Pumping Station Design: Not The Same Ball Game

OWEA – May 13, 2010
Garr Jones, PE – Brown and Caldwell
What has Changed?

- Hydraulic Institute Standards
- Evolving pump designs
- A clearer understanding of what happens when pumps are operated off-BEP
- Greater transparency on the part of pump manufacturers
- A more comprehensive understanding of cavitation in its various forms
- More definitive design standards for pump intakes and installation requirements
- In other words..........

CAVEAT EMPTOR
What is Needed in Design?

- Improved and more complete definition of operating conditions
- More attention to specification requirements to eliminate marginal pump selections
- Strengthened requirements for mechanical and hydraulic design
- Greater attention to installation details to conform to equipment physical, hydraulic and mechanical limitations
Typical Manufacturer’s Curve – before …..

ANSI/HI 9.6.3
What is a POR?

Preferred Operating Region
As defined in ANSI/HI 9.6.3

For most pump designs, this region defines the portion of the machine’s head/capacity curve where service life will be optimized.
Preferred Operating Region

- For Specific Speeds ≥ 4500:
  - 70 percent to 120 percent of BEP Flow

- For Specific Speeds > 4500
  - 80 percent to 115 percent of BEP Flow
What is an AOR?

Allowable Operating Region
As defined by ANSI/HI 9.6.3

The region on the machine’s head/capacity curve where continued or frequent operation will likely result in diminished service life and poor operation

Established by the pump manufacturer
How a Pump Works – II

Manufacturer’s minimum safe flow

Don’t Go here

Tread very lightly here

Don’t Even Think about it

70%

120%
Bad Things Begin to Happen in the AOR……

Increasing radial thrust

Increasing vibration

Increasing suction recirculation

Increasing inlet surging

Increasing discharge recirculation

Increasing cavitation
Piping Requirements
Basic Necessities

- Eliminate stress and strain at equipment connections
- Carry unbalanced hydraulic thrust to the structure
- Support valves, but NEVER anchor at a valve
- Minimum 5 pipe diameters straight run after last flow disturbing fitting and pump

Avoid stress risers at all pipe supports and anchors
All valves and appurtenances MUST be accessible for maintenance, removal/replacement
Poor Alignment Results in Unacceptable Forces

A single flexible coupling will not solve the problem
Misalignment

angular and parallel
Equipment Connection Fitting
Station Pipe Supports
Station Valve Supports
More Often than Not …

IT IS… THE INTAKE,
STUPID!
Features of a Good Pump Intake

- The pumped fluid must approach **THE PUMP OR PUMP INTAKE** symmetrically
- No high energy currents
- Minimal entrained air
- Sufficient NPSH margin
- Intake level must be high enough to prime the pump
- Sufficient submergence to avoid vortex development
ANSI/HI 9.8
Pump Intake Design

- All Types of Intakes
- Establishes Geometry and Physical Relationships
- Clear and Solids-Bearing Liquids
- Physical Model Tests Required
  - Large Pumps and Stations
  - Designs That Do Not Conform to Standard
Discuss?
That’s All Folks!

THANK YOU