FANUC Robotics

Draft Only

IPC Training Outline

1. Overview
2. Equipment
3. Setup/Operation
4. Maintenance/Troubleshooting
5. Reference

1. Overview

"IPC" stands for Integrated Pump Control. This system is intended for precision metering of paint materials. The IPC system can be used for solvent 1k and 2k systems (IPC has is also being used for 1k waterborne delivery systems). IPC uses FANUC servo motors to drive positive displacement gear pumps. The robot controller uses motorspeed and pump size to control output.

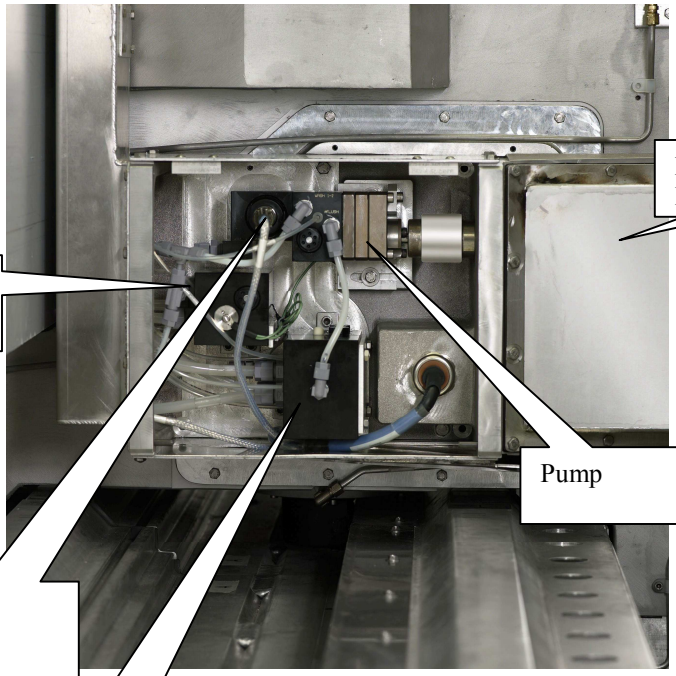
2. Equipment

P200Eib

Location of Side Saddle Pump/Motor Assembly

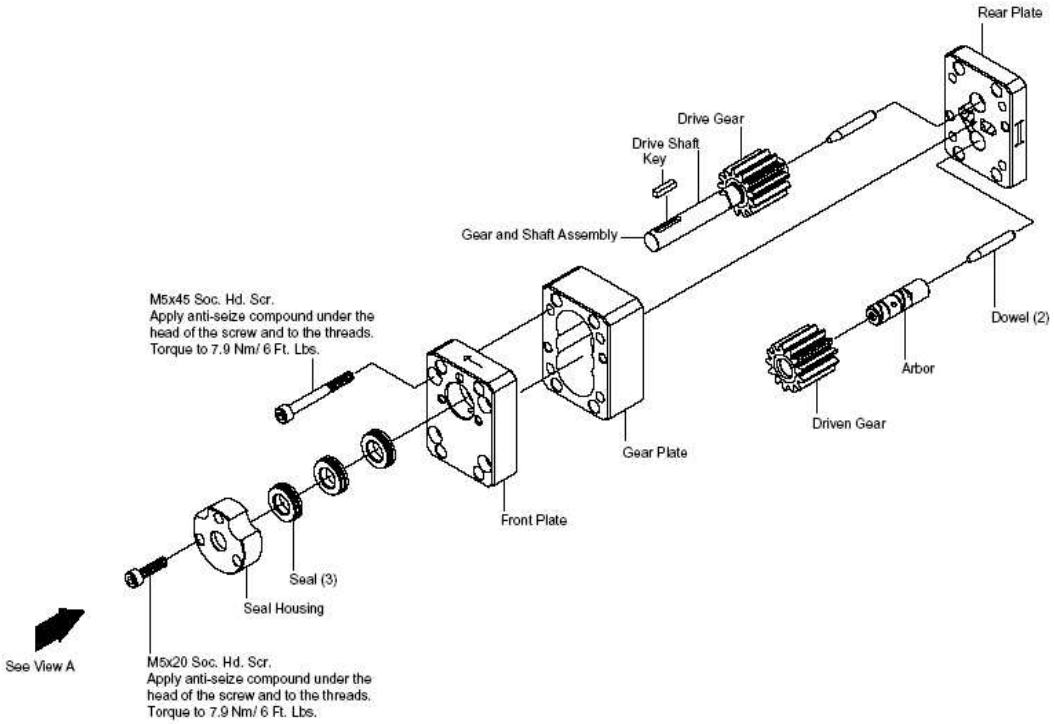
Location of Arm Mounted Pump and Color Changer Assembly

2k Versabell Arm



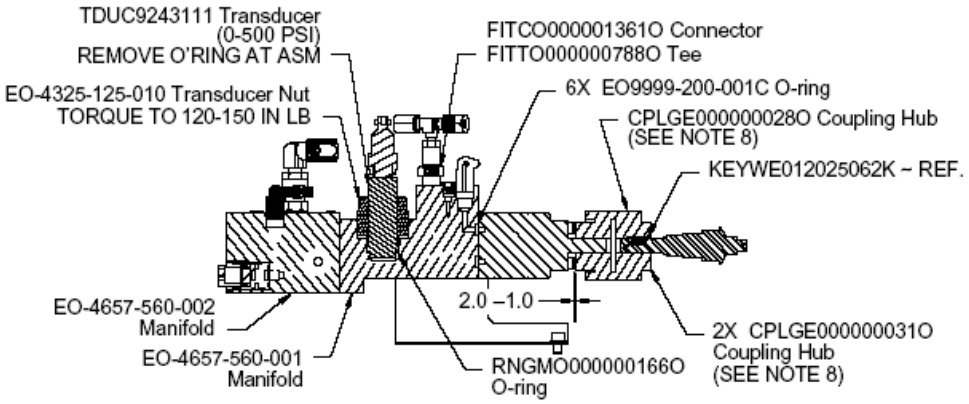
2k Side Saddle

Pump:
(6cc pump EO-4657-512-000 shown in exploded view)

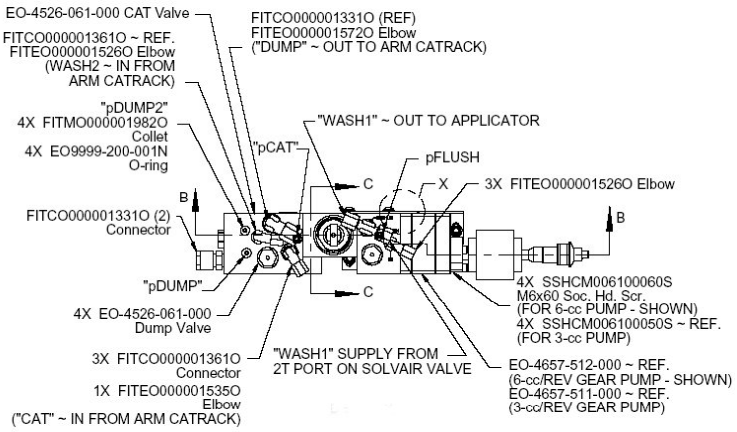


Pump and Mix manifold assemblies

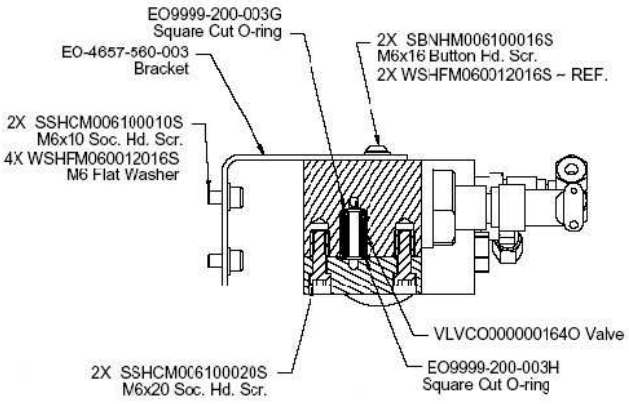
Figure 2.1



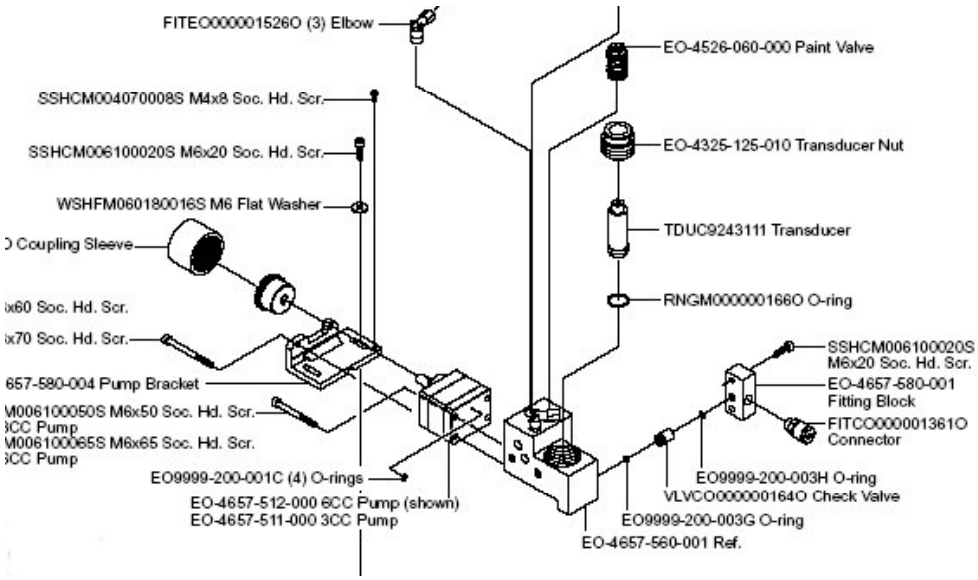
Resin and 2k Manifold Cross Section
"Side View"



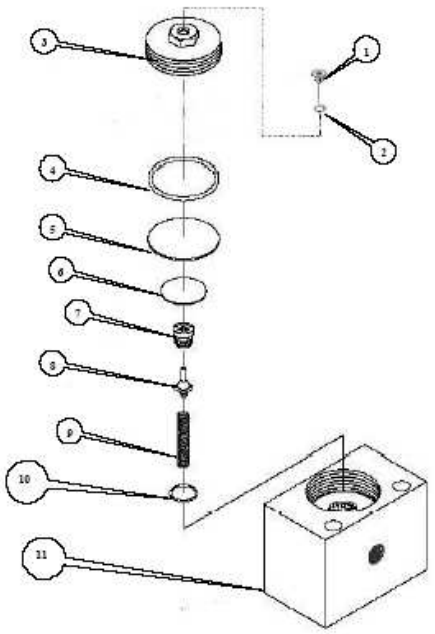
Resin and 2k Manifold
"Underside"



Section "C"



VersaBell Hardener Pump Manifold



FANUC Robotics
P200 Robots
Regulator Assembly
FR23
EO4657-503-000A

Soft Regulator Rebuild Kit O/FR23
HPNMO0000189210
Diaphragm, o-ring and seat o-ring.

Regulator Kit O/FR 23-1
HPNMO0000189220
Actuator, diaphragm and cap o-ring.

Regulator Kit P/FR 23
HPNMO0000189060
Actuator, poppet, seat, spring, seat o-ring, diaphragm, cap, tube fitting collet, o-ring, and cap o-ring.

Item	FANUC Part Number	Description	Quantity
1	FITMO0000020780	4mm Tube Fitting Collet, ACETAL	1
2	RNGMO0000001810	Collet O-Ring, Aegis PF133	1
3	CAPMO0000000950	Regulator CAP, Delrin	1
4	RNGMO0000001800	CAP O-Ring, Viton	1
5	HDWMO0000565110	Regulator Diaphragm, Kalrez 6580	1
6	HDWMO0000565100	Regulator Actuator, Delrin	1
7	HDWMO0000565090	Regulator Seat, 316 S.S.	1
8	HDWMO0000565070	Regulator Poppet, 316 S.S.	1
9	SPGMO0000000170	Regulator Spring, 302 S.S.	1
10	HDWMO0000565080	Regulator Gasket, Aegis PF133	1
11	HDWMO0000565060	Regulator Block, Delrin	1

3. Setup/Operation

General Rules for Setup:
General Rules for IPC Setup:

1. First thing is to setup anticipators for the pumps and applicator trigger. The Pump Start and Stop settings are found in the "IPC Setup" menu. The trigger settings are found in the Paint Setup Menu. **The following values are default parameters only. Field adjustments may be required.** Set Pump Start to –55 ms (can range from –45 to –60). Set the trigger "on" to –99ms. The purpose is to initiate tasks, like "Gun On", 99ms before the actual location. Then 40 or 50ms after the trigger opens, the pump will start. This is done to allow for a pneumatic lag (trigger) and to keep from having a burst of paint at the opening of the trigger valve (caused by too much pump pressure built up before the trigger is opened). Next set the Trigger Off to "0" and the Pump Stop to 15 ms. This keeps a small amount of pressure in the line for the next trigger event. Note: If you experience a low outlet pressure fault after the trigger has shut off the potential cause may be a trigger valve sticking open.

2. A good starting point for Delta Pressure (Delta P) is to begin with 5-7psi. This causes the regulator to have 5-7psi more air pressure applied than is being seen as fluid pressure on the outlet sensor. This means that if the outlet sensor is seeing 60 psi of paint pressure (during painting) then the inlet regulator would be getting 65-67psi of air pressure. You can watch the result[1] by then comparing the inlet regulator command to the outlet sensor reading. As flows and outlet pressure climb, the regulator will be opened more. If the outlet pressure meets or exceeds 100psi, the inlet regulator will be opened wide and you will be getting full line pressure to the pump. The purpose for this control is to keep a small differential pressure across the pump. Control of the Delta Pressure helps to keep the efficiency of the pump high. Note: Improper control of the pump differential can lead to a pulsating output, a flow rate that is too low or one that is too high. Refer to the trouble shooting chart in this document for causes and potential solutions to this problem.

3. When trying to spray at flow rates below 100 cc/min, you will need to adjust downstream restriction for the pump. Too little outlet pressure will lead to pulsation. A good pressure range for the outlet sensor (during painting) is 15-80 psi. Note: The outlet pressure warning level should be set around 150-175psi. The outlet pressure fault level should be set no higher than 250psi (high-pressure levels). These values may vary a little due to viscosity and flow rates but they will **help** to protect against over pressure related damage to paint lines and fittings. Repeated over pressure faults may indicate a valve that is sticking or a line that is blocked or pinched. If these faults keep repeating then the source of the fault needs to be investigated. Failure to correct the problem can result in broken paint lines, damaged valves and pumps.

Pump Setup:

Each project may require a different pump size (3cc and/or 6cc/rev). The size will be determined by the flow rates, viscosity's and mix ratio's. Generally a 3cc/rev pump is used for the catalyst and a 6cc/rev pump is used for the resin. The values

Go to "Menus", "Setup", "IPC". From this screen select System (should appear as follows).

(System)

1	Pump Start Anticipate	-55ms (Default value)
2	Pump Stop Anticipate	15ms (Default value)
3	Disable Pressure Monitor:	No
4	Disable Inlet Regulator:	No

The pump Start Anticipate controls when the pump starts in relation to the GUNON command in the path. The value of –55ms indicates that the pump will start 55ms (milliseconds) **before** the GUNON command. The Pump Stop Anticipate value controls the pump stop in relation to the GUNOFF command. The Disable Pressure Monitor and Inlet Regulator settings are not to be used during production. The Inlet regulator selection can be used in conjunction with a fixed inlet regulator. ***Note:** These values apply to both pumps when going through the teach pendant. Some systems have individual control on the GUI.

(Pumps)

Pump 1- Resin Pump

Size:	3.13cc/rev (example) **(Note: This value is the pump calibration setting)**
Max Speed:	250rpm
Motor/Pump reduction:	12:1

Pump 2-Hardener Pump

Size:	3.01cc/rev (example)
Max Speed:	250rpm
Motor/Pump reduction:	10:1

(I/P)

1	Inlet Regulator 1 – Resin I/P (Repeat for Pump #2 Hardener Pump)	
2	Cracking Pressure	5psi
3	Delta Pressure	5psi (5-7 are default range)
4	Sampling Average	5
5	Min Control Output	1600cnts
6	Max Control Output	8000cnts
7	Min Command Output	0psi
8	Max Command Output	100psi

(Sensor)

1	Pump 1 – Resin Pump (Repeat for Pump#2 Hardener Pump)	
	Outlet Pressure Transducer	
2	Low Pressure Warning:	10psi
3	Low Pressure Fault:	5psi
4	Low Pressure Sens:	4000ms **(Reducing this number will increase sensitivity)**
5	High Pressure Warning:	150psi
6	High Pressure Fault:	250psi
7	High Pressure Sens:	500ms
	Min Input	0psi
	Max Input	500psi
	Min Output	1600cnts
	Max Output	8000cnts

Sensitivity Adjustment:

The Sensitivity setting determines the time at which the controller must see a value before taking action. A 4000ms value for Low Pressure Warning means that the controller must see the low pressure setting (10psi

or lower for example) for 4000ms (4 seconds). After 4000ms the controller will post a warning. If the condition drops to the fault value (5psi for example) for 4000ms the robot will fault out. **These value must be set and tested on site.** This is done by setting the robot up to dispense paint (a trial should be run for a high and low flow rate relative to production). *Note: The flow test will need to be run through a GUI in order for the pressures to be monitored through the teach pendant. Once spraying you can disconnect the electrical connection for a resin/hardener (test one material at a time). The outlet pressure should drop off until the robot faults out. Monitor the pressure readings from the Teach Pendants Status Screen (again if run through a GUI). If the robot does not fault out then try lowering the Sensitivity value until it does (for example go in steps from 4000ms down to 1200). Once a value has been found then reconnect the solenoid and run test sprayouts to confirm this setting will not create nuisance faults. This should also be tested by shutting off the supply valve (at the drop) to the robot. Run the test and confirm that the robot faults. Note that the line pressure should drop down to "0". If the robot does not do this then there could be a couple of causes. First there could be other materials leaking into the fluid stream (solvent or another color). Air being fed into the line will also create pressure that could interfere (Note: This can be a problem when using Pressure Pots vs Main line circulation systems). Another cause for the outlet pressure not dropping to "0" could be the retaining nut, for the pressure transducer, being too tight (spec. is 120-150in lbs.)

Ratio setup:

The ratios for each material (2k systems only) are defined in the color setup table. From this screen you can select which resin, catalyst, and solvent are used. You can also assign a mix ratio (2:1, 4:1, 4.5:2.34 etc). Note: The flow rates, viscosity's and mix ratios will determine the pump size.

Transducer Check:

The purpose of this test is to confirm the functionality of the I/P (Current/Pressure) transducer that controls the fluid regulator. A 0-100psi pressure gauge with a 4mm pushloc connector will be required for this test. This test is best done from the teach pendant. Set the robot up for dispensing material from the teach pendant (for example Gun Test Mode). Lock the robot servos out and Remove the pilot line leading to the regulator. Connect the open end of the tube to the pressure gauge. From the teach pendant select "Menus", "I/O", "Analog Output". Locate RIP (Resin Inlet Pilot for this example) and enter 1600 cnts (counts). The gauge should read "0" psi. Enter analog values in 500 count increments up to 8000cnts. Record the pressure readings. The resultant values should show a linear relationship. If this is not the case then recheck and/or replace the transducer. Reconnect pilot line to regulator when finished with test. Note: This test can be used for the Resin and Hardener sides (2k only). The Hardener regulator pilot is HIP.

Regulator Check:

The purpose of this test is to check the function of the fluid pressure regulator that supplies the gear pump. The robot must be set to dispense paint from the teach pendant (as in the Transducer Check section). The test involves dispensing samples for five different Analog regulator values. The resulting sample volumes should be show linear relationship. This test only checks the functionality, not accuracy, of the regulator. Note: The purpose of this regulator is to control a differential across the pump up to 100 psi. This does not replace a paint drop regulator. Paint supply pressures in excess of 100psi (at the robot) can result in poor regulator performance. This test will require a graduated cylinder and two people. Remove the fluid supply line leading from the paint regulator to the pump inlet. Place the open end of the line into a beaker or graduated cylinder. From the teach pendant select "Menus", "I/O", "Analog Output" and set the analog value of RIP to 1600cnts. Next go to Digital Output 160-16X and select a production color valve. Open the valve. You should see little or no paint coming out of the tube, leading to the graduated cylinder, for 60 seconds. Note: Depending on the supply pressure, small amounts of paint may drip past the regulator. A steady stream may indicate a problem with the regulator internal components. Next turn off the color valve. Repeat this test in 500cnt increments up to 8000cnts. The resulting values should show a linear

relationship. If this is not the case then there may be internal problems with the regulator (diaphragm, needle and spring etc). Refer to the regulator drawing in this document for the P200Eib.

Ratio Check:

Note: The robot must be setup to dispense into a graduated cylinder. This can be done from a fixed location in the booth or by holding the cylinder in the operators hand. If the cylinder is to be held by hand then all safety precautions must be taken. This includes locking out all robots not being tested, and taking the teach pendant into the booth. First fill the robot with a production color. Select "Manual Functions", "Gun Control". From this screen enter a production flow rate with "no" air values (fan/atomization or shaping air depending on applicator type). *Note: If using a bell you may need to put in a bell speed command. **Test must be conducted without the bell cup installed!** After entering a flow rate, now put in a duration (60 seconds for example). Place the graduated cylinder under the applicator. Select "Pulse" from the Function keys. The teach pendant will post warnings screens. Following instructions and proceed with test. Once the robot has dispensed material for the selected time then record the sample volume. Repeat test three times. Take care to read the bottom of the Meniscus. Compare the recorded volumes to the requested. Adjust the pump "Size" in the IPC Setup section to match the new value. For example you requested 200cc/min with a 6.0cc/rev pump. The actual sample was 205cc/min. The percent of error was 2.44%. The new pump size is 6.15cc/rev. Note: A pump must be replaced if the error value reaches 15%.

4. Maintenance

A: P200E robots using non FANUC color changer equipment. This configuration includes a Catalyst pump in the side saddle. The resin pump is located in the arm and coupled to the drive motor by a flexible shaft.

B: P200Eib robots using FANUC color changer equipment.

The purpose of this document is to outline a maintenance plan recommended by FANUC Robotics (minimum requirements).

Daily:

System Start up - start of production

Step 1 Position robot at the Home Position over the purge bucket.

Step 2 Perform a Fill Cycle from the fluid maintenance screen (GUI) or the teach pendent manual functions screen.

Step 3 Confirm fluid is present by visual inspection or fluid calibration (if a change is seen). *Note: The calibration step is normally done every two weeks (up to one month).

Step 4 A Ghost job can executed from the GUI if so desired.

Step 5 Robot is now ready for automatic production.

System Shut down - end of production

Step 1 Position robot at the Home Position over the purge bucket.

Step 2 Perform a Trig Clean/or 1k Clean from the fluid maintenance screen (GUI) or the teach pendent manual functions screen. This cycle will clean the mixed material from the Mix block down through the gun.

Step 3 Confirm the cycle is executing.

Step 4 Robot is now in a storage condition, cleaned and ready for next shift

-Long term shut down plan (maintenance, shut down periods etc).

Step 1 Position robot at the Home Position over the purge bucket.

Step 2 Perform a Super Purge Cycle from the fluid maintenance screen (GUI) or the teach pendent manual functions screen. This cycle should leave both the hardener and resin systems filled with solvent.

Step 3 Confirm the cycle is executing and fluid is present by visual inspection.

Step 4 Robot is now in a storage condition.

Weekly:

*Tools and Material: 1 grease gun w/pure vaseline

* Remove pump access cover.

***Pump Assy.:** Visually inspect all connections, tubing, and paint valves for leaks. Repair if needed. Tubing that has burst or shows signs of expansion, may indicate a problem further down stream (pinched line, malfunctioning paint or trigger valve, or some type of restriction in the gun). Inspect pumps for signs of leaks. ***Leaking can come from around gear pump input shaft, seal plate, and paint fittings.** Any leaking indicates a need for service to be performed on the pump. The pump should be removed from service and inspected. If the leak is from the seal cup then service will be required. There are two seals located in the seal cup. These must be removed and replaced. Note: See the Zenith pump drawing in this manual for seal and tool part numbers. If the leak is from the fitting, then make sure the fitting is tight or replace. If the pump is delivering Catalyst material, then it is imperative that this pump be serviced. Failure to do this can result in the pump failing due to paint build up on the shaft area. At this point, the pump must be replaced and returned to FRNA for service (by Zenith).

*Apply a thin coat of pure Vaseline to surfaces of pumps, valves, transducers, and fittings. This will make maintenance easier in case of a resin or hardener leak.

*Spin pumps from Teach Pendant (do not do this step if material can not be supplied to pump). Listen for increases in noise from pump. A gear pump will make some noise during solvent flushing (due to cavitation). Noise during the dispensing of paint can indicate a pump problem. (check pump output with graduated cylinder).

*Check flow rates from each pump with beaker. If there is a drop in output from the pump then the calibration value will need to be adjusted. If calibrating does not help then the pump may need to be replaced and rebuilt. * As a general rule, a pump output variation of 10%-15% or more indicates a need to replace or rebuild the pump.

Monthly: *Tools and Material: 1 grease gun w/pure vaseline

*Remove robot arm and pump access covers.

* **Robot Arm:** Inspect all connections, tubing, and paint valves for leaks. Repair if needed. Tubing that has burst or shows signs of expansion, may indicate a problem further down stream (pinched line, malfunctioning paint or trigger valve, or some type of restriction in the gun). If the problem still persists, refer to site setup parameters document and verify changes**.**

***Pump Assembly:** Inspect all connections, tubing, and paint valves for leaks. Repair if needed. Tubing that has burst or shows signs of expansion, may indicate a problem further down stream (pinched line, malfunctioning paint or trigger valve, or some type of restriction in the gun). Inspect pumps for signs of leaks.

*Apply a thin coat of pure Vaseline to surfaces of pumps, valves, transducers, and fittings. This will make maintenance easier in case of a catalyst leak.

*Spin pumps from Teach Pendant (do not do this step if material can not be supplied to pump). Listen for increases in noise from pump. Some noise will result in running solvent through the pump (cavitation). A pump that is noisy during spraying paint, needs to be replaced.

***Flex Shaft (if applicable):** Lubricate flex shaft for resin pump. Grease with FANUC supplied LG-O2 or equivalent plant approved bearing grease. Inject a small amount, 10-12mm long, into the zirk fittings for the bushings.

*Check flow rates from each pump with beaker or graduated cylinder. If there is a drop in output from the pump then the calibration value will need to be adjusted. If calibrating does not help then the pump may need to be replaced and returned for service.

3 Months:

*Repeat weekly inspection.

*Inspect regulator diaphragm. If diaphragm is misshapen or shows signs of wear then it should be replaced. Inspect regulator assembly for signs of fluid build up. Clean or replace if needed.

*Inspect mixtube for signs of contamination. Replace if needed.

6 Months:

*Repeat weekly inspection.

*Inspect regulator diaphragm. If diaphragm is misshapen or shows signs of wear then it should be replaced. Inspect regulator assembly for signs of fluid build up. Clean or replace if needed.

*Replace mixtube for signs of contamination.

Yearly:

*Repeat weekly inspection.

*Replace any pumps that show signs of calibration problems (replace if pump output has dropped off by more than 10-15% from original setting).

*Inspect regulator diaphragm. If diaphragm is misshapen or shows signs of wear then it should be replaced. Inspect regulator assembly for signs of fluid build up. Clean or replace if needed.

*Inspect mixtube for signs of contamination. Replace if needed.

Pump Manual

***Disassembly**
If pumps are to be disassembled on a regular basis, we recommend that you establish a pump room with all the necessary tools and equipment for disassembly and cleaning with a separate "clean" area for assembly, testing and storing of rebuilt pumps. If maintenance is required due to low delivery or seizure, the following procedure is recommended for a "complete" disassembly.

NOTE: Be sure to note the location and orientation of all parts to ensure correct assembly. Refer to diagrams on pages 2 and 3 for your correct pump type.
Step 1) Remove the seal arrangement

Step 2) Remove all binder screws.

Step 3) Remove dowels (if used in pump) and arbor (refer to pump drawings) with an arbor press in the direction which disengages the press fit in the shortest distance.

NOTE: Dowels and arbors, for thePaint Pump, are press fit in the rear side plate. Press these parts out from the rear (port).

Step 4) Separate the plates by lightly tapping them with a soft head hammer. Great care should be taken not to scratch or damage the internal pump surface when prying the plates apart. **Note: The pump may need to be soaked in a cleaning solvent (see paint supplier) before repair is started on a catalyst pump. Material buildup on the outside of the pump body may require this step.**

Step 5) After disassembly, clean all components in purge solvent (or similar cleaning solvent. Again see paint supplier)

Step 6) (Alternate Step) Wash components in an ultrasonic cleaning tank and air dry. Be careful not to bang parts together.

Step 7) Inspect all parts for nicks, burrs, score marks and other signs of wear. The plates and faces of the gears may be hand blocked on 400/600 grit paper and any nicks, burrs or sharp edges can be lightly removed with an **Arkansas** stone. Be careful not to round off the edges of the gear teeth while lapping. **CAUTION:** Since the thickness relationship between the metering gears and center plate is critical to metering performance, and the center plate is non-wearing on its sides, lapping these components is not necessary and should not be done under any circumstances. Place a layer of 400 Grit Emery Cloth on a lapping block or plate–a granite flat is suitable. Apply light pressure to the component and turn it in a figure 8 fashion approximately 10 times until a smooth finish appears (see Figure #1). Turning in a circular fashion, or other non-uniform motion, may cause the ground holes to lose their perpendicularity to the faces. Always use clean, lint-free rags and compressed air to clean components. Paper towels are not acceptable; they may leave small pieces of paper and dust, on the components. Use chemical brushes to clean between gear teeth, bores, and relief'.

Step 8) FANUC recommends replacing Gear sets (pair).

Step 9) After each resurfacing, carefully gauge the area between the inlet and discharge ports at the mesh of the gears. This area, commonly referred to as the "throat," is the most critical part of the plate. Scoring or wear marks here will allow increased slippage from the high pressure discharge port section across the throat to the lower inlet port reducing efficiency. Therefore, carefully gauge this area for flatness after each resurfacing.

Step 10) After all components are "hospital clean," the pump is ready for assembly.

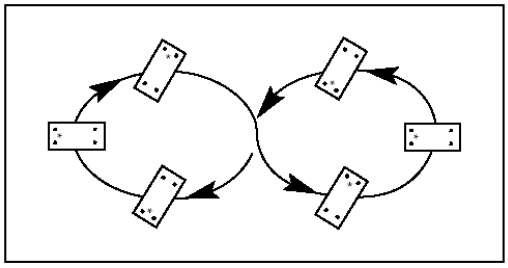


Figure #1

Note: Part Should be rotated by quarter turns at it moves through “Figure 8” pattern.

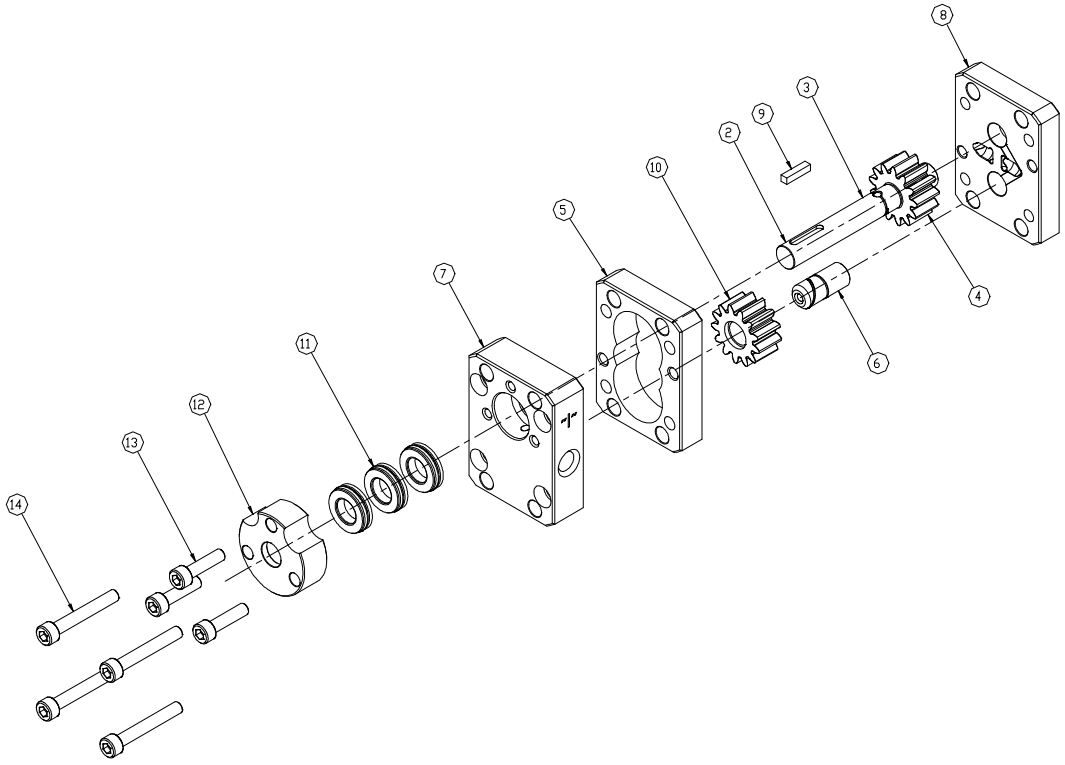


Figure #2

Item:

1. Pump Assembly (3cc shown in Figure 1
   (FANUC 3cc P/N EO-4325-223-001, 6cc P/N EO-4325-224-001)
2. Assembly, Gear and Shaft
3. Shaft, Drive
4. Gear, Drive

5. Plate, Gear
6. Arbor
7. Plate, Front
8. Rear Plate
9. Key, Square AISI 1095
10. Gear, Driven
11. Lip Seal (FANUC P/N SEALE000000077O)
12. Housing, Seal
13. SHCS #10-24 x .375 x Alloy
14. SHCS #10-24 x 1.375 Alloy (3cc only)
16. Bullnose Pump Assembly Tool (FANUC P/N TOOLO0000000029O)

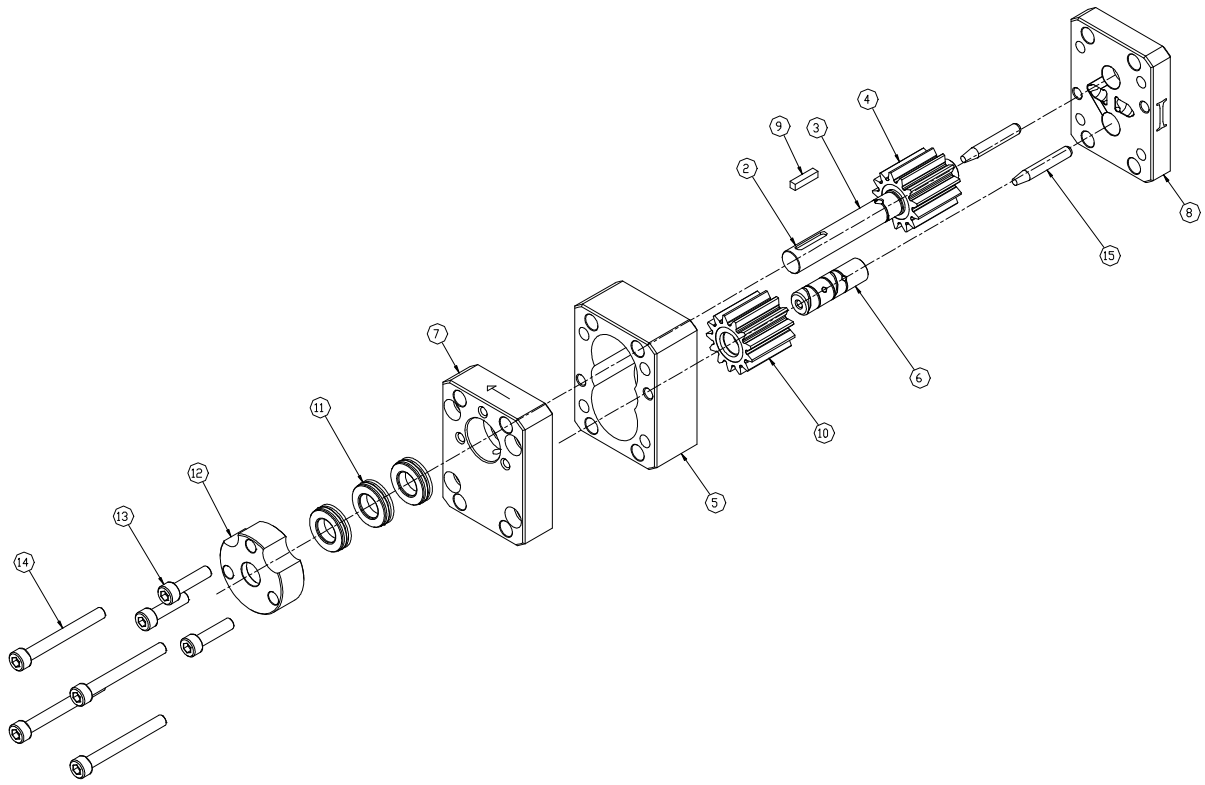


Figure #3

Item:
1. Pump Assembly (3cc shown in Figure 2
   (FANUC 3cc P/N EO-4657-511-000, 6cc P/N EO-4657-512-000)
2. Assembly, Gear and Shaft
3. Shaft, Drive
4. Gear, Drive

5. Plate, Gear
6. Arbor
7. Plate, Front
8. Rear Plate
9. Key, Square AISI 1095
10. Gear, Driven
11. Lip Seal (FANUC P/N SEALE000000077O)
12. Housing, Seal
13. SHCS M5x0.8 x 20mm Alloy 12.9
14. SHCS M5x0.8 x 45mm Alloy 12.9 (6cc only)
15. Dowel
16. Bullnose Pump Assembly Tool (FANUC P/N TOOLO0000000029O)

Re-assembly

NOTE: During and between each Re-assembly step, manually turn the metering gears to ensure that they are free turning. If binding occurs at any time, determine the cause and correct it immediately. A tiny nick, burr, or foreign particle can extensively damage a valuable pump component. Never use force in reassembling or turning a Zenith pump. If properly aligned, the pieces will fit easily into place, and the pump will turn freely. Reassemble the pump as follows:

Step 1) After all worn parts have been refinished or replaced, all parts should be thoroughly cleaned in a solvent and dried.

Step 2) Using the driven gear (4) as an up-righting fixture, carefully locate the arbor (6) over its press fit hole in the rear plate. Smoothly drive the arbor into its hole with the help of an appropriate arbor press.

Step 3) Place the rear plate (8) “upright” with the arbor in position in a soft-jaw vise or holding fixture. Reinstall arbor if removed for rebuild.

Step 4) Slip together the driving metering gear (4), drive shaft (3) and key (9).

Step 5) Place the driven metering gear (10) on its arbor and carefully mesh with the drive metering gear (4).

Step 6) Carefully lower the center plate (2) over the gears.

Step 7) Position the front plate (7).

Step 8) Rotate the gears to ensure free rotation.

Step 9) Press the dowels (15) into place moving in the direction of the shortest press distance. (Usually from the rear side of the pump.)

Step 10) Torque the screws in even increments to the manufacturer’s recommended limit (56in lbs). Follow the pattern shown in Figure #4. It is especially important to rotate the gears frequently during this operation. If the pump becomes difficult to turn, then go back to last the last screw. Loosen until pump is freed up and then continue.

Step 11) Reassemble the seal arrangement, making sure the sealing surfaces are perfectly clean and free of scratches, nicks, or burrs.

Step 12) Inspect the drive shaft at the seal area making sure that it is not scored, shouldered or worn. Worn shafts will result in premature seal leakage and should be replaced.

Step 13) Place the first lip seal (11) over the shaft bullnose tool (16) and force it firmly and evenly onto the shaft and into the front plate (7**). Note:** Locate the lip seal flush with the front face of the Front Plate (7). Use steel ruler or similar flat tool to seat the lip seal into the pocket. If the lip seal is pressed too far down into the front plate then it will interfere with pump operation and may lead to a leak. Note Figure #5 for correct lip seal orientation.

Step 14) Press two lip seals into seal housing (12). Place the seal housing (with seals installed) over the shaft bullnose tool (16). Force it firmly and evenly onto the shaft until it contacts the front plate.

Step 15) Install socket head screws, into seal housing, and torque to 56 in lbs.

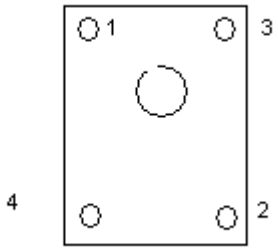
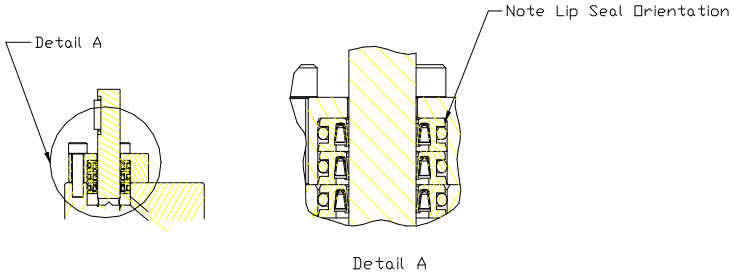
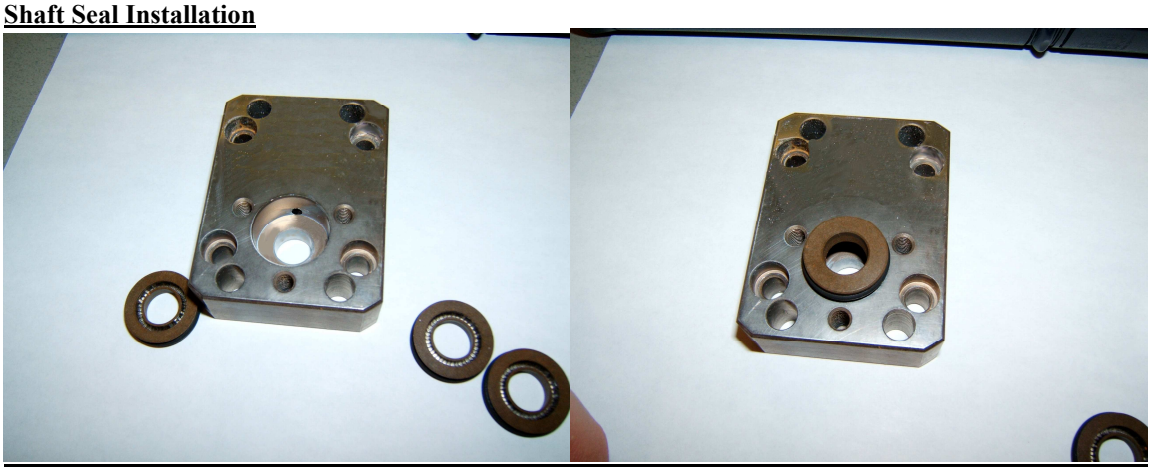


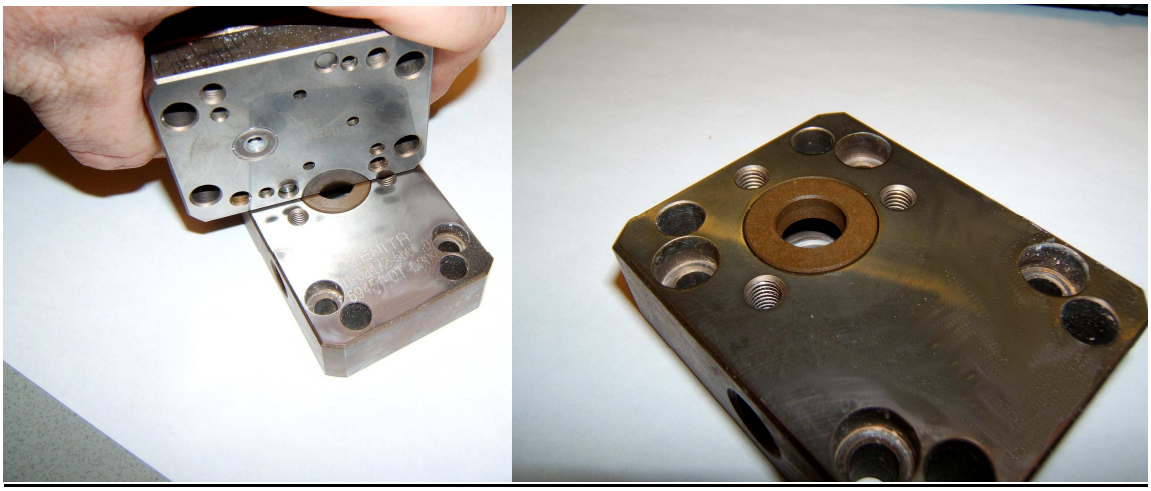
Figure #4

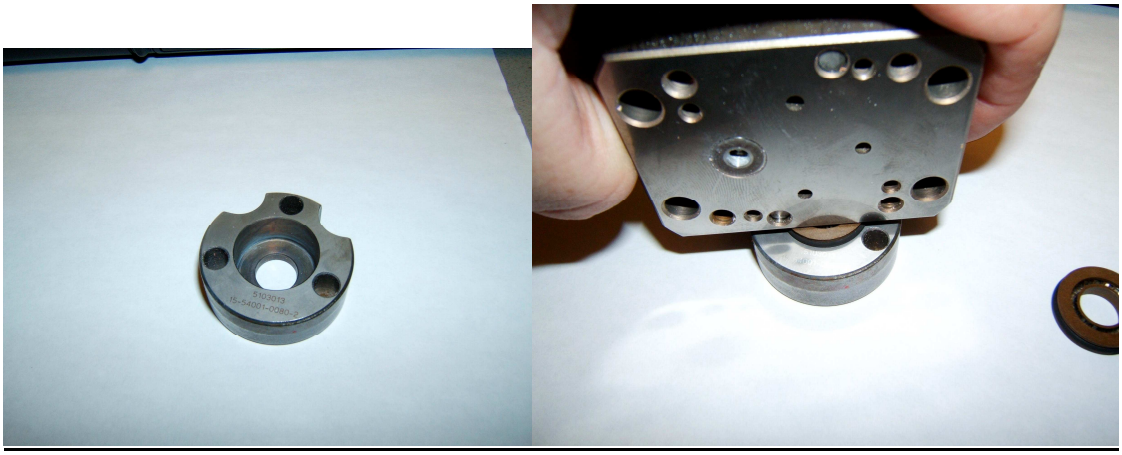
Figure #5

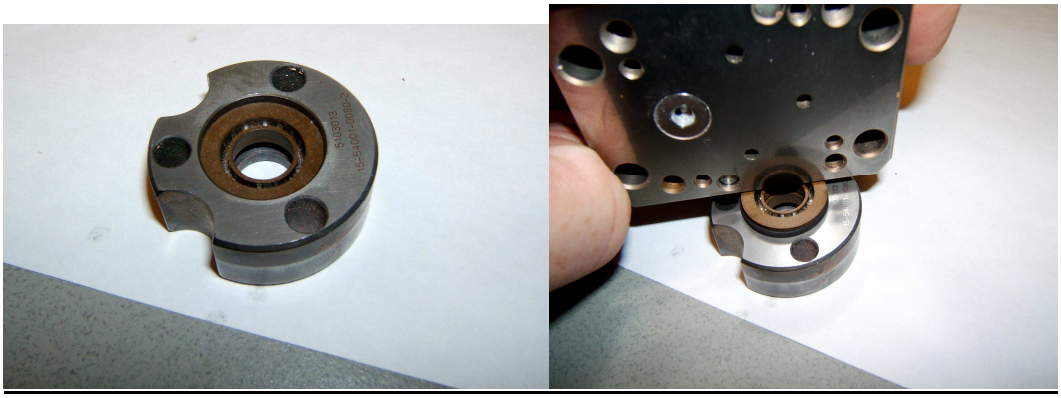


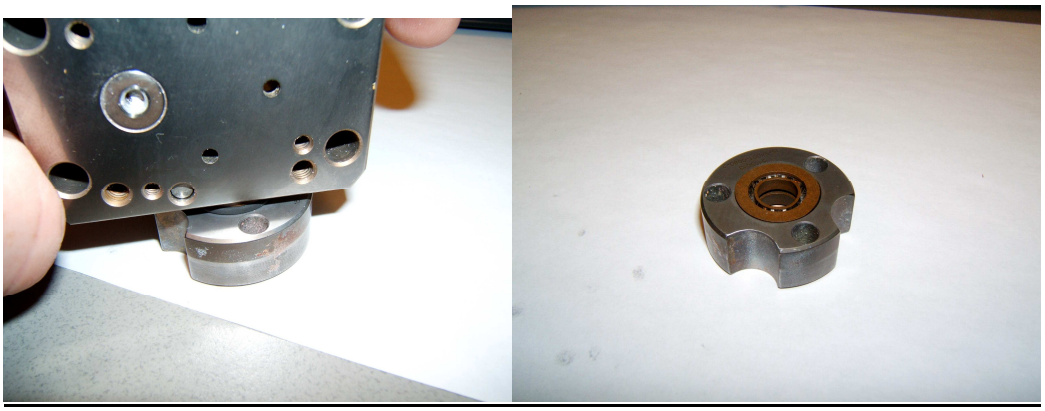
Shaft Seal Installation











Troubleshooting Chart (P200EiB)

	Type	Pump	Potential Causes	Debug Steps and Suggestions
1	Low outlet Pressure (Warnings/Fault)	1	Pump coupling broken	Check to see that coupling and motor/pump shafts turn when commanded .
			color valve not open	Manually fire color valve from teach pendant to see if it functions
			Inlet regulator not opening	Check control pilot signal. Remove pilot from regulator and insert commands in Analog Inlet. Check several steps on control scale. If air pressure changes then problem is with Regulator hardware, not transducer. Rebuild Regulator.
			Paint inlet line, to pump, broken/kinked	Inspect paint line and repair or replace
			Paint Supply shut off	Check paint supply
			Dump 2 (refer to system drawings!) may be open	Check discharge end of dump line and valve
			Broken line downstream from resin pump.	Check for leaks.
2	Low Outlet Pressure	2	Pump coupling broken	Check to see that coupling and motor/pump shafts turn when commanded.
			color valve not open	Manually fire color valve from teach pendant to see if it functions

			Inlet regulator not opening	Check control pilot signal. Remove pilot from regulator and insert commands in Analog Inlet. Check several steps on control scale. If air pressure changes then problem is with Regulator hardware, not transducer. Rebuild Regulator.
			Paint inlet line, to pump, broken/kinked	Inspect paint line and repair or replace
			Paint Supply shut off	Check paint supply
			Broken paint line after the pump but before mix point.	Check for leaks.
			Dump valve open	Check valve condition (remove for visual). Check for material flow in "Dump" line" during material delivery check.
			Pump/Trigger Off timing incorrect	Applicator Trigger may be set to stay open too long after pump has shut off. Pump Start/Stop timing can be adjusted in "Setup", "IPC". The trigger timing can be adjusted in the "Setup", "Paint" section.
3	Low Outlet Pressure	1 and 2	Trigger or Paint Enable (VersaBell only) valve may be sticking open.	Usually happens at the end of the painting process. Outlet pressure drops off as robot goes home. Check trigger and or paint enable valve (VersaBell only) for functionality. Replace if not cycling smoothly.
4	High Outlet Pressure (Warnings/Faults)	1	Applicator Trigger not open or slow to operate.	Fire valve on applicator. Remove and inspect. Replace if needed.
			Paint enable not open or slow (VersaBell only)	Fire valve on applicator. Remove and inspect. Replace if needed.
			Injector/nozzle blocked (bells only)	Visually inspect. Remove and soak in solvent. Note: Only clean per VersaBell manual!
			Kinked Paint line leading into applicator.	Inspect and replace
			Blockage in mix tube.	Inspect and replace
			Blockage in Pump manifold block(s)	Inspect and replace or clean
			Bad check valve in Pump manifold	Replace
5	High Outlet Pressure	2	Applicator Trigger not open or slow to operate.	Fire valve on applicator. Remove and inspect. Replace if needed.
			Paint enable not open or slow (VersaBell only)	Fire valve on applicator. Remove and inspect. Replace if needed.
			Injector/nozzle blocked (bells only)	Visually inspect. Remove and soak in solvent. Note: Only clean per VersaBell manual!
			Kinked Paint line leading into applicator.	Inspect and replace
			Blockage in mix tube.	Inspect and replace
			Blockage in Pump manifold block(s)	Inspect and replace or clean
			Bad check valve in pump manifold	Replace
			pCAT valve not opening (located in Arm manifold)	Fire valve in arm manifold. Remove and inspect. Replace if needed.
			Blocked paint line from pump outlet to in-arm pump manifold.	Inspect and Replace.

		HINTS :	***High outlet pressure faults or warnings start after the effected pump. If more than one pump is effected then concentrate on shared components (mix tube, injector nozzle, paint line to applicator, and trigger valve).***	
			Low Outlet/Inlet pressure generally start before the pump. The exception is where a line after the pump is broken or the injector nozzle is too large)	
6	OVC	1,2 or both	"Over current" alarm. Usually hardware related. Refer to the servo alarm code for instructions.	After reviewing alarm code info, items like pump couplings will need to be inspected. The "OVC" is caused by an increased load on the servo motor. A pump that is "seized" will also cause this problem. A seized pump can be caused by running a pump without lubrication. The Zenith gear pump uses paint as a lubricant. Solvent does not provide sufficient lubrication for long term operation. ***Never run the pump without some type of fluid.**
				An OVC fault that involves just the Resin portion would be identified by "Group Zero, Axis 1" associated with the fault I.D. The Resin Pump coupling consists of a Bowex sleeve and two gears. Make sure the moves a little between the two gears. This is the flex point. If the sleeve is not able to move then unwanted loads may be put against the pump or gearbox shafts. Another cause is the Servo motor or the gearbox itself. If the problem only happens during color change then check the cycles.
				An OVC that involves just the Catalyst (Hardener) will be identified by "Group Zero, Axis 2". The Catalyst (or Hardener) coupling assembly consists of two key gears and a sleeve coupling. Check to see that no foreign material has become lodged between the coupling assembly and the pump or the motor faceplate. This material could also be Hardener from a leak that has built up. This fault can also be the result of a pump the has seized. Check for signs of material leaking around the pump shaft. If this is found, remove pump and replace. *Note: Hardener pump must be flushed out (automatically or by hand) before it can be serviced. Failure to do this will ruin the pump! If the pump can not be turned automatically, while installed. Remove the pump (separated from the flush block). Spray or squirt solvent into inlet/outlet ports. Also spray or squirt solvent into each of the four holes on the back of the pump. This will clean out the internal passages. Remember to do the same to the flush block. The pump can now be serviced.
7	Overspeed	1,2 or both	Refer to posted Alarm code.	check to see that flow rate called out does not require pump to operate at more than 250rpm. This can occur when pump calibration number is adjusted too low (example: 2.4cc/rev vs 3.0).
8	**Pump Delivery Problems**			
	Output higher than requested		No alarm for this condition.	New pumps will have some manufacturing variations. It is a good practice to calibrate the pumps when installing them. Follow the calibration procedure in the service manual. This could indicate a pump that is worn which results in material "slipping" through.

	Output lower than requested		No alarm unless a "Low Outlet/Inlet Pressure Warning or Faults"	This can be due to a pump that needs calibration. Check by beakering. Another cause can be from an inlet regulator that is not functioning properly. Disassemble regulator and inspect diaphragm, needle and seat. The needle and the seat should show uniform wear around the parameter. There should also not be any scratches. If either is found then replace the needle, seat, spring and o-ring. Next inspect the diaphragm. First note if there is any sign of fluid on top of the diaphragm. This is a sign of a damaged/worn seal under the diaphragm. This could also be caused by a cap that is loose. The other cause could be failure to put the retaining ring on top of the diaphragm during a rebuild. Inspect diaphragm for signs of wear. Any sign of delamination or tears will require that the diaphragm be replaced. There will normally be a shallow ring, centered, just inside the parameter of the diaphragm. This is from being compressed in the regulator body. If this area shows signs of being curled or "pillowed" (looks thicker than surrounding area) then replace. This is caused by stretching of the diaphragm over time. Last of all this could be caused by a faulty regulator transducer. Disconnect the pilot to the regulator and attach to a pressure gauge. Step through the Analog command values for the regulator (from off-full open) and verify that the generate a linear relationship. If not then replace the transducer.
	Color Carry over after color change	1 or 2	Color change cycles	Compare to other robots in cell (if possible). Review fluid schematic for system. Confirm solvent and air supply are sufficient. Confirm regulators and transducer are operating properly (see “Check” section of this manual). Adjust cycle times and flow rates (color change presets) as needed. Inspect lines leading to applicator for fill or clean status. Confirm cleaned or filled state by dispensing a low volume onto white paper after a color change (example: from red to white or silver to black). Inspect for color or metallic carry over. Note: Bell cup needs to be removed if using this type of applicator.
			Insufficient Solvent Supply	If using Solv/Air valve, check that Solvent pressure is 10-15psi higher than air at all times (static and dynamic). Look for solvent pressure drops, at supply, during color change. Compare to other robots on same circuit. Beaker solvent delivery from drop.
			Damaged Regulator (Resin/Catalyst)	Debug regulator using “Regulator Check” section of this manual. Disassemble and rebuild if needed.
			Plugged Dump Line	Check both ends of dump line for blockage. Replace if plugged.
			Leaking Valve Manifold	Clean out color stack. Input 8000cnts to Regulator. If material is leaking out of regulator (w/o color valve being open) fix or repair valve/manifold that is source.

5. Reference

IPC pressure sensors

The FANUC IPC system uses one outlet pressure sensor in conjunction with the Zenith positive displacement gear pump. The purpose of the pressure sensor it to detect outlet over and under pressure conditions. The pressure sensor is also used as part of the control circuit for the inlet regulator for the pump. The following document outlines the general function of the outlet pressure sensor as it pertains to the FANUC IPC system. This document also includes trouble-shooting suggestions for this device.

The standard pressure sensor is a 0-500psi unit supplied by Data Instruments. This device is used to detect high and low outlet conditions. The high outlet faults and warnings can result from blockages, kinked lines, or defective trigger valves. The low outlet faults or warnings can be caused by a lack of supply, defective color valve, defective inlet regulator, broken paint line downstream, or too little downstream restriction (backpressure). The pressure sensor is used to drive the inlet regulator (for systems that are configured as such). The controller ads the "Delta P" value on to the pilot pressure for the regulator. The "Delta P" value is set in the IPC setup section on the robot controller. This value is generally 5-7 psi. For example: If the outlet sensor detects 50 psi of pressure, during a sprayout, then the regulator will get a command pressure of 55psi (if the Delta value is set to 5psi). A Delta Pressure setting that is too high can result in pump displacement problems. These can range from little or no paint at low flow settings (100-200cc/min) up to larger than requested outputs at high flow rates (750 vs 650 cc/min for example). A Delta setting that is too high results in excessive amounts paint being supplied to the pump. This can result in slippage past the pump due to insufficient back pressure. A Delta value that is set too low can result in excessive cycling on the inlet regulator. This can result in a shorter life on regulator components.

Related Faults/Warings			
Type	***Pump***	***Potential Causes***	***Debug Steps, suggestions***
Low Outlet Pressure	1	Pump coupling broken	Check to see that coupling and motor/pump shafts turn when commanded.
		color valve not open	Manually fire color valve from teach pendant to see if it functions
		Inlet regulator not opening	Check control pilot signal. Remove pilot from regulator and insert commands in Analog Inlet. Check several steps on control scale. If air pressure changes then problem is with Regulator hardware, not transducer.
		Paint inlet line, to pump, broken/kinked	Inspect paint line and repair or replace
		Paint Supply shut off	Check paint supply
		Dump (refer to system drawings!) may be open	Check discharge end of dump line and valve
		Broken line downstream from resin pump.	Check for leaks.
Low Outlet Pressure	2	Pump coupling broken	Check to see that coupling and motor/pump shafts turn when commanded.
		color valve not open	Manually fire color valve from teach pendant to see if it functions
		Inlet regulator not opening	Check control pilot signal. Remove pilot from regulator and insert commands in Analog Inlet. Check several steps on control scale. If air pressure changes then problem is with Regulator hardware, not transducer.
		Paint inlet line, to pump, broken/kinked	Inspect paint line and repair or replace
		Paint Supply shut off	Check paint supply
		Broken paint line after the pump but before mix point.	Check for leaks.
		Dump valve open	Check valve condition (remove for visual). Check for material flow in "Dump" line" during material delivery check.
		Pump/Trigger Off timing incorrect	Applicator Trigger may be set to stay open too long after pump has shut off. Pump Start/Stop timing can be adjusted in "Setup", "IPC". The trigger timing can be adjusted in the "Setup", "Paint" section.
Low Inlet Pressure	2	color valve not open	Manually fire color valve from teach pendant to see if it functions
		Inlet regulator not opening	Check control pilot signal. Remove pilot from regulator and insert commands in Analog Inlet. Check several steps on control scale. If air pressure changes then problem is with Regulator hardware, not transducer.
		Paint inlet line, to pump, broken/kinked	Inspect paint line and repair or replace
		Paint Supply shut off	Check paint supply
High Outlet Pressure	1	Applicator Trigger not open or slow to operate.	Fire valve on applicator. Remove and inspect. Replace if needed.
		Paint enable not open or slow (VersaBell only)	Fire valve on applicator. Remove and inspect. Replace if needed.
		Injector/nozzle blocked (bells only)	Visually inspect. Remove and soak in solvent. Note: Only clean per VersaBell manual!
		Kinked Paint line leading into applicator.	Inspect and replace
		Blockage in mix tube.	Inspect and replace
		Blockage in Pump manifold block(s)	Inspect and replace or clean
		Bad check valve in Pump manifold	Replace
High Outlet Pressure	2	Applicator Trigger not open or slow to operate.	Fire valve on applicator. Remove and inspect. Replace if needed.
		Paint enable not open or slow (VersaBell only)	Fire valve on applicator. Remove and inspect. Replace if needed.
		Injector/nozzle blocked (bells only)	Visually inspect. Remove and soak in solvent. Note: Only clean per VersaBell manual!
		Kinked Paint line leading into applicator.	Inspect and replace
		Blockage in mix tube.	Inspect and replace
		Blockage in Pump manifold block(s)	Inspect and replace or clean
		Bad check valve in pump manifold	Replace
		pCAT valve not opening (located in Arm manifold)	Fire valve in arm manifold. Remove and inspect. Replace if needed.
		Blocked paint line from pump outlet to in-arm pump manifold.	Inspect and Replace.