# Flow Induced Vibration (FIV) and Wear Analysis

## *Overview*

Tube wear due to Flow Induced Vibration (FIV) is one of the most significant degradation mechanisms affecting steam generators and heat exchangers. Using the latest analytical techniques, BWXT's FIV analysis can identify and prevent potential wear problems before they affect equipment reliability.

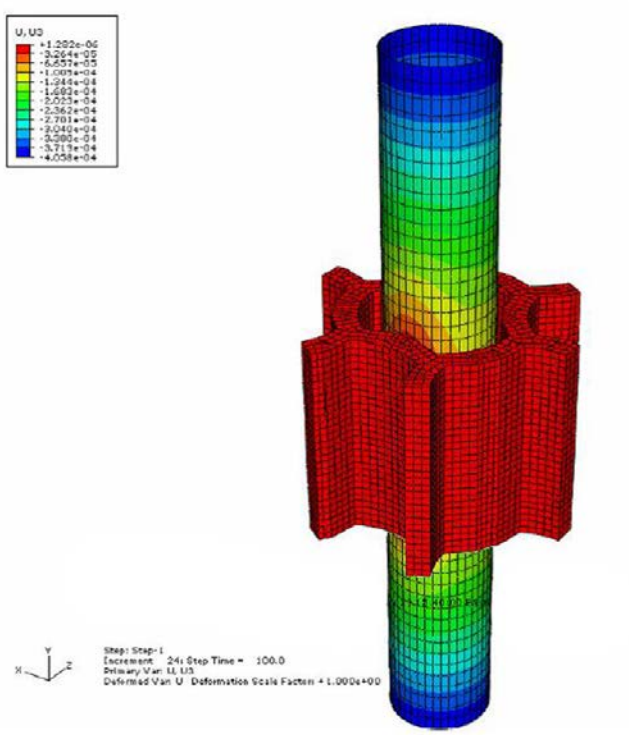
## *Applications*

A flow induced vibration and wear analysis will allow you to:

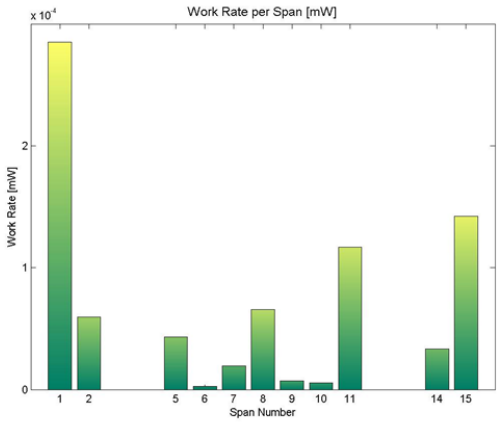
- Identify regions in a Steam Generator (SG) or heat exchanger where vibration problems are most likely to occur
- Assess how changes to process conditions will impact vibration and wear rates
- Determine the optimum location of support locations and qualify modified support configurations
- Predict the impact of flow changes (due to tube support fouling or installation of baffles) on vibration and wear rates

BWXT has experience performing FIV analysis in:

- Recirculating steam generators
- Once-through steam generators
- Preheaters
- Feedwater heaters
- Condensers
- Other shell and tube heat exchangers



*Abacus FE model of tube and tube support interaction*




*Critical mode shapes for two-phase and gas regions of an OTSG (LINFIV Results)*

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## *Capability and Tools*

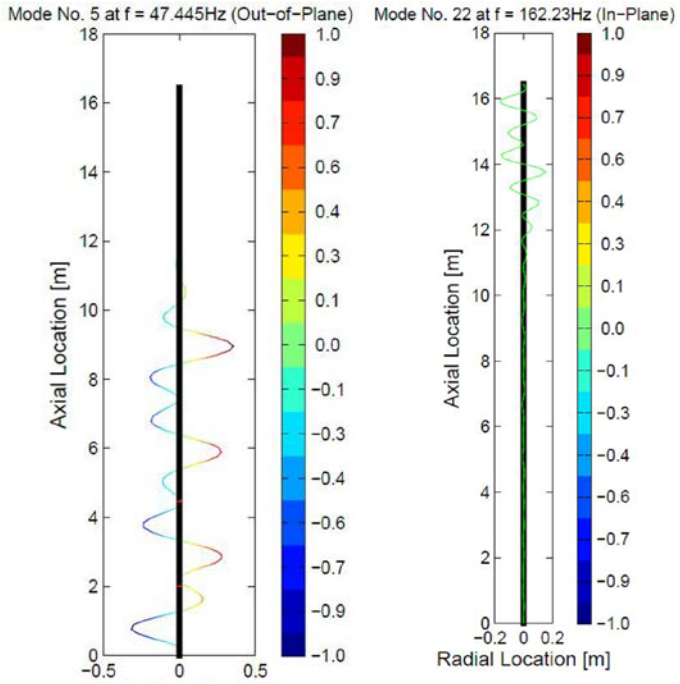
BWXT has the capability to perform FIV analyses using linear modal superposition analysis techniques using the LINFIV code, which was developed by BWXT and has been thoroughly verified against test data and analytical results. All FIV mechanisms relevant to steam generators and heat exchangers are assessed, including:

- Fluid-elastic Instability (in-plane and out-of-plane)
- Random Turbulence Excitation
- Vortex Shedding (Periodic wake shedding)
- Acoustic Resonance
- Tube wear prediction based on RT results

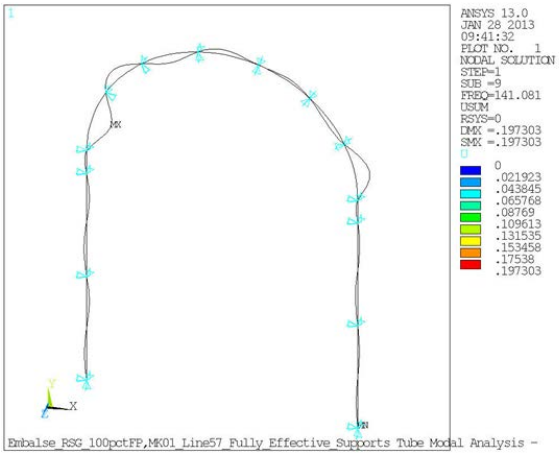
For FIV analysis, BWXT uses inputs based on the latest industry recommendations with references traceable to laboratory test results. Velocity and density profiles are obtained from three-dimensional thermal-hydraulic analysis codes for SGs (also provided by BWXT), heat exchanger codes, hand calculations or customer supplied data. Damping calculations include support friction damping, viscous damping, and two-phase damping as appropriate. The damping correlations are based on comprehensive test results and are adjusted based on the vibration frequency and local void fraction.

BWXT's FIV analysis capabilities can be used to model a wide range of conditions and geometries, including:

- A variety of liquid, two-phase and gas flows, including light water, heavy water, steam or other process fluids
- Models may include straight or bent sections having a variety of support conditions
- Tube tension and compression, which will affect the natural frequency and therefore the vibration response




*FIVDYNA output – wear work rates at tube support plate locations for 100% full power*




*Mode shape for U-Tube FIV analysis*

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