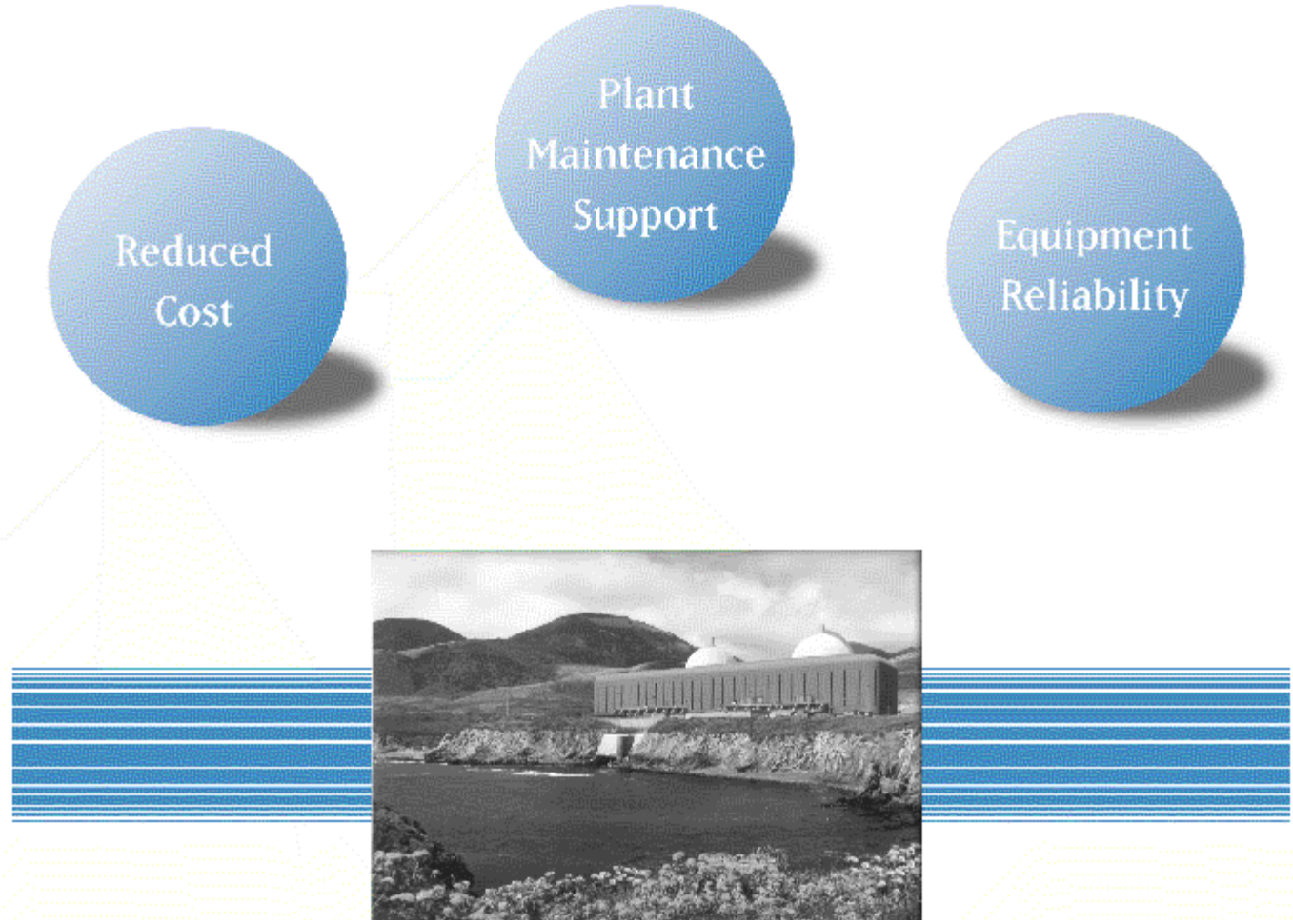
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INSPECTION, REPAIR, AND TESTING SPECIFICATION CHARGING/HHSI PUMP ROTATING ELEMENT

PACIFIC PUMP MODEL 2-1/2RL IJ

1001018



INSPECTION, REPAIR, AND TESTING SPECIFICATION CHARGING/HHSI PUMP ROTATING ELEMENT

Pacific PUMP MODEL 2-1/2RL IJ

Technical Evaluation, September, 2000

1001018

NMAC Pump Users Group

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ABSTRACT

The development of pump repair specifications is an important element in obtaining cost effective and technically adequate repair services. The NMAC Pump Users Group has developed this document as a template to assist member utilities in defining the technical requirements for repair of horizontal, multi-stage, centrifugal charging pumps. This document delineates instructions for the inspection, repair and testing and may be modified to suit site specific technical requirements and needs.

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INSPECTION, REPAIR, AND TESTING SPECIFICATION CHARGING/HHSI PUMP ROTATING ELEMENT

Pacific PUMP MODEL 2-1/2RL IJ

1.0 SCOPE OF WORK

This specification describes the instructions for the inspection, repair and testing of a radiological contaminated centrifugal charging/HHSI pump, rotating element.

2.0 INSPECTION

Upon receipt of the element, the following inspections are to be performed to evaluate the condition of the rotating element. The results of the inspection are to be documented and submitted to the Customer for review and approval of the final work scope. Do not proceed with any other work until an agreement has been reached regarding the final work scope.

The inspection report should include a failure analysis of broken or cracked components such as the pump shaft and impellers. No parts (particularly the shaft and impellers) are to be destroyed without prior approval from the Customer. Detailed inspections may require the decontamination of applicable components to safe radiological working levels.

2.1 Preliminary Inspections

- A Determine total rotor axial float
- B Catalog all loose components
- C Clean blast all rotating components except the shaft
- D Clean shaft using stainless wire brush
- E Clean blast all stationary components

2.2 Non-Destructive Inspections

A Visual Inspection of Shaft to determine or identify:

1. Large defects
2. Radii of all key ways
3. Key way straightness
4. Thread form (cut or rolled)
5. Shot peen of threaded areas
6. Radius at root of all undercut locations
7. If the shaft had been previously straightened (e.g., mechanical peening or heat)

B Visual Inspection of Impellers to determine or identify:

1. Large defects and condition of wear surfaces
2. Inlet and exit vane cavitation
3. Inlet and exit vane radii
4. Exit vane land length (“x” dimension)
5. Exit vane profile

6. Large defects and condition of sideplates (hub and shroud)

C Visual Inspection of Diffusers/Covers to determine or identify:
1. Water cutting of pressure faces
2. Cavitation at inlet and exit diffuser vanes
3. Radius and vane profile at inlet and exit diffuser vanes
4. Impeller and diffuse contact damage

D Visual Inspection of Miscellaneous Rotating Components:
1. Erosion, contact, and/or scoring of shaft sleeves, split rings, shaft sleeve lock nuts, coupling shaft, coupling half, mechanical seal components, thrust collar and hydraulic balancing device (i.e., pressure reducing sleeve)
2. Conditions of all rotor keys

2.3 Dimensional Inspections to provide:
A Parallelism and perpendicularity of mating components
B Component fit-up
C Total indicated run-out of shaft
D Critical dimensions of impellers, diffusers/covers, shaft, etc.
E Total rotor axial stack-up and identify relative shaft and diffuser centerlines
F Gasket crush (if applicable)
G Customer reserves the right to independently perform dimensional verifications

2.4 Non-Destructive Examinations,
A Wet magnetic fluorescent particle (MT) or liquid penetrant inspection of shaft
B Magnetism of shaft
C MT of all rotating components (e.g., impellers, pressure reducing sleeve, etc.)
D Hardness checks of impeller periphery, sideplates, and ring turns
E MT of large non-rotating components (e.g., diffuser/covers, suction spacer and discharge diffuser)
F Liquid dye penetrant (PT) inspections of stationary components not inspected in item E
G Customer reserves the right to independently perform NDE
H NDE required on existing shaft and impellers even if the components will be replaced during refurbishment

3.0 CONTAMINATED MATERIALS

The assembly for repair is radioactive. Following repair/refurbishment of the rotating assembly, performance tests are required in accordance with Section 5.0 of this specification. Facilities must be properly licensed for receiving, handling and processing contaminated materials. Material handling and decontamination procedures, including all chemicals used, require Customer approval. Only those facilities and procedures reviewed and approved by Customer shall be used.

4.0 REPAIRS

4.1 Prior to performance of any repairs a repair plan shall be submitted to the Customer for approval. Repair plan should specify the condition and the repair process to be utilized for each deficient part.

4.2 Shaft

A. Manufactured from Nitronic 50, high strength material or Custom Aged 625 Plus material. Shaft material shall meet the specification requirements identified in Westinghouse document WCAP-14801, “Centrifugal Charging Pump Shaft Failure Investigation, Phase 3 Report, Testing and Evaluation of Candidate Replacement Materials for Life Enhancement”. A copy can be provided upon request.

B. Latest design for replacement “in kind” of existing shaft, incorporating enhancements such as, rolled shaft threads with optimized thread root radii, optimized radii in key-ways and shaft diameter changes

C. Shaft straightening allowed only in the rough-cut condition, prior to final stress relief. No shaft straightening allowed after final stress relieve

D. Customer should be notified prior to final machining as a witness hold point to verify shaft straightness after machining

E. Maximum allowed shaft “total indicated run out” (TIR) – 0.0015” Witness HOLD Point

4.3 Impellers

A. Grind out any cavitation damage and linear indications
B. Weld impeller side plates at OD to establish GAP “A” at 0.025” to 0.030” and a minimum GAP “A” Overlap of 0.120”. Final dimensions require Customer approval.
C. Weld impeller damage areas and ring turns utilizing applicable processes and procedures per Section IX of the ASME Boiler & Pressure Vessel Code.
D. Post-weld heat treat to establish mechanical properties (minimum 16 Rc to maximum 22 Rc).
E. Machine impellers to establish proper Gap “A” and Gap “A” Overlap dimensions
F. Machine all impeller ring turns to obtain running clearance of .010” to .013”
G. Flame harden impeller ring turns to obtain a hardness of 44 to 46 Rc.
H. Smooth hydraulic passages
I. Grind impeller bores as required to accept hard chrome plating and provide a 0.0005” to 0.0015” interference fit to the shaft. Finish grind to tolerance
J. Following all repairs and machining to final dimensions perform an MT inspection on all impellers

K. Balance each impeller individually to less than or equal to 1 W/N residual unbalance, where W equals the impeller weight and N equals the nominal pump operating speed of 4800 rpm.

4.4 Rotor

A. Customer should be notified prior to balance of rotor as a witness hold point
B. Assemble impellers to shaft and check TIR at each impeller ring turn and shroud/hub OD (0.002" maximum allowable TIR)
C. Balance
    1. Fit the shaft with precision half keys where required
    2. Assemble impellers to shaft
    3. Obtain total indicated run-out of the shaft and impellers
    4. With impellers installed, balance rotor to less than 1 W/N
    5. Sequentially assemble remaining rotor components (e.g., pressure reducing sleeve and thrust collar) and balance the rotor assembly to less than 1 W/N. Make balance correction on last installed component
D. Disassemble the rotor down to the first stage impeller.

4.5 Covers and Diffusers

A. Remove all wear rings and bushings
B. Grind out all linear indications
C. Weld using applicable processes and procedures to ASME Section IX
D. Set up the components and mill the diffuser vanes to obtain equal cord lengths
E. Polish or smooth hydraulic passageways
F. Install new wear rings and diffuser bushings manufactured from ASTM A276 Type 440A or 440C material. Machine wear rings to obtain running clearance of .010" to .013. Harden wear rings to 52 to 56 Rc.
G. Machine the covers and diffusers to obtain inter-stage fits of 0.002" to 0.003" interference
H. Stone and polish all pressure faces

4.6 Parts

A. The Vendor shall provide an itemized quote for all parts in the element, indicating which components are considered standard replacement items and are included in the bid quotation
B. Customer reserves the right to provide any or all parts required in the repair, and will provide a list of parts after final work scope has been completed

4.7 Element

A. Clean all components
B. Customer to be notified prior to assembly of components to allow performance of independent dimensional verifications and witness assembly of element
C. Assemble the element in the vertical position
D. Dimensionally analyze the impeller to diffuser centerline compatibility at each stage to verify proper impeller seating and assure proper running position. Impeller to diffuser centerlines to be within 0.010".

E. Record total axial float
F. Tag element with total float and running position
G. Transfer rotor bundle from the vertical to the horizontal position and perform four vertical lift checks, minimum required lift of .006".
H. Using rollers under shaft, center the rotor in the diffusers/covers bushings and verify rotor spins freely.
I. Vendor shall supply a suitable shipping container for shipping the repaired./refurbished element

5.0 REPAIR REPORT

5.1 Prepare and submit a repair report that describes the details of the scope of the repairs that were performed, documenting the "as-found" and "as-left" condition of the rotating assembly.

6.0 TESTING *(Note: each utility inputs the XXX information in the following section)*

6.1 Perform a certified performance test at a minimum of 8 points from 0 gpm to a minimum of XXX gpm. All data to be corrected to: XXXX rpm, 1.02 Specific Gravity and 300^{o}F. Test to include,

A. Head, meeting requirements as shown in Figure 1 and Table 1, at XXXX rpm.
B. Efficiency
C. Brake Horsepower
   1. BHP not to exceed XXX horsepower at XXXX rpm
D. Net Positive Suction Head Required
   1. NPSHR shall not exceed XX feet at XXX gpm and XXXX rpm. Data should be collected at the following points of interest; XXX, XXX, etc. gpm.
E. Inboard and outboard pump bearing housing vibration not to exceed .157 in/sec in any direction (i.e., vertical, horizontal or axial) with minimum frequency span of 15 to 2000 Hx.
F. Inboard and outboard pump shaft vibration not to exceed 25% of bearing clearance (bearing clearance .004" to .0055") in any radial direction

APPENDIX A

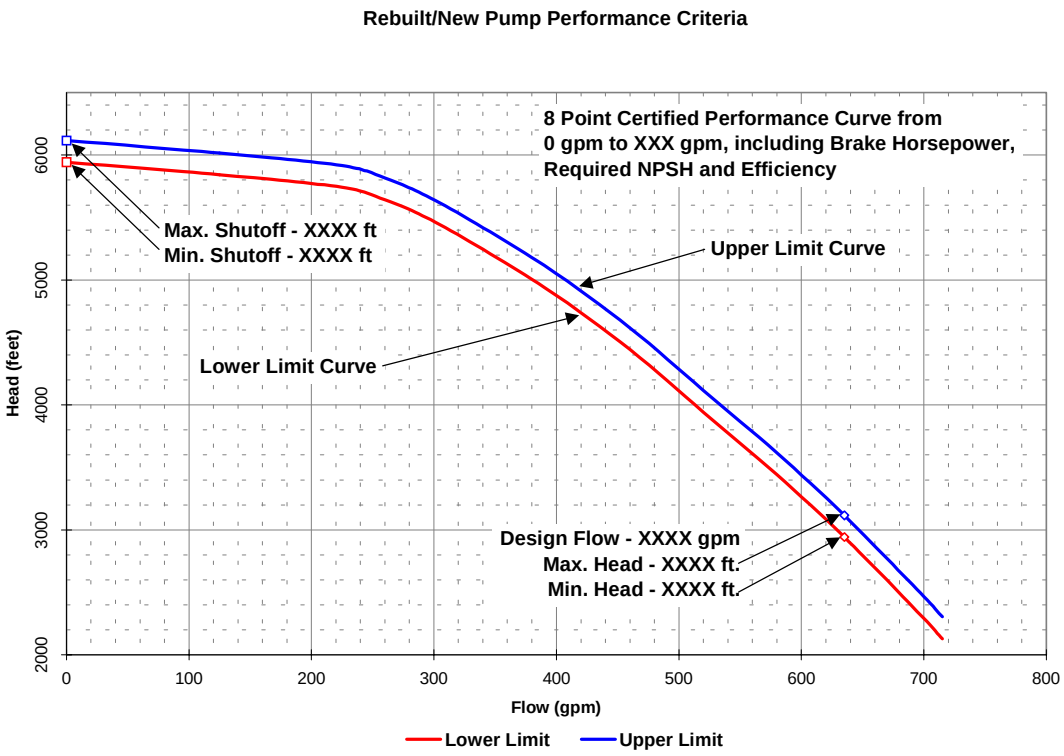


Figure 1: Required Pump Flow – Head Performance

gpm	Lower Limit Head	Nominal Curve Head	Upper Limit Head
XXX	XXXX	XXXX	XXXX
XXX	XXXX	XXXX	XXXX
XXX	XXXX	XXXX	XXXX
XXX	XXXX	XXXX	XXXX
XXX	XXXX	XXXX	XXXX
XXX	XXXX	XXXX	XXXX
XXX	XXXX	XXXX	XXXX
XXX	XXXX	XXXX	XXXX
XXX	XXXX	XXXX	XXXX

Table 1: Tabulated Performance Requirements

APPENDIX B

Comments and Clarifications:

4.3.B The Gap "A" & Gap "A" Overlap criteria provide here have been approved by the OEM for the Farley 900 HP and the Vogtle 600 HP pumps and are proper for this pump design and size.

4.3.D The ASTM for the impeller material requires a maximum of 22 Rc, but no minimum. During past repairs impeller hardness readings as low as 5 Rc have been found. A minimum hardness value assures the impellers have been heat-treated. These values were approved by the OEM for the Farley 900 HP and the Vogtle 600 HP pumps and recommended by the OEM in publications.

4.3.F 0.010" to 0.013" represents a nominal wear ring running clearance for this pump design. Each utility should consultant their instruction manual for their specific running clearance.

4.3.G These hardness values meet the original specifications for flame hardened ring turns in this pump design.

4.3.I The original pump design required .000" to .002" loose fit impellers. A 0.0005" to 0.0015" interference fit to the shaft prevents fretting of the shaft under the impeller, which has been documented as the point of crack initiation during previous shaft failures. These values were approved by the OEM for the Farley 900 HP and the Vogtle 600 HP pumps and recommended by the OEM in publications.

4.5.F These materials are the originals supplied by the original design. ASTM A276 no longer exists and has been replaced by ASTM A473. If a plant has approved a different material (e.g., ASTM 420F) it can be listed in place of these materials.

0.010" to 0.013" represents a nominal wear ring running clearance for this pump design. Each utility should consultant their instruction manual for their specific running clearance.

These hardness values meet the original specifications for flame hardened ring turns in this pump design.

4.5.G The original pump design required .000" to .002" loose fit covers. A 0.002" to 0.003" interference fit maintains the wear bushings on the same centerline. These values were approved by the OEM for the Farley 900 HP and the Vogtle 600 HP pumps and recommended by the OEM in publications.

4.7.G With a total wear ring clearance of 0.010" to 0.013", a radial lift check less than 0.006" would indicate a radial alignment problem in the pump.

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