Case History:
Vibration Problems in Vertical Pumps

Automotive Plant Vertical Turbine Pump

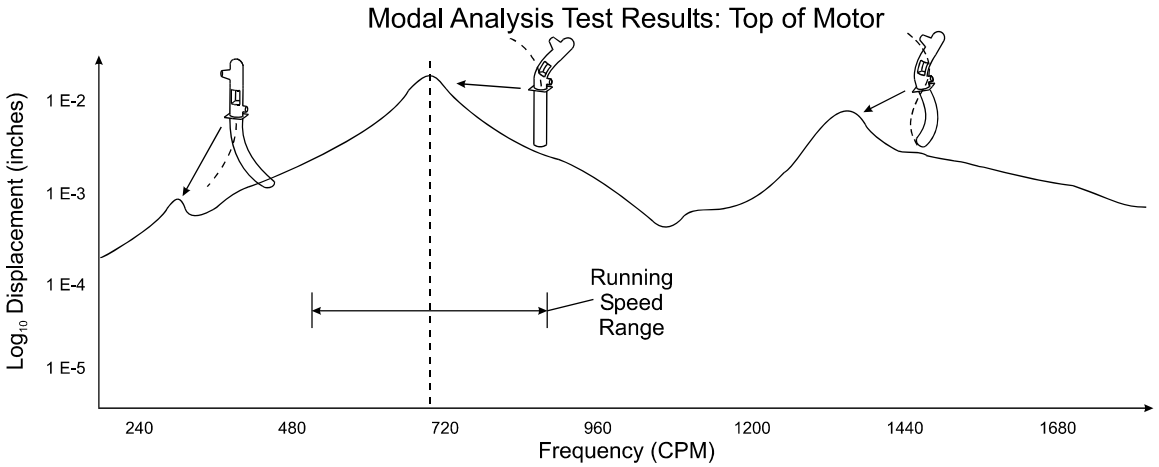
MSI completed finite element vibration analysis of an automotive company's proposed VTP installation. Analysis of the originally designed system indicated that there was a strong probability of resonant lateral vibration, in which the first "reed" frequency of the pump/motor/floor as a combined system would be driven by the 1200 rpm running speed. Whether or not the resonance would actually take place and how strongly it would affect the pump/motor system would depend in part on how firm the connection between the sub-floor beams and floor would be, where a particular pump would be located on the floor, and how stiffly the piping system would react at the discharge nozzle. In the analysis of the original system, however, under no set of assumptions was the margin between the predicted first reed natural frequency and the running speed equal to or greater than the Hydraulic Institute recommendation of 25 percent separation, or the common industry practice of minimum 15 percent separation.

Fortunately, no other potential natural frequency problems were evident, and in particular the second reed frequency, with a margin of about 25 percent above running speed, was shown to not shift down significantly if the first reed frequency resonance was de-tuned. This de-tuning was accomplished inexpensively by reducing pump base-to-foundation attachment stiffness. If the design had not been analyzed and modified, the pumps and motors would have been very balance-sensitive, and the initial installation's vibration probably would have been in excess of the Hydraulic Institute standards. The excessive vibration may have led to chronic premature failure the motor bearings, discharge head stuffing box seal, and pump bowl bearings.
Adding a damper ring or a tuned vibration absorber to the motor

top were also proposed as viable options, but were not done because of their extra complication. Adding dead mass to the motor top and/ or bowl assembly could have dropped the first reed frequency low enough to avoid the original problem, but it was shown by analysis that this would have also dropped the second reed frequency into the running speed range, trading one problem for another.

Vertical Turbine Pump Vibration Elimination

A Middle East power plant had a serious 1x running speed vibration problem with some vertical service water pumps and associated piping. Although these pumps were not central to the production of power, the plant could not run for extended periods without them, and motor bearing and discharge head mechanical seal problems were causing chronic pump shut-downs. A rotor critical speed problem was suspected by the plant. Testing showed that no shaft critical speeds were near running speed, but that a combined motor/ discharge head / floor / piping natural frequency was within several percent of running speed. Modification of the motor frame with bolt-on gussets and closing of the discharge head window with a removable stiffener plate shifted the natural frequency of the system up enough to avoid resonance, and bring vibrations down to acceptable limits.



Mechanical Solutions, Inc.
11 Apollo Drive **Tel: (973) 326-9920**
Whippany, NJ 07981 USA **Fax: (973) 326-9919**
www.mechsol.com **msi@mechsol.com**