

Quad Cities Extended Power Uprate (EPU) Meeting

March 22, 2007

Introduction

Randy Gideon
Quad Cities (QC) Plant Manager

AGENDA

- ✓ Introduction
- ✓ Vibration Source Reduction
- ✓ Steam Dryer Replacement
- ✓ Electromatic Relief Valve (ERV) Actuator Modification
- ✓ EPU Commitments
- ✓ EPU Monitoring Plan
- ✓ Summary

Introduction

✓ Purpose

- Communicate the results and conclusions of the modifications and evaluations performed supporting EPU operation at QC
- Status EPU-related regulatory commitments
- Demonstrate QC can continue to operate safely at EPU power levels

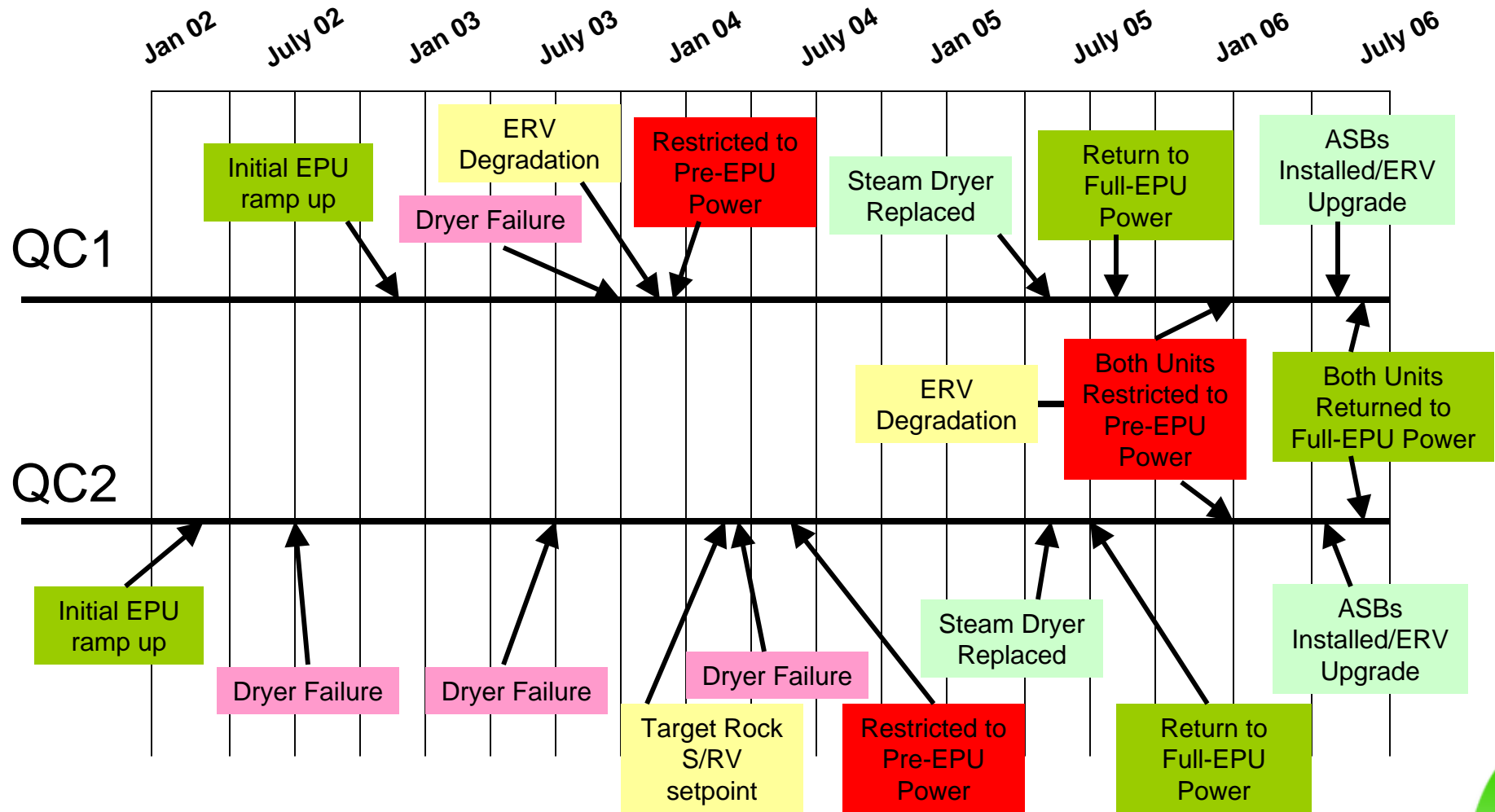
Introduction

- ✓ 17% power uprate (2511 MWt to 2957 MWt)
 - Approved in December 2001
 - Initial EPU operation in 2002
- ✓ Following initial EPU operation, both QC units experienced vibration related problems, resulting in several shutdowns and reactor power restrictions

Introduction

- ✓ Initial actions focused on improving components' ability to withstand EPU loading conditions
 - ERV actuators
 - Steam dryers
- ✓ In parallel, actions included identifying and eliminating the vibration driving force
 - Acoustic side branch (ASB) modification
- ✓ Supporting analysis and evaluations previously reviewed with NRC technical staff
 - QC technical issues resolved

Introduction



Vibration Source Reduction

Bruce Rash

Corporate Design Engineering Director

Roman Gesior

Corporate Engineering Programs Director

Vibration Source Reduction

- ✓ Following several EPU-related component problems, EGC determined that reduction of the vibration source should be pursued
- ✓ Scale model testing and in-plant data provided positive results in our efforts to identify the vibration source
- ✓ In early 2006, a thorough and comprehensive root cause evaluation (RCE) was performed
 - RCE confirmed the need to address the source of main steam line (MSL) vibration
 - Contributing factors related to ERVs also identified

Vibration Source Reduction

- ✓ RCE also identified contributing organizational weaknesses
 - A systematic approach was not used to evaluate decisions
 - Over-reliance on contractor products and expertise
 - Some decisions were based on the best information available; however, the collective conditions were not clearly understood

Vibration Source Reduction

- ✓ Organizational contributing cause corrective actions are complete
 - Revised operational and technical decision making (OTDM) process procedure
 - Trained personnel on OTDM process requirements
 - Revised process controls on review of complex vendor products
- ✓ NRC 95001 Supplemental Inspection evaluated organizational weaknesses and corrective actions

Vibration Source Reduction

- ✓ Testing confirmed the source of the pressure loads to be from the ERV and main steam safety valve (MSSV) standpipes
- ✓ Vortex shedding at the branch opening resonated with the acoustic standing wave in the ERV and MSSV standpipes
- ✓ Increased steam flow velocities at EPU conditions resulted in increased acoustic pressure loads

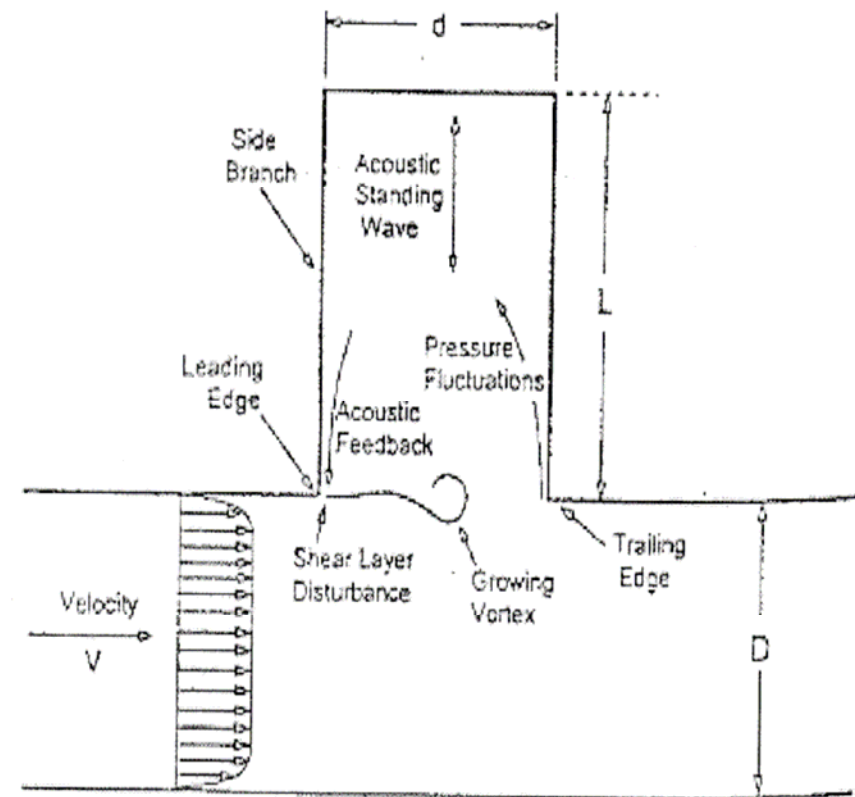


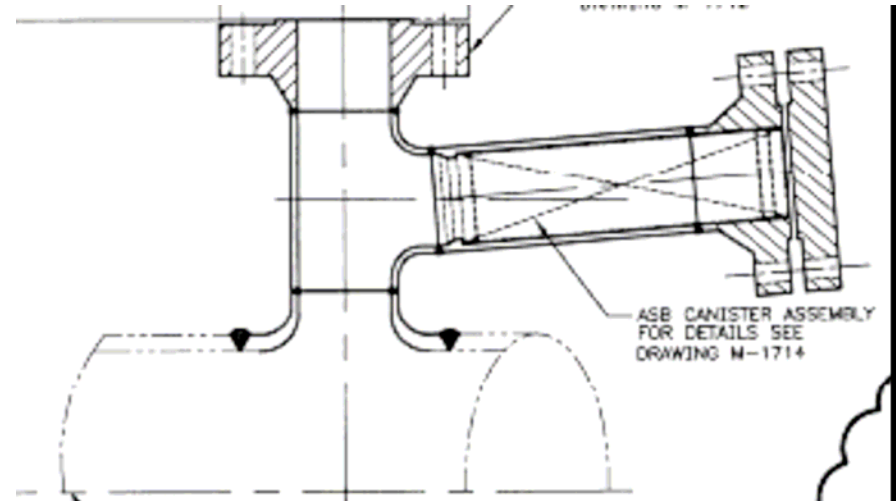
Figure 2: Shear Layer Excitation of Acoustic Resonance

Vibration Source Reduction

- ✓ ASB modification installed in Spring 2006 on standpipes of MSSVs and ERVs
 - Reduced steam dryer loading increases stress margin for long-term operation of steam dryer
 - Reduced overall MSL vibration impact on ERV actuators and other attached main steam components

Vibration Source Reduction

- ✓ The addition of the ASB increases the effective length of the ERV/MSSV standpipe, thereby decreasing the frequency of the acoustic standing wave
- ✓ When the acoustic and vortex shedding frequencies are no longer coupled, resonance does not occur
- ✓ The addition of screen mesh material inside the ASB introduces a damping medium that absorbs the energy in the standpipe

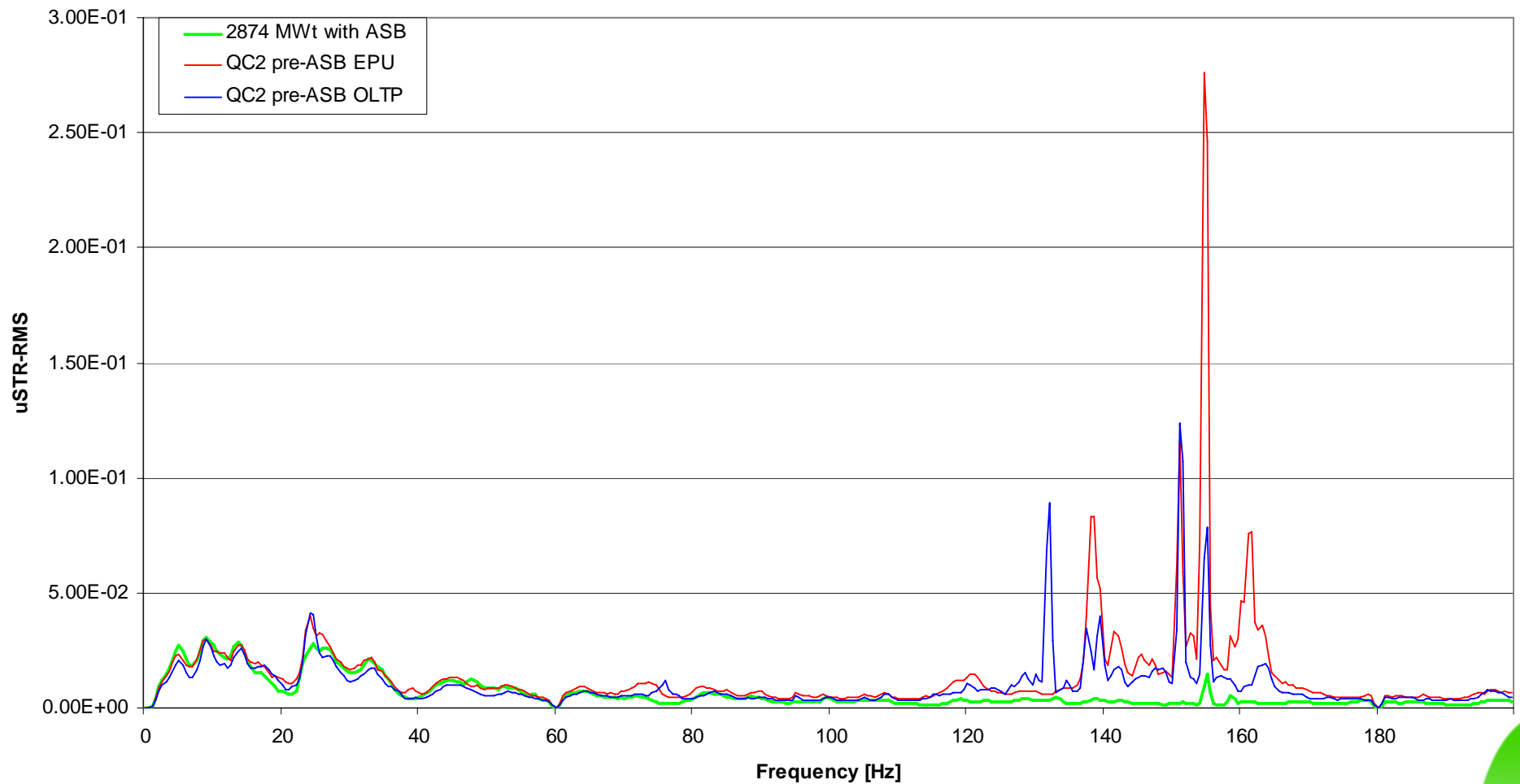


Vibration Source Reduction

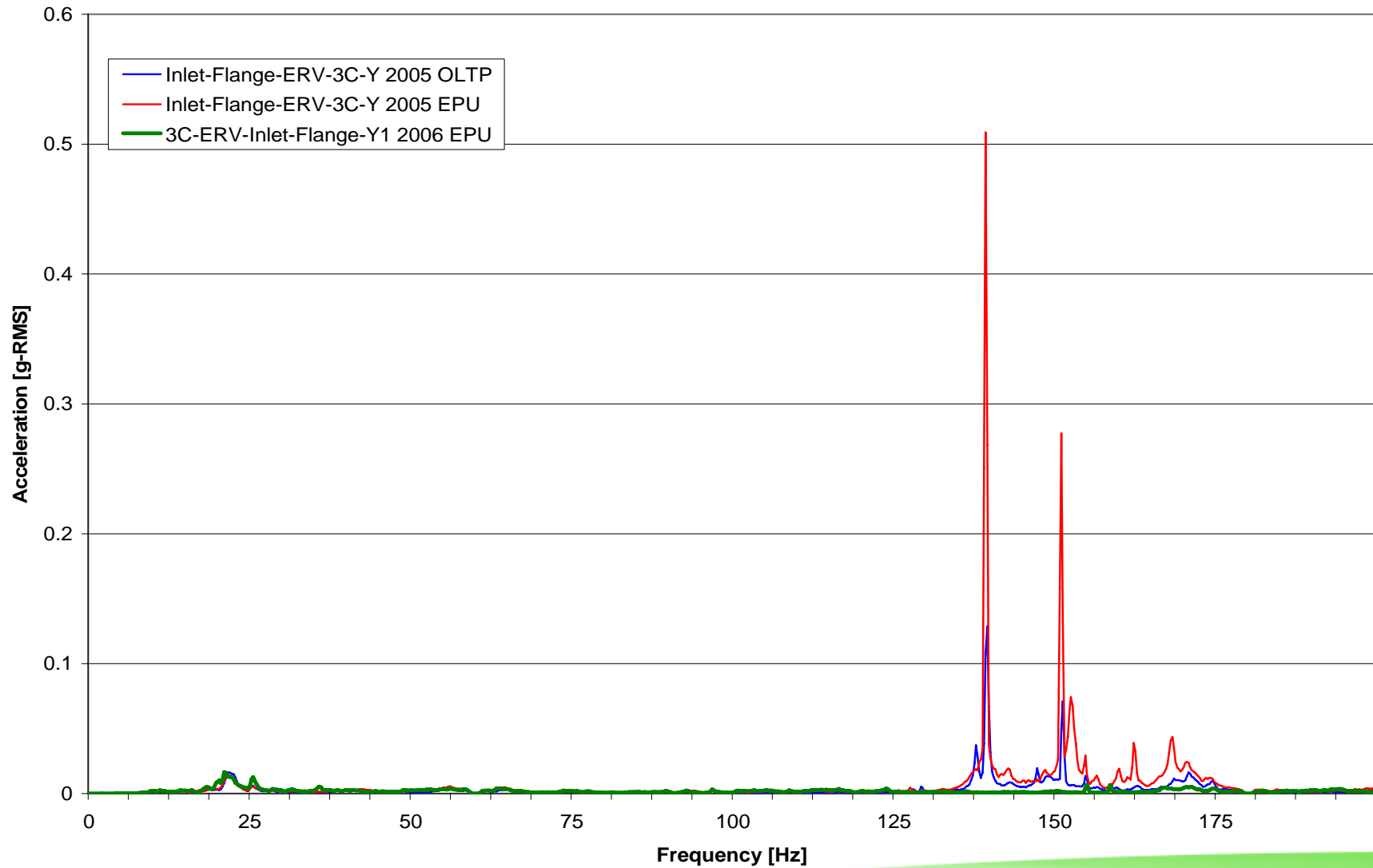
- ✓ Rigorous pre-installation test plan confirmed ASB performance under service conditions
- ✓ Further verification occurred during startup testing on both units
 - MSL strain gage data at EPU are below original licensed thermal power (OLTP) levels
 - Indication of MSL pressure oscillations and steam dryer load
 - MSL accelerometer data at EPU are below OLTP levels
 - Indication of MSL flow-induced vibration

Vibration Source Reduction

Q2R18 TC18 2874 MWt - MSL A Lower



Vibration Source Reduction



Vibration Source Reduction

✓ Conclusions

- In-plant data demonstrates the ASB effectiveness in reducing MSL pressure oscillations to pre-EPU levels
 - Reduces MSL component vibration related wear
 - Reduces the steam dryer pressure oscillation load
- ASBs tested and demonstrated to be robust

Steam Dryer Replacement

Roman Gesior

Corporate Engineering Programs Director

Steam Dryer Replacement

- ✓ Initial steam dryer damage identified on Unit 2 in July 2002
- ✓ Subsequent EPU-related steam dryer damage identified on both units over following two years
- ✓ Several repair and structural enhancements made to original steam dryers
- ✓ In 2004, decision made to replace both QC steam dryers

Steam Dryer Replacement

- ✓ New steam dryer design
 - More structurally robust and vibration tolerant
 - Minimizes number of welds in high-stress and high-fatigue areas
 - Meets the ASME Code limits for all service levels (i.e., normal, upset, and faulted)

Steam Dryer Replacement

- ✓ Unit 2 steam dryer instrumentation
 - First fully instrumented steam dryer in US
 - 96 sensors mounted on dryer and MSLs
- ✓ New steam dryer testing
 - Pressure and strain gage data collected at multiple power levels up to maximum achievable EPU power
 - Collected data verified steam dryer structural integrity

Steam Dryer Replacement

✓ Conclusions

- New steam dryer designed to meet pre-ASB, EPU loading conditions
- Robust steam dryer design, coupled with reduced vibration loading due to ASBs, results in significant structural margin

ERV Actuator Modification

Bruce Rash

Corporate Engineering Design Director

ERV Actuator Modification

✓ ERV degradation

- Unit 1 ERV actuator failed in 2003
 - Both units' ERV actuators were rebuilt with hardened materials
- Unit 2 ERV actuator inspections in December 2005 revealed internal damage, attributed to accelerated vibration-related wear
- ERV inspections performed on Unit 1 in January 2006 revealed similar wear

ERV Actuator Modification

- ✓ 2006 RCE identified contributing factors related to the ERVs
 - Inadequate design test control for the ERV actuators rebuilds in 2003
 - Inadequate ERV rebuild and inspection procedure
- ✓ Corrective actions included:
 - Development of comprehensive test control program
 - Revisions to ERV actuator/pilot valve rebuild and inspection procedures to address preventive maintenance weaknesses

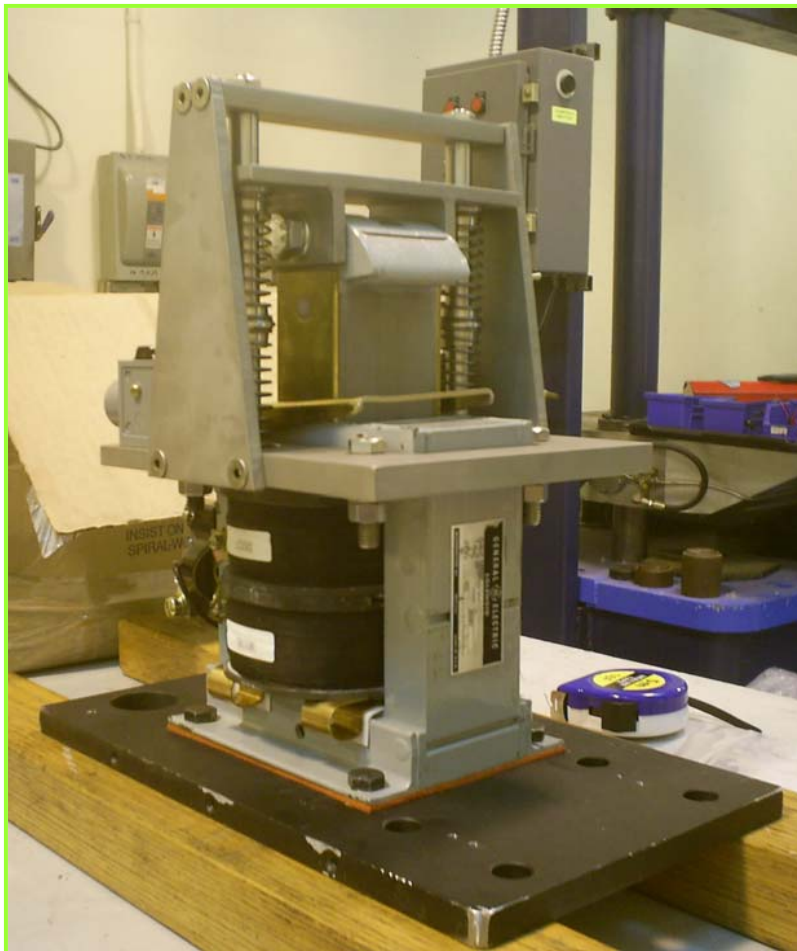
ERV Actuator Modification

✓ 2006 ERV actuator upgrade

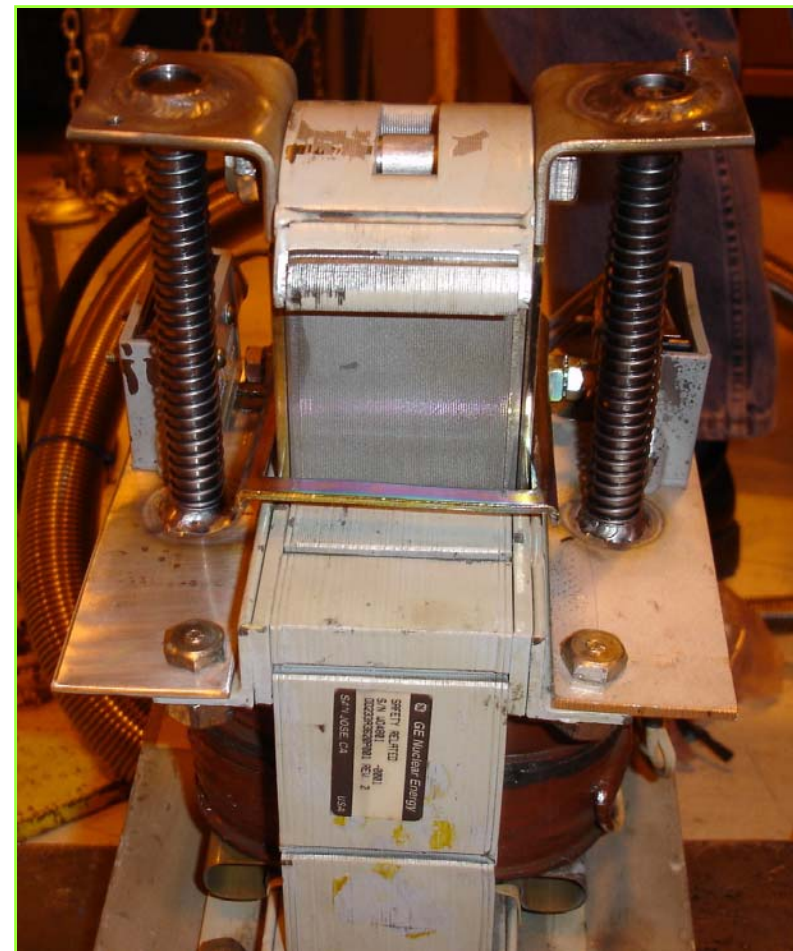
- ERV actuators replaced with more robust design
 - Several ERV actuator replacement options evaluated
- General Electric design selected
 - Included several material improvements
 - Significantly improved vibration resistance
- Actuator performance demonstrated through testing
 - Timing tests
 - Shaker table testing confirmed design robustness

ERV Actuator Modification

New GE Design



Original Design



ERV Actuator Modification

✓ Conclusions

- Cause of the ERV degradation identified as MSL vibration
- Upgraded ERV design, coupled with reduced vibration loading due to ASBs, results in significantly improved vibration resistance

EPU Commitments

Patrick Simpson
Corporate Licensing Manager

EPU Commitments

- ✓ In a January 26, 2006, letter to the NRC, EGC outlined 11 remaining regulatory commitments supporting long-term QC operation at EPU conditions

EPU Commitments

✓ ERV and Unit 2 Spring 2006 Refueling Outage Inspections

Commitment	Status
Inspect the 3E ERV turnbuckle tack welds and threads.	Complete
Inspect the currently (i.e., pre-Spring 2006 refueling outage) installed ERV actuators.	Complete
General visual inspection of reactor pressure vessel internals, steam, and feedwater systems, including inspection and disassembly, if necessary, of the most susceptible components.	Complete
Each QC unit will remain at pre-EPU power level until the ERV root cause evaluation is complete, necessary corrective actions implemented, and meeting with NRC held to discuss these actions.	Complete
Inspect Unit 2 steam dryer to ensure no structurally significant cracking that would limit operation.	Complete

EPU Commitments

✓ Meetings with NRC

Commitment	Status
Present the planned QC Unit 2 Spring 2006 ERV inspection scope and resultant extent of condition evaluations.	Complete
Following resolution of open technical issues, discuss with NRC management the results and conclusions of evaluations performed supporting EPU operation at QC Units 1 and 2.	Complete (Today)

EPU Commitments

✓ Continuous monitoring and inspection activities

Commitment	Status
Conduct daily monitoring of moisture carryover and other key reactor and plant parameters. Future monitoring will conform to industry guidance.	Ongoing
Perform future steam dryer inspections using BWRVIP-139 guidance.	Ongoing
Where lessons learned from evaluations or inspections conducted pursuant to other commitments indicate significant potential degradation of the steam dryer, EGC will take appropriate actions up to and including shutting down the applicable unit.	QC Unit 1 steam dryer to be inspected in May 2007 refueling outage

EPU Commitments

- ✓ Following the meeting with NRC management, EGC will formally request NRC acceptance of continuous EPU operation of QC

EPU Monitoring Plan

Steve Boline

Quad Cities Engineering Senior Manager
Design Engineering

EPU Monitoring Plan

✓ On-line monitoring

- ASB performance confirmed by monthly trending against baseline vibration levels
 - Trending includes vibration/strain/reactor pressure measurements until next refueling outage on each unit
 - Subsequent monitoring to consist of quarterly trending of reactor pressure
- Steam dryer performance confirmed by daily monitoring of moisture carryover and other key reactor parameters
 - Future monitoring will conform to BWRVIP-139 guidance

EPU Monitoring Plan

✓ Refueling outage inspections

- ASBs
 - 50% each outage until all ASBs inspected
 - Subsequent outages will include one ASB inspection
- Steam dryer
 - Inspections consistent with BWRVIP-139 guidance and vendor recommendations
- ERV inspections & PMs
 - ERVs will be stroked three times
 - Actuators and pilot valves will be replaced
 - General area walkdowns of steam affected zones
 - Frequency and sample size may be adjusted based on future performance

Summary

Randy Gideon
QC Plant Manager

Summary

- ✓ Vibration-related concerns resolved
 - ERV actuators and steam dryers redesigned to withstand pre-ASB, EPU loading conditions
 - ASBs reduce vibration loads to below original licensed thermal power levels
- ✓ Both QC units are operating safely at EPU power