KNIGHTHAWK TECH NOTES

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Large Fans Can Be Challenging

Your new world class facility has just started up. As the maintenance manager of the facility, your group is in charge of the rotating equipment. Your group has been fighting the typical “startup” battle and headway is being made. In your morning meeting, there is one item that shows up on the radar as the next battle for your team. The fan’s vibration is outside acceptable limits. The 3000 HP driver and fan design make the fan a “big” one. There are two fans that are running in parallel. The second fan serves as a backup, but the system is designed to run in parallel.

During planned outages that frequently occur on commissioning, the original equipment manufacturer (OEM) has sent a team to address the problem. They have found nothing wrong as they tested the fans during the planned outages. You decide to put a RCA (Root Cause Analysis) team together to attack the problem.

When looking at fans, there are several key areas to consider (but not limited to):

1. **Fan Performance Analysis:** One key point in the evaluation is to determine whether the fan is meeting its performance requirements. Typically a FAT (Factory Acceptance Test) is performed to validate the fan is fit for its purpose in the field. However, more often than not, the FAT does not duplicate actual field conditions. Historically the in plant inlet and outlet ducting systems are less favorable than the FAT test set up. For large fans, there may be inlet temperature gradients that effect actual performance. The FAT test does not include any interaction effects with spare fans or fans operating in parallel that could affect performance. One of the major issues with the fan performance analysis is converting the data to standard conditions most often listed in flow as MSCFH (million standard cubic feet per hour). The FAT test fan curves are validated or generated to serve as a basis for performance and design. The performance curves are also based on standard temperature conditions. Sometimes the fans have cooled bearings. Also field conditions typically run at a temperature higher than standard. These conditions can affect actual rotor dynamics response of the unit.
2. **Field Study:** A field study should be conducted for the fan. Thermal imaging of inlet and outlet ducting systems, the bearings, and the fan itself should be done to determine if there are any operating thermal gradients present. Field data should be acquired from the bearings, the inlet and outlet dynamic pressures, and structural vibration. In some cases, acoustic transducers should be put on the inlet and outlet ducting and fan casing. One of the major considerations in the field study is the movement and vibration of the pedestal supports. Usually during design, the supports are considered rigid, but in reality they are really not.
3. **Fan Balance:** Many fans are balanced in the shop and sent to the field. Shipping, coating, and other work done (after the shop balance) could affect the fan balance. Hands down the best way to handle the situation is to balance the fan in the field. Field balancing takes into account any residual differences between the shop mount and field mount.
4. **Aerodynamics:** A computational fluid dynamics (CFD) study should be conducted for the inlet and outlet fan ducting. This is especially important if the fan is not meeting design conditions. The model should be detailed enough to consider wake separation effects off the blades and any vane flow separation that could cause system excitation. Since these two fans are in parallel, the interaction effect should be considered in the model.
5. **Finite Element Analysis:** Finite element analysis (FEA) heat transfer models for the fan should be conducted to determine whether the shaft is bowing and what are the expected temperatures for the rotating elements. The FEA should be compared to any thermal imaging. Structural analysis should be conducted to evaluate system movement.
6. **Rotor Dynamics:** Rotor dynamics is one of the most important aspects when troubleshooting the fan. Evaluations should be conducted to look at transient and steady state conditions. The actual stiffness of the pedestals should be incorporated into the rotor dynamics model. Bearing damping should be considered based on actual operating conditions.
7. **Root Cause Analysis:** Finally, a root cause analysis (RCA) should be conducted to consider all that has been done above.

Rotating equipment problems should be supervised by qualified professional engineers with expertise with this type of equipment.

Cliff’s Notes: KnightHawk has evaluated fans in Nuclear and Fossil Power Plants and major petrochemical facilities. We have provided field services, process, mechanical, controls, and metallurgical and material analysis of the problems. KnightHawk is your one stop shop for these problems. Our rotating equipment engineers have over 250 years of combined experience to attack these problems. Our team has been called in on the most challenging problems in the industry and we have been highly successful in solving these type problems. Call us and we can tell you how we can help you. This is a special time of the year for all of us. I have enjoyed working with each of you this year. I want to wish you and your family a very Merry Christmas and Happy New Year.

Take care and God Bless,

Cliff Knight

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KnightHawk Project Update

- CFD of PSV Systems – Petrochemical
- 19 MW Diesel Engine Failures – Power
- Combustion CFD Analysis – Power
- Liquid Ring Compressor Failures – Oil & Gas
- CFD of Separator – Petrochemical
- Rod Mill Failure – Power
- Clamping Connector Analysis – Petrochemical
- Duct Work Redsign – Petrochemical
- Critical Pipe Stress – Petrochemical
- Vertical Cast Transporter Failure – Nuclear Power
- Compressor Cross Head Failure – Oil & Gas
- Transient Fluid Dynamics – Petrochemical
- API Tanks FFS – Petrochemical
- Gear Pump Failure Analysis – Petrochemical
- Transfer Line Exchanger – Petrochemical
- Brittle Fracture Analysis – Petrochemical
- Fit for Service Analysis – Petrochemical
- Tensile Testing – Manufacturing
- Pump Vibration Analysis – Petrochemical
- Motor Shaft Failure – Petrochemical
- Gas Pipeline Coupling Failure – Oil & Gas
- Reciprocating Compressor Re-Design – Petrochemical
- Compressor Skid Pipe Stress – Petrochemical
- Pump Vibration Analysis – Petrochemical
- Corrosion Analysis – Gas Pipeline
- Gasifier Equipment Design – Power
- High Temperature Molten Salt Tank Design – Green Energy
- Gas Plant Fire & Explosion – Oil & Gas