UNITED STATES
NUCLEAR REGULATORY COMMISSION
REGION IV
611 RYAN PLAZA DRIVE, SUITE 400
ARLINGTON, TEXAS 76011-8064

May 31, 2000

EA 00-081

Craig G. Anderson, Vice President,
Operations
Arkansas Nuclear One
Entergy Operations, Inc.
1448 S.R. 333
Russellville, Arkansas 72801-0967

SUBJECT: ARKANSAS NUCLEAR ONE PREDECISIONAL ENFORCEMENT CONFERENCE SUMMARY-(INSPECTION REPORT 50-313/00-04; 50-368/00-04)

Dear Mr. Anderson:

This refers to the Predecisional Enforcement Conference conducted in the Region IV office on May 8, 2000, between your staff, Region IV personnel, and representatives of the Office of Enforcement and the Office of Nuclear Reactor Regulation via video conference. This meeting was held at the request of Region IV. In this meeting, the apparent violations related to the inoperability of the Unit 1 low pressure injection/decay heat removal pumps were discussed. The attendance list, licensee presentation materials, and NRC handouts are enclosed.

Our enforcement deliberations are ongoing, and the results will be addressed by separate correspondence. Separately, however, you identified an error in the inspection report associated with this matter (50/313/00-04, 50-368/00-04). This error involved the statement provided in Section E.2.1.f (page 6) that discusses the replacement of the bearing housings in 1992. The statement has been changed to read, "It is now apparent that the installation of a bearing housing with a different coefficient of thermal expansion resulted in clearances between the internal pump parts becoming a problem." A corrected page is enclosed to replace the originally issued page.

In accordance with Section 2.790 of the NRC's "Rules of Practice," Part 2, Title 10, Code of Federal Regulations, a copy of this letter will be placed in the NRC's Public Document Room.

Should you have any questions concerning this matter, we will be pleased to discuss them with you.

Sincerely,

/RA/

Ken E. Brockman, Director
Division of Reactor Projects

Enclosures:
1. Attendance List
2. Licensee Presentation Material
3. NRC Handouts
4. Page 6 of NRC Inspection Report 50-313/00-04; 50-368/00-04

Docket Nos.: 50-313
50-368
License Nos.: DPR-51
NPF-6

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RIV:PE:DRP/A		C:DRP/D		D:DRP	
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05/23/00 ***/RA/ PHH***		05/23/00 ***/RA/***		05/31/00 ***/RA/***	

OFFICIAL RECORD COPY

Enclosure 1

Attendance List

Name	Organization	Title
Jim Vandergrift	EOI, ANO	Director, Nuclear Safety
Charles Zimmerman	EOI, ANO	U-1 Plant Manager
Dale E. James	EOI, ANO	Manager, Licensing
Bob Bement	EOI, ANO	General Manager Plant Ops
Craig Anderson	EOI, ANO	VP Operations
Tom Greene	MPR	Engineer
Jeff Priore	EOI, ANO	Engineer, Sr System
Don Phillips	EOI, ANO	SYE-1 Supv
Jessica Walker	EOI, ANO	Engineer
Ed France	EOI, ANO	Engineer, Sr Mech Design
Paul Allaire	Univ. of VA, ANO	Consultant, Ph.D.
Stephenie Pyle	Entergy	Licensing Specialist
Michael R. McKinney	Entergy	Superintendent, Reactor Engineering
Milton Huff	Entergy	Design Engineering Supv.
Joe Kowalewski	Entergy	System Engineering Mgr.
Rick Lane	Entergy	Director Engineering
Gary Sanborn	NRC, Region IV	Director, ACES
Art Howell	NRC, Region IV	Director, DRS
Ellis W. Merschoff	NRC, Region IV	RA
Ken E. Brockman	NRC, Region IV	Director, DRP
Russ Bywater	NRC, Region IV	SRI
Wayne Sifre	NRC, Region IV	Project Engineer
Donald B. Allen	NRC, Region IV	Project Engineer
Phil Harrell	NRC, Region IV	Branch Chief
Kriss Kennedy	NRC, Region IV	Sr. Project Engineer
Rachel Carr	NRC, Region IV	FCDB Inspector (Trng.)
Breck Henderson	NRC, Region IV	PAO
Jeff Shackelford	NRC, Region IV	SRA
Chris Nolan	NRC, NRR	Project Manager
Joe Colaccino	NRC, NRR	Mechanical Engineer
Bob Gramm	NRC, NRR	Section Chief
Sunild Weerakkody	NRC, RES	Sr. Reliability & Risk Analyst
Terry Reis	NRC, OE	Sr. Enforcement Specialist
Vonna Ordaz	NRC, DRIP	NRR Enforcement Coordinator

Enclosure 2

Licensee Presentation Material

Unit 1 Decay Heat Pump Pre-Decisional Enforcement Conference

May 8, 2000

Opening Remarks

Craig Anderson
Vice-President, ANO

Management Overview

Robert Bement

General Manager, ANO

Agenda

Opening Remarks………………………………………….……………	Craig Anderson *Vice President, ANO*
Management Overview…………………………..…..……………	Robert Bement *General Manger, ANO*
Event Overview……………………………………..……………..	Charlie Zimmerman *Plant Manger, Unit 1*
Equipment Failure Analysis and Corrective Actions……..………	Joe Kowalewski *System Engr Mgr, Unit 1*
Programmatic Root Cause and Corrective Actions………………	Rick Lane *Director, Engineering*
Safety Significance	
■ **Expert Panel Results……………………………………………**	Milton Huff *Supervisor, Design Engr*
■ **Risk Significance……………………………………………….**	Mike McKinney *Superintendent, Reactor Engr*
Enforcement Perspective……………………………………………	Dale James *Manager, Licensing*
Conclusions…………………………………………………………..	Craig Anderson *Vice President, ANO*

Apparent Violations

Violation A

- Two examples of inadequate engineering evaluations which constitute a failure to properly implement measures for the selection and review for suitability of application of material, parts, and equipment that are essential to the safety-related function of the structures, systems, and components covered by 10CFR50, Appendix B (LPI/DHR). This is an apparent violation of 10CFR50, Appendix B, Criterion III.
  - Stainless steel bearing housing installation in 1992
  - Bearing oil change from ISO 22 to ISO 46 in 1999

Violation B

- Due to the conditions in violation “A”, the “A” and “B” LPI/DHR pumps were not able to perform their intended safety function because of bearing temperature problems at SW temperatures below 42°F. From January 28 to February 5, 2000, the SW temperature was below 42°F. This is a violation of Technical Specification 3.3.1(D) which requires both pumps to be operable when: (1) RCS pressure is 300 psig or greater, (2) reactor coolant temperature is 200°F or greater, and (3) nuclear fuel is in the core.

Event Overview

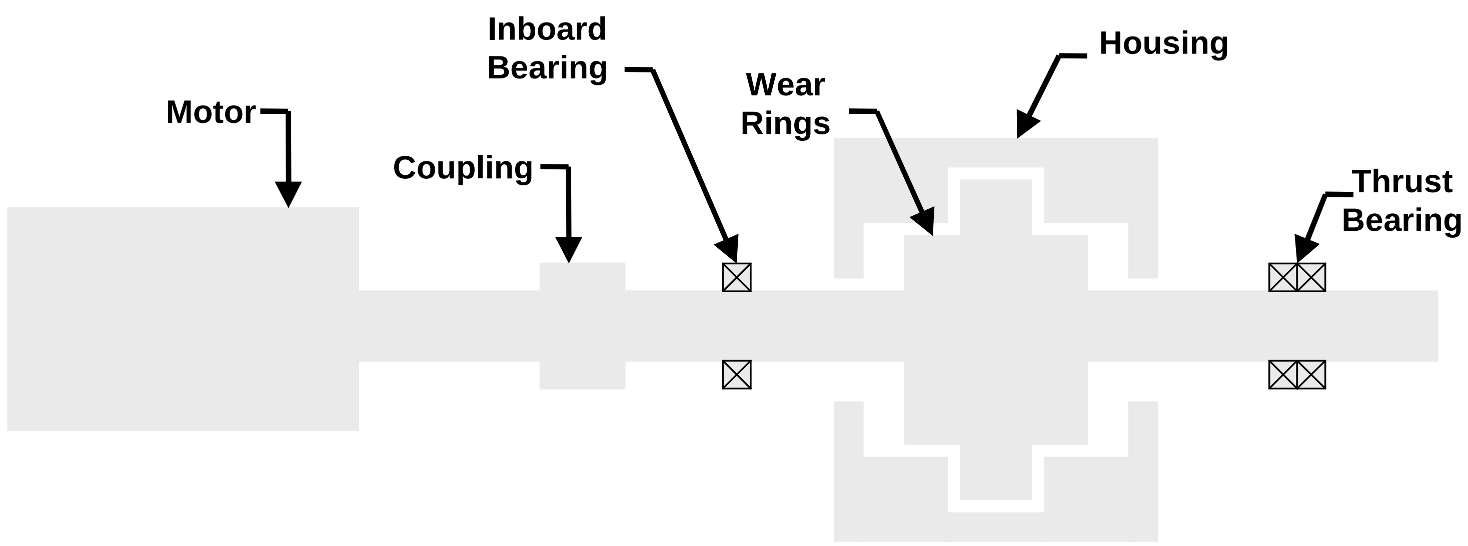
Charlie Zimmerman

Plant Manager, Unit 1

Event Overview

- Low Pressure Injection (LPI)/Decay Heat Removal (DHR) Pumps have four modes of operation
  - Surveillance test mode recirculating Borated Water Storage Tank (BWST)
  - Engineered Safeguards injection mode injecting BWST water to the core
  - Engineered Safeguards recirculation mode recirculating the Reactor Building Sump through core injection
  - DHR mode recirculating reactor coolant system (RCS) from the hot leg back through the core

LPI/DHR Pump with Radial Bearing



Event Overview

1971
- Purchase Order for Unit 1 LPI/DHR pumps issued
  - Babcock & Wilcox (B&W) design specification
    - RCS temperature 45-245°F
    - Service water (SW) design temperature 85°F maximum
  - Vendor Technical Manual specifies oil functional between 32-150°F

1987
- Changed bearing oil from ISO 46 to ISO 22
  - Technical manual recommended several different oils and a range of viscosity
  - ISO 22 recommended oil most nearly matched recommended viscosity range

1992
- Housing material changed from cast iron to stainless steel due to SW corrosion problems

Event Overview

09/15/96

- "B" pump utilized for DHR during 1R13 cooldown
  - Experienced a temperature increase on the inboard (IB) bearing from ~90°F to ~173°F prior to stabilizing at an operating temperature of ~100 °F
  - Lake temperature ~78 °F
- "B" pump remained in operation or standby for two weeks
  - Pump accumulated > nine days run time
  - Bearing temperatures and pump vibrations were normal
  - Pump stopped/started ten times over two week period

09/30/96

- "B" pump IB bearing inspected and discovered failed
  - Undersized bearing housing (as supplied) prevented bearing axial bearing movement
  - Stainless casing machined to vendor specified tolerances

Event Overview

09-10/99

- Bearing oil in "A" and "B" pumps changed from ISO 22 to a higher viscosity ISO 46 oil (original oil)
  - Reduce outboard thrust bearing wear rates

02/05/00

- Anti-Rotation Device (ARD) Replacement Outage
  - "A" and "B" pump IB bearing temperatures reached alarm set-points when individually placed in DHR mode
  - "A" and "B" pumps declared inoperable
  - Both pumps ran successfully on the BWST
  - DHR continues via Reactor Coolant Pumps (RCPs) and Steam Generators (SGs) satisfying Technical Specification requirements

Event Overview

02/06/00
- Changed oil in “A” pump to ISO 22
  - Successfully tested in service on DHR
  - Declared operable for DHR function
  - DHR continues via RCP/SG
- Changed oil in “B” pump to ISO 22
  - Tested in service on DHR, IB bearing temperature exceeded alarm set-point
  - Secured pump
  - DHR continues via RCP/SG

Event Overview

02/08/00
- Placed "A" pump in DHR service
  - Secured RCPs and SG cooling
  - Cooled RCS to cold shutdown (~190°F/240 psi)
  - Maintained RCP/SG cooling operable per Technical Specifications

02/12-14/00
- Installed IB bearing cooling water isolation valve temporary alteration on "A" and "B" pumps
  - Allowed housing temperature control
- Post modification testing completed and pumps declared operable for DHR

02/14/00
- Plant released for final cooldown/depressurization

Event Overview

03/08-11/00
- RCS filled and pressurized for RCP/SG decay heat removal
- "A" and "B" pump IB bearings modified and cast iron housing installed
- Pumps tested at RCS temperature ~190°F and declared operable for DHR and LPI function

03/11/00
- RCS heated to ~ 265°F
- Pumps tested at RCS temperature of ~265°F with cooling water temperatures 38-120°F
- Plant released for startup

Equipment Failure Analysis and Corrective Actions

Joe Kowalewski

System Engineering Manager, Unit 1

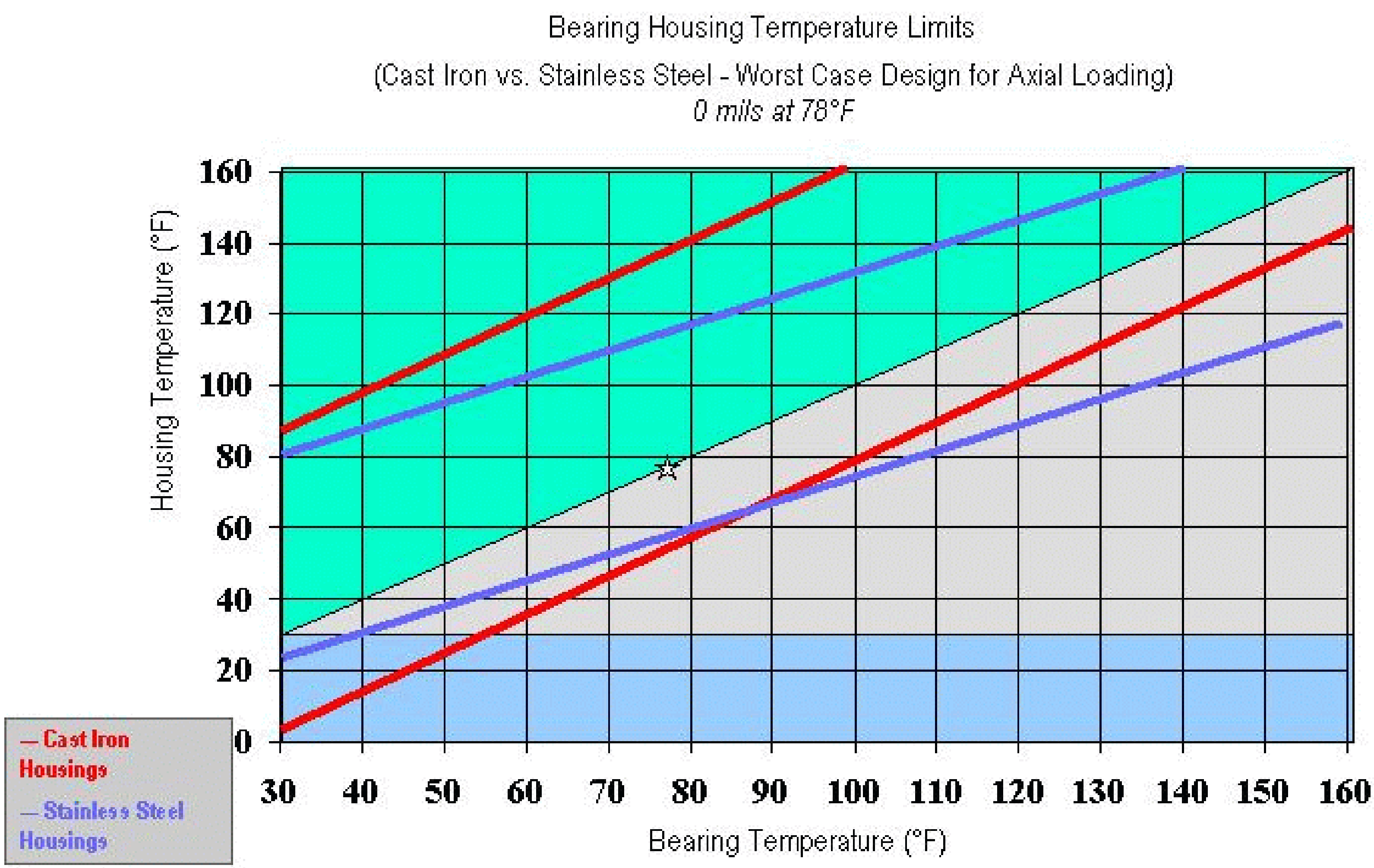
Equipment Failure Analysis

- Original manufacturing specification allowed clearances which would have caused bearing overheating at low SW temperatures
- Change from cast iron to stainless steel reduced design margin
- Pump as-found clearances could have resulted in bearing overheating with either housing material
- Change in oil viscosity caused additional bearing heating at low SW temperatures
- As-left pump condition has provided operating margin for temperature extremes

Failure Mode Analysis Developed

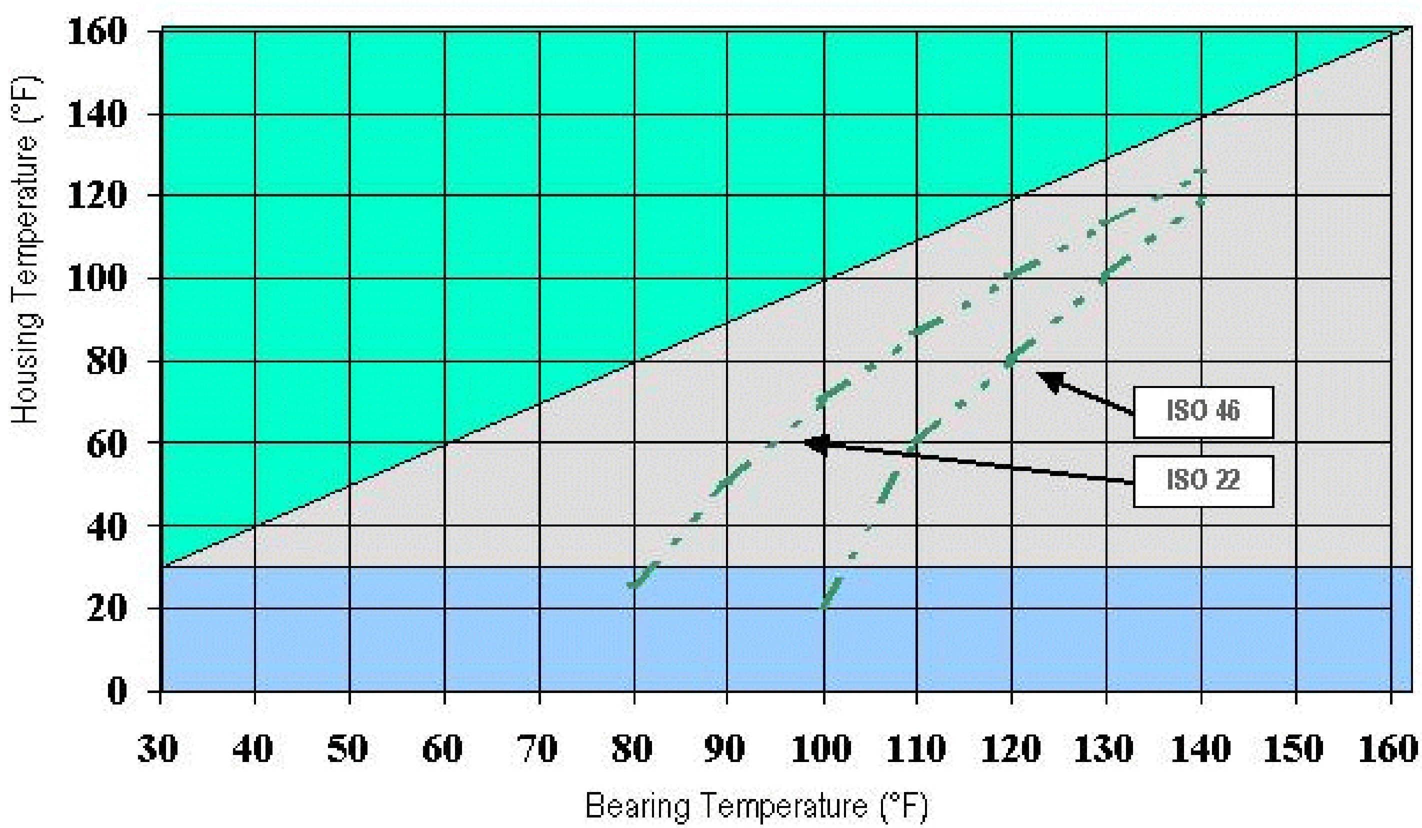
- Cause
  - Insufficient clearance to allow axial movement
    - Relationship to original specified dimensions
    - Relationship to bearing housing material
    - Relationship to oil viscosity
- Original manufacturing tolerances allowed IB bearing outer race to bearing housing clearances to be zero at ambient conditions

Original Specifications

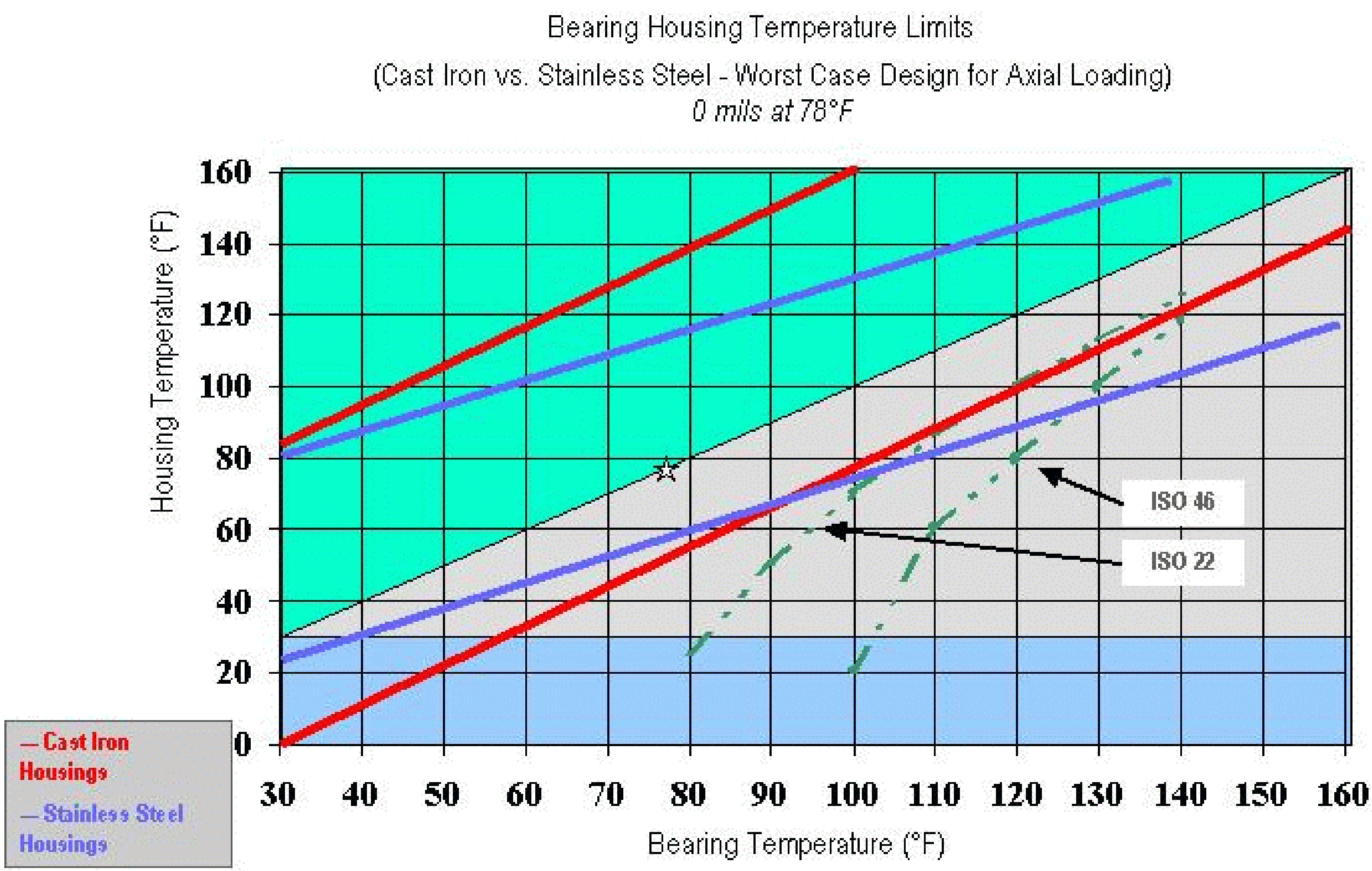


Original Specifications Dimensions

Equilibrium Bearing Temperatures for Specified Oil Type

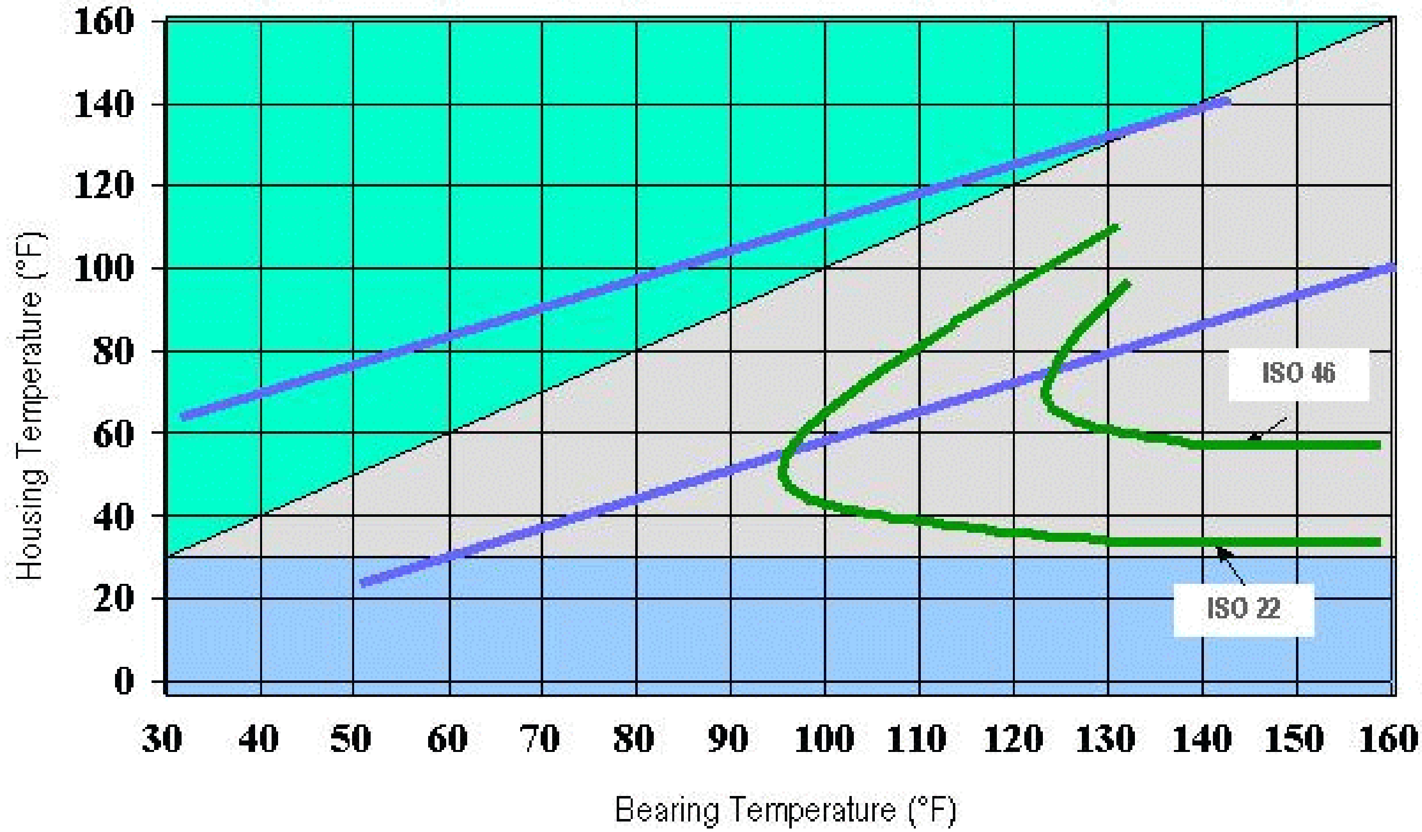


Original Specifications

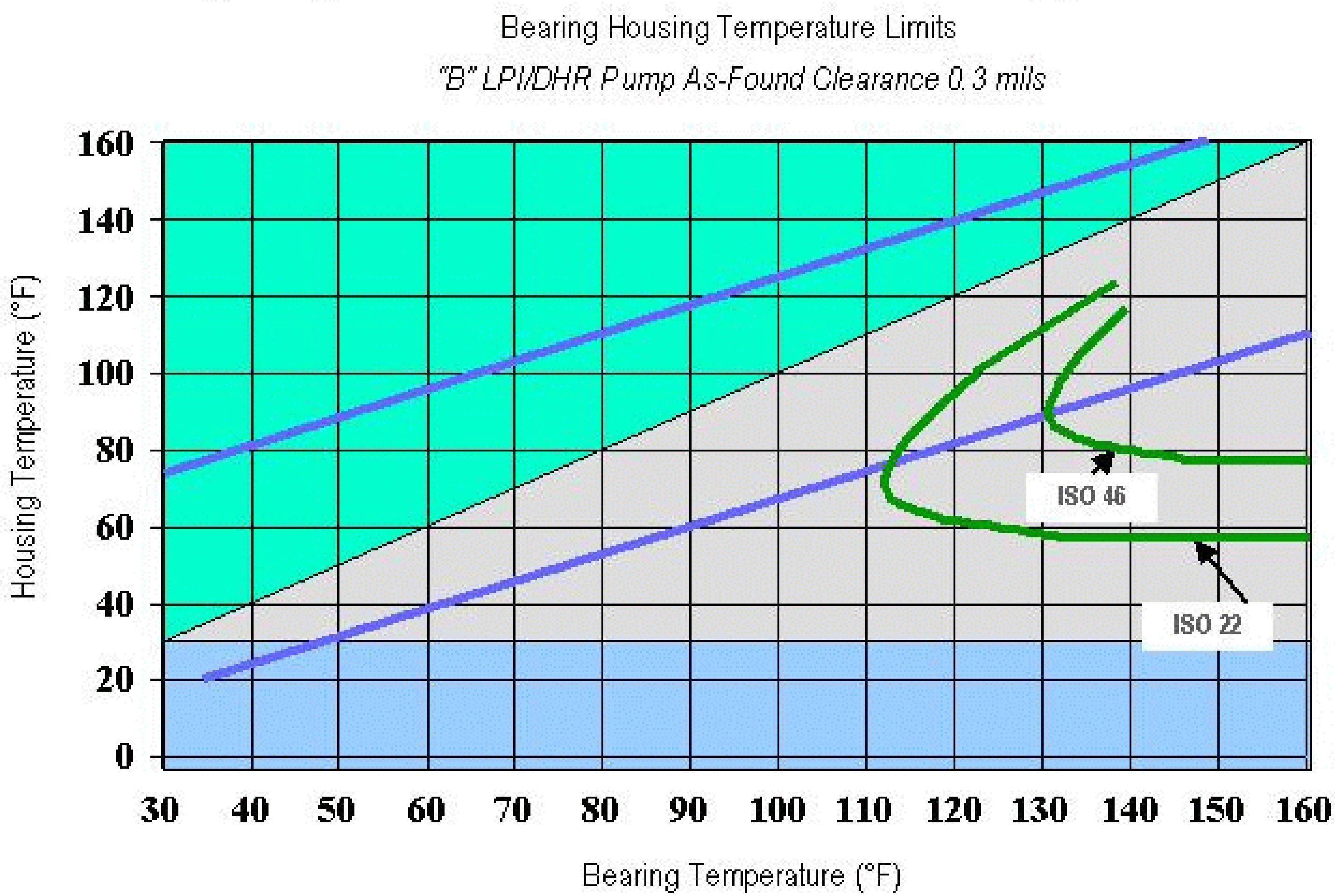


Equipment Failure Analysis

Bearing Housing Temperature Limits
"A" LPI/DHR Pump As-Found Clearance 1 mil



Equipment Failure Analysis



Completed Corrective Actions

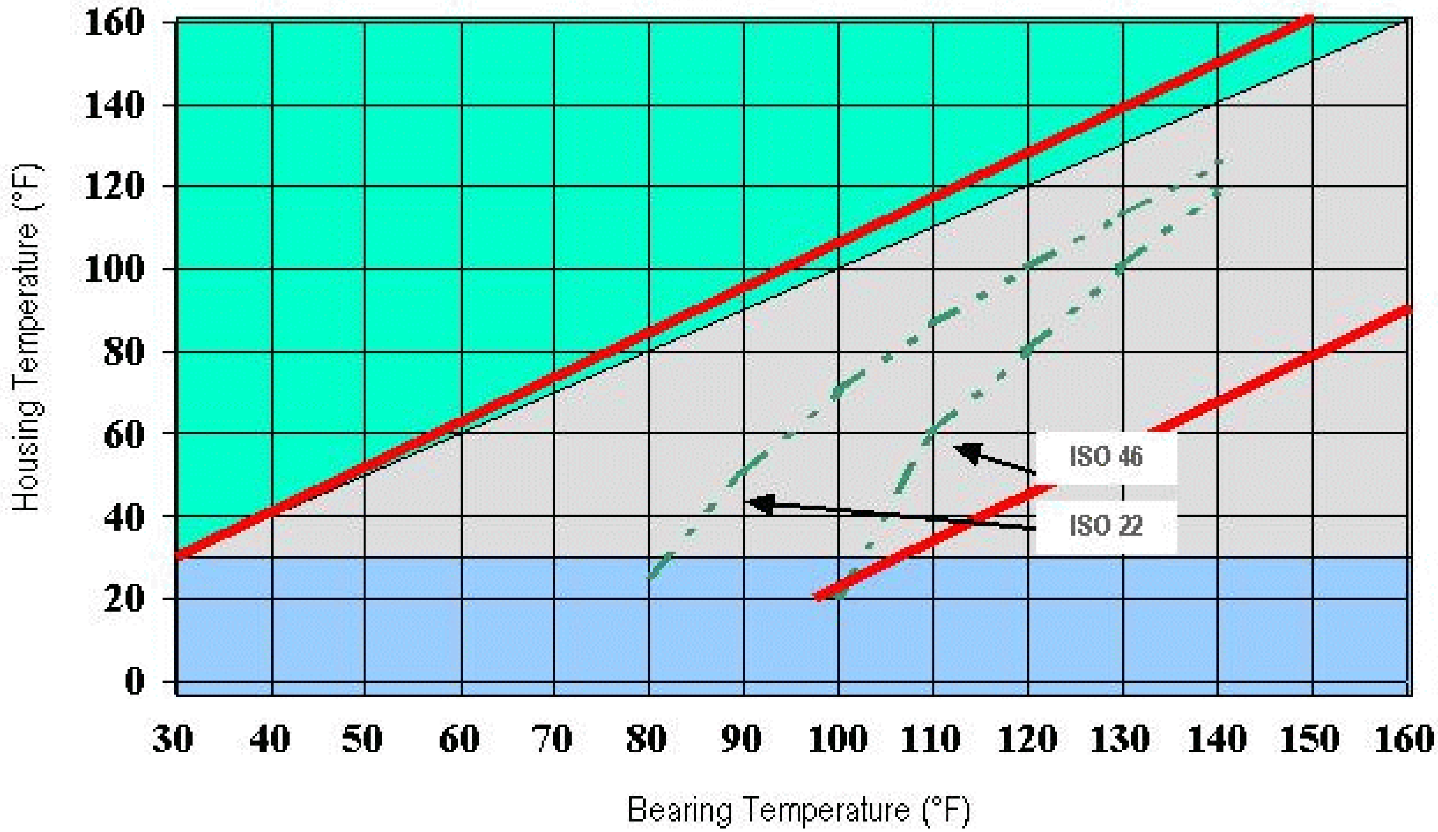
- Immediate Corrective Actions for DHR
  - The bearing oil was replaced with a lower viscosity oil
  - Completely disassembled "B" pump to evaluate all possible causal factors and verify condition and tolerances
  - Replaced the IB bearing for "B" pump establishing acceptable tolerances
  - Installed a temporary alteration to provide a manual valve to control SW cooling to the pump IB bearing housing
    - Revised operating procedures to provide instructions for maintaining IB bearing and bearing housing temperatures utilizing temporary alteration
    - Provided operations with training on the operational consideration associated with the temporary alteration and changes to the operating procedures
    - Completed post modification testing

Completed Corrective Actions

- Corrective Actions for Plant Start-up
  - Analysis was completed to demonstrate that the LPI/DHR pumps are capable of performing the necessary functions over the entire range of potential SW temperatures based upon:
    - Evaluation of lubrication requirements
      - Verified ISO 22 oil is adequate for full range of operating conditions
    - Modification installed on both pumps
      - Returned IB bearing housing to original cast iron material
      - Increased ID of IB bearing housing to in the upper half of the tolerance band
      - Replaced IB bearings with bearings that have larger internal clearances and selected bearing ID to reduce shaft to bearing interference

As-Left Conditions

"A" LPI/DHR Pump As-Left Clearance 1.8 mils at 78°F



Completed Corrective Actions

- Corrective Actions for Plant Start-up (continued)
  - Extensive functional testing
  - Normal surveillance test recirculating BWST
  - Functional test in DHR mode with RCS ~190°F and current SW temperatures ~50°F
  - Functional test in DHR mode with RCS at ~265°F and test rig supplying cooling water
    - Pump ran several hours with cooling water ~38°F
    - Cooling water allowed to increase
    - Pump ran several hours with cooling water ~120°F

Completed Corrective Actions

- Evaluated generic applicability for both Unit 1 and Unit 2
  - Effect of SW temperature from 32-121°F
  - Proper lubrication specified
  - Historical bearing temperature and vibration data
  - Modifications that could have effected system performance at temperature extremes
  - Safety-related equipment evaluated included
    - Emergency Diesel Generators
    - Room coolers and fans
    - Chillers
    - EQ equipment
    - Motor Operated Valves
    - Containment Fans
    - Intake structure fans
    - Large motors
    - Unit 1 High Pressure Injection, Emergency Feedwater, and Reactor Building Spray pumps
    - Unit 2 Low Pressure Safety Injection, High Pressure Safety Injection, Chemical Volume and Control System, Emergency Feedwater, and Containment Spray pumps

Long-Term Corrective Actions

- Change maintenance procedures and tasks for bearing change-outs to ensure critical tolerances on pump components are maintained
- Evaluate and determine long-term solution for both LPI/DHR pumps to provide added margin for critical tolerances

Summary

- Identified the cause of the bearing overheating
  - Potential for condition existed due to original design parameters
  - Change from cast iron to stainless steel reduced design margin
  - Oil viscosity change caused additional bearing heating
  - Condition could have occurred with cast iron at as-found clearances
- Broad and comprehensive corrective actions taken
- Restored the pumps to an acceptable configuration with operating margin and successfully tested to operating extremes
- Valuable lessons learned gained from this condition
- Applied lessons learned to a comprehensive review of safety related equipment for generic applicability

Programmatic Root Cause and Corrective Actions

Rick Lane

Director Engineering

Root Cause

- Original design inadequate
  - The design allowed ranges in bearing size, oil viscosity, and bearing housing bore diameter that, when combined with variations in cooling water temperatures, could result in inadequate clearances between the bearing and bearing housing
    - Inadequate original design specifications
      - Original pump specification listed 85°F maximum temperature requirement
        - Did not specify minimum
      - Vendor technical manual listed bearing temperature of 32°F to 150°F
    - Sliding radial bearing understanding
      - Intuition erroneously indicates that colder cooling water should be better
      - ANO and pump vendors did not have detail technical understanding of sliding radial bearing design requirements
      - Original pump vendor designed pumps such that at extreme of allowed tolerances interference fits could result at operating conditions

Root Cause

- Contributing Cause
  - Inadequate review of design change
    - Replacement stainless steel housings were installed without adequately considering the entire operating range of cooling water supplied to the pump
  - Discussion
    - Occurred in 1992
    - Utilized Plant Change Process (not as rigorous as current process)
    - Did not specify design details
    - Vendor provided Certificate of Conformance without rigorous evaluation
    - Vendor does not have original specifications and analysis (i.e., not original equipment manufacturer)

Root Cause

- Contributing Cause
  - Inadequate review of design change
    - The bearing oil in both LPI/DHR pumps was changed without ensuring capability with specified service conditions
  - Discussion
    - Engineering reply utilized to document change
    - Oil specified was listed in the vendor technical manual
    - Heavier viscosity oil originally used in pumps
    - Coordinated with plant with similar pumps
    - Discrepancy in vendor technical manual between specified oils and viscosity range recommendations
    - Rigorous lube application evaluation not done

Corrective Actions

- Provide engineering training on radial bearing design considerations (including operations and maintenance)
- Revise processes and provide appropriate training to help ensure:
  - Equipment modifications which do not change form, fit, and function of original equipment are consistent with the original design requirements
  - Adequacy of original design specifications when specified
  - When specifying equipment modifications, that the entire operating range of the process system as well as support systems, such as cooling water, are included
  - Engineers challenge vendor recommendations and ensure vendors understand all equipment operating conditions
  - Ample internal clearances exist when making changes to rotating equipment

Corrective Actions

- Strengthen guidance on post modification testing to ensure that it covers the entire system operating range as well as support systems
  - If testing the full range is not reasonable, define actions to ensure equipment will operate satisfactorily
- Evaluate the vendor qualification program relative to restrictions when vendors lack original specifications and analysis
- Change lubrication program to require engineering evaluations vs. replys for lube oil changes (including critical characteristics checklist)
- Update documentation to reflect design requirements
- Enhance safety system functional assessment guidance to improve component level design reviews
- Issued operating experience report to industry on bearing/temperature concerns

Related Engineering Initiatives

- Engineering human performance impact on equipment reliability
  - Root cause analysis efforts not consistent
  - Performance monitoring weak at times
  - Design change and vendor interface problems periodically identified
- Enhancements
  - Root cause analysis training being provided to additional personnel
  - Purchased equipment failure modes handbook and will train to improve analysis process and techniques on component problem evaluations
  - Provide Kepner-Tregoe problem solving and decision making training
  - Modifying performance monitoring section of the System Engineering Deskguide

Related Engineering Initiatives

- Enhancements (Continued)
  - Conducted engineering human performance stand down
    - Reviewed lessons learned from prior problems/concerns
    - Defined engineering human performance expectations
    - Identified action items (examples follow)
      - Define core business and strategic initiatives relative priority
      - Expand scope/use of the Design Review Committee
      - Capture and trend low level items
      - Provide human performance training
      - Participation in new site human performance team

Summary

- Root cause
  - Original design inadequate
    - Inadequate original design specifications
    - Sliding radial bearing understanding
- Broad and comprehensive corrective actions and follow-up
- Engineering aggressively addressing improvements from a broad perspective

Safety Significance
Expert Panel Results

Milton Huff

Supervisor, Design Engineering

Expert Panel Overview

- Purpose was to organize an engineering and technical staff to evaluate the effect of a radial bearing failure on LPI/DHR pump operation
- This presentation will show that the LPI/DHR pump would function with a failed radial bearing

Expert Panel

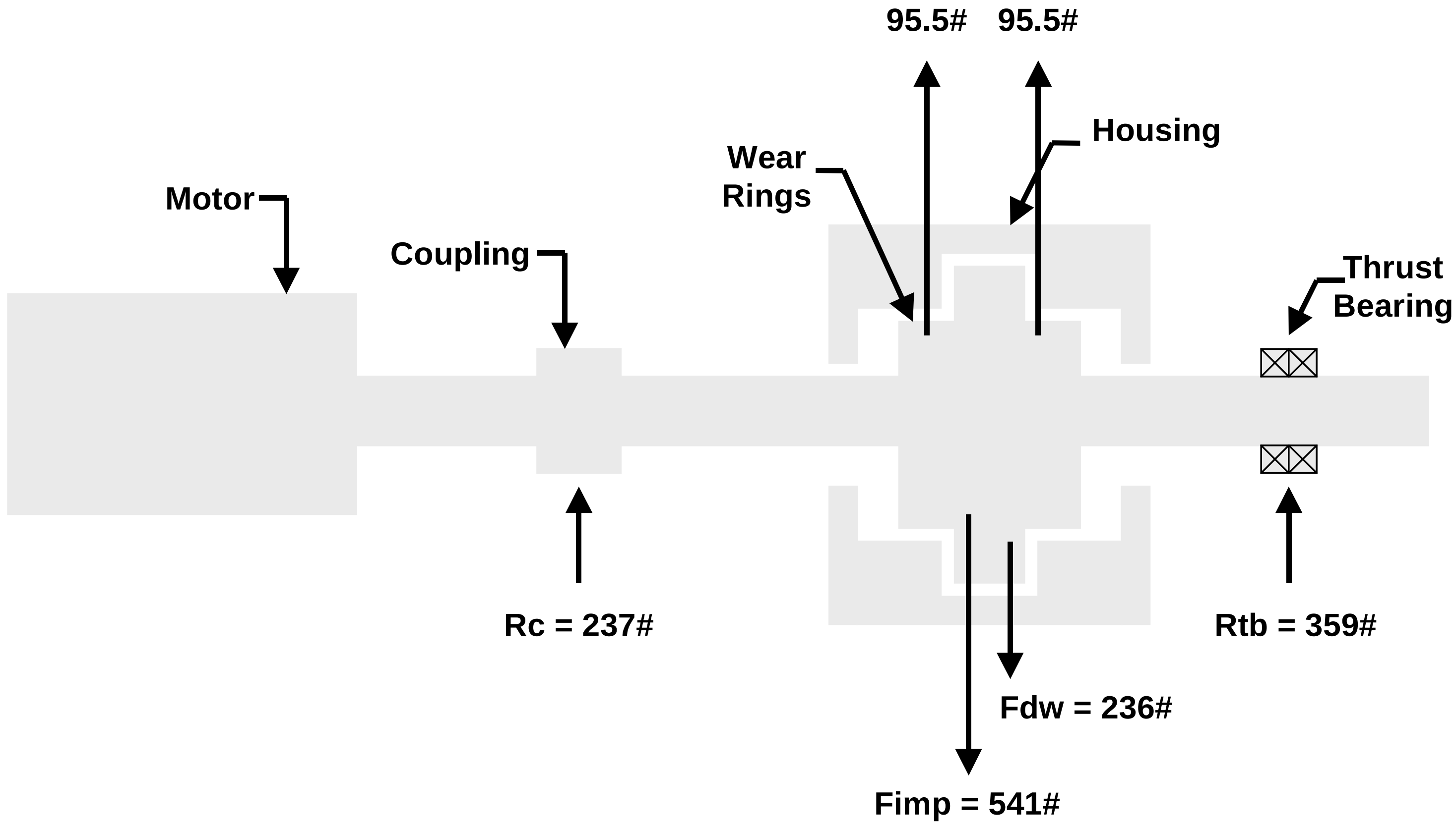
- Expert panel organizations involved in the assessment
  - Mechanical Civil Structural Engineering
  - Nuclear Safety Analysis
  - Operations
  - University of Virginia
  - MPR Associates
  - Coupling manufacturer

Expert Panel

- Determine probability of pump operation through radial bearing failure
- Expert Panel Process
  - Evaluate the capability of the LPI/DHR pump to perform its function with the radial bearing failure
    - Mechanical analysis of pump components
      - Components analyzed
        - Coupling
        - Thrust bearing
        - Wear rings
        - Pump shaft
        - Motor bearing
      - Current pump vendor provided initial input
    - Determine impact on pump operation
    - Assess probability of LPI/DHR pump operation by using fault tree

LPI/DHR Pump without Radial Bearing

Dynamic Loads at 1750 RPM



Expert Panel

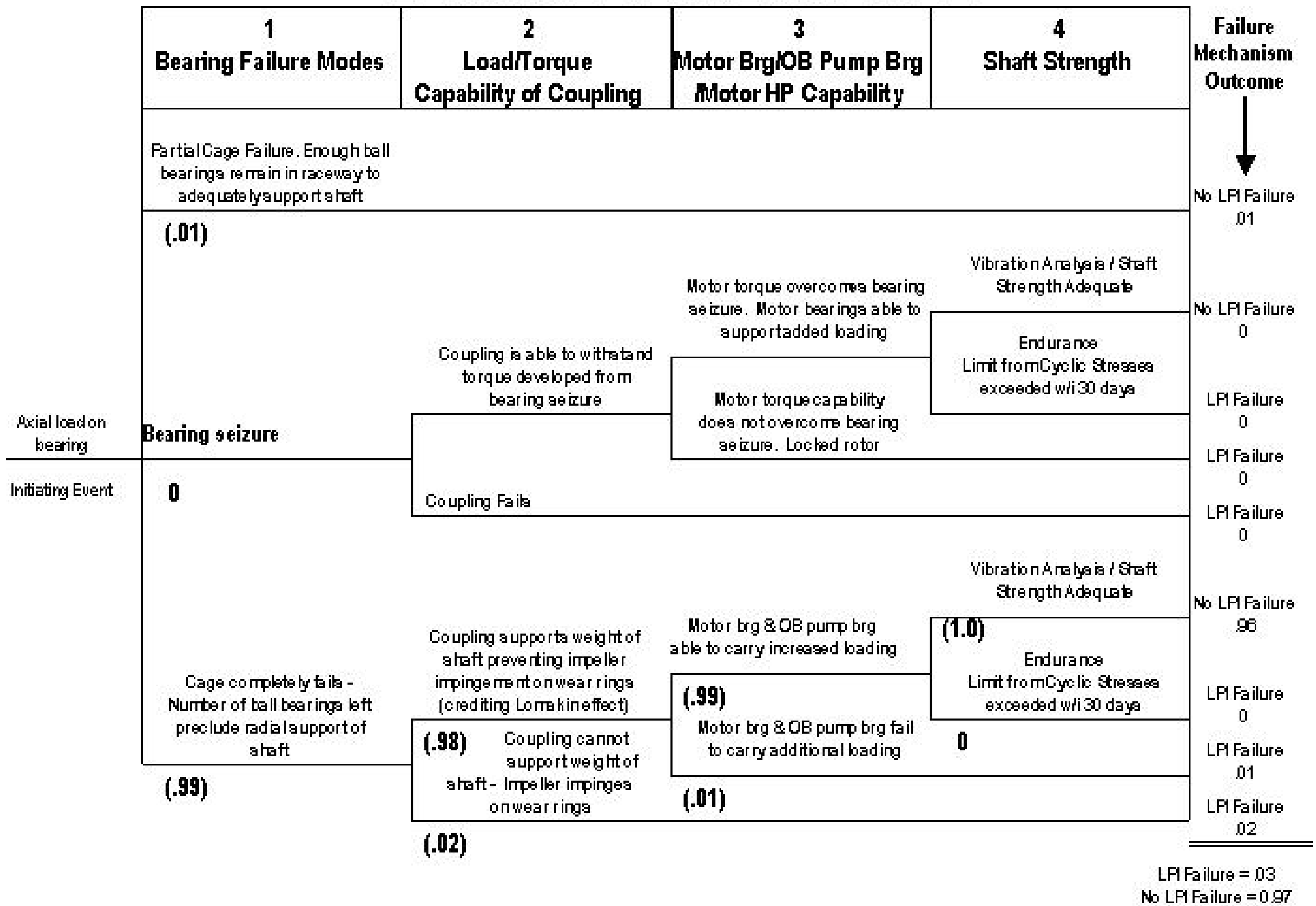
Mechanical Evaluation of effects of a failed radial bearing

	Calculated	Allowed
Shaft bending stresses	1,782 psi	20,000 psi
Static shaft deflection Dynamic shaft deflection	14.5 mils 6.6 mils	14.5 mils 14.5 mils
Fatigue analysis	8,234 psi	24,000 psi @ 10^8 cycles (38 days)
Coupling load Coupling torque	237# 12,000 in # (full load)	400# 16,000 in # (rated)
Critical speed	4,477 rpm (running speed = 1,750 rpm)	>2,013 rpm
Unbalanced response	0.26 mils	1.6 mils
Motor bearing load	76 psi	300 psi
Thrust bearing load (net)	359#	20,000#
Hydraulic Centering Force	191#	n/a

Expert Panel

- Mechanical Conclusions
  - Shaft design can accommodate loading and vibration without radial bearing
  - Hydraulic effect at the wear ring adds support to the shaft
  - Coupling is self centering and can carry analyzed load
  - Motor bearing can carry extra load
  - No significant pump degradation
  - No significant performance degradation
- Dynamic analysis shows that the pump would continue to run including multiple starts and stops for greater than 30 days
- 1996 bearing failure and subsequent pump operation supports the conclusion reached above and serve as empirical evidence of what the expert panel predicted analytically
  - Pump operation not impeded during bearing failure
  - Bearing temperatures and pump vibrations were normal after bearing failure
  - Pump stopped/started ten times over two week period
  - Pump accumulated > nine days run time

Fault/Decision Tree



Summary

- DHR/LPI pump analysis, expert panel results, and 1996 empirical data, provide reasonable assurance the pump would have been capable of performing specified function

Safety Significance
Risk Significance

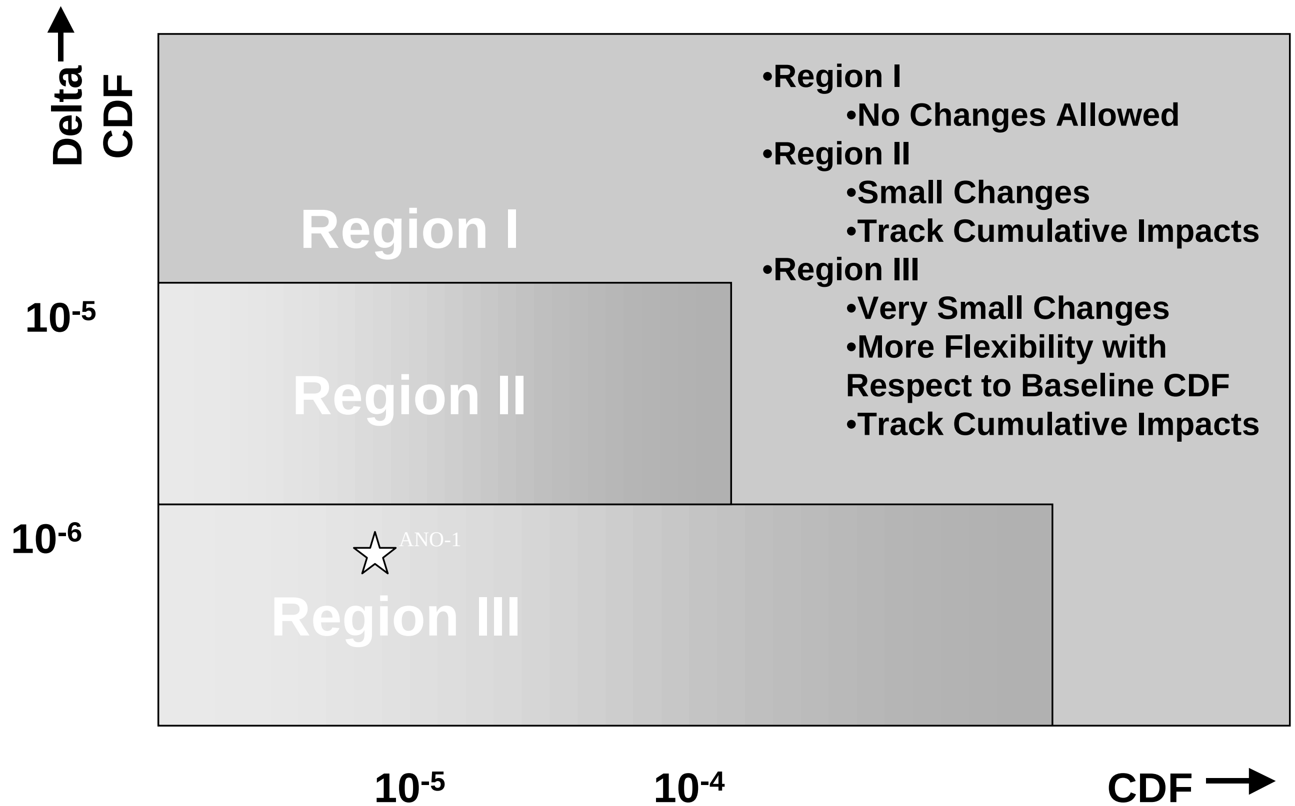
Mike McKinney

Superintendent, Reactor Engineering

Risk Significance

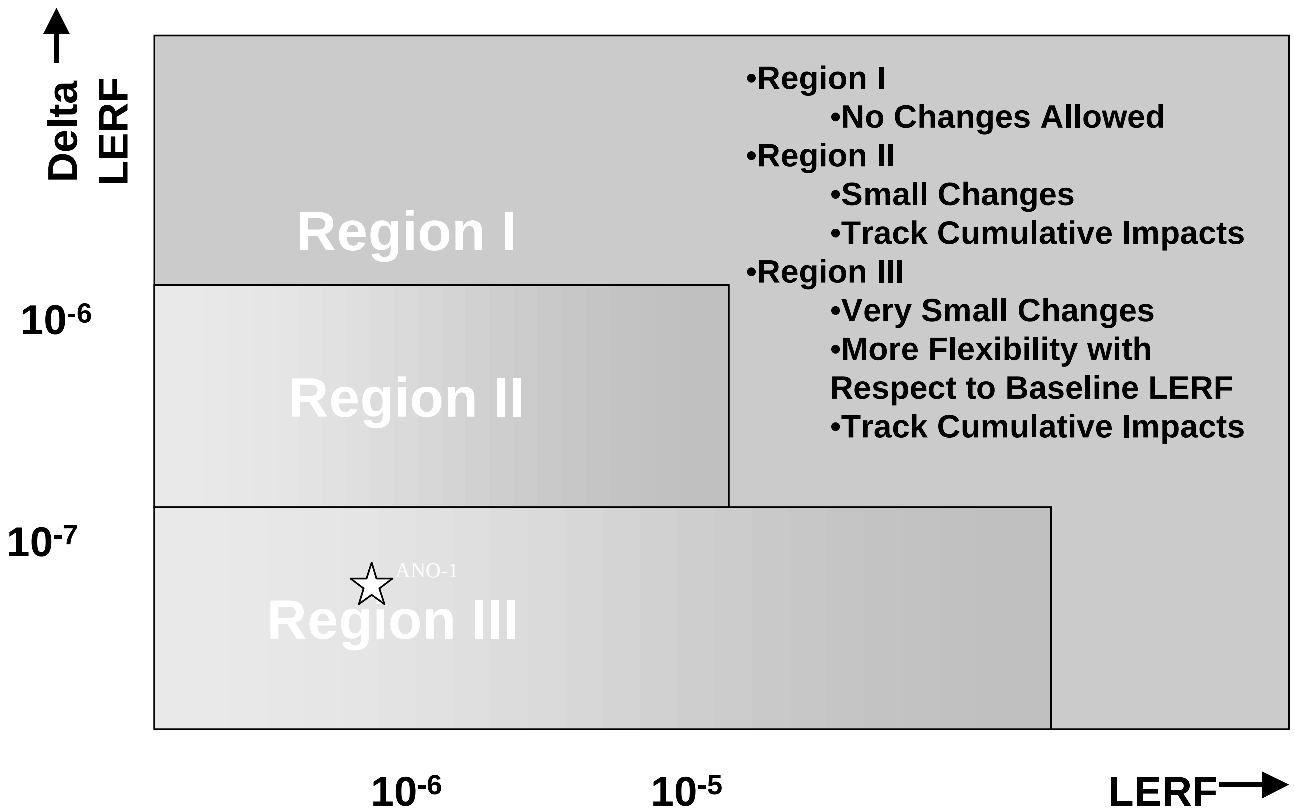
- Primary Objective
  - Used the ANO-1 Updated PSA Model to assess the risk significance of the LPI/DHR IB pump bearing being susceptible to failure
- Results
  - Due to limited impact on the LPI/DHR pump failure probability, the resulting total Core Damage Frequency (CDF) is 9.7E-06 per reactor year and the total CDF increase is 7.7E-07 per reactor year
  - The CDF and Delta-CDF falls within Region III of RG 1.174 and is not significant
  - The Large Early Release Frequency (LERF) was qualitatively assessed to also be within Region III of RG 1.174. The resulting LERF is 6.8E-07and the LERF increase is 5.7E-08 per reactor year
- Conclusion
  - The Unit 1 LPI/DHR pump susceptibility to IB bearing binding was not risk significant

Core Damage Frequency



RG 1.174 Acceptance Guidelines for Core Damage Frequency

Large Early Release Frequency



RG 1.174 Acceptance Guidelines for Large Early Release Frequency

Risk Significance

- The PSA Model Risk Assessment considered the most recent past reactor year of operation for consistency with the basis of the PSA Model and the per reactor year guidance of RG 1.174
- The PSA Model assumes the use of LPI/DHR pumps for three modes of operation:
  - LPI from the BWST to the reactor vessel,
  - Low pressure recirculation from the reactor building sump to the reactor vessel, and
  - DHR when necessary to remove decay heat by a means other than the SGs

Input to the PSA Model Risk Assessment

- Probabilistic Input
  - Expert panel probability value provides reasonable assurance pump would have been capable of performing specified function
- Deterministic Input
  - Actual performance and history of the LPI/DHR pumps
  - Calculations were used to determine when to apply a 3% failure probability based on the following information:
    - Axial clearances in the pump
    - Oil viscosity effects
    - SW temperature effects
    - Mode of pump operation
  - Actual temperature data for the SW during the most recent reactor year of operation
  - Operators are not allowed to secure both LPI/DHR pumps, if in ES mode, with high bearing temperature

PSA Model Input Summary

- Injection mode of operation
  - LPI pump injection from the BWST was not affected
- DHR mode of operation
  - Use previous actual pump performance history with ISO 22 oil
    - Successful performance with high RCS temperature was demonstrated:

      for the “A” LPI/DHR pump with SW temperature of 42°F,

      for the “B” LPI/DHR pump with SW temperature of 60°F,

      and indicating the ability of the IB bearing to slide in the IB bearing housing
  - Use calculations to determine service water temperature at which bearing will slide with ISO 46 oil
    - Calculations indicate that the IB bearing will slide in the IB bearing housing for the “A” LPI/DHR pump with SW temperature in excess of 68°F, but that the observed SW temperatures were too low for the “B” LPI/DHR pump IB bearing to slide

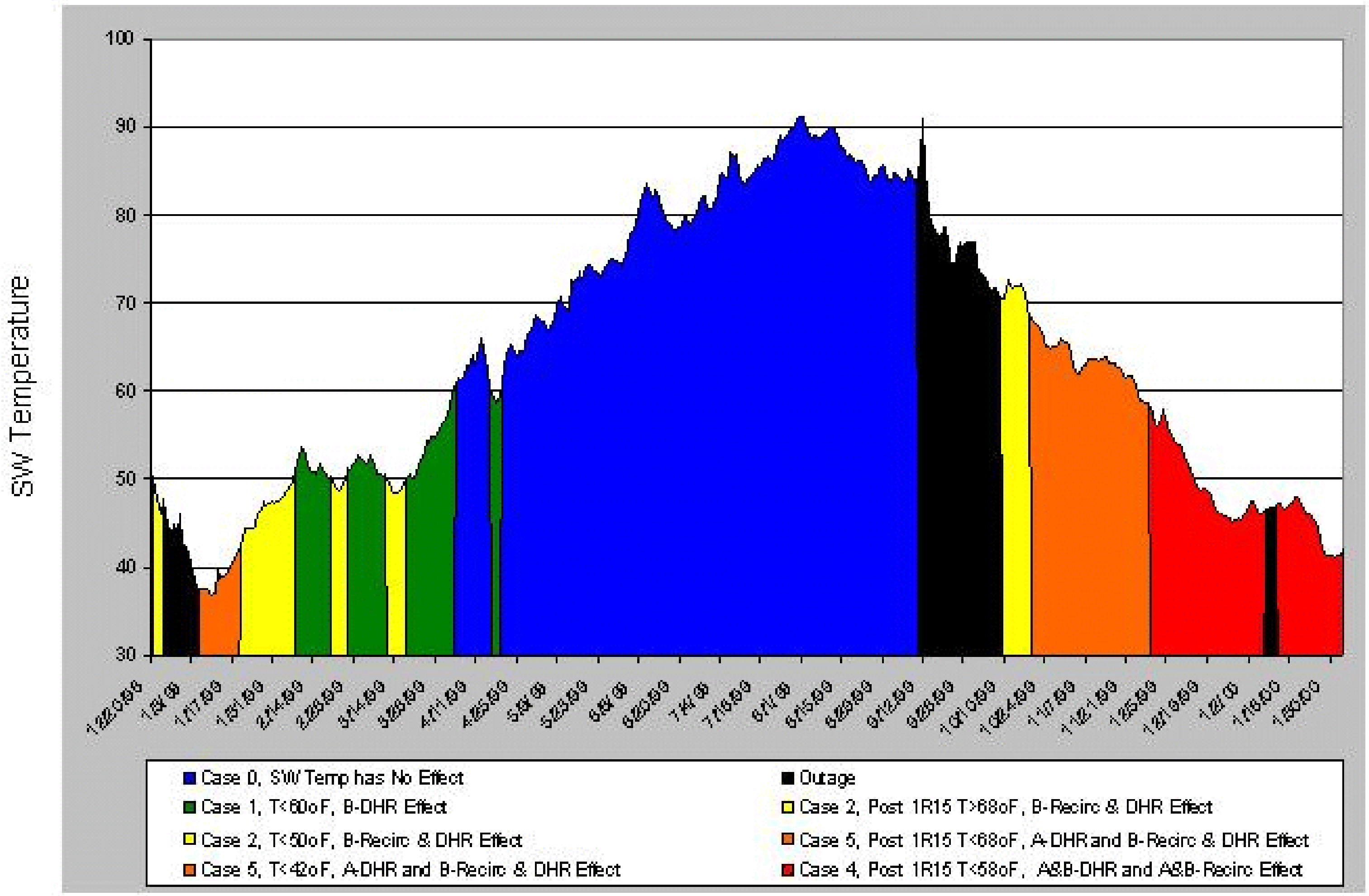
PSA Model Input Summary

- LPI recirculation mode of operation
  - Use previous actual pump performance history with ISO 22 oil
    - Successful performance with high RCS temperature was demonstrated:
      for the “A” LPI/DHR pump with SW temperature of 42°F, and
      for the “B” LPI/DHR pump with SW temperature of 60°F
  - Use calculations to determine the SW temperature at which bearing will slide while taking advantage of pre-heat of the bearing housing during the injection mode of operation
    - Calculations indicate that the IB bearing will slide in the housing:
      for the “A” LPI/DHR pump with SW temperature in excess of 32°F, and
      for the “B” LPI/DHR pump with SW temperature in excess of 50°F
  - Use calculations to determine service water temperature at which bearing will slide with ISO 46 oil and pre-heat of the bearing housing
    - Calculations indicate that the IB bearing will slide in the housing:
      for the “A” LPI/DHR pump with SW temperature in excess of 58°F, but the observed SW temperatures were too low for “B” LPI/DHR pump IB bearing to slide

PSA Model Runs

- A matrix of conditions were identified for which the PSA Model would be run
  - Case 0 - Both LPI/DHR pumps are not affected
  - Case 1 - “B” pump DHR mode affected
  - Case 2 - “B” pump DHR and recirculation modes affected
  - Case 3 - “A” and “B” pumps DHR mode affected (enveloped in Case 5)
  - Case 4 - “A” and “B” pumps DHR mode affected and “A” and “B” pumps recirculation modes affected
  - Case 5 - “A” pump DHR mode and “B” pump DHR and recirculation modes affected
- The above cases were then applied to the temperature data for the past reactor year of operation

Risk Significance Case Input



Summary

- CDF Increase:
  - The CDF and Delta-CDF falls within Region III of RG 1.174
  - Use of Reactor Building Spray pumps and other less proceduralized mitigating actions are not credited in this risk significance conclusion
- LERF Increase
  - The LERF was qualitatively assessed to also be within Region III of RG 1.174
- Low risk significance

Enforcement Perspective

Dale James
Manager, Licensing

Enforcement Perspective
Apparent Violations

Violation A

- Two examples of inadequate engineering evaluations which constitute a failure to properly implement measures for the selection and review for suitability of application of material, parts, and equipment that are essential to the safety-related function of the structures, systems, and components covered by 10CFR50, Appendix B (LPI/DHR). This is an apparent violation of 10CFR50, Appendix B, Criterion III.
  - Stainless steel bearing housing installation in 1992
  - Bearing oil change from ISO 22 to ISO 46 in 1999

Violation B

- Due to the conditions in violation “A”, the “A” and “B” LPI/DHR pumps were not able to perform their intended safety function because of bearing temperature problems at SW temperatures below 42°F. From January 28 to February 5, 2000, the SW temperature was below 42°F. This is a violation of Technical Specification 3.3.1(D) which requires both pumps to be operable when: (1) RCS pressure is 300 psig or greater, (2) reactor coolant temperature is 200°F or greater, and (3) nuclear fuel is in the core.

Enforcement Perspective

Apparent Violation B

- Definition of Operable
  - ANO-1 Technical Specifications
    - A component is OPERABLE when it is capable of performing its specified function(s)
  - NRC Inspection Manual, Part 9900, “OPERABLE/OPERABILITY”
    - If "system capability is degraded to a point where it cannot perform with reasonable assurance or reliability, the system should be judged inoperable..." (3.3)
    - "The operability decision may be based on analysis, a test or partial test, experience with operating events, engineering judgment, or a combination of these factors taking into consideration equipment functional requirements." (6.1)
    - "The determination process ... must be predicated on the licensee's reasonable expectation that the SSC is operable..." (6.8)

Enforcement Perspective

Apparent Violation A

- Entergy admits a failure to complete adequate engineering evaluations for the replacement of the cast iron bearing housing with a stainless steel housing and the change in lubricating oil viscosity
- These failures did not result in the LPI/DHR inoperability

Enforcement Perspective

Apparent Violation A

- Actual Safety Consequences
  - None
- Potential Safety Consequences
  - Detailed risk evaluation performed to determine differential –CDF per guidance in Regulatory Guide 1.174
  - Risk evaluation show low safety significance

Enforcement Perspective

Apparent Violation A

- Conclusion
  - Enforcement Policy Supplement I - Severity Level IV Violations
    - A failure to meet regulatory requirements that have more than minor safety or environmental significance
    - Low safety consequences
  - Discretion should be applied
    - Comprehensive root cause evaluation
    - Broad and comprehensive corrective actions
      - Compliance restored
    - Not willful
  - May be classified as a non-cited violation

Conclusions

Craig Anderson
Vice-President, ANO

Enclosure 3

NRC Handouts

PREDECISIONAL ENFORCEMENT CONFERENCE AGENDA

CONFERENCE WITH ENTERGY OPERATIONS, INC. (EOI)

ARKANSAS NUCLEAR ONE, UNIT 1

MAY 8, 2000

NRC REGION IV, ARLINGTON, TEXAS

1.	INTRODUCTIONS & OPENING REMARKS - NRC	ELLIS MERSCHOFF REGIONAL ADMINISTRATOR
2.	APPARENT VIOLATIONS & REGULATORY CONCERNS - NRC	KEN BROCKMAN DIRECTOR, DIVISION OF REACTOR PROJECTS
3.	ENFORCEMENT PROCESS - NRC	GARY SANBORN DIRECTOR, ALLEGATIONS AND ENFORCEMENT STAFF
4.	LICENSEE PRESENTATION - EOI	CRAIG ANDERSON VICE PRESIDENT, OPERATIONS
5.	NRC CAUCUS (APPROXIMATELY 10 MINUTES)	
6.	RESUMPTION OF CONFERENCE	
7.	CLOSING REMARKS - EOI	CRAIG ANDERSON VICE PRESIDENT, OPERATIONS
8.	CLOSING REMARKS - NRC	ELLIS MERSCHOFF REGIONAL ADMINISTRATOR

APPARENT VIOLATIONS*

PREDECISIONAL ENFORCEMENT CONFERENCE

ENTERGY OPERATIONS, INC.

ARKANSAS NUCLEAR ONE, UNIT 1

MAY 8, 2000

**NOTE: THE APPARENT VIOLATIONS DISCUSSED AT THIS PREDECISIONAL ENFORCEMENT CONFERENCE ARE SUBJECT TO FURTHER REVIEW AND MAY BE REVISED PRIOR TO ANY RESULTING ENFORCEMENT ACTION.*

APPARENT VIOLATION

1. Unit 1 Technical Specification 3.3.1.D requires, in part, that two engineered safety feature actuated low pressure injection pumps shall be operable whenever containment integrity is established as required by Specification 3.6.1.

   Contrary to the above, from January 28 to February 5, 2000, a period when the temperature of the cooling water supplied to the bearings of the low pressure injection pumps was less than or equal to 42°F, a combination of inappropriate bearing housing material, high viscosity lubricating oil and low cooling water temperature resulted in both low pressure injection pumps being inoperable.

THIS APPARENT VIOLATION IS SUBJECT TO FURTHER REVIEW AND MAY BE REVISED

APPARENT VIOLATION

2. 10 CFR 50 Appendix B, Criterion III states, in part, that measures shall be established for the selection and review for suitability of application of materials, parts, equipment and processes that are essential to the safety-related functions of the structures, systems, and components.

   Contrary to the above, on two occasions the measures that were established for the selection and review for suitability of application of materials, parts, equipment and processes that are essential to the safety-related functions of the low pressure injection system failed to ensure that the system would be capable of performing its safety-related function.

   1. In 1992, stainless steel bearing housings were installed to replace the original carbon steel housings. This was done to minimize corrosion on the cooling water side of the housings. The housings had a greater coefficient of thermal expansion and a lower heat transfer coefficient than the original cast iron housings. The engineering evaluation completed for this design change failed to consider the greater thermal expansion of the new material and, as a result, did not identify the potential affect the change to the new material would have on pump internal clearances

   2. In September 1999, the bearing oil in the pumps was changed from ISO 22 to a higher viscosity oil, ISO 46. This change was initiated to reduce the wear on bearings, thereby increasing bearing life. The engineering evaluation for this change in oil type failed to identify that the higher viscosity oil would increase the heat generation in the bearing and cause greater thermal expansion of the bearing race. As a result of this change, internal clearances became critical to the performance of the pumps. The engineering evaluation for the change in oil viscosity was not thorough and did not adequately consider the thermal characteristics of the lubricant and the resultant impact on the inboard bearing performance.

THIS APPARENT VIOLATION IS SUBJECT TO FURTHER REVIEW AND MAY BE REVISED

Enclosure 4

Page 6 of NRC Inspection Report 50-313/00-04; 50-368/00-04 from the higher temperature of the shaft, could cause an interference that prevents the bearing from sliding axially in the housing. The contraction of the housing and expansion of the shaft could also result in the loss of clearance between the inner and outer bearing races. The licensee concluded that the primary conditions that were all necessary for the pumps to become inoperable were: (1) original equipment design specification did not include the cooling water temperature range, and (2) the bearing housing material was changed without adequate technical review. The licensee noted that a secondary contributing factor was the changing of the bearing oil to higher viscosity oil (ISO 22 to ISO 46).

The inspectors reviewed the evaluation completed by the licensee with respect to determination of the root cause of the high bearing temperatures. Based on this review, the following observations were made:

- The licensee stated that the basic root cause was the original design of the pumps. Specifically, the problem involved the allowed vendor tolerances for the pump component and assemblies. The licensee determined that, even if the pump was assembled within the tolerances specified by the vendor, the pump may not have operated within the full range of cooling water temperatures that it would experience.

  The inspectors acknowledged that the vendor tolerances for clearances of parts in the pump were not adequate for the range of cooling water temperatures the pump could experience. However, the inspectors also noted that both pumps had historically performed well in service for the decay heat removal function. It was not until a different material for the bearing housing and a different viscosity oil was introduced by the licensee that the pump experienced problems.

- In 1992, when the carbon steel bearing housing was replaced with a stainless steel housing, there was an opportunity to identify the problem with internal clearances in the pump. After the new bearing housings were installed, Pump P-34B was operated and high bearing temperatures were experienced during a surveillance test. No action was taken to identify the reason for the temperature problem.

- In 1996, the bearing temperature on Pump P-34B increased and then stabilized. The pump was operated a number of times over the next 2 weeks and was then inspected. The bearing was found to have failed. At that time, the licensee identified that internal pump clearances were critical to the proper functioning of the pump. However, actions were not taken to address all the potential causes for this problem, which included installation of the stainless steel bearing housing in 1992.

- In 1999, the bearing oil was changed to a higher viscosity oil to reduce wear on pump bearings. This change resulted in increased heat generation in the