed would be matched to the total UV outside air volume for the area served, which would require the installation of a VFD described in Option#2.

We recommend implementing the low-cost options (starting with option 1) and then monitoring the system to confirm that building pressurization is proper. If it is, there will be no need to proceed further with the additional options.

2. Classrooms with Unit Ventilators (Humidity Corrections-Option 2)

A costly, yet surefire way to eliminate the excess humidity in the classrooms with UV's would be to provide new roof mounted dedicated outdoor air units and associated supply and return distribution duct systems to properly dehumidify code required outdoor air supplied to all the classrooms served by the UV's.

All new dedicated outdoor air units should have energy recovery capability, gas fired or hot water heating, chilled water cooling or modulating dx cooling with passive type reheat to deliver neutral room temperature air to each space. Dedicated outdoor air systems (DOAS) are frequently used in energy efficient buildings to handle only the ventilation air component of the HVAC system. Limiting its function to conditioning outdoor air allows for optimum humidity control, heat recovery and smaller duct systems since only ventilation air is being distributed.

If a DOAS is used, the existing outdoor intake louver/damper arrangement behind each existing unit ventilator should be sealed closed.

Operating sequence for the UV's will need to be changed so that the UV conditions recirculated room air only.

The roof is supported by light weight bar joists, therefore, new outdoor air units and associated condensing units will likely require structural steel dunnage to accommodate additional weights.

3. Classrooms with Unit Ventilators (General Recommendations)

For all UV's, we recommend the following:

1. Check all condensate pumps to confirm that they are plugged in and operational.
2. Troubleshoot and correct the float switch issue (switch not activating an alarm when water is sensed).

3. Permanently mount the float switch to the unit in an area that will sense a drain pan overflow condition.

4. Classrooms with Fan Coil Units

The use of an outside air volume reduction strategy to reduce the ERU fan speed would be an effective way to improve the relative humidity levels in the classrooms served by the FCU's. This would be the same strategy as described in the UV section, "Outside Air Quantity Reduction / CO2 Control". The use of CO2 monitoring would allow for the FCU to cycle off and the associated outside air and exhaust dampers to close when the space temperature setpoint is met.

5. Energy Recovery Units

Currently the ERU's have localized controls to operate frost control, economizer and summer switchover modes. Since these are functions happening within the unit, they are not able to be seen or trended by the BAS. We highly recommend that these control functions be brought on to the BAS system to allow for better control and monitoring of the ERU's in both the heating and cooling seasons.

6. Chilled Water System Operation

As discussed in the previous section, we only had a limited amount of time to review the system during a peak summer load. We feel that further monitoring and investigation will be useful in refining the operation and performance of the variable flow chilled water loop.

7. Dectron Unit Recommendations

Now that the greasing schedule has been determined, we recommend that EMCOR perform the maintenance and update the O&M manual with this new information. Also, we would highly recommend that IDS return in six months (May of 2019) to recheck the fan bearings. Subsequent vibration testing intervals should be determined after the six-month evaluation.

8. General Recommendations

As per our scope or work, we performed limited testing and sampling on specific pieces of equipment during this evaluation. Based on our findings in the sample areas, we feel that the School would greatly benefit from a complete Re-Commissioning of all the systems within the building. Not only would there be performance and comfort benefits, but there will likely be energy savings as well from this Re-Commissioning exercise.

Appendix A-Photos

Figure 1-Typical Unit Ventilator

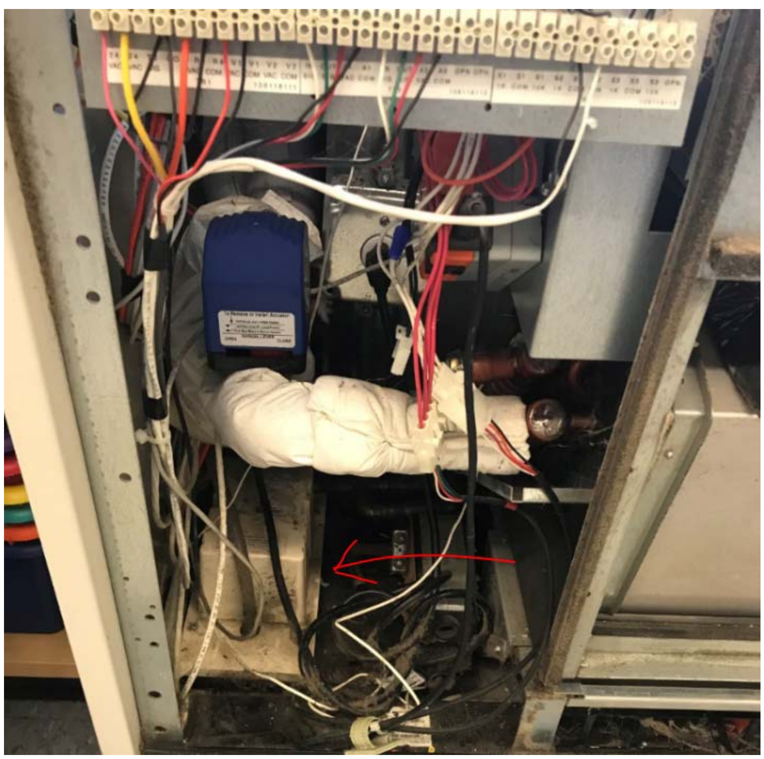

Figure 2- Location of condensate pumps on UV's

Figure 3- Typical UV float switch

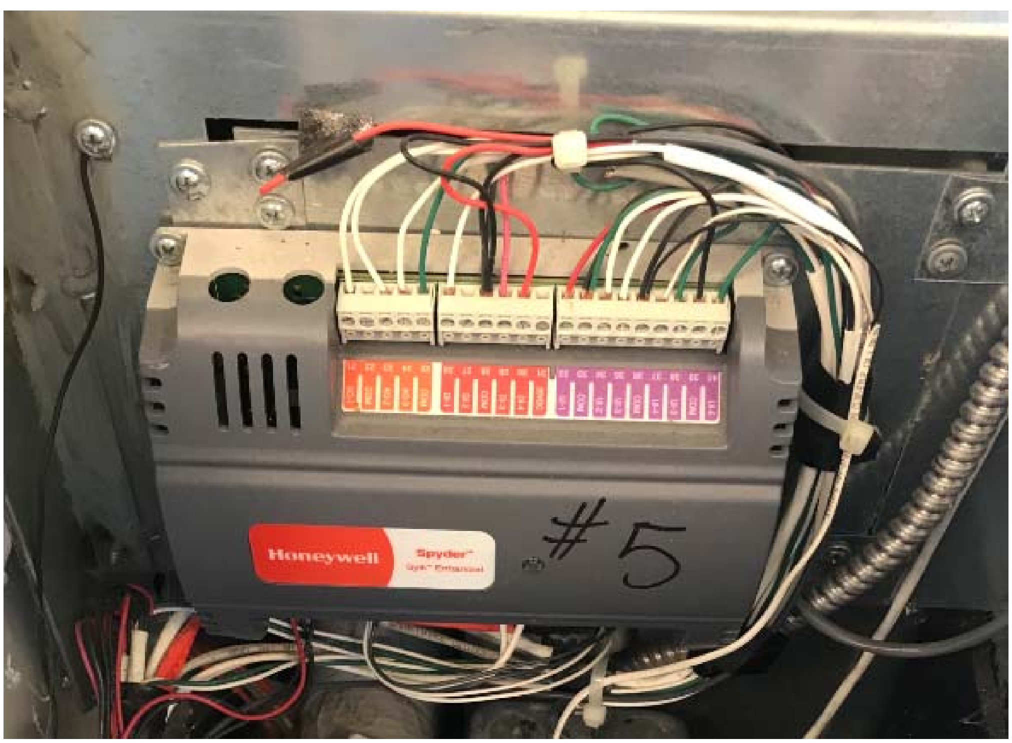

Figure 4- Typical Honeywell controller for UV

Figure 5- Typical Exhaust grill in classrooms with UV's

Figure 6- Typical Roof Mounted Exhaust fans serving classrooms with UV's

Figure 7- Xetex Energy Recovery Unit

Figure 8- ERU local controls

Figure 9- Typical Rooftop Unit (not in scope of evaluations)

Figure 10-Roof mounted Chiller

Figure 11-Dectron Unit serving pool

Figure 12-Dectron Unit-Supply Fan section

Figure 13-Fan Coil Unit BAS Graphic

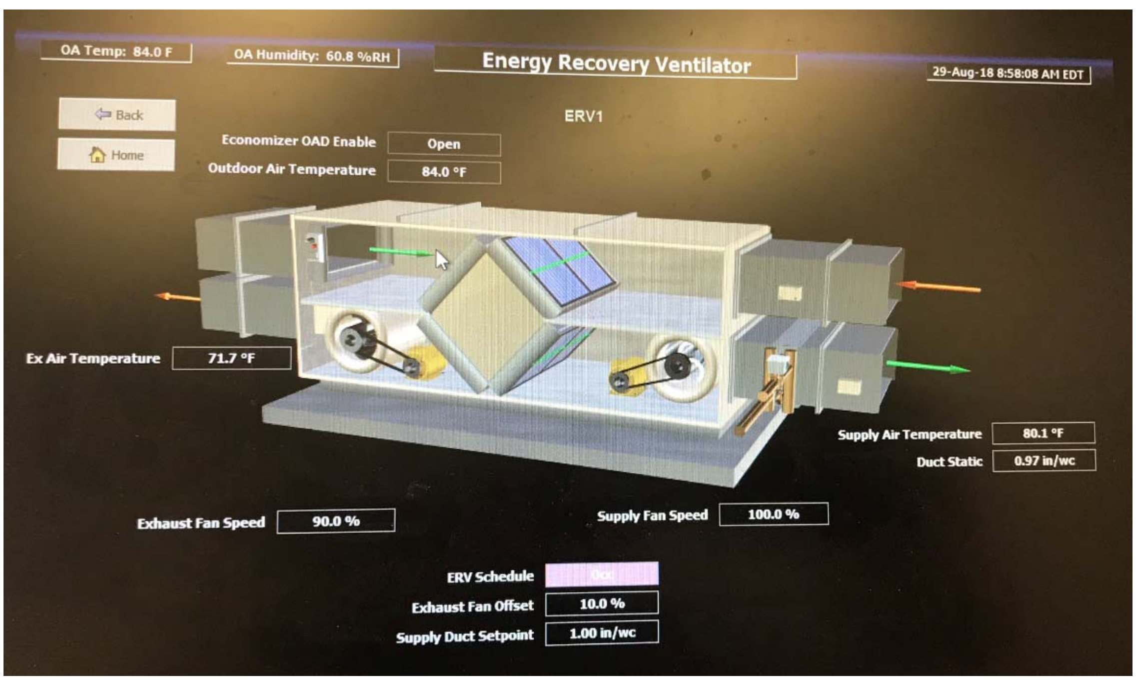

Figure 14-ERU BAS Graphic

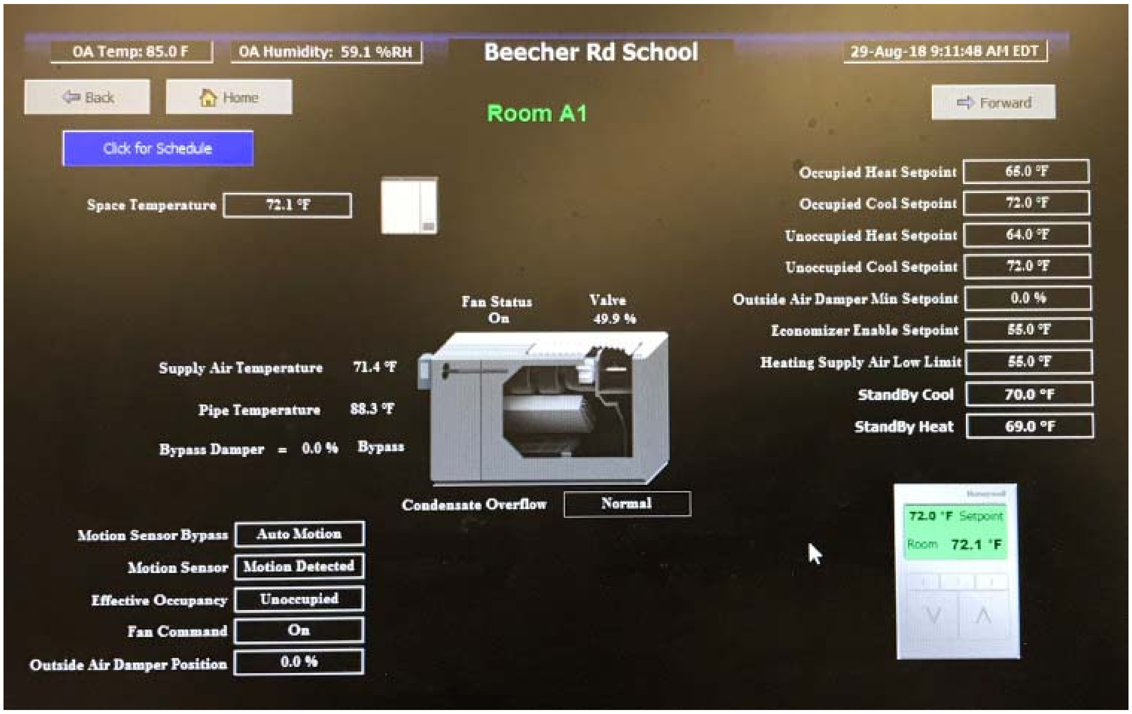

Figure 15-Unit Ventilator BAS Graphic

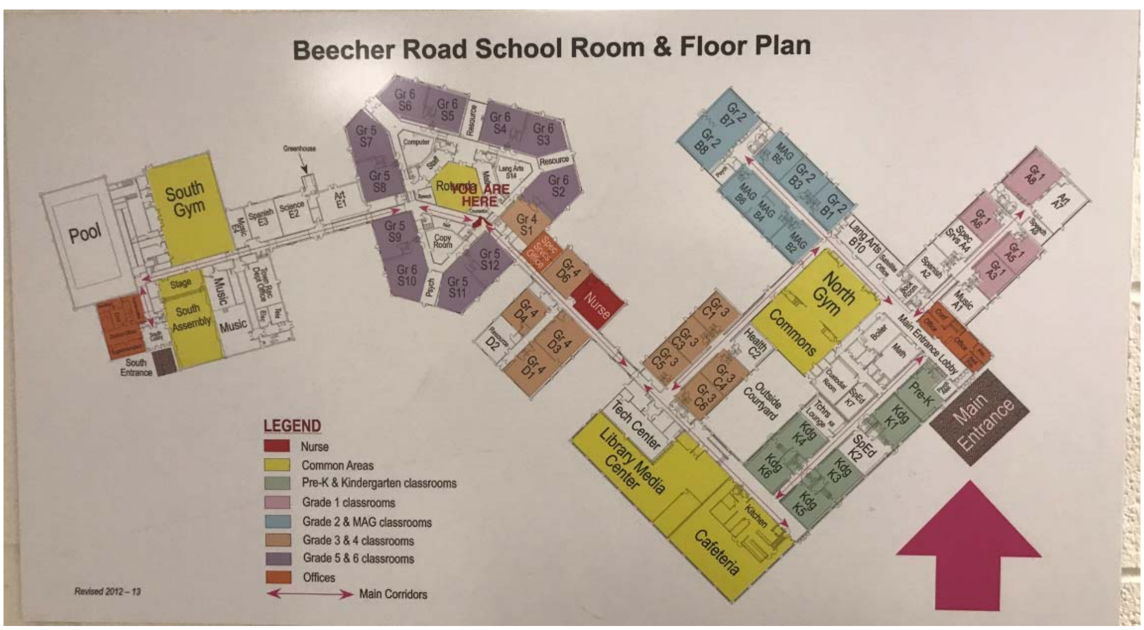

Figure 16-Building Floor Plan

B

Appendix B-Dectron Bearing Replacement Documentation

Operation Maintenance Schedule

The following list is important to the proper function and long life of the unit.

Every Month

Check the Air Filters

- All units have intake air filters. The unit cannot work properly with dirty filters.
- All dirty filters should be replaced with identical new filters. Filters for outdoor air should be moisture resistant.
- Do not operate the unit for any amount of time without all filters in place.

Check the blower belt

- Check for excessive wear. Be sure the belt will operate another month.
- Check the blower belt tension. Belts should not be so loose as to cause increased slip, nor so tight as to cause excessive shaft bearing wear.

Check that the condensate drain pan(s) is clean.

For indoor units-

- Remove all chemicals from the DRY-O-TRON® equipment room.

Every Six Months

Check that there are no bubbles in the sight glass after 10 minutes of compressor operation.
See **Startup - Adjustments**.

Check the compressor discharge temperature. See **Startup - TXV Adjustment**.

Check that the heat wheel (if any) is not dirty. Clean as necessary.
See **Operation - Maintenance - Heat Wheel**.

Every Twelve Months

Check for blower bearing wear.

Grease the blower bearings.

- Use a high quality grease for HVAC applications.
- Do not over-grease. Add grease until just a little oozes out from the bearing shield.

Check the condensate drain pan for any accumulated residue. Clean as necessary.

Check the air heat transfer coils for dirt and/or trash.

- If the coils are dirty
  - Δ Clean the coils with a solution of mild soap in warm water. Do not use corrosive cleaning agents.
  - Δ Increase the frequency of filter replacement. Dirty filters leak dirt onto the coils.

In the event of a future shutdown, leave power on the unit for the crankcase heaters if it is safe and possible to do so. To start the DRY-O-TRON® again, follow the steps in the **STARTUP** section of this manual.

Should refrigeration service be necessary, do not allow anyone to close the refrigerant-receiver isolation valves or the remote-condenser (if any) isolation valves without following the procedures under **Operation -Service - Isolation Valves**. Failure to follow these procedures may result in damage that is not covered by the warranty.

VOID

Installation of the Expansion Unit

1. *Remove lock plate located on the face of the locknut.*
2. *Turn locknut counter clockwise until bearing will freely slide onto the shaft.*
   a. *If Locknut Facing Outboard: Align housing mounting holes with substructure mounting holes and snug bolts. Push insert as far as possible in the direction of the fi xed bearing.*
   b. *If Locknut Facing Non-Expansion Bearing:* Align housing mounting holes with substructure mounting holes and snug bolts. Position Expansion bearing insert in center of housing. (Note: This is necessary because in the process of mounting, the bearing is being drawn toward the locknut.)

Note: All weight must be removed from the bearing when obtaining the "Zero Reference Point".

3. 3. Follow steps 4 through 10 found under the Installation of the Non-Expansion Unit.

DISMOUNTING

1. Remove weight from bearing via slings or jacks.
2. Remove mounting bolts from bearing.
3. Remove button head screws and lock plate from locknut.
4. Rotate locknut counter clockwise until bearing freely slides from the shaft.

FIELD CONVERSION OF A NON-EXPANSION BEARING INTO AN EXPANSION BEARIN

Move snap ring, opposite the collar side, to the outermost snap ring groove. Remove Non-Expansion nameplate and re-label as an Expansion bearing.

GREASE LUBRICATION

DODGE ISN bearings are pre-packed with a NLGI #2 Lithium Complex grease. For re-lubrication, select a grease that is compatible with a #2 Lithium Complex grease. Relubricate in accordance with Table 2.

Table 2 Re-Lubrication Intervals (in Months)

(Based on 12 hours per day, 150° F (66° C) Max

SHAFT SIZE		RPM								
mm	inch	250	500	750	1000	1250	1500	2000	2500	>3000
30 to 35	1-1/8 to 1-1/2	4	3	2	2	1	0.5	0.25	0.25	0.25
40	1-5/8 to 1-3/4	4	3	2	2	1	0.5	0.25	0.25	0.25
45 to 50	1-7/8 to 2	4	3	2	2	1	0.5	0.25	0.25	0.25
55	2-3/16 -2-1/4	3.5	2.5	1.5	1	0.5	0.5	0.25	0.25	0.25
60	2-3/8 to 2-1/2	3	2	1.5	1	0.5	0.25	0.25	0.25	0.25
65 to 75	2-11/16 to 3	3	2	1.5	1	0.5	0.25	0.25	0.25	0.25
80 to 85	3-3/16 to 3-1/2	2.5	1.5	1	0.5	0.25	0.25	0.25	0.25	--
90 to 100	3-11/16 to 4	2	1.5	1	0.5	0.25	0.25	0.25	--	--
110	4-7/16 to 4-1/2	2	1.5	1	0.5	0.25	0.25	0.25	--	--
115 to 125	4-15/16 to 5	1.5	1	0.5	0.25	0.25	0.25	--	--	--
135	5-7/16 to 5-1/2	1.5	1	0.5	0.25	0.25	0.25	--	--	--
140 to 150	5-15/16 to 6	1	0.5	0.5	0.25	0.25	0.25	--	--	--
160 to 170	6-7/16 to 7	1	0.5	0.25	0.25	0.25	--	--	--	--

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09/13 Litho 20,000

Instruction Manual for Adapter Mounted DODGE® ISN Unitized Spherical Roller Bearings

These instructions must be read thoroughly before installing or operating this product.

Warning: To ensure the drive is not unexpectedly started, turn off and lock-out or tag power source before proceeding. Failure to observe these precautions could result in bodily injury.

INSPECTION

Inspect shaft to ensure it is smooth, straight, clean and within commercial tolerances.

MOUNTING

Installation of the Non-Expansion Unit

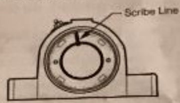
1. Remove lock plate located on the face of the lock nut.
2. Turn locknut counter clockwise until bearing will freely slide onto the shaft.
3. Slide bearing to the desired position on the shaft.

NOTE: All weight must be removed from the bearing when obtaining the "Zero Reference Point".

4. The "Zero Reference Point" is defi ned as the point when the clearance between the adapter sleeve, shaft, and bearing bore has been removed.
   a. *To reach the "ZERO Reference Point" rotate locknut clockwise, using both hands, as tightly as possible. When mounting bearings with shaft sizes 90mm and larger the following TEST must be performed. As a test to insure you have reached the "ZERO Reference Point" tap on the O.D. of the nut with a hammer and attempt to rotate the nut using both hands. If the nut will not rotate then you have reached the "ZERO Reference Point" and you should proceed to step 5. If you can rotate the nut using both hands, then you have not reached the "ZERO Reference Point", and should repeat step 4a until "ZERO Reference Point" is obtained.*

WARNING: Because of the possible danger to persons(s) or property from accidents which may result from the improper use of products, it is important that correct procedures be followed. Products must be used in accordance with the engineering information specified in the catalog. Proper installation, maintenance and operation procedures must be observed. The instructions in the instruction manuals must be followed. Inspections should be made as necessary to assure safe operation under prevailing conditions. Proper guards and other suitable safety devices or procedures as may be desirable or as may be specified in safety codes should be provided, and are neither provided by Baldor Electric Company nor are the responsibility of Baldor Electric Company. This unit and its associated equipment must be installed, adjusted and maintained by qualified personnel who are familiar with the construction and operation of all equipment in the system and the potential hazards involved. When risk to persons or property may be involved, a holding device must be an integral part of the driven equipment beyond the speed reducer output shaft.

5. Scribe a line through the locknut face and adapter face.



6. Using a Spanner or Drift and Hammer, rotate locknut clockwise by the number of turns shown in Table 1.

7. Slide lock plate over shaft and align tang of lock plate with slot in adapter sleeve.
8. TIGHTEN NOT LOOSEN locknut until lock plate slots overlap the two threaded holes on the locknut face.
9. Insert and tighten button head screws to locknut face.
10. Bolt down pillow block on to the structure.

Table 1 - Locknut Rotation from "Zero Reference Point"

Shaft Size		Locknut Rotation		
mm	inch	Basic Bearing No.	Turns	Degrees
30 to 35	1-1/8 to 1-1/2	22208K	3/4 to 7/8	280 ± 25
40	1-5/8 to 1-3/4	22209K	7/8 to 1	330 ± 25
45 to 50	1-7/8 to 2	22210K	7/8 to 1	330 ± 25
55	2-3/16 to 2-1/4	22211K	1 to 1-1/4	405 ± 40
60	2-3/8 to 2-1/2	22213K	1 to 1-1/4	405 ± 40
65 to 75	2-11/16 to 3	22215K	1 to 1-1/4	405 ± 40
80 to 85	3-3/16 to 3-1/2	22218K	1-1/4 to 1-1/2	495 ± 40
90 to 100	3-11/16 to 4	22220K	1-1/4 to 1-1/2	495 ± 40
110	4-7/16 to 4-1/2	22222K	1-1/8 to 1-3/8	450 ± 40
115 to 125	4-15/16 to 5	22226K	1-3/8 to 1-5/8	540 ± 40
135	5-7/16 to 5-1/2	22228K	1-3/8 to 1-5/8	540 ± 40
140 to 150	5-15/16 to 6	22232K	1 to 1-1/4	405 ± 40
160 to 170	6-7/16 to 7	22236K	1-1/8 to 1-3/8	450 ± 40

BALDOR • DODGE®

Donald, Bill

From: Tom Lapoint <lapoint@nemsi.com>
Sent: Friday, December 14, 2018 11:30 AM
To: Donald, Bill; vesparo@woodbridgeps.org
Cc: Anthony Daros; john_chase@mobile.emcor.net
Subject: Fw: Manual for Dectron
Attachments: image703173.png; DS SPVR PGD OM 2012-Mar-27.pdf

Gentlemen
I spoke to Gary Jones at Dectron. His recommendation is to follow the schedule in the attached manual. Refer to page 7.13 for bearing greasing schedule. 4 month intervals.
Gary is going to send this same information to Evan. Hope this helps to clarify the situation.

Regards

Tom LaPoint
Service Manager
EMCOR Services New England Mechanical
55 Gerber Road East
South Windsor, CT 06074

P: 860.870.2206
C: 860.508.5253
lapoint@nemsi.com
----- Forwarded by Tom Lapoint/NEMSI/EMS/EMCORGROUP on 12/14/2018 11:21 AM -----

From: Gary Jones <gjones@dehumidifiedairservices.com>
To: "lapoint@nemsi.com" <lapoint@nemsi.com>
Date: 12/14/2018 11:11 AM
Subject: Manual for Dectron

BE ADVISED - This email originated outside EMCOR.

VOID

Gary Jones
Legacy Product & Aftermarket Service Manager
Office: 1.833.DAS.POOL Mobile: 514.241.5812
Email: gjones@dehumidifiedairservices.com

Please note our e-mail coordinates have changed:
To schedule / modify a startup, e-mail: startups@DehumidifiedAirServices.com
To inquire about warranty, e-mail: warranty@DehumidifiedAirServices.com
To order parts, e-mail: parts@DehumidifiedAirServices.com
To request inspections, preventative maintenance, or controller replacements, email: support@DehumidifiedAirServices.com
To request service training, e-mail: training@DehumidifiedAirServices.com

⚠ WARNING

Risk of contact with moving parts. Can cause injury or death.

This product contains rotating parts and V-belt drives. Some procedures could expose personnel to the risk of injury or death from contact with these parts.

Using only approved devices (e.g. locking safety switch), disconnect, lockout, and tagout all sources of electrical energy before working inside the unit cabinet. Allow adequate time for rotating parts to stop. Follow all applicable safety regulations.

Some smaller blowers may be permanently lubricated. Other blowers may have bearings that have grease fittings or oil ports and require lubrication. Where this is the case, use the lubricating instructions provided on the blower nameplate or in accompanying documents. If no instructions are available, then until the proper instructions can be obtained

a) Use a high-quality NLGI No. 2 or No. 3 multipurpose ball-bearing grease with rust inhibitors and anti-oxidant additives. Examples are:
 Shell - Alvania No. 2
 Gulf - Gulfcrown No. 2
 Mobil - Mobilith AW2 / Mobilith SHC100
 American - Rykon Premium 2

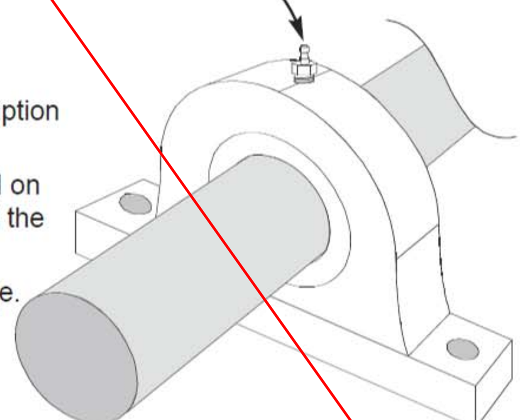
b) Follow the schedule below, based on size and speed of blower shaft.

Initial Relubrication Schedule
Ball Bearing Pillow Blocks

Number of Months Between Lubrications

Speed (RPM)	500	1000	1500	2000	2500	3000	3500	4000	4500
Shaft Diameter									
1/2" through 1-11/16"	6	6	5	3	3	2	2	2	1
1-15/16" through 2-7/16"	6	5	4	2	2	1	1	1	1
2-11/16" through 2-15/16"	5	4	3	2	1	1	1		
3-7/16" through 3-15/16"	4	3	2	1	1	1			

1. Be sure the electric power to the unit is OFF, locked out, and tagged out.
2. Clean all grease fittings or plugs to remove any paint, dirt, or dust.
3. If possible and safe to do so, slowly turn the blower by hand while adding grease.
4. Add grease just until a small amount of grease oozes from the seals.
5. Repeat for the bearing on the other end of the shaft.
6. When safe an practical to do so, return the blower to operation.



NOTE: Some units have more than one blower. See Product Description for suggested search locations.

NOTE: The frequency of lubrication may have to be changed, based on hours of operation, temperature, surrounding conditions, and the condition of the purged grease.

NOTE: Grease the bearings before an extended shutdown or storage.

NOTE: During an extended shutdown, rotate the blower shaft monthly.

VOID

OPERATION

Donald, Bill

From: Evan Cohen <evan@aerconcorp.com>
Sent: Tuesday, December 18, 2018 10:36 AM
To: Donald, Bill
Subject: FW: Beecher Elementary School ref#26079 bearing lubrication
Attachments: Comefri USA Fans Relubrication ATZAF ATZAF FF 7-28-2011.pdf

FYI - read below.

Evan Cohen
President
1486 Highland Ave.#7A
Cheshire, CT 06410
203 271 3386 (office)
203 915 4428 (mobile)
www.aerconcorp.com
evan@aerconcorp.com

From: Gary Jones [mailto:gjones@dehumidifiedairservices.com]
Sent: Tuesday, December 18, 2018 8:36 AM
To: Evan Cohen <evan@aerconcorp.com>
Cc: Marc Benard <Mbenard@dectron.com>
Subject: Beecher Elementary School ref#26079 bearing lubrication

Good morning Evan.
I have attached a bearing relubrication chart from our Blower supplier. The blower used on this job is an ATZF- 22-22 T2. It does show a relubrication of every 2 months, compared to our manual showing every 3-4 months. It is a lot more reasonable than every 2 weeks like shown on the bearing paperwork. As discussed previously, this is due to there are a number of factors such as temperature, chemicals in the air, and dirt that dictate how often bearings should be lubricated. As the air going through the dehumidifier is temperate and very clean, the times between relubricating the bearings should be longer. Every 2-3 months should be fine.
Best regards,
Gary

Gary Jones
Legacy Product & Aftermarket Service Manager
Office: 1.833.DAS.POOL **Mobile:** 514.241.5812
Email: gjones@dehumidifiedairservices.com

Fan Type	ATHI 9-9		ATHI 9-9		ATHI 10-10		ATHI 10-10		ATZAF 12-12		ATZAF 12-12	
Class	T1		T2		T1		T2		T1		T2	
Bearing size	3/4		1		3/4		1		1		1 3/16	
Bearing Model	P2B-SCAH-012-FF		P2B-SCAH-100-FF		P2B-SCAH-012-FF		P2B-SCAH-100-FF		P2B-SCAH-100-FF		P2B-SCUAH-103-FF	
Relubrication grease quantity [oz]	0.09		0.11		0.09		0.11		0.11		0.14	
	rpm	Frequency of relubrication (weeks)	rpm	Frequency of relubrication (weeks)	rpm	Frequency of relubrication (weeks)	rpm	Frequency of relubrication (weeks)	rpm	Frequency of relubrication (weeks)	rpm	Frequency of relubrication (weeks)
	1200	69	1400	58	800	88	1300	60	1000	70	1200	57
	1920	61	2220	51	1280	78	2080	53	1620	62	1920	50
	2640	52	3040	44	1760	67	2860	45	2240	53	2640	43
	3360	44	3860	37	2240	57	3640	38	2860	45	3360	36
	4080	36	4680	30	2720	47	4420	31	3480	37	4080	29
	4800	28	5500	23	3200	37	5200	23	4100	28	4800	22

Grease type : NLGI #2 Lithium complex grease

Fan Type	ATZAF 15-15		ATZAF 15-15		ATZAF 18-18		ATZAF 18-18		ATZAF 20-20		ATZAF 20-20	
Class	T1		T2		T1		T2		T1		T2	
Bearing size	1 3/16		1 7/16		1 3/16		1 1/2		1 1/2		1 11/16	
Bearing Model	P2B-SCUAH-103-FF		P2B-SCAH-107-FF		P2B-SCUAH-103-FF		P2B-SCBAH-108-FF		P2B-SCBAH-108-FF		P2B-ISN 510-111	
Relubrication grease quantity [oz]	0.14		0.13		0.14		0.15		0.15		0.22	
	rpm	Frequency of relubrication (weeks)	rpm	Frequency of relubrication (weeks)	rpm	Frequency of relubrication (weeks)	rpm	Frequency of relubrication (weeks)	rpm	Frequency of relubrication (weeks)	rpm	Frequency of relubrication (weeks)
	800	73	1000	58	700	80	900	60	600	72	800	13
	1280	64	1580	51	1100	71	1400	53	980	64	1240	11
	1760	56	2160	44	1500	61	1900	46	1360	55	1680	9
	2240	47	2740	37	1900	52	2400	38	1740	47	2120	6
	2720	39	3320	30	2300	42	2900	31	2120	38	2560	4
	3200	30	3900	23	2700	33	3400	24	2500	30	3000	2

Grease type : NLGI #2 Lithium complex grease

Fan Type	ATZAF 22-22		ATZAF 22-22		ATZAF 25-25		ATZAF 25-25		ATZAF 28-28		ATZAF 28-28	
Class	T1		T2		T1		T2		T1		T2	
Bearing size	1 1/2		2		1 11/16		2		1 15/16		2 3/16	
Bearing Model	P2B-SCBAH-108-FF		P2B-ISN 511-200		P2B-SCAH-111-FF		P2B-ISN 511-200		P2B-SCAH-115-FF		P2B-ISN 513-203	
Relubrication grease quantity [oz]	0.15		0.22		0.23		0.22		0.25		0.26	
	rpm	Frequency of relubrication (weeks)	rpm	Frequency of relubrication (weeks)	rpm	Frequency of relubrication (weeks)	rpm	Frequency of relubrication (weeks)	rpm	Frequency of relubrication (weeks)	rpm	Frequency of relubrication (weeks)
	500	80	700	13	500	84	600	16	400	82	600	13
	820	71	1120	11	760	74	960	13	660	72	940	11
	1140	61	1540	8	1020	64	1320	11	920	63	1280	8
	1460	52	1960	6	1280	54	1680	8	1180	53	1620	6
	1780	43	2380	4	1540	45	2040	6	1440	44	1960	4
	2100	33	2800	2	1800	35	2400	3	1700	34	2300	2

Grease type : NLGI #2 Lithium complex grease

Fan Type	ATZAF 32-32		ATZAF 32-32		ATZAF 36-36		ATZAF 36-36		ATZAF 40-40		ATZAF 40-40	
Class	T1		T2		T1		T2		T1		T2	
Bearing size	2 3/16		2 3/16		2 7/16		2 7/16		2 3/16		2 7/16	
Bearing Model	P2B-SCAH-203-FF		P2B-ISN 513-203		P2B-SCBAH-207-FF		P2B-ISN 515-207		P2B-ISN 513-203		P2B-ISN 515-207	
Relubrication grease quantity [oz]	0.3		0.26		0.34		0.43		0.26		0.43	
	rpm	Frequency of relubrication (weeks)	rpm	Frequency of relubrication (weeks)	rpm	Frequency of relubrication (weeks)	rpm	Frequency of relubrication (weeks)	rpm	Frequency of relubrication (weeks)	rpm	Frequency of relubrication (weeks)
	400	88	500	14	400	83	400	15	300	20	400	16
	600	78	780	12	600	73	660	13	500	17	620	13
	800	68	1060	9	800	64	920	10	700	14	840	11
	1000	57	1340	7	1000	54	1180	8	900	11	1060	8
	1200	47	1620	4	1200	44	1440	5	1100	8	1280	6
	1400	37	1900	2	1400	34	1700	3	1300	5	1500	3

Grease type : NLGI #2 Lithium complex grease

Fan Type	ATZAF 44-44		ATZAF 44-44		ATZAF 49-49		ATZAF 49-49	
Class	T1		T2		T1		T2	
Bearing size	2 15/16		2 15/16		2 3/4		2 15/16	
Bearing Model	P2B-SCUAH-215-FF		P2B-ISN 517-215		P2B-ISN 516-212		P2B-ISN 517-215	
Relubrication grease quantity [oz]	0.46		0.57		0.49		0.57	
	rpm	Frequency of relubrication (weeks)	rpm	Frequency of relubrication (weeks)	rpm	Frequency of relubrication (weeks)	rpm	Frequency of relubrication (weeks)
	200	95	300	17	200	23	300	18
	340	84	500	14	340	20	480	15
	480	73	700	12	480	16	660	12
	620	62	900	9	620	13	840	10
	760	51	1100	6	760	10	1020	7
	900	40	1300	4	900	6	1200	4

Grease type : NLGI #2 Lithium complex grease

C

Appendix C-Vibration Testing Reports

Integrated Diagnostic Services, Inc.

63 Lakeside Road - Mahopac, NY 10541

Mr. Bill Donald

vanZelm Engineers

10 Talcott Notch Road

Farmington, CT 06032

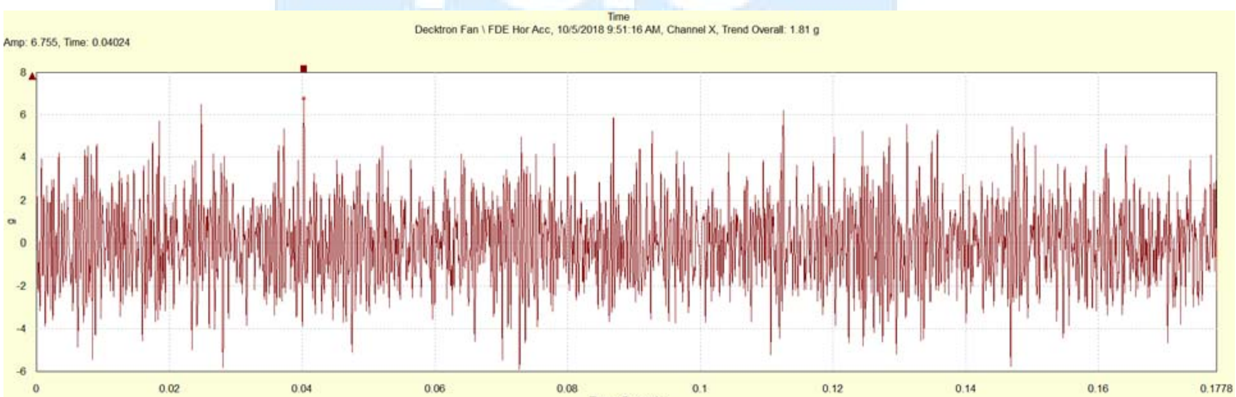
Re: Beecher Road Pool Unit Bearings

Bill

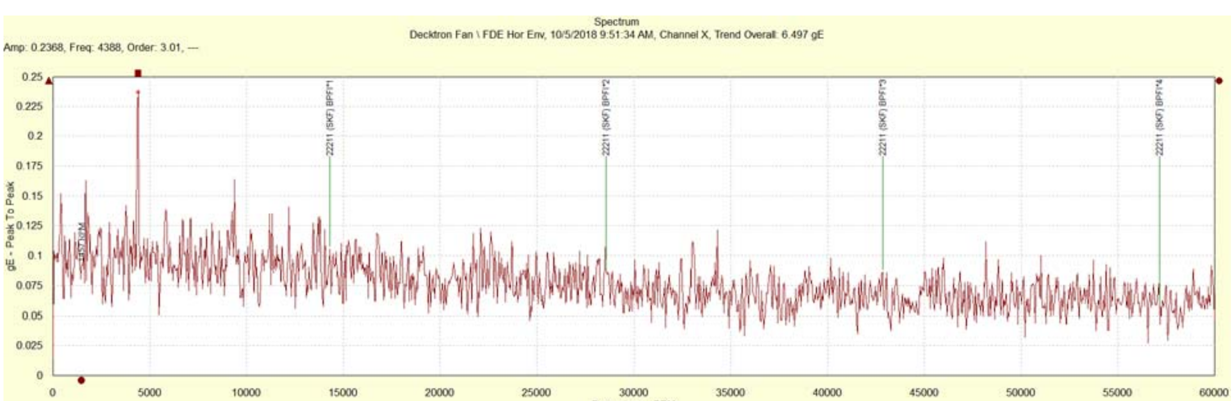
This is the summary report of the vibration readings taken on the motor and fan bearings for the pool unit.

Fan Bearings:

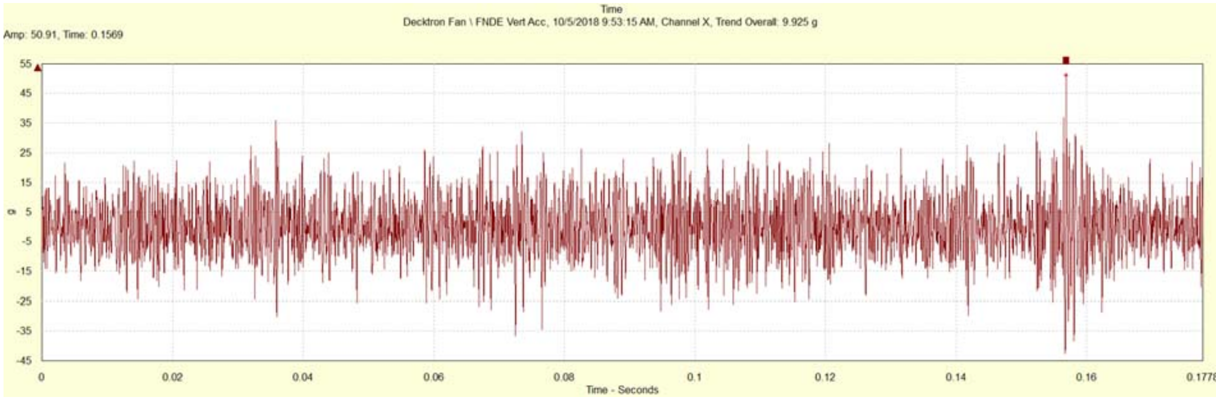
The drive side fan bearing shows an acceleration reading of 1.81g. This is well above a normal alarm threshold of 1.00g. There are multiple mid-to-high level impacts visible in the Time Waveform. This bearing should be considered in fault and can fail at any time.



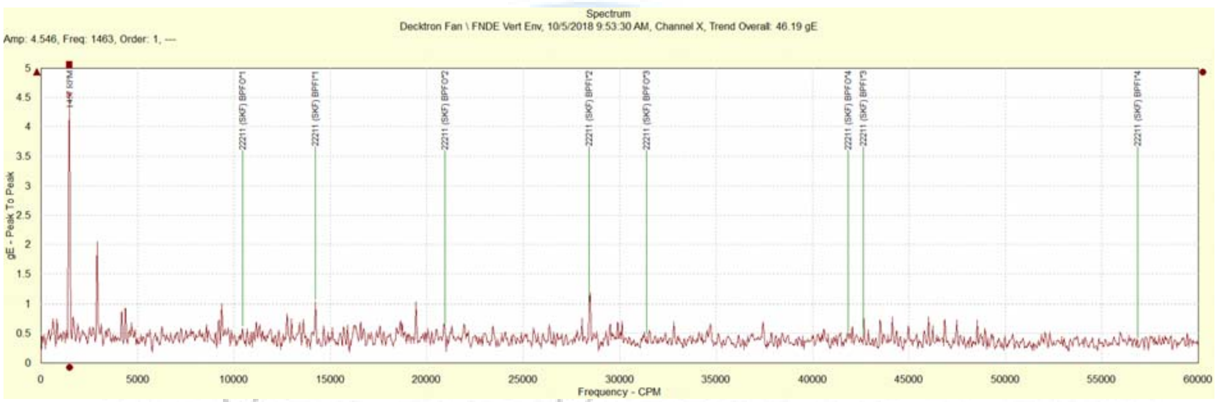
The Envelope Spectrum confirms the above impacts. There are multiple defect frequencies at the Inner Race.



The non-drive side fan bearing shows an acceleration reading of 9.925g. This bearing should be considered at a Stage 4 fault and can fail at any time.



The Envelope Spectrum shows multiple bearing defect frequencies at both the Inner and Outer Race.

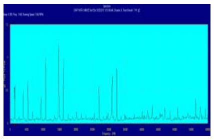
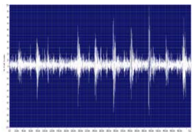
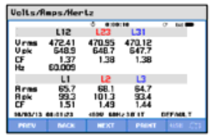


The Velocity Spectrum shows multiple harmonics of the running speed. This would indicate a Mechanical Looseness. Either the bearing is getting loose on the shaft (shaft may be scored) or the bearing is loose in the housing. Though there is a high amplitude at the running speed, it does not indicate a fan unbalance at this time. This does not mean that the fan is not out of balance, it means that a correct diagnosis cannot be done while the bearing is in fault.

Another thing to think about is: these bearing usually come with a fixed or an expandable spacer. If both bearings are of the fixed variety; they will cause a premature bearing failure. Make sure to order the correct bearings so this does not happen.

John S. Tecchio

Integrated Diagnostic Services, Inc.

Vibration Analysis | Ultrasound | Power Quality | Pump Alignment | Fan Alignment | Fan Balancing

Analysis Report

BEECHER ROAD SCHOOL

40 Beecher Road South

Woodbridge, CT 06525

Pool Dectron Unit – 11/9/2018

Analyst: John S. Tecchio

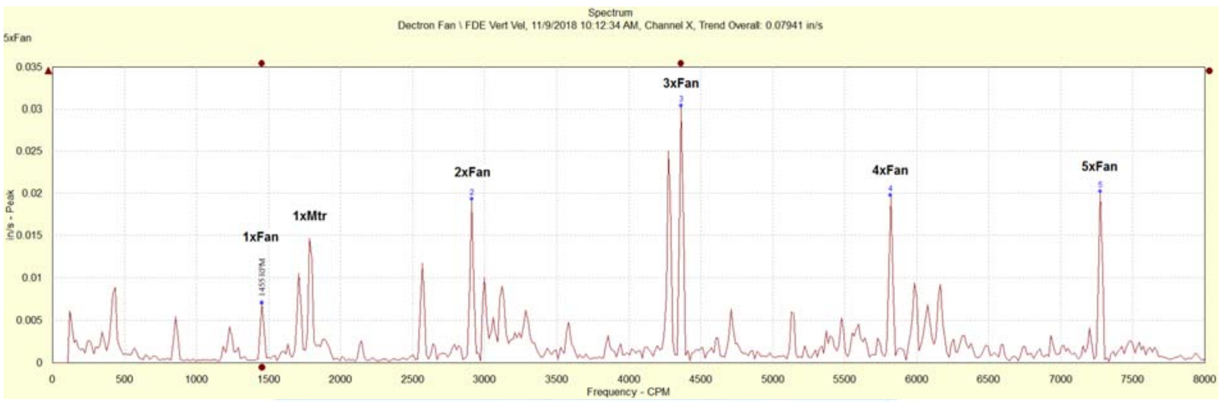
63 Lakeside Road 848.702.0087 Mahopac, NY
www.int-diag.com

Integrated Diagnostic Services, Inc.

63 Lakeside Road - Mahopac, NY 10541

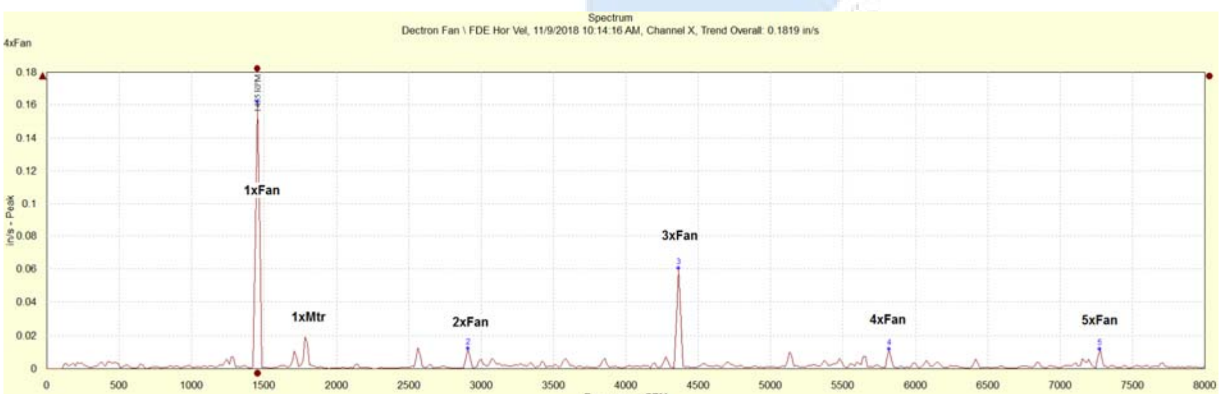
SUMMARY OF NEW BEARING READINGS

The Fan Drive End Bearing Velocity reading taken in the Vertical Position shows multiple harmonics of the fan running speed. This is an indication of a Type C Mechanical Looseness.



integrated diagnostic services inc.

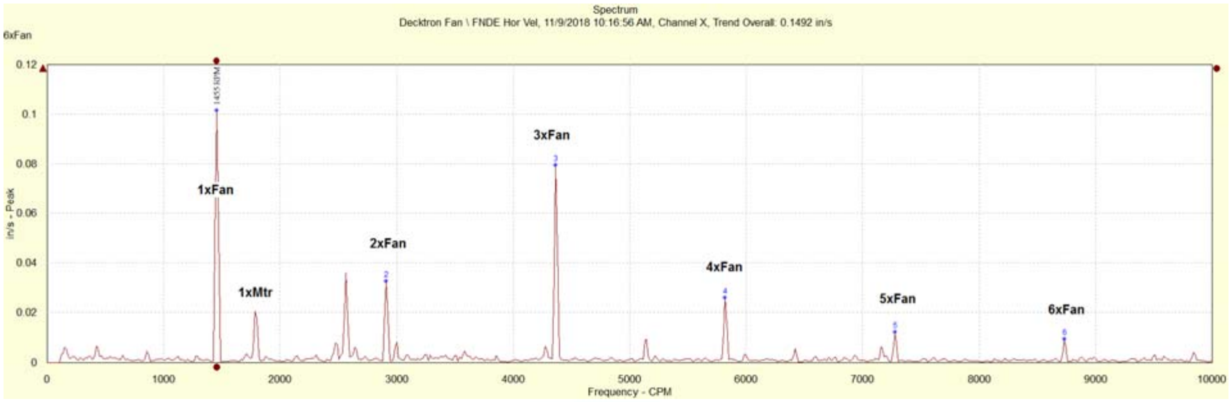
The Fan Drive End Bearing Velocity reading taken in the Horizontal Position shows the same harmonics of running speed with a higher Fundamental amplitude.



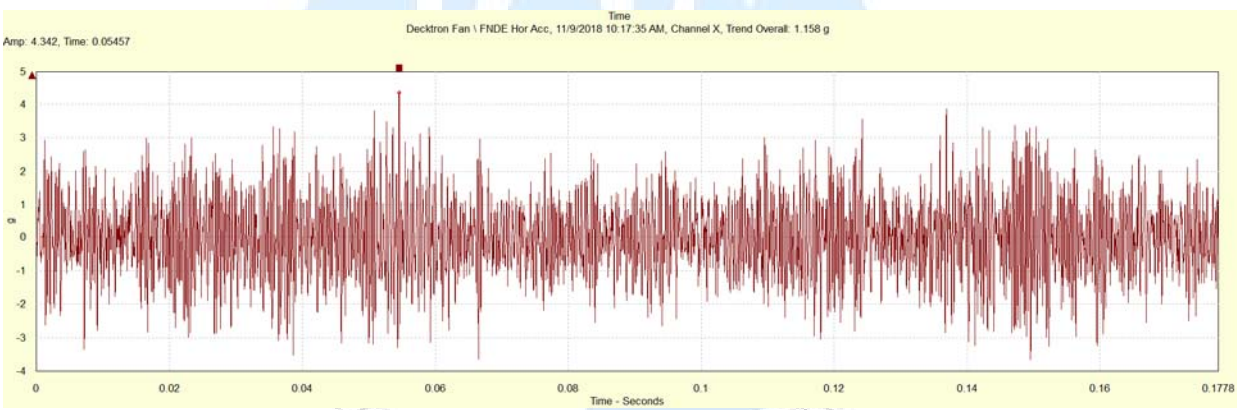
A Type C Mechanical Looseness can be caused by a bearing loose in its housing, an improper fit between components, and a loose impeller on its shaft. All bolts should be checked for proper torque on the fan and bearing assemblies. The sheaves should be checked to see if they need to be replaced (they do look bad) and the belts should be checked for proper tension.

The Overall reading shows very little vibration on the bearing.

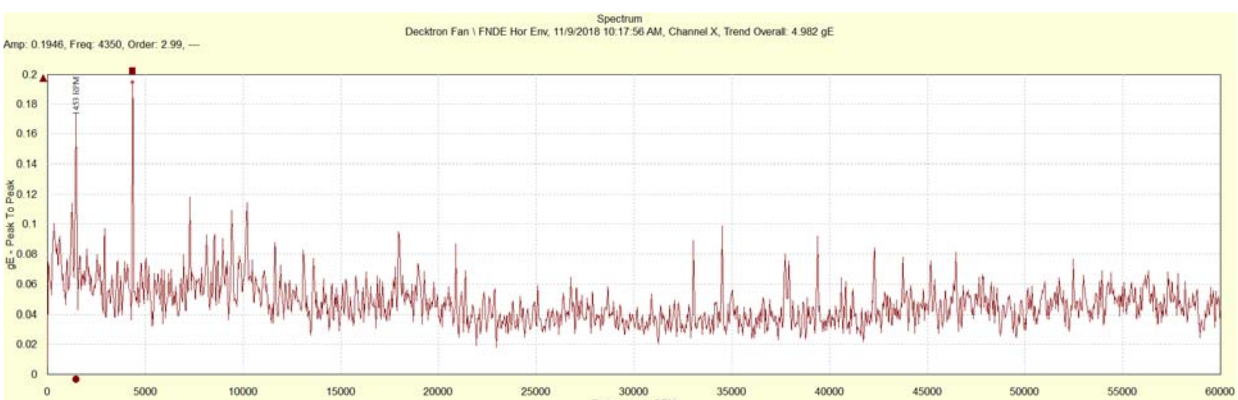
The Fan Non-Drive end Bearing Velocity reading in the Horizontal Position shows the same indications of a Mechanical Looseness.



The Fan Non-Drive End Bearing Acceleration reading in the Horizontal Position shows an elevated Overall value. A good reading would be below 1.0g and a reading above 1.0g would show signs of a possible bearing issue.



The Fan Non-Drive End Bearing Envelope reading in the Horizontal Position shows and elevated Overall value. A good reading would be below 4.0gE. A reading between 4.0gE and 7.0gE would show the possibility of a bearing fault.



I have seen these readings on new bearings many times in the past. Usually they can be reduced or eliminated by properly greasing the bearing. Manufacturers will tell you that the bearing comes pre-lubricated, but it is up to the field technician to determine if the bearing is properly lubricated.

I would highly recommend checking all the above points as well as adding the proper amount and proper lubricant to the bearings to see if the readings become acceptable.

There is currently a grease tube on the Non-Drive End Bearing. This tube will need to be removed and purged with the correct lubricant. There is no way to ascertain what grease (or greases) have been used in the past.

A proper lubrication plan should be developed and adhered to. This should extend the life of the bearings.

John Tecchio

While the utmost care is taken in performing the analysis and making recommendations, there is always something that can occur that was not planned. Bearings have been known to last well after they have entered a Stage 4 Fault and a Stage 2 Fault has been known to rapidly accelerate a fail a bearing. Integrated Diagnostic Services, Inc. can only make recommendations based on what was seen at the moment of the last readings.

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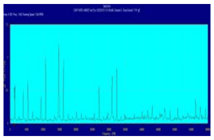
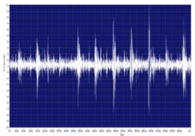
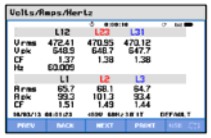
integrated diagnostic services inc.
SPECIALISTS IN HVAC SYSTEMS


Vibration Analysis Ultrasound Power Quality Pump Alignment Fan Alignment Fan Balancing

Vibration Analysis Definitions

UNBALANCE: A condition where the mass centerline does not match the shaft centerline, usually denoted by a high 1X peak in the vibration spectrum, and where the 1X peak is greater than 80% of the Overall.

There are three different types of unbalance.

Force (Static) Unbalance: A condition where the mass centerline is moved from the shaft centerline but still stays parallel. This can be seen on a fan when the belts are removed. When the out of balance spot is placed at the top of the fan, the fan will rotate until the out of balance spot ends up at the bottom.

Couple Unbalance: A condition where the mass centerline intersects the shaft centerline but does not stay parallel.

Dynamic Unbalance: A combination of Force Unbalance and Couple Unbalance. This is the most common form of Unbalance.

ECCENTRICITY:

A condition where the shaft is not completely straight and concentric end to end.

A satisfactory rotor balance usually cannot be achieved when there is a bent shaft. There are some instances where a thermal treatment can straighten the shaft but can, then induce fatigue.

MISALIGNMENT:

A Condition where the shaft centerline of one component does not coincide with the shaft centerline of another component.

Misalignment is probably the most prevalent problem in most plants.

There are 3 different types of misalignment.

Angular Misalignment is a condition where the shafts of each component are angled at the coupler.

Parallel Misalignment is a condition where the shafts of each component are offset at the coupler.

Bearing Misalignment is a condition where either the bearing is cocked inside its housing or the bearing is cocked on the shaft.

RESONANCE:

A condition where a forcing frequency (Unbalance, Misalignment, Looseness, Bearing Defects, etc) coincides with a natural frequency. The natural frequency can be of the rotor, the support frame, the foundation, or even the drive belts.

MECHANICAL LOOSENESS:

There are 3 types of mechanical looseness. Looseness is not a cause of vibration but an effect of other problems (Unbalance, Misalignment, etc.)

Type A Looseness is a condition caused by a weakness of the machine feet, deteriorated grout or concrete base, a distortion of the frame (Soft Foot) or loose hold down bolts.

Type B Looseness is a condition caused by a rocking motion from a cracked or fatigued structure or cracked bearing pedestal.

Type C Looseness is a condition caused by a loose bearing in its housing or an improper fit between components. Type C is often caused by a bearing liner loose in its cap, a bearing loose and turning on its shaft, a loose impeller (fan) on its shaft, etc.

ROLLING ELEMENT BEARING FAULTS:

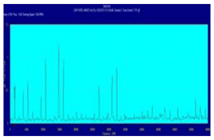
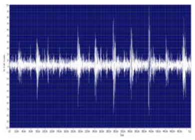
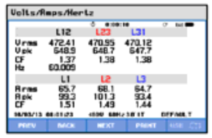
There are 4 stages of a rolling element fault. There are many companies that have broken these four stages down farther to nine stages. There are 4 defect forcing frequencies.

BPFO = Outer Race Faults ***BPFI*** = Inner Race Faults

BSF = Ball or Roller Fault ***FTF*** = Fundamental Train (Cage) Faults

Stage 1: The earliest detection of a bearing issue will appear in the ultrasonic frequencies in the 250,000 to 350,000Hz range. These are undetectable by means of the equipment used in vibration analysis. As the bearing wear increases, the ultrasound range will drop. The Bearing Envelope readings are able to detect bearing faults in the 500 to 10,000Hz range. Should any of the bearing forcing frequencies (BPFO, BPFI, BSF, FTF) show up in the enveloped spectrum, the bearing would be considered at a Stage 1 Fault.

Stage 2: Slight bearing defects begin to excite the bearing's natural frequencies, which can be seen in a Velocity Spectrum in the 30,000 to 120,000 cpm range. These natural frequencies may also be a resonance of the bearing support structure. Sideband frequencies appear above and below the natural frequencies toward the end of the Stage 2 Fault. The Bearing Envelope reading will increase from the Stage 1 Fault.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Stage 3: Bearing defect frequencies and harmonics will appear in the low frequency Velocity Spectrum. As the bearing wear progresses, more defect frequency harmonics will appear and the number of sidebands will increase. Overall Bering Envelope readings will continue to increase. At this point, the defects in the bearings are usually visible. Sidebands of the defect frequencies will become more pronounced as the wear continues throughout the periphery of the bearing. It is usually recommended that the bearing be replaced at this point.

Stage 4: Toward the end of the bearing's life, the amplitude of the fundamental frequency (1x RPM) can be affected. The amplitude can increase and show many harmonics of the fundamental. The Vibration peaks that had previously shown up now begin to disappear into a random, broadband high frequency noise floor. The Bearing Envelope readings will actually begin to decrease until immediately before the failure, when they will spike to excessive amplitudes.

With all the above technical information, it should be noted that bearings have lasted well past a Stage 4 Fault and they have also catastrophically failed in a Stage 3 Fault.

FLOW INDUCED VIBRATION:

Hydraulic and Aerodynamic Forces are generated by either pump vanes (VPF) or fan blades (BPF), which generate a pressure variation each time a vane (or blade) loads or unloads as it passes a stationary component.

Cavitation is a condition that occurs when a pump is operating at excess capacity or low suction, causing implosions at the eye of the impeller.

Recirculation is a condition that occurs when a pump is operating at diminished capacity or high suction.

Flow Turbelence is a condition that occurs which impedes or resists the normal flow through pumps and fans.

SURGE:

Surge is a condition that occurs when a centrifugal or axial component is operating outside its design limits.

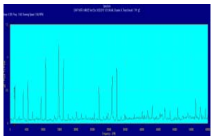
GEAR PROBLEMS:

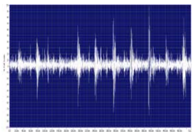
Gear Tooth Wear refers to surface damage across the face of the gear tooth.

Excessive Tooth Load refers to a significant increase in load for an extended period of time.

Gear Eccentricity – See Eccentricty

Cracked, Chipped or Broken Teeth will increase vibration levels drastically.


Vibration Analysis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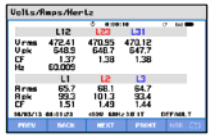

Power Quality


Pump Alignment


Fan Alignment


Fan Balancing

Hunting Tooth Problems are usually associated with the gear manufacturing process where the gear teeth do not mesh correctly.

ELECTRICAL PROBLEMS:

Misalignment occurs when the driver and driven sheaves are not in the same plane. This can also happen when using variable pitch sheaves.

Sheave Eccentricity – See Eccentricity

Worn, Loose, or Mismatched belts will create vibration at the belt pass frequency.

Belt Resonance occurs at the belt natural frequency, which corresponds to the mass, stiffness and length of the belt. A natural frequency can be changed by adjusting tension on the belt or changing the length.

SOFT FOOT:

Soft foot is a condition where all four motor feet do not sit flat on their base. This causes a deformation of the motor housing, which changes the air gap between the rotor and stator; causing possible damage. Damage to the shaft and bearings can also occur.

TWICE LINE FREQUENCY (2x LF):

2x line frequency is, mathematically, 2 times the electrical line frequency (60Hz normally) x 60 (to convert cycles/sec to cycles/min. Therefore 7200 cpm is 2x line frequency for a 60Hz electrical supply.

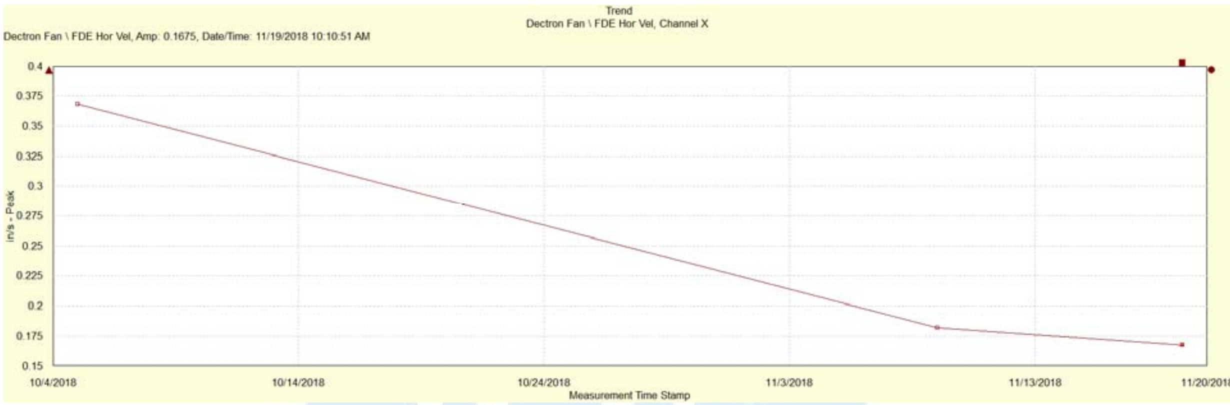
While these are not all the reasons for vibration or the effects of vibration, they do cover the majority.

Integrated Diagnostic Services, Inc.

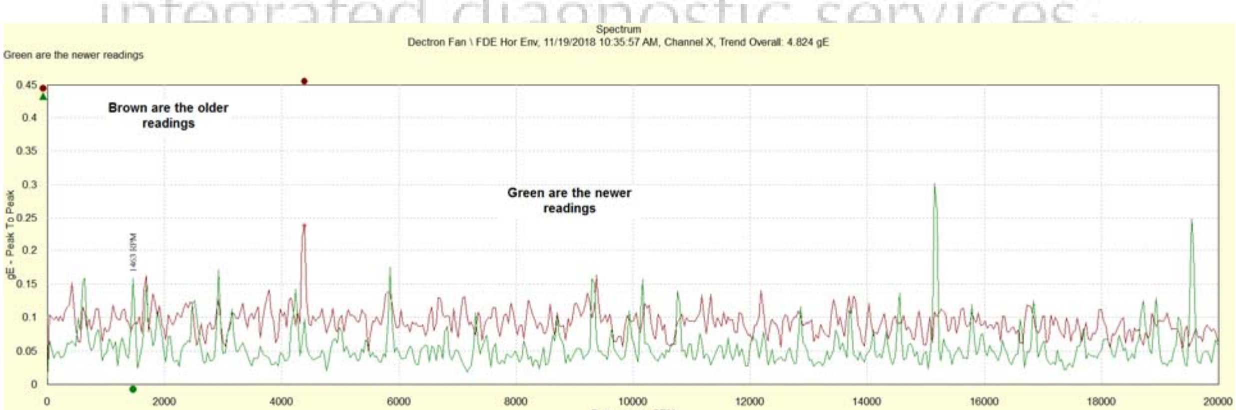
63 Lakeside Road - Mahopac, NY 10541

This is the summary of the readings taken today.

The vibration trend shows a 55% reduction in the velocity readings since the first trip to the site.



While there is still bearing noise showing up in the Envelope, there has been a 50% reduction since the first visit. The Overall reading is still showing the beginning stage of a fault.



A strobe was used to look at the fan during operation to see if there was any movement, possibly showing a bent shaft. There was no discernible movement in the shaft.

The recommendation would be to check these readings in 6 months to see if there is any increase in the readings.

John S. Tecchio