KNIGHTHAWK TECH NOTES

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High Energy Systems

It is 8:30 a.m., you have just gotten out of the morning meeting and you have a sinking feeling in your gut. You're the maintenance manager in a Power Unit and you just learned that Turbine 1 is going off line at midnight and you are going on steam bypass to export. Well, you know what that means. It will be going through the let down station and it will be "screaming'". You also remember when you worked in a large ethylene facility where the cracked gas compressor would go on recycle and the system vibration led to heavy vibrations and failure in a short time. You could only wonder if that will happen here.

The two situations discussed above are high energy systems. High energy systems as discussed here in today's newsletter are piping systems that contain high steady state and transient pressure and momentum effects that dissipate remarkable energy into the mechanical systems. Good examples of these systems are steam bypass and letdown stations, blow down, vent, relief and recycle systems.

Many times in the evolution of plant design heavy attention is paid to the overall all process. Things like vent, relief, blowdown, and letdown systems are not always well thought out in every detail. There may be a variety of reasons, but part of the problems lie in the fact that these systems are normally temporally in service. Typically in these systems we are going from a high pressure to a lower pressure. During this time all sort of interesting things can happen such as:

- High Noise
- Vibration
- Chatter
- Failures
- Performance Short fall

Typically in two phase systems we reach "choke" flow conditions within the let down device. When this happens, shock waves are produced and can excite acoustic natural frequencies within the piping system. If these acoustic natural frequencies are coincident with any mechanical natural frequencies, a structural vibration may occur. A general methodology to troubleshoot and design these systems are as follows:

1. Perform a process simulation of the system and evaluate fluid property conditions downstream and up.
2. Determine if choke flow conditions will be achieved across the let down device at any location.
3. Depending on the complexity of the system, develop a CFD model of the letdown device.
4. Perform a FE acoustic analysis of the let down device and inlet and outlet piping systems. Determine all acoustic frequencies.
5. Perform a structural dynamics analysis of the system.
6. Make sure shock waves and acoustical energy is contained within the letdown device.
7. Decouple the mechanical from any acoustical natural frequencies in the piping system. Also at this time, it is a good idea to perform a Code or Fit for Service analysis, since these systems are covered by the ASME Code and therefore fall under the Process Safety Management Program.

In general, a good system will contain all the kinetic energy within the let down device and the Mach numbers on the outlet will be below 0.3. High Mach numbers in the piping system can lead to turbulence that can cause head aches from stuff like "side branch" excitation and other things.

Now every situation is unique to itself but we have always found the methodology above to be very successful to capture even the expressly tough problems.

As I have said many times in the past, make sure all work is reviewed by a professional engineer (competent in the field) and nothing beats experience.

KnightHawk Project Update

- Special Process Reactor Design – DOD
- Ethylene Crack Gas Cooler – Fit For Service – Petrochemical
- Flange Design – Off Shore Riser
- 110 MW Gas Turbine Failure – Power
- 250 MW Turbine Failure – Power
- Compressor Vibration Study - Petrochemical
- Axial Turbine Compressor Blade Redesign - Petrochemical
- Lube Oil System Acoustics – Petrochemical
- Gasifier Reactor Redesign – Petrochemicals
- Gas Turbine Filter House Aerodynamics – Turbine Mfg
- Burner Acoustics Failure Analysis – Petrochemical
- Incinerator Design Review – Petrochemical
- Steam Turbine Failure - Power
- Boiler Analysis – Petrochemical
- Vessel Fit for Service – Petrochemical
- High Pressure Steam Let down – Petrochemical
- Pelletizing Die Train Troubleshooting – Petrochemical
- Accident Investigation – Pipeline
- Boiler Failure - Petrochemical
- TLE Inlet Design – Petrochemical
- Wind Turbine Aerodynamics – Energy
- Pelletizing Die Study – Petrochemical
- Boiler Failure Analysis – Petrochemical
- Heat Exchanger Failure - Petrochemical
- Boiler Failure analysis – Petrochemical
- Valve Analysis – NASA
- Non Linear FEA - Petrochemical
- Inlet Cone Design for TLE's – Petrochemical
- Integral Gear Compressor Failure Analysis – Petrochemical
- Aerodynamic Study of Inlet of TLE – Petrochemical
- Pipe Stress – Refinery
- Structural Dynamics – Rotating Equipment – Petrochemical
- Acoustical Analysis – Screw Pump – Petrochemical
- Pelletizing Die Analysis – Petrochemical / Die Manufacturer

Cliff's Notes: Well, summer is over and the kids are heading back to school. What a relief. I hope all of you had a wonderful summer vacation in some way. Football is starting and that is *all* my son is talking about (well he also talks about food) as he starts his season. The LSU Tigers are ranked number 3 going into to the regular season but I wait to see what happens. This weekend I am going to the Texas showdown of the Houston Texans versus the Dallas Cowboys. Personally, I believe the Tigers could beat both of them.

Regarding "High Energy Systems", we have fought these battles all over the world. I believe our methodology and approach is one of the best in the business. We have developed comprehensive simulations of these systems and our work has been proven time after time.

I also want to introduce Steve Newcomb into our company as Senior Vice President and Operation Manager. Steve's job is to run the company on the Commercial and Project Management side and I will mainly work things as Chief Engineer. Steve comes from the production environment and as a former Maintenance Superintendent of a major Petrochemical facility, he knows the ball game.

Cliff Knight