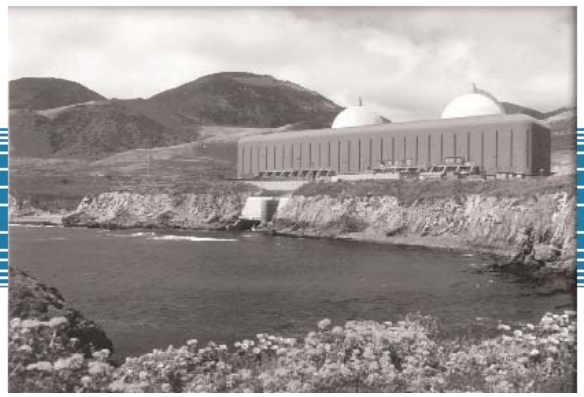
Refurbishment/Repair Specification for APKD Pumps

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Refurbishment/Repair Specification for APKD Pumps

Final Report, December 2002

EPRI Project Manager

Mike Pugh

EPRI • 3412 Hillview Avenue, Palo Alto, California 94304 • PO Box 10412, Palo Alto, California 94303 • USA
800.313.3774 • 650.855.2121 • askepri@epri.com • www.epri.com

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EPRI Nuclear Maintenance Applications Center (NMAC)
1300 W. T. Harris Blvd.
Charlotte, NC 28262

Principal Investigator or Author
M. Pugh

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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 this commonly used pump. This document delineates instructions for the inspection, repair and testing and may be modified to suit site specific technical requirements and needs.

CONTENTS

1.0 PURPOSE……1
2.0 OBJECTIVE……1
3.0 GENERAL SCOPE……1
3.1 Applicable Pump(s)……1
3.2 Owner Responsibilities……...1
3.3 Refurbishment Facility Responsibilities……2
3.4 Reports……3
3.5 Receipt Inspection……..……3
3.6 Disassembly……..3
3.7 Cleaning……3
3.8 General NDE and Dimensional Analysis……..4
4.0 SPECIFIC SCOPE……... 4
4.1 Dimensional Inspection, NDE, & Repair Requirements……4
4.2 Pump Assembly……10

Appendix A
Figure 1, Outline Drawing
Figure 2, Bill of Material

REFURBISHMENT/REPAIR SPECIFICATION FOR APKD PUMPS

1.0 PURPOSE

The purpose of this refurbishment/repair specification is to specify instructions for an offsite Refurbishment/Repair Facility (RF) to inspect, repair and re-assemble Ingersoll-Rand (currently know as Flowserve Corporation) model APKD vertical pump(s) identified in section 3.1.

2.0 OBJECTIVE

The objective is to obtain, in a timely manner, refurbished pump(s) which will meet or exceed the original specified design or upgrades as specified within section 4.1 of this specification.

3.0 GENERAL SCOPE

3.1 APPLICABLE PUMP(S)

3.1.1	Pump Service :	XXX
3.1.2	Plant ID Number(s):	XXX
3.1.3	Serial Number(s):	XXX
3.1.4	Model Number:	XXAPKD, X stg.
3.1.5	Plant Manual Number:	XXX
3.1.6	Outline Drawing:	XXX
3.1.7	Bill of Material:	XXX
3.1.8	Weight:	XXX lbs.
3.1.9	QA Requirement:	XXX
3.1.10	ASME Code:	XXX

3.2 OWNER RESPONSIBILITIES

3.2.1 Unless specified otherwise within the Purchase Order, the Owner will be responsible for the shipping to and from the RF.

3.2.2 Owner will provide the RF a proper Bill of Lading and 48 hour notification of anticipated delivery and pick-up.

3.2.3 Owner will provide copies of pump vendor manual/plant manual, outline drawing(s) and Bill of Material(s), if not classified as proprietary. Where available, the Owners parts numbers will be provided and the quantity available from Owners stock.

3.2.4 Owner will provide points of contact for technical and contractual issues, within the governing Purchase Order.

3.3 REFURBISHMENT FACILITY RESPONSIBILITIES

3.3.1 For the purposes of this work scope, the Refurbishment Facility (RF) shall be the organization with which the Owner has entered into agreement to provide refurbishment/repair of APKD pumps.

3.3.2 The RF shall provide a refurbishment/repair proposal describing the remedy to all anomalies identified through inspections and measurements. The proposal shall identify the techniques, including any and all procedures that will be utilized, including methodology of qualifying said procedures and techniques.

3.3.3 The RF proposal shall include copies of all Welding Procedures (WRS) and Procedure Qualification Records (PQR) for all proposed weld repairs. Weld procedures and welders shall be qualified in accordance with ASME Section IX.

3.3.4 The RF shall provide in writing/electronic media any exceptions being taken to this specification. The exceptions shall be clearly linked to the specification sections being objected to. The RF shall include their proposed remedies for their exceptions for Owner review.

3.3.5 The RF proposal shall include pricing for the following parts:

(Typical)

Part No.	Part Description	Qty/pmp	Material
6A	Casing and Suction Head Rings	9	65K
6B	Booster Impeller Casing Ring	1	
10A	Pump Shaft	1	
10B	Upper Shaft	1	
88	Stuffing Box Extension Bushing	1	378H
135A	Suction Head Journal Sleeve	1	65K
135B	Discharge End Cover Journal Sleeve	1	65K
227A	Suction Head Bearing	1	Graphite - Nickel
227B	Casing Bearings	7	Graphite - Nickel
227C	Discharge Head Bearing	1	Graphite - Nickel

3.4 REPORTS

Three separate reports (written or electronic media) shall be provided to the Owner. The first report will be a Receipt Inspection report detailing equipment condition "as-received", (shipping damage or other visually identified discrepancies with the received components, assembled pump(s), and any components shipped loose), prior to commencing disassembly. The second report will be the "As-Found" Report; detailing the results of the NDE and dimensional inspections. This report is the basis for repair decision analysis. This report will identify all components that the RF believes requires refurbishment or replacement and the methodology which will be used in accomplishing the repair or refurbishment. The third report will be the Refurbishment/Repair Report and will detail all "as-left" dimensions, pump settings, NDE/testing "as left" results including any heat treating (temp. vs. time traces), hardness testing, etc. If hydraulic performance testing was included in the P.O., performance test curves will be provided in this report.

3.5 RECIEPT INSPECTION

3.5.1 The pump(s) shall be receipt inspected, (visual only), and any damage, defects, or discrepancies identified shall be documented in writing and immediately identified per purchase order requirements to those individuals identified per section 3.2.4.

3.5.2 Catalog all loose parts per reference drawings and Bill of Material (BOM).

3.6 DISASSEMBLY

3.6.1 Record total rotor end float (vertical lift). If pump has a mechanical seal installed, remove it or "release" it prior to end float measurement.

3.6.2 Record shaft stick up relative to motor support plate with shaft bottomed within column.

3.6.3 Disassemble pump and record rotor end float as components are removed.

3.7 CLEANING

3.7.1 Approval from the Owner shall be obtained prior to using any solvents, chemicals, greases, lubricants, coatings or paints. The RF shall provide a listing of their customary solvents, chemical, greases, lubricants, coatings and paints along with application/usage procedures with the Receipt Inspection Report. The Owner reserves the right to provide these items.

3.7.2 Stationary Components shall be steam cleaned, glass bead blasted or blasted with non-aggressive media such as aluminum oxide or walnut shells as required to remove rust or scale and to prepare critical surfaces for non-destructive examinations (NDE) and dimensional analyses.

3.7.3 Rotating Components shall be cleaned using stainless wire brushes, or blasting with aluminum oxide, walnut shells or similar non-aggressive blasting media. However use only new stainless wire brushes on shaft journals and impeller bores, as required to prepare critical surfaces for NDE and dimensional analyses.

3.8 GENERAL NDE AND DIMENSIONAL ANALYSIS

3.8.1 Certified personnel shall perform NDE examinations ("Magnetic Particle", "Liquid Penetrant", etc.) Certification records of each inspector shall be included with the As-Found Report.

3.8.2 Dimensional measurements (running clearances, and fit up fits/clearances along with their perpendicularity and concentricity) shall be recorded and provided within the As-Found Report.

3.8.3 If disassembly inspection identifies wall thinning/erosion/corrosion or impeller damage then wall thickness measurements (calipers/UT etc.) shall be performed. Components subject to repair with no BOM material specifications shall have material analysis performed to identify material for weld ability. In addition impellers will have hardness readings taken (mapped) and recorded.

4.0 SPECIFIC SCOPE

4.1 DIMENSIONAL INSPECTION, NDE, & REPAIR REQUIREMENTS

4.1.1 Discharge Head (Part No. xxx- Qty. 1/pump)

4.1.1.1 Record the diameter of the alignment registers for the discharge end cover, (part no. xxx), outer column (part no. xxx), and shell, (part no. xxx), in a minimum of two places 90^{o} apart. Acceptance Criteria is 0.000" to 0.002" clearance with mating register.

4.1.1.2 Record inside diameter (ID) of booster impeller casing ring (part no. xxx) and discharge head bearing (part no. xxx) a minimum of 2 places 90^{o} apart.

4.1.1.3 Remove the discharge head bearing (part no. xxx) and the booster impeller casing ring (part no. xxx). Record outside diameter (OD) of bearing and casing ring and ID of their corresponding fit location(s) in the discharge head at a minimum of two places 90^{o} apart.

4.1.1.4 Record concentricity and perpendicularity of the fit locations, alignment registers, mating surfaces, flanges and motor support plate relative to the centerline of the register for the discharge end cover. Acceptance Criteria is 0.000” to 0.002” concentricity and perpendicularity.

4.1.1.5 Pad weld the alignment registers and component fit locations a minimum of 8 locations to restore any **“out of tolerance”** conditions. Continuous weld may be used if desired. Document work performed in the final report.

4.1.1.6 Machine fit, registers, support plate, and flanges as required, to satisfy concentricity, perpendicularity, and fit criteria. Document work performed in the final report.

4.1.1.7 Replace discharge head bearing (part no. xxx). Use either a shrink or a press fit, as specified. Acceptance Criteria is 0.005” – 0.008” running clearance

4.1.1.8 Replace casing ring (part no. xxx). Use either a shrink or a press fit, as specified. Acceptance Criteria is 0.015” to 0.019” running clearance.

4.1.1.9 Machine alignment registers on underside of motor support plate of the discharge head, if not already provided, relative to the discharge head end cover register or discharge head bearing bore, for verification, (sweeping), of motor shaft alignment (run out and parallel) during pump motor installation.

4.1.1.10 Paint with with approved Owner paint or coating systems.

4.1.2 Discharge End Cover (Part No. xxx - Qty. 1/pump)

4.1.2.1 Record the diameter of the alignment register for the discharge head (part no. xxx), in a minimum of two places 90^{o} apart. Acceptance Criteria is 0.000” to 0.002” clearance with mating register.

4.1.2.2 Record inside diameter (ID) of the stuffing box bushing (part no. xxx) in a minimum of 2 places 90^{o} apart.

4.1.2.3 Remove stuffing box bushing. Record outside diameter (OD) of bushing and ID for stuffing box bushing fit and mechanical seal locations at a minimum of two places 90^{o} apart.

4.1.2.4 Record concentricity and perpendicularity of the stuffing box bushing fit location, alignment register, mating surfaces, and mechanical seal area relative to the centerline of the discharge end cover. Acceptance Criteria is 0.000” to 0.002” concentricity and perpendicularity.

4.1.2.5 Pad weld alignment register and stuffing bushing fit a minimum of 8 locations to restore any **"out of tolerance"** condition. Continuous weld may be used if desired.

4.1.2.6 Machine fits and registers, as required, to satisfy concentricity, perpendicularity, and fit criteria.

4.1.2.7 Replace stuffing box extension bushing (part no. xxx). Acceptance Criteria is 0.020" – 0.025" running clearance.

4.1.2.7 Paint to match discharge head with approved Owner paint or coating systems.

4.1.3 Outer Column (Part No. xxx – Qty. 1/pump)

4.1.3.1 Record the diameter of the alignment registers for the discharge head (part no. xxx) and the last stage casing (part no. xxx) in a minimum of two places 90^{o} apart. Acceptance Criteria is 0.000" to 0.002" clearance with mating register.

4.1.3.2 Record concentricity and perpendicularity of male and female registers and mating surfaces. Acceptance Criteria is 0.000" to 0.002" concentricity and perpendicularity.

4.1.3.3 Pad weld registers a minimum of 8 locations to restore any **"out of tolerance"** condition. Continuous weld may be used if desired.

4.1.3.4 Machine registers, as required, to satisfy concentricity, perpendicularity, and fit criteria.

4.1.4 First Stage Casing (Part No. xxx – Qty. 1/pump), Intermediate Casing (Part No. xxx – Qty. x/pump), Last Stage Casing (Part No. xxx – Qty. 1/pump)

4.1.4.1 Record the diameter of the alignment registers in a minimum of two places 90^{o} apart. Acceptance Criteria is 0.000" to 0.002" clearance with mating register.

4.1.4.2 Record ID of casing bearing (part no. xxx) and casing wear rings (part no. xxx) a minimum of 2 places 90^{o} apart.

4.1.4.3 Remove bearings and casing wear rings. Record OD of bearings and wear rings and ID of fit locations in casing in a minimum of two places 90^{o} apart.

4.1.4.4 Record concentricity and perpendicularity of alignment registers, mating surfaces and casing wear ring fit relative to the casing bearing fit centerline. Acceptance Criteria is 0.000” to 0.002” concentricity and perpendicularity.

4.1.4.5 NDE casing guide vanes from the vane inlet to approximately 6 inches along the vane.

4.1.4.6 Pad weld registers and bearing/ring fits a minimum of 8 locations to restore any **“out of tolerance”** condition. Continuous weld may be used if desired.

4.1.4.7 Machine alignment registers, mating surfaces, and bearing/ring fit locations, as required, to satisfy concentricity, perpendicularity, and fit criteria.

4.1.4.8 Replace casing bearings (part no. xxx). Acceptance Criteria is 0.005” to 0.008” running clearance.

4.1.4.9 Replace casing wear rings (part no. xxx)**.** Acceptance Criteria is 0.015” to 0.019” running clearance.

4.1.5 Suction Head (Part No. xxx – Qty. 1)

4.1.5.1 Record the diameter of the alignment register in a minimum of two places 90^{o} apart. Acceptance Criteria is 0.000” to 0.002” clearance with mating register.

4.1.5.2 Record ID of suction head bearing (part no. xxx) and wear ring (part no. xxx) a minimum of 2 places 90^{o} apart.

4.1.5.3 Remove bearing and case wear ring. Record OD of bearing and wear ring and ID of fit locations in suction head in a minimum of two places 90^{o} apart.

4.1.5.4 Record concentricity and perpendicularity of alignment register, mating surfaces and casing ring fit relative to the suction head bearing fit centerline. Acceptance Criteria is 0.000” to 0.002” concentricity and perpendicularity.

4.1.5.5 Pad weld registers and bearing/ring fits a minimum of 8 locations to restore any **“out of tolerance”** condition. Continuous weld may be used if desired.

4.1.5.6 Machine alignment registers, mating surfaces, and bearing/ring fit locations, as required, to satisfy concentricity, perpendicularity, and fit criteria.

4.1.5.7 NDE suction head bearing supports.

4.1.5.8 Replace suction head bearing (part no. xxx). Acceptance Criteria is 0.005" to 0.008" running clearance.

4.1.5.9 Replace casing ring (part no. 6A)**.** Acceptance Criteria is 0.015" to 0.019" running clearance.

4.1.6 1st Stage Impeller (Part No. xxx, double suction – Qty. 1), 2nd through xth Stage Impeller (Part No. xxx, single suction - Qty. x), and Booster Impeller (Part No. xxx, single suction – Qty. 1)

4.1.6.1 Perform 100% crack inspection of impellers using magnetic particle or liquid penetrant examination.

4.1.6.2 Record OD of impeller wear ring turns a minimum of 2 places 90^{o} apart. Acceptance Criteria is 0.015" to 0.019" running clearance.

4.1.6.3 Record impeller shaft bore. Acceptance Criteria is 0.000" to 0.002" clearance fit.

4.1.6.4 Record wear ring turns concentricity with impeller bore centerline. Acceptance Criteria is 0.000" to 0.002" concentric.

4.1.6.5 Weld repair impeller wear ring turns and bore as required to meet fit and concentricity tolerances.

4.1.6.5 Individually balance each impeller to achieve a maximum residual unbalance of 1 W/N per balance plane.

4.1.7 Pump Shaft (Part No. xxx – Qty. 1), Upper Shaft (Part No. xxx - Qty. 1)

4.1.7.1 Perform 100% crack inspection of shafts using magnetic particle or liquid penetrant examination.

4.1.7.2 Record shaft "total indicated runout" (TIR) at each bearing journal, impeller fit, coupling fit and journal sleeve fit location. Acceptance 0.003" TIR Maximum.

4.1.7.3 SHAFT SHALL NOT BE STRAIGHTENED USING HEAT, BENDING OR PEENING WITHOUT PRIOR APPROVAL.

4.1.7.4 Record OD of shaft at bearing journal locations. Acceptance Criteria is 0.005” to 0.008” running clearance.

4.1.7.5 Record OD of shaft at impeller, shaft coupling, and journal sleeve locations. Acceptance Criteria is 0.000” to 0.002” clearance fit.

4.1.7.6 Remove suction head bearing journal sleeve (part no. xxx) and stuffing box extension journal sleeve (part no. xxx). Record ID of journal sleeve and OD of shaft fit location in a minimum of two places 90^{o} apart.

4.1.7.7 Replace shaft journal sleeves. Acceptance Criteria is 0.005” to 0.008” running clearance, and 0.000” to 0.002” clearance fit to shaft.

4.1.7.8 For the suction head bearing journal sleeve, verify three set screws equally spaced around the circumference of the sleeve are installed to hold the sleeve into place.

4.1.7.9 Prepare and burnish upper shaft near drive coupling fit if proximity probes are used.

4.1.8 Shaft Coupling (Part No. xxx – Qty. 1)

4.1.8.1 Record ID of shaft coupling at shaft fit locations. Acceptance Criteria is 0.000” to 0.002” loose.

4.1.8.2 Record concentricity of shaft fit bores. Acceptance Criteria is 0.000” to 0.001” concentricity.

4.1.8.3 Replace two coupling keys with a single coupling key.

4.1.8.4 Balance shaft coupling. Acceptance Criteria is 1 W/N maximum residual unbalance.

4.1.9 Rotor Balance

4.1.9.1 Install impeller stages 2 through x on to the pump shaft.

4.1.9.2 Place rotor in balance stand with impellers between supports.

4.1.9.3 Dynamically balance rotor. Acceptance Criteria is 4 W/N maximum residual unbalance.

4.1.9.4 Install 1^{st} stage on to balanced rotor assembly.

4.1.9.5 Balance 1^{st} stage impeller as single plane, over hung weight.

4.1.10 Miscellaneous

4.1.10.1 Restore proper fits for keys, split rings, etc.

4.1.10.2 Base work scope includes the replacement of consumables such as gaskets, keys, split rings, etc.

4.2 Pump Assembly

4.2.1 Assemble pump and document “as-left” condition of the pump in Refurbishment/Repair Report.

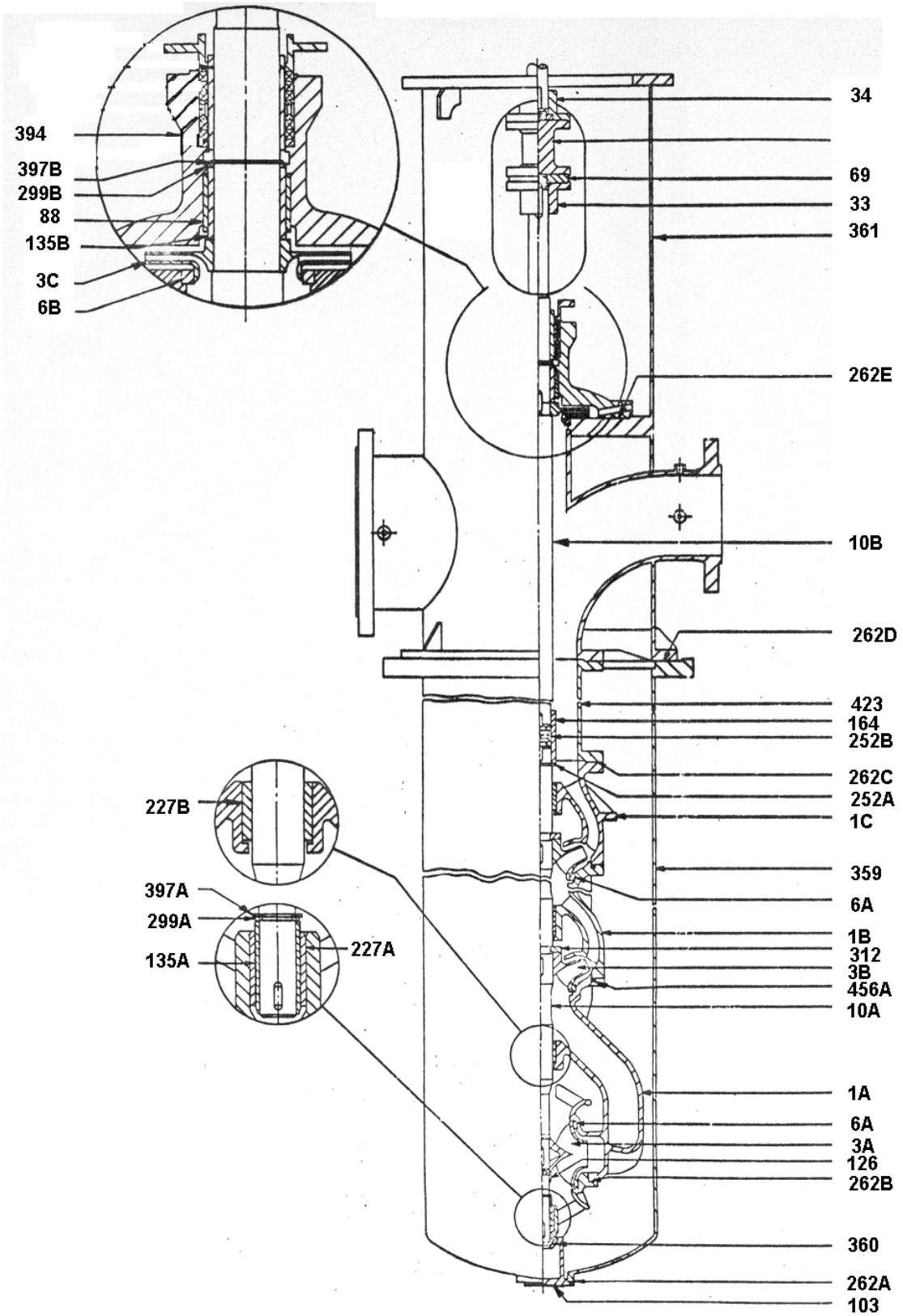
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Appendix A

Figure 1, Outline Drawing

Figure 2, Bill of Material

Figure 1, Typical APKD Outline Drawing



		MATERIAL COLUMN		
PART NO.	PART NAME	B PH Range 6.5 to 9.0	CF 9.0 to 11.0	KN 6.5 to 11.0
1	Casing	ASTM A48 class 30B – Gray cast iron		
3	Impeller	ASTM B143 alloy 922	ASTM A48 class 25A, Gray Iron	12 Chrome CA-15 Casting
6	Casing Ring	ASTM A48 class 30B – Gray cast iron		410 SS
8	Shaft Sleeve	AISI Type 410 Stainless Steel – Condition K		
10A	Shaft Pumping Element	AISI Type 410 Stainless Steel – Condition B		
10B	Intermediate (When Used)	Carbon Steel Bars and Forgings		
10C	Upper	Carbon Steel Bars and Forgings		
14	Seal Cage	ASTM A48 class 30B – Gray cast iron		
16	Gland	ASTM a47, Grade 32510, Malleable Iron		
64	Packing	Cottonite		J. Crane
88	Stuffing Box Bushing	AISI Type 410 Stainless Steel – Condition K		
126	Shaft Nut at Suction Head	AISI Type 410 Stainless Steel – Condition B		
127	Shaft Sleeve Nut	Copper Alloy 932	Carbon Steel Bars and Forgings	
135	Journal Sleeve	AISI Type 410 Stainless Steel – Condition K		
164A	Shaft Column Coupling	Carbon Steel Bars and Forgings		
227	Bearings	Nickel Filled Carbon		
252	Split Ring @ Impeller	AISI Type 410 Stainless Steel		
262	Gaskets - Flat	Hydroil		
264	Stuffing Box Extension	ASTM A48 class 30B – Gray cast iron		
312	Lock Collar	AISI Type 410 Stainless Steel		
359	Shell	766 or 667		
360	Suction Head	ASTM A48 class 30B – Gray cast iron		
361	Discharge Head	ASTM A283, Grade C or ASTM A36 Carbon Steel		
423	Outer Column (When Used)	ASTM A283, Grade C or ASTM A36 Carbon Steel		
456	"O" Ring Gaskets	BUNA-N		EPR

PART NO.	BOLTING & MISC PARTS		CF	KN
	Impeller Lock Collar	ANSI B18.3 Alloy Steel (N)		
	Pressure Bolting	ASTM A193, Grade B7, Alloy Steel (B, N)		
	Pressure Nuts	ASTM A194, Geade 2H, Carbon Steel Nuts (N)		
	Keys	ASTM A582 Type 416 SS Condition H		
48	Intermediate Piece	ASTM A48 class 30B – Gray cast iron		
164B	Shaft Coupling	AISI Type 410 Stainless Steel		
262	Split Ring @ Coupling	AISI Type 410 Stainless Steel		
172	Motor Support	Carbon Steel (S)		
471	Sole Plate	Carbon Steel (S)		

NOTES

(1) Materials in column CF & KN denote upgrading from standard column B (carbon steel bars and forgings) intermediate and upper shafts require journal sleeve.

(2) When shafting is all stainless, the upper and intermediate shaft will be AISI Type 410 Stainless Steel (B), shaft coupling will be AISI Type 410 Stainless Steel (B,F, S).

(3) Where low sulphur is a requirement, AISI Type 316 will be used in place of ASTM A582 Type 416.



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EPRI • 3412 Hillview Avenue, Palo Alto, California 94304 • PO Box 10412, Palo Alto, California 94303 • USA
800.313.3774 • 650.855.2121 • askepri@epri.com • www.epri.com