BWR Owners' Group
Extended Power Uprate Committee

Presentation for Meeting with NRC Staff

August 18, 2004

Rockville, MD

BWR Extended Power Uprate Presentation Agenda

- BWROG EPU Committee Objectives and Background Information
- Steam Dryer Evaluation
- Survey and Evaluation of BWRs That Have Implemented EPU (Appendix B)
- Analysis of INPO Power Uprate and Cycle Extension Database (Appendix C)
- EPU Extent of Condition Evaluation for Dresden and QC
- Vibration Monitoring and Evaluation Information Exchange Meeting
- "EPU Lessons Learned and Recommendations" Document Status
- Updated EPU Integrated Industry Schedule

BWR Extended Power Uprate Committee Objective

- Ensure that operating experience and lessons learned are incorporated into power uprate programs to assure safe and reliable operations
- Provide oversight for a broad range of industry efforts related to BWR extended power uprates

EPU Background

- EPU defined as power increased in excess of 5% of the original licensed power
- Initial EPUs implemented approximately 10 years ago
- 2004 BWROG survey showed very few component failures that were attributed to EPU
- Most issues are related to flow-induced vibrations in main steam, feedwater, and EHC systems

- Tom asks for full power equivalent dates

EPU Operating Experience

Plant	Licensed Power (%OLTP)	Approx. Max Power Achieved (%OLTP)	Approx. Date of Initial Operation at Max Power Achieved
KKM	110	110	June 1993
Monticello	106	106	Oct 1998
Hatch 1	115.1	115.1	Nov 1998
Hatch 2	115.1	115.1	Nov 1998
Duane Arnold	120	112	Nov 2001
Dresden 2	117	117	Dec 2001
Quad Cities 2	117	117	March 2002

EPU Operating Experience

Plant	Licensed Power (%OLTP)	Approx. Max Power Achieved (%OLTP)	Approx. Date of Initial Operation at Max Power Achieved
Clinton	120	112	May 2002
Brunswick 2	120	116	April 2003
KKL	119.5	119.5	Aug 2002
Dresden 3	117	117	Nov 2002
Quad Cities 1	117	117	Dec 2002
Cofrentes	110	110	Jan 2003
Brunswick 1	120	120	April 2004

EPU Background

- Cracking of BWR steam dryer components has occurred since early plant operations
  - More than 120 instances of dryer component cracking - across all BWR product lines and at all power levels
- Because of unique damage to BWR 3 steam dryers at Quad Cities following EPU implementation, the BWR industry increased its attention to operational reliability at EPU conditions
  - GE screening matrix ranks susceptibility of plant-specific BWR dryers for similar damage
  - GE SIL 644 and 644 supplement 1 provide inspection recommendations

EPU Background

- BWROG Commitments
  - Monitor industry activities on EPU issues
  - Prepare and maintain an integrated schedule and help coordinate these activities (Appendix A)
  - Develop appropriate recommendations for plants that have implemented EPU, plants that are in the implementation process, and plants that will implement EPU in the future
  - Accept responsibility to be the BWR industry representative on EPU issues

Current BWR Steam Dryer Analysis

- Structural methodology includes GE finite element model and response spectra input
- Generic load definition based on historical instrumented dryer data
- Methods conservatively predict steam dryer loads
- GE and Entergy VY met with NRC staff on July 21, 2004 regarding current BWR steam dryer structural analysis methodology
- Details to be reviewed with NRC Staff week of August 23, 2004 in San Jose for application at Entergy-VY

Steam Dryer Load Definition Refinements

- Refinement of the BWR steam dryer load methodology to facilitate more realistic evaluation of steam dryer structural integrity prior to implementation of EPU
- Several efforts are underway to achieve objective
  - GE/BWRVIP program
  - Utility programs

GE/BWRVIP Steam Dryer Load Definition Program

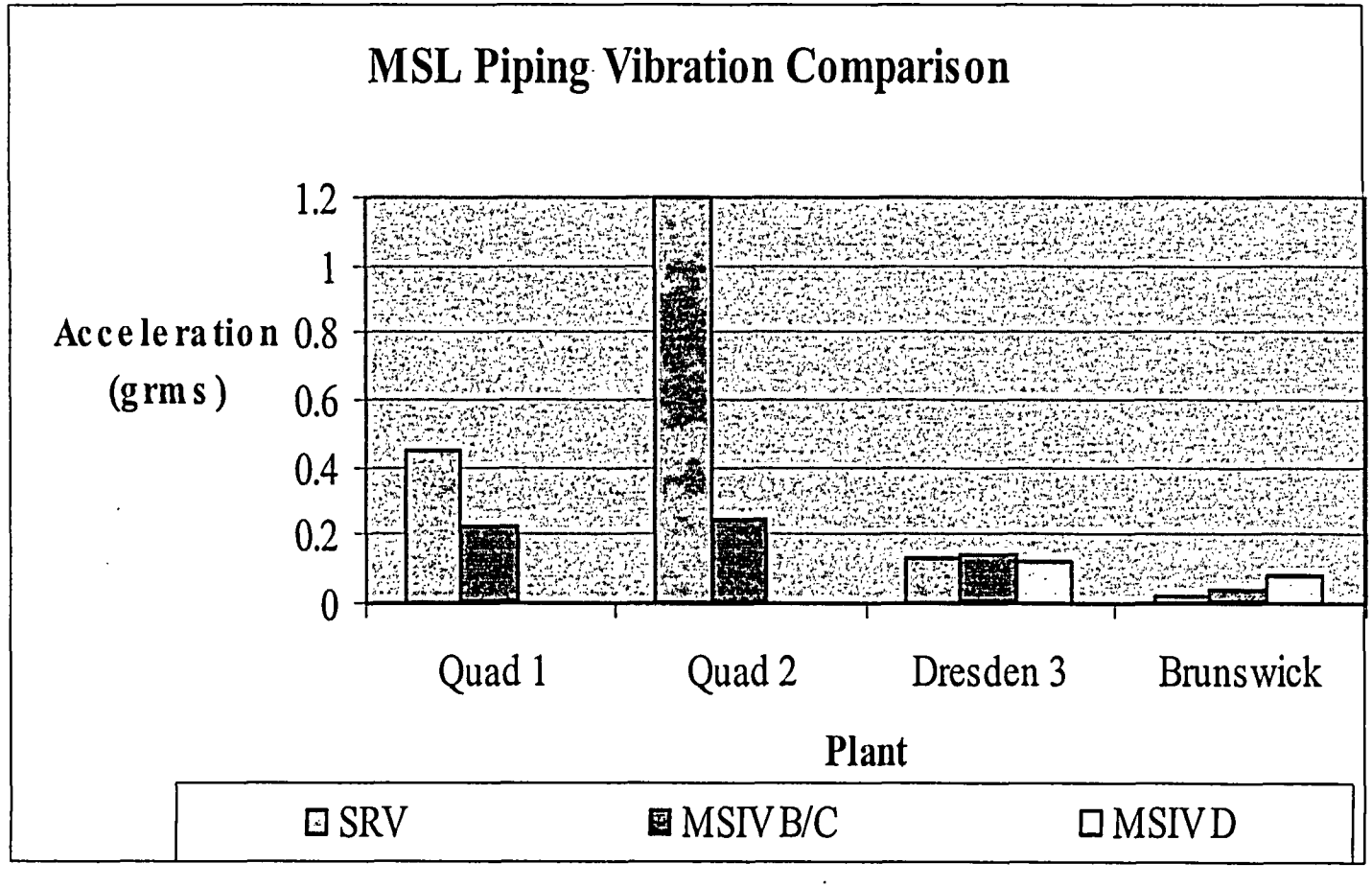
- Objective of acoustic model is to predict plant-specific steam dryer loads at EPU conditions
  - Acoustic model will be benchmarked against plant-specific sub-scale test results and full-scale instrumented steam dryer data
  - Loads measured on plant-specific sub-scale test facility will be scaled to full size and combined with other loads determined analytically to arrive at the total plant-specific loads definition
- After sufficient experience is gained, it is expected that the acoustic model can be employed without the sub-scale testing to predict realistic BWR steam dryer acoustic loads

Utility Steam Dryer Load Definition Efforts

- Some utilities are conducting parallel efforts due to near term needs
- Acoustic circuit model developed to predict acoustic loads on the steam dryer from plant operational data taken from main steam system
- Calculated dryer loads are used in steam dryer analysis

Steam Dryer Load Definition

- Available data suggests that the major vibration problems that have occurred at Quad Cities are an anomaly related to high steam velocities and unusually high acoustic vibration levels
  - Compared vibration levels at selected BWRs at maximum licensed EPU power levels (see next slide)
  - Brunswick SRV inlet vibration levels (120% OLTP) are about 60 times lower than at Quad Cities 2 (117% OLTP)
  - Dresden 3 SRV inlet vibration levels (117% OLTP) are about 8 times lower than at Quad Cities 2 (117% OLTP)
- Steam dryer load definition work expected to confirm this anomaly


MSL Piping Vibration Comparison
Acceleration (grms)
1.2
1
0.8
0.6
0.4
0.2
0
Quad 1
Quad 2
Dresden 3
Brunswick
Plant
SRV
MSIV B/C
MSIV D

Other Steam Dryer Integrity Industry Workscope

- Steam dryer I&E Guidelines for maintaining long term health of steam dryers (GE/BWRVIP)
  - Provides detailed inspection guidance
  - Provides flaw evaluation methods
  - Provides repair and flaw mitigation guidance
  - Applicable to all steam dryers regardless of EPU status
- Update of BWRVIP-06 loose parts evaluation to include recent industry experience (GE/BWRVIP)
- Revision of SIL 644 "BWR Steam Dryer Integrity" to include more recent experience (GE)

Steam Dryer Integrity
BWROG Workscope

- BWROG has drafted "BWR Moisture Carryover and Operational Response Guidance"
- Requires consideration of plant parameters other than steam dryer failure that could impact moisture carryover
  - Bundle power and flow distribution
  - Power level
  - Total core flow
  - Water level
  - Feedwater temperatures (end of cycle)
    - Core inlet subcooling
- Industry survey utilized in development of document

BWROG EPU Survey Results

- Responses received from 13 BWRs that have EPU operational experience
- EPU adversely impacted 2 BWR units Unplanned Capacity Loss Factor (UCLF)
- UCLF improved at 2 BWRs
- Most issues related to flow-induced vibrations in main steam, feedwater, and EHC systems

BWROG EPU Survey Results

- 17 component failures identified (Appendix B)
  - 3 EHC accumulator seal (3 plants)
  - 2 EHC drain line at TCV (failures also pre-EPU at these 2 plants)
  - 9 steam dryer component failures or growth of pre-existing crack (4 plants)
  - Stator water cooling pump
  - MSL drain line
  - FW pump drain line and pump suction relief valve line (small bore piping)

BWROG EPU Survey Results

- Other known issues not identified by BWROG survey (some after date of survey)
  - Electromatic relief valve actuator
  - Limitorque valve operator (limit switch)
  - S/RV spring setpoint
  - Mechanical snubber (may have been caused by snubber reduction program, not EPU)
- Many of the identified issues have also occurred under non-EPU conditions
- EPU has the potential to decrease the time between failures

BWROG EPU Survey Results

- Unexpected increase in component wear
  - Frequency of EHC TCV accumulators losing their charge
  - FW heater shell erosion rate near extraction steam inlet nozzles (occurred pre-EPU also, identified for near-term replacement)
  - ERV actuators (Quad Cities)

BWROG Review of INPO Power Uprate and Cycle Extension Database

- 103 BWR/PWR Events 1992 thru January 2004 (Appendix C)
  - 51 only tangentially related to power uprate
  - 52 events to which power uprate directly or indirectly contributed
    - 15 caused by vibration
    - 18 due to instrument calibration problems
    - 12 due to operational procedure deficiencies
    - 5 due to pre-existing conditions, installation errors, defective components, or miscellaneous
    - 2 due to erosion / corrosion

BWROG Review of INPO Power Uprate and Cycle Extension Database

- BWROG focused on the events categorized as vibration and erosion / corrosion (due to resulting component degradation and/or failure)
- Except for main steam and feedwater vibrations, the majority of INPO database events of interest were caused by inadequate calibrations or inadequate revision of operational procedures

BWROG Review of GE/Exelon Extent of Condition Review for Dresden and Quad Cities

- Completed rigorous component level review
- Evaluated changes in parameters as a result of EPU
  - Flow rates, temperature, pressure, radiation levels, vibration levels
- Components susceptible to increased wear or increases in other failure mechanisms identified and recommended for closer inspection

BWROG Review of GE/Exelon Extent of Condition Review for Dresden and Quad Cities

- Committee reviewed Results of Extent of Condition Evaluation in June 2004
- 43 Balance of Plant (BOP) Systems and 10 Safety Systems
- GE/Exelon documented recommendations to address potential problems due to EPU implementation into categories
  - Strategic Initiatives
  - Additional Analyses
  - Inspections, Enhanced Maintenance and Modifications
- BWROG will evaluate for fleet applicability

BWROG Review of GE/Exelon Extent of Condition Review for Dresden and Quad Cities

- GE/Exelon classified into cause categories
  - (1) Acoustic driven vibrations
  - (2) Documentation and design basis issues
  - (3) Accelerated wear and degradation
  - (4) FW flow requirements
  - (5) Known material condition issues
  - (6) Thermal power calculation
  - (7) Reduced operations and analysis margin
  - (8) Reactor internals flow and vibration

BWROG Review of GE/Exelon Extent of Condition Review for Dresden and Quad Cities

- GE/Exelon Conclusions for Safety Systems
  - Functions remain uncompromised
  - Design inputs for the analyses are clearly conservative

BWROG Review of GE/Exelon Extent of Condition Review for Dresden and Quad Cities (Continued)

GE/Exelon Conclusions for BOP Systems

- No vulnerabilities identified that could result in an immediate challenge to plant operations
- Material condition of plant pre-EPU should be an important factor for future EPU evaluations
- Value from identification of and institution of critical PM changes for components affected by EPU
- Value from monitoring and trending of critical operating parameters

BWROG Review of GE/Exelon Extent of Condition Review for Dresden and Quad Cities (Continued)

- Revisions made to GE EPU process
  - More detailed structural analysis of steam dryer and other components in the steam and FW flow path
    - Future inclusion of acoustic and flow induced vibration (FIV) loads on susceptible components
  - Performance of pre-EPU assessment of material condition of the plant that involves careful evaluation of operating data and trends, including interviews of the plant staff
- Will not impact NRC-approved GE LTRs

BWR Extended Power Uprate
Vibration Monitoring and Evaluation Information Exchange Meeting

- Committee held vibration monitoring and evaluation information exchange meeting on June 9, 2004
- Four formal presentations
  - Exelon – Dresden and QC vibration assessment
  - PSEG – Hope Creek Recirc System vibration monitoring
  - Progress Energy – Brunswick 1 vibration monitoring
  - SNC – Farley main steam vibration monitoring
- Others participated in roundtable discussion
- Developed specific recommendations to be included in BWROG Lessons Learned and Recommendations document

Near Term BWROG Activities Summary

- "EPU Lessons Learned and Recommendations" document – draft issued for comment
- Issue BWR Moisture Carryover and Operational Response Guidance – September 2004
  - Assure consistency with GE SIL 644 revision 1
- Meeting with ACRS Operations Subcommittee - To be determined

BWR Extended Power Uprate
Summary and Interim Conclusions

- Recent problems attributed to EPU are related to power production or component reliability
  - Many issues involve pre-existing material issues that are exacerbated by EPU
- Majority of draft BWROG recommendations involve strategies to improve robustness during EPU implementation
- BWROG recommendations will reduce challenges during the EPU implementation process
- Recommendations will also reduce the potential that safety component functionality will be degraded by loose parts from non-safety systems and will help assure that plant reliability remains high

BWR Extended Power Uprate
Summary and Interim Conclusions (continued)

- Data suggests that the vibration problems at Quad Cities are an anomaly related to high steam velocities and unusually high acoustic vibration levels
- Refinement of the BWR steam dryer load methodology will facilitate more realistic evaluation of steam dryer structural integrity prior to implementation of EPU

Appendix A
Exelon and GE - Evaluation for Extent of Condition

Task	Responsibility	Scheduled Completion
EPU Extent of Condition Evaluation for Dresden and Quad Cities	GE/Exelon	Complete May 2004
Modify GE Process for EPU Evaluations as Required	GE	Complete June 2004

Appendix A
Steam Dryer and Internals Initiatives

Task	Responsibility	Scheduled Completion
Revision of SIL 644 to include more recent experience	GE	Sept 2004
Steam Dryer I&E Guidelines	GE/BWRVIP	Dec 2004
Revision of BWRVIP-06 including revised guidance for addressing loose parts	GE/BWRVIP	Dec 2004 submittal
Validate a methodology for determining steam dryer loading using main steam acoustic circuit analysis and verification with scale model testing and plant data	GE/BWRVIP	May 2005

Appendix A
BWROG Assessment of Industry Experience

Task	Responsibility	Scheduled Completion
Analysis of INPO Power Uprate and Cycle Extension Database	BWROG	Completed Feb 2004
BWROG EPU Survey summary and evaluation	BWROG	Completed March 2004
Best practices for steam dryer performance monitoring	BWROG	Sept 2004

Appendix A
BWROG Oversight of Industry Activities

Task	Responsibility	Scheduled Completion
Review EPU Extent of Condition Evaluation process and pilot for Dresden and Quad Cities	BWROG	Completed Feb 2004
Review EPU-related vulnerabilities for "Group 1" systems from EPU Extent of Condition Evaluation	BWROG	Completed April 2004
Review EPU Extent of Condition final recommendations	BWROG	Completed June 2004
Conduct vibration monitoring and evaluation information exchange meeting and document lessons learned and industry recommendations	BWROG	Completed June 2004

Appendix A
BWROG Oversight of Industry Activities

Task	Responsibility	Scheduled Completion
Develop draft "EPU Lessons Learned and Recommendations" document from review of industry data and GE/Exelon extent of condition reviews for BWR owners	BWROG	Complete July 2004
Issue final "EPU Lessons Learned and Recommendations"	BWROG	Dec 2004
Review results of industry programs and BWROG recommendations with NRC management	BWROG	Ongoing

Appendix B
BWR Owners' Group Component Failure Experience Survey Summary
August 18, 2004 Presentation to NRC Staff

Plant(s)	Max. % PU	Months at EPU	Component/ Subcomponent Failures	Increased Wear Rates or Parts Replacement	Impact on UCLF due to EPU	Operational Impacts and Other Comments of Interest
A1, A2	13.5 16	20 10	EHC Accum seals failed a few months after EPU. Failure related to operation at interim powers. EHC drain line fitting at turbine control valve (unit 1 failed in 23 months; unit 2 failed in 8 months). These fittings also experienced failures pre-EPU.	Shorter life for condensate demin filters and deepbed demins (expected) Shorter life expectancy for control rod blades (expected)	No	EHC drain line fittings is not a new failure mode but believed to be driven by EPU, designing mod to install flexible connections Condenser sensing line determined to be located at different points for trip/alarm versus operator indication (mod planned to relocate so that operators valid indication of margin to trip) Downpower dose rates are higher because of increased flow and reduced transport time, RWP changes required because some dose rates exceed 10 R/Hr

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B	112.4	27	None	Accumulator on EHC FAS lines to each TCV had a recent history prior to EPU of losing their charge, and the frequency increased after EPU Two FW heaters have experienced significant internal shell wastage near extraction steam inlet nozzles	No (increase due to problems with main condenser and DW coolers not related to EPU)	Increased frequency of the EHC accumulators losing their charge due to high gain for the TCV position at the interim power level (not the EPU power level). OEM predicted these swings since the equipment was re-designed for the EPU power level. FW heater shell wastage near the extraction nozzles was occurring prior to EPU. These heaters were previously identified as needing to be replaced due to expected decrease in tube life from increased tube vibration at higher power levels.

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C1, C2	117 117	26 14	Seven specific steam dryer components	Reactor feed pumps (all 3 pumps operating, no longer a stand-by pump) Condensate and condensate booster pumps (all 4 pumps are operating, no longer a stand-by condensate and condensate booster pump)	"Forced Loss Rate" reduced from 3.4% to 0.8% and UCLF reduced from 4.72% to 1.6% on unit C1 "Forced Loss Rate" reduced from 4.5% to 2.2% and UCLF reduced from 6.12% to 3.8% on unit C2	Not enough operating time at EPU to identify trends on other plant equipment other than failed components

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D1, D2	15.1 15.1	58 63	None	None	No	During the implementation of the Unit 1 EPU, experienced erroneous high level indication and subsequent level control on the high pressure feedwater heaters. It was later determined that the heater was experiencing a phenomenon known as "wall wetting" due to the additional flow to the HP heaters. The sensing lines for the level transmitters had to be inserted beyond the wall of the heater to negate the additional flow impact. This problem was diagnosed as a condition previously experienced by the heater vendor.

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E	119.5	64	None	None	No	As expected, have seen an increase in iron in the condensate system that is indicative of increased erosion in piping due to the increase in steam and condensate flow rates. Possible higher wear rate on shaft seals of FW pumps due to higher speed and/or altered water chemistry. Plant completed extensive surveillance, testing, and analysis program that accompanied the steps of power uprate. Power uprate was implemented in four steps increases over several years.

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F	6.1	64	Stator water cooling pumps seized within 1 month of implementation of EPU, design issue for larger pumps with different couplings and seals	None	No	The feed water nozzle discharge coefficient changes were not translated to the plant process computer correctly causing plant to operate at a slightly higher power level. Turbine component replacements with tighter packings caused higher vibration during startup.

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G1, G2	17.0 17.0	15 24	MSL drain lines Small bore piping failures on feed pump drain lines and suction relief valves Steam dryer	ERV actuators	Increased UCLF due to forced outages	Chattering of MSL low pressure relays due to in appropriate setpoint Increased condensate pump noise EHC leaks caused unplanned load reductions Higher steam lines caused steam line drains to vibrate at higher amplitude RFP TBCCW cooling line cracked Loose nuts on 2C RFP disch. MOV Pinhole leak on 2B RFP discharge drain line High temperature on isophase bus duct system Recirc loop sample line wear

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G1, G2 (continued)						MSIV supply line to accumulator leakage MSIV room cooler leakage ERV discharge piping snubber loose HPCI steam bellows cover missing a nut off a capscrew and nut and capscrew in another location RWCU valve cracked limit switch Loose nut on turbine control valve Locknuts and hangers on moisture separators loose Survey also summarized reduced margin issues several of which have been identified after the EPU outages.

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H	10	22	Pre-existing crack in steam dryer drain channel observed to exhibit 1.1 inch growth.		No Capacity factor slightly higher because operation is not limited by licensed power output.	SJAE exhibited chugging during rapid power ascension at high condensate and lake temperatures. Turbine pressure spikes observed at point where last TCV reached opening point. Partial 3+1 arc admission implemented in conjunction with EPU. Condensate polisher resins changed post-EPU to achieve better chemistry control, which resulted in lower system flow rates. This resulted in a reduction in feedwater pump suction pressure. Additional condensate polisher and improvements to feedwater pump efficiency (pump impeller changeout) are being considered.

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H (continued)						Increased feedwater heater wear predicted by EPU. Plant is performing eddy current testing to quantify changes in heater tube wear rates. Flow accelerated corrosion wear rates in accordance with predictions based on data observed after one operating cycle at EPU.
I	110	130 (122 months at 110%)	None	None	No	

Appendix C
INPO Power Uprate or Cycle Extension Events - Database Evaluation
August 18, 2004 BWROG Presentation to NRC Staff

INPO Event No.	Event Summary	%Power (time of event)	PU Directly Caused or Indirectly Contributed to Event								Events Only Tangentially Related to PU or Comment
			Vibr.	Erosion / Corrosion	Mod. or Install. Error	Calib. Def.	Amb. Temp. Change	Oper. Proc. Def.	Def. Comp.	Pre-exist. Cond. or Other	Cause of Event
1	BWR-3 Increased Moisture Carryover	100	X								
2	BWR-3 Automatic Reactor Scram	8						X			
3	PWR Flux Anomoly	-									Axial flux, increased crud layer at top of high-powered rods
4	PWR Boric Acid Corrosion of valve yokes	0									Increased fuel cycle length
5	Broken Extraction Steam at BWR-4 plate leads to Excessive Tube Failures in F.W. Heater	0	X								
6	BWR-4 Calibration error in CS line break DP instrument	100				X					
7	BWR-3 EHC system leaks caused by Pressure Oscillations		X								

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8	BWR-3 Computer code predicts RCICS Line may not isolate	-									Concern resolved via analysis
9	BWR-6 Condenser Vacuum Loss results 15% power reduction	85						X			
10	BWR-6 Criticality couldn't be maintained in 2 reactor startups	0									Procedure Inadequacy
11	BWR-4 Reactor heat balance error during EPU implementation	94						X			
12	PWR Discrepancies in vendor calculations	-						X			
13	BWR-3 Nonconservative FW temp. calibrations result in operation at power levels greater than licensed max.	100				X					

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			Vibr.	Erosion / Corrosion	Mod. or Install. Error	Calib. Def.	Amb. Temp. Change	Oper. Proc. Def.	Def. Comp.	Pre-exist. Cond. or Other	Cause of Event
14	PWR Nonconservative time constants trip channels	100				X					
15	PWR Extraction steam line breech	100								X	
16	PWR Oil leaks on new heater drain pump	100									Manufacturing defect
17	BWR-3 Leaking seal welds on FW flow elements	-									Manufacturing defect
18	BWR-3 MELLLA exceeded during planned load drop	90						X			
19	PWR references between CSH assumptions and current fuel management	-						X			
20	BWR-5 Manual Scram Generator Stator Cooling	77						X			

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21	BWR-5 Multiple FW heater tube leaks	Start-up	X								
22	PWR Manual reactor trip in response to MFRV failure	100									Coil failure due to age degradation
23	BWR-4 Degraded FW heater system level control valves	0	X								
24	PWR Difficulty in synchronizing main generator to electrical grid	Startup						X			
25	BWR-4 Error in generic analysis results in non-conservative OPRM setpoint	100									Error in reload licensing analysis
26	BWR-3 Errors identified in fuel vendors supplemental reload analysis	-									Error in transient analysis

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27	BWR-3 Excessive EH pipe vibration following PU	100	X								
28	BWR-4 Failure of reactor recirc pump "B" discharge valve to close	-									Inadequate maintenance
29	PWR Failure to perform full flow test of turbine auxiliary FW pumps due to personnel error	-									Personnel error
30	BWR-4 FW flow indication discrepancy	95				X					
31	BWR-4 FW heater wall thinning and tube support damage due to erosion	0		X							
32	PWR FW Oscillations during startup result in Manual Scram	7									AOV problem

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33	PWR FW transient during MFW pump stop valve testing	100									Apparent valve sticking, operator change after PU
34	BWR-5 Forced power reduction due to FW heater steam leak	100		X							
35	PWR Fuel defects	100									One fuel defect
36	PWR Heat exchanger biofouling during ECT system outages	-									Biofouling
37	BWR-6 High-Pressure turbine horizontal joint leak	100									Inadequate bolt tension
38	BWR-4 Hydraulic oil intrusion into primary coolant	100									GEZIP valve issues
39	PWR Incorrect part numbers found in power range channel rate circuit	-									Drawing discrepancy

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40	PWR Incorrect thermal power calculation caused by software problem	-									Software problem
41	PWR Larger axial offset deviation	-									Fuel burnable absorber issue
42	PWR Licensed max power level exceeded	100				X					
43	PWR Licensed max power level exceeded	100				X					
44	BWR-4 Low condenser vacuum manual scram due to air entrapment	41						X			
45	BWR-4 Main generator causes turbine trip and automatic reactor scram due to manufacturing error	98									Manufacturing error

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INPO Event No.	Event Summary	%Power (time of event)	PU Directly Caused or Indirectly Contributed to Event								Events Only Tangentially Related to PU or Comment
			Vibr.	Erosion / Corrosion	Mod. or Install. Error	Calib. Def.	Amb. Temp. Change	Oper. Proc. Def.	Def. Comp.	Pre-exist. Cond. or Other	Cause of Event
46	PWR Generator lockout/turbine trip and reactor scram	100									gound fault
47	BWR-3 MS isolation signal stop valve testing and steady-state operation after PU	90				X					
48	BWR-3 MS piping low point drain line fails due to vibration related to EPU	100	X								
49	BWR-3 MS safety relief valve exceeded setpoint tolerance	100									Corrosion bonding at disc/seat interface
50	PWR Main transformer high oil temp.	100					X				
51	PWR Main turbine overspeed trip mechanism failure delays unit startup	0									Installation deficiency

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52	BWR-3Manual reactor scram due to an EHC oil leak	100									Poor fabrication
53	PWR Manual reactor trip in response to MFRV failure	100									Excess current in coil
54	BWR-4 New MS line differential pressure switches w/ out-of-specification as-found setpoint	-									Inappropriate assumption regarding setpoint drift
55	BWR-4 Socket weld failure	100	X								
56	BWR-4 RFPT control valve oscillations	0									Digital fw control system
57	PWR Turbine runback after normalization of loop delta-T	0				X					
58	PWR Feed Reg Bypass valve controller cards configured incorrectly	-									Incorrectly configured controller cards

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59	BWR-3 Main condenser performance degraded	-									Ineffective cleaning
60	BWR-3 Reactor vessel steam dryer structural steel bracing degraded	0	X								
61	BWR-6 Licensed thermal power limit exceeded	-				X					
62	PWR Blue channel Tavg response	-									Inadequate replacement part
63	PWR Error in temporary change of anomalies surveillance procedure	-									Calculational error
64	PWR Brief power excursion to 101%	101									Full arc turbine control system
65	PWR Licensed max power level exceeded	100				X					
66	BWR-3 Reactor steam dryer damaged	100	X								

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67	PWR Unintended effects on secondary plant	-						X			
68	PWR Turbine runback due to OPDT	100				X					
69	BWR-4 Operation above licensed power due to missed process computer setpoint changes	100				X					
70	PWR Over Power delta temp runback alarms	100								X	
71	BWR-6 RFP Sere Inspection	-						X			
72	PWR Intermediate range excore channel automatic scram while shutting down	8									Calibration deficiency
73	BWR-3 Plant [illegible] shutdown due to damaged steam dryer	100	X								

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74	BWR-6 Plant shutdown to replace defective fuel assemblies	100									Fuel Performance
75	BWR-3 POWERPLEX input deck errors	100				X					
76	BWR-3 EPU created increased high frequency vibration of turbine stop valve component (pressure switches)	[redacted]	X	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	
77	PWR Reactor coolant system leak greater than 10 GPM	100									Surveillance test deficiency
78	PWR Reactor Core Axial Offset Anomaly	100									Crud burst
79	BWR-4 RCIC Automatic Isolation during Surveillance Test	100									Extended cycle surveillance test

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80	BWR-4 Reactor Scram caused by FW Pump Over-speed Testing	100									Surveillance test inadequacy
81	BWR-6 Reactor Scram due to MPT B SPR Actuation	95									Single failure vulnerability, latent defect
82	BWR-4 Reactor scram during main turbine control valve testing	79									Failed seal in pneumatic actuator
83	BWR-4 Reactor Trip on High Neutron Flux caused by Reactor Pressure Transient	87									Reactor pressure regulator failure
84	BWR-5 Recirc MG Set B Stops Exceeded Tech Spec Limits	95				X					
85	BWR-5 Recirc Pump Vibration following PU Implementation (GE issued SIL 600)	100	X								

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86	PWR Recurring Axial Offset Anomaly	-									Crud deposition on upper regions of fuel rods
87	BWR-6 Scram during EPU Testing (Inadequate maintenance)	86								X	
88	PWR Secondary Calorimetric Inaccuracy resulting from Main FW Mass Flowrate Inconsistencies	100				X					
89	BWR-5 Shift Ave. Max. Power Level Exceeded	100				X					
90	Core Flow Measurement System Summer Calibrations	-				X					
91	BWR-3 Steam Dryer Failure		X								

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92	BWR-5 SLCS unable to meet requirements of the ATWS Rule for a LOOP/ATWS Event	100									System design inadequacy
93	PWR Stator Cooling Water System encountered a fast Rise in the Max DT	100									Decision to not perform chemical cleaning
94	PWR Steam Leaks from High Pressure Turbine Blade Ring	100			X						
95	PWR 3rd Point Extraction Steam Expansion Bellows Failure	-									Inadequate evaluation of plant modification
96	PWR Tube Leaks in LPFW Heater	100								X	
97	BWR-2 Turbine Anticipatory Scram Bypass Setpoints Nonconservative	99									Setpoint error

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98	BWR-3 Turbine Control Valve Accumulator Leaks caused Unplanned Shutdown	100	X								
99	BWR-3 Turbine Control Valve Oscillations following PU	100				X					
100	BWR-4 Two-Stage Target Rock Safety Relief Valve Pilot Valve Assembly Leakage	0									Manufacturing tolerance problem
101	BWR-3 Unexpected Recirculation Pump Runback	32									Operational procedure deficiency
102	PWR Unit taken offline to identify/repair 2C SG Leakage	-									Foreign material caused tube degradation

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103	PWR Unplanned Power Excursion when Transferring Main Turbine Control from Manual to Automatic	100						X			