



**43rd Turbomachinery
30th Pump SYMPOSIA**

GEORGE R. BROWN CONVENTION CENTER
HOUSTON, TX | SEPT. 22 - 25, 2014

VIBRATION PROBLEMS AND SOLUTIONS IN TURBOMACHINERY

*William D. Marscher, P.E. - MSI Technical Director
Member TAMU Pump Symposium Advisory Committee*

*Eric J. Olson - MSI VP
Engineering*

*Paul A. Boyadjis - MSI Director of Structural
Analysis*

*Maki M. Onari - MSI Principal Engineer
Manager of Turbomachinery Testing*



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Presenters

- **William D. Marscher, P.E.**
 - Mechanical Solutions, Inc. - Technical Director
 - B.S.M.E. & M.S.M.E., M.S. Applied Mechanics, FSTLE, FMFPT
 - Past President, STLE, & Machinery Failure Prevention Technology Society
 - Member of US Delegation, ISO108 S2 Machinery Vibration Standard Committee
 - Author, 8 Handbook Chapters on Vibration & Predictive Maintenance
- **Eric J. Olson**
 - Mechanical Solutions, Inc. – VP Engineering
 - Graduate Marine Engineer
 - About 30 years in turbomachinery
 - Previously Field Engineer, then Regional Manager Dresser Industries
 - With Consultancy Firms for 17 years
- **Paul A. Boyadjis:**
 - Mechanical Solutions, Inc. – Director of Structural Analysis
 - BS and MS in Mechanical Engineering from Lehigh University
 - He has over 30 years of diverse experience in pump analysis/design/test
 - Lead analytical engineer for major compressor and pump manufacturers
 - Member of the API Machinery Standards Committee and a Standards Partner of the Hydraulic Institute. Co-Author Pump Vibration Chapter, McGraw-Hill Pump Handbook
- **Maki M. Onari**
 - Mechanical Solutions, Inc. – Principal Engineer
 - B.S.M.E., Zulia University
 - Staff Engineer, PDVSA Machinery Maintenance
 - Responsible for all MSI Turbomachinery Testing
 - Co-Author Pump Vibration Chapter, McGraw-Hill Pump Handbook



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Turbomachinery Vibration Basics

- Internals & Problems of Major Types of Turbomachinery
 - Gas Turbines
 - Steam Turbines
 - Axial and Centrifugal Compressors
 - Horizontal and Vertical Pumps
- Effects of Operating Point: Turbomachinery vs. System
- Off-Design Flow Pulsation & Vibration: Surge, Stall, Recirculation
- Inlet Conditions as Vibration Excitation
- Rotordynamics & Structural Dynamics of Casing/ Foundation
- Bladed Disk Vibration
- Vibration Specs
- Test Instrumentation & Procedures
- Case Histories & Animations of Problems



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Turbomachinery Operation for “Good Vibrations”

- **Rule # 1:** Match Design Point to System Head & Flow Requirements
- **Rule # 2:** For Pumps, Require NPSHA Above NPSHR, with Margin
- **Rule # 3:** Use a Long Straight Piping Run to the Inlet
- **Rule # 4:** Careful When & How You Throttle
- **Rule # 5:** Avoid H-Q Slopes Being Similar, Machine vs. System
- **Rule # 6:** Minimize Nozzle Loads & Use Exp Joint Tie Rods
- **Rule # 7:** Avoid Structural Natural Frequencies & Rotor Criticals
- **Rule # 8:** Minimize Load Cycling, if Practical
- **Rule # 9:** Select Materials Based on Corrosion, Galling, Fatigue & Erosion Resistance
- **Rule # 10:** You Get What You Spec & Pay For



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