Docket Nos.: 50-528, 50-529 and 50-530

APR 27 1984

APPLICANT: Arizona Public Service Company

FACILITY: Palo Verde, Units 1, 2 and 3

SUBJECT: SUMMARY OF MEETING CONCERNING TESTING OF PALO VERDE COMPONENTS

A meeting was held on March 20, 1984 in Bethesda, Maryland with representatives of the applicant and Combustion Engineering (CE). The purpose of the meeting was to provide the staff with (1) an updated status on the evaluations of the hot functional testing anomalies which occurred at Palo Verde Unit 1 and (2) a discussion of the problems encountered with the Low Pressure Safety Injection (LPSI) pumps. (Previous status reports on the hot functional testing evaluations were presented at meetings held on August 17 and October 12, 1983.) Enclosure 1 lists the attendees for the meeting and Enclosure 2 includes the viewgraphs used during the presentation. The meeting is summarized as follows.

Thermal Sleeves

The applicant has completed the removal of the thermal sleeves from Palo Verde Units 1 and 2. In addition to the thermal sleeves in safety injection lines (4 sleeves per unit), the applciant also removed the sleeve from the pressurizer surge line since the usage factor in this line without the sleeve in is also significantly below 1, as is the case with the safety injection lines. The thermal sleeve in the charging line will remain.

The applicant stated that it would submit additional information to the staff relating to the removal of the presurizer surge line thermal sleeves.

Thermowells

Testing of the modified thermowell design at the CE facilities has been completed. The results showed that (1) the natural frequency of the thermowell tip is about 2400 hertz, (2) a vortex shedding frequency of about 700-800 hertz occurs at the 70 to 80 ft/sec flow range, (3) vortex shedding loads were absorbed without causing overstress or fatigue, and (4) no wear occurred.

Installation of the modified thermowell design has been completed in Palo Verde Units 1 and 2. This design will be checked out as part of the objectives of the demonstration test to be performed on Palo Verde Unit 1 in June 1984.

RCS Pumps

Testing of the modified full scale prototype pump has been completed at the CE facilities. The results indicated that the modified design showed that (1) there was no evidence of cavitation, (2) diffuser bolt strains were significantly reduced, (3) there was no indication of any defects in the impeller as a result of testing, and (4) hydraulic performance met design requirements.

Following installation of the modified pumps in Unit 1, the modified design will also be checked out during the plant demonstration test to be performed in June 1984.

CES Shrouds

The hydraulic and mechanical tests of the CEA shroud tubes and assembly have been completed at the CE facilities. The results indicated that (1) hydraulic forces did not contribute to shroud cracking, (2) vibration testing of the original design revealed that the CEA guide and tube frequencies are in the range of the RCS pumps blade passing frequency and in the frequency range of the upper guide structure tube sheet, and (3) excitation tests of the modified guide tube design showed that the CEA guide frequency was eliminated.

The staff raised questions about the observed stress corrosion cracking in the Unit 1 shroud assembly and pointed out that the shielded metal arc welding process, which was used in the root pass for this component, would contribute to generating such cracks. CE pointed out that the modified CEA shroud assembly for Unit 1 is a different component than the cracked assembly that was removed, and that shielded metal are welding was not used for root passes in the new assembly.

Following installation of the modified CEA shroud assembly in Unit 1, the plant demonstration test will be used to check out its performance.

Demonstration Test

The applicant plans to run a test at Palo Verde Unit 1 to demonstrate the adequacy of the component modifications to the reactor coolant pumps, thermowelds and the CEA shroud assembly. The test conditions will be representative of those used during the hot functional test and the system will be appropriately instrumented to check out the structural and hydraulic performance.

The test is scheduled to start in June 1984. Following completion of the test, the reactor vessel head will be removed and a reactor coolant pump will be disassembled to perform visual inspections. After the inspections and the evaluation of the test results are complete, the applicant will submit final

reports for the reactor coolant pumps, CEA shroud assemblies and thermowelds. (A final report for the thermal sleeves was submitted in January 1984.) The target date for submittal of the remaining reports is August 1984.

LPSI Pumps

The applicant and CE provided a history of the problems encountered with the LPSI pumps. Initial problems were encountered in Unit 1 with Pump 1B between March and June 1983, during which time a series of intermittent non starts were experienced. Replacing the motor with a Unit 3 LPSI pump motor did not solve the problem. In July 1983, the lower wear ring was replaced and the pump operated satisfactorily during 10 starts.

In October 1983 LPSI Pump 2A in Unit 2 failed to start. This event reopened the applicant's evaluation of the LPSI pump design for all units. The cause of the failure was attributed to contact of the impeller and wear ring on start. A number of possible causes for the unacceptable contact were considered and several investigations were made (included in LPSI viewgraphs 4 and 5).

As a result of the above evaluations, several modifications were made to the LPSI pump design (viewgraph 6) and the modified pump was tested in air and water. The tests showed that the modifications resulted in improved pump performance (starting) but the pump did fail to start once during a water test.

At that point, additional testing was conducted by using the motor from the containment spray pump in lieu of the original LPSI motor. The containment spray pump design is very similar to the LPSI pump but has a larger motor with a stiffer shaft. For this series of testing, the LPSI pump started 100 consecutive times without failure. Visual examination after testing revealed little to no contact between the impeller and the lower wear ring.

The applicant stated that it is still evaluating the LPSI pump problems and has not yet made any final conclusions on what modifications will be made to resolve this issue.

Original signed by:
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Enclosures:
1. Meeting Attendees
2. Viewgraphs

DL:LB#3
EALicitra/yt
4/26/84

DL:LB#3
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R. Dernedde

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E. Makay

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GAP

L. Bernabei

AGENDA
APS MEETING WITH THE
NRC STAFF
(TESTING OF C-E COMPONENTS)

I NRC OPENING REMARKS — NRC STAFF

II INTRODUCTION — E. E. VAN BRUNT

- HOT FUNCTIONAL TESTING CONCERNS (HFT)
- LOW PRESSURE SAFETY INJECTION PUMPS (LPSI)

III HFT

- SUMMARY OF TESTING PROGRAM — C. FERGUSON
  - C-E TEST PROGRAM STATUS
    - THERMAL SLEEVES
    - THERMOWELLS
    - REACTOR COOLANT PUMP
    - CONTROL ELEMENT ASSEMBLY SHROUD
- PVNGS DEMONSTRATION TEST — C. HAYES
  - OBJECTIVES
  - TEST PROGRAM
  - POST TEST PROGRAM
- HFT CONCERN CONCLUSIONS — E. E. VAN BRUNT

IV LPSI PUMP

- INTRODUCTION — E. E. VAN BRUNT
- SUMMARY OF CONCERNS — C. FERGUSON
  - HISTORY
  - EVALUATION

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PVNGS
DEMONSTRATION TEST
C-E TEST PROGRAM

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C-E TESTING PROGRAM

- C-E TEST OBJECTIVES
  - THERMAL SLEEVES
    - A. NO TESTING REQUIRED
  - THERMOWELLS
    - A. VERIFY HIGHER NATURAL FREQUENCY WITH MODIFIED DESIGN
    - B. VERIFY REDUCED VORTEX SHEDDING WITH MODIFIED DESIGN
  - RC PUMP
    - A. VERIFY ADEQUACY OF BOLTING IMPROVEMENTS
    - B. VERIFY ADEQUACY OF IMPELLER IMPROVEMENTS
    - C. VERIFY REDUCED CAVITATION TENDENCY
    - D. VERIFY REDUCED PRESSURE PULSATIONS AT PUMP DISCHARGE
    - E. VERIFY REDUCED INTERNAL STRESSES
  - CEA SHROUD
    - A. VERIFY ELIMINATION OF EXCITABLE FREQUENCY
    - B. VERIFY STRESS ANALYSIS
    - C. VERIFY VIBRATIONAL MODES USED IN ANALYSIS

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1A

- TESTING WAS CONDUCTED ON THE FOLLOWING COMPONENTS TO VERIFY THE ADEQUACY OF THE DESIGN MODIFICATIONS

  - THERMOWELLS
  - RC PUMP
  - CEA SHROUD

- THE SAFETY INJECTION AND SURGE LINE THERMAL SLEEVES WERE REMOVED. CONSEQUENTLY, NO THERMAL HYDRAULIC TESTS WERE CONDUCTED

- THE C-E TESTING HAS BEEN DESCRIBED IN PAST PRESENTATIONS TO THE NRC AND TO THE ACRS IN DECEMBER 1983

- PRELIMINARY RESULTS WERE PROVIDED BY APS IN THE INTERIM REPORTS

THERMAL SLEEVES

TEST PROGRAM

- TESTING WAS LIMITED TO DEMONSTRATION OF EXTRACTION AND EXPLANSION JOINT MACHINING TOOLS AND FIXTURES

- METALLURGICAL EXAMINATIONS WERE CONDUCTED TO DETERMINE IF THE MATERIALS HAD CONTRIBUTED TO THE FAILURE, WHICH THEY DID NOT

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DEMONSTRATION TEST
THERMAL SLEEVES

OBJECTIVES

- VERIFY THAT SLEEVE DID NOT ROTATE OR MOVE OUT OF POSITION.

DEMONSTRATION TEST ACTIVITIES

- EXAMINATION OF THE CHARGING LINE SLEEVE TO ASSURE PROPER INSTALLATION

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RTD - THERMOWELLS

TEST PROGRAM

- VORTEX SHEDDING TESTS
- FLOW TESTS UP TO 100 FT/SEC IN LOOP TEST AND SIMULATED OPERATING CONDITIONS IN THE FULL SCALE RC PUMP TEST LOOP
- STRUCTURAL RESPONSE AND TOTAL SYSTEM VIBRATION TESTS
- DEMONSTRATION OF PIPE NOZZLE REMOVAL AND INSTALLATION TOOLING AND FIXTURES

RTD - THERMOWELLS

SUMMARY OF TESTS

- NATURAL FREQUENCY OF MODIFIED THERMOWELL TIP IS ~2400 Hz
- VORTEX SHEDDING FREQUENCY ~700-800 Hz AT THE 70 TO 80 FT/SEC FLOW RANGE
- THERMOWELL/NOZZLE STRUCTURE ABSORBED VORTEX SHEDDING LOADS WITHOUT CAUSING OVERSTRESS OR FATIGUE
- NO WEAR OCCURRED

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DEMONSTRATION TEST

RTD - THERMOWELLS

- OBJECTIVES

  -VERIFY THAT THE MEASURED FREQUENCIES AND AMPLITUDES OF THE IMMERSED TIP ARE COMPARABLE TO THOSE OBSERVED DURING THE C-E TEST PROGRAM

  -MEASURE RTD/TW HEAD AND LOOP VIBRATIONS TO DEMONSTRATE ADEQUACY OF VALUE USED IN THE STRESS ANALYSIS

DEMONSTRATION TEST INSTRUMENTATION

- INTERNAL AND EXTERNAL BIAXIAL ACCELEROMETERS WILL BE INSTALLED TO MEASURE THERMOWELL TIP, HEAD AND RC PIPING VIBRATION

RC PUMP

TEST PROGRAM

- MODEL TEST AT KSB

  - IMPACT OF INCREASING IMPELLER-DIFFUSER VANE GAP ON HYDRAULICS AND CAVITATION AT RUNOUT CONDITIONS

  - CHANGES IN PRESSURE PULSATIONS RESULTING FROM INCREASING THE GAP

  - INFLUENCE OF BACKFILING OF IMPELLER TO REGAIN HEAD

  - VERIFICATION OF STRESS LOADING ON IMPELLER VANES

  - VERIFICATION OF LOADINGS ON DIFFUSER VANES

  - ESTABLISH METHOD FOR CUTTING BACK THE DIFFUSER VANES TO INCREASE GAP AND FOR BACKFILING IMPELLER VANES

RC PUMP

SUMMARY OF KSB TESTS

- STRESS LEVELS ON IMPELLER AND DIFFUSER VANES WERE OF ACCEPTABLE LEVELS
- INCREASING GAP HAD MINOR IMPACT ON HYDRAULIC PERFORMANCE AND REDUCED CAVITATION POTENTIAL
- HEAD LOSSES DUE TO GAP INCREASE, REMOVAL OF SUCTION PIPE RINGS CAN BE RECOVERED BY BACKFILING THE IMPELLER
- PRESSURE PULSATIONS WERE REDUCED BY INCREASING THE GAP
- GUIDELINES FOR CUTTING BACK THE DIFFUSER VANES, BACKFILING OF IMPELLER VANES AND BOLTING MODIFICATION WERE DEVELOPED

RC PUMP

TEST PROGRAM

- RC PUMP FULL SCALE C-E TEST LOOP
  - RUN BASELINE TEST OF ORIGINAL DESIGN AT DESIGN AND RUNOUT CONDITIONS
  - INCORPORATE MODIFICATIONS AND RUN TESTS TO COMPARE WITH ORIGINAL DESIGN
  - DETERMINE HYDRAULIC PERFORMANCE

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RC PUMP

- TEST PROGRAM AT CE-NEWINGTON

TEST	TIME
1. PHASE 1	
A. 95 TO 130% FLOW DATA	50 HOURS
B. BASE LINE DATA FOR INSTRUMENTATION. NO MODIFICATIONS. GAP 2.3 PERCENT	
2. PHASE 2	
A. 130 TO 150% FLOW DATA	100 HOURS
B. CONTINUATION OF BASELINE DATA. NO MODIFICATIONS. GAP 2.3 PERCENT	
C. DISASSEMBLY AND INSPECTION	
3. PHASE 3	
A. 130 TO 150% FLOW DATA	150 HOURS
B. ALL MODIFICATIONS INCORPORATED. GAP 6.0 PERCENT.	
4. PHASE 4	
A. 95 TO 130% FLOW DATA	30 HOURS
B. ALL MODIFICATIONS INCORPORATED. GAP 6.0 PERCENT.	
C. DISASSEMBLY AND INSPECTION	
5. PHASE 5	
A. 95 TO 130% FLOW DATA	20 HOURS
B. ALL MODIFICATIONS	
C. ADDITIONAL BACKFILING OF IMPELLER	

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RC PUMP

SUMMARY OF CE-N TESTS (PHASE 3, 4 AND 5)

- THE MODIFIED DESIGN OF THE DIFFUSER AND SUCTION PIPE BOLTING CONFIGURATION WAS SUCCESSFULLY DEMONSTRATED
- HYDRAULIC PERFORMANCE MET DESIGN REQUIREMENTS
- DIFFUSER BOLT STRAINS WERE REDUCED SIGNIFICANTLY
- VERTICAL AND HORIZONTAL ACCELERATIONS OF DIFFUSER HALVES WERE SIGNIFICANTLY REDUCED
- THERE WAS NO EVIDENCE OF CAVITATION ON DIFFUSER OR IMPELLER
- NDE EXAMINATION OF IMPELLER SHOWED NO INDICATIONS OF ANY DEFECTS AS A RESULT OF TESTS

DEMONSTRATION TEST

RC PUMP

OBJECTIVE

- VERIFY RESULTS OF THE RC PUMP MODIFICATIONS AS DEMONSTRATED IN THE CE-N FULL SCALE PUMP TESTS

- VERIFY THE RCS FOUR PUMP OPERATION FLOW RATE (486,900 GPM - 523,400 GPM)

DEMONSTRATION TEST INSTRUMENTATION

- NORMAL RC PUMP INSTRUMENTATION TO MEASURE OPERATING PARAMETERS WHICH INCLUDES SHAFT ORBIT MONITORING

- TRIAXIAL ACCELEROMETERS ON THRUST HOUSING FRAME TO MEASURE PUMP VIBRATION

- PRESSURE TRANSDUCER ON SUCTION PRESSURE LINE TO MEASURE NPSH

- PRESSURE TRANSDUCERS (COLD LEGS 1A & 2A) INSTALLED IN RTD THERMOWELL LOCATIONS ON DISCHARGE TO MEASURE PRESSURE PULSATIONS

- ULTRASONIC FLOW MEASUREMENT (UFM) INSTRUMENTATION

CEA SHROUD

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CEA SHROUD

C-E TEST PROGRAM

- HYDRAULIC TESTS
  - AXIAL FLOW UP THROUGH CEA TUBES.
  - LATERAL FLOW PAST BOTTOM OF CEA TUBE ACROSS SUPPORT PLATE
- MECHANICAL TESTS
  - VIBRATION TESTS
    - SINGLE TUBE
    - CEA SHROUD ASSEMBLY
    - EXCITATION TESTS- SINGLE TUBE
      - ORIGINAL DESIGN
      - MODIFIED DESIGN

CEA SHROUD

SUMMARY OF C-E TESTS

- HYDRAULIC TESTS DID NOT IDENTIFY DIRECT HYDRAULIC FORCES ON SHROUD OF A MAGNITUDE THAT COULD RESULT IN A SIGNIFICANT CONTRIBUTION TO SHROUD CRACKING.
- CEA GUIDE AND TUBE FREQUENCIES ARE IN THE RANGE OF THE RC PUMP BLADE PASSING FREQUENCY AND ITS FIRST HARMONIC.
- CEA GUIDES AND TUBES WERE ALSO IN THE FREQUENCY RANGE OF THE UPPER GUIDE STRUCTURE TUBE SHEET.
- VIBRATION TESTS OF THE CEA SHROUD ASSEMBLY IDENTIFIED FREQUENCIES BELOW THAT OF THE CEA GUIDES AND TUBES.
- EXCITATION TESTS PROVIDED AN ESTIMATE OF THE STRESS CONCENTRATION FACTOR OF THE CEA GUIDE WELDED CONFIGURATION.
- EXCITATION TEST OF MODIFIED SINGLE GUIDE TUBE SHOWED THE CEA GUIDE FREQUENCY TO BE ELIMINATED.

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DEMONSTRATION TEST

CEA SHROUD

OBJECTIVES

- VERIFY HYDRAULIC LOADING ON THE UPPER GUIDE STRUCTURE(UGS).
- VERIFY STRUCTURAL INTEGRITY OF CEA SHROUD.
- CONFIRM ACCEPTABILITY OF UGS PERFORMANCE WITH MODIFIED CEA SHROUD ASSEMBLY.

DEMONSTRATION TEST INSTRUMENTATION

- CEA SHROUD IS INSTRUMENTED WITH STRAIN GAGES, PRESSURE TRANSDUCERS AND ACCELEROMETERS.
- THEY ARE LOCATED BOTH AT TOP AND BOTTOM OF SHROUD(SLIDES 14 A&B)
- VIBRATORY MOTION WILL BE DETERMINED USING BI-DIRECTIONAL ACCELEROMETERS.
- STRAIN GAGES WILL PROVIDE STRESS LEVELS IN SELECTED TUBES AND WEBS.
- DYNAMIC STRAIN WILL BE CORRELATED WITH DYNAMIC PRESSURE AT THE TOP AND BOTTOM OF THE SAME TUBES.

DEMONSTRATION TEST
PROBLEMS AND TEST OBJECTIVES

- HFT PROBLEMS
  - THERMAL SLEEVES
  - RTD THERMOWELLS
  - RC PUMPS
  - CEA SHROUD

- COMPONENT TEST OBJECTIVES
  - THERMAL SLEEVES
    - A. VERIFY THE ADEQUACY OF INSTALLATION PROCESS
    - B. VERIFY NO SLEEVE ROTATION OR MOVEMENT
  - THERMOWELLS
    - A. VERIFY THAT FORCES AND FREQUENCIES ARE COMPARABLE TO EARLIER TESTING
    - B. VERIFY ADEQUACY OF STRESS ANALYSIS
  - RC PUMP
    - A. VERIFY ADEQUACY OF PUMP MODIFICATIONS
  - CEA SHROUD
    - A. VERIFY HYDRAULIC LOADING
    - B. VERIFY STRUCTURAL INTEGRITY OF MODIFIED SHROUD
    - C. VERIFY OVERALL UPPER GUIDE STRUCTURE PERFORMANCE

- SYSTEM TEST OBJECTIVES
  - DEMONSTRATE ADEQUACY OF COMPONENT MODIFICATIONS IN SYSTEM APPLICATION
  - VERIFY REDUCTION IN PRESSURE PULSATIONS
  - VERIFY ADEQUACY OF TOTAL SYSTEM FLOWRATE
  - VERIFY MINIMAL COMPONENT INTERACTIONS DUE TO MODIFICATIONS

DEMONSTRATION TEST

- TEST PROGRAM DESCRIPTION
- OBJECTIVES
- SUMMARY OF TESTS TO BE CONDUCTED
- INITIAL TEST CONDITIONS
- TEST TEMPERATURE/PRESSURE PLATEAUS
- POST DEMONSTRATION TEST INSPECTIONS

TEST PROGRAM DESCRIPTION

- C-E ESTABLISHED CRITERIA

- DEMONSTRATION TEST TO VERIFY MODIFICATIONS

OBJECTIVES

- VERIFY UGS MODIFICATION
- VERIFY RCP'S MODIFICATIONS
- VERIFY RTD REDESIGN
- MEASURE RCS FLOW RATES
- RECORD BASELINE DATA

SUMMARY OF TESTS TO BE CONDUCTED

- REACTOR COOLANT SYSTEM TEST PROCEDURE

  - UGS MODIFICATION VERIFICATION

  - RCS PUMP DATA, OPERATING AND CONTINUOUS MONITORING

  - PRE-CORE RCS FLOW RATE

INITIAL TEST CONDITIONS

- PRE-CORE HOT PUMP TEST CONTROLLING DOCUMENT ESTABLISHES PLANT CONDITIONS

TEST TEMPERATURE/PRESSURE PLATEAUS

- CE ESTABLISHED CRITERIA

- VARIOUS PUMP COMBINATIONS AT SPECIFIED TEMPERATURE/ PRESSURE PLATEAUS

- FOUR PUMP, NOP, NOT, 200 HOUR, STEADY-STATE RUN

POST DEMONSTRATION TEST INSPECTIONS

- REMOVE REACTOR VESSEL HEAD - VISUAL INSPECTION

- DISASSEMBLE AND INSPECT ONE RCP

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LPSI PUMPS

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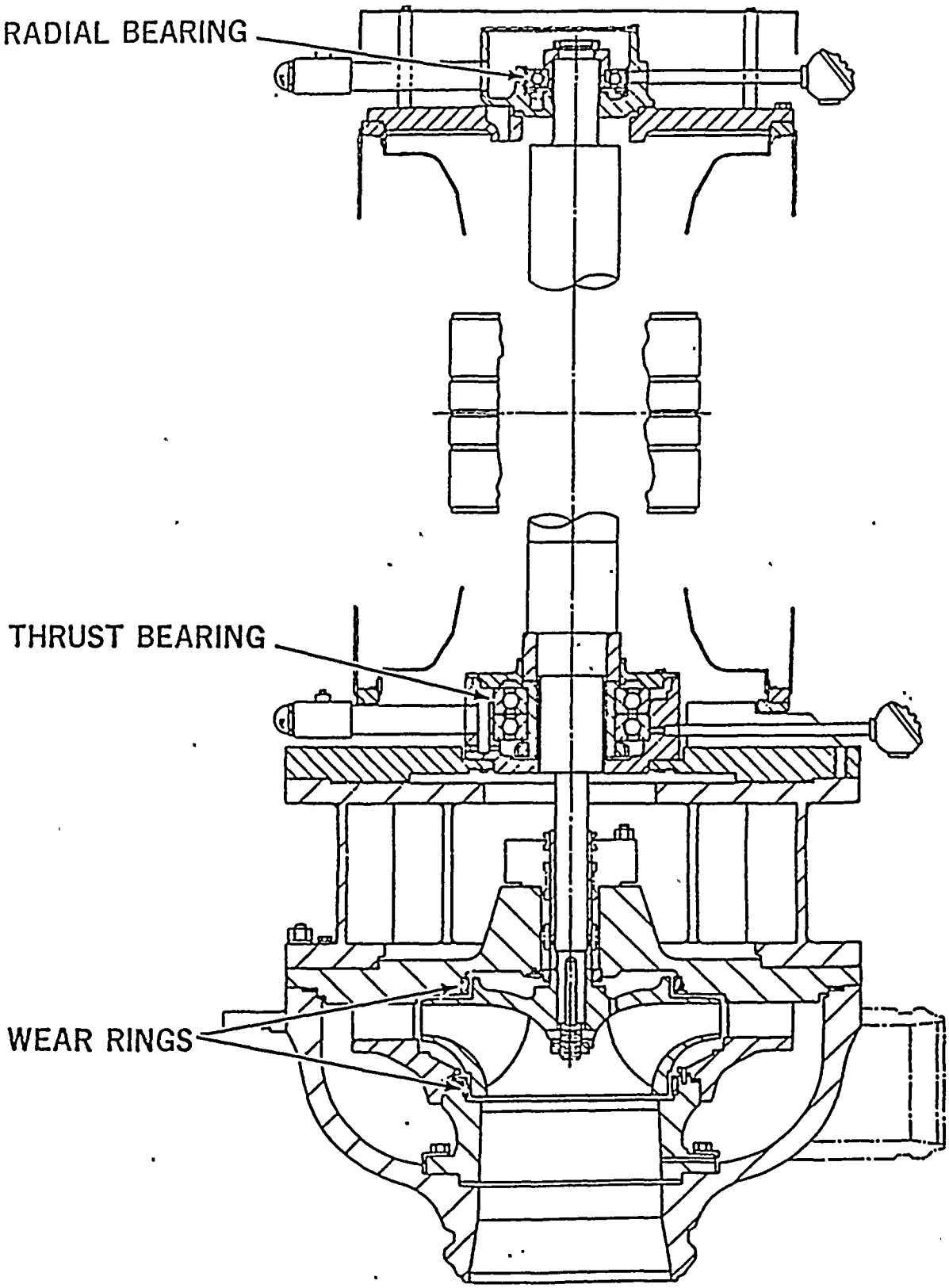
LOW PRESSURE SAFETY INJECTION PUMP



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HISTORY OF FAILURES TO START

MARCH 18, 1983, 1B OPERATED THREE MINUTES WITH SUCTION VALVE CLOSED. THE PUMP WAS SECURED AND RESTART FAILED.

THE PUMP WAS DISASSEMBLED AND INSPECTED.

DURING MAY AND JUNE THERE WAS A SERIES OF INTERMITTENT NON STARTS.

IN JUNE, THE MOTOR WAS REPLACED WITH A UNIT 3 LPSI MOTOR AND SUBSEQUENTLY A FAILURE TO START OCCURRED.

IN MID JULY, THE LOWER WEAR RING WAS REPLACED AND SINCE THEN 1B HAS OPERATED SATISFACTORILY. (10 STARTS)

EARLY OCTOBER 1983 FAILURE TO START OF LPSI 2A.

THIS MARKED THE OUTSET OF THE PRESENT PROGRAM.

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LPSI PUMP

ANALYSIS OF CAUSE OF FAILURE TO START

1. CONTACT OF IMPELLER AND WEAR RING ON START

2. POSSIBLE CAUSES OF UNACCEPTABLE CONTACT

   - INSUFFICIENT IMPELLER TO WEAR RING CLEARANCE
   - IMPELLER AND WEAR RING MATERIAL INCOMPATIBILITY
   - EXCESSIVE LOOSENESS IN MOTOR BEARINGS
   - MOTOR ROTOR OFFSET
   - EXCESSIVE TOLERANCE BUILDUP
   - ROTATING ASSEMBLY DYNAMICS
   - OTHER

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4.

LPSI PUMP

INVESTIGATIONS

- DISASSEMBLED PUMP AND INSPECTED IMPELLER AND WEAR RINGS
- MEASURED CLEARANCES BETWEEN IMPELLER AND WEAR RING
- MEASURED CONCENTRICITY OF MOTOR TO PUMP AND PUMP TO CASING INSTALLATION TO DETERMINE EXTENT OF ECCENTRICITY
- MEASURED RELATIVE DISPLACEMENTS OF SHAFT AND BEARINGS BOTH RADIALLY AND VERTICALLY
- MEASURED AIR GAP BETWEEN MOTOR ROTOR AND STATOR
- DEVELOPING ROTOR DYNAMIC MODELS TO ASSIST IN EVALUATION OF STRUCTURAL DEFORMATION AND DYNAMIC RESONANCES

LPSI PUMP

MODIFICATIONS IMPLEMENTED PRIOR TO NOVEMBER TESTING

1. CHANGE CASING RING FROM K-MONEL TO NITRONICS 60

   - REDUCED GALLING TENDENCY
   - GOOD CORROSION RESISTANCE
   - REDUCED COEFFICIENT OF FRICTION
   - NOT SUBJECT TO WORK HARDENING

2. INCREASE IMPELLER TO CASING RING CLEARANCE

   - NOMINAL .006 INCH DIAMETRAL INCREASE
   - REDUCE POTENTIAL FOR RING CONTACT
   - REDUCED HYDRAULIC PERFORMANCE

3. SERRATING IMPELLER

   - REGAIN PORTION OF PUMP PERFORMANCE LOSS DUE TO INCREASED GAP

4. MOTOR DOWELING AND IMPROVED TOLERANCING

   - REDUCED TOLERANCE FROM .005 TO .002 INCHES
   - IMPROVE CONCENTRICITY OF MOTOR TO SUPPORT HEAD
   - IMPROVE CONCENTRICITY OF IMPELLER AND CASING RING

5. MOTOR LOWER BEARING REPLACEMENT (LPSI MOTOR ONLY)

   - PRELOAD TO REDUCE BEARING INTERNAL CLEARANCE
   - REDUCES IMPELLER RADIAL MOTION UNDER LOAD

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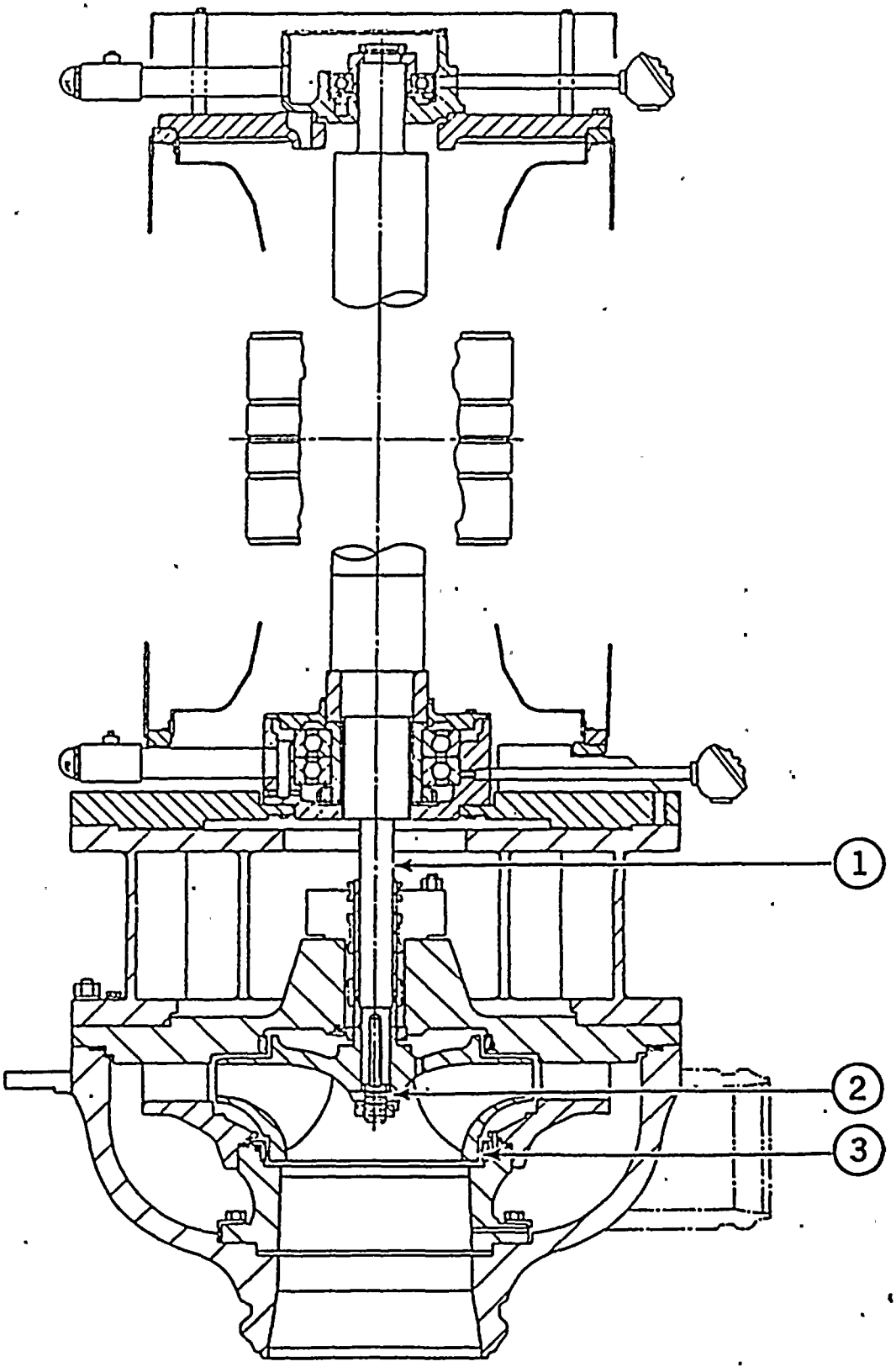
LPSI PUMP

TEST PROGRAM AND STATUS

- LPSI PUMP MOTOR AIR TESTS
  - RADIAL DEFLECTIONS WERE MEASURED AT LOCATIONS SHOWN ON SLIDE 8
    - WITHOUT LPSI IMPELLER
      - ORIGINAL LOWER BEARING
      - PRELOADED LOWER BEARING
    - WITH LPSI IMPELLER
      - ORIGINAL LOWER BEARING
      - PRELOADED LOWER BEARING

- LPSI PUMP MOTOR WATER TEST
  - MEASURE RADIAL DEFLECTIONS AT POSITION 1 SHOWN ON SLIDE 8
    - FIVE START WET TEST
  - FAILED TO START AT FIFTH START POSITION
  - PUMP DID START IN EACH OF FIVE SUBSEQUENT STARTS

DEFLECTION MEASUREMENTS



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LPSI PUMP

TEST PROGRAM AND STATUS - CONTINUED

- CS PUMP MOTOR AIR TESTS
  - RADIAL DEFLECTIONS MEASURED IN SAME MANNER AS LPSI TESTS (SLIDE 8)
    - WITHOUT IMPELLER - ORIGINAL BEARING
    - WITH IMPELLER - ORIGINAL BEARING

- CS PUMP MOTOR WATER TESTS
  - MEASURED DEFLECTIONS AT POSITION 1 (SLIDE 8)
    - FIVE START TEST
      - NO FAILURE TO START
      - DISASSEMBLED FOR INSPECTION
        - NO CONTACT ON UPPER WEAR RING OR IMPELLER
        - VERY SLIGHT TO NO CONTACT ON LOWER WEAR RING
    - 100 START TESTS
      - NO FAILURE TO START
      - DISASSEMBLED FOR INSPECTION
        - LITTLE TO NO ADDITIONAL CONTACT

APR 27 1984

MEETING SUMMARY DISTRIBUTION

Docket No(s): 50-528/529/530
NRC PDR
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NSIC
PRC System
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