

Dean

SERIES RAV/RWAV

High Temperature Air Cooled Vertical In-Line Pumps

INSTALLATION

OPERATION

MAINTENANCE MANUAL

RAV3096
RAV3146



RWAV4096
RWAV4166



**DO NOT INSTALL, OPERATE, OR SERVICE THIS PUMP
BEFORE READING THE ENTIRE MANUAL**

INDEX

Product Inspection and Test	1
Warnings	1
Receiving Pump	1
Storage	1
Mechanical Design Specifications	2
Standard Materials of Construction	3
Allowable Working Pressure	3
Installation	4
Application and Reapplication	4
Casing Foot Mounting and Alignment	4
Suction and Discharge Piping	4
Allowable Piping Loads	5
Pump Lubrication	6
Bearings	6
Mechanical Seal	6
Small Piping Connections	7
Starting the Pump	8
Filling	8
Operating	8
Pump Start-Up Checklist	9
Spare Parts	10
Ordering Spare Parts	10
Pump Section Views	12
RAV3096/RWAV4096	12
RAV3146/RWAV4166	13
Disassembly and Reassembly Procedures	14
Warnings	14
Disassembly Procedure	15
Reassembly Procedure	16
Notes	19

PRODUCT INSPECTION AND TEST

The Products of Dean Pump Division are subject to thorough and rigorous quality control and inspection procedures throughout the whole of the manufacturing process to assure proper operation in full conformity with established performance standards. On completion of inspection, each unit is sprayed internally with rust inhibitor (if material is subject to atmospheric corrosion), sealed

against the entrance of dirt, and tagged with a signed certificate of inspection prior to shipment. Each pump when shipped is ready to perform the service for which it was designed with minimum maintenance and expense if properly installed and operated in accordance with the instructions furnished.

WARNING

HAZARDOUS SITUATIONS MAY OCCUR UNLESS THIS EQUIPMENT IS APPLIED, INSTALLED, OPERATED, AND MAINTAINED BY THOROUGHLY QUALIFIED PERSONNEL IN STRICT ACCORDANCE WITH THE INSTRUCTION MANUAL AND ALL APPLICABLE DRAWINGS AND CODES.

Read the instruction manual completely before installing, filling, operating, or maintaining this equipment.

Obtain, read and heed the MSDS (Material Safety Data Sheet) for the fluids being handled before attempting to fill, operate or maintain this equipment. Obtain instructions from the Safety Engineer responsible for your facility before performing any work on the pumping equipment and systems.

Proper storage while not in use and proper installation and startup are essential for successful pump operation. Misuse or improper storage, installation or operation of pumps may result in serious loss or damage. Dean Pump Division is not responsible for any loss or damage resulting from causes beyond its control, and is not liable for charges for work performed or materials furnished to repair such loss or damage.

All installation, operation, and maintenance must be done by thoroughly qualified personnel in strict accordance with this manual and must comply with all local, state and Federal codes. Only Dean authorized service parts must be used in the repair of these pumps.

RECEIVING PUMP

When the pump is received from the transportation company it should be promptly inspected for damage and such damage noted on the bill of lading before it is signed. Claims for shipping damage must be filed against the carrier.

Care must be exercised in unloading and handling the pump.

STORAGE

Pumps must be properly covered and protected against moisture, dirt, and physical damage during storage prior to installation.

If prolonged storage is anticipated, do the following:

- 1) Seal the suction and discharge opening of the pump with a blind flange, gasket, and bolts.
- 2) Remove the vapor vent and fill through the discharge opening of the pump with a corrosion inhibiting liquid that is also compatible with the liquid that will later be pumped. Evaluation of compatibility must include consideration of the temperature at which the system will later operate. Remove the seal vent plug while filling to assure that all air is purged from the mechanical seal cavity. When the liquid flows through the vent connection, replace the seal vent plug. If liquid does not flow from this connection, fill through this connection until all air is purged.
- 3) Continue filling through the discharge opening until the pump is completely filled.
- 4) Seal the vapor vent opening with a pipe cap
- 5) Remove the barrier oil fill plug and turn the elbow up. Fill the barrier cavity with a corrosion inhibiting liquid that is compatible with the barrier liquid that will be used later for pump operation. When this liquid starts to flow out of the overflow pipe, replace the fill plug.

- 6) Remove the bearing end cover (28) and cradle (7) and fill the center pocket of the end cover with the grease described under "PUMP LUBRICATION". Replace and secure the end cover.
- 7) Apply a heavy protective coating to all exposed machined surfaces. A rust preventive must be used to protect all steel and iron parts.
- 8) Rotate the pump shaft "by hand" each month. Wear heavy gloves when rotating the shaft, to protect your hands.

When you are ready to place the pump in service;

- 1) Remove the bearing end cover (28). Remove and discard about one half of the grease that is in the end cover. Replace and secure the end cover (see assembly instructions). Be sure to comply with all government regulations in the disposal of the grease.
- 2) Remove the barrier oil drain plug and turn the elbow down. Drain and discard the storage liquid. Remove the barrier oil fill plug. Flush all remains of the storage liquid from the barrier cavity. Replace the fill and drain plugs. Use a flush liquid that is compatible with the barrier fluid to be used. Be sure to comply with all governmental regulations in disposal of the storage liquid and the flush liquid.
- 3) Remove the casing drain plug and the seal vent plug. Drain and discard the storage liquid. Remove and discard the suction bolts, blind flange, and gasket. Flush all remains of the storage liquid from the pump. Use a flush liquid that is compatible with the pumpage, as any flush liquid remaining in the pump when it is placed in operation, will be exposed to the operating temperatures and pressures. Vapor pressure is "one" of the critical properties to be considered. Be sure to comply with all environmental regulations in disposal of the storage liquid, flush liquid, and gaskets.

WARNING:

Be sure that there is nothing remaining in the pump that could react with the liquid that will be pumped or that would have an excessive vapor pressure at the system operating temperature. For example, water residue left in the pump, when exposed to the operating temperature of the system, would create a vapor pressure in excess of the capability of the system to retain it, therefore causing an explosion that could prove fatal.

- 4) Replace the casing drain plug and the seal vent plug.
- 5) Remove the "storage" protective coating from the external surfaces of the pump.

Pumps must also be protected from moisture, dirt, and physical damage, during and after installation while the system is being completed. Pumps "stored" on their foundations must be completely checked for proper installation prior to start-up.

Care in storage and installation will preserve the built-in quality of each Dean Product.

FAN COOLED, HORIZONTAL, SINGLE STAGE, END SUCTION, ENCLOSED IMPELLER, CENTRIFUGAL, HIGH TEMPERATURE PUMPS

THESE PUMPS ARE DESIGNED SPECIFICALLY FOR USE WITH HOT OIL/HOT WATER/GLYCOL

MECHANICAL DESIGN SPECIFICATIONS				
PUMP TYPE	RAV3096	RAV3146	RWAV4096	RWAV4166
Direction of Rotation (Viewed from Coupling End)	CW	CCW	CW	CCW
Casing Thickness, Minimum	5/16"	5/16"	5/16"	5/16"
Corrosion Allowance	1/8"	1/8"	1/8"	1/8"
Impeller Balance Standard Optional Extra	Single Plane Dynamic	Single Plane Dynamic	Single Plane Dynamic	Single Plane Dynamic
Flanges ANSI Class Facing Finish	300 Raised Face 125 Ra	300 Raised Face 125 Ra	300 Raised Face 125 Ra	300 Raised Face 125 Ra
Suction Pressure, Maximum	100 PSIG	100 PSIG	260 PSIG	260 PSIG
Horsepower Rating, Maximum @3500 RPM @1750 RPM @1150 RPM	35 15 10	35 15 10	35 15 10	35 15 10
Bearings Thrust Bearing, Ball Type, Grease Lubricated Radial Bearing, Sleeve Type, Pumpage Lubricated	5306 2RS Double Row	7308 GB Angular Contact Pair	5306 2RS Double Row	7308 GB Angular Contact Pair
Seal Chamber Dimensions Length (Depth) Inside Diameter (Bore Dia.) Shaft Diameter	1 5/8" 2 1/6" 1 1/8"	2 13/16" 3 1/8" 1 3/4"	1 5/8" 2 1/6" 1 1/8"	2 13/16" 3 1/8" 2"
Pump Shaft Dimensions Span Between Bearings Span Between Radial Bearing Centerline and Impeller Centerline Diameter at Coupling Diameter Between Bearings Diameter at Impeller	8 11/16" 1 5/8" 7/8" 15/16" 3/4"	11 7/16" 2 5/16" 1 1/8" 1 9/16" 1 1/8"	8 11/16" 1 5/8" 7/8" 15/16" 3/4"	11 7/16" 2 5/16" 1 1/8" 1 9/16" 1 1/8"
L³D⁴	4.3	2.1	4.3	2.1
Material Class	22 (Ductile Iron)	22 (Ductile Iron)	22 (Ductile Iron)	22 (Ductile Iron)
Maximum Working Pressure	250 PSIG	250 PSIG	450 PSIG	450 PSIG
Pumping Temperature Minimum Maximum	-20°F @ 250 PSIG 650°F @ 250 PSIG	-20°F @ 250 PSIG 650°F @ 250 PSIG	-20°F @ 250 PSIG 400°F @ 450 PSIG	-20°F @ 250 PSIG 400°F @ 450 PSIG
Maximum Ambient Temperature (temp. within 12" of pump)	104°F	118°F	104°F	118°F
Hydrostatic Test Pressure	550 PSIG	550 PSIG	700 PSIG	700 PSIG

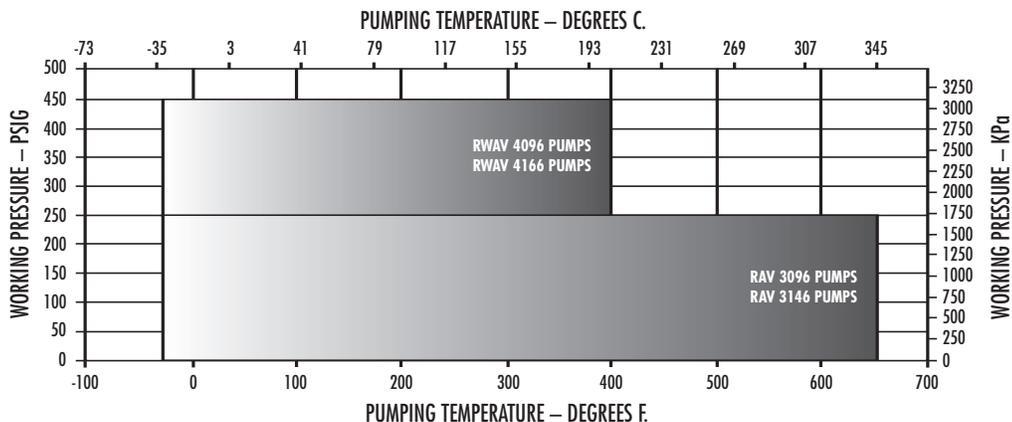
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STANDARD MATERIALS OF CONSTRUCTION					
PART #	PART NAME	RAV3096 CLASS 22	RAV3146 CLASS 22	RWAV4096 CLASS 22	RWAV4166 CLASS 22
3	Impeller	C.I. (1)	C.I. (1)	C.I. (1)	C.I. (1)
4	Impeller Key	Steel (2)	Steel (2)	Steel (2)	Steel (2)
5	Casing	D.I. (10)	D.I. (10)	D.I. (10)	D.I. (10)
5A	Casing Drain Plug	Steel (2)	Steel (2)	Steel (2)	Steel (2)
5B	Casing Stud	Steel (4)	Steel (4)	Steel (4)	Steel (4)
5C	Casing Nut	Steel (5)	Steel (5)	Steel (5)	Steel (5)
5D	Jack Screw	Steel (2)	Steel (2)	Steel (2)	Steel (2)
7	Cradle	C.I. (1) & Steel (2)	C.I. (1) & Steel (2)	C.I. (1) & Steel (2)	C.I. (1) & Steel (2)
10	Shaft Sleeve	NA	NA	NA	316 SS (8)
12	Impeller Nut/Bolt	Steel (2)	Steel (2)	Steel (2)	Steel (2)
12A	Impeller Washer	Steel (2)	Steel (2)	Steel (2)	Steel (2)
12B	Impeller Jam Nut Washer	Steel (2)	NA	Steel (2)	NA
13	Mechanical Seal Gland	Steel (2)	Steel (2)	Steel (2)	Steel (2)
25A	Thrust Bearing	Double Row	Angular Cont. Pair	Double Row	Angular Cont. Pair
26	Bearing Housing	D.I. (10)	D.I. (10)	D.I. (10)	D.I. (10)
28	Bearing Housing Cover	C.I. (1)	C.I. (1)	C.I. (1)	C.I. (1)
28A	Cover Bolt	Steel (2)	Steel (2)	Steel (2)	Steel (2)
28B	Cover Washer	Steel (2)	NA	Steel (2)	NA
29	Pump Shaft	11-13 S/S (12)	11-13 S/S (12)	11-13 S/S (12)	11-13 S/S (12)
31	Thrust Bearing Lock Nut	NA	Steel (2)	NA	Steel (2)
31A	Thrust Bearing Lock Washer	NA	Steel (2)	NA	Steel (2)
56	Casing Foot	C.I. (1)	C.I. (1)	C.I. (1)	C.I. (1)
56A	Casing Foot Bolts	Steel (2)	Steel (2)	Steel (2)	Steel (2)
75	Snap Ring	NA	Steel (2)	NA	Steel (2)
75A	Snap Ring	Steel (2)	NA	Steel (2)	NA
76	Grease Seal-Front	Viton (13)	Viton (13)	Viton (13)	Viton (13)
76A	Grease Seal-Rear	NA	BUNA (14)	NA	BUNA (14)
77	Casing Gasket	Grafoil (11)	Grafoil (11)	Teflon (15)	Teflon (15)
77A	Sleeve Gasket	NA	NA	NA	AFLAS
77B	Bearing End Cover Gasket	NA	BUNA (14)	NA	BUNA (14)
84	Barrier Fill Plug	Steel (2)	Steel (2)	Steel (2)	Steel (2)
92	Barrier Drain Plug	Steel (2)	Steel (2)	Steel (2)	Steel (2)
95A	Mechanical Seal Stationary	Silicon Carbide & Viton	Silicon Carbide & Viton	Silicon Carbide & Aflas	Silicon Carbide & Aflas
95B	Mechanical Seal Rotary	S/S, Carbon & Viton	S/S, Carbon & Viton	S/S, Carbon & Aflas	S/S, Carbon & Aflas
98	Coupling Guard	Steel (2)	Steel (2)	Steel (2)	Steel (2)
98A	Coupling Guard Bolts	Steel (2)	Steel (2)	Steel (2)	Steel (2)
120	Fan	Aluminum	Aluminum	Aluminum	Aluminum
121	Fan Collar	NA	Steel (2)	NA	Steel (2)
122	Fan Clamp Ring	Steel (2)	Steel (2)	Steel (2)	Steel (2)
180	Radial Bearing	Carbon & Steel	Carbon & Steel	Carbon & Steel	Carbon & Steel
325	Seal Gland Gasket	Viton (13)	Viton (13)	Aflas	Aflas
365	Seal Collar	Steel (2)	Steel (2)	NA	NA
370	Collar Set Screw	Steel (2)	Steel (2)	NA	NA

*Denotes parts interchangeability in all pump sizes of a given series.

- | | | | | |
|---|----------------------------------|--|-----------------------|---|
| (1) Cast Iron | (4) AISI 4140 ASTM A193-B7 Steel | (8) ANSI 316 S/S with ANSI 416 S/S at the sleeve bearing | (11) Grafoil® | (14) Buna N Rubber |
| (2) AISI 1020 | (5) ASTM A194 Grade 2 Steel | (9) Ductile Iron – ASTM A536 | (12) ANSI – 420 S/S | Viton® is a registered Trademark of E.I. DuPont Co. |
| (3) SAE Grade 5 or ASTM A449 Type 1 Steel | (7) Hardened Iron | (10) Ductile Iron ASTM A395 | (13) Viton® Elastomer | Grafoil® is a registered Trademark of Union Carbide Corp. |

ALLOWABLE WORKING PRESSURE VS. PUMPING TEMPERATURE



INSTALLATION

Obtain MSDS data sheets for all liquids (from the manufacturers of those liquids) being used with the pump, and heed all cautions.

Always wear the appropriate protective apparel when working on or around the pumping equipment. Safety glasses with side shields, heavy work gloves (use insulated work gloves when handling hot items), steel-toed shoes, hard hat, and any other protective gear as needed for protection. One example of other gear would be breathing apparatus when working near toxic materials. Use lifting devices, manufactured expressly for the purpose of lifting, to move the pumping machinery. Do not attempt to lift the assembly or its components manually. Use only devices with lifting capabilities in excess of the weight of the unit being lifted. Inspect straps, chains, hooks, etc. for damage and lifting capability before use.

Personal injury, death, and/or equipment damage could occur if good lifting practices are not used.

APPLICATION AND REAPPLICATION

At the time of installation, the equipment received should have already been selected for the service required. You must read the paperwork for the installation and check the serial number of the pump to assure that you are installing the correct pump into the service for which it was selected.

Many pumps look identical from the outside but can be made of different materials and/or be constructed differently inside. Personal injury, death, equipment damage, product (pumpage) damage, and/or product loss could occur if the incorrect pump is installed.

Do not transfer an existing pump to any other service conditions until you have thoroughly reviewed the pump construction, materials, sizing, sealing, pressure containing capability, head/capacity capability, and temperature capability with respect to the required service. Consult your Dean Pump sales engineer with all the service requirements and a full description of the existing pump (including the serial number), seal, and sub-systems so that we can assist you in a successful reapplication.

CASING FOOT (56) MOUNTING AND ALIGNMENT

The sequence of mounting which must be observed for proper casing foot (56) and pump mounting is:

- 1) Place Casing Foot (56), with pump and driver mounted thereon, on the pump foundation.
- 2) Use wedges under the casing foot edges, at each foundation bolt, to properly support and level the unit. Check this with a spirit level. Pull down the casing foot mounting bolts tightly and recheck for level. Correct if necessary.
- 3) Install "new" gaskets, of the correct material for the service, and the correct size per ASME B16.20, or ASME B16.21 at the suction and the discharge flanges of the pump. Use only new gaskets.

Connect the suction and discharge piping without forcing the piping into position. See **"Suction and Discharge Piping"** below. The pipe flanges must line up with the pump flanges "freely".

Install a "new" bolt, of the correct size per ASME/ANSI B16.5, and of the correct material per ASME/ANSI B16.5, in every bolt hole. Tighten all bolts evenly. Use only new uncorroded fasteners.

WARNING:

Strain caused by "forcing", improper flange bolting, and/or misalignment may cause failure of the pumping unit, flanges, piping and/or fluid (pumpage) release which could cause personal injury, death, and/or damage to this and/or other equipment.

WARNING:

Make sure that all piping is installed into its correct connection. Installation of a pipe into an incorrect location could result in an explosion and personal injury or death as well as damage to this and/or other equipment.

Install pressure relief valves in any cavities that could be subjected to pressures in excess of the allowable working pressure. Explosion, personal injury, death, and/or damage to this and/or other equipment may occur if pressure exceeds allowable.

SUCTION AND DISCHARGE PIPING

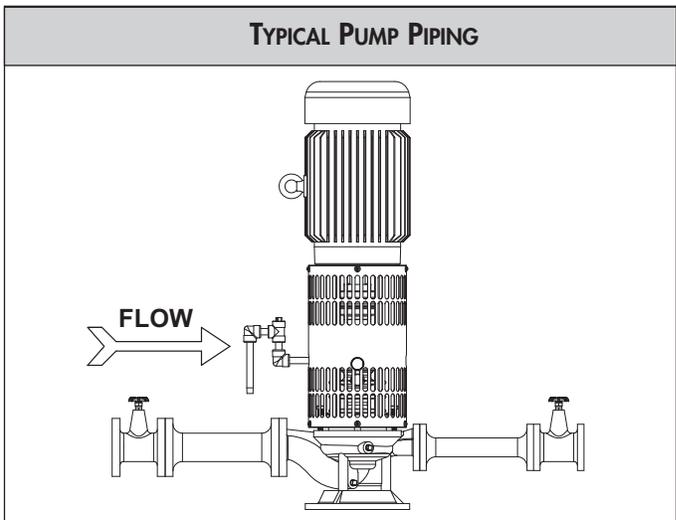
Suction and discharge nozzle sizes of Dean pumps are selected for proper performance of the pumping unit and are not intended to determine the suction and discharge pipe sizes. Pipe sizes must be determined by the user based on the system requirements.

Suction piping should have a minimum friction loss and thus should be as short and straight as possible with a pipe diameter as large as economically feasible for the flow rate handled.

Suction piping should never be smaller in diameter than the suction nozzle size. When the suction piping is larger than the suction nozzle size an eccentric reducer is required at the suction flange and must be installed with the taper located on the underside to eliminate air or vapor pockets. The section of piping attached to the suction flange of the pump should be straight for a length of eight pipe diameters or more.

Discharge piping may be the same size as, larger, or smaller than the discharge nozzle as the system flow may demand.

In new installations or rebuilt systems, dirt, pipe scale, welding slag, and general construction debris may get into the piping. It is important to prevent this material from entering the pump and damaging pump parts, bearings, mechanical seal faces, or lip seals. Bearings, mechanical seals and lip seals are especially subject to damage even by very small particles. To prevent damage, a strainer or filter installed in the suction line is recommended. Commercially available strainers or filters as recommended by their manufacturers can do an excellent job.



Suction line screens or strainers may usually be removed when, after several days of use, no dirt has been collected and the system is clean.

Remember that screens and filters in the suction line are restricting devices which reduce the net positive suction head (NPSH) available to the pump and should be considered at the time the system is designed.

ALLOWABLE PIPING LOADS FOR RAV3096/RAV3146 & RWAV4096/RWAV4166 PUMPS

FLANGE STRESS

The maximum stress developed in the pump flanges by the applied nozzle loads combined with internal pressure will not exceed 26,250 PSI tensile and 13,125 shear. This in accordance with the allowable stress for ASTM A351 (A 744/743) - Grade CF8M per ASME Boiler and Pressure Vessel Code.

The flange stress is calculated using the method contained in the ASME Boiler and Pressure Vessel Code, 1995 Edition, Section III, Division 1, Appendix XI - Rules for Bolted Flange Connections for Class 2 and 3 Components and lass MC Vessels.

The maximum bending (M_x, M_z) and torsional (M_y), moments are those moments that, when applied to the flange, will develop the maximum allowed flange stress.

The maximum shear force (F_x, F_z) equals the maximum bending moment divided by overall pump length: SD, as defined by ASME B73.2M.

The maximum axial force (F_y), is that force which will develop tensile stress of 7000 psi in the flange bolts. This tensile stress is in addition to the stress developed by internal pressure and flange gasket seating loads. The total combined stress must be evaluated for the service conditions and bolts of adequate strength must be used. The minimum required bolt strength is equal to the sum of: 7000 psi plus bolt stress due to internal pressure plus bolt stress due to gasket loads. Higher nozzle loads may be permitted if bolting of higher than minimum required strength is used.

PRESSURE-TEMPERATURE

The temperature shown for a corresponding allowable nozzle load is the temperature of the pressure-containing components of the pump. In general, this temperature is the same as that of the contained liquid.

Use of a pressure rating as specified in ANSI/ASME B16.5 corresponding to a temperature other than that of the contained liquid is the responsibility of the user, subject to the requirements of the applicable code or regulation.

Low-temperature and high-temperature considerations addressed in ANSI/ASME B16.5 should be examined.

PUMP NOZZLE LOADS

Loads given in Table 2 are applicable for ASME B73.2M pumps constructed of ASTM A 743/744 - Grade CF8M (Type 316SS) operated between -20°F and 100°F.

For an individual force or moment or for a combination of more than one force and/or moment, pumps must be capable of satisfactory operation when subjected to loads shown in Table 2 (adjusted if applicable), while meeting the criteria of Equation Set 1. Each load in the Table 2 is such that it is the maximum value for that particular load regardless of whether or not any other external loads are applied.

When applying loads, the absolute value of any individual load must not exceed the value given in Table 2.

TEMPERATURE AND MATERIAL ADJUSTMENT FACTORS

Adjustment of allowable load values using Table 1 is required if any of the following occur:

- a) Temperature is above 100°F.
- b) The pump material construction is not ASTM A744 - Grade CF8M.

ADJUSTMENT FACTOR BASIS

Adjustment factors are determined by taking the ANSI/ASME B 16.5 Class 300 pressure-temperature rating of ASTM A 351 - Grade CF8M Class 300 at 100°F as specified in ANSI/ASME B16.5.

In the case of ductile cast iron, adjustment factors were determined by taking the ANSI/ASME B16.42 Class 300 pressure-temperature ratings and dividing by the pressure-temperature rating of ASTM A 351 - Grade CF8M Class 300 at 100°F as specified in ANSI/ASME B16.5.

ADJUSTMENT FACTORS

For temperatures above 100°F and/or the use of a material other than ASTM A 744 - Grade CF8M, the loads in Table 2 should be reduced by multiplying them by the proper adjustment factor from Table 1.

For intermediate temperatures not shown in Table 1, linear interpolation is permitted.

TERM DEFINITIONS (REFER TO FIG. 1)	
F_x = Applied force on X-Axis on suction or discharge nozzle	M_x = Applied moment on X-Axis on suction or discharge nozzle
F_y = Applied force on Y-Axis on suction or discharge nozzle	M_y = Applied moment on Y-Axis on suction or discharge nozzle
F_z = Applied force on Z-Axis on suction or discharge nozzle	M_z = Applied moment on Z-Axis on suction or discharge nozzle

TABLE 1

TEMP. (°F)	MATERIAL GROUP NO.													
	1	1.1	2.1	2.2	2.3	2.4	2.8	3.1	3.2	3.4	3.5	3.7	3.8	
	AUSTENITIC STEELS						NICKEL AND NICKEL ALLOYS							
DUCTILE CAST IRON	CARBON STEEL	TYPE 304			TYPE 316	TYPE 316L	TYPE 321	C-4MU CU	ALLOY 20	NICKEL	MONEL	INCONEL	HAST B.	HAST C.
-20-100	0.89	1	1	1	0.83	1	1	0.83	0.5	0.83	1	1	1	
200	0.83	0.94	0.83	0.86	0.7	0.98	1	0.77	0.5	0.74	0.93	1	1	
300	0.78	0.91	0.74	0.78	0.63	0.83	1	0.73	0.5	0.69	0.89	1	1	
400	0.73	0.88	0.65	0.72	0.58	0.69	0.98	0.67	0.5	0.67	0.85	0.98	0.98	
500	0.69	0.83	0.6	0.67	0.53	0.64	0.92	0.65	0.5	0.66	0.83	0.92	0.92	
600	0.65	0.76	0.58	0.63	0.5	0.6	0.84	0.63	0.5	0.66	0.8	0.84	0.84	
650	0.63	0.74	0.57	0.62	0.49	0.6	0.82	0.63	-	0.66	0.78	0.82	0.82	
700	-	0.74	0.56	0.6	0.48	0.58	0.79	0.62	-	0.66	0.77	0.79	0.79	

TABLE 2

PUMP GEOMETRY		ALLOWABLE NOZZLE LOADS					
PUMP TYPE	PUMP SIZE	FORCES (LB.)			MOMENTS (FT. - LB.)		
		F _x MAX	F _y MAX	F _z MAX	M _x MAX	M _y MAX	M _z MAX
RAV/RWAV	1X1.5X6	410	3976	410	510	720	510
RAV/RWAV	1X1.5X8	360	3976	360	510	720	510
RAV/RWAV	1.5X3X6	410	3976	410	510	720	510
RAV/RWAV	1X3X8.5	360	3976	360	510	720	510
RAV/RWAV	1.5X3X8.5	360	3976	360	510	720	510
RAV/RWAV	2X3X8.5	540	6328	540	900	1270	900

EQUATION SET 1

The allowable nozzle loads for Table 2 are based on the following formula:

$$\left| \frac{F_{xs}}{F_{x \max}} \right| \leq 1.0, \left| \frac{F_{ys}}{F_{y \max}} \right| \leq 1.0, \left| \frac{F_{zs}}{F_{z \max}} \right| \leq 1.0, \left| \frac{M_{xs}}{M_{x \max}} \right| \leq 1.0, \left| \frac{M_{ys}}{M_{y \max}} \right| \leq 1.0, \left| \frac{M_{zs}}{M_{z \max}} \right| \leq 1.0,$$

$$\left| \frac{F_{xd}}{F_{x \max}} \right| \leq 1.0, \left| \frac{F_{yd}}{F_{y \max}} \right| \leq 1.0, \left| \frac{F_{zd}}{F_{z \max}} \right| \leq 1.0, \left| \frac{M_{xd}}{M_{x \max}} \right| \leq 1.0, \left| \frac{M_{yd}}{M_{y \max}} \right| \leq 1.0, \left| \frac{M_{zd}}{M_{z \max}} \right| \leq 1.0,$$

PUMP LUBRICATION

BEARINGS

The radial bearing (180) is lubricated by the liquid being pumped and therefore needs no external lubrication.

The RAV3096/RWAV4096 uses a "sealed for life" thrust bearing(s) (25A) that is packed with grease by the ball bearing manufacturer.

The RAV3146/RWAV4166 ball bearings are hand packed as an assembly procedure when the pump is assembled. The grease is a lithium 12-hydroxystearate soap-thickened grease that has rust inhibitors and extreme pressure additives. This is a NLGI, Grade 2, similar to: Shell Oil Company's "Alvania" Grease #EP2 or Union Oil of California's "Unoba EP" Grease Grade #2

Grease is also available from Dean Pump in individual containers which contain enough grease for one RAV3146/RWAV4166 pump. Order "RA3000" Grease #2 for bearing lubrication.

MECHANICAL SEAL

The RAV/RWAV Pumps are arranged with a mechanical face seal (95A & 95B) that was specifically selected for the sealing of hot oils, hot water, hot solutions of ethylene glycol in water, hot solutions of propylene glycol in water, and solutions of triethylene glycol in water. The mechanical seal faces are lubricated by the liquid being pumped – it is therefore necessary to have liquid at the seal faces at all times. To accomplish this, the mechanical seal cavity of the pump must be vented when filling the pump with liquid to allow the seal cavity to also fill with liquid.

When operating, these liquids may vaporize at the seal faces. The vapor will be removed by the vapor eliminator mounted to the side of the bearing housing.

Since some of the heat transfer oils "oxidize," the pumps have a cavity provided between the mechanical seal's stationary face (95A) and the front grease seal (76) to permit the injection of a barrier fluid to keep oxygen away from the mechanical seal faces when operating with oxidizing oil.

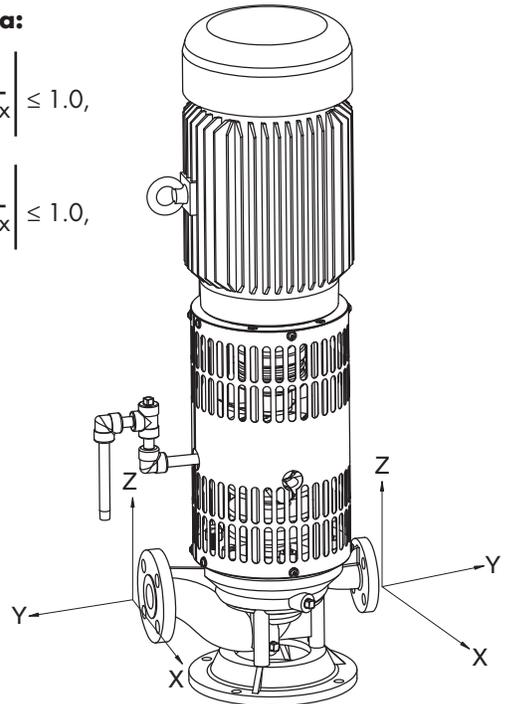


FIG. 1

PUMP LUBRICATION (CONT.)

All "oils" will oxidize at some point depending upon the amount of air contamination and the temperature. Most "oils" will begin to oxidize at 250°F. Some "oils" will oxidize as low as 150°F. The oxidation rate doubles for every 18 to 20°F increase in temperature, so it is very important to not use a barrier fluid that has a low oxidation temperature. The user should check to see at what temperature his oil will start to oxidize.

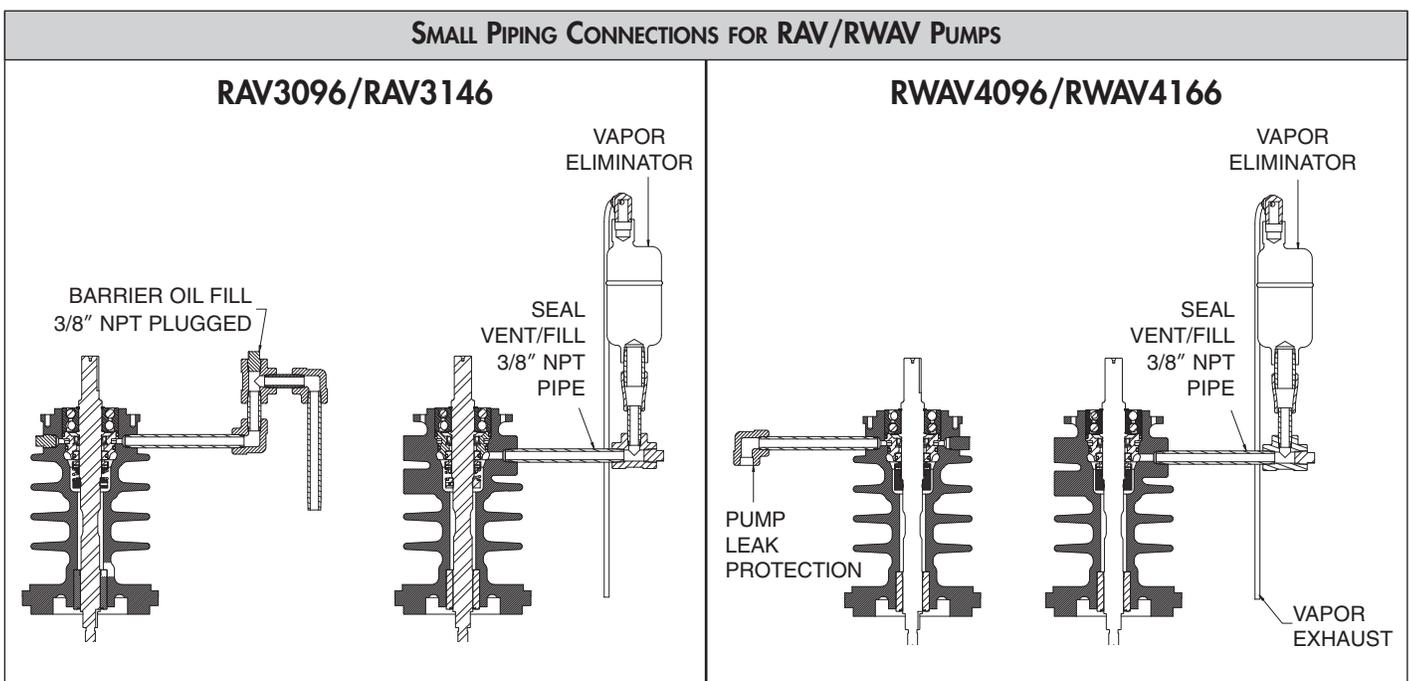
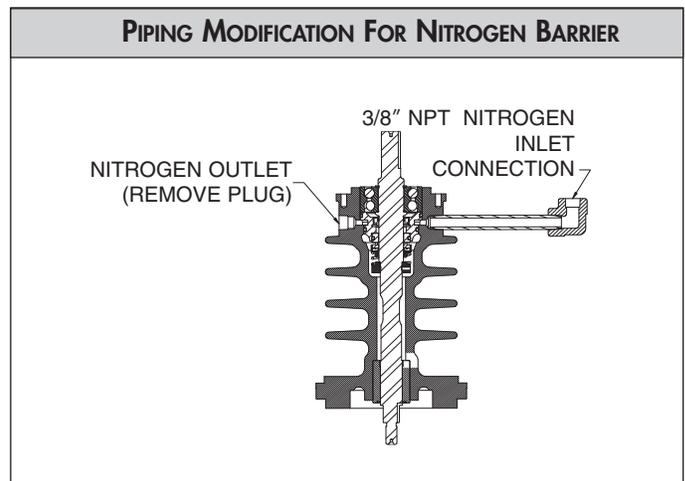
When the oil being pumped by the RAV is one that oxidizes, a barrier fluid should be used. Select a fluid to be used as the barrier fluid that is compatible with the pumpage and not detrimental to the lip seal, bearings, mechanical seal, or the bearing housing. The best fluid to use is nitrogen, but many customers prefer to use a liquid instead of a gas. Many oil companies produce a (barrier) oil that would be compatible with the oil being pumped, mechanical seal elastomers, lip seal, bearings, bearing grease, and the bearing housing. Two examples of this type of oil are Calflo AF (Petro-Canada) and Dowtherm RP (Dow Chemical). The user should check with his oil supplier for his recommendation for a non-oxidizing or low oxidizing oil to use as a barrier. Sometimes the oil being pumped can be used as the barrier fluid.

Since most of our customers are using a liquid as a barrier fluid, the RAV pump is supplied with the barrier oil piping shown at the bottom of page 7.

When using a liquid barrier fluid for the RAV, the barrier cavity is filled through the pipe tee located directly above the cavity. Remove the 3/8" pipe plug (84) from the top of the tee (see the drawing on page 6) and pour the barrier liquid into the tee until the liquid level is flush with the bottom of the pipe nipple that extends horizontally out of the side of the tee. Any excess above this level will run out on to the floor. Rotate the shaft by hand (wear gloves for this operation) to help remove any trapped air pockets. Refill to previous level and replace the pipe plug (84).

If nitrogen is to be used as the barrier fluid, for the RAV or RWAV the barrier piping must be modified, from that shown on page 6, to that shown below. For the RAV, remove the vertical overflow pipe nipple, the 3/8" pipe tee and elbow, and the horizontal pipe nipple connecting the pipe elbow to the pipe tee. Discard these parts. For the RWAV, turn the elbow to the up position. Remove the 3/8" barrier oil drain plug from the side of the bearing housing, and discard it. Connect the nitrogen supply line to the top of the pipe tee and regulate the pressure to 1/4 P.S.I.G. maximum. The 3/8" connection at the bottom of the bearing housing will be left un-plugged to become an outlet for the nitrogen and serve as a leak detection in the event of mechanical seal failure.

When pumping a heat transfer oil that does not oxidize, a barrier fluid is not needed. Modify the barrier piping as described above for the use of nitrogen except plug both of the connections in the pipe tee. A collection pan could be placed under this drain opening to collect any condensed vapors or leakage from the mechanical seal when the faces wear.



STARTING THE PUMP

It is important that a pump should never be subjected to thermal or pressure shock. The liquid should therefore be allowed to flow into the casing slowly. A centrifugal pump should never be started until all the parts are up to the temperature of the liquid to be pumped.

FILLING

WARNING:

Before filling the pump with liquid, check to see that all possible leak locations are sealed. See that all of the connections into the pressure containing cavity are sealed or connected to a related piping system that also has all possible leak paths sealed. Do not plug unused cavities, as this could develop dangerous pressure build-up. Use a wrench on all bolted joints to apply torque to assure that all gaskets are sealed in a tight joint. Check to see that all threaded pipe connections are also tight enough to seal the Liquid pressure that will be applied when the system is started.

WARNING:

Filling directions below refer to venting of "air" to the atmosphere, but dependent upon the physical properties of the liquid intended to be pumped, temperature, pressure, and other variables related to the system and its operational requirements, this may not be allowed by federal or local regulations, or may not be acceptable for whatever other reasons. Consult your plant or corporate safety engineer for instruction on possible required procedures for the specific liquid, operating conditions and legal requirements.

When the source of the liquid to be pumped is below atmospheric pressure or located below the pump, the filling may be accomplished in any of several ways, three of which are listed below:

- 1) An exhauster may be connected to the discharge piping between the pump and the discharge isolation valve. With the discharge isolation valve closed and the suction valve open, the air can be exhausted from the pump and the suction piping. When all the air has been removed, close the suction valve, remove the exhauster, plug the access port where the exhauster was connected, and then open the discharge valve. Remove the seal vent plug from the side of the bearing housing below the vapor eliminator, refer to the drawings on pages 5 and 6. Allow the air to flow from this port until the pumpage starts to flow. This could take considerable time dependent upon the viscosity of the pumpage. Fifteen to twenty minutes is not unusual, however some liquids may vent out in less than a minute.
- 2) With a foot valve installed in the suction piping, the pump may be filled with pumpage introduced somewhere above the pump in the discharge piping. A foot valve may create extensive losses and therefore must be allowed for in calculating the available NPSH. When the pump is filled, plug the port through which you were filling. Remove the seal vent plug from the top of the bearing housing, refer to the drawings on pages 5 and 6. Allow the air to flow from this port until the pumpage starts to flow. This could take considerable time dependent upon the viscosity of the pumpage. Fifteen to twenty minutes is not unusual, however some liquids may vent out in less than a minute.
- 3) A vacuum pump (preferably a wet vacuum pump) may be used for evacuating air from the pump and piping. The vacuum pump should be connected as is the exhauster covered in No. 1 above and the procedure is the same.

When the source of the liquid to be pumped is above atmospheric pressure or above the pumps discharge flange, the pump may be filled by venting through a bleed-off line to atmosphere. When the source of the liquid is above the pumps discharge flange the venting could be back to the suction source, instead of to atmosphere. When all of the air has been expelled through the bleed-off, seal it. Remove the seal vent plug from the side of the bearing housing below the vapor eliminator, refer to the drawings on pages 5 and 6. Allow the air to flow from this connection until the pumpage starts to flow. This could take a considerable amount of time, dependent upon the viscosity of the pumpage. Fifteen to twenty minutes is not unusual, however some liquids may vent out in less than a minute.

It is most important to check the direction of rotation of the pump before allowing the pump to come up to speed. The pump was shipped with the coupling spacer not installed to allow alignment and motor rotation direction check. If, however, someone installed this spacer assembly, remove it at this time. To check rotation direction, push the starting button and instantly push the stop button. This will allow the motor to turn over a few revolutions and the direction of rotation to be observed. A direction of rotation arrow is shown on the front of the pump casing. If rotation is incorrect, change the wiring connections and recheck rotation. ***Operating the pump in reverse rotation may cause extensive damage.***

WARNING:

Lock-out the power to the driver (motor, turbine, engine, etc.) install the shaft coupling spacer. Be sure that you install all the retaining devices and bolts and that they are tight. Read and comply with the coupling manufacturer's instructions. Personal injury, death, and/or equipment damage could occur if the coupling spacer is not properly installed. Remove all debris and tools from the area near the shafts and the shaft coupling. Do this to assure that nothing is caught and thrown by the rotating parts when the pump is started. Bolt the coupling guard securely to the cradle (7), checking to assure that it is not contacting any parts that will rotate when the pump is started.

OPERATING

WARNING:

Before starting the unit, see that all personnel are a safe distance away from all possible hazards, that all sub-systems are connected and operating, that all debris has been removed, that the shaft coupling guard is securely in place, and that the pump is full of liquid.

Do not operate this pump at shut-off (no flow) as an explosion may result. This can occur with any liquid, even "cold water".

Personal injury, death, equipment damage, and/or loss of product (pumpage) is Likely to occur. If your system is operated where it is possible for all outlets of the discharge from the pump to be closed while the pump is still operating, a modification of the system needs to be made to assure a continual flow of pumpage through the pump. NOTE: Some people have a belief that a bypass line from the discharge side of the pump to the suction side of the pump will relieve this problem, this is "NOT TRUE"; DO NOT ATTEMPT THIS.

WARNING:

Do not operate a pump at a low flow condition, unless provision has been made to prevent dangerous heat build up within the pump casing. The liquid in the pump will heat up and this may result in high pressure in the pump in a short time. Such pressure may result in a rupture of the pressure-containing parts and cause severe hazard to personnel and/or damage to the system.

A centrifugal pump should never be run without liquid in the casing. Extensive damage may result, particularly to the bearing or the mechanical seal. Vent or fill the pump seal chamber through the seal vent connection to provide lubrication to the mechanical seal faces.

A centrifugal pump should be started with the suction valve fully open and the discharge valve opened a slight amount. Start the pump.

As soon as the pump is up to speed, the discharge valve must be opened slowly. A centrifugal pump cannot be operated with the discharge valve closed without heating up dangerously.

During the first several minutes of operating watch the pump carefully for overheating, vibration, and other abnormal conditions. If trouble develops, stop the pump at once and correct the problem.

After thirty minutes of operation, stop the pump. If the pump is using a barrier fluid, check the level by removing the 3/8" pipe plug (84) from the pipe tee, and refill, if necessary, to a level flush with the bottom of the pipe nipple that extends horizontally out of the tee.

If a small amount of barrier oil has dropped from the barrier overflow pipe onto the floor, do not be concerned as this might occur with the initial heat expansion of the barrier liquid.

The barrier overflow pipe is also used to detect mechanical seal leakage. If, after the pump has run for a few hours at system temperature, oil starts to spill from this pipe, it is an indication of impending mechanical seal failure. The mechanical seal (95A and 95B) should be replaced before the leakage becomes excessive.

Restart the pump.

PUMP START-UP CHECKLIST

These points must be checked after pump installation and before starting up the pump.

- 1) Read instruction manual thoroughly and understand it.
- 2) Review pump order head sheet for the service rating of the pump and any special features.
- 3) Check to see that the seal chamber has been vented.
- 4) Check all piping connections making certain that they are both tight and in the proper places. All piping includes the small piping described on page 6.
- 5) Check to see that the motor is of the fan cooled type. A fan cooled motor is necessary for successful operation of the pump.
- 7) Check the electrical connections to the driver.
- 8) Bump the motor starting button to check motor rotation. Operating the pump in reverse rotation may cause extensive damage. If the rotation is incorrect, connect the wiring for proper rotation and recheck.
- 9) Check to see that the barrier fluid has been installed, if the barrier fluid is required for your operation.
- 10) Check to be sure that the pumpage leak detection connection is open for proper operation.
- 11) Rotate the pump shaft by hand to be sure that there is no binding or rubbing within the pump or driver. Wear heavy gloves to protect your hands. Correct any problems before proceeding.
- 12) Remove all dirt, waste, tools, and construction debris from the area.
- 13) Check to see that the coupling guard is fastened securely in place.

SPARE PARTS

To avoid prolonged down time and facilitate rapid repair of damaged pump parts, Dean recommends that the pump user maintain a minimum stock of spare parts. If the pump service is critical, a spare parts stock is even more important to the user. Such spares inventory may extend from a spare mechanical seal through complete impeller-bearing housing assemblies prepared for immediate insertion in the pump casing. Consult your Dean representative who will assist you in selecting your spares stock.

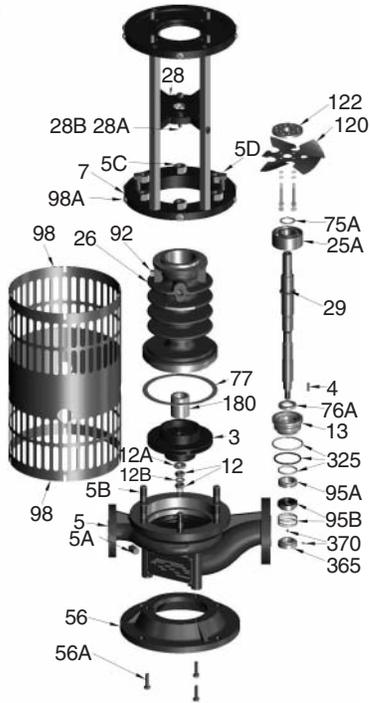
ORDERING SPARE PARTS

Spare part orders will be handled with a minimum delay if the following information is furnished by the customer with the order:

- 1) Give the pump serial number and size. These may be found on the pump name plate. The serial number is also stamped on the suction flange of the pump.
- 2) Give the part name, part number, and material of part. These should agree with the standard parts list.
- 3) Give the quantity of each part required.
- 4) Give complete shipping instructions.

TYPE RAV/RWAV PUMP PARTS

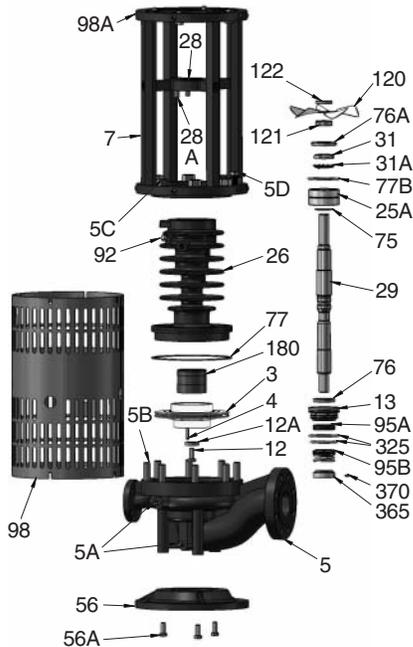
RAV3096



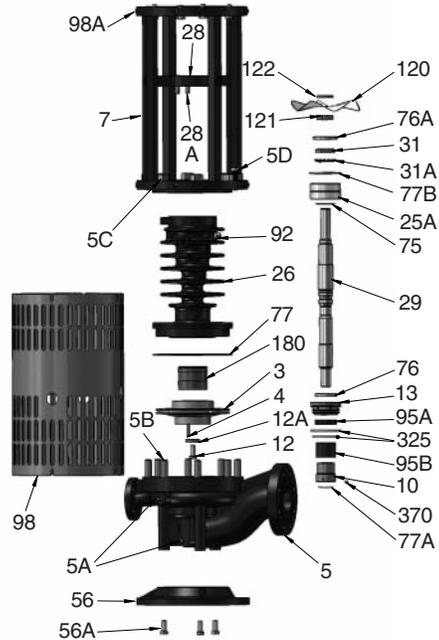
RWAV4096



RAV3146



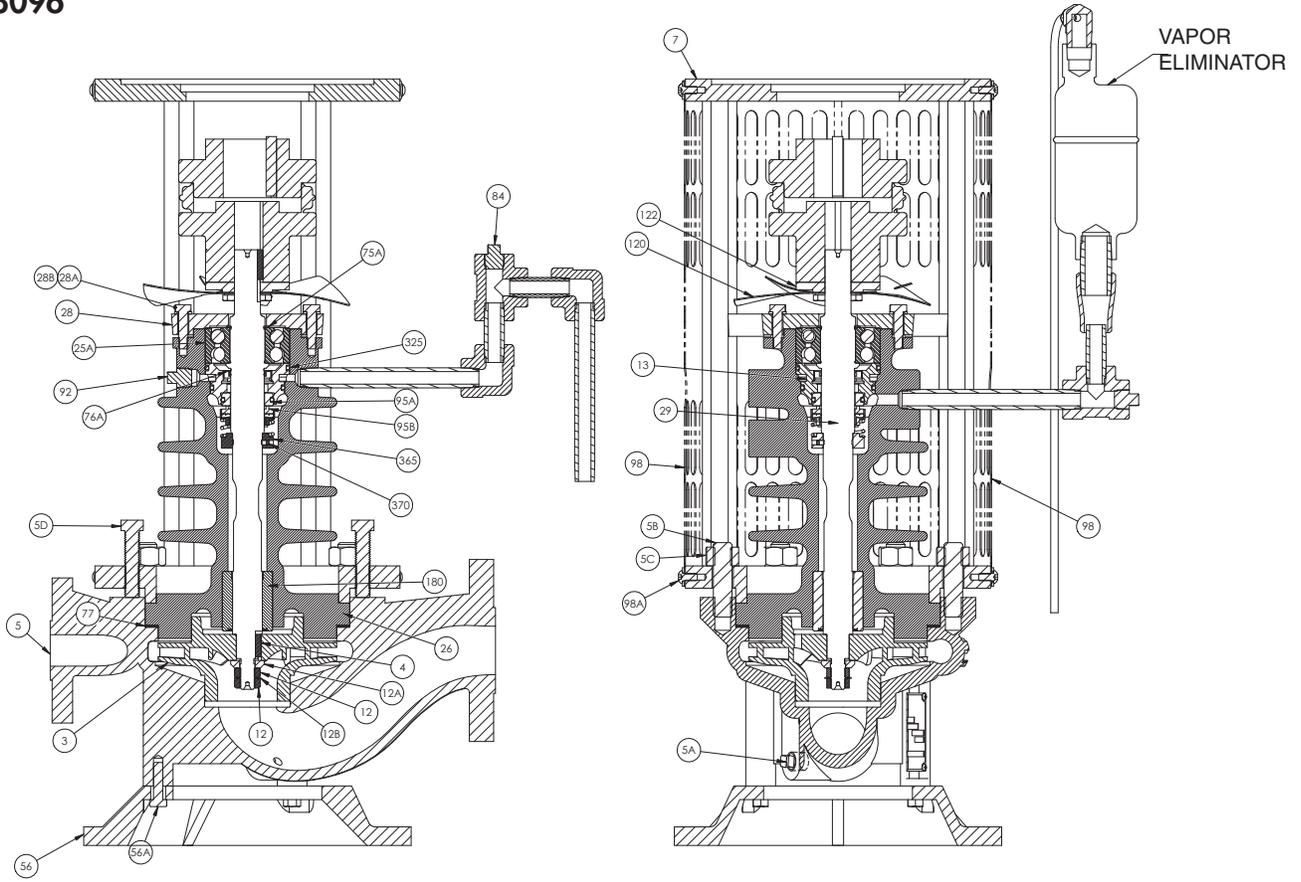
RWAV4166



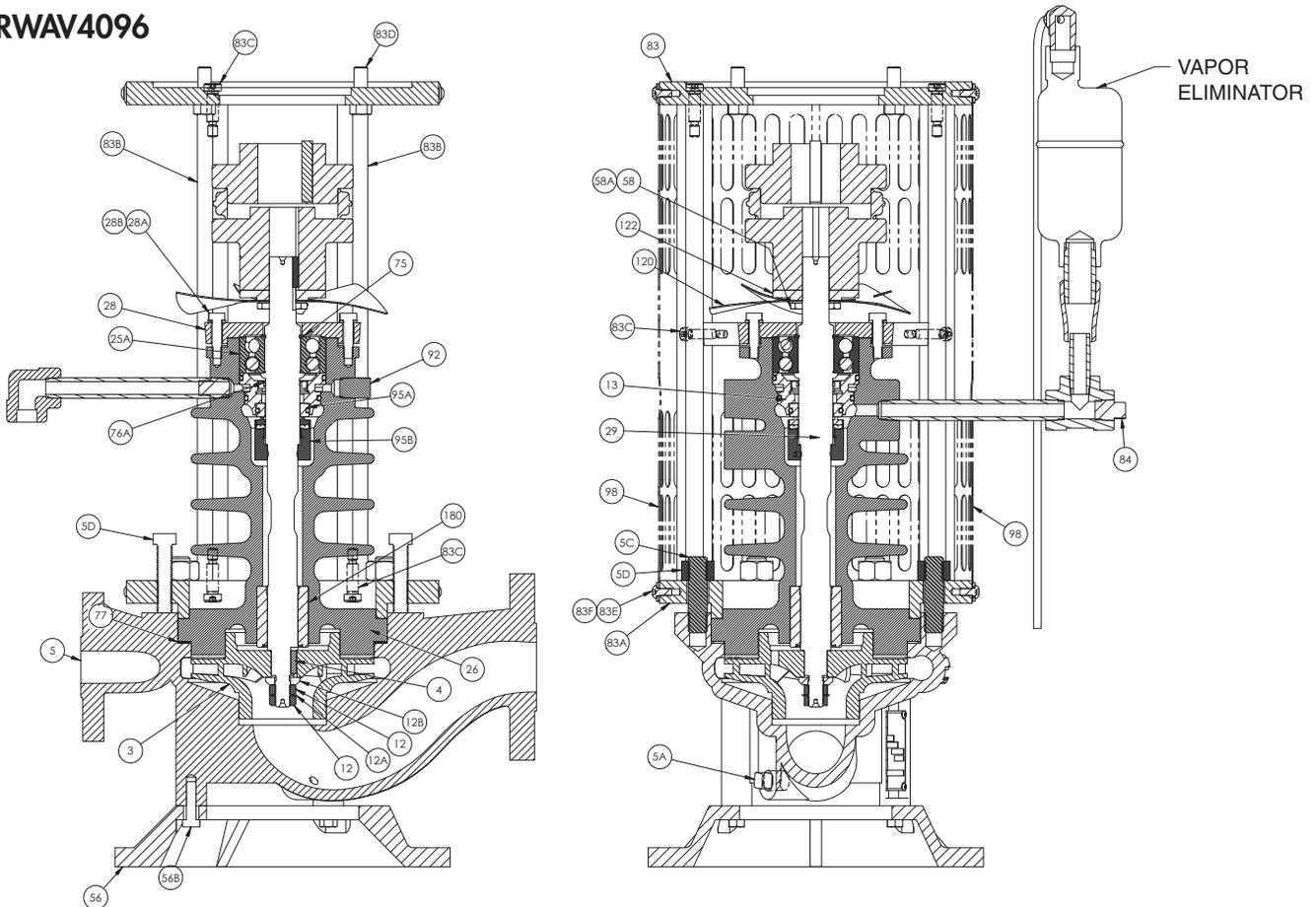
Part #	Part Name
3	Impeller
4	Impeller Key
5	Casing
5A	Casing Drain Plug
5B	Casing Stud
5C	Casing Nut
5D	Jack Screw
7	Cradle
10	Shaft Sleeve
12	Impeller Nut
12A	Impeller Washer
12B	Impeller Jam Nut Washer
13	Mechanical Seal Gland
25A	Thrust Bearing
26	Bearing Housing
28	Bearing Housing Cover
28A	Cover Bolt
28B	Cover Washer
29	Pump Shaft
31	Thrust Bearing Lock Nut
31A	Thrust Bearing Lock Washer
56	Casing Foot
56A	Casing Foot Bolts
75	Snap Ring
75A	Snap Ring
76	Grease Seal (Front)
76A	Grease Seal (Rear)
77	Casing Gasket
77A	Sleeve Gasket
77B	Bearing End Cover Gasket
84	Barrier Fill Plug
92	Barrier Drain Plug
95A	Mechanical Seal Stationary
95B	Mechanical Seal Rotary
98	Coupling Guard
98A	Coupling Guard Bolts
120	Fan
121	Fan Collar
122	Fan Clamp Ring
180	Radial Bearing
325	Seal Gland Gasket
365	Seal Collar
370	Collar Set Screw

SECTIONAL ASSEMBLY DRAWINGS

RAV3096

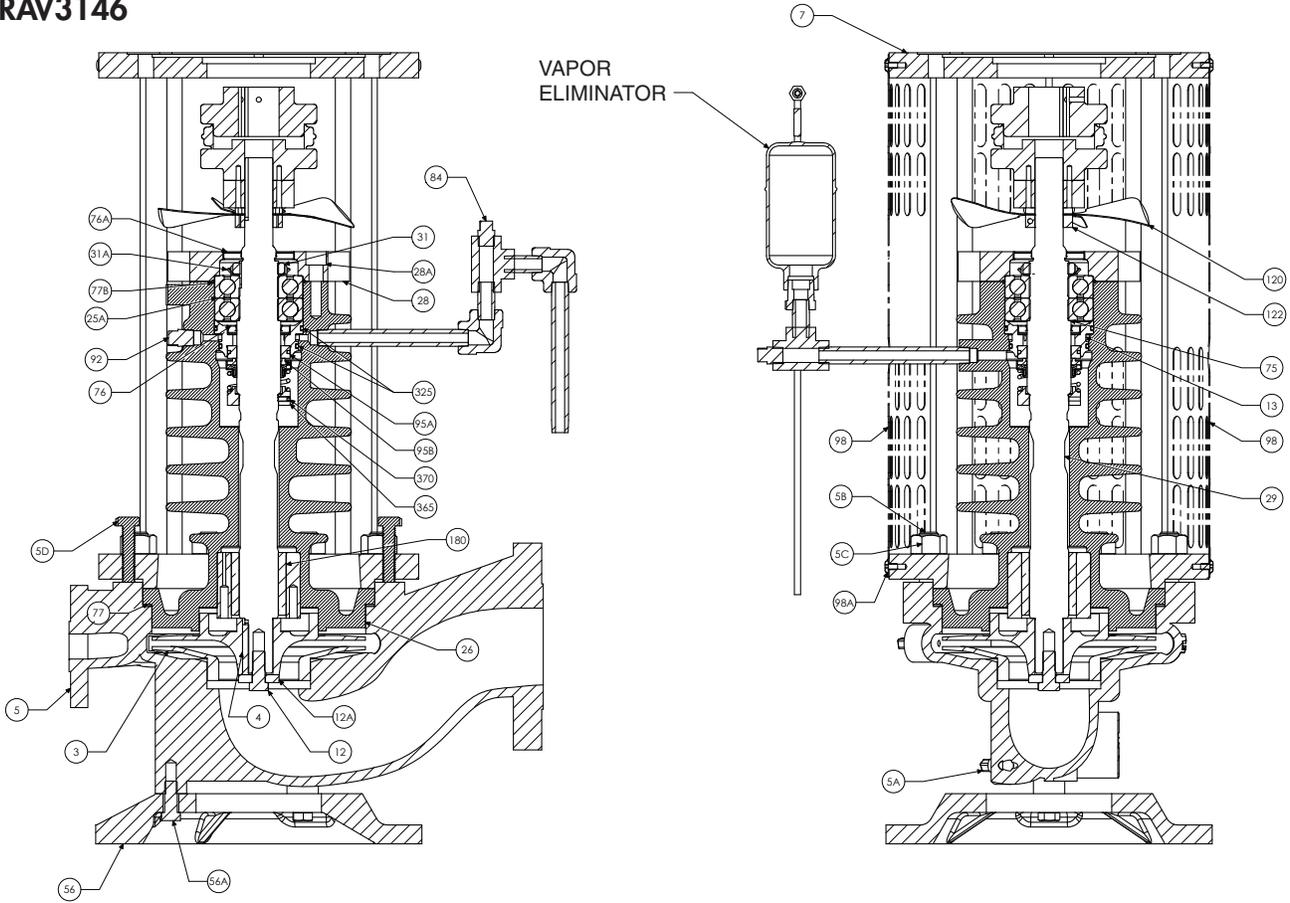


RWAV4096

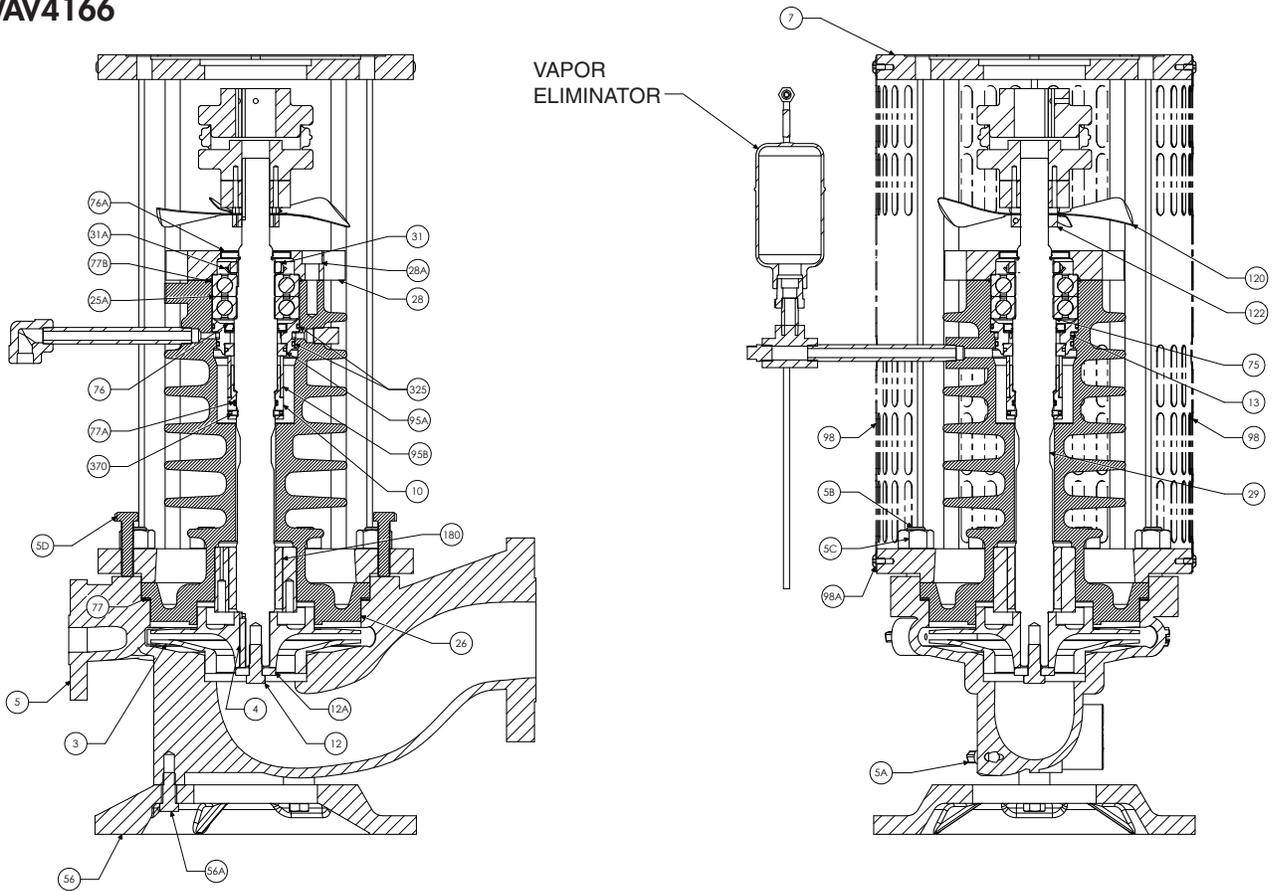


SECTIONAL ASSEMBLY DRAWINGS

RAV3146



RWAV4166



DISASSEMBLY AND ASSEMBLY PROCEDURES

WARNING:

Work must be performed only by thoroughly trained and qualified personnel to assure quality repair and to reduce the possibilities of injury to personnel and/or damage to equipment. If you do not have personnel who are capable of safe quality repair of this equipment, we advise you to return the equipment to DEAN PUMP to be repaired.

When it is necessary to open the pump and/or the pumping system the fluid will be exposed to the atmosphere and personnel in the area. For the safety of all involved, the risk of exposure of personnel to the hazards of the pumpage can be reduced by flushing the entire system with a compatible, non-toxic, non-hazardous, stable fluid before opening the pump or the system. In all cases, where the system is flushed or not, use the utmost care around the pumpage and the pumping system.

Always wear the appropriate protective apparel when working on or around the pumping equipment. Safety glasses with side shields, heavy work gloves (use insulated work gloves when handling hot items), steel-toed shoes, hard hat, and any other protective gear as needed for protection. One example of other gear would be breathing apparatus when working near toxic materials.

Use only top quality tools.

- a) Stop the pump. Turn off the power supply (electricity) to the pump driver (motor) and lock the switching device so that it can not be restarted. Tag the switching device so that no one will attempt to restart the unit.
- b) Close the suction and discharge valves completely to isolate the pump from the system. Lock the valves in the closed position and tag them so that no one will attempt to open them.
- c) Turn off, lock out, and tag all sub-systems and auxiliary equipment and auxiliary supply lines to isolate the pumping unit from any and all power, energy, and/or fluids.

WARNING:

Do not attempt to perform any work on the unit until you are confident that the pump and its contents have been stabilized at ambient temperature, and atmospheric pressure.

Put on protective wear to protect human tissue from attack by the fluids contained in the pump and any sub-systems, and from any vapors or fumes that could possibly be released from these fluids. This could mean breathing apparatus, face shields, heavy long sleeve rubber gloves, rubber apron, hood, and possibly more, dependent, of course, on the properties of the fluids involved and the installed drain and vent piping arrangement. Personal injury and/or death can occur if adequate precautions are not taken with regard to the fluid, the installation and the possibilities of the release of fluid, vapors, and/or fumes.

- d) Remove the coupling guard. Remove the coupling spacer. Be careful to not bend the blades of the fan (120). The removal of the spacer will also loosen the fan (120) from the face of the coupling hub.
- e) Drain all the fluids from all the auxiliary sub-systems (lubrication, cooling, heating, seal barrier, etc.) that are connected to the pump. Drain each fluid into a separate container. Use caution required for each fluid after reading the MSDS (Material Safety Data Sheet) for each.
- f) Flush each sub-system with a compatible, non-toxic, non-hazardous, stable liquid. Drain into individual containers for each fluid. Disconnect and remove all auxiliary piping.

- g) Carefully bleed off any pressure remaining in the pump. Pressure remaining in the pump will be dependent upon the pressure in the system when the pump was stopped; the quality, type, and condition of the isolation valves; the thermal expansion values of the fluid and the pump material; and the change in the vapor pressure of the fluid between the temperature at the time the isolation valves were closed and the ambient temperature. Bleeding must be through a valved drain line piped to a closed container mounted lower than the pump. The container must be arranged with a relief passage to some point where pressure and fumes will not be harmful to personnel. The container must also have a Level device so that determination can be made that sufficient fluid has been drained to empty the pump cavity and the volume of fluid that was contained in the run of suction and discharge pipe between the isolation valves and the pump. After the initial rush of fluid from the pump relieves the pressure, the drain valve can be opened further to speed the draining operation. When fluid quits running into the drain tank, gauge the volume to see if it is sufficient to have fully drained the contents of the pump and the suction and discharge pipes between the isolation valves.

If the system was constructed without any drain connections, it will be necessary to consult the designers of the system for safe draining procedures.

- h) Now drain any small piping, that contains the fluid pumped, from all low points into the same container used to drain the pump. Do not drain any other fluids (different than the pumpage) into this container as they may not be compatible. Personal injury, death, and/or equipment damage could occur.

WARNING:

Even though it might appear that the cavity being drained has completely drained, be extremely careful about opening the system and/or opening the pump. If something solid in the pumpage moves to the vicinity of the drain connection, it could seal-off the drain and maintain pressure in the cavity thought to have been drained. It is also possible that the isolation valves are not sealing and therefore allowing liquid to flow from the system into the pump. Personal injury, death and/or equipment damage may occur if great caution is not exercised.

- i) Loosen the casing nuts only one full turn. Then use jack-screws (two, 180° apart) through the flange of the cradle to "break" the gasket seal. If fluid and/or pressure remains in the pump, it will spray out now. Use extreme caution, wearing protective gear, to avoid injury. Do not proceed with disassembly until leakage ceases completely. If leakage does not cease, the isolation valves may not be sealing. Note that if the pump was purchased without a drain, the pump will contain fluid which will flow out at the time the nuts or capscrews are loosened and the gasket seal is "broken".

WARNING:

When you open the pump, the fluid will be exposed to the atmosphere and personnel in the area. For the safety of all involved, the risk of exposure can be reduced by flushing the cavity that was just drained with a compatible, non-toxic, non-hazardous, stable liquid, before disassembling the pump.

- j) Remove the casing nuts (5C), and using mechanical lifting apparatus to support the weight, pull the rotating unit from the casing (5). Un-screw the two jack-screws until they are not protruding through the "casing side" of the bearing housing (26) flange.
 - k) Flush the wetted parts, now exposed, with a compatible, non-toxic, non-hazardous, stable liquid.
 - l) Remove the gasket (77) from the face of the casing (5) or the bearing housing (26) dependent on which one the gasket may have adhered to. The type of gasket and material of construction will vary with service requirements. Attack by prying and then, if necessary, layering off the old gasket with a sharp scraper, attempting to remove it in the largest possible pieces. Wear heavy Leather, long sleeve work gloves when using the scraper. Wet the gasket before and during the scraping operation to reduce the possibility of fibers becoming airborne. Wear a respirator during this operation and until all debris has been disposed of in a plastic bag. Remove all of the gasket material down to clean metal surfaces on both parts that contacted the gasket. Use care to not damage the metal faces. Place all of the gasket residue in a plastic bag, seal the bag and dispose.
 - m) Inspect the inside of the casing (5) for any signs of wear, corrosion or any other damage. If the casing needs to be removed, remove the bolts from the suction and discharge flanges. Remove the bolts that hold the casing feet to the foot (56). The casing can now be removed. Remove the suction and discharge flange gaskets using the procedure as in paragraph "l" above.
 - n) The rotating assembly of the pump can now be moved to a more convenient location for further disassembly. Use mechanical lifting equipment to move assemblies and components.
- b) Remove the coupling hub from the pump shaft (29) by loosening the set screws and using a gear puller to pull the hub from the shaft. Do not hammer on the coupling hub or the shaft. Remove the coupling key. Be careful to not bend the blades of the fan (120).
 - c) Remove the fan (120) from the pump shaft (29). If the pump is a RA3096/RWA4096, slide the fan (120) and the fan clamp ring (122) off of the end of the pump shaft (29). If the pump is a RAV3146/RWA4166, loosen the radially positioned securing screw in the side of the fan collar (121) and slide the fan (120), fan collar (121), and fan clamp ring (122) assembly off the end of the pump shaft (29). If this assembly resists removal, loosen the two axially positioned screws that hold these parts together.

WARNING: Wear gloves when removing the fan (120) to protect your hands as the fan is made of thin metal and could cut you.

- d) Remove the bearing end cover (28) from the bearing housing. Remove the bearing end cover gasket (77B) if the pump is an RAV3146/RWAV4166.
- e) Press the grease seal (76A) from the bearing end cover (28), if the pump is an RAV3146/RWAV4166.
- f) Pull the pump shaft (29) from the bearing housing (26), using care to keep the shaft in line with the bearing housing so as not to damage any parts. Wear heavy work gloves. Compression of the mechanical seal spring will be detected during this operation.
- g) Remove the set screws (370) from the mechanical seal collar (365) and then slide it from the shaft (29). Slide the mechanical seal rotary (95B) from the shaft (29). It may take a considerable amount of force to remove the rotary (95B) as the elastomeric shaft sealing element may grip the shaft quite tightly.
- h) Remove the mechanical seal gland (13) from the shaft. Remove the seal gland gaskets (325) from the seal gland (13). Remove the mechanical seal stationary (95A) from the mechanical seal gland (13).
- i) Remove the seal gland gaskets (325) from the seal gland (13).
- j) Remove the grease seal (76) from the seal gland (13). This can be removed by inserting a screw driver or a small drive pin punch into the open side of the seal and driving it out of the seal gland.
- k) If the pump is an RAV3096/RWAV4096, remove the snap ring (75A) from the pump shaft (29). If the pump is an RAV3146/RWAV4166, bend the tab of the bearing lock washer (31A) out of the slot in the bearing lock nut (31). Remove the bearing lock nut and bearing lock washer from the pump shaft (29). Press the thrust bearing(s). Do not press on the shaft snap ring (75) of the RA3146/RWAV4166. Do not hammer on the bearings or the shaft in any manner as this may result in damage to the shaft. Remove the snap ring (75) from the pump shaft of the RAV3146/RWAV4166, only if it is damaged.
- l) Press or drive the bearing cartridge (180) from the bearing housing (26).
 - 1) RAV3096/RWAV4096 procedure: Use a 1-1/4" diameter bar, 12" long, cut square on the ends. Insert bar into the coupling end of the bearing housing (26) until it stops against the bearing cartridge (180). Use a hydraulic press to press the bearing cartridge (180) from the bearing housing (26).

DISASSEMBLY PROCEDURE

To further dismantle the pump, perform the following steps in the sequence shown:

WARNING:

Use only high quality tools.

Obtain MSDS data sheets for all liquids (from the manufacturers of those liquids) being used with the pump, and heed all cautions.

Flush parts as disassembled to remove hazardous residue from the pumpage and/or sub-system fluids.

Wear protective equipment as advised at the beginning of this section.

Use mechanical lifting equipment to lift assemblies and components.

Do not apply heat to parts to assist in disassembly. Explosion could occur causing personal injury, death, and/or damage to equipment.

Do not attempt to drill, saw or otherwise cut parts to remove them. Explosion and/or fuming could occur causing personal injury, death, and/or equipment damage.

Do not hammer on any parts. Personal injury and/or damage to equipment may occur.

- a) Remove the impeller nuts/bolt (12) while holding the pump shaft (29) against rotation with a wrench on the flats of the coupling hub. When loosening the impeller nuts/bolt (12) be sure to loosen the outer nut and remove it, before loosening the nut that is closest to the impeller (3). Remove the impeller retaining washer (12A). Slide the impeller (3) off the shaft (29). Remove the impeller key (4) from the shaft (29).

- 2) The RAV3146/RWAV4166 procedure: The bearing cartridge (180) has two 3/8" - 16 UNC tapped holes that are accessible from the impeller end of the bearing housing. Securely bolt a 1/2" Class 300 flange to the cartridge, using washers and bolts. Use a 14" long piece of 1" pipe (1-5/16" OD), cut square on the ends, to reach down through the bearing housing (26) to press the bearing cartridge out.
- m) Remove the seal vent plug from the pump and discard it. Refer to drawings on page 6.

REASSEMBLY PROCEDURE

WARNING:

Use only high quality tools.

Wear protective equipment as advised at the beginning of this section.

Use mechanical lifting equipment to lift assemblies and components.

Do not hammer on any parts. Personal injury and/or damage to equipment may occur.

Do not attempt to manufacture parts or modify Dean Pump parts in any manner. Death, personal injury, and/or damage to equipment may occur.

Replace all gaskets, seals, bearings, and lubricants. Replace all parts that have worn, corroded, eroded, or otherwise deteriorated.

Use only Dean Pump Division of Met-Pro Corporation parts.

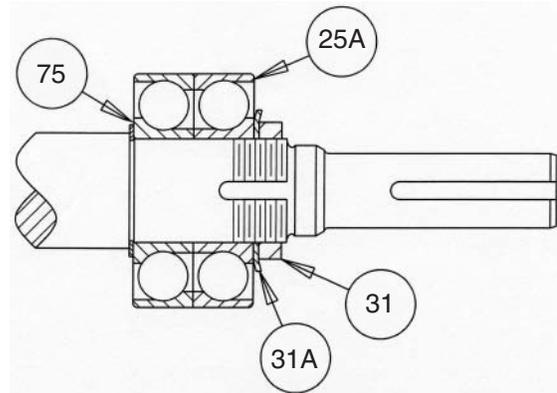
To reassemble the pump, perform the following steps:

- a) Clean all parts, thoroughly inspect them, and replace where necessary. If the pump shaft (29) has two lip contact wear patterns (lip seal contact area) under the lip seal (76), replace the shaft. If the shaft is scored under the bearing (180), replace the shaft.
- b) Install a new seal vent plug into the top of the bearing housing (26), but do not apply any pipe sealant, and do not tighten the plug. The plug will need to be removed again later, for venting, when the pump is installed into the system. Refer to the drawings on pages 5 and 6.
- c) Press a new bearing cartridge (180) into the bearing housing (26) until it seals firmly against the shoulder in the bearing housing. On the RAV3096/RWAV4096, install with the exposed carbon bearing face facing outward. On the RAV3196/RWAV4166, install with the two tapped holes facing outward and the 1/8" diameter through hole positioned at the top of the bearing housing. Use a press and a pad over the end of the bearing cartridge (180). Do not hammer on the bearing housing cartridge; the bearing could be broken. If a press is not available, the bearing cartridge (180) could be pulled into the bearing housing (26) by using a piece of threaded rod through the bearing housing (26) with a large washer and a nut on each end.
- d) If the pump is a RAV3146/RWAV4166, install the snap ring (75) onto the pump shaft (29) insuring that it is securely into the snap ring groove.
- e) If you are reinstalling a previously used pump shaft (29), inspect the shaft for wear under the grease seal(s) as directed in paragraphs h) and r) below. Press the thrust bearing(s) (25A) onto the pump shaft (29).

- 1) RAV3096/RWAV4096 procedure:
Press the thrust bearing (25A) onto the pump shaft (29) and firmly against the shaft shoulder. Do not hammer on the bearing or shaft in any manner as this will cause damage.

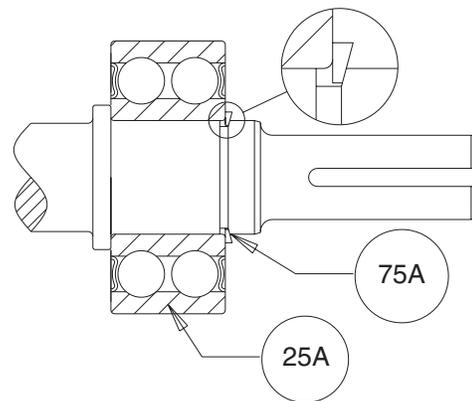
- 2) RAV3146/RWAV4166 procedure: Press the thrust bearings (25A) onto the pump shaft (29) and firmly against the shaft shoulder. Do not hammer on the bearings or shaft in any manner as this will cause damage.

THRUST BEARING POSITION – RAV3146/RWAV4166



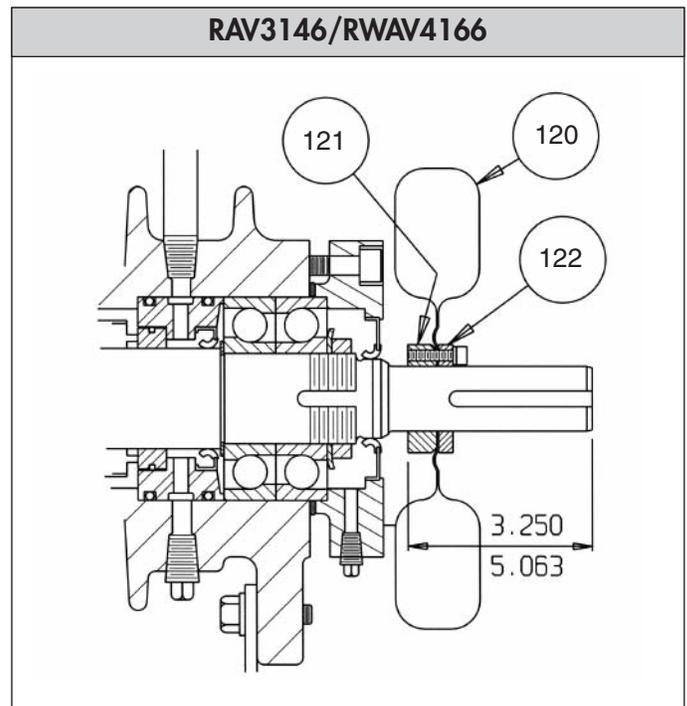
- f) Secure the thrust bearing(s) (25A) to the pump shaft (29).
- 1) RAV3096/RWAV4096 procedure: Install the bearing retaining snap ring (75A) with tapered side away from the bearing (see illustration).
- 2) RAV3146/RWAV4166 procedure: Install new bearing lock nut washer (31A). Install the bearing lock nut (31). Bend a tab of the bearing lock nut washer (31A) into an aligned slot of the bearing lock nut (31).

THRUST BEARING POSITION – RAV3096/RWAV4096



- g) Thrust bearing lubrication.
- 1) RAV3096/RWAV4096 procedure: The thrust bearing (25A) of the RAV3096/RWAV4096 is already packed and sealed for life.
- 2) RAV3146/RWAV4166 procedure:
Pack the thrust bearings (25A) with 1.1 cubic inches of grease. Attempt to force all of the grease into the bearings. The grease must be a lithium 12-hydroxy-stearate soap thickened grease that has rust inhibitors and extreme pressure additives and must be a NLG1, Grade 2, similar to: Shell Oil Company's "Alvania" Grease #EP2 or Union Oil of California's "UNOBA #EP" Grease Grade #2 for bearing lubrication.

- h) Press a new grease seal (76) into the mechanical seal gland (13). Remove and discard the garter spring from a new grease seal (76). Install with the lip pointing towards the impeller end of the pump as shown in the pump sectional assembly drawing.
- i) Install new seal gland gaskets (325) into the mechanical seal gland (13). Lubricate the gaskets before installing, with an oil that is compatible with the liquid to be pumped, or with the pumped liquid itself.
- j) Install a new mechanical seal stationary seat (95A) into the mechanical seal gland (13). Be sure that there is an "O" ring installed in the groove in the outside diameter of the mechanical seal stationary seat (95A).
- k) Lubricate the area of the shaft over which the lip seal will slide, then carefully slide the mechanical seal gland (13) assembly over the shaft, so as not to damage the lip seal (76) nor the mechanical seal stationary seat (95A). Push the mechanical seal gland snugly against the thrust bearing (25A).
- l) Lubricate the area of the shaft over which the mechanical seal rotary (95B) will slide. Carefully slide the mechanical seal rotary (95B) over the shaft (29) until it contacts the mechanical seal stationary (95A). **Do not damage the seal on any of the shaft shoulders.**
- m) Slide the mechanical seal collar (365) carefully over the shaft (29) until it is firmly against the shaft shoulder and compressing the spring of the mechanical seal rotary (95B). Tighten the set screws while holding the seal collar (365) firmly against the shaft shoulder.
- n) Lubricate the bore in the back of the bearing housing (26) so that the seal gland gaskets (325) will slide in without damage. Carefully slide the shaft assembly (29) into the bearing housing (26) from the bearing end cover end. Do not strike the carbon bearing (180) with the end of the pump shaft (29). Guide the mechanical seal gland (13) and the thrust bearings (25A) into the bearing housing (26) as the shaft assembly (29) is installed.
- o) If the pump is a RAV3096/RWAV4096 go to step v.
- p) Install a new end cover gasket (77B) over the thrust bearing (25A) and against the bearing housing (26).
- q) Remove the garter spring from a new lip seal (76A) and discard it. Press the lip seal into the bearing end cover (28), from the bearing side, and up against the shoulder at the opposite side, when a new shaft is being used. If the pump shaft is not new, stop pressing on the lip seal $1/16$ " before it reaches the shoulder of the end cover, placing the sealing lip at a new location on the pump shaft (29).
- r) Lubricate the pump shaft (29) at the diameter where the lip seal (76A) contacts. Apply any remaining grease from packing the thrust bearings (25A) around the exposed face of the bearings. Slide the cradle (7) over the bearing housing and bolt it securely into position against the bearing housing (26). Torque the end cover bolts to 20 lb. ft.



- s) Mark (pencil or light scribe) a line on the pump shaft (29), $3\text{-}1/4$ " from the coupling end. Place the fan collar (121), grooved face first, onto the pump shaft and up to the $3\text{-}1/4$ " mark. Refer to the drawing above. Tighten the fan collar locking screw tightly.
- Place the fan (120), with the concave side of the blades towards the pump, over the end of the pump shaft (29) and up against the fan collar (121). The concave side of the fan blade was indicated with a label "PUMP SIDE" at the time it was shipped from factory. Rotate the fan until the holes in the fan align with the tapped holes in the fan collar.
- Place the fan clamp ring (122) over the end of the pump shaft (29) and up against the fan (120), into the tapped holes of the fan collar (121) and tighten them securely.
- t) Insert the coupling bolts through the lockwashers and the pump coupling hub. Place the hub onto the pump shaft (29), positioning the outer face of the hub flush with the end of the pump shaft. Install the coupling key and tighten the hub set screw(s).
- u) Go to step (y)
- v) Slide the cradle (7) over the bearing housing and bolt it securely into position against the bearing housing (26). Torque the end cover bolts to 11 lb ft.
- w) Insert the four coupling bolts through the lockwashers and the fan clamp ring (122) from the side opposite of the raised face. The clamp ring is made to fit three different sizes of couplings, so you must insert the bolts into the holes that match the coupling hub that you are using. Slide the clamp ring onto the pump shaft (29) with the raised face facing the motor.

- x) Place the coupling hub over the end of the pump shaft (29) and onto the coupling bolts, until the face of the hub is flush with the end of the pump shaft. Install the coupling key, with the end of the key flush with the end of the pump shaft and the face of the hub. Tighten the hub set screw(s).
- y) Place the impeller key (4) into the keyway of the pump shaft (29). Carefully slide the impeller (3) onto the pump shaft (29).
 - 1) If the pump is a RAV3096/RWAV4096, slide the impeller washer (12A) over the pump shaft (29) and against the impeller (3). Thread one of the impeller nuts (12) onto the pump shaft (29) and tighten it to a torque of 40 lb. ft. Thread the second impeller nut (12) onto the end of the pump shaft (29) and tighten it to a torque of 40 lb. ft. Hold the pump shaft (29), against the tightening torque, by placing a wrench on the flats of the coupling hub. Be careful to not bend the blades of the fan (120).
 - 2) If the pump is a RAV3146/RWAV4166, place the impeller washer (12A) on to the impeller bolt (12) into the end of the pump shaft (29). Tighten the impeller bolt (12) to a torque of 60 lb. ft. Hold the pump shaft (29), against the tightening torque, by placing a wrench on the flats of the coupling hub. Be careful not to bend the blades of the fan (120).
- z) If the pump has a casing ring (6A), press it into the casing (5).
 - aa) Carefully insert the bearing housing (26) assembly into the casing with a new casing gasket (77). Assure that the bearing housing (26) assembly is fully into the casing (5). Tighten the casing capscrews (5D) or the casing stud nuts (5C) slowly and evenly so that the casing gasket will compress evenly. Torque the casing stud nuts (5C) of the pumps to 105 lb. ft. if the studs are 3/4" and to 165 lb. ft. if the studs are 7/8".
 - ab) Rotate the pump shaft (29) by hand to check for interference. Wear heavy gloves when rotating the shaft, to protect your hands. Correct if any rubbing is detected.
 - ac) If the casing (5) was removed from the foot (56), reattach it with bolts to the foot (56). Reattach the suction and discharge flanges, installing new gaskets.
 - ad) Rotate the pump shaft (29) again by hand to check for rubbing. Wear heavy gloves when rotating the shaft, to protect your hands. Correct if any rubbing is detected.
 - ae) Follow the instructions under "PUMP LUBRICATION", "STARTING THE PUMP" and "PUMP START UP CHECKLIST".

READ WARNINGS

HAZARDOUS SITUATIONS MAY OCCUR UNLESS THIS EQUIPMENT IS APPLIED, INSTALLED, OPERATED, AND MAINTAINED BY THOROUGHLY QUALIFIED PERSONNEL IN STRICT ACCORDANCE WITH THE INSTRUCTION MANUAL AND ALL APPLICABLE DRAWINGS AND CODES.

Read the instruction manual completely, before installing, filling, operating, or maintaining this equipment.

Obtain, read, and heed the MSDS (Material Safety Data Sheet) for the fluids being handled before attempting to fill, operate or maintain this equipment.

Obtain instructions from the Safety Engineer responsible for your facility before performing any work on the pumping equipment and systems.

APPLICATION AND REAPPLICATION - At the time of installation, the equipment received should have already been selected for the service required. You must read the paperwork for the installation and check serial number of the pump to assure that you are installing the correct pump into the service for which it was selected.

Many pumps look identical from the outside but can be made of different materials and/or be constructed differently inside. Personal injury, death, equipment damage, product (pumpage) damage, and/or product loss could occur if the incorrect pump is installed.

Do not transfer an existing pump to any other service conditions until you have thoroughly reviewed the pump construction, materials, sizing, sealing, pressure containing capability, head/capacity capability, and temperature capability with respect to the required service. Consult your DEAN PUMP sales engineer with all the service requirements and a full description of the existing pump (including the serial number), seal, and sub-systems so that we can assist you in a successful reapplication.

INSTALLATION - Always wear the appropriate protective apparel when working on or around the pumping equipment. Safety glasses with side shields, heavy work gloves (use insulated work gloves when handling hot items), steel toed shoes, hard hat, and any other protective gear as needed for protection. One example of other gear would be breathing apparatus when working near toxic materials.

Use lifting devices, manufactured expressly for the purpose of lifting, to move the pumping machinery. Do not attempt to lift the assembly or its components manually. Use only devices with lifting capabilities in excess of the weight of the unit being lifted. Inspect straps, chains, hooks, etc. for damage and lifting capability before use. Lift only at the center of gravity.

Personal injury, death, and/or equipment damage could occur if good lifting practices are not used.

Install the equipment on a properly designed and built foundation. Assure that the driver (motor, turbine, or engine) shaft is properly aligned to the pump shaft.

Connect the suction and discharge piping without forcing the piping into position. The pipe flanges must line up with the pump flanges "freely". Strain caused by "forcing" and/or misalignment may cause failure of the pumping unit, flanges, and/or the piping resulting in fluid (pumpage) release. This could cause personal injury, death and/or damage to this and/or other equipment.

Install a "new" bolt, of the correct size per ASME/ANSI B16.5 and the correct material per ASME/ANSI B16.5, in every bolt hole. Tighten all bolts evenly. Use only new uncorroded fasteners.

Improper flange bolting may cause failure of the pumping unit, flanges, piping, and/or fluid (pumpage) release which could cause personal injury, death, and/or damage to this and/or other equipment.

Connect all other (auxiliary) piping necessary for safe and successful operation of the equipment in the specific service conditions of the application. Make sure that all piping is installed into it's correct connection. Installation of a pipe into an incorrect location could result in an explosion and personal injury or death as well as damage to this and/or other equipment.

Install pressure relief valves in any cavities that could be subjected to pressures in excess of the allowable working pressure of that cavity. Explosion, personal injury, death, and/or damage to this and/or other equipment may occur if pressure exceeds allowable.

Recheck the alignment between the driver (motor, turbine, or engine) and pump shafts. Installation of piping may have forced the pump out of alignment. If so, correct the piping to remove the distorting load.

Check to be certain that the shaft coupling spacer is not installed, and then gently bump the motor starter to check the rotational direction of the motor. If this is not in the direction of rotation required for the pump, make the necessary corrections.

Lock-out the power to the driver (motor, turbine, engine, etc.)

Install the shaft coupling spacer. Be sure that you install all the retaining devices and bolts and that they are tight. Read and comply with the coupling manufacturer's instructions. Personal injury, death, and/or equipment damage could occur if the coupling spacer is not properly installed. Remove all debris and tools from the area near the shafts and the shaft coupling. Do this to assure that nothing is caught and thrown by the rotating parts when the pump is started. Bolt the coupling guard securely to the baseplate, checking to assure that it is not contacting any parts that will rotate when the pump is started.

FILLING - Before filling the pump with liquid, check to see that all possible leak locations are sealed. See that all of the connections into the pressure containing cavity are sealed or connected to a related piping system that also has all possible leak paths sealed. Do not plug unused jacket cavities, as this could develop dangerous pressure build-up. Use a wrench on all bolted joints to apply torque to assure that all gaskets are sealed in a tight joint. Check to see that all threaded pipe connections are also tight enough to seal the liquid pressure that will be applied when the system is started.

OPERATING - Before starting the unit, see that all personnel are a safe distance away from all possible hazards, that all sub-systems are connected and operating, that all debris has been removed, that the shaft coupling guard is securely in place, and that the pump is full of liquid.

Do not operate this pump at shut-off (no flow) as an explosion may result. This can occur with any liquid, even "cold water". Personal injury, death, equipment damage, and/or loss of product (pumpage) is likely to occur. If your system is operated where it is possible for all outlets for the discharge from the pump to be closed while the pump is still operating, a modification of the system needs to be made to assure a continual flow of pumpage through the pump. Note that some people have a belief that a bypass line from the discharge side of the pump to the suction side of the pump will relieve this problem, this is "NOT TRUE"; DO NOT ATTEMPT THIS.

MAINTENANCE, DISASSEMBLY AND REPAIR - Work must be performed only by thoroughly trained and qualified personnel to assure quality repair and to reduce the possibilities of injury to personnel and/or damage to equipment. If you do not have personnel who are capable of safe quality repair of this equipment, we advise you to return the equipment to DEAN PUMP to be repaired.

When it is necessary to open the pump and/or the pumping system, the fluid will be exposed to the atmosphere and personnel in the area. For the safety of all involved, the risk of exposure of personnel to the hazards of the pumpage can be reduced by flushing the entire system with a compatible non-toxic, non-hazardous, stable liquid before opening the pump or the system. In all cases, where the system is flushed or not, use the utmost care around the pumpage and the pumping system.

Always wear the appropriate protective apparel when working on or around the pumping equipment. Safety glasses with side shields, heavy work gloves (use insulated work gloves when handling hot items), steel-toed shoes, hard hat, and any other protective gear as needed for protection. One example of other gear would be breathing apparatus when working near toxic materials.

Use only top quality tools.

Stop the pump. Turn off the power supply (electricity, steam, etc.) to the pump driver (motor, turbine, engine, etc.) and lock the switching device so that it cannot be restarted. Tag the switching device so that no one will attempt to restart the unit.

Close the suction and discharge valves completely to isolate the pump from the system. Lock the valves in the closed position and tag them so that no one will attempt to open them.

Turn off, lock out, and tag all sub-systems and auxiliary equipment and auxiliary supply lines to isolate the pumping unit from any and all power, energy, and/or fluids.

Do not attempt to perform any work on the unit until you are confident that the pump and its contents have been stabilized at ambient temperature, and atmospheric pressure.

Put on protective wear to protect human tissue from attack by the fluids contained in the pump and any sub-systems, and from any vapors or fumes that could possibly be released from these fluids. This could mean breathing apparatus, face shields, heavy long sleeve rubber gloves, rubber apron, hood, and possibly more, dependent of course on the properties of the fluids involved and the installed drain and vent piping arrangement. Personal injury and/or death can occur if adequate precautions are not taken with regard to the fluid, the installation, and the possibilities of the release of fluid, vapors, and/or fumes.

Remove the coupling guard. Remove the coupling spacer.

Drain all the fluids from the auxiliary sub-systems (lubrication, cooling, heating, seal barrier, etc.) that are connected to the pump. Drain each fluid into a separate container. Use caution required for each fluid after reading the MSDS (Material Safety Data Sheet) for each.

Flush each sub-system with a compatible, non-toxic, non-hazardous, stable liquid. Drain into individual containers for each fluid. Disconnect and remove all auxiliary piping.

Carefully bleed off any pressure remaining in the pump. Pressure remaining in the pump will be dependent upon the pressure in the system when the pump was stopped; the quality, type, and condition of the isolation valves; the thermal expansion valves of the fluid and the pump material; and the change in the vapor pressure of the fluid between the temperature at the time the isolation valves were closed and the ambient temperature. Bleeding must be through a valved drain line piped to a closed container mounted lower than the pump. The container must be arranged with a relief passage to some point where pressure and fumes will not be harmful to personnel. The container must also have a level device so that determination can be made that sufficient fluid has been drained to empty the pump cavity and the volume of fluid that was contained in the run of suction and discharge pipe between the isolation valves and the pump. After the initial rush of fluid from the pump relieves the pressure, the drain valve can be opened further to speed the draining operation. When fluid quits running into the drain tank, gauge the volume to see if it is sufficient to have fully drained the contents of the pump and the suction and discharge pipes between the isolation valves.

If the system was constructed without any drain connections, it will be necessary to consult the designers of the system for safe draining procedures.

Now drain any small piping, that contains the fluid pumped, from all low points, into the same container used to drain the pump. Do not drain any other fluids (different than the pumpage) into this container as they may not be compatible. Personal injury, death, and/or equipment damage could occur.

Even though it might appear that, the cavity being drained has completely drained, be extremely careful about opening the system and/or opening the pump. If something solid in the pumpage moves to the vicinity of the drain connection, it could seal-off the drain and maintain pressure in the cavity thought to have been drained. It is also possible that the isolation valves are not sealing and therefore allowing liquid to flow from the system into the pump. Personal injury, death, and/or equipment damage may occur if intense caution is not exercised.

Because of the above possibility, when you loosen the gasketed joint at the back of the casing (5), loosen the bolts or nuts only one full turn, and then use jack screws to break the gasket seal. If fluid and/or pressure remains in the pump, it will spray out now. Use extreme caution, wearing protective gear, to avoid injury. Do not proceed with disassembly until leakage ceases completely. If leakage does not cease, the isolation valves may not be sealing. Note that if the pump was purchased with out a drain, the pump will contain fluid which will flow out at the time the bolts are loosened and the gasket seal is broken.

When you open the pump, the fluid will be exposed to the atmosphere and personnel in the area. For the safety of all involved, the risk of exposure can be reduced by flushing the cavity that was just drained, with a compatible non-toxic, non-hazardous, stable liquid, before disassembling the pump.

Remove the casing bolts or nuts and using mechanical lifting apparatus to support the weight, pull the rotating unit from the casing.

Flush the wetted parts now exposed with compatible, non-toxic, non-hazardous, stable liquid.

Remove the gasket from the face of the casing (5) or the bearing housing (26) dependent on which one the gasket may have adhered to. The type of gasket and material of construction will vary with service requirements. Attack by prying and then, if necessary, layering off the old gasket with a sharp scraper, attempting to remove it in the largest possible pieces. Wear heavy leather, long sleeve work gloves when using the scraper. Wet the gasket before and during the scraping operation to reduce the possibility of fibers becoming airborne. Wear a respirator during this operation and until all debris has been disposed of in a plastic bag. Remove all of the gasket material down to clean metal surfaces on both parts that contacted the gasket. Place all of the gasket residue in a plastic bag, seal the bag and dispose of it in compliance with all government requirements.

The rotating assembly of the pump can now be moved to a more convenient location for further disassembly. Use only high quality tools. Flush parts as disassembled to remove hazardous residue from the pumpage and/or sub-system fluids.

Wear protective equipment as advised at the beginning of these warnings.

Use mechanical lifting equipment to lift assemblies and components.

Do not apply heat to parts to assist in disassembly. Explosion could occur causing personal injury, death, and/or damage to equipment.

Do not attempt to drill, saw, or otherwise cut parts to remove them. Explosion and/or fuming could occur causing personal injury, death, and/or equipment damage.

Do not hammer on any parts. Personal injury and/or damage to equipment may occur.

Do not attempt to manufacture parts or modify Dean Pump parts in any manner. Death, personal injury, and/or damage to equipment may occur.

One example of the above would be overboring the seal chamber, which removes metal that is required to contain fluids. Removal of this metal reduces the pressure containing capability of the part, and may create a leak path through the part.

Replace all gaskets, seals, bearings, and lubricants. Replace all parts that have worn, corroded, eroded, or otherwise deteriorated.

Use only Dean Pump MetPro Corporation parts.