



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 1st -6th stage, good. All NDE by Mag-particle method all passed except for the 1st, 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

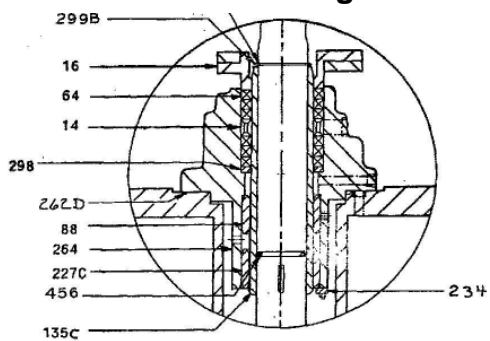
Carbon Bearings/Journal Sleeves-Minor wear and scoring, .006"-.018" clearance, (STD .005"-.008")

Bowls-General condition good

Axial Float-.850"

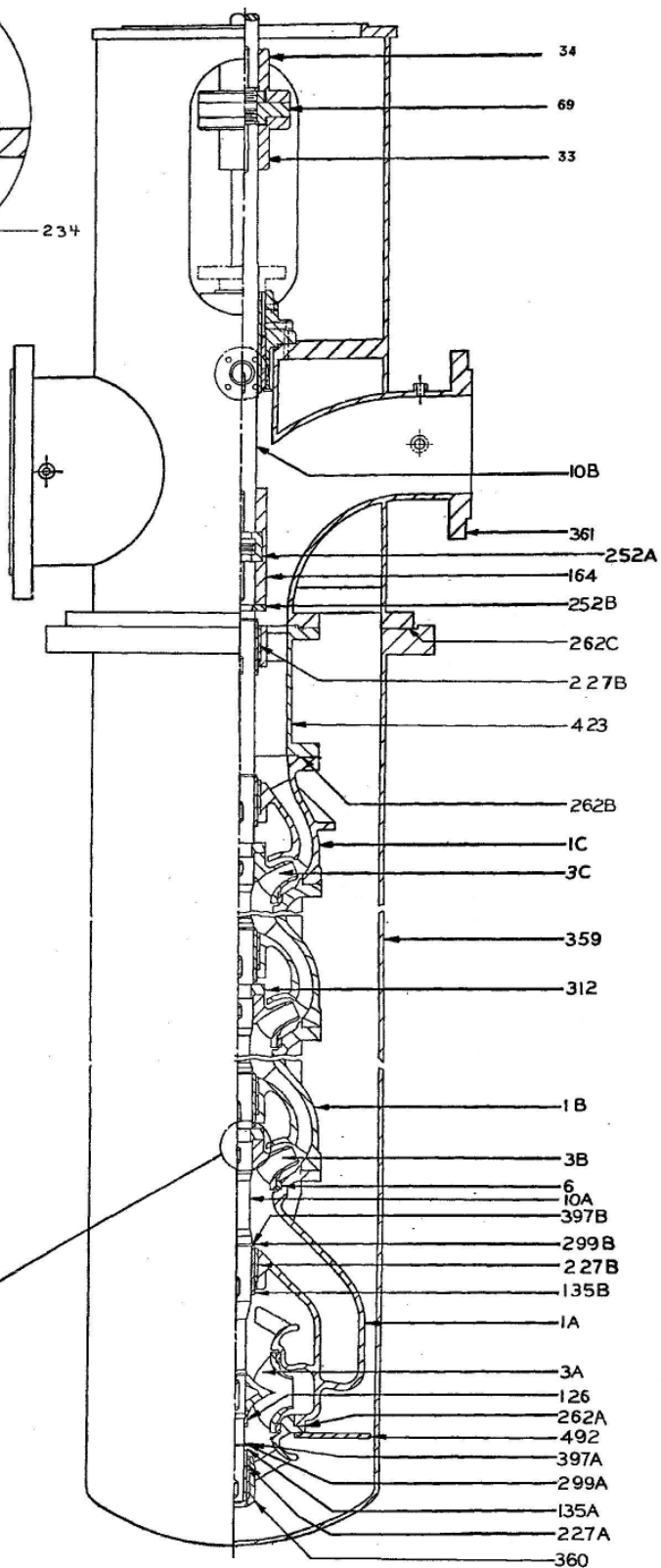
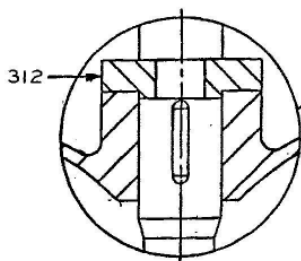
PUMP SHAFT-Record diameters, TIR and condition for journals and impeller fits

Location	Journal OD	Standard	TIR	Conditions
Lower Brg	1.999"	2.000" -.001"	.005"	Bent
1 st Stage	2.124"	2.125" -.002"	.004"	Bent
2 nd Stage	4.249"	4.250" -.001"	.001"	Good
3 rd Stage	4.249"	4.250" -.001"	.001"	Good
4 th Stage	4.249"	4.250" -.001"	.002"	Good
5 th Stage	4.248"	4.250" -.001"	.002"	Good
6 th 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

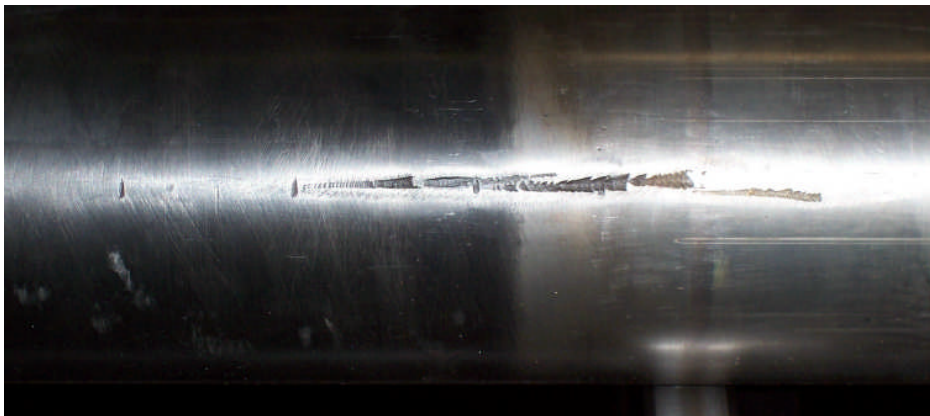
Recommended Additional Work Scope-Pump Shaft

- 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 st Outboard	10.502"	10.482"	.020"	.015"-.019"	Minor Scoring
1 st Inboard	10.504"	10.482"	.022"	.015"-.019"	Minor Scoring
2 nd	10.500"	10.481"	.019"	.015"-.019"	Minor Scoring
3 rd	10.502"	10.481"	.021"	.015"-.019"	Minor Scoring
4 th	10.501"	10.481"	.020"	.015"-.019"	Minor Scoring
5 th	10.502"	10.481"	.021"	.015"-.019"	Minor Scoring
6 th	10.502"	10.481"	.021"	.015"-.019"	Minor Scoring

IMPELLERS-SHAFT FITS

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

1st 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



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



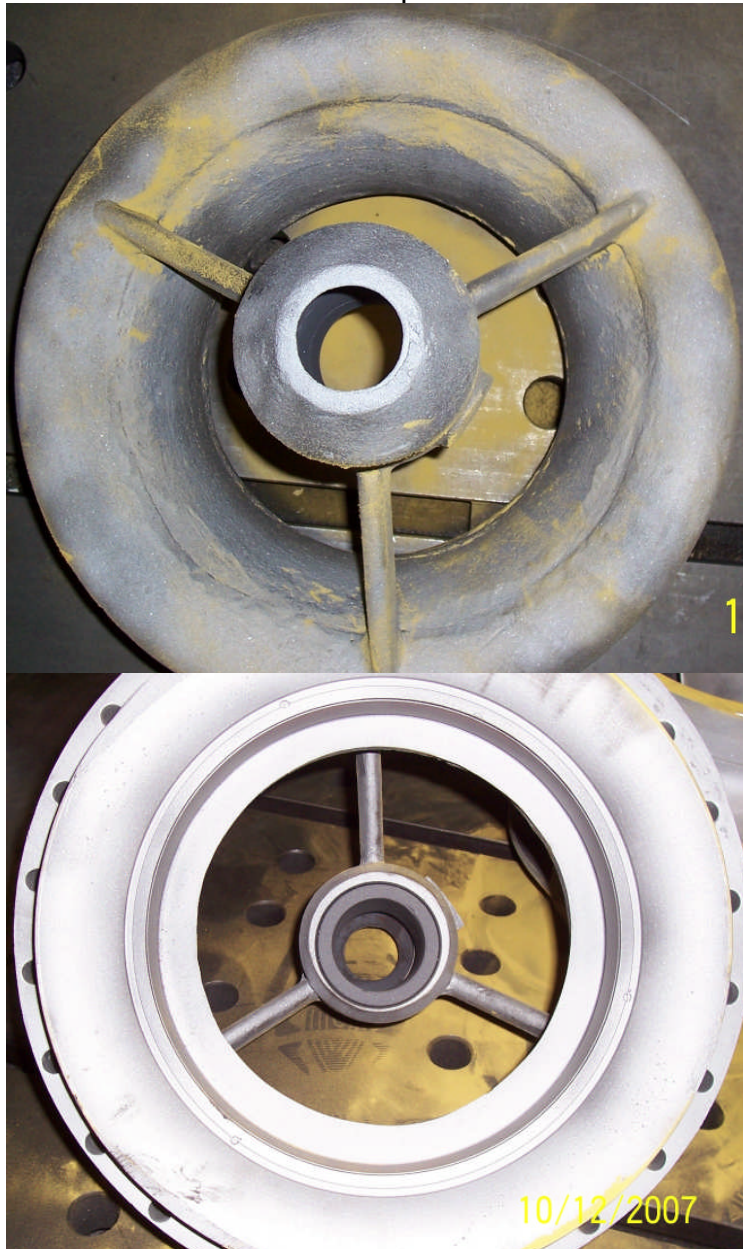
Planned Work Scope-Impellers

- 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 1st stage impeller and weld in accordance with proper procedures for CA-15 material. Hand dress weldments to original vane profile.
- On the 2nd -6th 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 nd Stage	17.001"	16.9995"	.0015"	.000"-.002"
2 nd to 3 rd Stage	17.002"	16.9985"	.0035"	.000"-.002"
3 rd to 4 th Stage	17.001"	16.9992"	.0018"	.000"-.002"
4 th to 5 th Stage	17.003"	16.995"	.0035"	.000"-.002"
5 th to 6 th Stage	17.002"	17.001"	.001"	.000"-.002"
6 th 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 st Stage Volute	4.763"	4.745"	.018"	.005"-.009"
2 nd	4.762"	4.745"	.017"	.005"-.009"
3 rd	4.755"	4.744"	.011"	.005"-.009"
4 th	4.753"	4.744"	.009"	.005"-.009"
5 th	4.753"	4.744"	.009"	.005"-.009"
6 th	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 st Stage Volute	5.5052"	4.56"	.0015"-.002"	.000"-.002"
2 nd	5.502"	4.56"	.0015"	.000"-.002"
3 rd	5.5023"	4.56"	.002"	.000"-.002"
4 th	5.019"	4.56"	.002"-.0025"	.000"-.002"
5 th	5.501"	4.56"	.003"	.000"-.002"
6 th	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 st Outboard	11.131"	1.248"	.0015"	.000"-.002"
1 st Inboard	11.128"	1.245"	.002"	.000"-.002"
2 nd	11.129"	1.250"	.002"	.000"-.002"
3 rd	11.134"	1.260"	.002"	.000"-.002"
4 th	11.131"	1.260"	.002"	.000"-.002"
5 th	11.125"	1.250"	.0012"	.000"-.002"
6 th	11.126"	1.245"	.002"	.000"-.002"

Planned Work Scope- Casing Rings/ Bowls

- Furnish and install two (2) new 1st stage casing rings, five (5) new 2nd through 6th 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 1st through 6th stage bearings
- Pad weld the 2nd to 3rd, 4th to 5th 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 (1st) impeller and balance as single plane, over hung weight.
- Install sixth (6th) 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

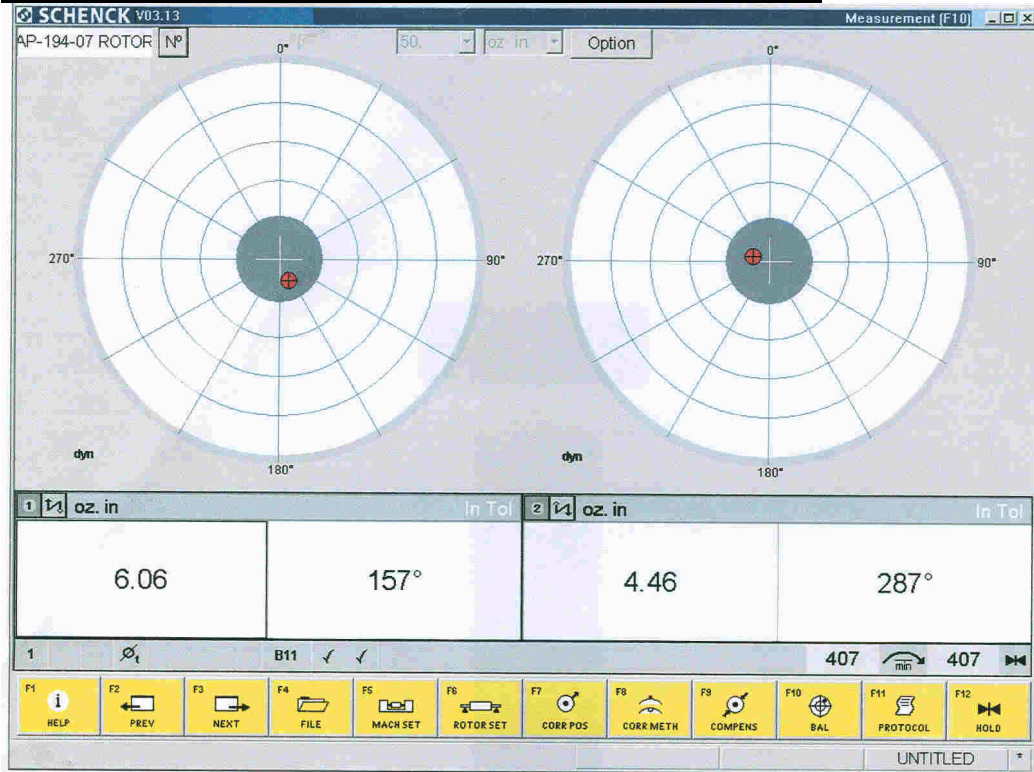
Recommended Additional Parts

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

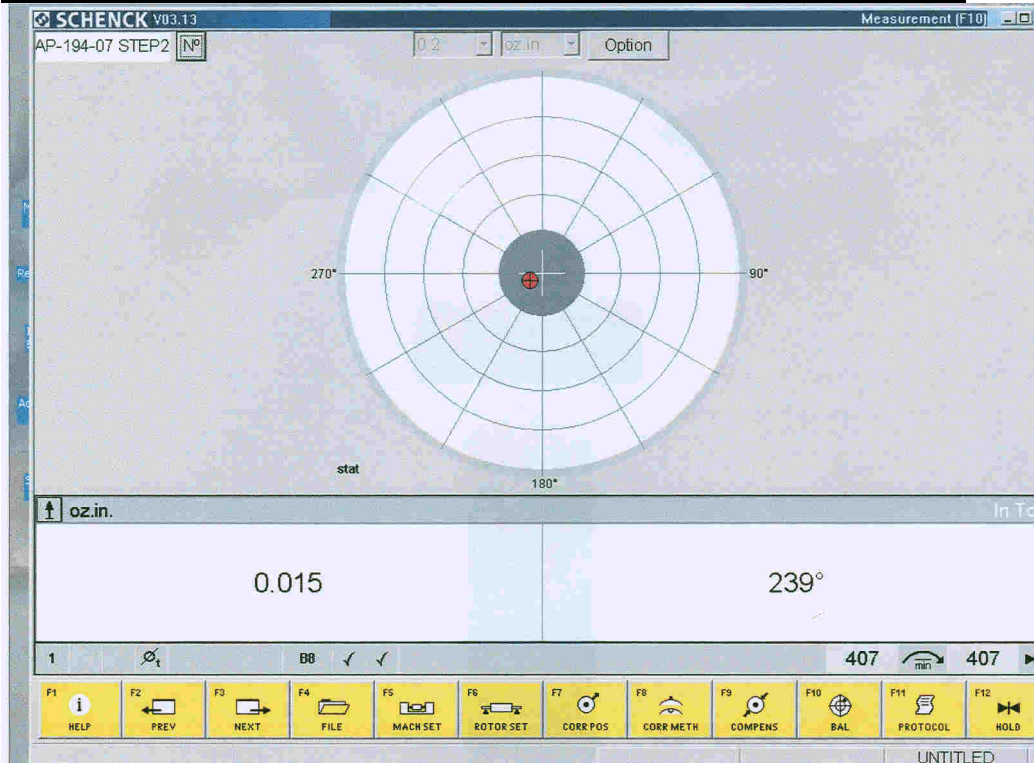


FINAL REPORT DOCUMENTATION

Dynamic Balance-Step 1 Stages 2-5 Mounted on Shaft



Dynamic Balance-Step 2 1st Stage Added for Overhung Balance





Dynamic Balance of Complete Rotor-Step 3 Added 6th 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 1st stage .456"

IMPELLERS/CASING RINGS CLEARANCES

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



IMPELLERS-SHAFT FITS

Location	Impeller ID	Shaft OD	Clearance	Standard	Condition
1 st	2.1249/2.1255"	2.1235"- 2.124"	.002"	.000"-.002"	Good
2 nd	4.2505	4.249"	.0015"	.000"-.002"	Good
3 rd	4.250"	4.249"	.001"	.000"-.002"	Good
4 th	4.250"	4.2485"	.0015"	.000"-.002"	Weld Band
5 th	4.2495"	4.2475"	.002"	.000"-.002"	Weld Band
6 th	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 st Stage Volute	4.758"	4.750"	.008"	.005"-.009"
2 nd	4.757"	4.751"	.006"	.005"-.009"
3 rd	4.756"	4.750"	.006"	.005"-.009"
4 th	4.757"	4.750"	.007"	.005"-.009"
5 th	4.757"	4.751"	.006"	.005"-.009"
6 th	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 nd Stage	17.001"	16.9995"	.0015"	.000"-.002"
2 nd to 3 rd Stage	17.002"	17.000"	.002"	.000"-.002"
3 rd to 4 th Stage	17.001"	16.9992"	.0018"	.000"-.002"
4 th to 5 th Stage	17.003"	17.001"	.002"	.000"-.002"
5 th to 6 th Stage	17.002"	17.001"	.001"	.000"-.002"
6 th to Column	17.000"	16.9985"	.0015"	.000"-.002"

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

