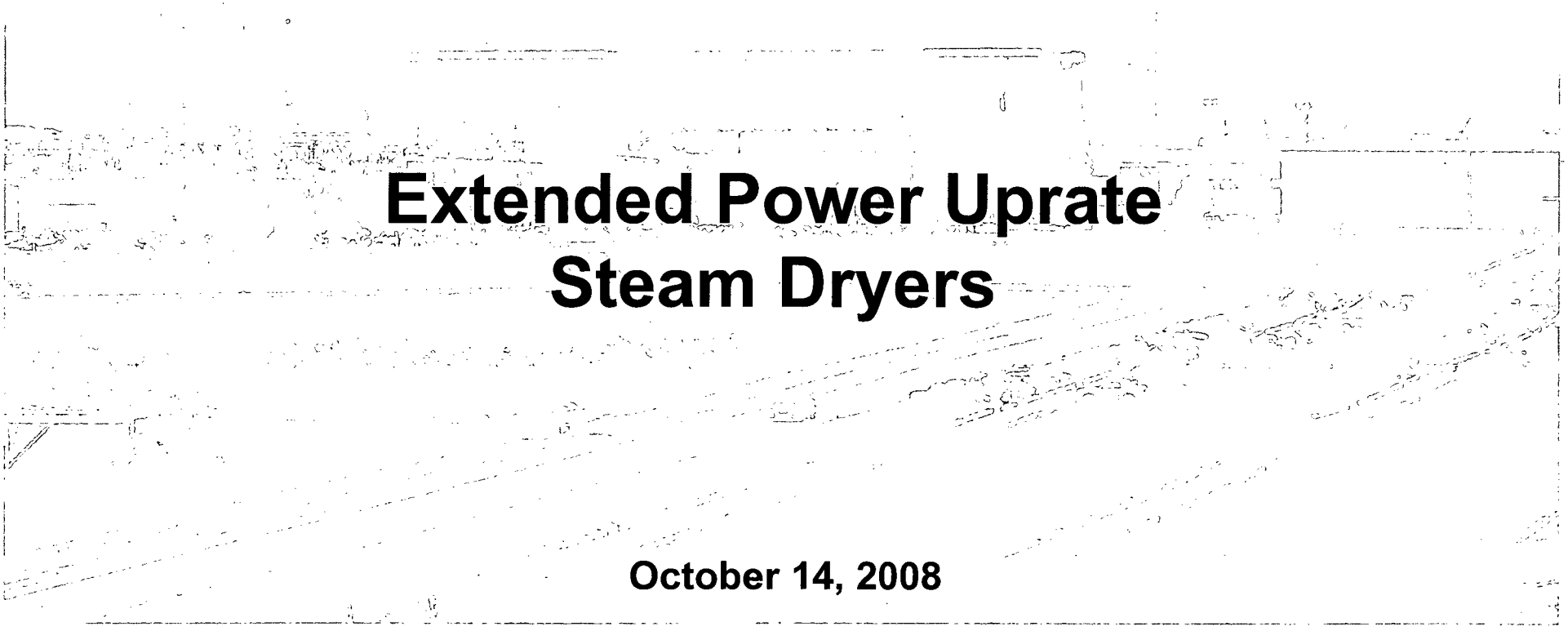
TENNESSEE VALLEY AUTHORITY
BROWNS FERRY NUCLEAR PLANT



Extended Power Uprate
Steam Dryers

October 14, 2008

Agenda

- Status of Unit 1 and 2 Dryer Analyses
- Decision on Acoustic Side Branches
- Plan to Address SRV Resonance
- Changes in EIC Removal Method
- Unit 2 Noise Removal
- Submodeling Questions
- Review of RAI 19, 20 and 21 Responses
- Schedule

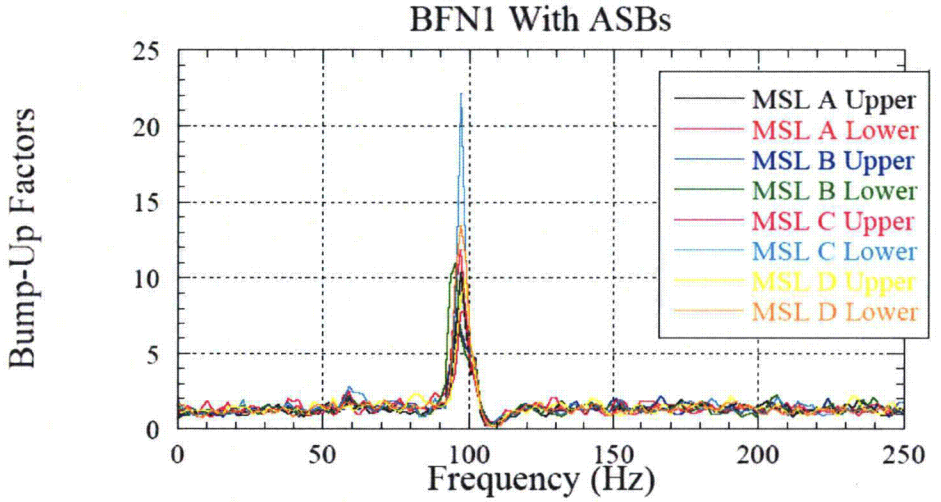
Status of Unit 1 and 2 Dryer Analyses

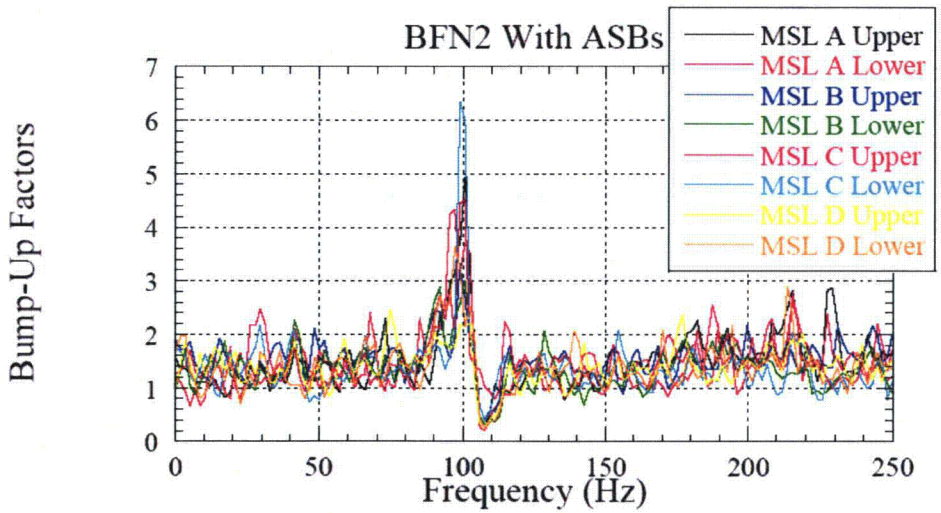
- TVA Decided not to Install Acoustic Side Branches (ASB)
  - No clear advantage
- Unit 1 and 2 Stress Reports (June 2008) Need to be Revised
  - SR-a > 2.7 at CLTP
  - Evaluates CLTP only
  - Unit 2 anomalous low flow (LF) signal (19% power)
  - Newer strain gage data now available
- Additional Strain Gage Data
  - Unit 1 startup August 2008
  - Unit 2 startup September 2008
- Unit 1 Stress Report Being Finalized
- Unit 2 Stress Report in Progress

Decision on Acoustic Side Branches

- 24-inch Quad Cities Design Chosen
  - Governed by clearance limitations
- Acoustic Design Relied on Damping Effect
  - Assumed to eliminate Safety Relief Valve (SRV) resonance
- Confirmation of ASB design by 1/8 Scale Model Test (SMT)
  - Damping effect less than expected
  - SRV resonance still present
- TVA Decided to Cancel ASB Modification
  - No clear advantage to Flow Induced Vibration (FIV)
- Requires Stress Analysis to Address EPU
  - Bump-up factor

Decision on Acoustic Side Branches





Plan to Address SRV Resonance

- 1/8 SMT Performed for each Unit's Configuration
  - Data at each strain gage location
  - Data at CLTP and EPU Mach numbers
- Bump-up Factors Calculated as a Function of Frequency by Equation:

$$BF = \sqrt{\frac{PSD_{EPU}}{PSD_{CLTP}}} \quad \text{At each frequency}$$

- Applied to Plant CLTP Strain Gage Data to Predict EPU Load

$$P_{CLTP} = C_{CLTP}(CLTP - EIC_{CLTP}) - C_{LF}(LF - EIC_{LF})$$

$$P_{EPU} = BF[C_{CLTP}(CLTP - EIC_{CLTP}) - C_{LF}(LF - EIC_{LF})]$$

P = Steam line unsteady pressure

BF = Bump-up factor for SG location

C = Coherence factor between upper and lower locations

EIC = Signal taken with zero excitation voltage

LF = Low flow signal

Changes in EIC Removal Method

- EIC Signal Taken by Removing Strain Gage Excitation Voltage
- Electrical Noise is Removed by Using EIC signal

Mechanical Component = SG Signal - EIC

- Additional EIC Signals on Units 1 & 2
- EIC now Matched with Companion CLTP and LF Signals

$$P_{CLTP} = C_{CLTP}\left(CLTP - EIC_{CLTP}\right) - C_{LF}\left(LF - EIC_{LF}\right)$$

P = Steam line unsteady pressure

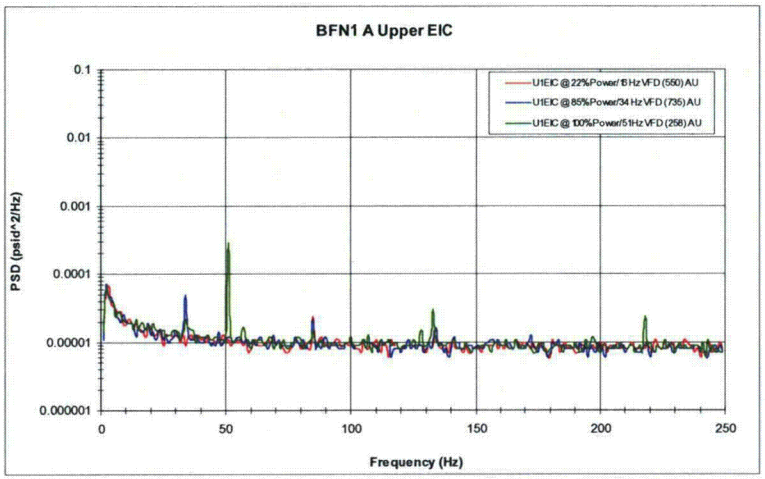
C = Coherence factor between upper and lower locations

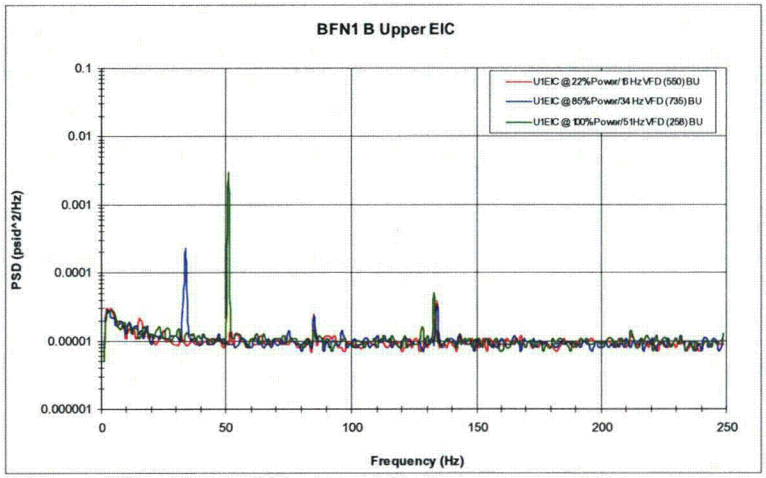
EIC = Signal taken with zero excitation voltage

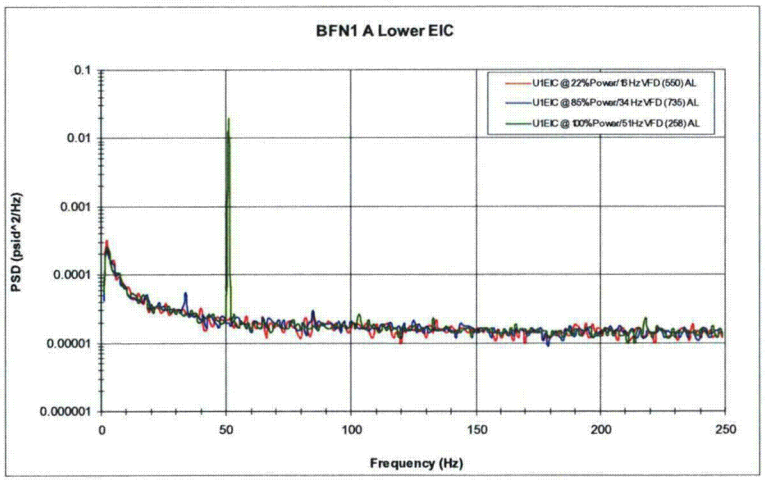
LF = Low flow signal

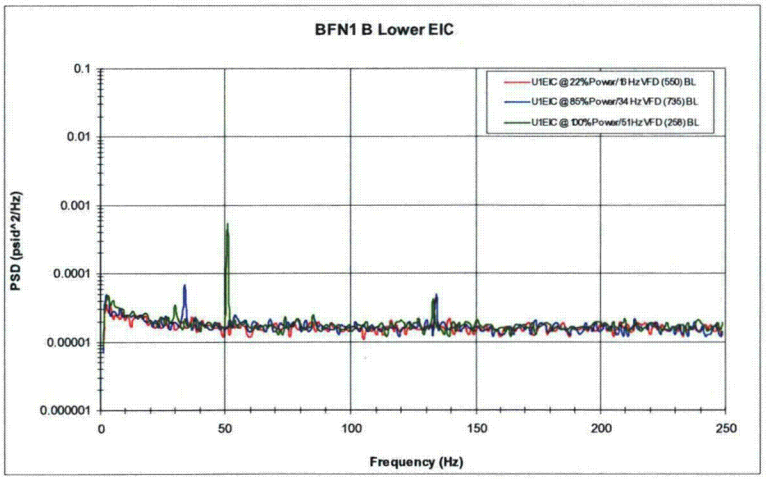
Changes in EIC Removal Method

EIC Signals



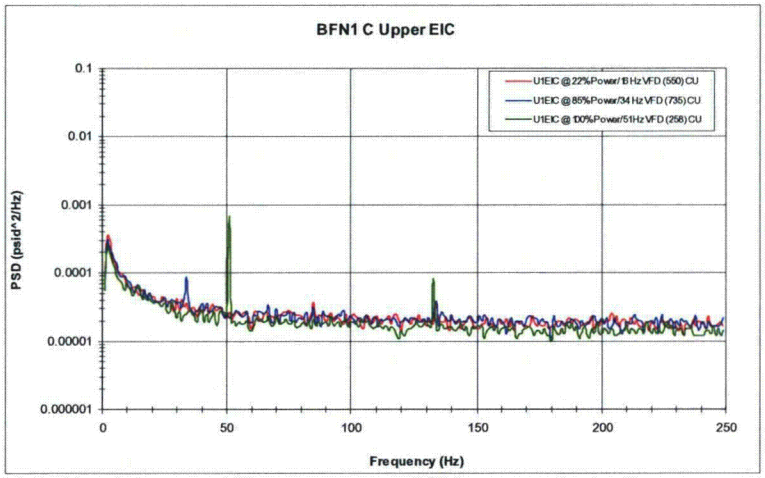


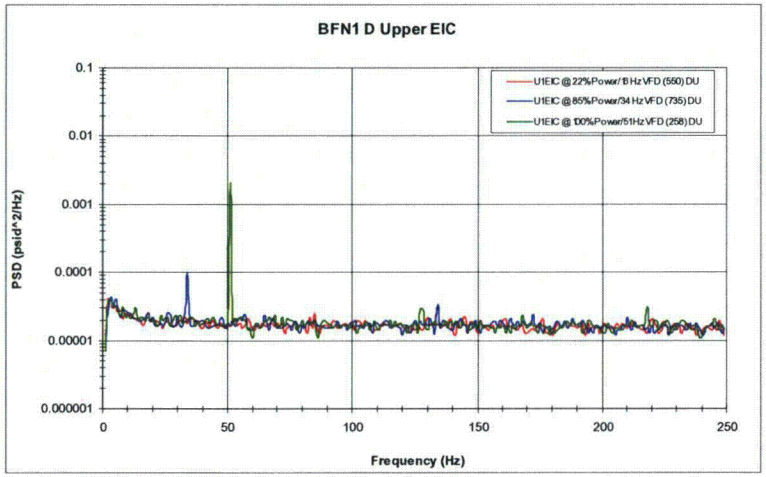


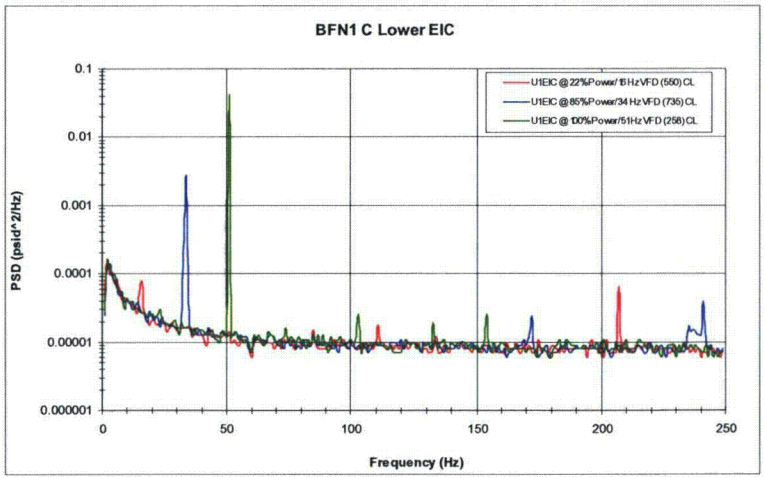


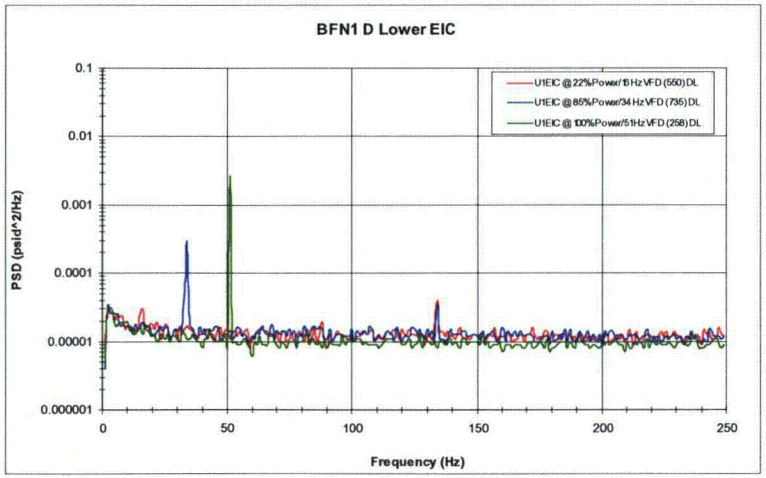
Changes in EIC Removal Method

EIC Signals



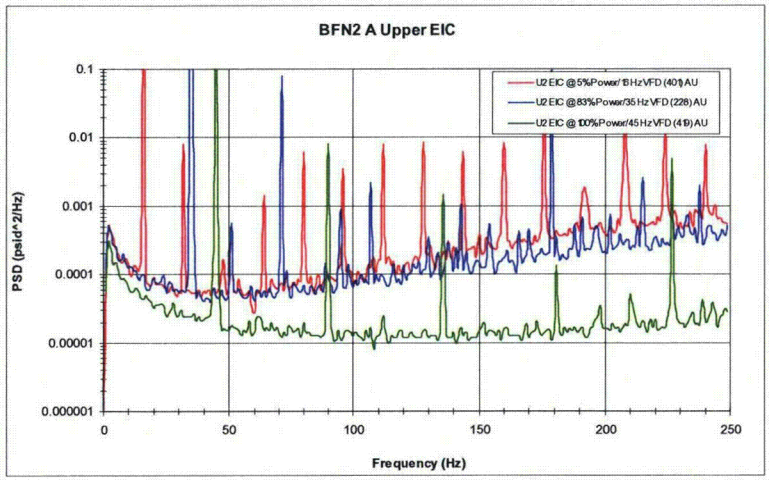


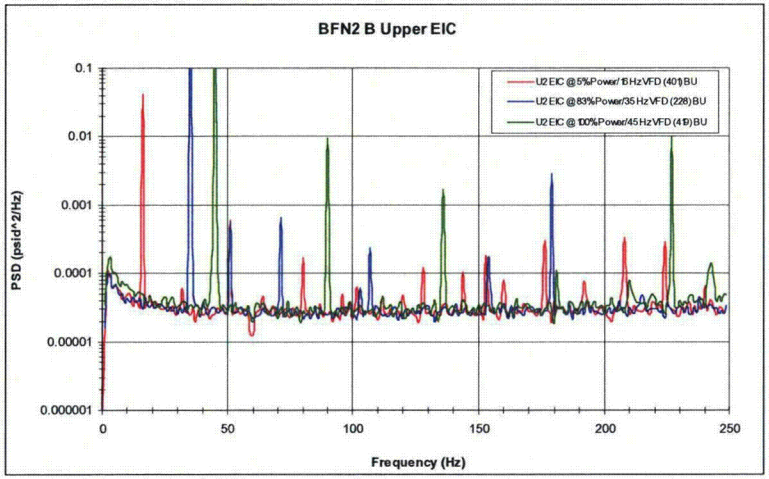


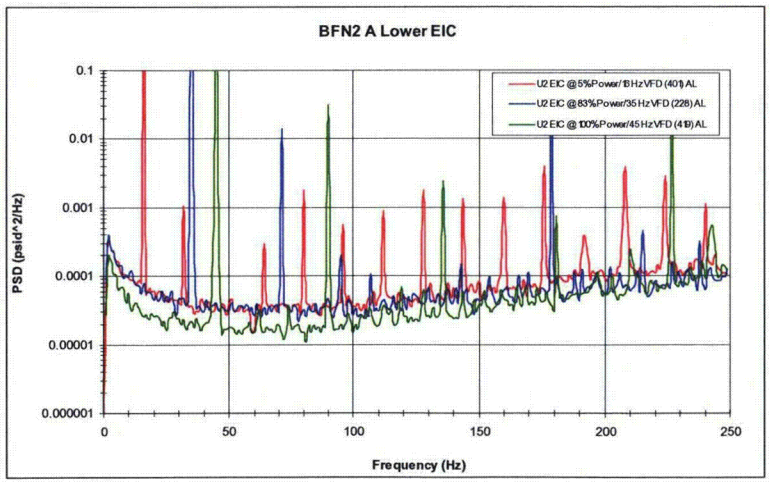


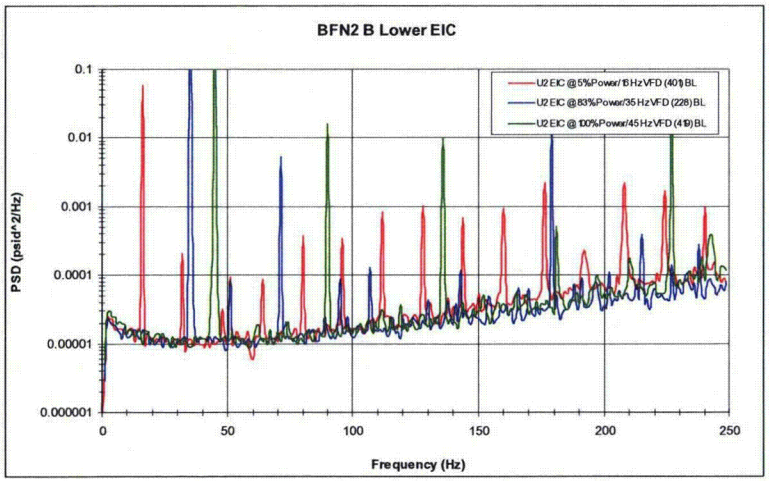
Changes in EIC Removal Method

EIC Signals



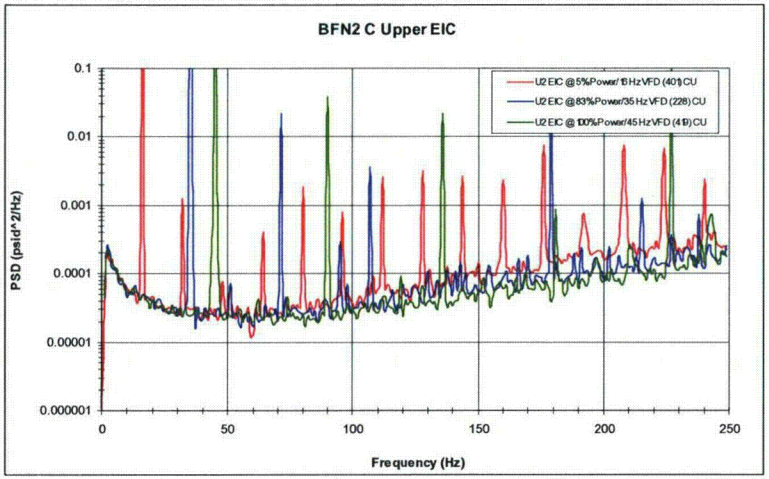


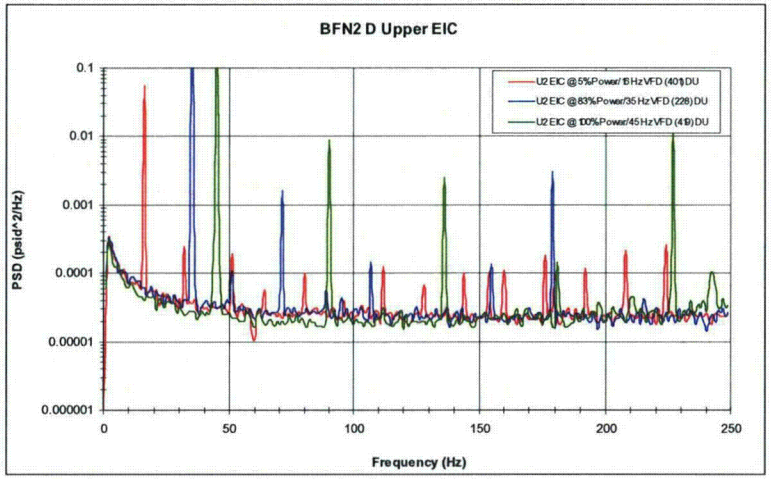


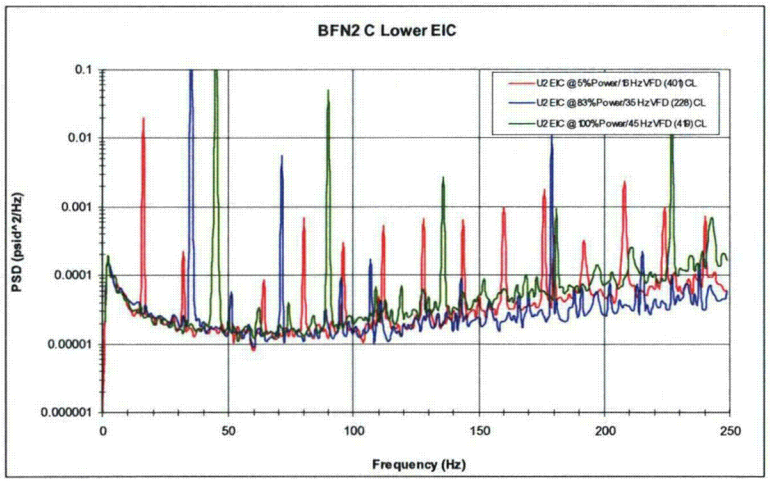


Changes in EIC Removal Method

EIC Signals





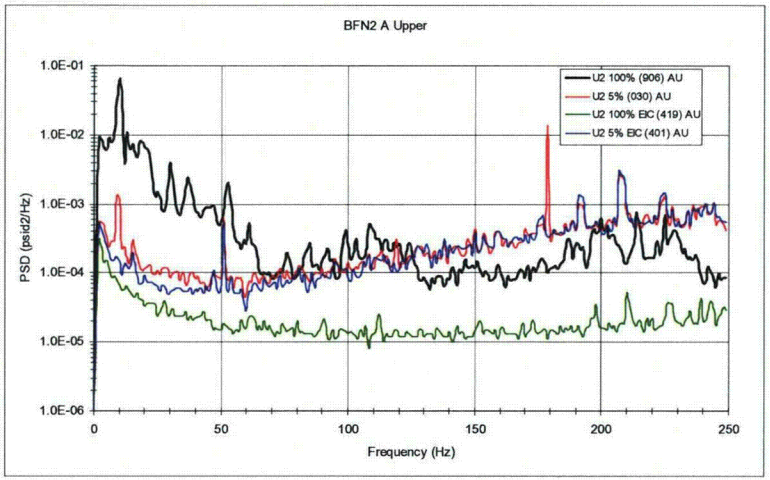


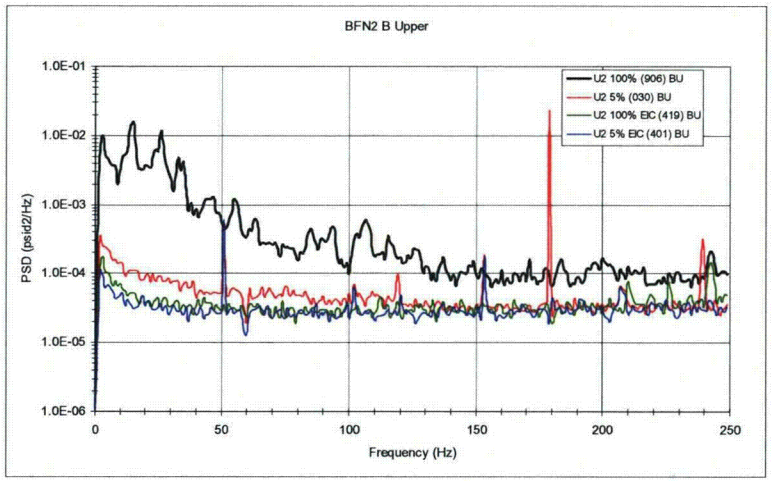
Unit 2 Noise Removal

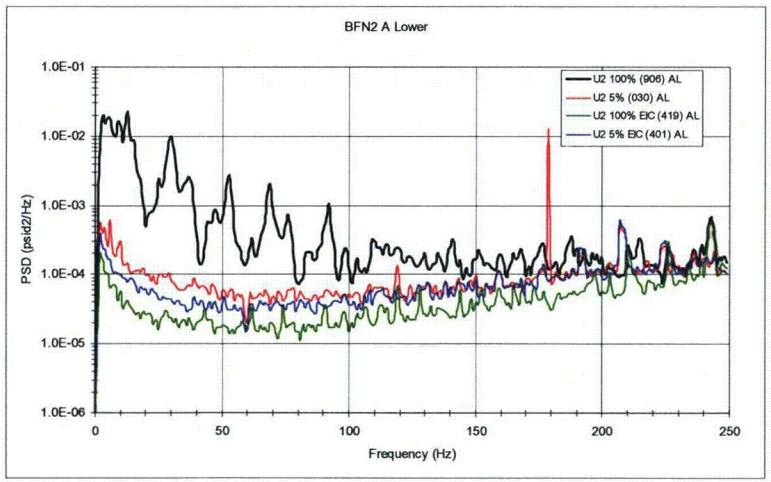
- Additional Data Taken on Unit 2 to Confirm Signal Behavior
  - Electrical noise on Unit 2 varies with recirculation pump speed (VFD frequency)
  - Relationship is not well understood
  - 19% power signal originally used for noise removal was atypical
  - Composite 19% & 30% power signals replaced
- New LF signal at 5% Power and Companion 5% EIC Signal
  - All strain gages on MSL D lower damaged
  - Substituting MSL A for MSL D due to strain gage failures
  - CLTP signal and companion EIC signal unchanged

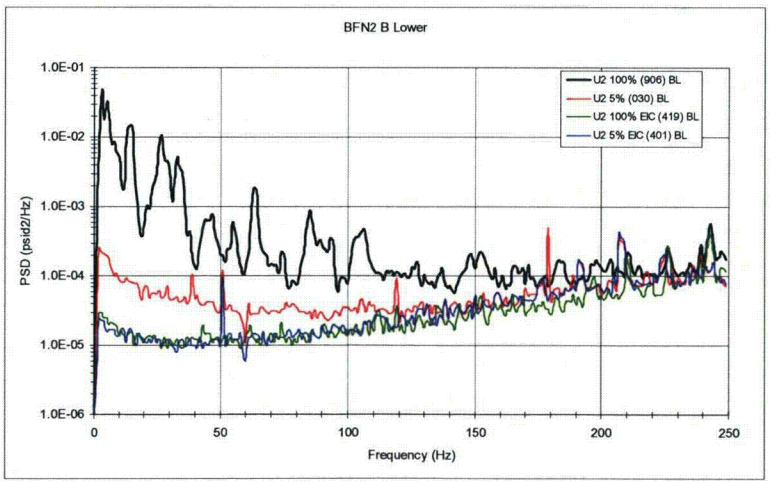
Unit 2 Noise Removal

PSD Signals



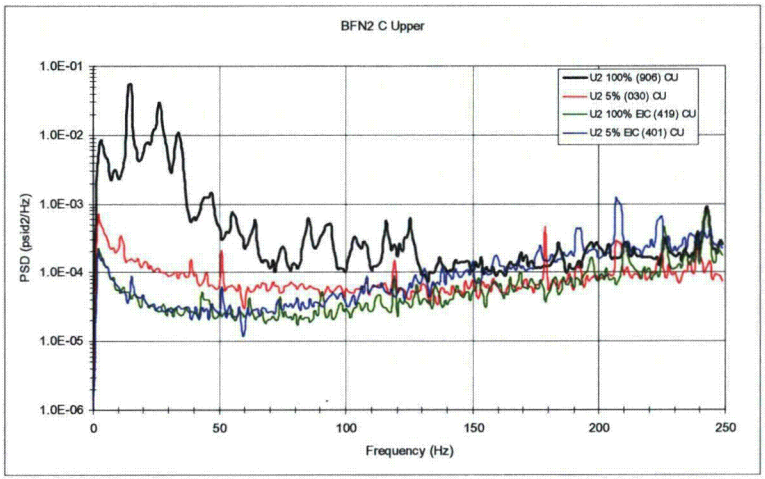


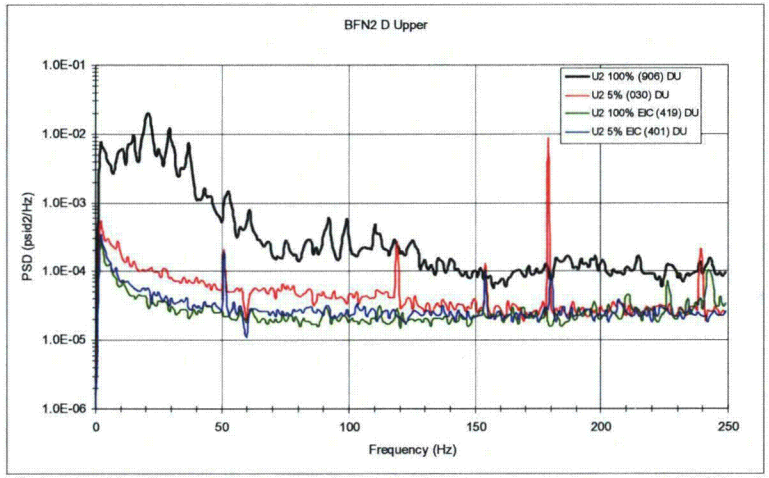


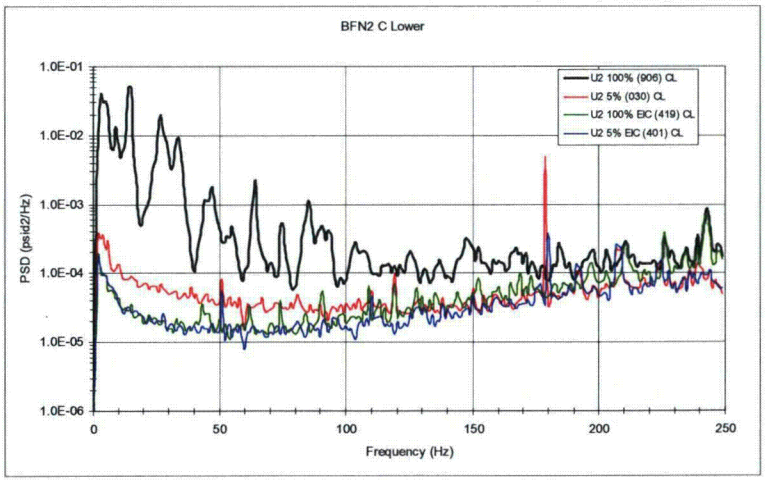


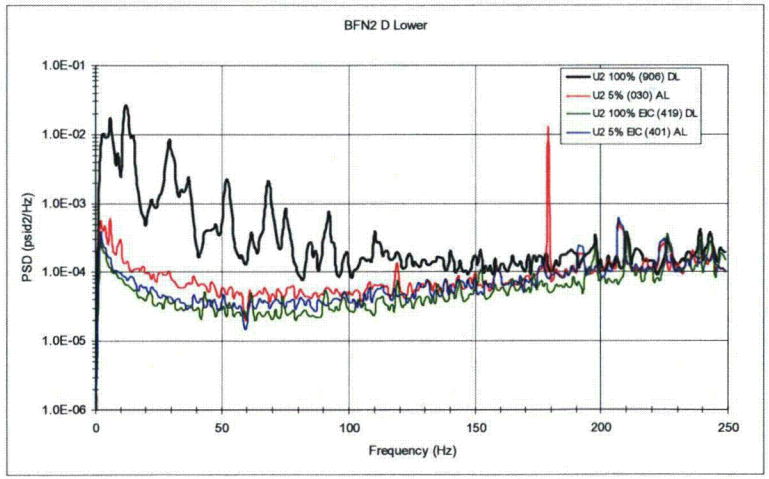
Unit 2 Noise Removal

PSD Signals







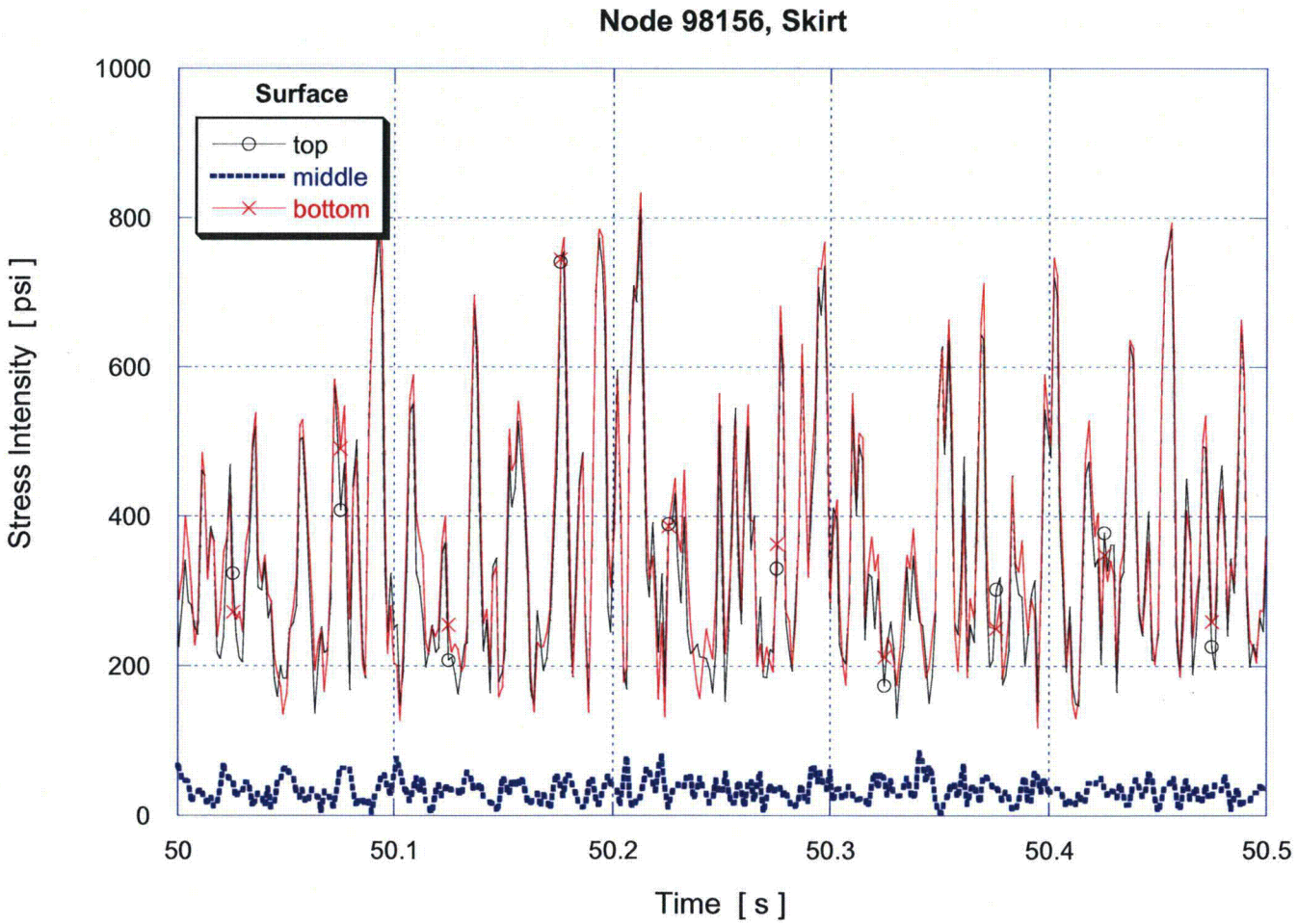


Submodeling Questions

- Is the Stress Reduction Factor (SRF) accurate and unique? Would a different analyst get the same solution?
  - Limited, Specific Purpose
    - Avoid excess conservatism of shell model
    - Based on mechanistic behavior along weld line
  - CDI Shell Model => SIA Shell Submodel
    - Characteristic load matches CDI stress along the weld line
      - Drain Channel-to-skirt: Bending thru the joint – See Figure 1
      - Hood Stiffener-to-Hood: Membrane in stiffener – See Figure 2
  - SIA Shell Submodel => SIA Solid Submodel
    - Incorporates weld geometry
    - Applies characteristic loads
    - Accurately captures load transfer mechanism and stress distribution through weld
  - Submodel attributes (loads & boundary conditions) are not unique, but SRF is unique & accurate. So a different analyst would get the same result.

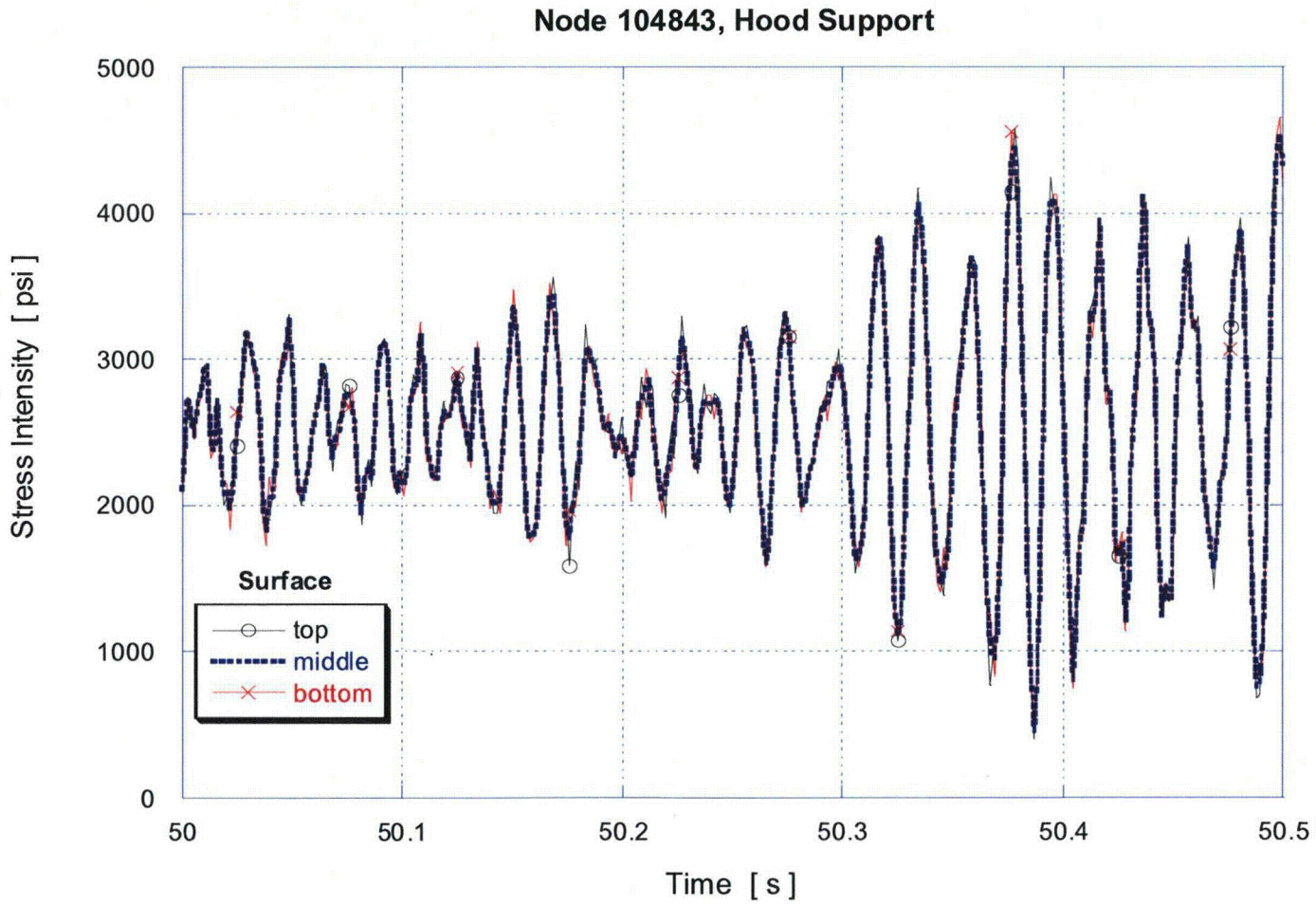
Submodeling Questions

Submerged Skirt – Figure 1



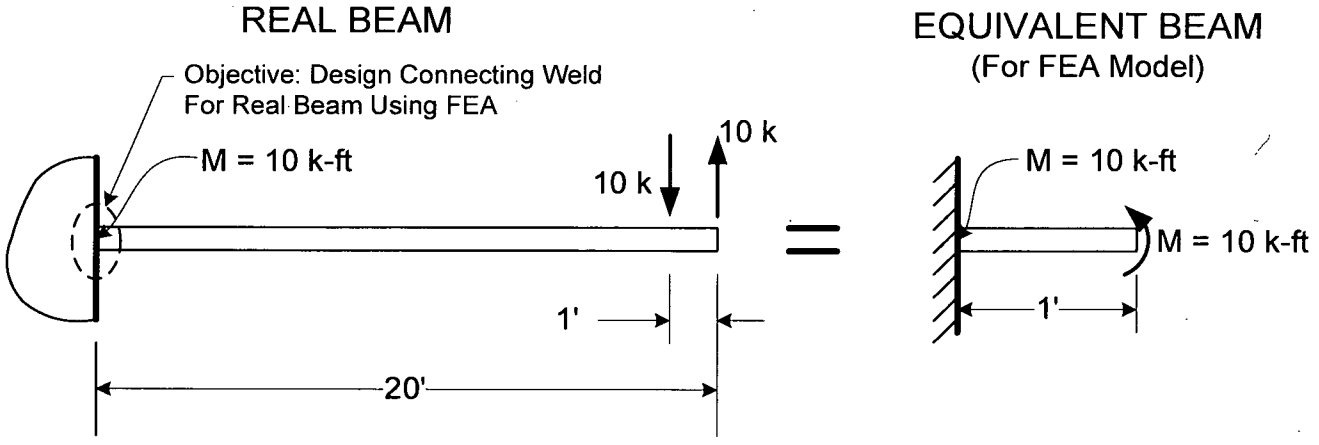
Submodeling Questions

Inner Hood Stiffener – Figure 2



Submodeling Questions

- Are the submodel loads statically equivalent to the CDI model?
  - No – not statically equivalent, nor required
  - Limited objective is to capture stress along weld line
  - Simple Example:



Submodeling Questions

- Are the times used the ones which yield the largest stress intensity after application of the SRF?

  Refer again to Figures 1 & 2

  - Alternating stress defined by either membrane or bending extrema
  - Extrema states produce maximum strain (i.e., fatigue usage)
  - SRF should be based on the extrema stress state
  - At other points in time, the product of stress intensity and SRF would have a lower value; i.e., be less conservative

Submodeling Questions

- Demonstrate that the uncertainty in calculating the SRF is small
  - Approach produces high certainty that bounding stress of weld line is captured
  - Solid submodel mesh sensitivity study demonstrated convergence
  - Weld factor of 1.8 retained
  - Low level of uncertainty subsumed by bias and uncertainty applied to overall process

Review of RAI 19, 20 and 21 Responses

- RAI 19
  - EMCB.147 (Unit 2 only)
    - New Unit 2 stress analysis
    - Revised response based on revised analysis
  - EMCB.192/150
    - SRV Resonance
  - EMCB.181 Follow-up (Unit 1 only)
    - 0 - 2 Hz mean filter
  - EMCB.182 Follow-up (Unit 1 only)
    - EIC removal
  - EMCB.183 Follow-up (Unit 1 only)
    - SR-P values in table

Review of RAI 19, 20 and 21 Responses

- RAI 19 (continued)
  - EMCB.181 (Unit 1) & EMCB.147 (Unit 2) Follow-up
    - PSD plot filtering
  - EMCB.186 & EMCB.187 Follow-up (Unit 1 only)
    - Sub Modeling
- RAI 20
  - EMCB.194 (Unit 1 only)
    - 9% signal coherence
  - EMCB.195 (Unit 1 only)
    - Fan noise

Review of RAI 19, 20 and 21 Responses

- RAI 20 (continued)
  - EMCB.196 (Unit 1 only)
    - EIC plots
  - EMCB.197/153
    - Strain gage penetration location
  - EMCB.154 (Unit 2 only)
    - 9% signal coherence
  - EMCB.195
    - Extended frequency plots - VFD

Review of RAI 19, 20 and 21 Responses

- RAI 21
  - EMCB.198 (Unit 1 only)
    - EIC removal
  - EMCB.155 (Unit 2 only)
    - EIC removal

Schedule

Item	Date
TVA response to RAI 21 on Channel Bow	10/17/08
TVA submit Unit 1 stress analysis & Unit 2 status	10/31/08
TVA submit Unit 2 stress analysis	11/14/08 Tentative
ACRS meetings	2/09-3/09
Unit 2 outage begins	4/09
NRC issue EPU Amendment for Units 1, 2, and 3	4/09
Unit 2 startup at EPU	5/09
Unit 1 implement EPU	6/09
Unit 3 implement EPU	Spring 2010