KNIGHTHAWK TECH NOTES

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"Forensic Analysis - It Can Help When Data is Limited?"

You have been working a long week and your boss just called and told you compressor 5A just went down. This is a steam turbine driven system that has all the "bells and whistles", i.e. data taken at time of failure. This system has the most advanced historian in your company because it is a critical piece of rotating equipment. You gather the data and immediately proceed into root cause analysis by assembling the support teams you need, from engineering, maintenance, production, and process.

Unfortunately it is more often that older critical rotating equipment in aged facilities does not have a historian with all the data. In many cases it involves the operator logging critical data. How many times have you been faced with a design issue, troubleshooting problem, or failure evaluation and there is just not enough data to solve the problem in your mind. This often leads to another problem, even though you feel you do not have enough data to push on, the problem must still be solved. Most of us are acquainted with the schoolbook test problem where all the data is given to solve the problem. Then we graduated and went to work and the problem solving became real sporty. How many times has your supervisor come to you with a problem and said "Here is the problem and here is the data you need to solve the problem"? So how do you attack a problem with limited data? Well there are several ways.

One way is to collect data through research. Another way is to take measurements. But what if it is a new design or the problem involves a failure investigation. Suppose you do not have time for research and there is no way to take any measurements. The typical solution is to use good engineering judgement based on experience and charge forward, taking all available precautions to minimize any risk. While engineering judgement and experience are great, there are analyses methods available to provide additional information to the problem.

There are analysis methodologies that combine engineering experience with high-end technological approach to ensure a high probability of success for the problem you are looking to solve. A simple example can be a pump failure. All you have is discharge pressure data and pump speed. For some reason you do not have flow rate. But you do have the pump curves for that pump so you can go to them to get the flowrate assuming the pump had been operating on the curves. Certainly data can be challenged, but forensically, challenges can be ruled out. So the challenge to the pump example is you don't know if it was running on the curves. Well, suppose you determine that it has run smooth with little vibration for years up until it failed. Well it was likely running on the curves.

There are three basic technological approaches to solve a problem:

1. Absolute Methodology – This analysis methodology calculates the exact solution to the problem based on the actual load condition. But the problem is in the real world we do not always know the scientific constraints for the problem or have high knowledge of the load conditions. This analysis methodology is used widely in design, with success primarily due to the safety factor built into the analysis to account for the intangibles. Good examples of this are vessel and heat exchanger design, turbine blade design, and typical process design.
2. Relative Parameter Methodology – In this situation the engineer has some idea of the behavior of the physical system under a particular load. Examples are a measured deflection under a certain load, pressure drop in a process system under a particular flow-rate, turbine HP under certain load conditions. A sensitivity study could be performed and an analysis method can be derived to predict the response based on a change in load. Also, a numerical model can be developed to incorporate all parameters and the relative response will be accurate to the corresponding change in load. This methodology is often paramount in failure analysis and troubleshooting.
3. Bracketed Parameter Methodology – This methodology usually involves a sensitivity study of parameters. A good example is the convective heat transfer film coefficient used as a boundary condition to determine the temperature distribution through a component. An exact number may be difficult to calculate. However, upper and lower bounds can be derived through a sensitivity study. The response of the equipment can then be calculated.

There is a way to do some type of calculation method for most any problem based on the three methodologies described above. It can be very powerful when you do not have all the data you think you need. You may have more than you think!

Cliff's Notes:

At KnightHawk we have really wrote the book on the type analyze shown above. We have over 25 years' experience in applying forensic approaches to a physical situation to get the right solution or understand what happened. Call us and we can show you how we can help you solve your problems. With field services, a materials lab, and multidiscipline engineering group we are a one stop shop!

As I write this letter the hot summer has started in Houston. Yes hot and humid. I hope you stay cool where you are.

Take care and God Bless,

Cliff Knight
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KnightHawk Project Update

- Rotordynamics of a centrifugal compressor
- Fan Performance Failure Analysis
- Steam Turbine Failure Analysis
- Valve Failure Investigation
- Failed Pump Root Cause Analysis
- Check Valve Testing
- TLE Inlet Redesign
- Metallurgical Failure Analysis
- Thermal Oxidizer Feed Mixing CFD
- Rail Car Pressure Containment FFS
- Heat Exchanger Rerate Analysis
- Furnace Ethane Feed Optimization
- Coker Furnace Outlet Piping Non-Linear Creep Stress Analysis
- Vessel Code Calculations
- Heat Exchanger Diaphragm Failure
- Storage Rack System FFS
- Fan Vibration Analysis
- Reverse Engineering of Medical Devise
- PMI and Materials Consulting
- Boiler Tube Failure Analysis
- Silo Rerate Analysis
- Brittle Fracture Analysis