By: CLIFF KNIGHT, Owner/President
KnightHawk Engineering

Structural dynamics — The challenge

It's another day at the plant and you pass by that same turbine deck on the way to your office area next to the unit. Your office is elevated within the structure and you can feel what mode of operation the plant is in by the familiar vibration that passes through your chair. In today's petrochemical environment all kinds of process equipment are elevated in structures for a variety of reasons. Typical reasons are shortage of space, economics or process requirements. Sometimes this can lead to interesting structural dynamics issues. The real challenge is to predict how the equipment will function in the structure and implement measure up-front to prevent unwanted vibration.

A structural problem can be fixed in reasonable time and cost for most all applications.

Typically when a vendor designs process equipment all aspects of support design are not considered, and it is not necessary. What is important is that the designer of the structure has some idea how the equipment functions in various modes of operation. There are also challenges when running high-pressure piping from reciprocating compressors and pumps. The pulsation can cause high forced vibration and, in some cases, resonant vibration due to acoustics. Another good example is pressure relief valves. The transient pressure-momentum conditions can lead to high "kick down" forces and cause structural failure. A plan of attack may be as follows:

1. Lay out the equipment on a plot plan.
2. Try to locate any equipment with potential vibration issues as close to ground elevation as possible. If that is not possible put it as close to primary members as possible.
3. Meet with the process and mechanical teams and review potential vibration problems. Tour any plant facilities with similar equipment and learn from the past.
4. Perform preliminary sizing of structural members and lay out the structure.
5. Define any known or calculable vibration forcing functions or "exciters."
6. Develop a simple structural dynamics model of the system.
7. Assess the results.
8. Sometimes the vibration may be so high isolators or "inertia blocks" might have to be installed. It is easier to "tweak" a model than modify on the fly during the start-up of a new plant. In exotic cases, a variable speed driver to detune the system might be a solution.
9. Meet again with process, production and mechanical and see if things make sense.

But there is the other scenario, which is getting back to your office in the structure. How does one address the vibration problems of an existing system? Well to address this we need knowledge of the process, the mechanical equipment and the structural design. There may not be a quick fix. The college try for the quick fix always amazes me. Sometimes you're lucky, and more often not. A structural problem can be fixed in reasonable time and cost for most all applications. The following plan of attack, with experience, can work.

1. Define the driving forces.
2. Develop a structural dynamics model, preferably with the finite element method.
3. Perform a field study of the problem. This might involve measuring dynamic flow, pressure and vibration. A protocol should be developed and approved by operations before a field study is performed. The protocol should clearly state the goals and objectives of the testing. Typically in a field study it's desirable to capture any forcing functions that may be present. Sometimes a hazardous operations analysis is required.
4. Normalize the finite element model. Normalization is a complex process and should be carefully introduced into the model. The boundary conditions of the model are very important. Some may be complex and require a separate model to determine the behavior.
5. Revise model as required solving the problem. Once an accurate simulation is produced of the existing situation "what if" can be executed to solve the problem.

These are some ideas on structural design with the only purpose being to get you thinking. Don't let structural dynamics problems bite you. As always, a registered professional engineer should review these problems.

For more information, visit www.knighthawk.com or call (281) 282-9200. ●

NEWS **UPDATE**

BP creates new safety division

HOUSTON — BP is to create a new safety division with sweeping powers to oversee and audit the company's operations around the world. The Safety & Operational Risk function will have authority to intervene in all aspects of BP's technical activities.

It will have its own expert staff embedded in BP's operating units, including exploration projects and refineries. It will be responsible for ensuring all operations are carried out to common standards, and for auditing compliance with those standards.

The powerful new organization is designed to strengthen safety and risk management across the BP group. It will be headed by Mark Bly and report directly to incoming chief executive Bob Dudley.

The company said the decision to establish the new function follows the Deepwater Horizon accident in the Gulf of Mexico and BP's investigation into the disaster.

Dudley also disclosed that BP is to re-structure its upstream segment from a single business into three functional divisions — Exploration, Development and Production — and to carry out a detailed and wide-ranging review of how it manages third-party contractors.

The Safety & Operational Risk function will have authority to intervene in all aspects of BP's technical activities.

It will also conduct a fundamental review of how the group incentivizes business performance, including reward strategy, with the aim of encouraging excellence in safety and risk management.

Dudley said, "These are the first and most urgent steps in a program I am putting in place to rebuild trust in BP — the trust of our customers, of governments, of our employees and of the world at large.

"The changes are in areas where I believe we most clearly need to act, with safety and risk management our most urgent priority."

For more information, visit www.bp.com or call (281) 366-2000. ●