A follow-up to the author’s ICONE-11 2003 paper
Fretting In Nuclear Steam Generators –A New Approach

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2003 paper #36443 2004 paper #49059
A new theory suggesting that Rohsenow's Bubble layer acts to form a protective blanket around every tube as a 'spoiler'.

It prevents the ABV from breaking through the bubble layer to cause tube failures.
AVB Design with Wide Bar

- AVB should be wide enough to develop ample cushioning force between the parts.
- AVB tube gap should be wide enough to allow $T_{\text{SAT}}$ fluid to operate.
- AVB should be thin to absorb some vibration energy.
Bubbles and their Effect on AVB Design

- The square bar 'slips' through the bubble layer.
- A square AVB will penetrate Rohsenow's layer.
Water Treatment caused changes in Design of AVB’s

Using co-ordinated phosphates additions caused:

- Acid attack of the tube walls adjacent to sludge piles on the tube sheet plates.

- Because the water flows in Nuclear is so much higher than in Fossil Boilers, chemical cleaning became necessary earlier than expected.
Changing to AVT changed the design requirements once more

- The use of all volatile treatment (no solid additions) set up conditions where the carbon steel parts became unprotected.

- Slow growth oxides formed in the crevice of the TSP’s.

- Tube crushed into an hour glass shape.

- This affected most N.A. Boilers.
Pickering A Nuclear Steam Generator
B&W Ltd. Vertical Recirculating Boiler
with Internal Economizer & Lattice Bars

- No tight tube bends
- No stress Corrosion cracking

Internal Economizer
Feed Water Inlet

PICKERING A Straight Support
Twenty year operation longevity
Looking at Ideas from other Equipment - Smoke Stacks

Will vibrate to destruction in high winds if unsupported
Spoilers

- 3” x 5/8” bar welded to the circumference of the stack, spiral shape.
- Spoilers break up the wind into two opposite and equal forces.
- Stack does not vibrate.
Effect of spoilers to stop vibrations from the wind's effects.
The Importance of Proper Lubrication in Sleeve Bearings

Oil wedge formed by the rotating shaft dragging the oil under the shaft supports the load.
In Conclusion - 1

- This theory requires verification by an accredited laboratory.
- Pickering A design worked for 20 years.
U Bend Design 2

- The lattice bars freely float in the bubble streams and therefore do not fret.

- Operated for 20 years without fretting.
Lattice Bar Design

- A new theory suggesting that Rohsenow’s Bubble Layer acts to form a protective blanket around every tube as a ‘spoiler’.

- It prevents the ABV from breaking through the bubble layer to react with the tubes wall and causes fretting.
Rohsenow’s Bubble
The Basis of the Theory

Physical model of transient conduction mechanism

Natural convection layer

Transient conduction layer
COOLANT FLOW
ROHSENOW'S LAYER