



## Engineered Pumps and Services

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### HEATER DRAIN PUMP OVERHAUL CASE NO AP-194

Chas G Allen received the contract to overhaul an Ingersoll-Rand Model No. 29 APKD-6 Heater Drain Pump Service for a for a 1100 Mw Unit. The internal element removed from the pump well is driven by a 1,250 HP Motor 1,800 RPM, GPM 5,430, TDH 770 Ft Heater Drain Water Temperature 370°F. Below are the component observations and inspection of the rotor with corrective action plan for the equipment. The final documentation of the completed project is also included

#### GENERAL OBSERVATIONS

**Shafts**-Both shafts in fair condition, .005" Max TIR, Both NDE by Ultrasonic, acceptable

**Impellers**-General overall condition of the 1<sup>st</sup> -6<sup>th</sup> stage, good. All NDE by Mag-particle method all passed except for the 1<sup>st</sup>, which two small indications 1/8" and 3/8" at the root of the inlet vanes

**NDE**-Reports attached

**Casing Rings/Impeller Front Hubs**-Minor scoring .019"-.022" clearance (STD .015"-.019")

**Suction Head**-Old style three support ribs for bearing, NDE no indications

**Suction Head Journal Sleeve**-Old style retained with spirolox ring and key only, new modification specifies two addition dog point set screws on the sleeve

**Journal Sleeves**-Minor wear and scoring, note several had a copper coating on the OD

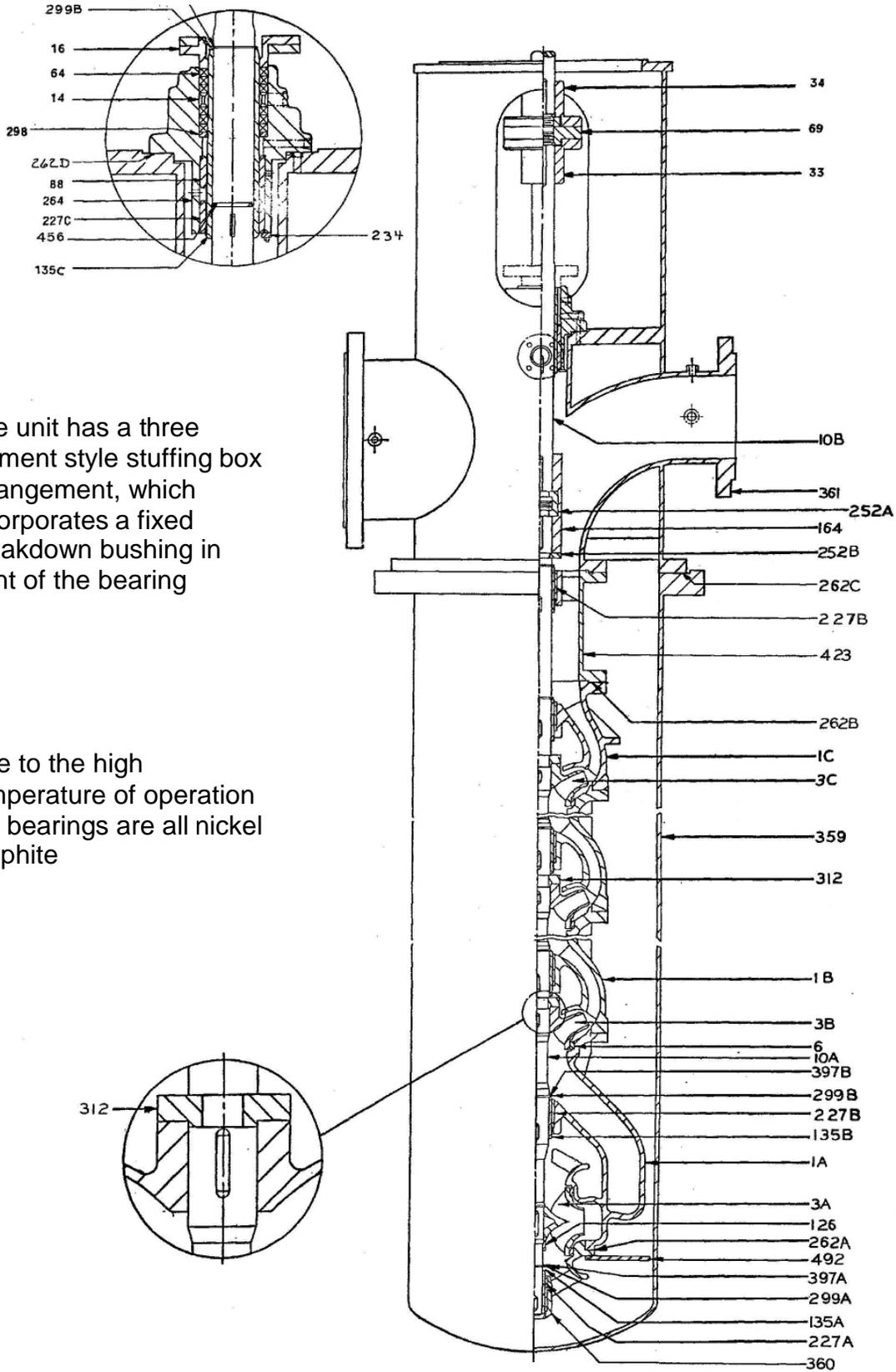
**Carbon Bearings/Journal Sleeves**-Minor wear and scoring, .006"-.018" clearance, (STD .005"-.008")

**Bowls**-General condition good

**Axial Float**-.850"

**PUMP SHAFT**-Record diameters, TIR and condition for journals and impeller fits

Location	Journal OD	Standard	TIR	Conditions
Lower Brg	1.999"	2.000" -.001"	.005"	Bent
1 <sup>st</sup> Stage	2.124"	2.125" -.002"	.004"	Bent
2 <sup>nd</sup> Stage	4.249"	4.250" -.001"	.001"	Good
3 <sup>rd</sup> Stage	4.249"	4.250" -.001"	.001"	Good
4 <sup>th</sup> Stage	4.249"	4.250" -.001"	.002"	Good
5 <sup>th</sup> Stage	4.248"	4.250" -.001"	.002"	Good
6 <sup>th</sup> Stage	4.248"	4.250" -.001"	.004"	Minor Scoring
Upper Brg	4.246"	4.246" -.001"	.005"	Minor Scoring
Coupling Fit	4.246"	4.246" -.001"	.004"	Good



The unit has a three element style stuffing box arrangement, which incorporates a fixed breakdown bushing in front of the bearing

Due to the high temperature of operation the bearings are all nickel graphite



**Planned Work Scope-Pump Shaft**

- Clean and polish for reuse
- Final inspect

**Recommended Additional Work Scope-Pump Shaft**

- Straighten the shaft to within maximum of .002" TIR

**TOP SHAFT-Record diameters, TIR and condition for journals and coupling**

Location	Journal OD	Standard	TIR	Conditions
Drive Coupling	3.9992"	3.999" -.001"	.0008"	Fair to good needs polishing
Shaft Sleeve	4.2499"	4.250"-.001"	.001"	Two score marks, needs to be polished
Line Coupling	4.2452"	4.246" -.001"	.001"	Good Condition

**TOP SHAFT-Old score marks under the stuffing box sleeve area on two sides, scoring to remain as is**



**Opposite side**



**Planned Work Scope-Top Shaft**

- Clean and polish for reuse
- Final inspect

**Recommended Additional Work Scope-Top Shaft**

- Furnish a new stuffing box sleeve in ASTM A276, Type 410SS, HT to 38-42 RC



**IMPELLERS/CASING RINGS CLEARANCES**

Location	Casing Ring ID	Impeller OD	Clearance	Standard	Condition
1 <sup>st</sup> Outboard	10.502"	10.482"	.020"	.015"-.019"	Minor Scoring
1 <sup>st</sup> Inboard	10.504"	10.482"	.022"	.015"-.019"	Minor Scoring
2 <sup>nd</sup>	10.500"	10.481"	.019"	.015"-.019"	Minor Scoring
3 <sup>rd</sup>	10.502"	10.481"	.021"	.015"-.019"	Minor Scoring
4 <sup>th</sup>	10.501"	10.481"	.020"	.015"-.019"	Minor Scoring
5 <sup>th</sup>	10.502"	10.481"	.021"	.015"-.019"	Minor Scoring
6 <sup>th</sup>	10.502"	10.481"	.021"	.015"-.019"	Minor Scoring

**IMPELLERS-SHAFT FITS**

Location	Impeller ID	Shaft OD	Clearance	Standard	Condition
1 <sup>st</sup>	2.1249/2.1255"	2.1235"- 2.124"	.002"	.000"-.002"	Good
2 <sup>nd</sup>	4.2525	4.249"	.0035"	.000"-.002"	Good
3 <sup>rd</sup>	4.2517"	4.249"	.0027"	.000"-.002"	Good
4 <sup>th</sup>	4.2525"	4.2485"	.004"	.000"-.002"	Fair Taper .0008"
5 <sup>th</sup>	4.2523"	4.2475"	.0048"	.000"-.002"	Fair Taper .0009"
6 <sup>th</sup>	4.2522"	4.248"	.0042"	.000"-.002"	Fair Taper .001"

**1<sup>st</sup> STAGE IMPELLER** has two small cracks at the root of the inlet vanes one on each side





**IMPELLER CONDITION CODES**

**Bores and Hubs** A) Smooth B) Scratched C) Grooved D) Galled E) Other

**Waterways** A) Smooth B) Sand Holes C) Lumps

**Exit Vane** A) None B) Upper Side C) Lower Sides

**Exit Vane Tips** A) Rounded B) Square C) Sharp Edges D) Cracks E) Erosion

**Inl Vane Cav** A) None B) Visible Side C) Non-Visible Side

**Inl Vane Tips** A) Rounded B) Square C) Pitted D) Nicked E) Other

**Shrouds** A) Smooth B) Pitched C) Sand Holes D) Cracks E) Other

Stage	1	2	3	4	5	6
Bore	A	A	A	A	A	A
Front Hub	B	B	B	B	B	B
Back Hub	A	A	A	A	A	A
No. of Vanes	5/5	8	5	5	5	5
Waterways	A	A	A	A	A	A
Exit Vanes	A	A	A	A	A	A
Exit Vane Tips	A	A	A	A	A	A
Inlet Vanes	A	A	A	A	A	A
Inlet vane Tips	E Cracks	A	A	A	A	A
Shrouds	A	A	A	A	A	A



2<sup>nd</sup> stage impeller in good condition, with the exception of the bore which is slightly over sized, typical of the condition of the 3<sup>rd</sup> thru 6<sup>th</sup> stage



**Planned Work Scope-Impellers**

- Skim cut all wearing surfaces to a nominal cleanup dimension
- Clean and snag all inlet and exit vanes and waterways
- Final inspect

**Recommended Additional Work Scope-Impellers**

- Excavated the crack on the 1<sup>st</sup> stage impeller and weld in accordance with proper procedures for CA-15 material. Hand dress weldments to original vane profile.
- On the 2<sup>nd</sup> -6<sup>th</sup> stage weld two bands on the front and back sides of the bores.
- Weld in accordance with proper procedures for CA-15 material
- Setup and finish machine each bore to provide .000”-.002” clearance to the shaft

**SUCTION HEAD**-Old style with three support ribs for the bearing, in good condition,  
NDE accepted





**CASINGS REGISTER FITS**

Location	ID Register Fit	OD Register Fit	Clearance	Standard
Suction to Volute	15.001"	15.000"	.001"	.000"-.002"
Volute to 2 <sup>nd</sup> Stage	17.001"	16.9995"	.0015"	.000"-.002"
2 <sup>nd</sup> to 3 <sup>rd</sup> Stage	17.002"	16.9985"	.0035"	.000"-.002"
3 <sup>rd</sup> to 4 <sup>th</sup> Stage	17.001"	16.9992"	.0018"	.000"-.002"
4 <sup>th</sup> to 5 <sup>th</sup> Stage	17.003"	16.995"	.0035"	.000"-.002"
5 <sup>th</sup> to 6 <sup>th</sup> Stage	17.002"	17.001"	.001"	.000"-.002"
6 <sup>th</sup> to Column	17.000"	16.9985"	.0015"	.000"-.002"

**BEARING RUNNING CLEARANCES**

Location	Bearing ID	Journal OD	Clearance	Standard
Suction Bell	2.505"	2.490"	.015"	.004"-.009"
1 <sup>st</sup> Stage Volute	4.763"	4.745"	.018"	.005"-.009"
2 <sup>nd</sup>	4.762"	4.745"	.017"	.005"-.009"
3 <sup>rd</sup>	4.755"	4.744"	.011"	.005"-.009"
4 <sup>th</sup>	4.753"	4.744"	.009"	.005"-.009"
5 <sup>th</sup>	4.753"	4.744"	.009"	.005"-.009"
6 <sup>th</sup>	4.750"	4.744"	.006"	.005"-.009"
Column Upper	4.755"	4.744"	.011"	.005"-.009"

**BEARING BORE FITS**

Location	Bearing Housing ID	Bearing Length	TIR to Register Fit	Standard
Suction Bell	3.2501"	5.0"	.002"	.000"-.002"
1 <sup>st</sup> Stage Volute	5.5052"	4.56"	.0015"-.002"	.000"-.002"
2 <sup>nd</sup>	5.502"	4.56"	.0015"	.000"-.002"
3 <sup>rd</sup>	5.5023"	4.56"	.002"	.000"-.002"
4 <sup>th</sup>	5.019"	4.56"	.002"-.0025"	.000"-.002"
5 <sup>th</sup>	5.501"	4.56"	.003"	.000"-.002"
6 <sup>th</sup>	5.5015"	4.56"	.0015"	.000"-.002"
Upper	5.501"	4.56"	.001"	.000"-.002"

**CASING RING FITS**

Location	Casing Ring Fit ID	Casing Ring Depth	TIR to Register Fit	Standard
1 <sup>st</sup> Outboard	11.131"	1.248"	.0015"	.000"-.002"
1 <sup>st</sup> Inboard	11.128"	1.245"	.002"	.000"-.002"
2 <sup>nd</sup>	11.129"	1.250"	.002"	.000"-.002"
3 <sup>rd</sup>	11.134"	1.260"	.002"	.000"-.002"
4 <sup>th</sup>	11.131"	1.260"	.002"	.000"-.002"
5 <sup>th</sup>	11.125"	1.250"	.0012"	.000"-.002"
6 <sup>th</sup>	11.126"	1.245"	.002"	.000"-.002"



**Planned Work Scope- Casing Rings/ Bowls**

- Furnish and install two (2) new 1<sup>st</sup> stage casing rings, five (5) new 2<sup>nd</sup> through 6<sup>th</sup> stage casing rings. Note special ID to re-establish design running clearance
- Furnish and install one (1) new suction bell bearing and six (6) new 1<sup>st</sup> through 6<sup>th</sup> stage bearings
- Pad weld the 2<sup>nd</sup> to 3<sup>rd</sup> , 4<sup>th</sup> to 5<sup>th</sup> stages with eight (8) weld on the male register fits and machine for .000”-.002”

**JOURNAL SLEEVES**



Note copper coating on the journal sleeves

Sleeves are to be replaced as part of the planned work scope



**Planned Work Scope-Balance**

- Assemble Stages (2) two through (5) on the shaft and balance to 4W/N maximum residual unbalance.
- Install first stage (1<sup>st</sup>) impeller and balance as single plane, over hung weight.
- Install sixth (6<sup>th</sup>) stage impeller and dynamically balance to 4 W/N maximum residual unbalance.
- Remove all parts from the shaft to facilitate reassembly

**Planned Work Scope-Reassembly**

- Reassemble the pump with new gaskets, O-rings , retaining rings and the following new parts:

Qty	Description	Part Number	Material
7	Casing Rings Special ID's	29APKD6-410SS	ASTM A276 Type 410SS HT 38-42Rc
1	Suction Bell Bearing	29APKD-227X8-GC	GM 111.3 Nickel Graphalloy
6	Intermediate Bearings	29APKD-227X11-GC	GM 111.3 Nickel Grapalloy
1	Journal Sleeve Suction Head. With mods	29APKD-135YX2-410SS	ASTM A276 Type 410SS HT 38-42Rc
7	Journal Sleeves Casings	29APKD-135YX2-410SS	ASTM A276 Type 410SS HT 38-42Rc

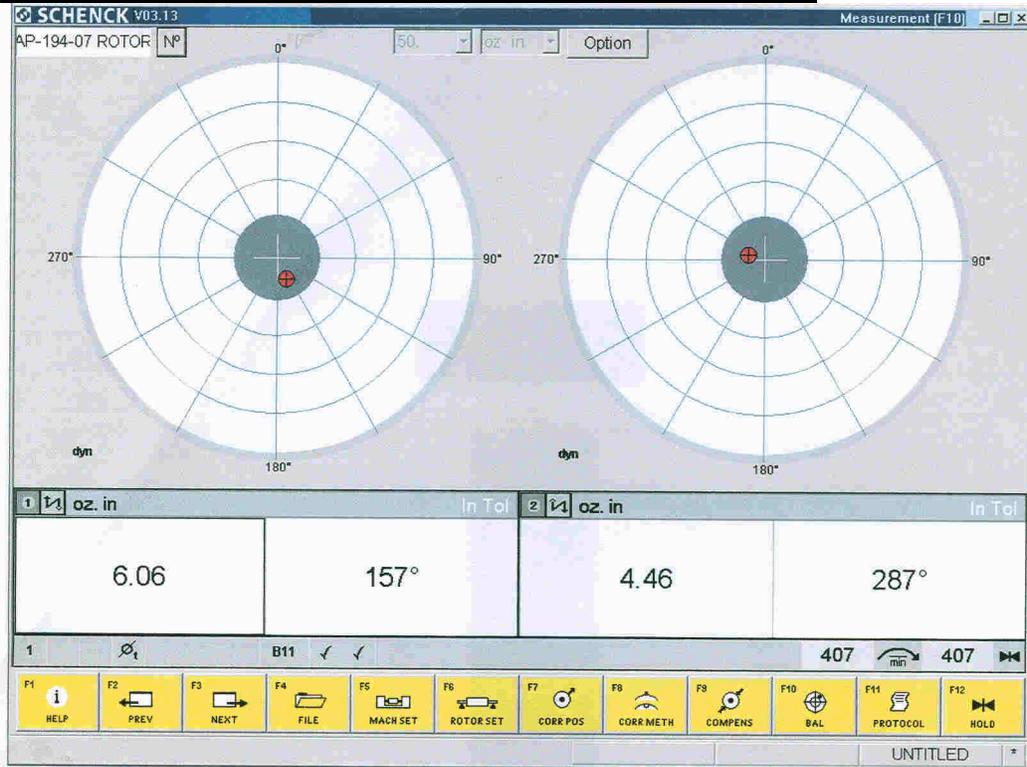
- Torque all bolting to proper value ½"-45 ft. lbs. /1-1/8"-585 ft. lbs.
- Use Loctite N-5000 anti seize on fasteners
- Package for shipment with lower bowl assembly separate from the upper shaft and column
- Deliver to FPL Seabrook Station

**Recommended Additional Parts**

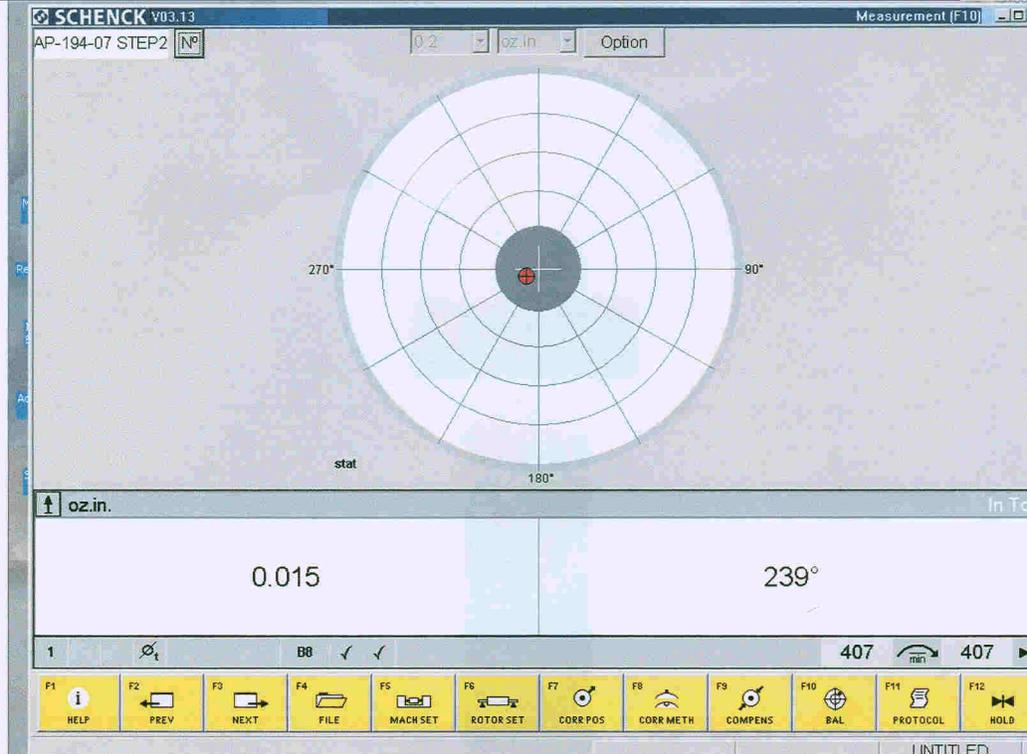
Quantity	Description	Part Number	Material
10	Retaining Rings-Journal Sleeves	RSN-425	18-8SS
2	Retaining Rings	RSN-200	18-8SS
1	Stuffing Box Sleeve		ASTM A276 Type 410SS HT 38-42Rc



**FINAL REPORT DOCUMENTATION**  
**Dynamic Balance-Step 1 Stages 2-5 Mounted on Shaft**



**Dynamic Balance-Step 2 1<sup>st</sup> Stage Added for Overhung Balance**





**Dynamic Balance of Complete Rotor-Step 3 Added 6<sup>th</sup> Stage**

**Rotor Weight 2,530 LbsX4=10,120/1800 RPM=5.62 Oz/In. Allowable Residue Unbalance**



**ROTOR ASSEMBLY FLOATS**

Stages 2-6 .870"

Final with 1<sup>st</sup> stage .456"

**IMPELLERS/CASING RINGS CLEARANCES**

Location	Casing Ring ID	Impeller OD	Clearance	Standard	Condition
1 <sup>st</sup> Outboard	10.486"	10.468"	.018"	.015"-.019"	New Casing Ring
1 <sup>st</sup> Inboard	10.486"	10.468"	.018"	.015"-.019"	New Casing Ring
2 <sup>nd</sup>	10.486"	10.470"	.016"	.015"-.019"	New Casing Ring
3 <sup>rd</sup>	10.486"	10.470"	.016"	.015"-.019"	New Casing Ring
4 <sup>th</sup>	10.486"	10.469"	.017"	.015"-.019"	New Casing Ring
5 <sup>th</sup>	10.486"	10.469"	.017"	.015"-.019"	New Casing Ring
6 <sup>th</sup>	10.486"	10.470"	.016"	.015"-.019"	New Casing Ring



**IMPELLERS-SHAFT FITS**

Location	Impeller ID	Shaft OD	Clearance	Standard	Condition
1 <sup>st</sup>	2.1249/2.1255"	2.1235"- 2.124"	.002"	.000"-.002"	Good
2 <sup>nd</sup>	4.2505	4.249"	.0015"	.000"-.002"	Good
3 <sup>rd</sup>	4.250"	4.249"	.001"	.000"-.002"	Good
4 <sup>th</sup>	4.250"	4.2485"	.0015"	.000"-.002"	Weld Band
5 <sup>th</sup>	4.2495"	4.2475"	.002"	.000"-.002"	Weld Band
6 <sup>th</sup>	4.250"	4.248"	.002"	.000"-.002"	Weld Band

**BEARING RUNNING CLEARANCES**

Location	Bearing ID	Journal OD	Clearance	Standard
Suction Bell	2.502"	2.495"	.007"	.004"-.009"
1 <sup>st</sup> Stage Volute	4.758"	4.750"	.008"	.005"-.009"
2 <sup>nd</sup>	4.757"	4.751"	.006"	.005"-.009"
3 <sup>rd</sup>	4.756"	4.750"	.006"	.005"-.009"
4 <sup>th</sup>	4.757"	4.750"	.007"	.005"-.009"
5 <sup>th</sup>	4.757"	4.751"	.006"	.005"-.009"
6 <sup>th</sup>	4.757"	4.751"	.006"	.005"-.009"
Column Upper	4.754"	4.749"	.005"	.005"-.009"

**CASINGS REGISTER FITS**

Location	ID Register Fit	OD Register Fit	Clearance	Standard
Suction to Volute	15.001"	15.000"	.001"	.000"-.002"
Volute to 2 <sup>nd</sup> Stage	17.001"	16.9995"	.0015"	.000"-.002"
2 <sup>nd</sup> to 3 <sup>rd</sup> Stage	17.002"	17.000"	.002"	.000"-.002"
3 <sup>rd</sup> to 4 <sup>th</sup> Stage	17.001"	16.9992"	.0018"	.000"-.002"
4 <sup>th</sup> to 5 <sup>th</sup> Stage	17.003"	17.001"	.002"	.000"-.002"
5 <sup>th</sup> to 6 <sup>th</sup> Stage	17.002"	17.001"	.001"	.000"-.002"
6 <sup>th</sup> to Column	17.000"	16.9985"	.0015"	.000"-.002"

**PARTS IN BOX-Stuffing Box Sleeve, Head Shaft, Line Coupling Assembly, Shaft Keys**

