SYSTEMS, INC.

FS40R
ROTARY ATOMIZER
OPERATION MANUAL

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1. INTRODUCTION

1.1 General Description

The FS40R-SYS is a rotary atomizer system designed to electrostatically apply solvent borne paint used in the automotive and related industries.

It is important to read and fully understand this operation manual, the UP-200 Service and Operations Manual, the EFC 4x4 Card cage Installation Manual, the TSC-400 Service and Operations Manual and the AFC-400 Service and Operation Manual before installing, operating and maintaining the FS40R-SYS. Operators of this atomizer system must be especially aware of all safety considerations and performance specifications involved. Each of these manuals should be kept in a safe location that is easily accessible to everyone involved with this system.

It is the responsibility of the end user of this system to ensure that all local, state and federal laws and regulations concerning safety are followed, including but not limited to fire and environmental codes, building codes, as well as occupational safety and health acts.

1.2 Copyrights

1.3 Precautionary Symbols

 **DANGER!** – An alert to a health hazard that could result in serious bodily injury or death.

 **WARNING!** – An alert to a hazardous situation that could result in serious bodily injury and/or serious equipment damage.

 **CAUTION!** – An indication that extra precautions should be taken to prevent bodily injury or equipment damage.

 **TIP** – An indication of some useful information when working with the FS40R.

2. SAFETY

All personnel who operate and maintain the equipment presented within this manual must to be fully trained on the safety guidelines that must be followed concerning this equipment and the environment in which this equipment is operated.

2.1 Experience

 **DANGER!** All those involved with the operation and maintenance of this system need to have the expertise and experience to do so. Severe injury or death may result from unqualified individuals who attempt to operate or handle this equipment. An electrical shock, fire or explosion may also occur if this warning is not followed.

2.2 Safety Codes

All personnel involved with the operation of the FS40R, and the environment in which it operates, must understand and follow all local, state and federal laws and regulations concerning safety, including but not limited to fire and environmental codes, building codes, as well as occupational safety and health acts. Failure to do so could result in bodily injury and equipment damage due to a fire, explosion or electrical shock.

2.3 Sparks & Open Flames Within Spray Booth

 **DANGER!** All open flames and sources of spark are to be kept out of and away from the spray booth. Failure to do so could result in the ignition of a flammable object, creating a fire and explosion hazard.

2.4 Grounding

 **WARNING!** All conductive objects within the spray booth must be properly grounded. These include paint, solvent, metal objects and humans. Failure to do so could result in a spark and ignition of a flammable material.

Surfaces within the spray booth must be kept as clean as possible. An accumulation of paint within the spray booth could result in equipment and surfaces that are normally grounded, to become electrically insulated. An excessive amount of charge build-up on these surfaces could cause a spark and therefore presents a fire, explosion and shock hazard.

Halogenated hydrocarbons must never be used with the FS40R. Several of the components within the FS40R are made of aluminum, steel and titanium which can have a violent (explosive) reaction with halogenated hydrocarbons.

2.5 Personnel Safety

 **WARNING! Ventilation**

Adequate ventilation must be maintained at all times in the spray booth in which the FS40R is operating. Without proper ventilation, noxious fumes from paints and solvents as well as ozone gas may build to unsafe levels, causing poisoning, bodily irritations and fire and explosion hazards.

Physical Hazards

All personnel are to remain clear of the FS40R during operation. The system is charged to a very high potential and could cause a severe electrical shock if the system is approached during operation. The bell cup rotates at a very high speed and utilizes an extremely sharp edge to atomize the paint during operation. Contact with the bell cup, even as the system is at an idle speed, could result in

severe injury. Safety devices must be in place and functioning to prevent individuals from approaching the FS40R during operation. These safety devices may include safety locks on spray panels and spray booth doors. Safety lockouts for high voltage switches should be utilized to prevent the charging of the system, while the system is down for maintenance.

 **CAUTION! Protective Gear**

Adequate protective gear must be worn at all times when working with the FS40R system. Protective gear should include safety glasses that are impact resistant, electrostatic work shoes, work clothing and ear protection, gloves and respirators.

Health Conditions

Persons with health problems should not work in the spray booth environment, nor should they operate, maintain or service the FS40R system. Persons with an implanted cardiac pacemaker should stay clear of the spray booth area because the high voltage utilized by the FS40R may interfere with the operation of the pacemaker.

Improper Use

 **DANGER! High Voltage Fault**

If a voltage overload fault occurs, immediately correct the problem. Continuing to use the FS40R with excessive voltage could cause an explosion and fire.

 **WARNING! Safe Distance**

A safe working distance of 6” must be maintained between all objects and the atomizer.

 **CAUTION! Fluid Pressure**

Before removing any of the atomizer parts from the robot mount, first flush out and dry all liquid lines. Release any residual pressure from all fluid (air & liquid) lines before servicing the atomizer. Removing any of the components before relieving residual pressure could result in paint and/or solvent being released onto the operator causing bodily injury.

 **WARNING! Complete Assembly**

Before operating the FS40R, all components must be completely and correctly assembled. Operating an improperly assembled FS40R may result in a fire and/or bodily injury as well as equipment damage.

Proper Tooling

All personnel servicing and maintaining the FS40R must use the proper tooling to do so. The proper tooling will allow the service personnel to disassemble and reassemble the atomizer correctly and safely. Failure to use the proper tooling could result in bodily injury and equipment damage.

Additional Risks

 **WARNING! Abnormal Phenomenon**

If any abnormal instances occur during operation, immediately shut down the FS40R system and correct the problem. Abnormal phenomena include but are not limited to: excessive motor vibration, excessive motor noise, and voltage losses. Continuing to operate the FS40R with obvious system problems could lead to bodily injury and equipment damage.

System Modifications

Under no circumstances are personnel to modify the FS40R without written permission from EFC SYSTEMS, INC. This also

applies to the use of replacement parts and systems other than EFC supply parts. Modifications made to this system could result in bodily injury and equipment loss, and/or a warranty void.

Maintenance

Proper maintenance procedures must be followed according to the maintenance sections of this manual to ensure the safe operation of the FS40R. Failure to follow the maintenance procedures and checks could result in equipment failure and personal injury.

Bearing Air Drop

The FS40R utilizes an air bearing motor, which allows the shaft within the motor to "float" on a thin pocket of air, known as bearing air. To prevent damage to the motor, bearing air should not drop below 80 psi. It is recommended the motor should always have a constant supply of bearing air of at least 85 psi when operating or idling. If the bearing air drops below this setting, the turbine *must be brought to an immediate stop* by discontinuing the drive air and engaging the brake air. The FS40R consumes approximately 2 scfm of bearing air, when bearing air is supplied at 85 psi.

Bell Cup Assembly

It is important to properly attach the bell cup to the motor shaft. The bell cup, motor shaft and paint injector should be clean and free of debris. Placing the bell cup on the motor, with one or both being dirty, would increase the possibility of the bell cup disconnecting from the motor or the paint injector disconnecting and injuring someone or damaging the equipment and injuring someone. A dirty or damaged bell cup could also create an imbalance within the motor assembly, thereby increasing the chances of motor failure.

2.6 Noise Level

Speed	1' Distance	10' Distance
20krpm	**80dB**	**75dB**
30krpm	**84dB**	**77dB**
40krpm	**84dB**	**78dB**
50krpm	**90kB**	**82dB**

Ambient Noise – 70dB

3. FEATURES

3.1 Physical

- 60º Manifold orientation to allow for easier access within and around the vehicle
- Compact and light weight
- Streamlined profile for ease of cleaning
- Internal fluid regulator (0-1000 ccpm)
- Fluid lines with connection means to prevent fluid lines from contaminating one another
- Highly efficient, self cleaning bell cup assembly
- Aluminum inner and outer shrouds to help reduce the amount of wrap back onto the atomizer
- Nanovalves located within the manifold to provide for internal and external bell wash
- Microvalve dump located within the manifold for quick purges
- Quick disconnect nut to easily and quickly remove the FS40R from the robot mount
- Self-contained air motor for fast and easy replacement
- All motor and Q.D. o-rings are chemically resistant Tekrez® that resist swelling
- Fiber optic speed sensing
- Pneumatic pressure switch for disabling the speed card (i.e. drive air supply) in case of loss of bearing air.

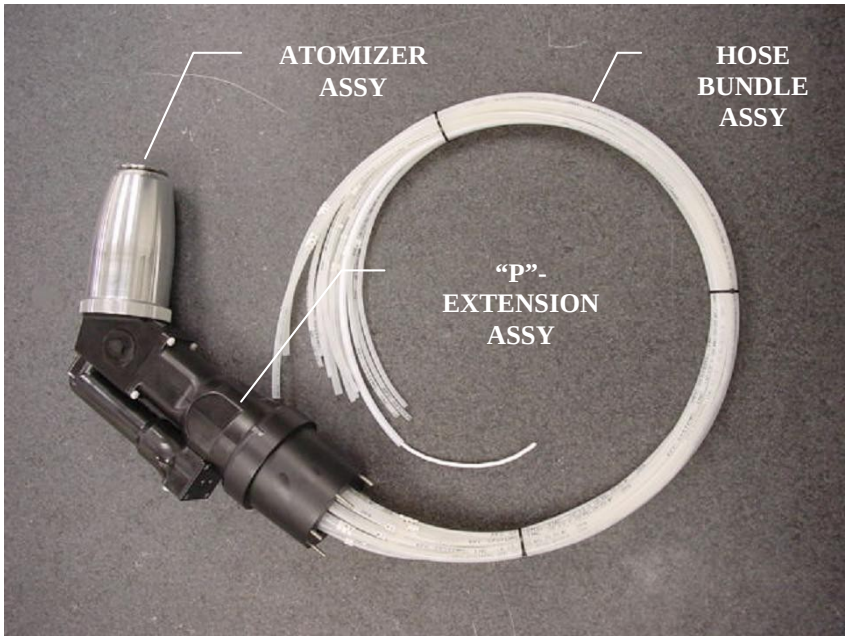


Figure 1: FS40R-SYS (Power supply not shown)

3.2 Safe Guards

The EFC FS40R has numerous safety features built into the power supply (UP-200). The UP-200 incorporates state of the art safety features and fail-safes to provide for a safe operating environment. These include:

- Over voltage detection
- Over current detection
- Fast current slew rate detection and limiting
- Turn-on proximity detection
- Open and short line detection and protection
- Current limiting via voltage fold-back
- Voltage control 0 – 10 VDC
- Current control 4 – 20 mA

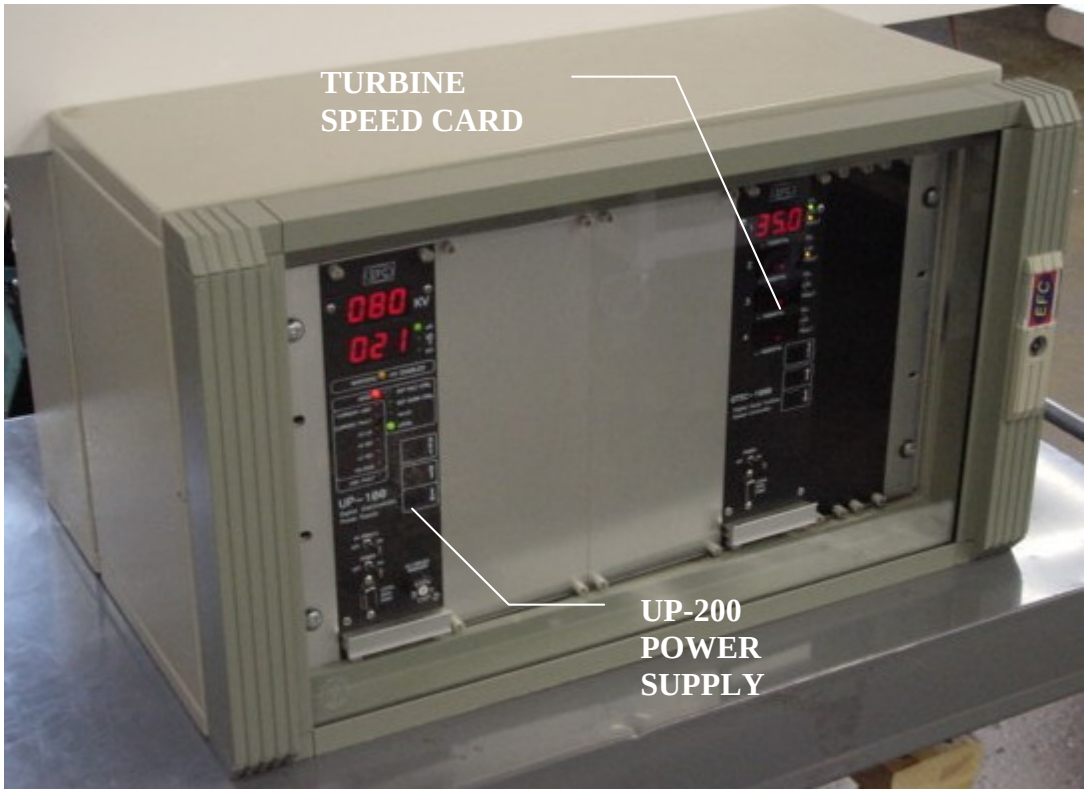


Figure 2: UP-200 POWER SUPPLY

3.3 Finishing Characteristics

- Superior finish
- High transfer efficiency
- Improved atomization via serrated bell cup
- Uniform droplet size distribution
- Good metallic color match

4. FS40R

4.1 Start – Up Procedures

Once the FS40R has been assembled properly and mounted correctly, the following steps must be taken to ensure proper start – up:

1. Bearing air MUST be on and set at 85 psi minimum entering the FS40R. Bearing air must be on at all times during operation.
2. Ensure the turbine shaft is floating on bearing air. This may be done either by carefully spinning the bell cup by hand, or by watching the bell cup to see if it is spinning freely. If the bell cup is spun by hand, gloves and safety glasses must be worn. Note: The bell cup will not spin freely without the addition of drive air, if the brush ring is installed. The brush ring (needed for directly charging the paint during operation) is installed at the back of the air bearing motor and uses soft bristles that contact the turbine shaft (See Figure 30.).
3. Do not trigger the paint or solvent on unless the bell is spinning at operating speed and sufficient shaping air is supplied. To do so would allow paint (or solvent) to enter the air bearing motor assembly, possibly destroying it.
4. Once bearing air is on and the shaft and bell cup are spinning freely, the drive air may be applied. The bell does not need a “warm-up” period. It does not need to be gradually brought up to operating speed and therefore may be immediately given enough drive air to bring it to operating speed.
5. The system is now ready for operation.

4.2 Shut – Down Procedures

1. While the system is spinning at operating speed, and with the e-stats off, flush the system with solvent and completely dry the system with air.
2. Set the turbine speed to zero and allow brake air to decelerate the bell cup completely.
3. Turn off shaping air.
4. Verify that the bell has come to a complete stop. *Important: Verification should be done visually.* It is possible the bell cup may still be spinning very slowly, even though the speed card is not displaying a speed.
5. If the complete bell system is to be removed (i.e. unattached from the robot) then bearing air supply may be discontinued. If the system is not to be removed, then bearing air should remain on.

4.3 Overall Dimensions

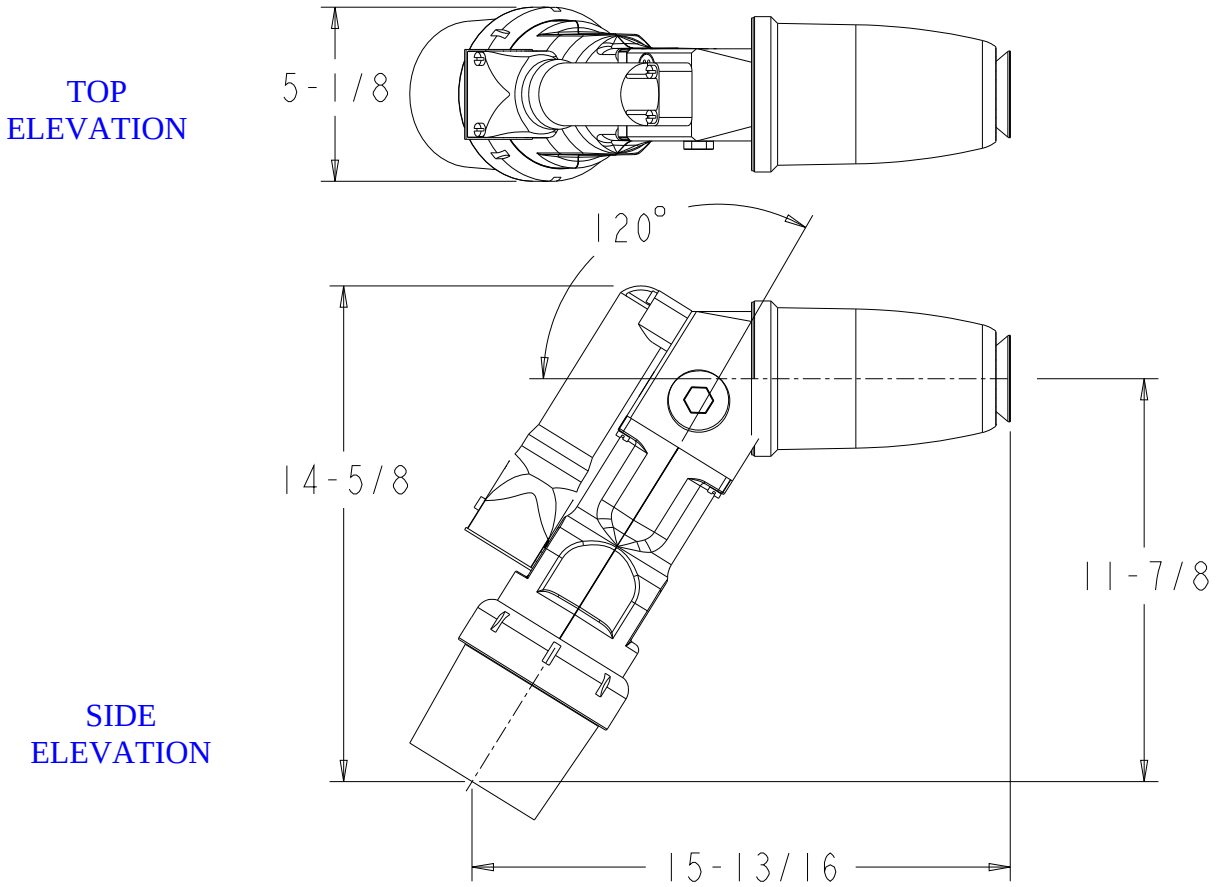


Figure 3: FS40R OVERALL DIMENSIONS

4.4 FS40R Components

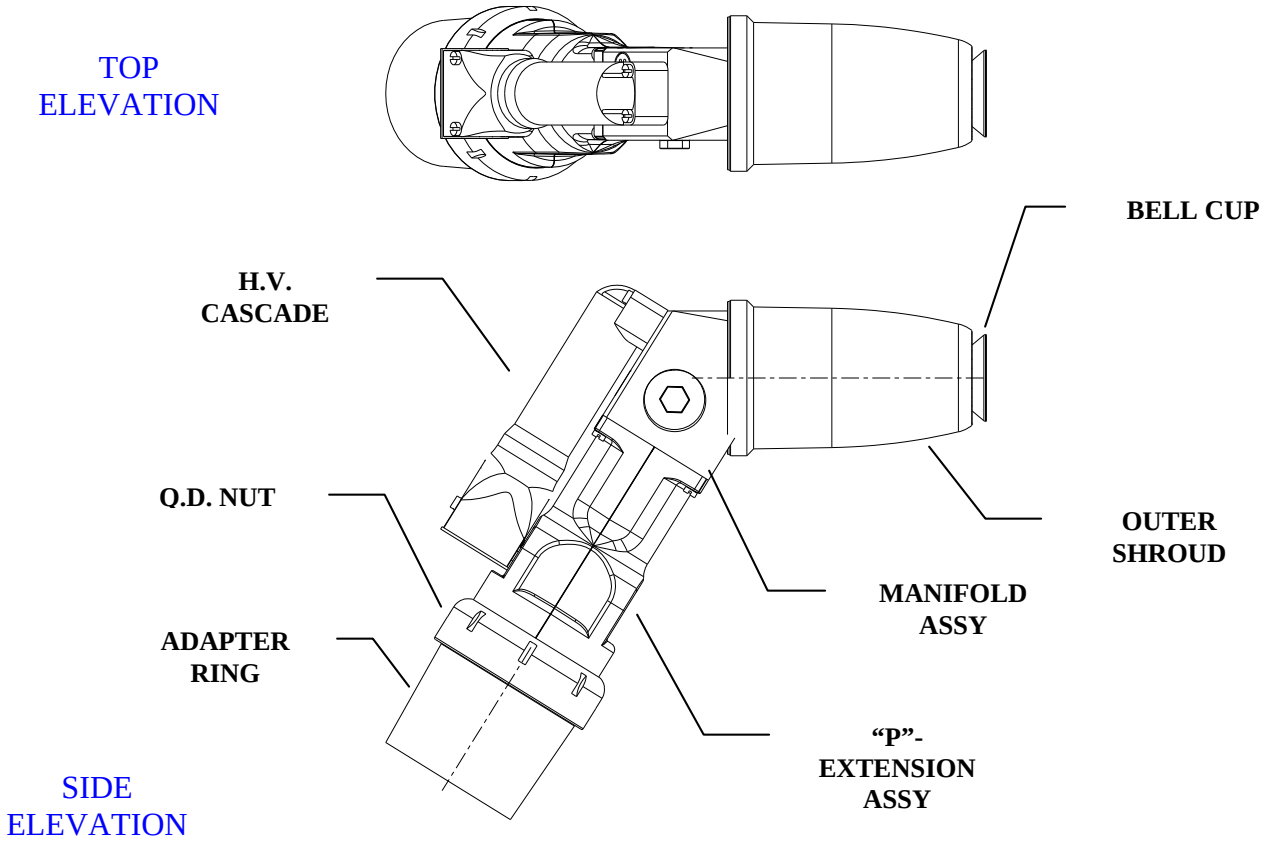


Figure 4: FS40R COMPONENTS

4.4.1 ROBOT ADAPTER RING

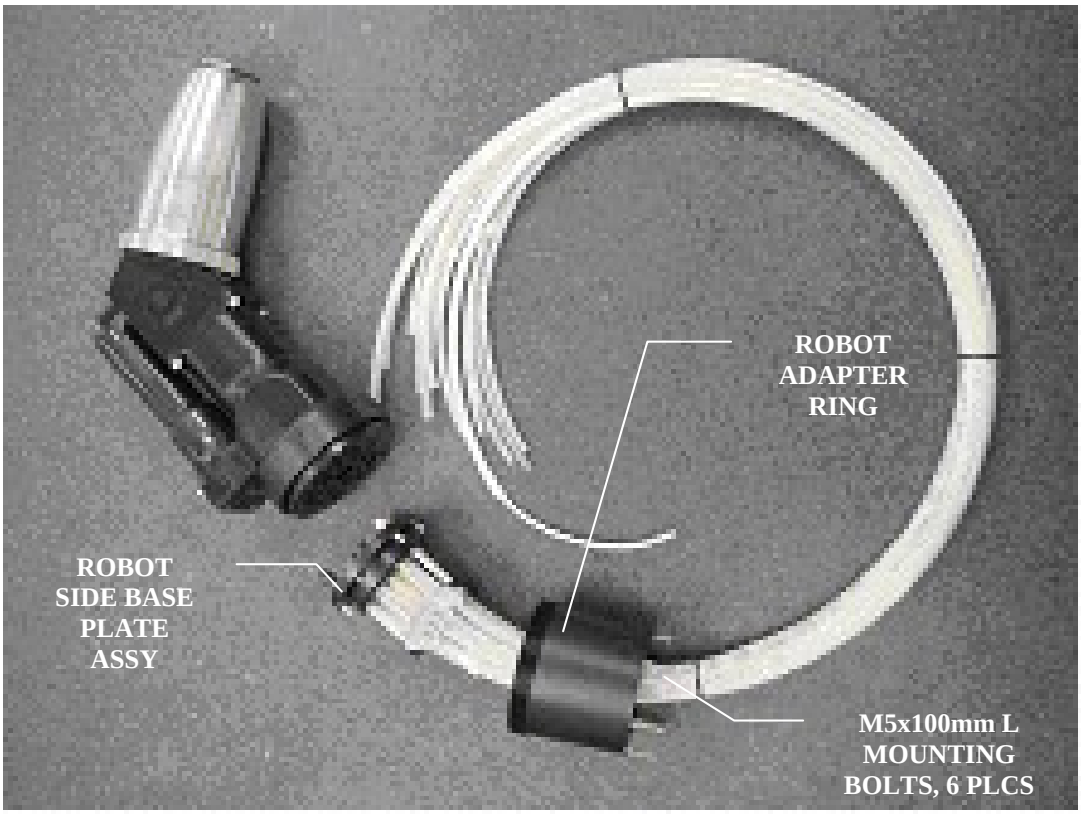


Figure 5

The robot adapter ring is used to house the robot side base plate assembly with the hose bundle, as well as offer an affixing means to the robot arm. Six M5 x 100mm long stainless steel screws attach the adapter ring to the robot arm.

Adapter rings are available for ABB, Fanuc and Behr robots. Consult the factory for specific adapter ring numbers.

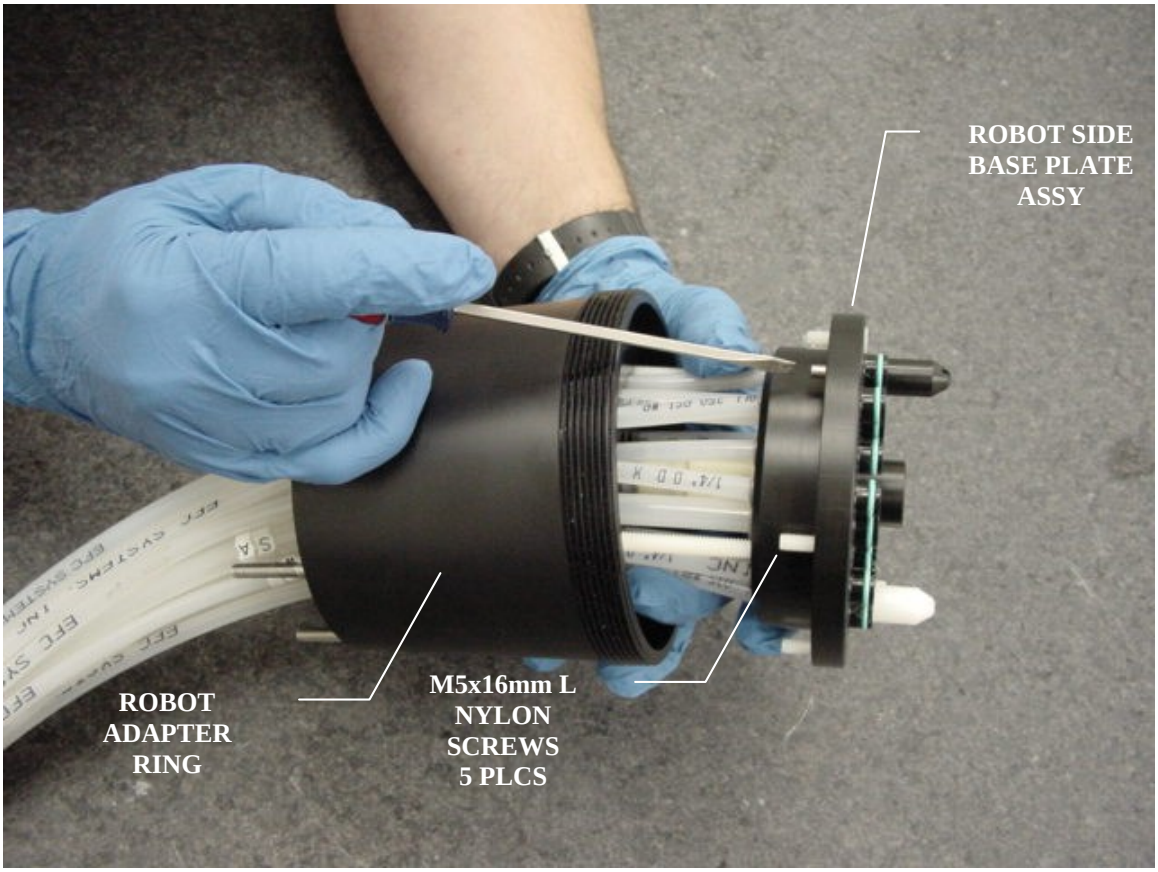


Figure 6

ASSEMBLY / DISASSEMBLY

The robot side base plate assembly drops into the adapter ring and locates itself via a plastic locating pin as shown in Figure 6. Five M5 x 16mm long nylon flat head screws attach the robot side base plate to the adapter ring. The six adapter ring mounting bolts (M5 x 100mm) are evenly spaced and therefore may mount to the robot arm in six different orientations. To understand the final orientation of the FS40R, when mounted on the robot, first find the dowel hole in the adapter ring that receives the single plastic dowel (4mm). With this hole at the 3 o'clock position, the cascade on the FS40R will be at the 12 o'clock position.

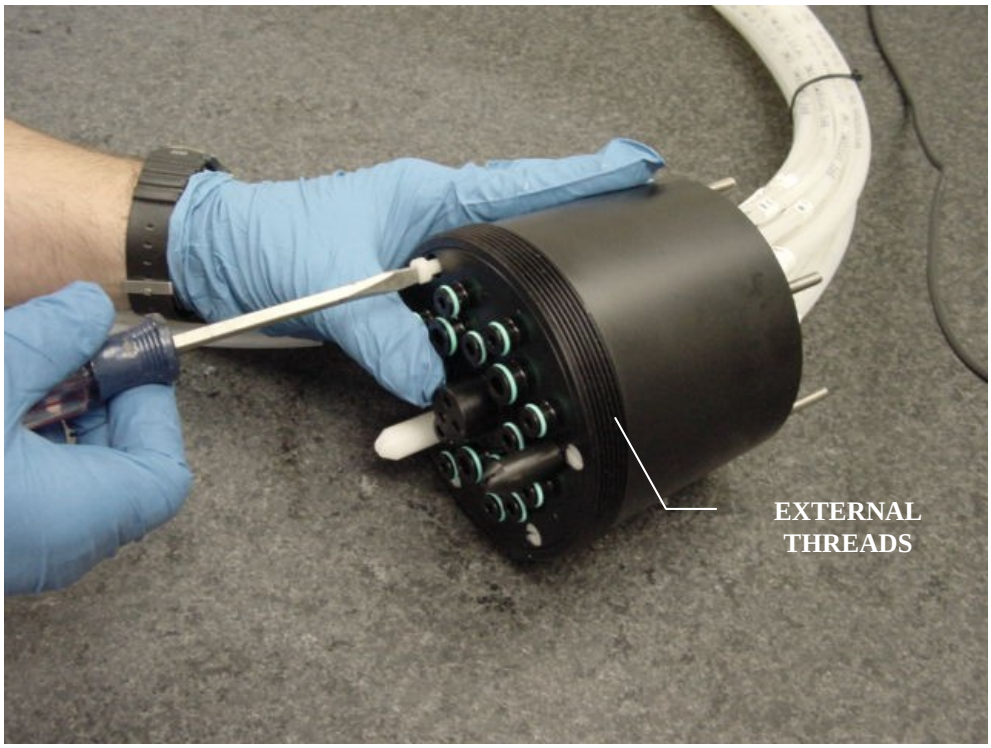


Figure 7

CAUTION! Do not over tighten the robot side base plate nylon screws. Over tightening the screws could strip out the threads in the adapter ring, or break the nylon screws. Torque these five screws to 3 in-lbs max.

OPERATION

There are no special operating instructions required for the adapter ring.

MAINTENANCE

It is helpful to apply a sparing amount of pure Vaseline (EFC PN: 668M60) to the external threads of the adapter ring. This will help with the installation and removal of the Q.D. nut on the FS40R from the robot arm.

Inspect the external threads on the adapter ring for damage. Placing the Q.D. nut on the adapter ring with damaged threads could damage the Q.D. nut threads as well.

4.4.2 HOSE BUNDLE ASSEMBLY

Figure 8: Insertion of Push Lock Fitting O-Ring

ASSEMBLY / DISASSEMBLY

The hose bundle assembly consists of a robot side base plate and all of the fluid and electrical lines associated with the FS40R (Figure 1). The robot side base plate assembly utilizes push lock fittings for all fluid lines (air and liquid). Each push lock fitting consists of the push lock fitting top and at least one Tekrez® o-ring. Paint, dump and bell wash solvent employ two o-rings to prevent fluid leaks. To assemble, insert the proper o-ring into the push lock fitting port (see Table 1). Use a blunt object to insert the o-rings into each port. Afterwards, carefully insert each push lock fitting top into the base plate (Figure 9).

To remove, insert a small flat blade screwdriver under the push fitting top and gently pry upwards. With a pointed (but not sharp) pick, carefully remove the o-ring(s) from the push lock fitting port.

Table 1: Robot Side Base Plate O-Rings and Push Fittings

Port	Port Description	Hose Size	P.F. Top Size / EFC PN	P.F. O-ring EFC PN	Q.D. Nipple O-Ring	Signal
DAT	DRIVE AIR	3/8" NYLON, BLACK	3/8" / 90-1A13	9027CR	8717CR	0-100 psi TRANSDUCER
BAT	BRAKE AIR	¼" NYLON, RED	¼" / 90-1A17	6026CR	6017CR	90 psi I/O SOLENOID
P	PAINT	3/8" NYLON, NAT.	3/8" / 90-1A13	9027CR	6017CR	PAINT SUPPLY
D	DUMP	3/8" NYLON, NAT.	3/8" / 90-1A13	9027CR	6017CR	DUMP
SA	SHAPING AIR	3/8" NYLON, BLUE	3/8" / 90-1A13	9027CR	8717CR	0-100 psi TRANSDUCER
EX1	EXHAUST 1	3/8" NYLON, NAT 4'	3/8" / 90-1A13	9027CR	8717CR	N/A
EX2	EXHAUST 2	3/8" NYLON, NAT 4'	3/8" / 90-1A13	9027CR	8717CR	N/A
BE	BEARING AIR	¼" NYLON, BLACK	¼" / 90-1A17	6026CR	6017CR	0-90 psi AIR REGULATOR
PD	PILOT DUMP	3/16" NYLON, YELLOW	3/16" / 316PLFT	4324CR	6017CR	90 psi I/O SOLENOID
PR	PILOT REGULATOR	3/16" NYLON, NAT.	3/16" / 316PLFT	4324CR	6017CR	0-60 psi TRANSDUCER
SAR	SHAPING AIR RETURN	¼" NYLON, BLUE	¼" / 90-1A17	6026CR	6017CR	RETURN PRESSURE FOR SHAPING AIR OR C02
PT	PILOT TRIGGER	3/16" NYLON, RED	3/16" / 316PLFT	4324CR	6017CR	0-90 psi I/O SOLENOID
BWS	BELL WASH SOLVENT	3/16" NYLON, NAT.	3/16" / 316PLFT	4324CR	6017CR	SOLVENT SUPPLY
BWA	BELL WASH AIR	3/16" NYLON, NAT.	3/16" / 316PLFT	4324CR	6017CR	0-90 psi AIR REGULATOR
PBWS	PILOT BELL WASH SOLVENT	3/16" NYLON, BLACK	3/16" / 316PLFT	4324CR	6017CR	0-90 psi I/O SOLENOID
PBWA	PILOT BELL WASH AIR	3/16" NYLON, GREEN	3/16" / 316PLFT	4324CR	6017CR	0-90 psi I/O SOLENOID
L. V. CABLES	LOW VOLTAGE RED = COMMON WHITE = POWER BLACK = FEEDBACK SILVER = SHIELD TURBINE SPEED RED = COMMON WHITE = FEEDBACK BLACK = POWER SILVER = SHIELD	3/8" NYLON, NAT	308P52 FEMALE PLUG ASSY.	N/A	N/A	N/A

NOTES:

1. P.F. = Push Lock Fitting

2. If bell wash is not used, then BWS, BWA, PBWS and PBWA will not be blocked off.

Figure 9: Insertion of Push Lock Fitting Top

After all o-rings and push lock fitting tops have been installed, it is now time to assemble the hoses.

Care must be taken not to damage the o-rings within the push fitting ports when inserting the hose into the robot side base plate. Carefully insert the end of the hose through the push lock fitting top. Continue pushing the hose into the port until it completely bottoms out. For fluid lines, the hose will have to be inserted through two o-rings, so make certain the hose is all the way in. Make certain the hose is secure by carefully pulling on it.

TIP: It is recommended that the ends of each hose be chamfered to reduce the risk of the o-rings being damaged (Figure 10). Use the EFC deburr tool to remove the sharp outer edge at the end of all of the hoses.

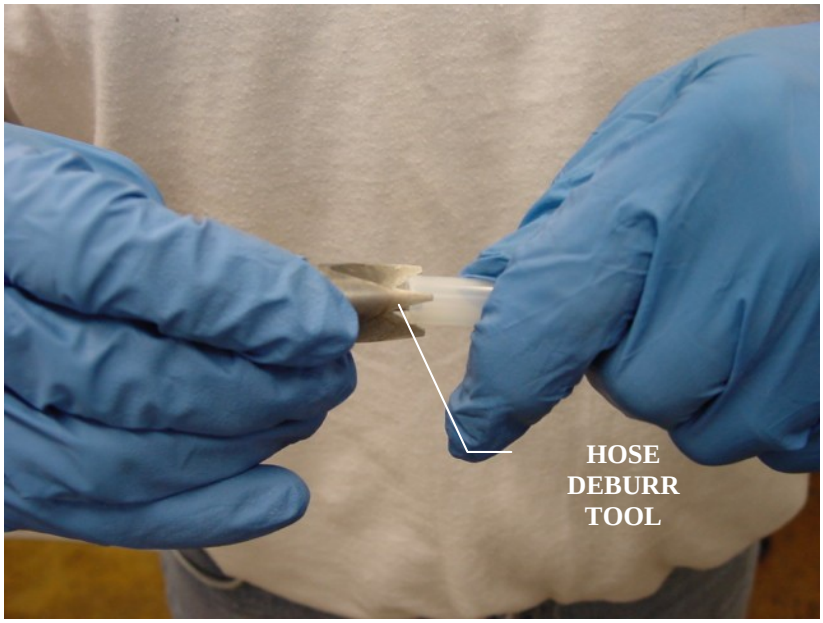


Figure 10: HOSE DEBURR TOOL

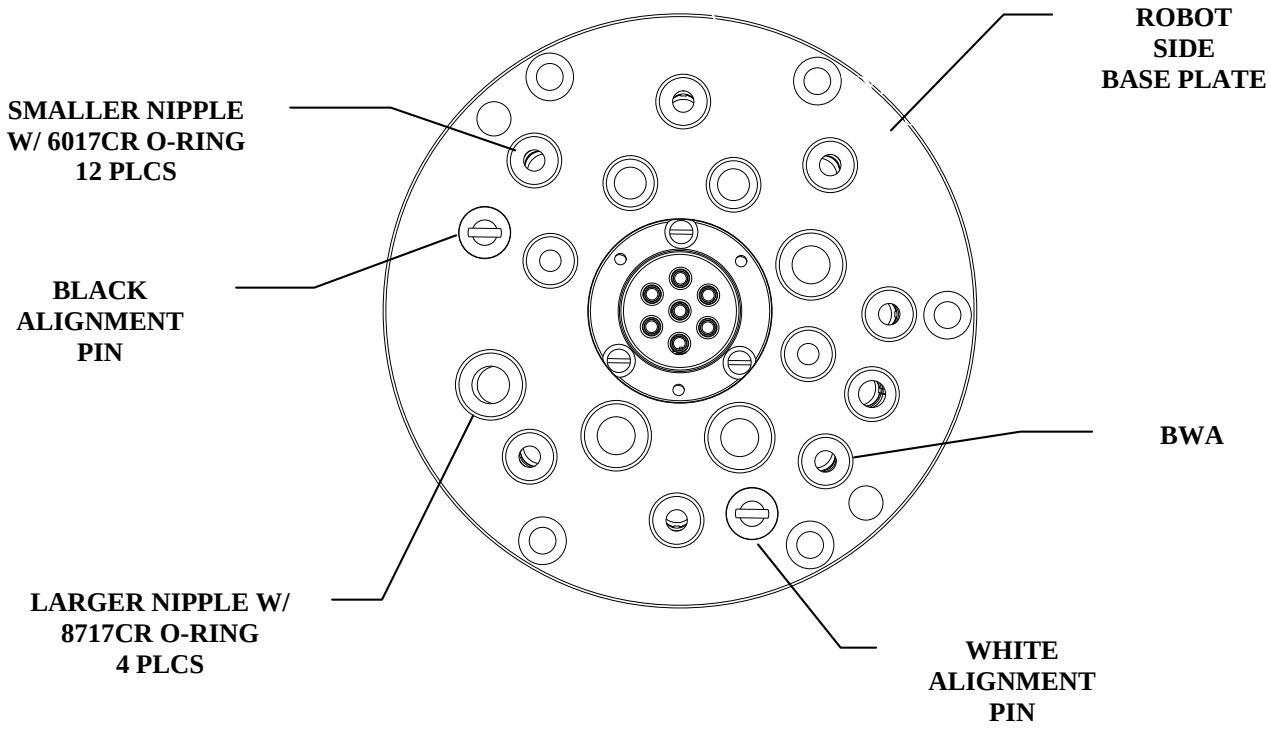


Figure 11: Locating Pins & O-Rings

Machined nipples are on the side opposite of the push fittings on the robot side base plate. There are two different size nipples. The larger (4 places) takes an 8717CR o-ring, while the smaller (12 places) takes a 6017CR o-ring. The base plate also has two tapped holes for a white and a black alignment pin. The white alignment pin is inserted into the tapped hole located closest to BWA. This white pin will align itself to a white alignment plug on the turbine side base plate when the FS40R is assembled to the robot side base plate.

TIP: It is a good idea to place a small amount of Vaseline on all of the o-rings before attaching them to the robot side base plate nipples. This will allow for easier attachment of the turbine side base plate of the FS40R to the robot side base plate.

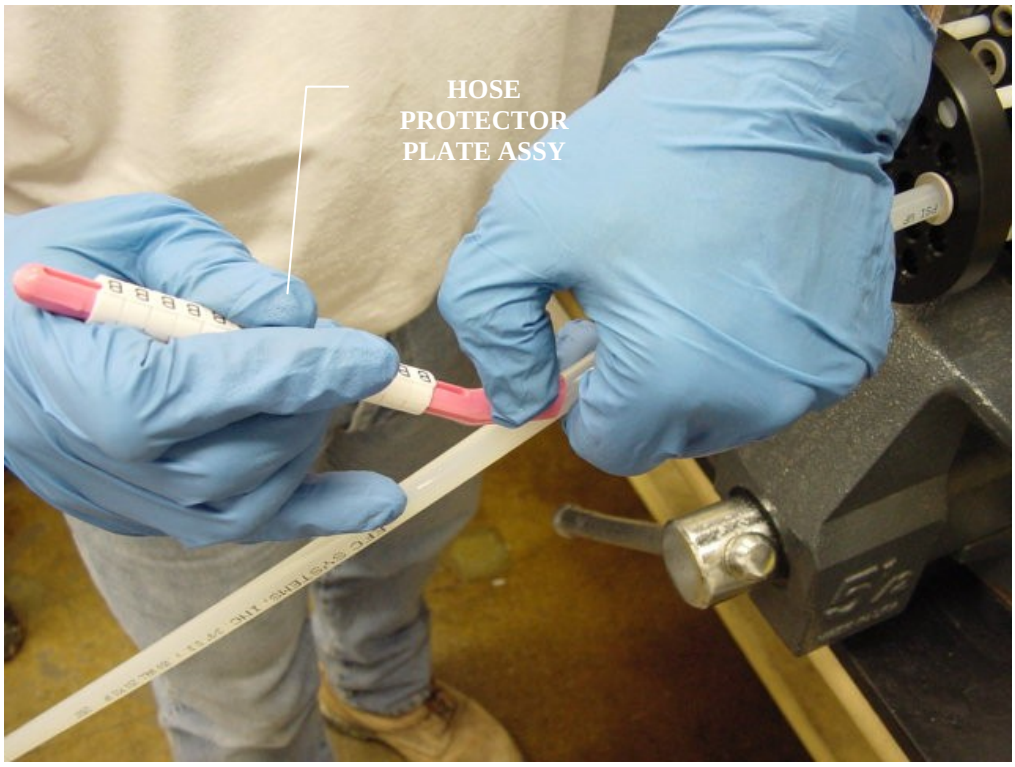


Figure 12: HOSE INDICATORS

Label the hoses with clip on markers or adhesive labels sealed with heat shrink to properly identify each air and liquid line.

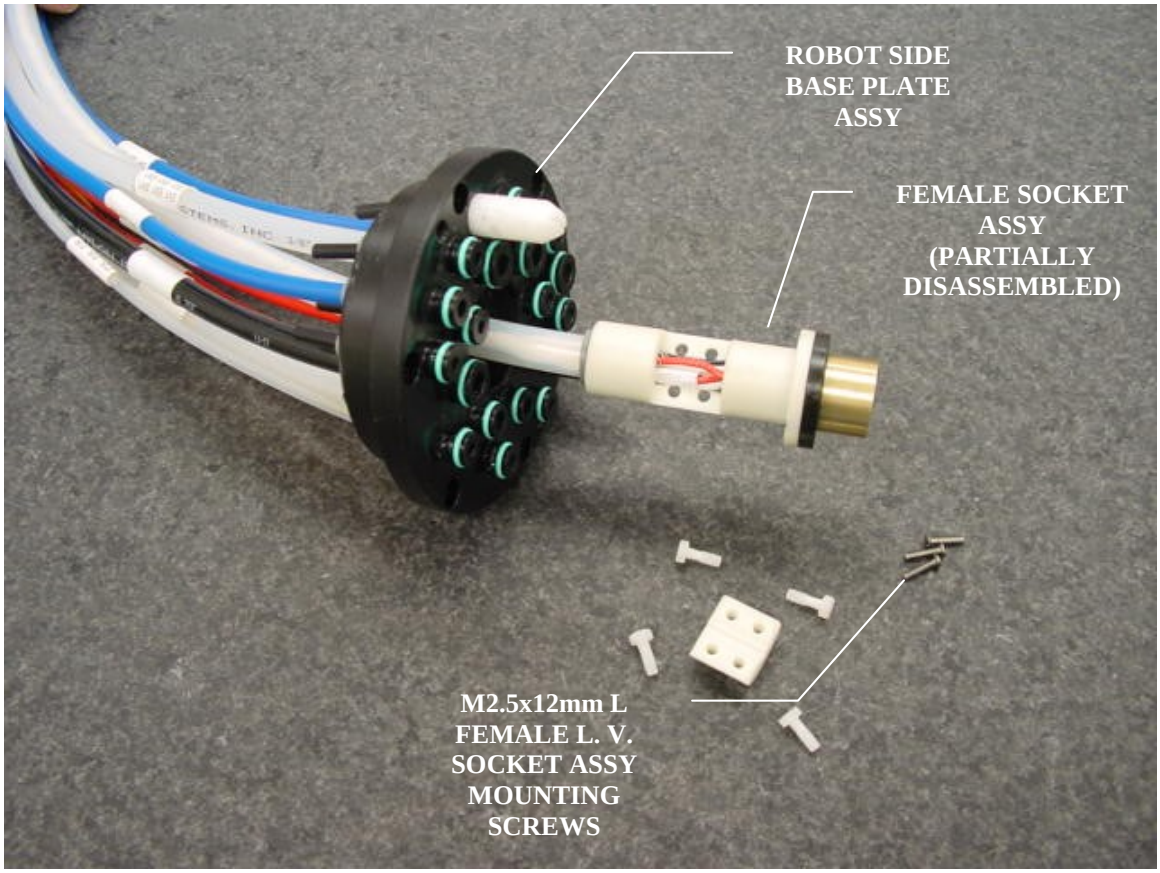


Figure 13: Female Low Voltage Socket Assembly

Within the hose bundle assembly is the female socket assembly. The socket assembly is used to supply 0-21 volts D.C. to the FS40R from the UP-200 power supply as well as send and receive turbine speed signals. The socket assembly is fastened to the robot side base plate by three M2.5 x 12mm long screws, and can only be assembled to the robot side base plate one way.

CAUTION! DO NOT over tighten the three M2.5 x 12mm long screws. If the screws are over tightened it is possible that they will strip out the threads in the robot side base plate. Torque these three screws to 2 in-lbs max.

TIP: In earlier versions of the FS40R, all of the hoses within the hose bundle were clear. Newer versions utilize colored hoses. When colored hoses are used, it is still necessary to label each hose end, preferably with an

adhesive backed label, sealed with heat shrink. See Table 1 for hose color and size specifications.

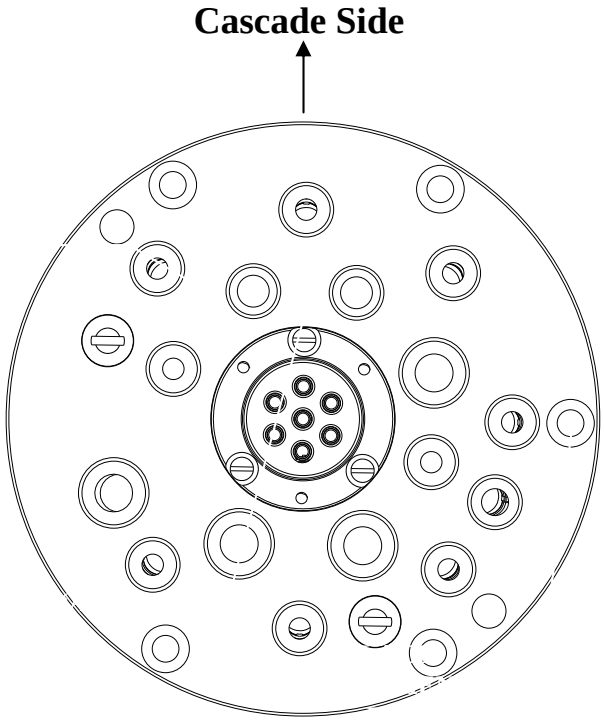


Figure 14: Female Socket Assy Orientation

CAUTION! It is important to understand the orientation of the female socket assembly within the robot side base plate. The female socket assembly will only mount to the robot side base plate with the above indicated orientation. Therefore, when the FS40R is mounted to the robot side base plate, the cascade will be located as shown above.

OPERATION

Each hose in the hose bundle assembly is marked with a working pressure rating. Fluid pressures should not exceed those indicated on the hoses. If the working pressures are exceeded, then there is a possibility of a hose rupturing, leading to a chance of personal injury. Fluid temperature within the hoses should not exceed 150^{o}F. Exceeding this temperature could cause a hose to rupture.

MAINTENANCE

The hose bundle assembly requires very little maintenance since there are no moving parts within the assembly. The maintenance defined below should be performed when the FS40R is removed from the robot side base plate.

Items that require the most attention are the o-rings on and within the robot side base plate. It is important to inspect for damage and lubricate all the o-rings found at the Q.D. surface (on the nipples) before installing the FS40R. Lubricating these o-rings reduces the chance of the turbine side base plate cutting them, when the FS40R is installed. When applying pure Vaseline to any of the o-rings on the robot side base plate, care must be taken to not get any Vaseline or debris inside any of the air or liquid lines. Debris inside any of the lines could lead to equipment damage and finished appearance defects.

The female socket assembly does not require any periodic maintenance, unless one of the wires breaks within the hose bundle. If this occurs, the entire socket assembly will need to be replaced. A line breakage will generate a fault within the UP-200 power supply, or TSC-400 turbine speed card.

A quick check of the two locating pins (black and white) along with the nipples should be performed to ensure none have broken off or are damaged.

4.4.3 AIR BEARING MOTOR ASSEMBLY

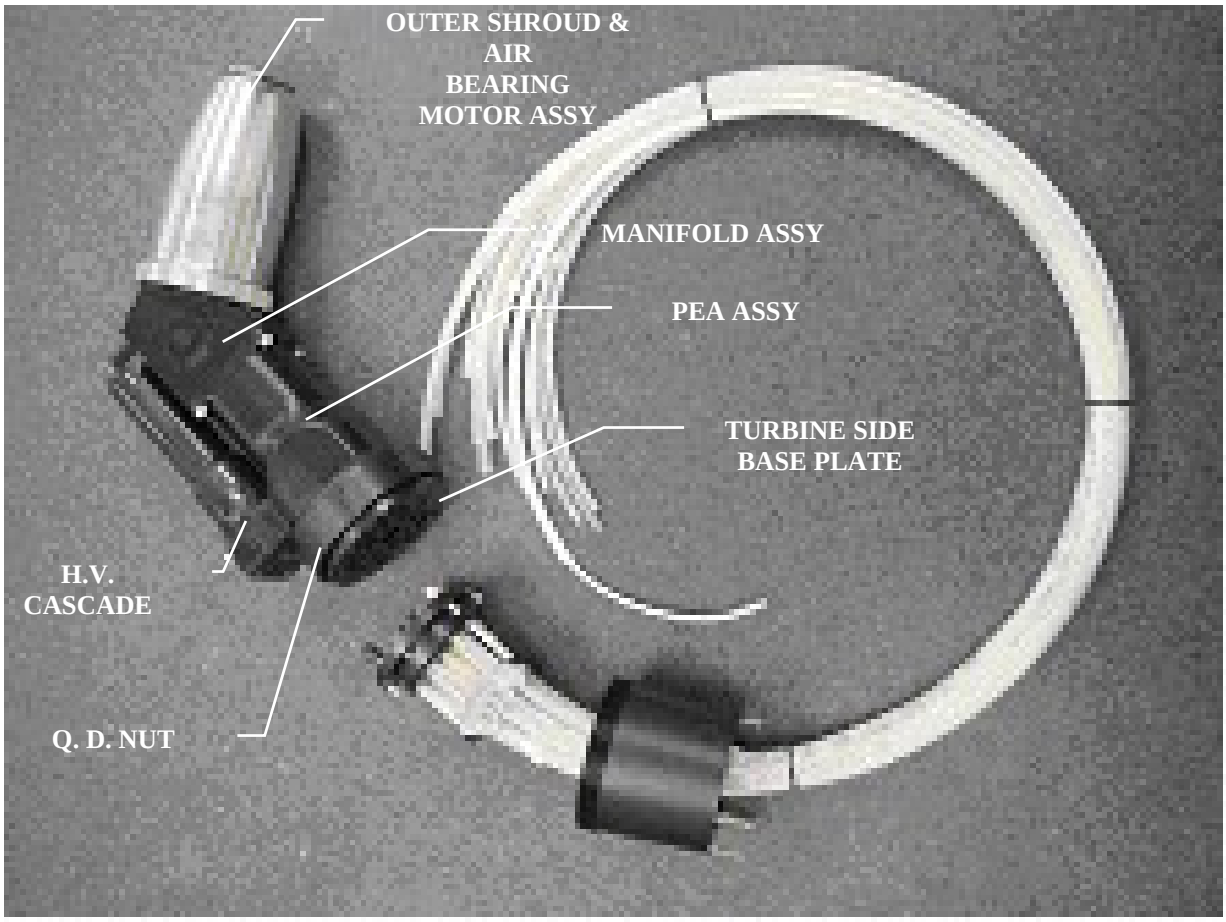


Figure 15

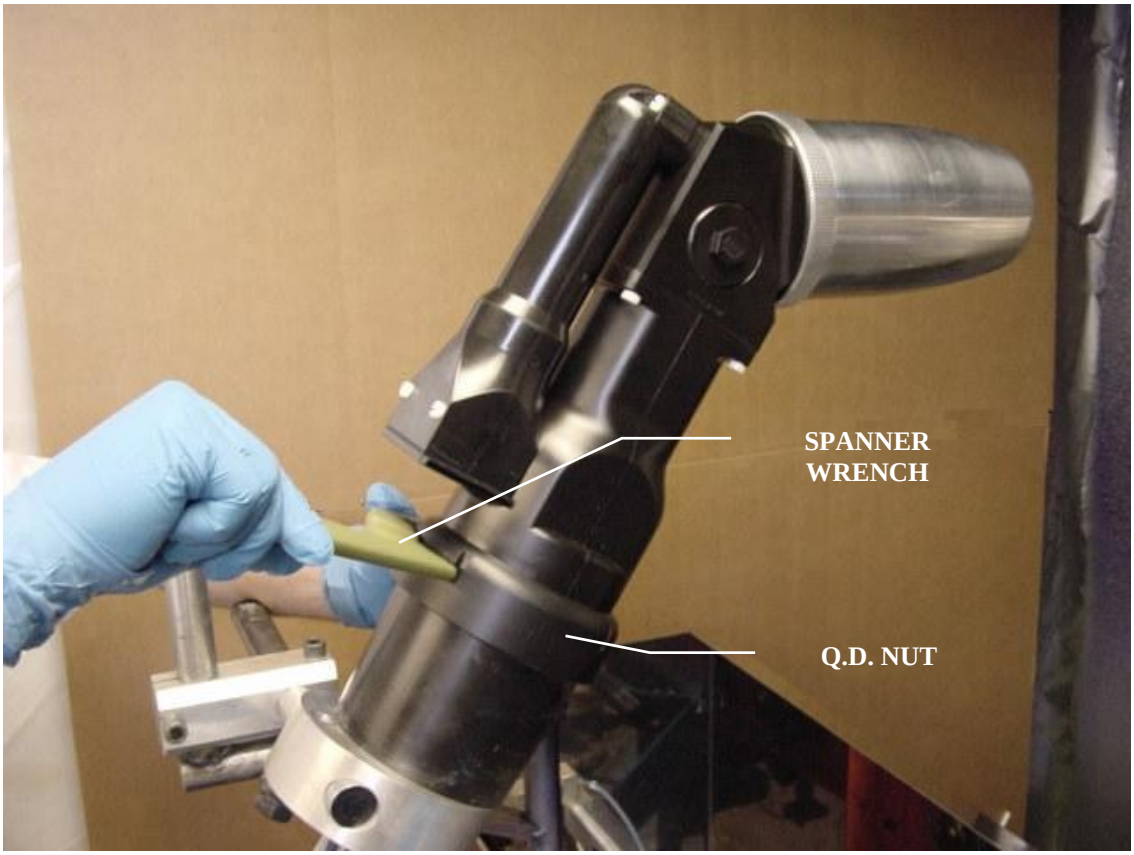


Figure 16

ASSEMBLY / DISASSEMBLY

To remove the FS40R from the Q.D. mount, simply unscrew counter-clockwise the Q.D. nut with the spanner wrench (EFC PN TL650). Once the Q.D. nut is fully disconnected from the external threads on the robot adapter ring, the FS40R assembly can be pulled straight off of the robot side base plate.

To install the FS40R onto the Q.D. mount, ensure the nipple o-rings are lubricated with pure Vaseline and carefully press the FS40R onto the robot side base plate. The two locating pins (one black, one white) on the robot side base plate will align with two corresponding holes on the turbine side base plate. Note: There is a white indicator mark on the turbine side base plate that aligns with the white pin protruding from the robot side base plate. Screw the Q.D. nut down onto the external threads of the robot adapter ring and tighten with the spanner wrench TL650.

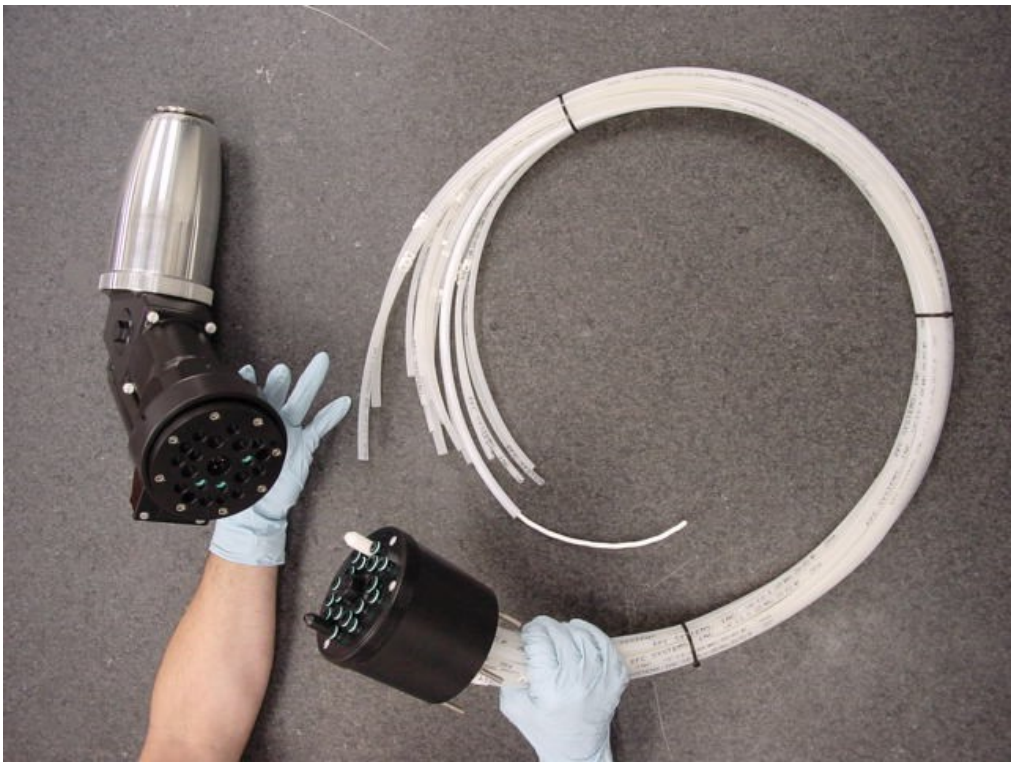


Figure 17

The bottom of the turbine side base plate has counter bored holes to accept the nipples of the robot side base plate as well as two through holes for the black and white alignment pins.

Figure 18: OUTER SHROUD REMOVAL

The air bearing motor is beneath the aluminum outer shroud. To gain access to the motor, unscrew, counterclockwise, the aluminum shroud that is

affixed to the manifold by way of external threads on the manifold and remove the outer shroud (Figure 18). Strap wrench TL-1A51 may be used.

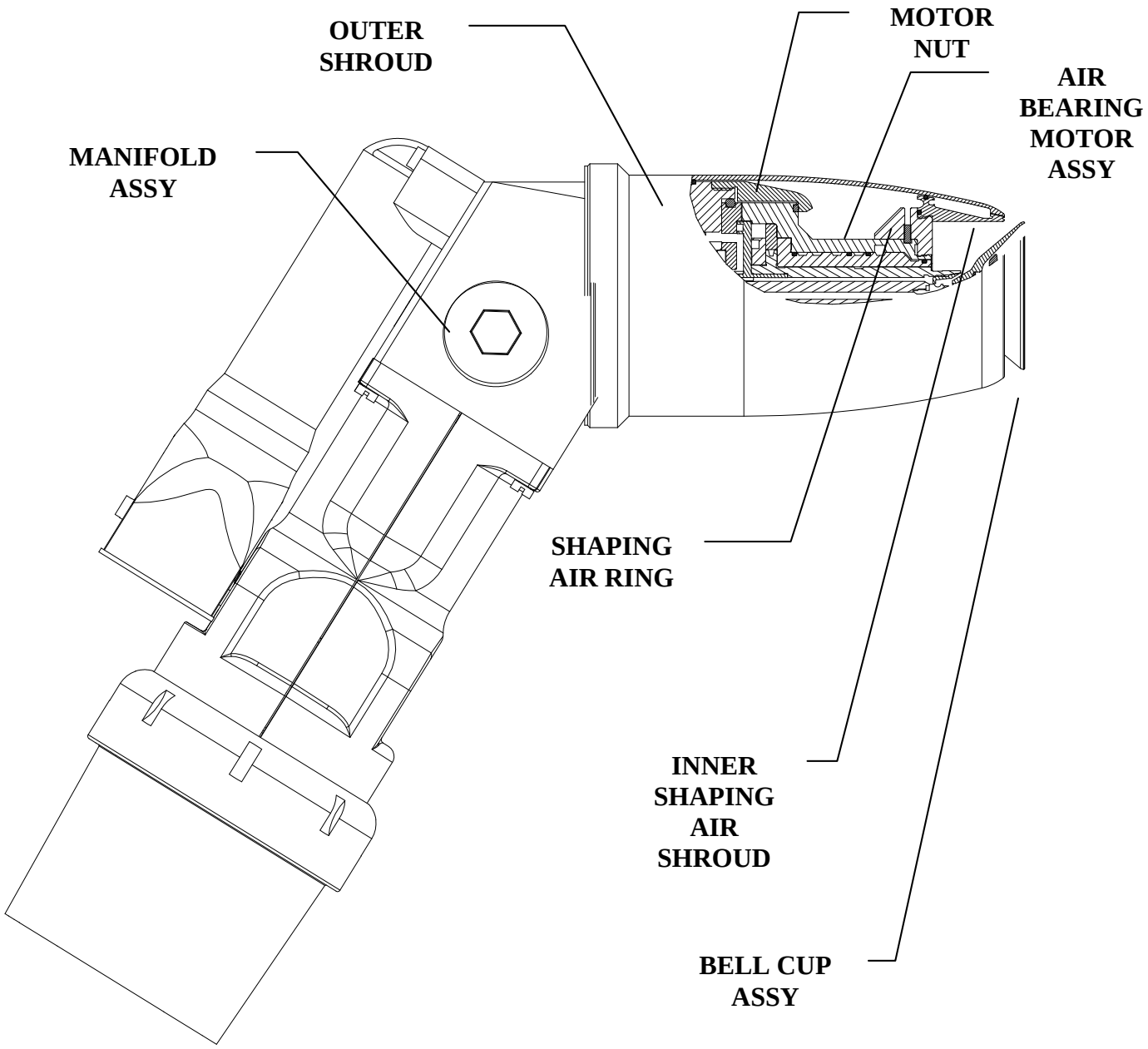


Figure 19: PARTIAL CUT-AWAY VIEW OF THE FS40R

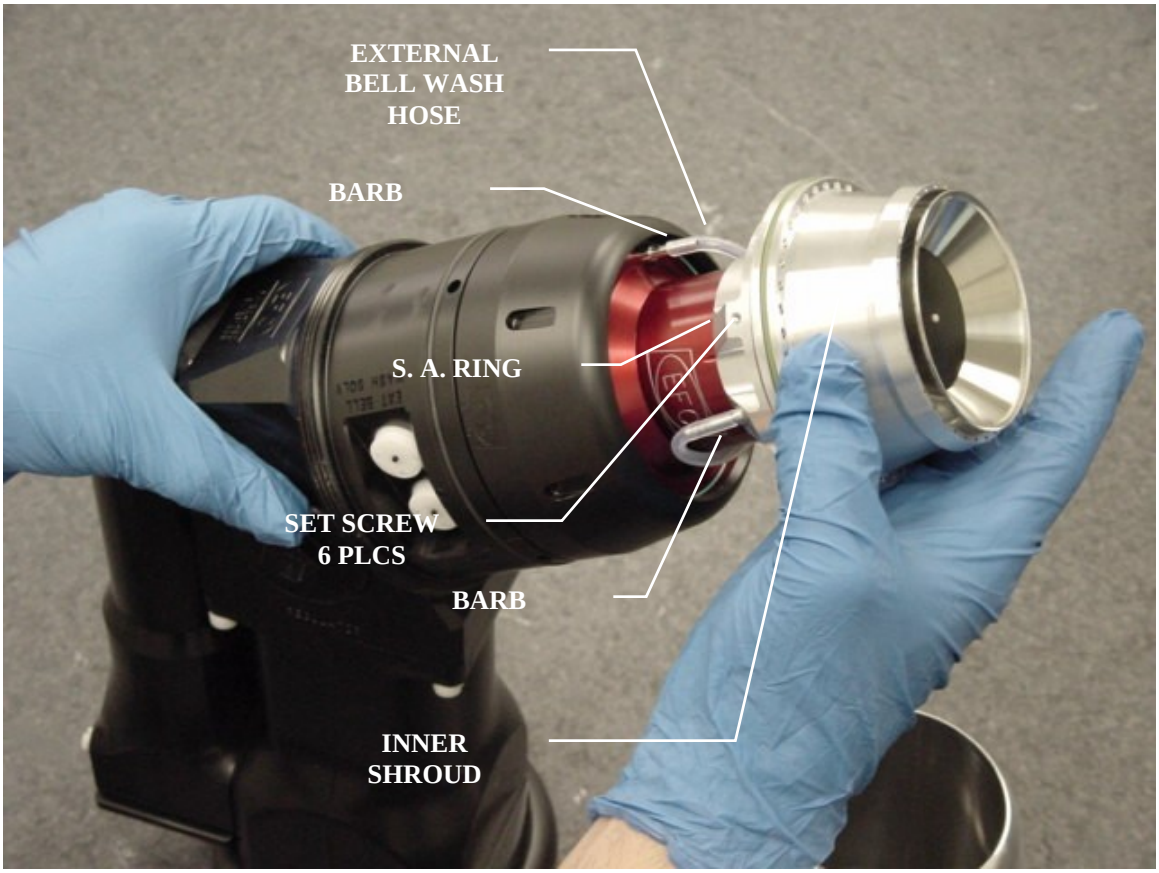


Figure 20

Unscrew the inner shroud using the strap wrench TL-1A52. The inner shroud will just clear the bell cup assembly. Both the inner and outer shroud need to be removed to change the bell cup. A stainless steel barb, on the motor, connects to a stainless steel barb on the shaping air ring by way of a TEFLON® tube. Bell wash is fed through this tube to clean the back of the bell cup (external bell wash).

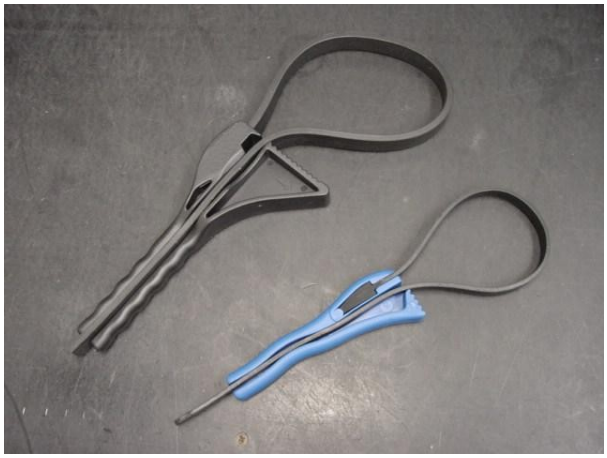


Figure 21: Strap Wrenches

Figure 22: BELL CUP REMOVAL/INSTALLATION

Use the EFC bell cup wrench TL-1A31 to remove or install a bell cup. To remove, firmly grasp the bell cup and place the wrench on the flats of the shaft. Unscrew the bell cup, counterclockwise, until it disengages the shaft.

WARNING! When removing or installing the bell cup, wear tear resistant gloves that will not damage the bell cup. The bell cup uses a very sharp edge to atomize the paint that could cause severe lacerations if not handled carefully. Also, the edge needs to remain damage free to ensure the paint will atomize uniformly during operation.

CAUTION! When removing or installing the bell cup, DO NOT ROTATE THE TURBINE SHAFT. During operation, the motor's shaft floats on a very thin film of bearing air that is supplied by tiny holes (orifices) within the air bearings. If bearing air is not being supplied, the shaft is then in contact with the bearings, and rotating the shaft will wipe the tiny orifices closed, thereby destroying the air bearings.

To remove the shaping air ring, the external bell wash tube has to be cut off of one of the barbs. Four M3 x 8mm long set screws and two M3 X 8mm long modified set screws hold the shaping air ring to the motor. After removing the set screws, the shaping air ring can then be unscrewed, counterclockwise, from the motor housing and removed.

After the shaping air ring has been removed by cutting the external bell wash line and removing the six set screws, the motor nut may be loosened with a spanner wrench TL650.

Figure 23: MOTOR NUT REMOVAL

CAUTION! Grip the FS40R assembly and spanner wrench firmly to prevent the atomizer assembly from being damaged, and the spanner wrench from slipping.

To install the motor nut, first start the nut by hand (to prevent cross-threading), then use the spanner wrench to tighten.

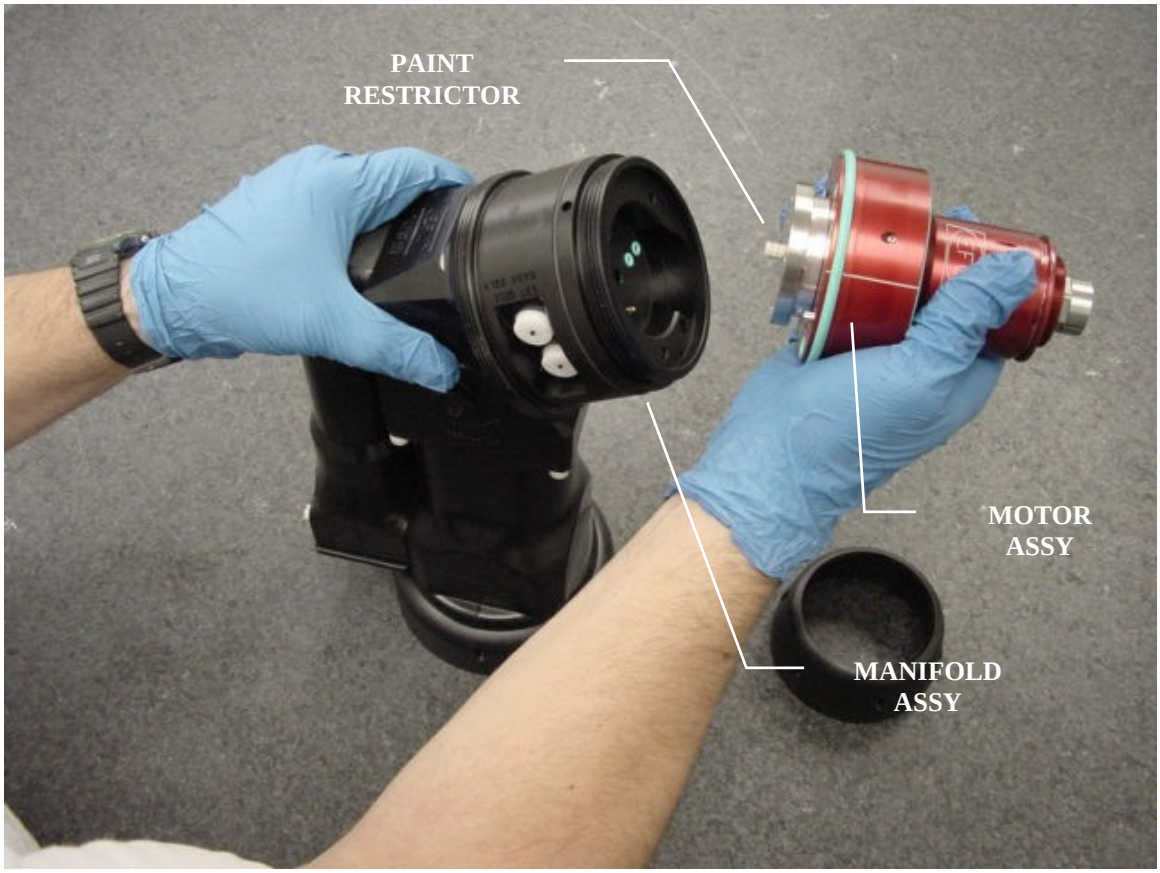


Figure 24: MOTOR REMOVAL/INSTALLATION

The motor can be removed from the manifold assembly after the motor nut is removed. Holding the FS40R steady, gently pull the motor assembly off the manifold.

CAUTION! Do not drop the motor. The motor has been precision balanced and care must be taken not to damage it.

To install the motor assembly, ensure all motor o-rings are in place on the motor assembly as well as the manifold assembly. Make certain the paint restrictor is in either the back of the motor (see Figure 24) or in the corresponding bore of the manifold assembly. The motor assembly has two stainless steel locating dowels that align it to the manifold assembly. Gently force the motor onto the manifold assembly and fasten with the motor nut. Using the spanner wrench TL650, tighten the motor nut.

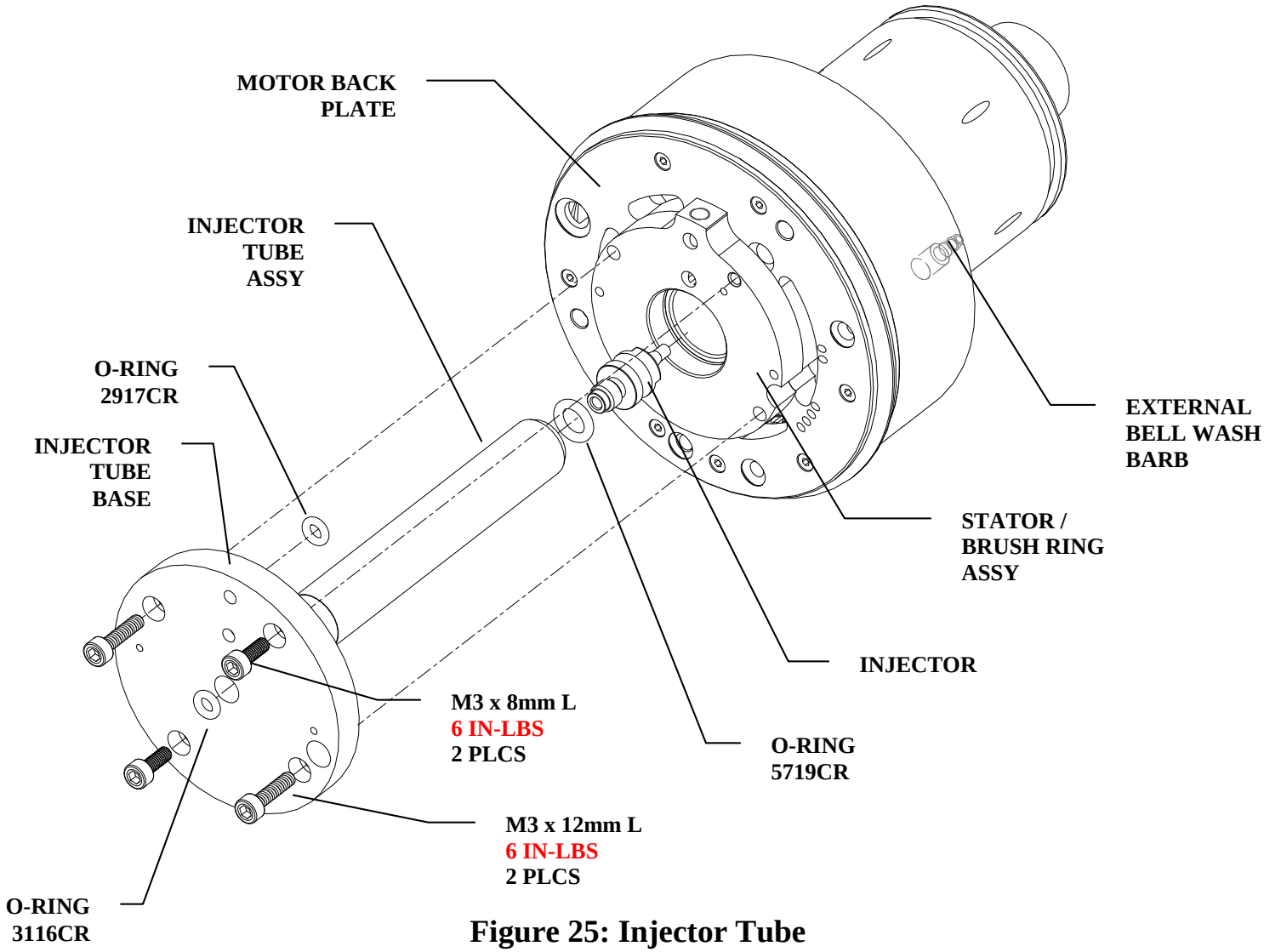


Figure 25: Injector Tube

The injector tube assembly is fastened to the back of the motor by four screws. Two of the screws (M3 x 8mm) hold the injector tube base to the stator/brush ring assembly. The other two screws (M3 x 12) hold the injector tube base to the motor back plate. These four screws are to be torqued to 6 in-lbs. Two chemically resistant o-rings seat in the injector tube base.

CAUTION! It is important to notice the orientation of the injector tube assembly to the stator/brush ring assembly and the orientation of the stator/brush ring assembly to that of the motor. For the motor to operate properly, these components must be assembled with the correct orientation.

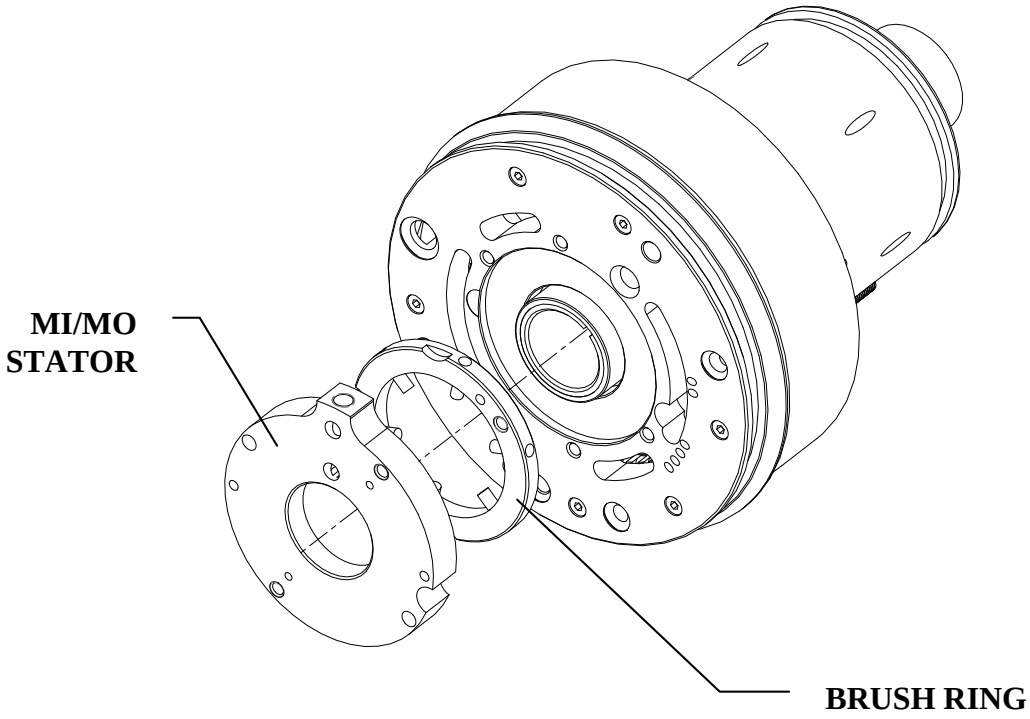


Figure 26: Stator, Brush Ring

The microphone in / microphone out (MI/MO) stator and brush ring are beneath the injector tube base. After the injector tube assembly has been removed, the MI/MO stator and brush ring can be removed next. The brush ring is used to transfer high voltage to the turbine shaft. Earlier EFC air bearing motors used a rotor to transmit an acoustic signal to the turbine speed control card. The newer versions use a more reliable fiber optic light signal and don't rely on a rotor. However, to maintain a proper fit when assembled, the motor still uses the MI/MO stator but not the MI/MO rotor.

To reassemble, place the brush ring in the counter bored hole on the MI/MO stator not shown. This assembly sits in a counter bored hole on the back of the motor. On earlier motors an alignment pin on the rotor fit into an alignment groove inside the center bore of the flywheel. This was used to properly orient the rotor to the flywheel. Since the rotor is no longer used, this alignment groove is no longer necessary and has been phased out.

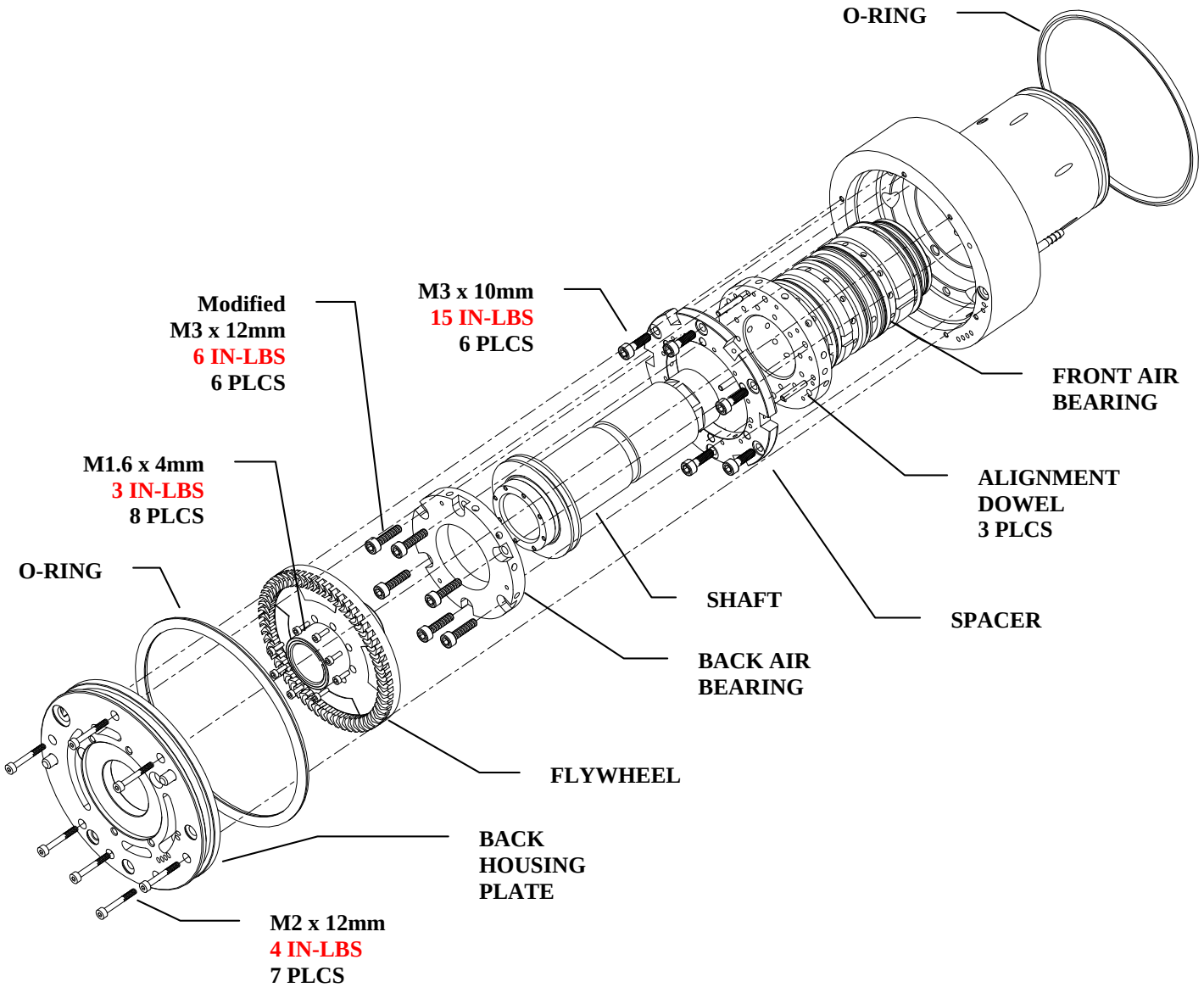


Figure 27: Flywheel, Shaft, Bearings, Motor Housing

Contained within the motor housing are the flywheel, shaft, shaft spacer and air bearings. The seven M2 x 12mm long cap screws that hold the back plate to the motor housing are torqued to 4 in-lbs. Removing them exposes the flywheel held in place by eight M1.6 x 4mm long cap screws. These eight are torqued to 3 in-lbs. Once the flywheel is removed, the bearing cartridge may be unbolted from the housing and removed by unscrewing the six M3 x 10mm long socket head cap screws. The bearing cartridge contains the shaft and shaft spacer, sandwiched between the front and back air bearings as well as four external o-rings located on the front air bearing.

CAUTION! The flywheel screws that attach the flywheel to the shaft *must* be reassembled in the order in which they were removed. This will make certain the flywheel and the shaft remain balanced, as prior to disassembly. It is important to tighten all screws in a "star" (every other one) pattern when assembling any of the components in the FS40R. This will allow for an even clamping force.

TIP: The front housing must be properly aligned to the back housing, and the bearing cartridge assembly (flywheel, shaft, shaft spacer, front and back air bearings) should be aligned such that the groove on the front air bearing is 120º (in either direction) away from the bearing air port. This allows for a more even bearing air distribution inside the front housing.

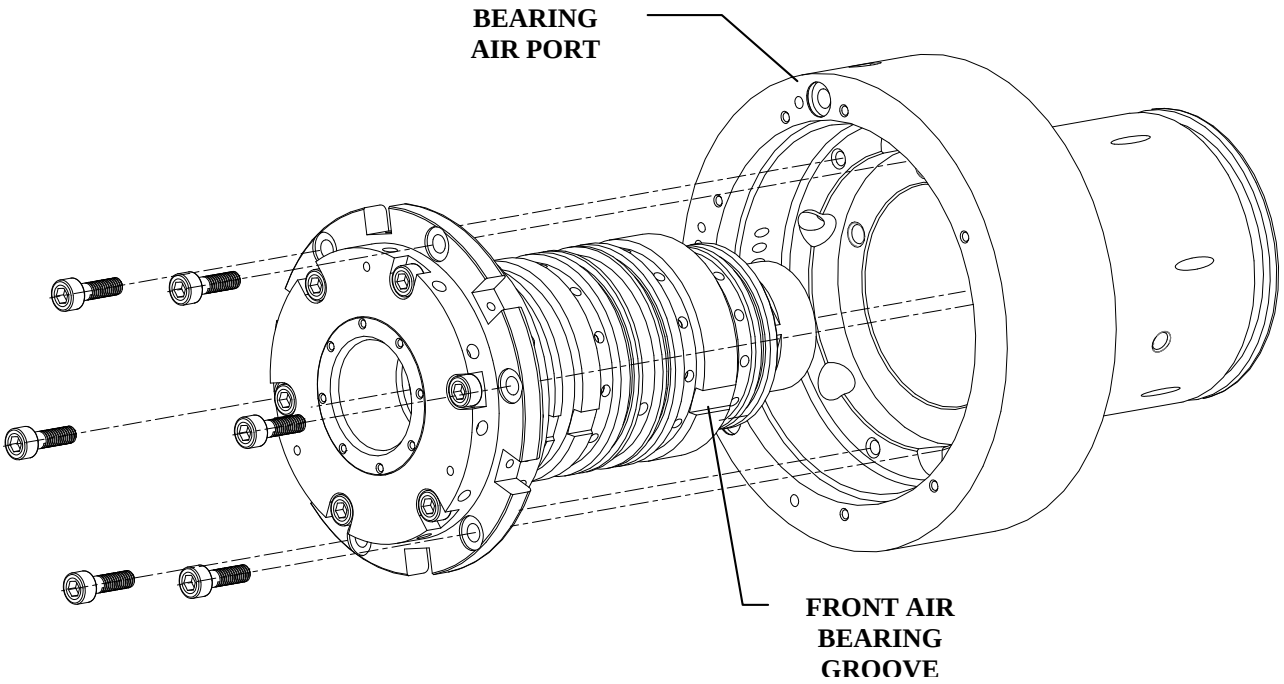


Figure 28: Cartridge Alignment to Front Housing.

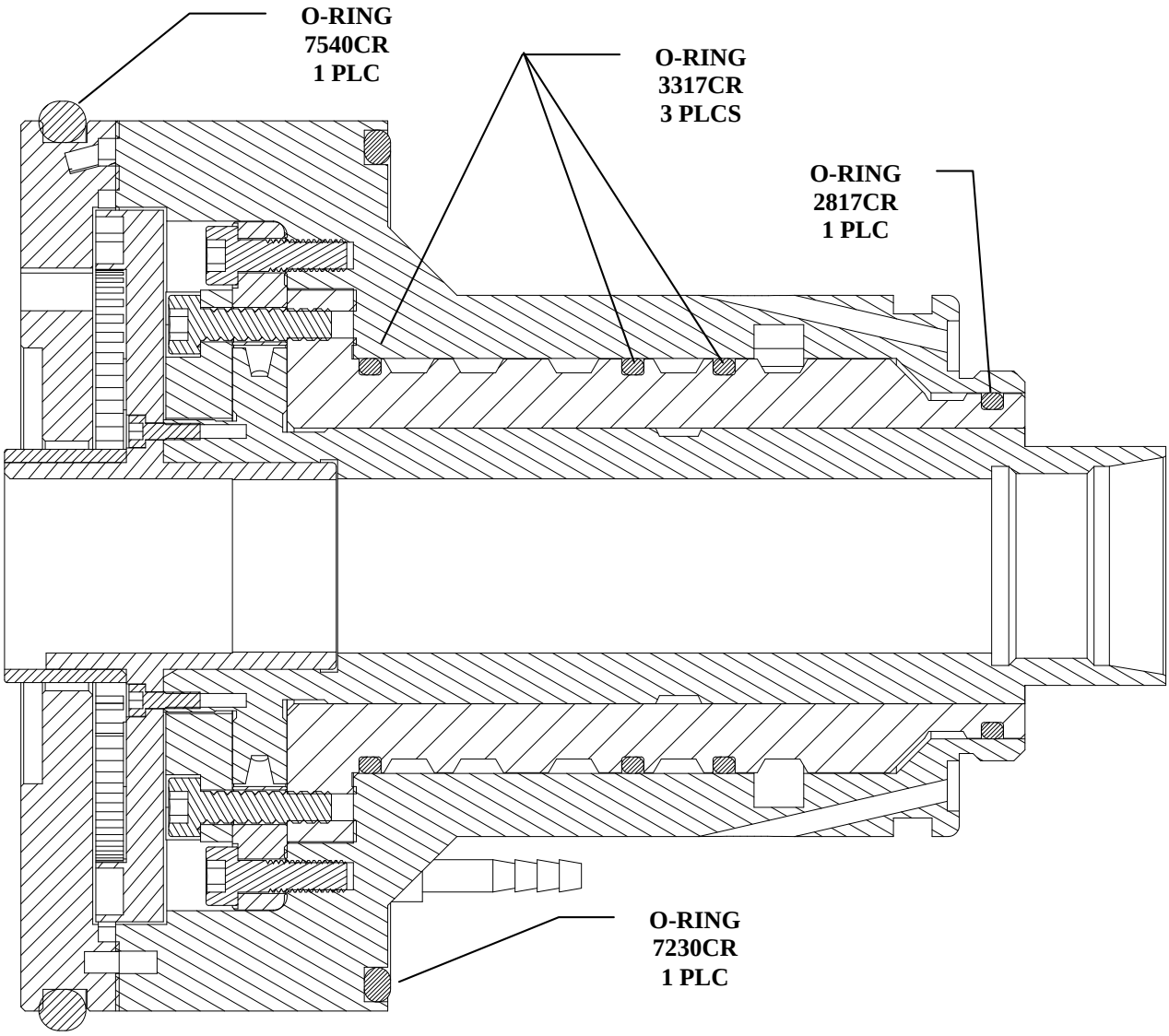


Figure 29: Cross-Sectional View of Air Bearing Motor Assy

The Figure 29 shows the air bearing motor completely assembled. Not shown is the injector and MI/MO assembly.

TIP: When installing the air bearing cartridge into the motor housing, spray the o-rings 3317CR and 2817CR with brake cleaner. This will allow the cartridge to slip easily into the motor housing. After a few minutes, the brake clean will evaporate without leaving behind any residue. It is *not* recommended that Vaseline or any other type of gel lubricant be used on the air bearing cartridge. If lubricants such as these are used, there is a possibility of motor damage or paint finish problems.

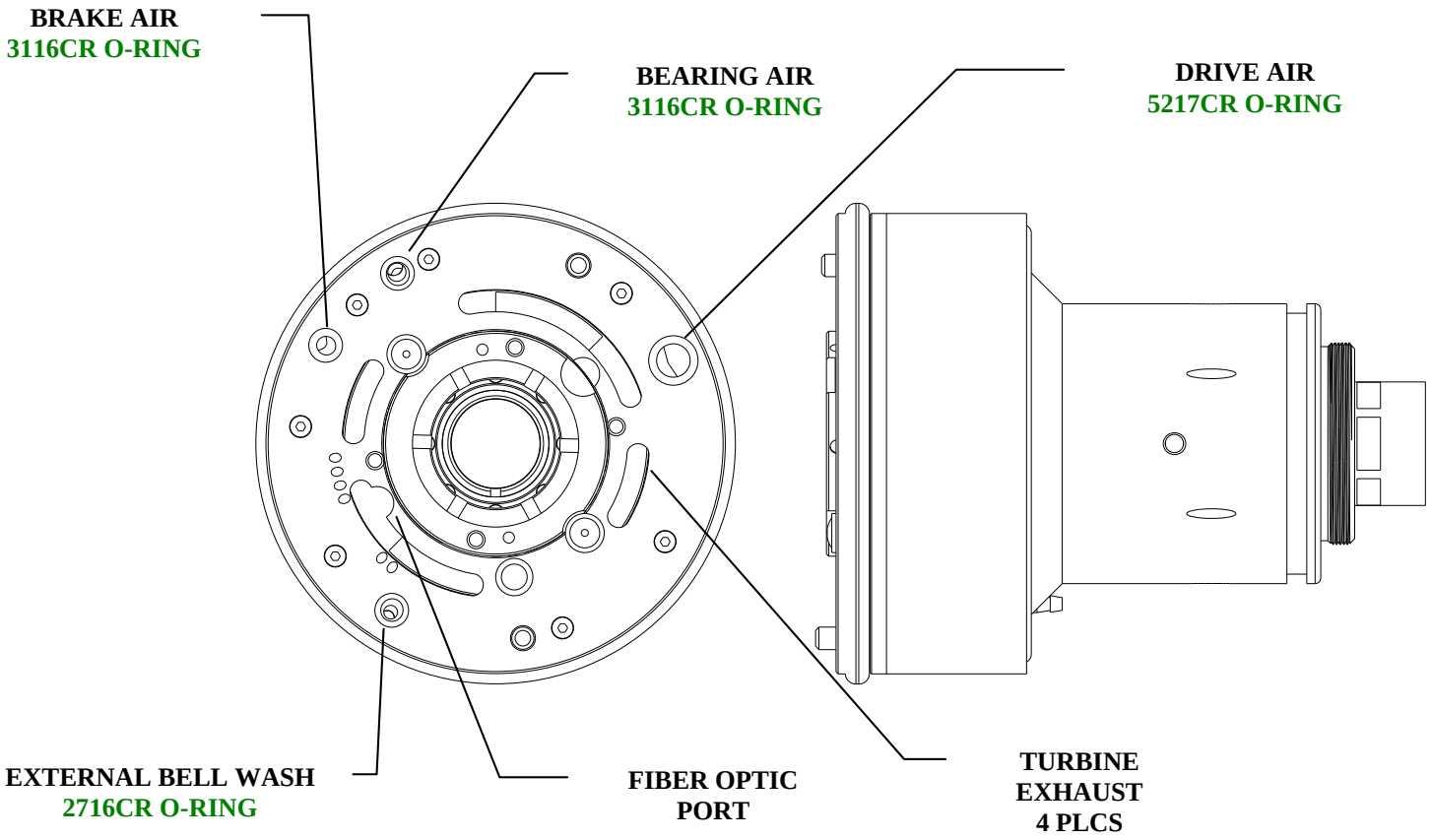


Figure 30: Complete Air Bearing Motor Assembly Porting

OPERATION

The EFC air bearing motor is a self contained unit that has been engineered and manufactured to the highest standards. The motor is of the orifice type that allows the shaft, flywheel and bell cup to "float" frictionless on a thin film of air during operation. Bearing air, turbine drive air, brake air and external bell wash enter the back of the motor. Turbine exhaust exits the back of the turbine through four slot openings.

CAUTION! The flywheel and turbine shaft have been precision balanced and care must be taken not to damage them. Dropping or damaging any of the rotating parts (i.e. shaft, flywheel, bell cup) will result in the motor operating out of balance and could possibly destroy the motor during operation.

O-rings are placed over each air and fluid supply hole at the back of the motor. The o-rings are recessed into the back motor housing to prevent them from falling out and to ensure a tight, leak free seal between the motor and manifold. All motor o-rings are chemically resistant and may be cleaned with aggressive solvents.

WARNING! *It is of the utmost importance that the motor never be operated without bearing air.* The orifice bearings will be destroyed if drive or break air is supplied to the motor without sufficient bearing air. It is not advisable to even rotate the shaft of the motor assembly by hand without a sufficient supply of bearing air. Bearing air must be maintained at 85 psi minimum.

Figures 31 & 32 offer data on drive air and shaping air consumption, respectively. For the "under load" drive air data, solvent based PPG platinum paint with a viscosity of 25 seconds (Ford #4 cup) was supplied at 200 ccpm to the bell cup (65mm). The shaping air consumption graph displays the shaping air mass flow rate as a function of shaping air input pressure.

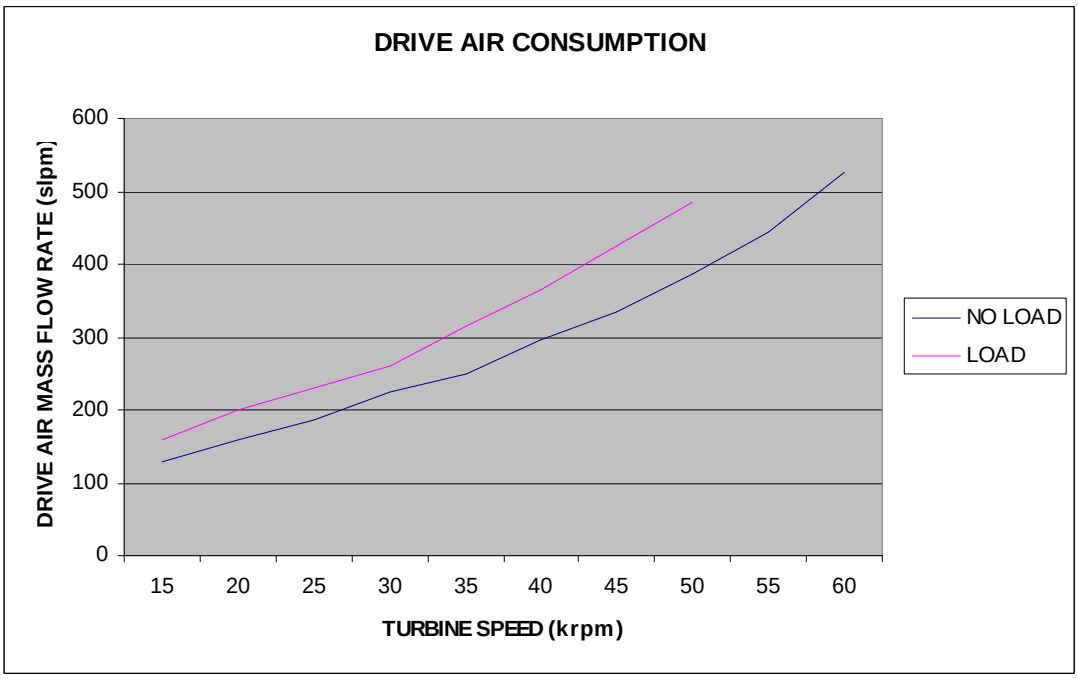


Figure 31: Drive Air Consumption

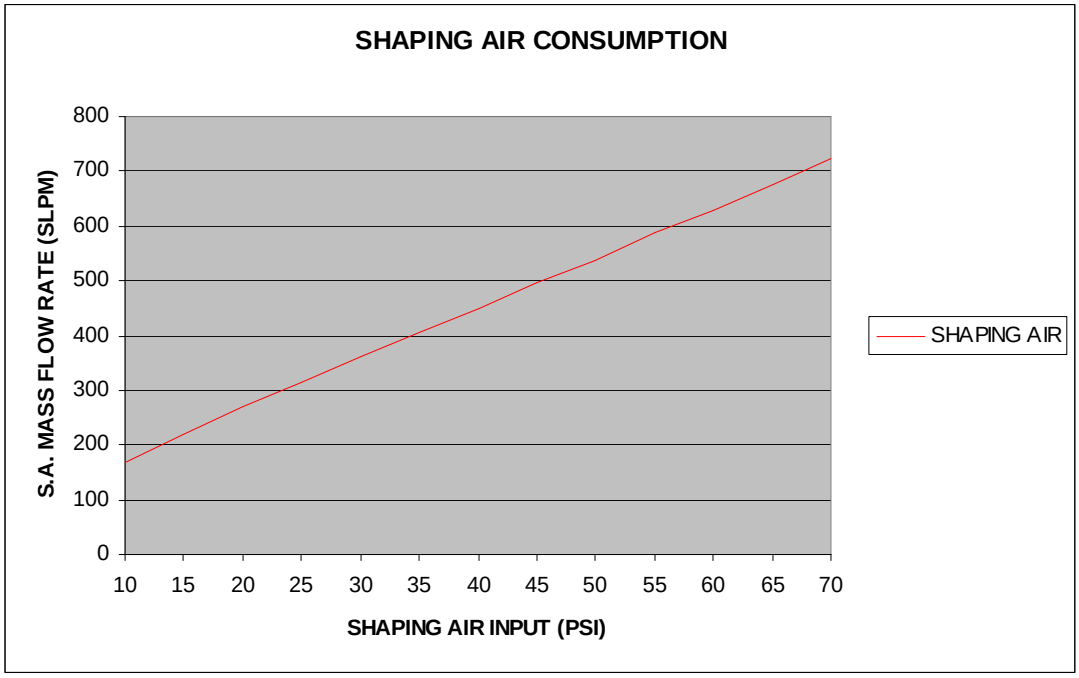


Figure 32: Shaping Air Consumption

MAINTENANCE

The EFC air bearing motor should be kept clean, dry and free of any type of debris (i.e. paints, solvents, dust, moisture, lubricants). Keeping the motor clean will 1) prevent the motor from failing due to dirt entrapment in the bearings and 2) help keep the paint finish defect free.

The chemically resistant o-rings may be soaked in aggressive solvents for twenty-four hours, after which they should be removed and dried. Use a blunt (not sharp) object to remove or install any of the o-rings within the FS40R, to prevent damaging (cutting) the o-rings. Inspect all external o-rings for damage and replace as necessary. If the cartridge is removed, inspect the four o-rings on the front bearing for damage and replace as necessary.

Inspect all internal components (flywheel, shaft, air bearings, and spacer) for damage and debris and replace or clean as necessary. Inspect the front and rear air bearing orifices for debris. These tiny holes must be kept clean because of their importance in supplying bearing air to the shaft. Check the o-ring grooves on the outside of the motor housing for damage. Check the threads on the front housing (for the shaping air ring) for damage. If these are damaged, then screwing on the shaping air ring will damage its threads as well.

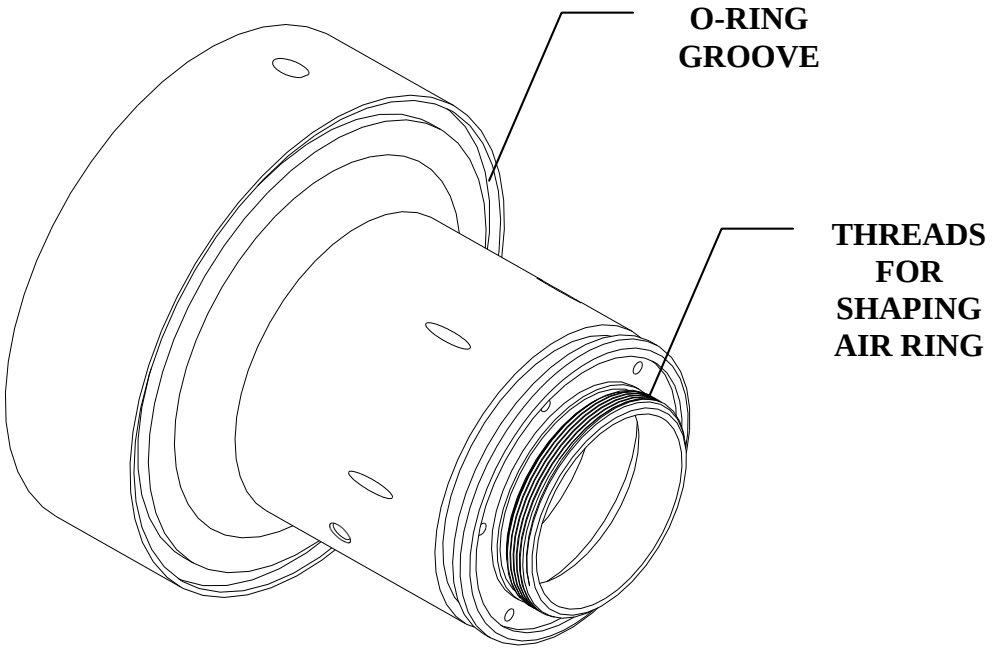


Figure 33: Front Turbine Housing Body

4.4.4 MANIFOLD ASSEMBLY

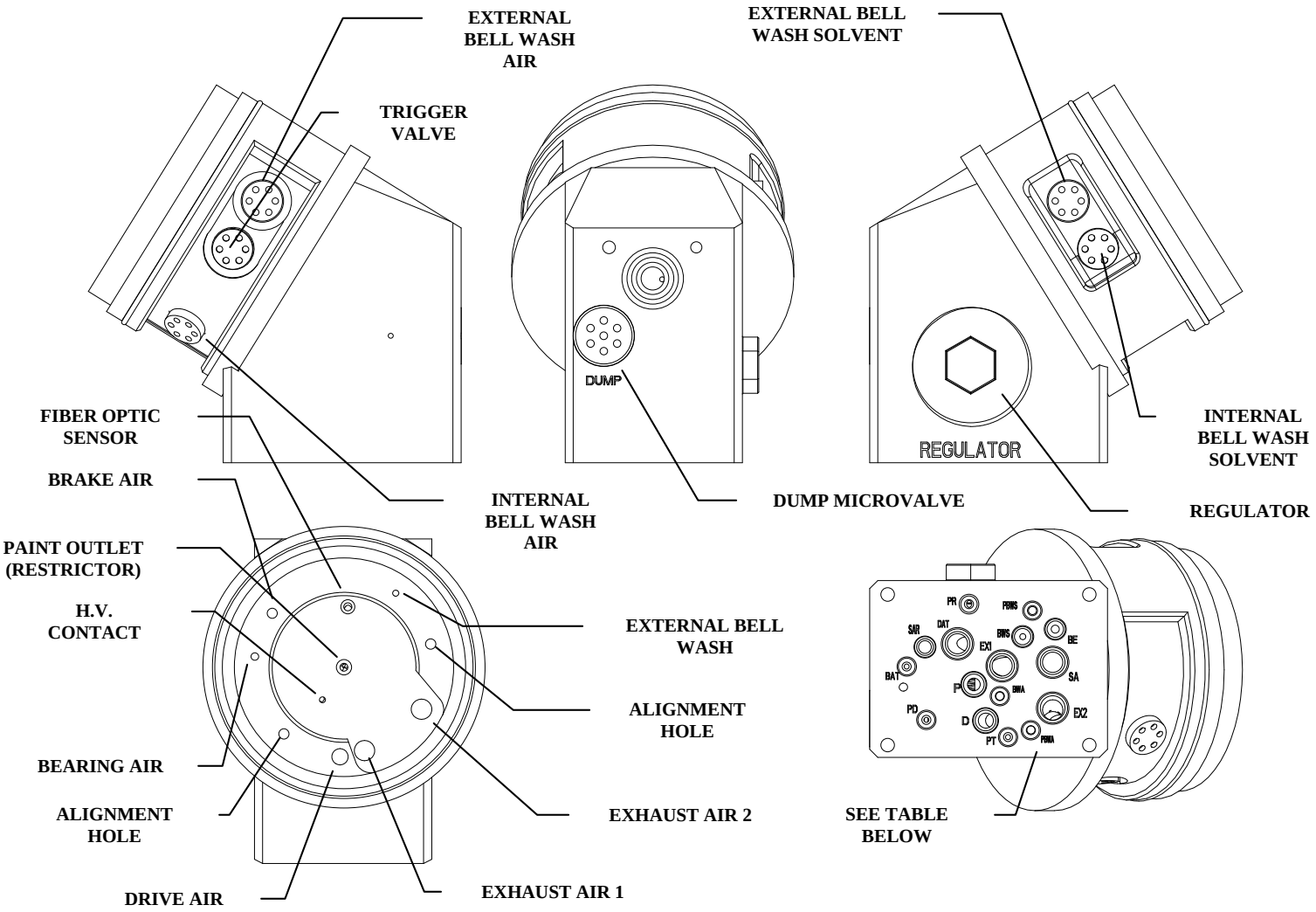


Figure 34: MANIFOLD ASSEMBLY

OVERALL MANIFOLD CONFIGURATION

The single purge manifold contains a 0-1000 cc/min regulator cavity, one microvalve dump cavity, five nanovalve cavities for external bell wash solvent, external bell wash air, internal bell wash solvent, internal bell wash air and pilot trigger and a fiber optic sensor with approximately one foot of fiber optic cable. The regulator cavity houses a regulator spring, seat and poppet valve along with a diaphragm, diaphragm holder, spacer and three o-rings. Within the dump cavity is a microvalve assembly and a microvalve seat. Within each nanovalve cavity is a nanovalve assembly and a nanovalve seat.

Fluids are supplied to the bottom of the manifold (through the P-Extension) via push fittings (P.F.). The push fittings allow for easy hose installation and removal. All fluid push fittings (paint, dump and bell wash) are designed to use a dual Tekrez® o-ring sealing mechanism. This eliminates the possibility of a fluid leak. All other push fittings contain a single o-ring seal.

Table 2: Manifold Port Description

Port	Description	Size
PR	Pilot Regulator	4mm P.F.
PBWS	Pilot Bell Wash Solvent	4mm P.F.
PBWA	Pilot Bell Wash Air	4mm P.F.
PD	Pilot Dump	4mm P.F.
PT	Pilot Trigger	4mm P.F.
BAT	Turbine Brake Air	4mm P.F.
BE	Turbine Bearing Air	¼" P.F.
DAT	Turbine Drive Air	3/8" P.F.
SA	Shaping Air	3/8" P.F.
P	Paint	5/16" P.F.
D*	Dump	5/16" P.F.
BWA	Bell Wash Air Supply	4mm P.F.
BWS	Bell Wash Solvent Supply	¼" P.F.
SAR	Shaping Air Return	¼" P.F.
EX1 & EX2	Turbine Exhaust	3/8" P.F.

*NOTE: Earlier versions of the manifold used a 3814PLFR reducer (3/8" to ¼") fitting for the Dump line. This reducer fitting is needed only on manifolds with a 3/8" dump line.

The EFC air bearing motor mounts to the front of the manifold via a quick disconnect nut. This part of the manifold holds a removable restrictor, a high voltage contact and a fiber optic light pickup probe.

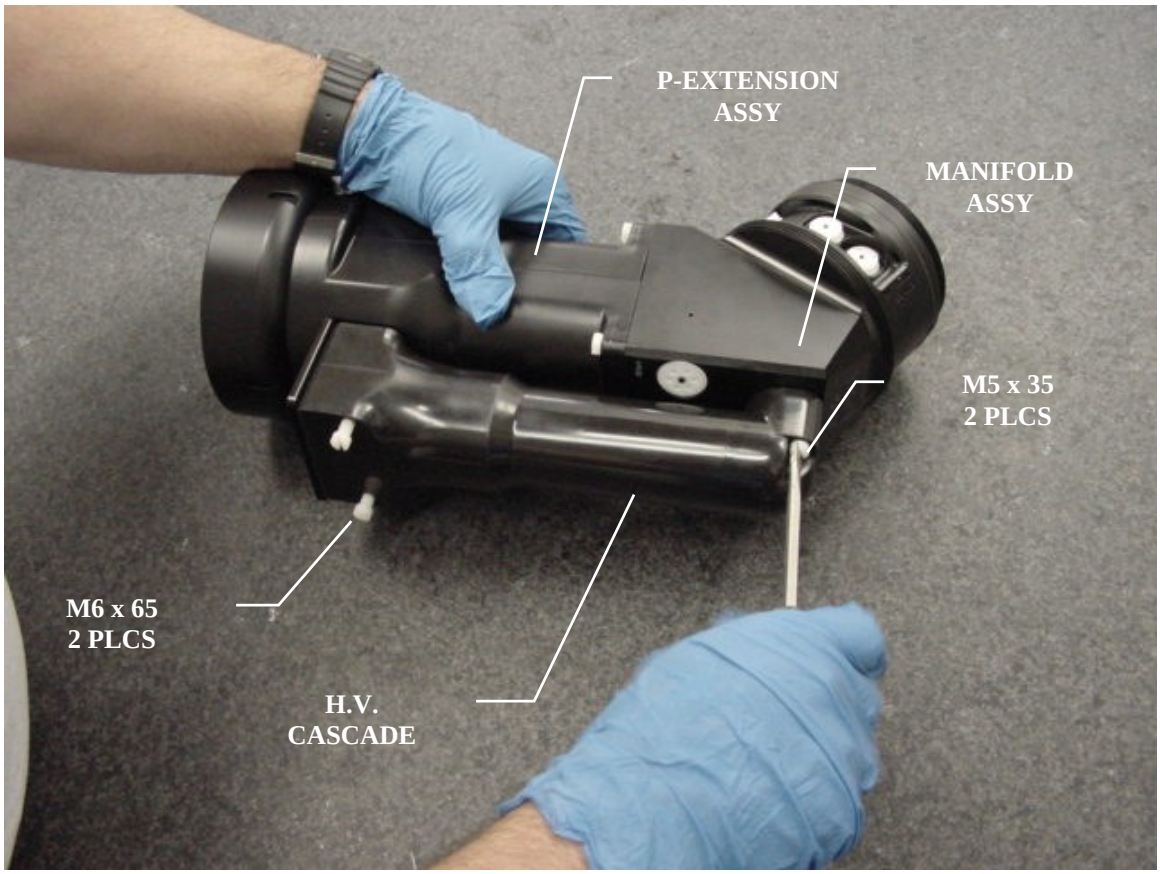


Figure 35

ASSEMBLY / DISASSEMBLY

To service the manifold remove the two M5 x 35 screws and two M6 x 65 nylon screws that hold the cascade and the P-extension to the manifold. Carefully remove the cascade.

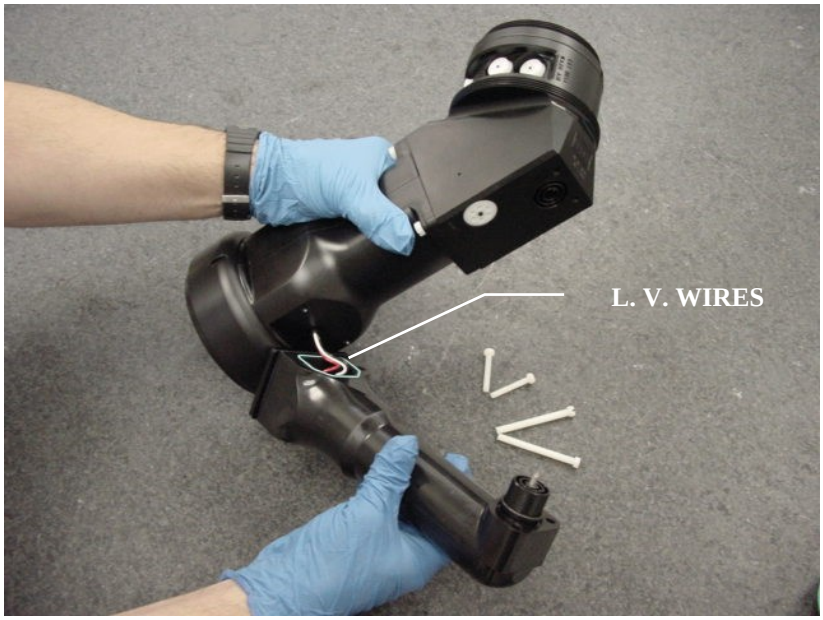


Figure 36

Three low voltage wires (red, white and black) run from the male socket assembly within the P-extension, out to the cascade. Using a pair of long nosed pliers, carefully remove each wire (Each is connected to the cascade via a spade clip.).

CAUTION! Be careful when removing the three low voltage wires. The tabs inside the cascade cavity can be broken off.

Once the cascade has been removed, then the four M6 x 20 nylon screws that hold the manifold to the P-extension may be removed.

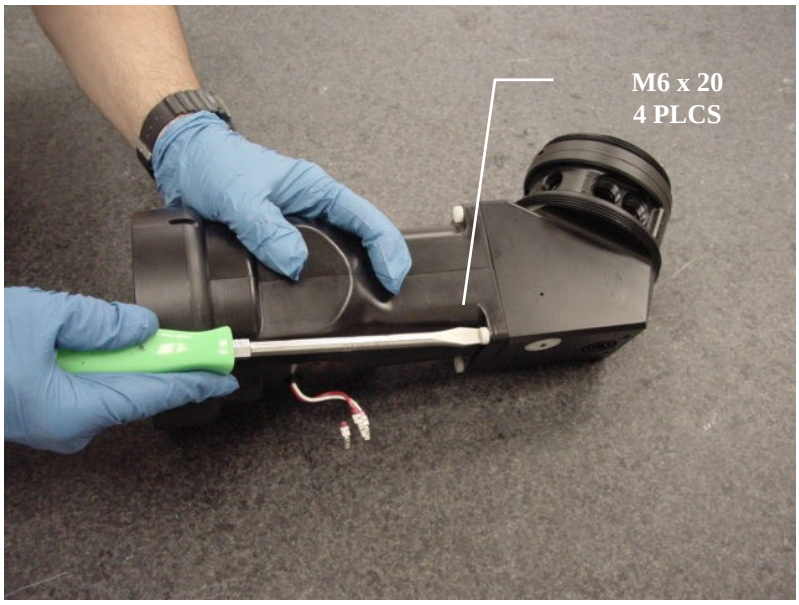


Figure 37

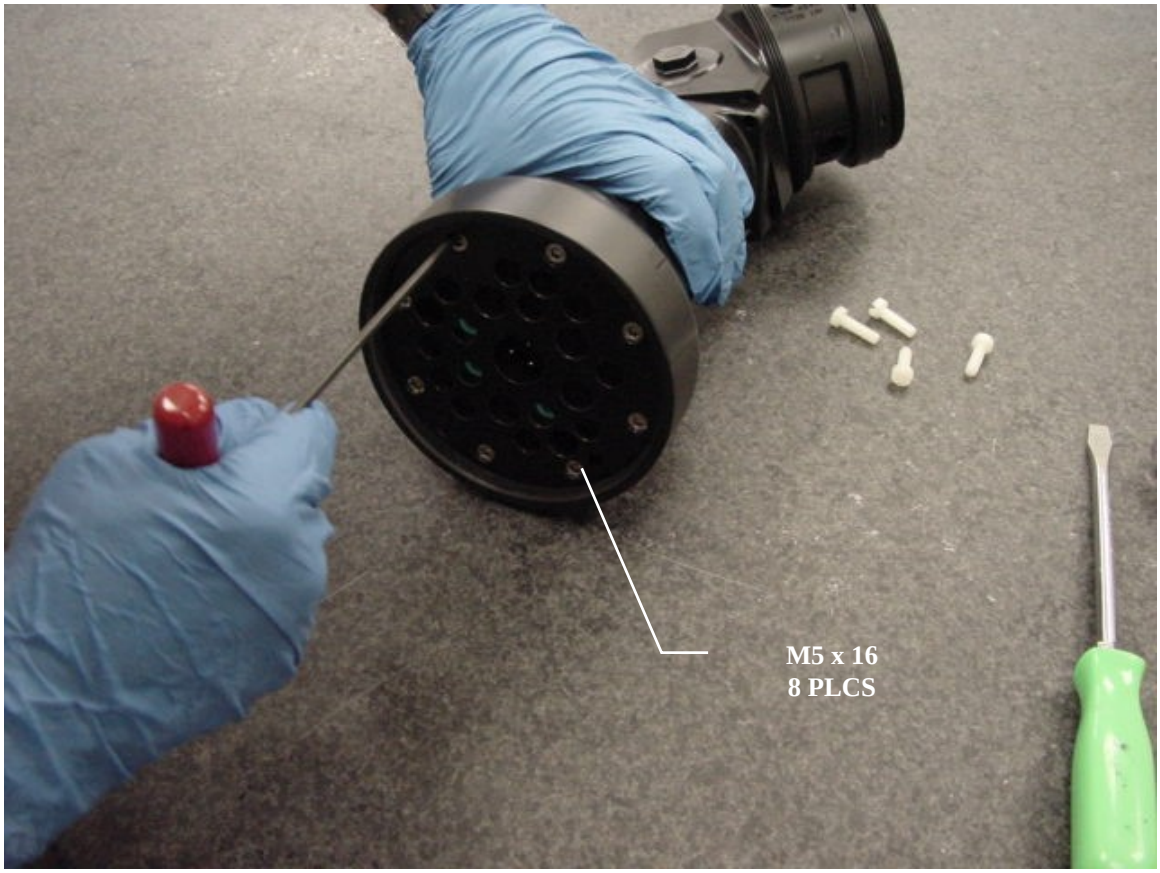


Figure 38

After the four M6 x 16 nylon screws have been removed, the P-extension halves will have to be removed to gain access to the hoses within the P-extension that connect to the bottom of the manifold. Remove the P-extension halves by unscrewing, counterclockwise, the eight M5 x 16 stainless steel socket head cap screws at the bottom of the turbine side base plate. Once they are removed, the P-extension halves may be removed. Care must be taken not to damage the low voltage wires.

Figure 39: Nanovalve Tool

To remove the nanovalves, use the EFC nanovalve wrench TL-1A39. The small end of the wrench is used to loosen/tighten the nanovalve, and the larger end is made to extract the nanovalve.

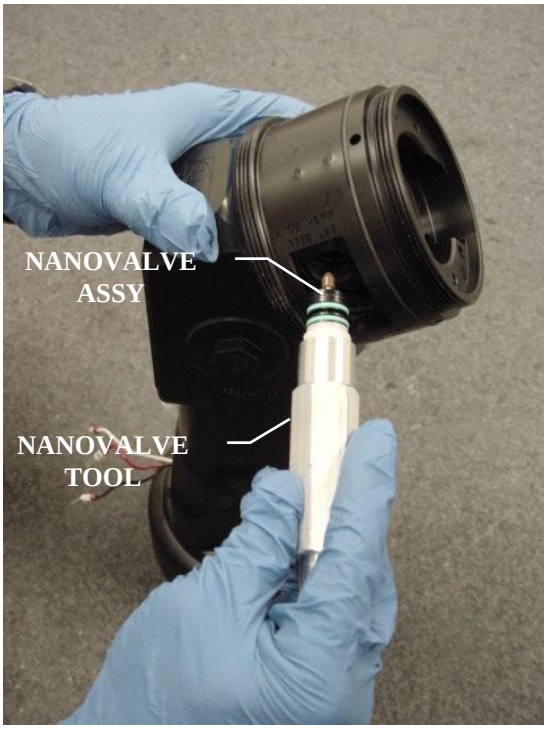


Figure 40: Extracting a Nanovalve

Figure 41: Regulator Seat Tool

The nanovalves should be tightened to 15 in-lbs. Over tightening a nanovalve could result in the valve malfunctioning. A very thin film of Vaseline may be applied to the o-rings on the outside of all of the valves.

This will help with the insertion of the valves, as well as maintaining a tight seal between the valve and the manifold body. Tighten the dump microvalve to 60 in-lbs. The regulator cover nut should be tightened to 150 in-lbs and the poppet valve seat within the regulator cavity should be tightened until the seat bottoms out (Use seat tool TW1001.).

CAUTION! Do not use a sharp pointed object in the regulator cavity, especially to remove the diaphragm. Damaging the surface on which the diaphragm seals could cause paint or solvent to leak past the diaphragm and into the pilot regulator (PR) line decreasing the life of the diaphragm.

Figure 42: Extracting a Hose

To remove the hoses at the bottom of the manifold, use the EFC extraction tool TL-1A45 for the ¼" and 4mm push lock fittings, and TL-1A46 for the 3/8" push lock fittings. Hold down on the push lock fitting top with the tool, and pull the hose out.

To insert a hose, carefully insert the hose into the push lock fitting until the hose bottoms out. Give a forceful tug to make certain the hose is seated all the way in the fitting.

OPERATION

The primary function of the manifold assembly is to accept the fluid (air & liquid) lines from the hose bundle (via the P-extension) and send those fluids to the air bearing motor assembly. The manifold assembly also acts as a mounting place for the outer shaping air shroud and motor assembly. Fluids enter the bottom of the manifold through push lock fittings.

PAINTING CIRCUIT

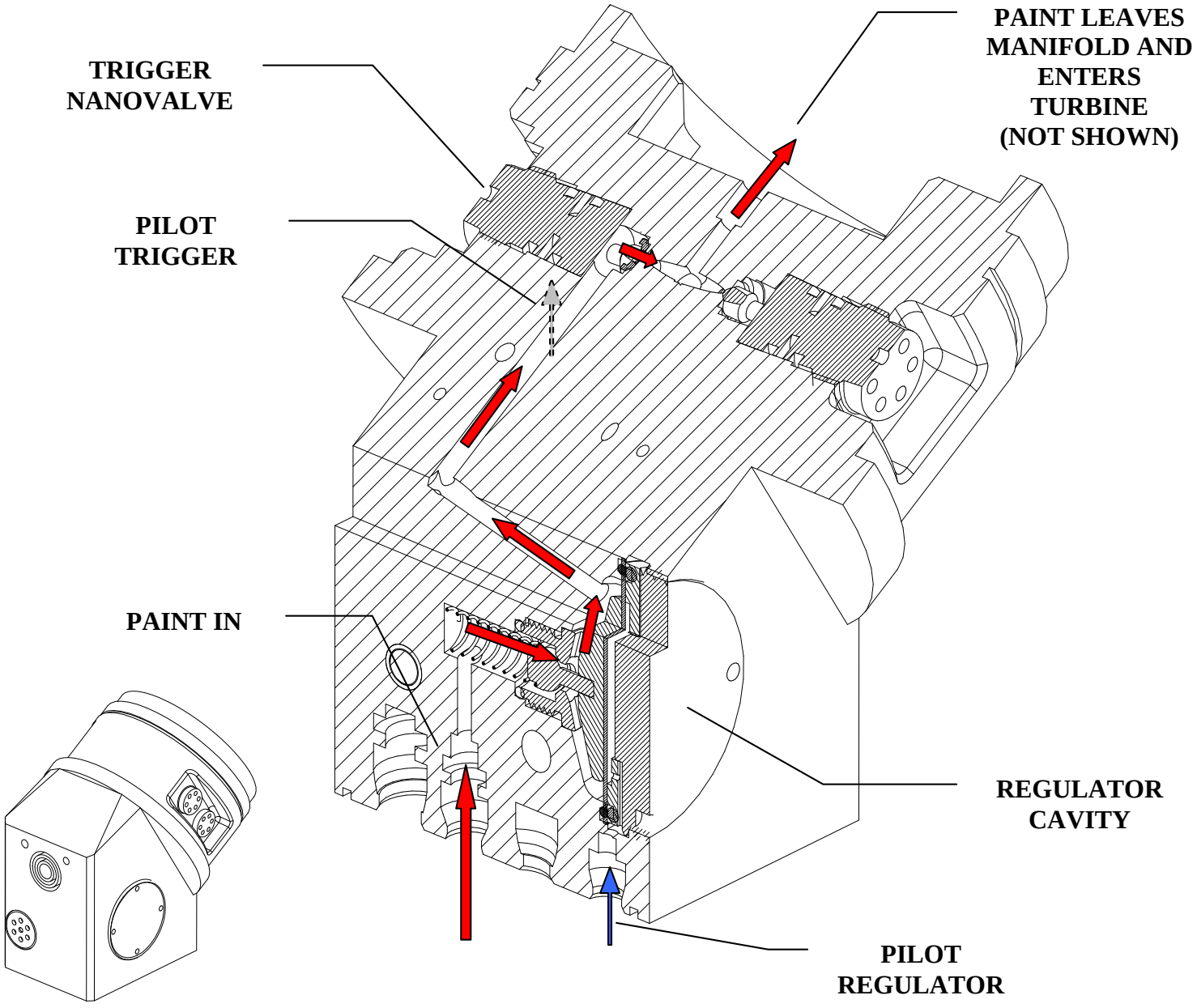


Figure 43: Manifold Cut-Away – Painting Sequence

1. Paint enters the bottom of the manifold through the paint push fitting and fills the bottom of the regulator cavity.
2. Pilot regulator air enters the regulator cavity via the “PR” push fitting through the bottom of the manifold. PR is used to control the paint flow through the turbine and pushes down on the regulator diaphragm, releasing the poppet valve from the poppet seat, allowing paint to flow through the regulator cavity.
3. Paint leaves the regulator cavity and travels to the Pilot Trigger nanovalve.
4. Pilot trigger “PT” enters the bottom of the manifold via a push fitting and opens the Trigger nanovalve thereby allowing the paint to travel out of the manifold and into the bell cup on the motor assembly.

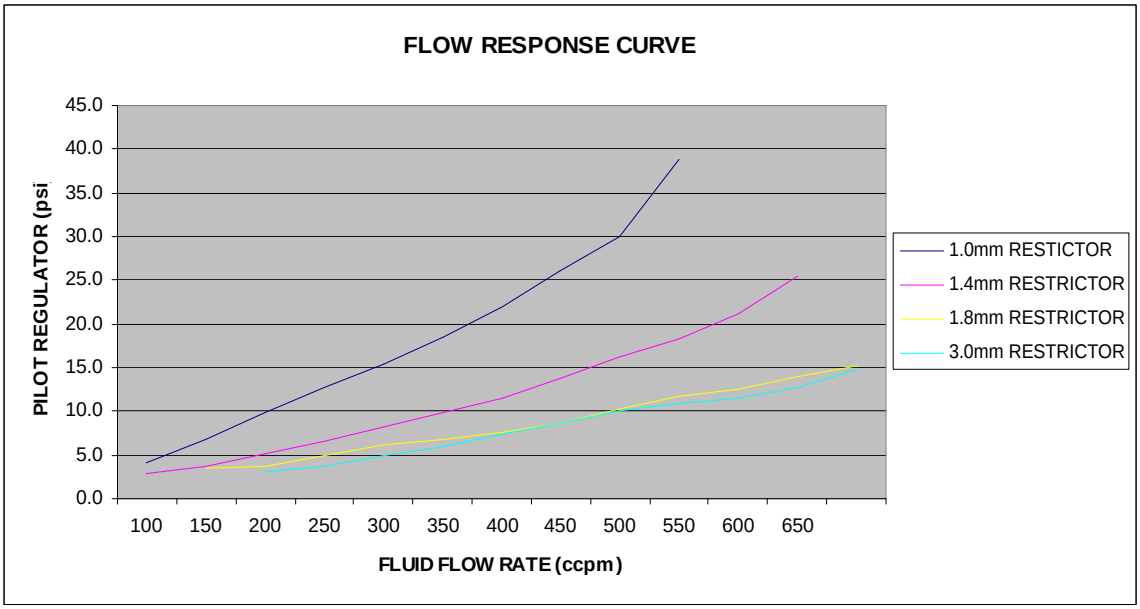


Figure 44: Regulator Response

Figure 44 shows the flow response curve for the regulator. The curve will vary slightly depending on the fluid being sprayed (i.e. basecoat, clear coat, waterborne, solvent based, etc.) and the restrictor used in the manifold. Restrictors are placed in the flow path, downstream of the regulator, to generate enough fluid back pressure to give the regulator a good response time. Too small a restrictor will not only restrict the paint flow, and will create a response curve with a very narrow range (i.e. it will be difficult to generate high flow rates). Too large a restrictor will

generate very little back pressure to the regulator, thereby creating a shallow response curve (i.e. the regulator will be able to reach high flow rates, but the response of the regulator will be sluggish). So, it is important to select the proper restrictor that will allow for the required flow range and also give the optimum regulator flow response.

DUMPING CIRCUIT

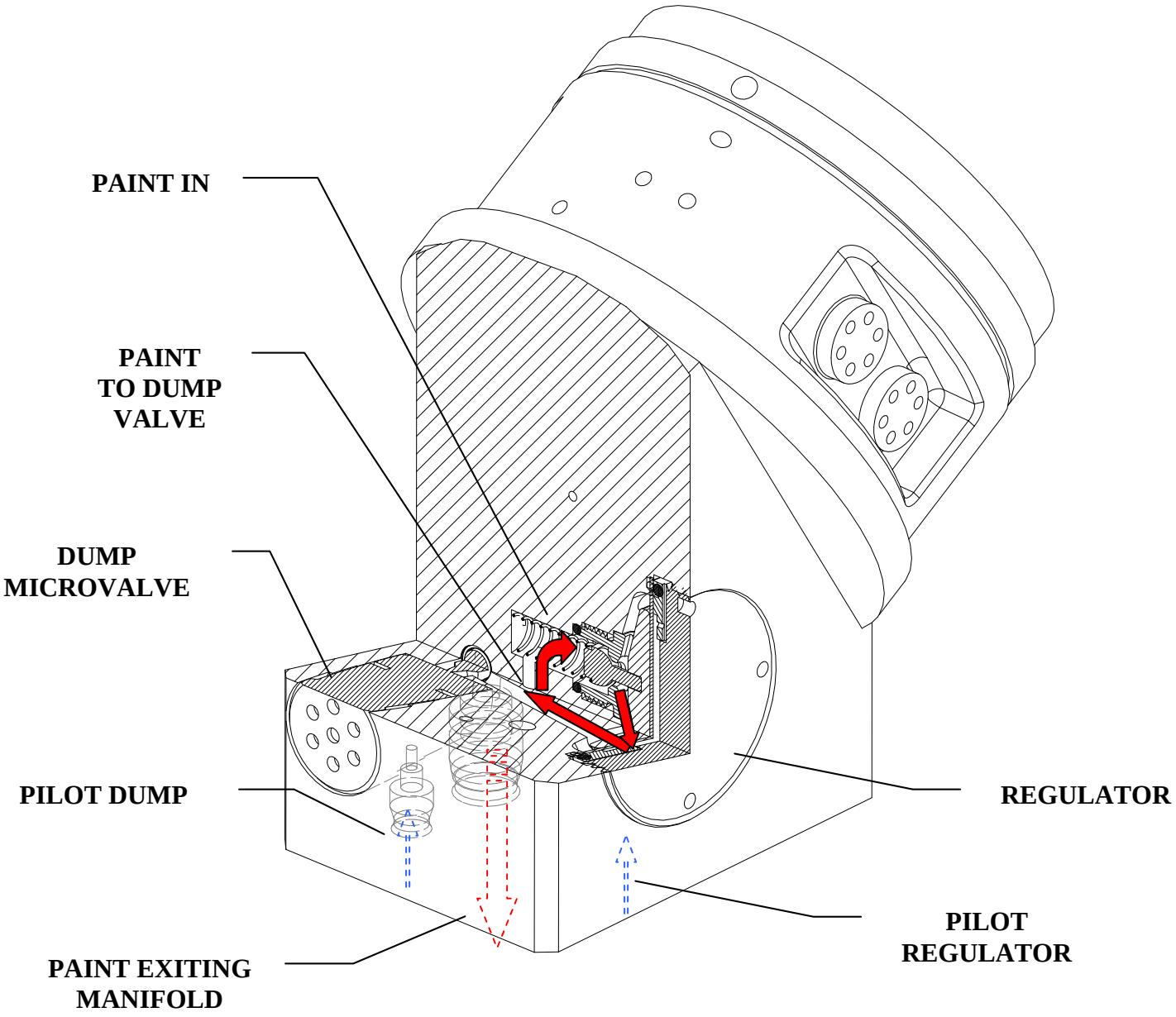


Figure 45: Manifold Cut-Away – Dump Sequence

DUMPING CIRCUIT

1. Paint enters the bottom of the manifold through the “P” paint push lock fitting and fills the bottom of the regulator cavity.
2. Pilot regulator air is supplied at the bottom of the manifold to allow paint to flow through the regulator cavity.
3. Paint leaves the regulator cavity and travels to the dump microvalve.
4. Pilot Dump “PD” is triggered, allowing the paint to exit the bottom of the manifold through “D” dump push lock fitting.

Notes:

a. All hoses are attached to the bottom of the manifold by push lock fittings. Push lock fittings used for each of the liquid carrying hoses (i.e. Paint, Dump and Bell Wash Solvent) are designed with a two Tekrez™ o-rings, to ensure a complete seal.
b. A 5/16” O. D. hose is used for the Dump fitting to allow for a quicker purging of the manifold.

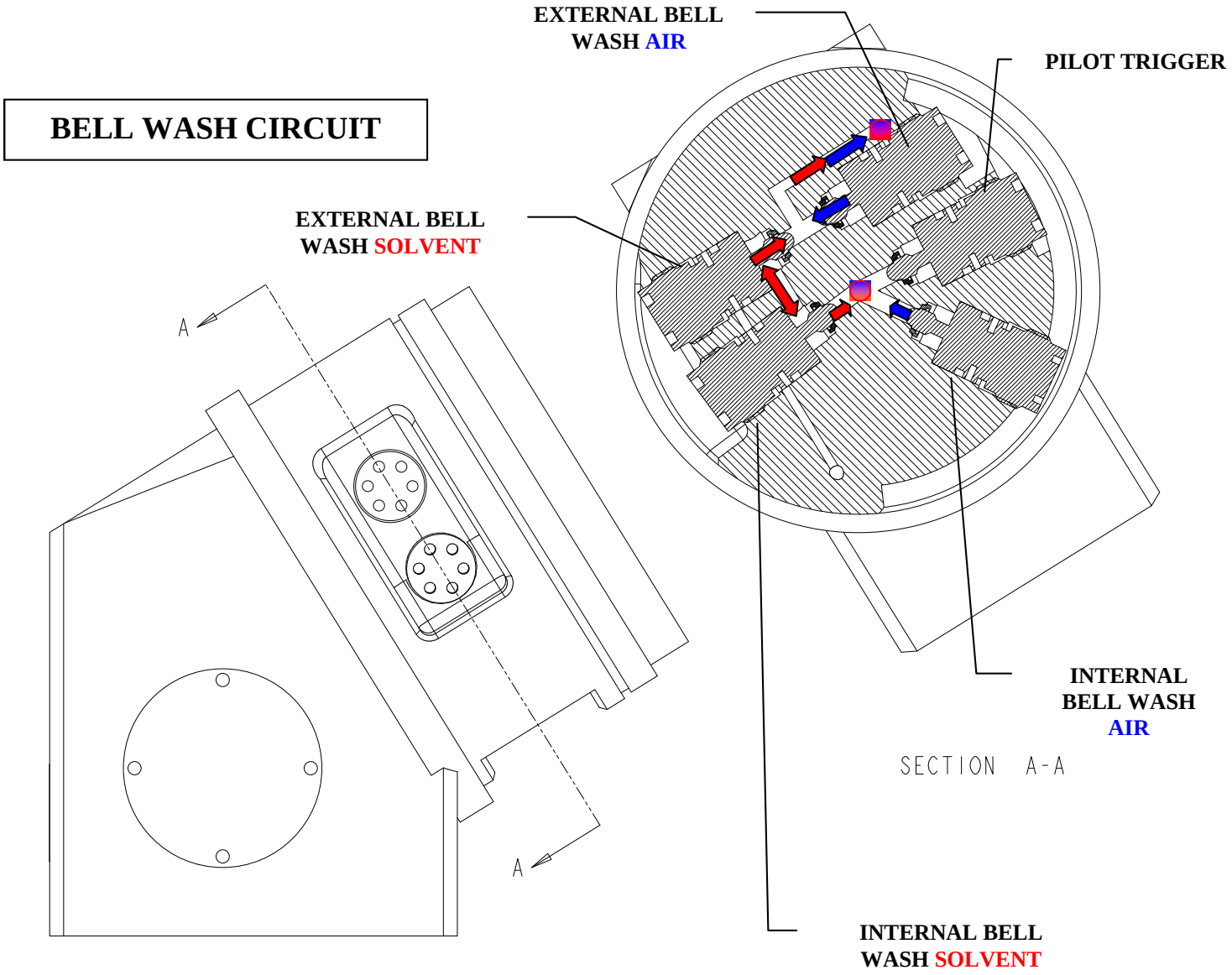


Figure 46: Manifold Cut-Away – Bell Wash Sequence

BELL WASH CIRCUIT

1. After the painting cycle is complete, air and solvent are introduced into the bell cup.
2. Triggering bell wash solvent activates both the internal and external bell wash solvent nanovalves, thereby cleaning the entire bell cup.
3. Triggering the bell wash air activates both the internal and external bell wash air nanovalves, thereby drying the entire bell cup.
4. If an external bell wash is not necessary, then the bell wash solvent (or air) nanovalve may be replaced with a “dummy” nanovalve that will not trigger. This will block off that part of the cleaning circuit.

MAINTENANCE

To keep the manifold assembly operating problem free, the nanovalves, dump microvalve, regulator, push lock fittings and all of the manifold o-rings must be undamaged and functioning properly.

Microvalve:

With the microvalve installed, make certain the valve is working properly by supplying pilot dump air (PD) (min. 85 psi). The indicator pin should protrude from the valve end cap. If the indicator pin does not protrude, check the PD supply or replace the microvalve if necessary. With the microvalve removed, check the outer threads, body, and tip for damage and replace as necessary. Check the external o-rings for damage.

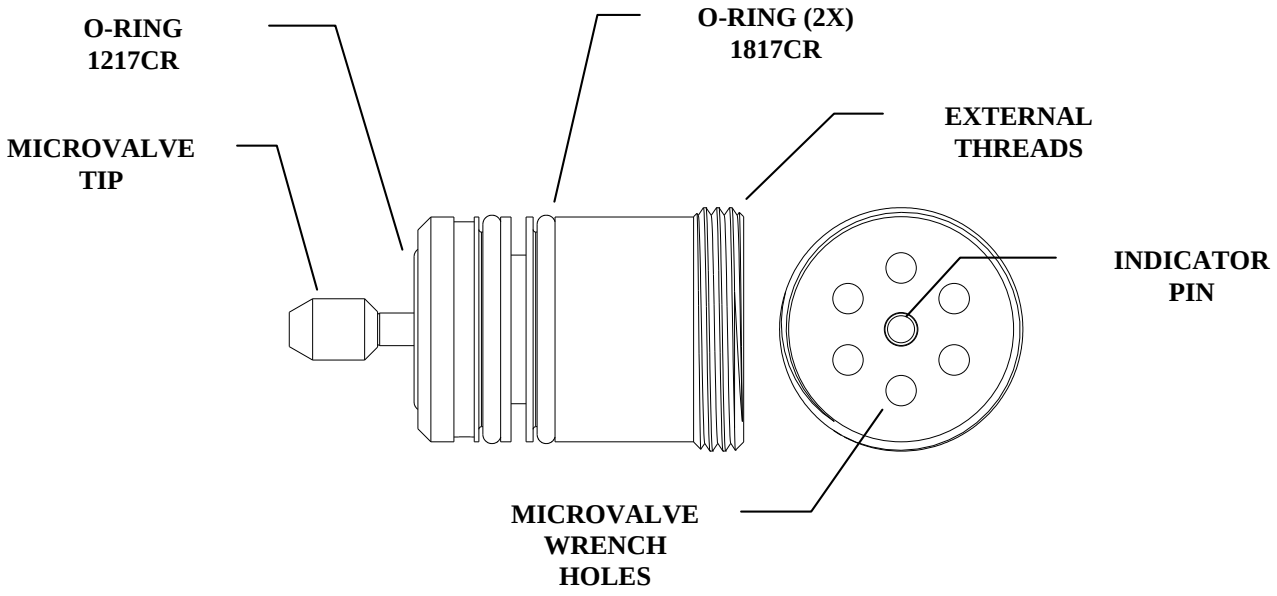


Figure 47: Microvalve

Nanovalves:

The nanovalves are smaller versions of the microvalve. They contain the same type of assembly components and operate the same as microvalves. Inspection of the nanovalves is the same as for the microvalves.

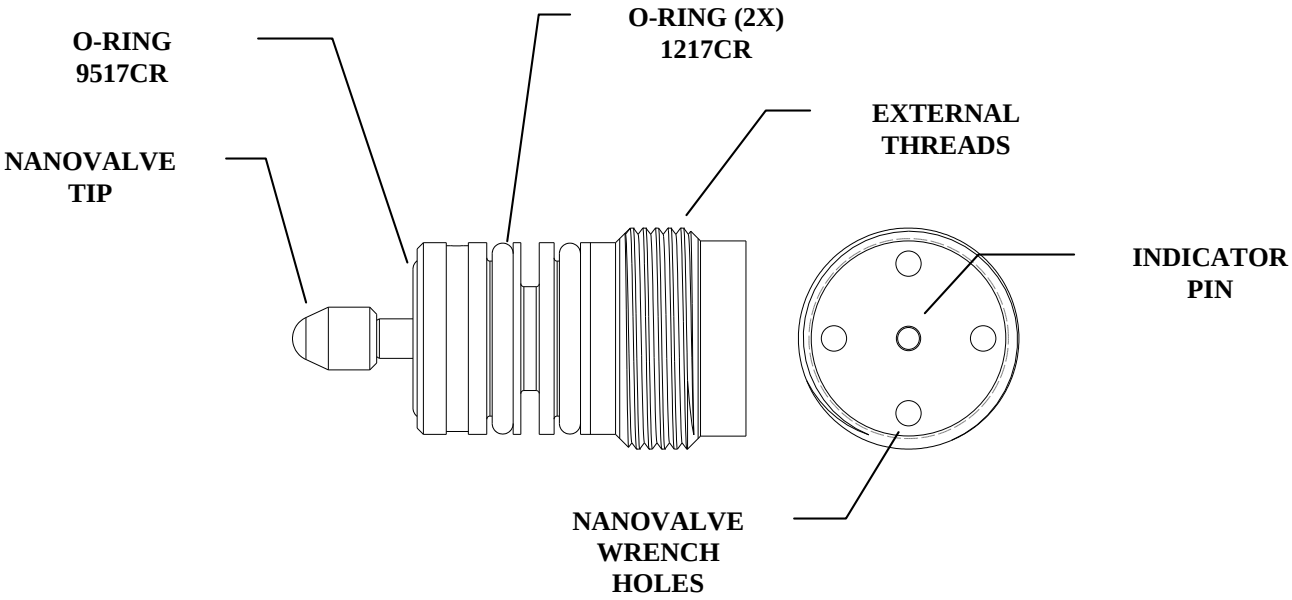


Figure 48: Nanovalve

Push lock fittings:

Make certain none of the fittings are damaged or broken. If so, replace the fitting top. Inspect the o-ring(s) within the push lock fitting cavity and replace if damaged.

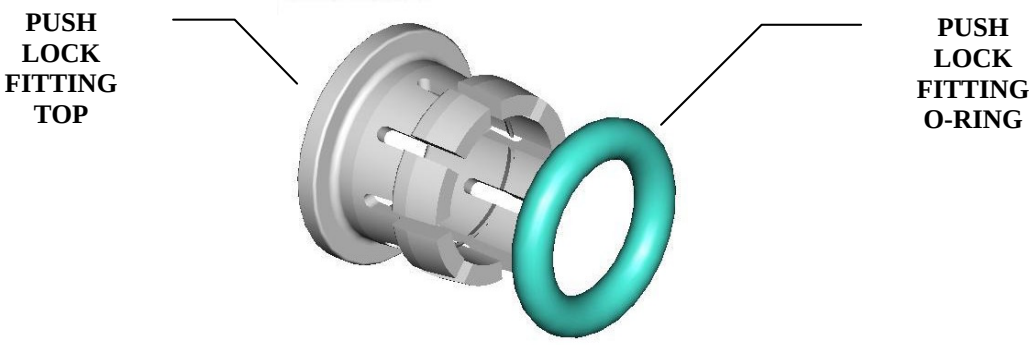


Figure 49: Push Lock Fitting and O-Ring

Manifold body:

Check the overall appearance of the manifold body. Inspect the microvalve, nanovalve and regulator cavities for damage. The manifold body should be kept clean and dry.

Care must be taken not to damage the regulator cavity (with a sharp object) when replacing the regulator diaphragm. Note: The regulator diaphragm is installed with the smooth (TEFLON®) side down (away from the regulator nut). Install and remove the valves (micro & nano) so as not to cause damage to the valve or the manifold. Be sure to tighten all components to their proper torque setting.

4.4.5 P-EXTENSION ASSEMBLY

The P-extension assembly is comprised of a two piece "clam shell" housing, a quick disconnect (Q.D.) nut, a turbine side base plate, a male socket assembly, paint and dump coils, fiber optic cables as well as shorter pieces of tubing for each of the lines in the hose bundle assembly. It is configured such that it and the atomizer assembly may be quickly and easily removed from the robot arm by simply unscrewing the Q.D. nut. The P-extension also offers a connection means for the high voltage (H.V.) cascade and manifold assembly.

ASSEMBLY / DISASSEMBLY

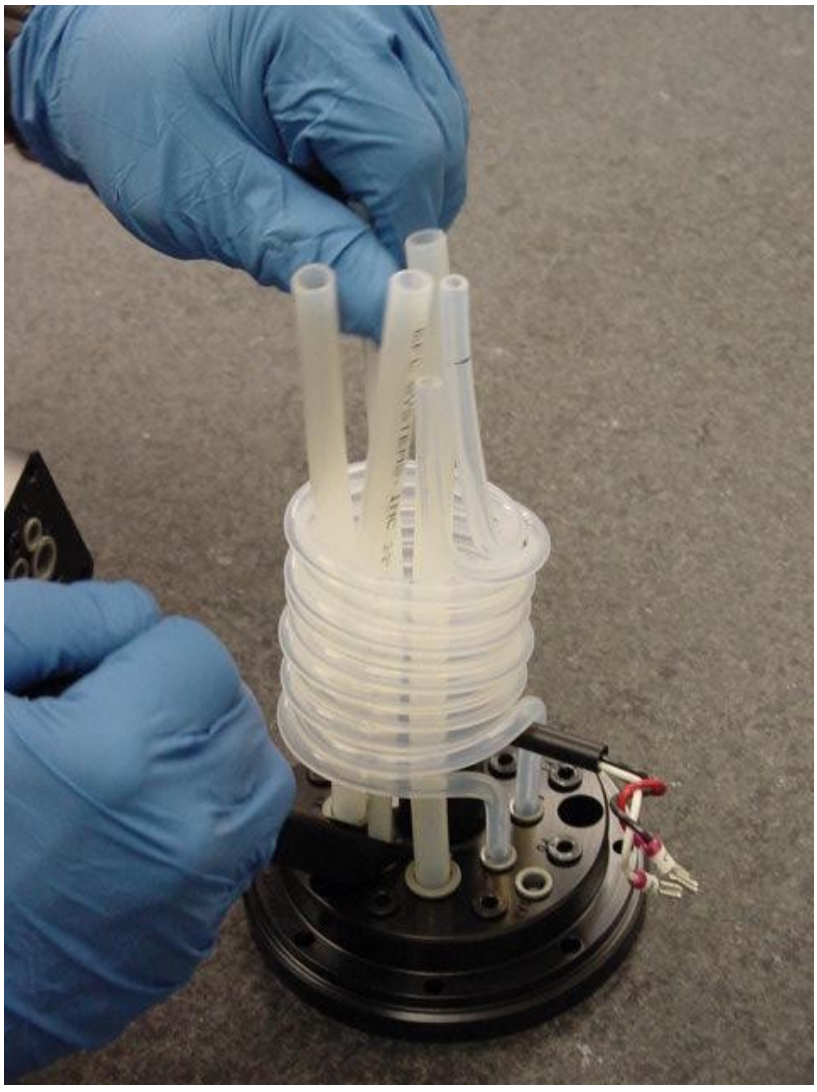


Figure 50: P-Extension Hose Removal

Using the hose removal tools (TL-1A45 & TL-1A46), remove each of the hoses (including the coils). The male socket assembly is held to the base plate by three nylon screws, M3 x 16, torqued to 10 in-lbs.

CAUTION! Notice the orientation of the male socket assembly to the base plate. The socket assembly must be attached to the base plate with the socket assembly stem between P and D on the turbine side base plate.

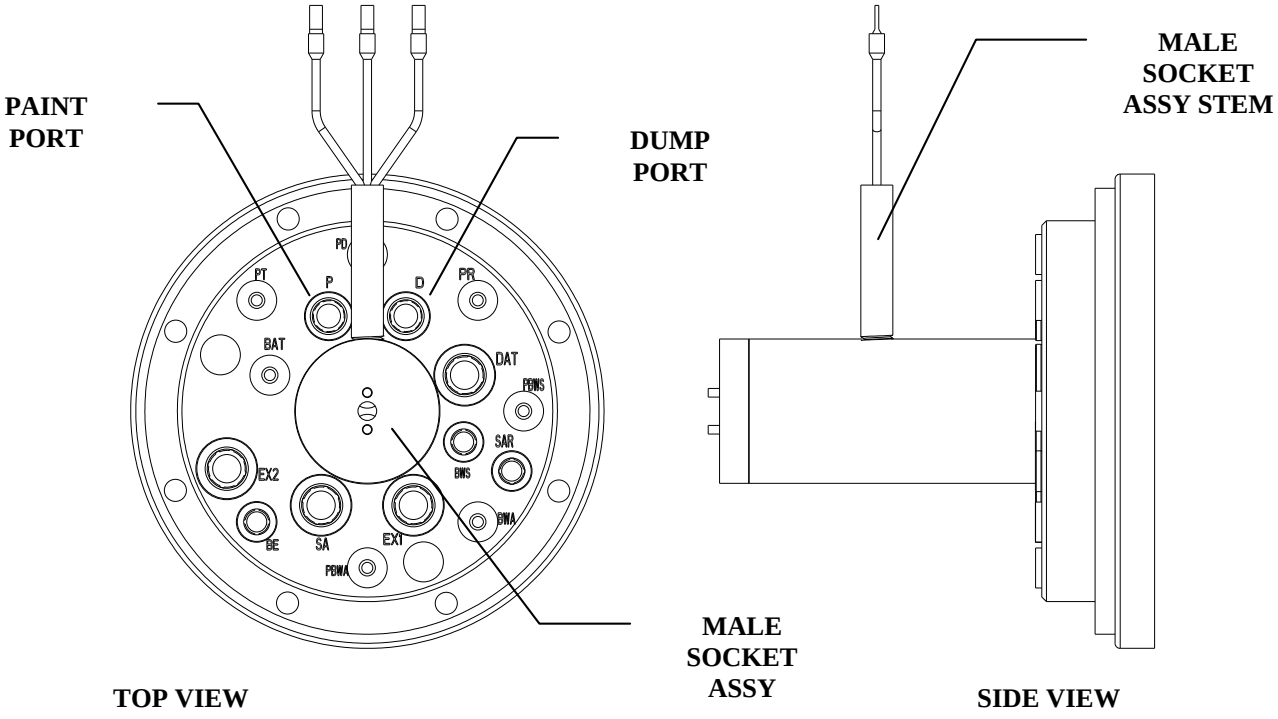


Figure 51: Male Plug Assy Orientation

MAINTENANCE

The short segments of hose within the P-Extension must remain damage free to prevent leaks. For the male socket assembly, use a multimeter to check the continuity between the pin and wire tab for each of the wires. Check the push lock fitting tops and all o-rings for damage and replace as necessary

4.4.6 FIBER OPTIC CONNECTIONS

Turbine speed is monitored by two fiber optic cables routed through the p-extension and into the manifold assembly. One of fibers transmits a light signal, which bounces off a reflective surface on the turbine flywheel within the air bearing motor, and is then sent back down the second fiber to a receiver within the p-extension. The receiver converts the light signal to a low voltage signal. As the flywheel rotates, a continuous stream of low voltage pulses are sent back down the second low voltage cable where it is then sent to the EFC speed card for analysis. The speed card then makes an adjustment to the proportion air valve supplying turbine drive and brake air to adjust the turbine speed.

Figure 52 is a computer rendering of the fiber optic components within the manifold and p-extension assemblies. This is a partial exploded view showing only the manifold and turbine side base plate. For simplicity, all other components normally assembled in this area are not shown.

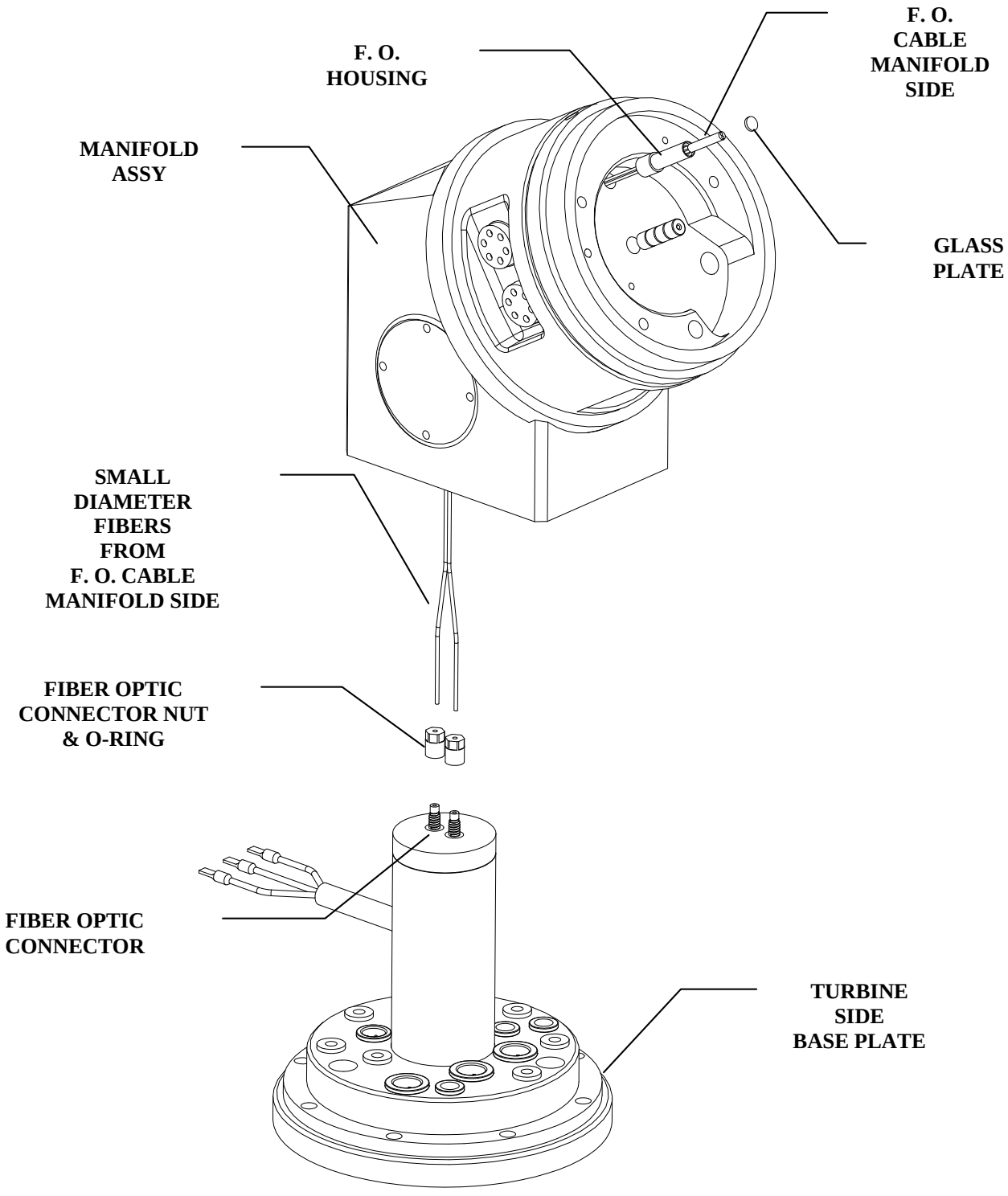


Figure 52: Fiber Optic Cable Assy, Manifold & P-Extension

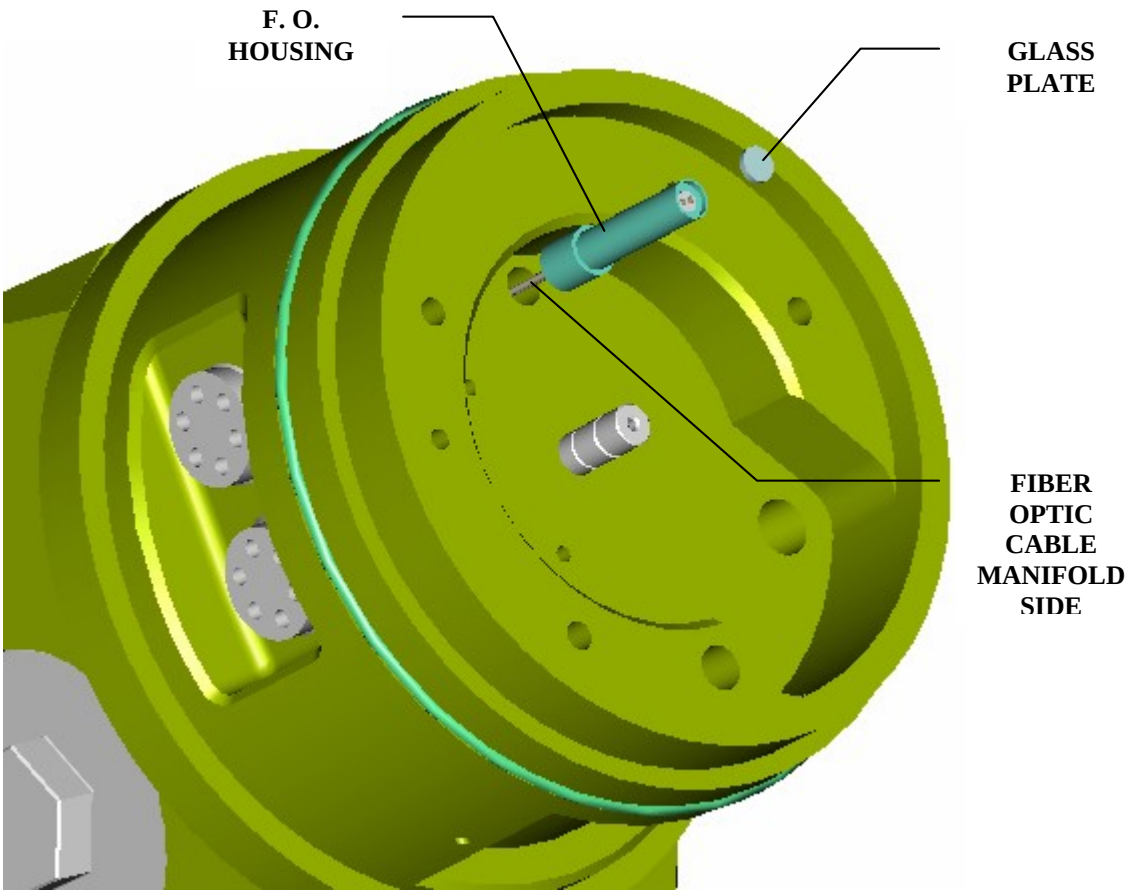


Figure 53: Fiber Optic Cable Assy, Manifold Side

ASSEMBLY

To install the fiber optic components within the manifold assembly, the fiber optic cable manifold side (with approx. 20" of fiber) must be pressed into the fiber optic housing. This assembly is then pressed into the manifold body in the location shown in Figure 53. Finally, a glass plate is then *carefully* pressed into the end of the fiber optic housing. The dual fiber will exit the bottom of the manifold close to the BAT push lock fitting.

WARNING! Care must be taken when pressing the glass plate into the fiber optic housing so as not to break the glass causing bodily injury. The glass plate will bottom out once it is installed completely.

CAUTION! It is important to install the fiber optic housing and fiber optic cable into the manifold properly. As seen in Figure 54, the fiber optic housing must be oriented such that the twin fibers are as shown. This orientation will produce the best light pulse to be sent back to the speed control card.

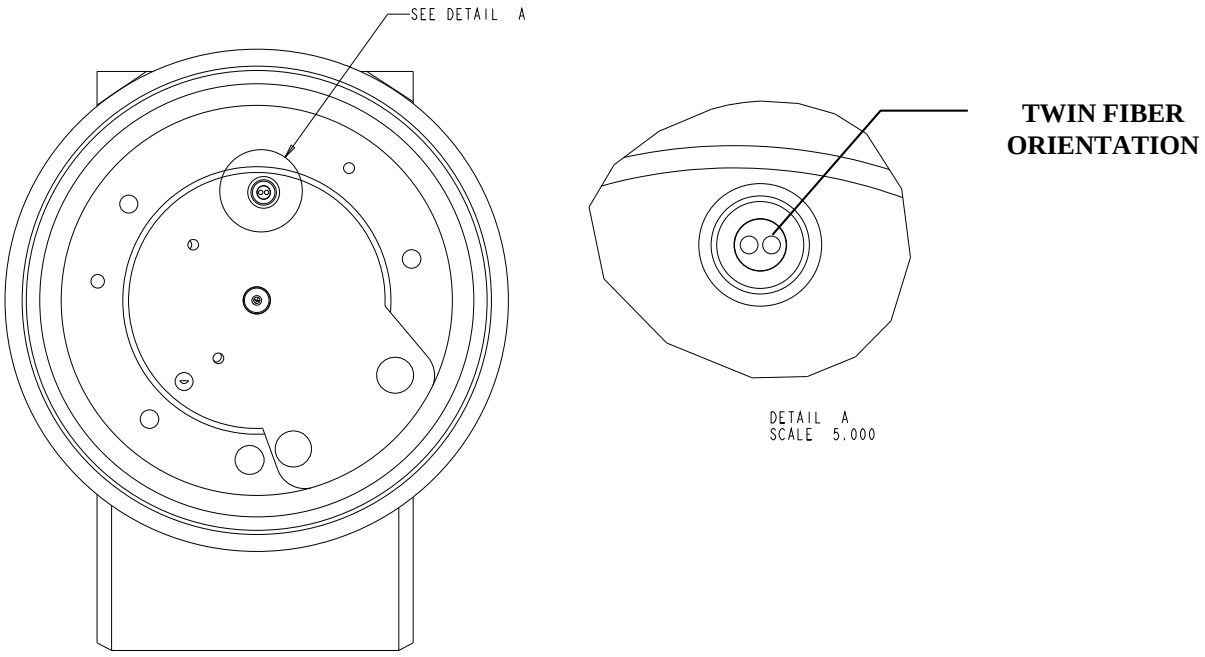


Figure 54: Fiber Optic Cable Assy Orientation, Manifold Side

After the fiber optic housing and fiber optic cable assembly have been installed into the manifold, it is time to install the fiber optic cables into the 7-pin male socket assembly. Looking at Figure 55, insert the fiber optic *segments* into the 7-pin male socket assembly. Insert the fibers from the manifold (Figure 52, not shown in Figure 55) through the fiber optic connector nuts, then through the small o-ring. Insert the end of the fiber into the male socket assembly, abutting the shorter fiber optic segment installed earlier. Screw the fiber optic connector nut onto the 7-pin male socket assembly, securing the fiber from the manifold to the 7-pin male socket assembly. Repeat for the other fiber.

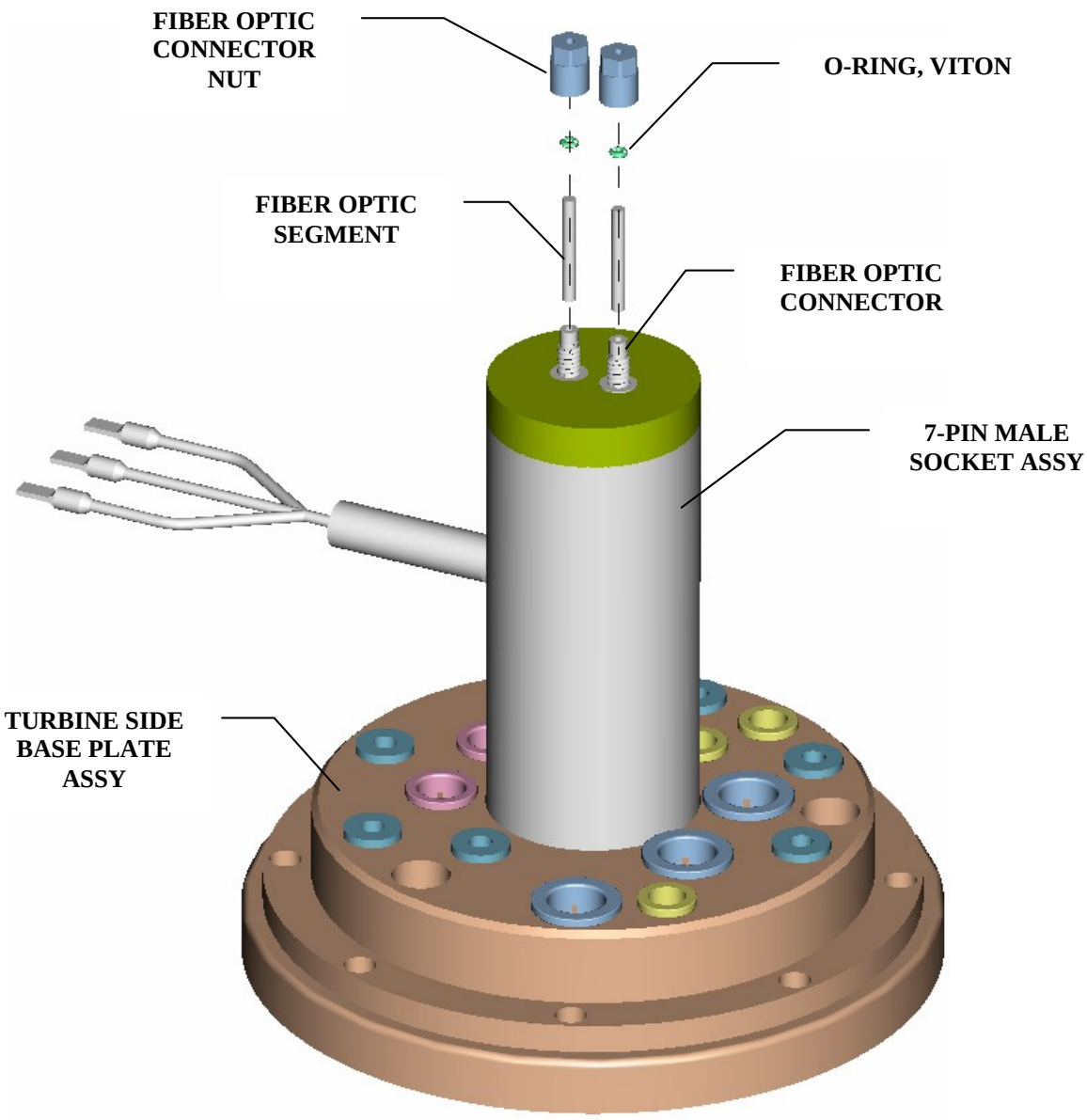


Figure 55: Male Socket Assy & F. O. Connector

DISASSEMBLY

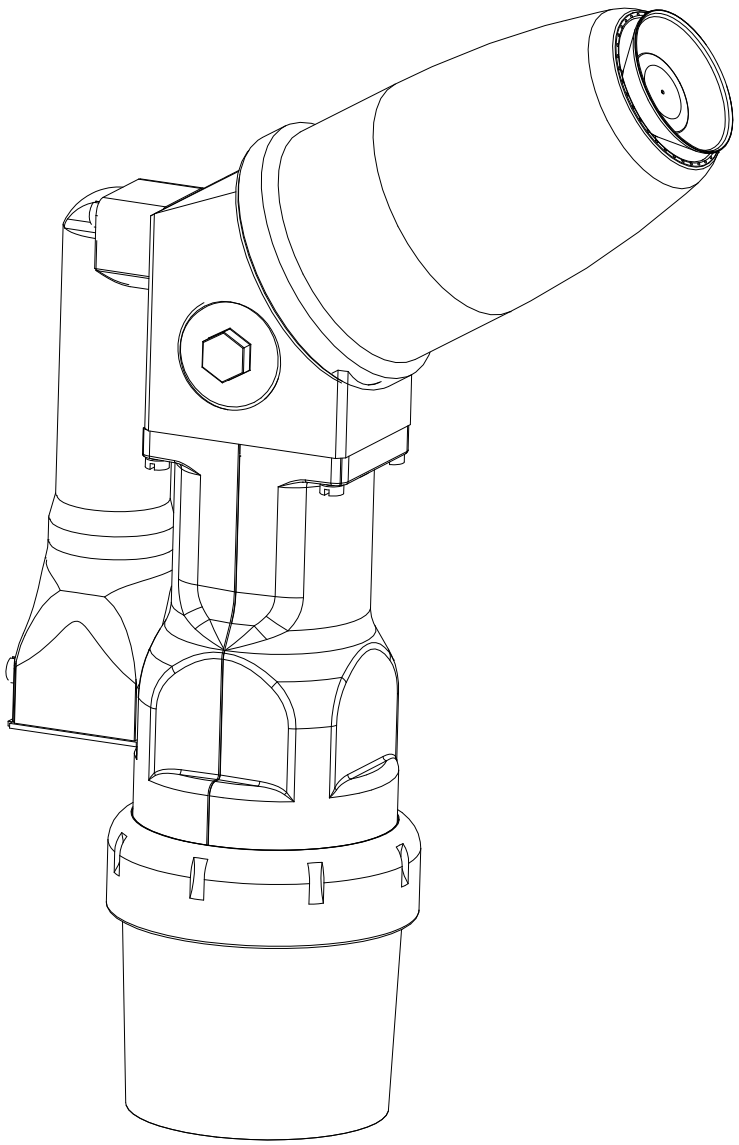
To disassemble, unscrew, counterclockwise, the fiber optic connector nuts from the fiber optic connectors in the 7-pin male socket assembly. Be careful when removing the fiber optic cable from the nut, so as not to loose the small o-ring on the cable.

MAINTENANCE

It is important that no dirt or debris get into either fiber optic connector. Such an instance would degrade the light signal to the turbine speed controller, thereby creating turbine speed faults.

The ends of the fibers must be smooth, flat and polished. If either end is cut, then care must be taken to properly dress the ends.

5.0 FS40R – ASSEMBLY DRAWINGS



5.1: HOSE BUNDLE ASSEMBLY & ADAPTER RING

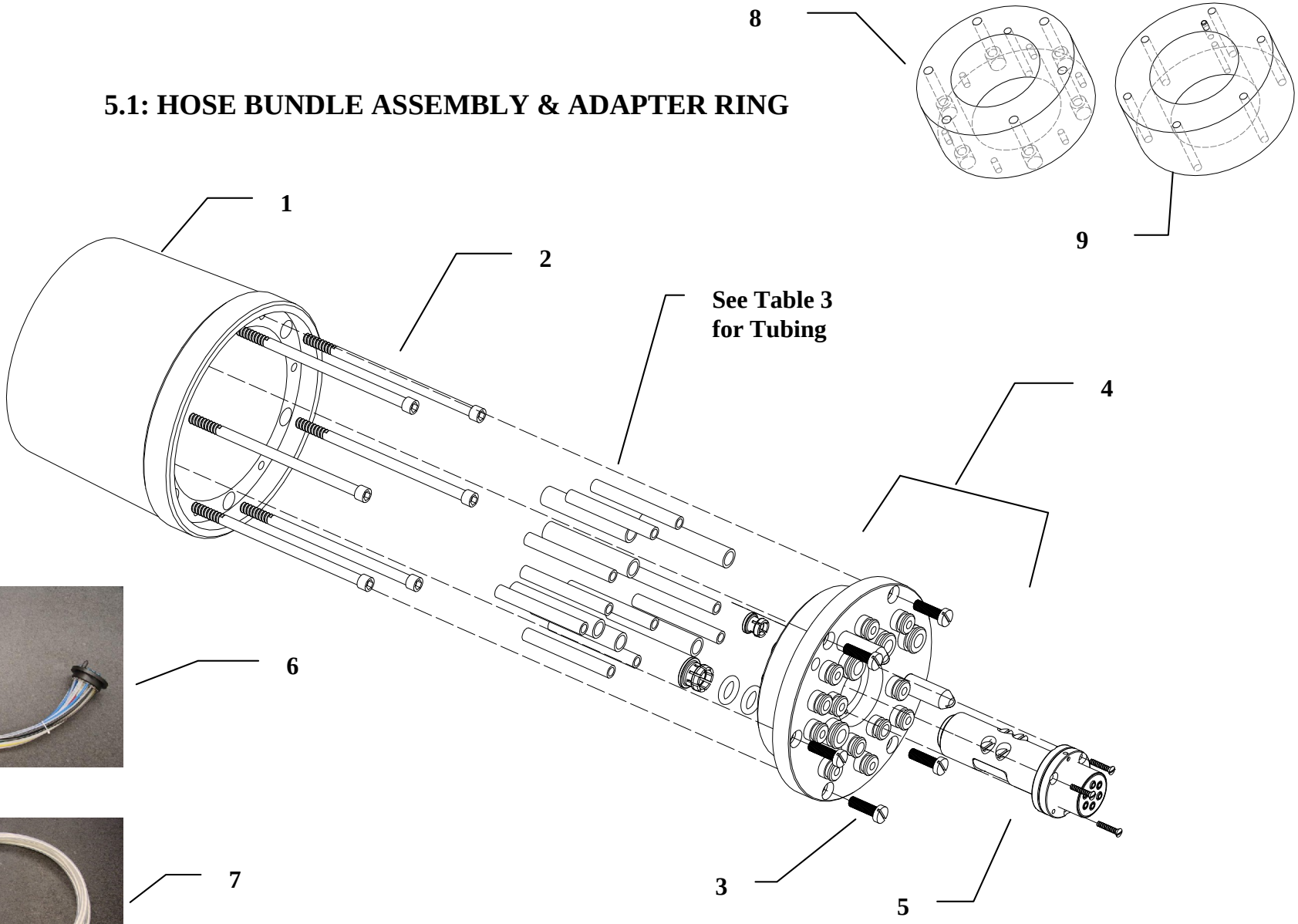


Table 3: HOSE BUNDLE & ADAPTER RING PARTS LIST

ITEM	EFC PN	DESCRIPTION	QTY
1	45-1A48	ROBOT ADAPTER RING	1
2	5100SSC	M5 x 100mm L CAP SCREW, STAINLESS STEEL	6
3	516NSC	M5 x 16mm L NYLON SCREW, CHEESE HEAD	5
4	45-1A46	ROBOT SIDE BASE PLATE ASSY	1
5	304P55	FEMALE SOCKET ASSY, 7 PIN	1
6	45-1A49	HOSE BUNDLE ASSY, 30’	-
7	308P58	CABLE ASSY, 7 PIN, 30’	-
8	45-1A22	ADAPTER RING, FANUC P200	-
9	45-1A22-P155	ADAPTER RING, FANUC P155	-

Table 3: HOSE BUNDLE & ADAPTER RING PARTS LIST (cont.)

ITEM	EFC PN	DESCRIPTION	QTY
N/S	NTB3618-NAT	PR HOSE – 3/16" O. D. x .035" WALL, NYLON, NATURAL	25 FT
"	NTB3618-RED	PT HOSE – 3/16" O. D. x .035" WALL, NYLON, RED	"
"	NTB3618-YELLOW	PD HOSE – 3/16" O. D. x .035" WALL, NYLON, YELLOW	"
"	NTB3618-BLACK	PBWS HOSE – 3/16" O. D. x .035" WALL, NYLON, BLACK	"
"	NTB3618-GREEN	PBWA HOSE – 3/16" O. D. x .035" WALL, NYLON, GREEN	"
"	NTB1436-BLACK	BE HOSE - ¼" O. D. x .035" WALL, NYLON, BLACK	"
"	NTB1436-BLUE	SAR HOSE - ¼" O. D. x .035" WALL, NYLON, BLUE	"
"	NTB3618-NAT	BWS HOSE – 3/16" O. D. x .035" WALL, NYLON, NATURAL	"
"	NTB3618-NAT	BWA HOSE – 3/16" O. D. x .035" WALL, NYLON, NATURAL	"
"	NTB1436-RED	BAT HOSE – ¼" O. D. x .035" WALL, NYLON, RED	"
"	TTB3814	FO1 / FO2 HOSE – 3/8" O. D. x .063" WALL, NYLON, NATURAL	"
"	NTB3814-SG	P HOSE – 3/8" O. D. x .050" WALL, NYLON, NATURAL	"
"	NTB3814-SG	D HOSE – 3/8" O. D. x .050" WALL, NYLON, NATURAL	"
"	NTB3814-BLACK	DAT HOSE - 3/8" O. D. x .050" WALL, NYLON, BLACK	"
"	NTB3814-BLUE	SA HOSE - 3/8" O. D. x .050" WALL, NYLON, BLUE	"
"	TTB3814	HOSE – 3/8" O. D. x .063" WALL, TEFLON®	"
"	TTB3814	EX1, EX2 – 3/8" O. D. x .063" WALL, TEFLON®	4'

N/S = NOT SHOWN

5.3: ROBOT SIDE BASE PLATE ASSEMBLY

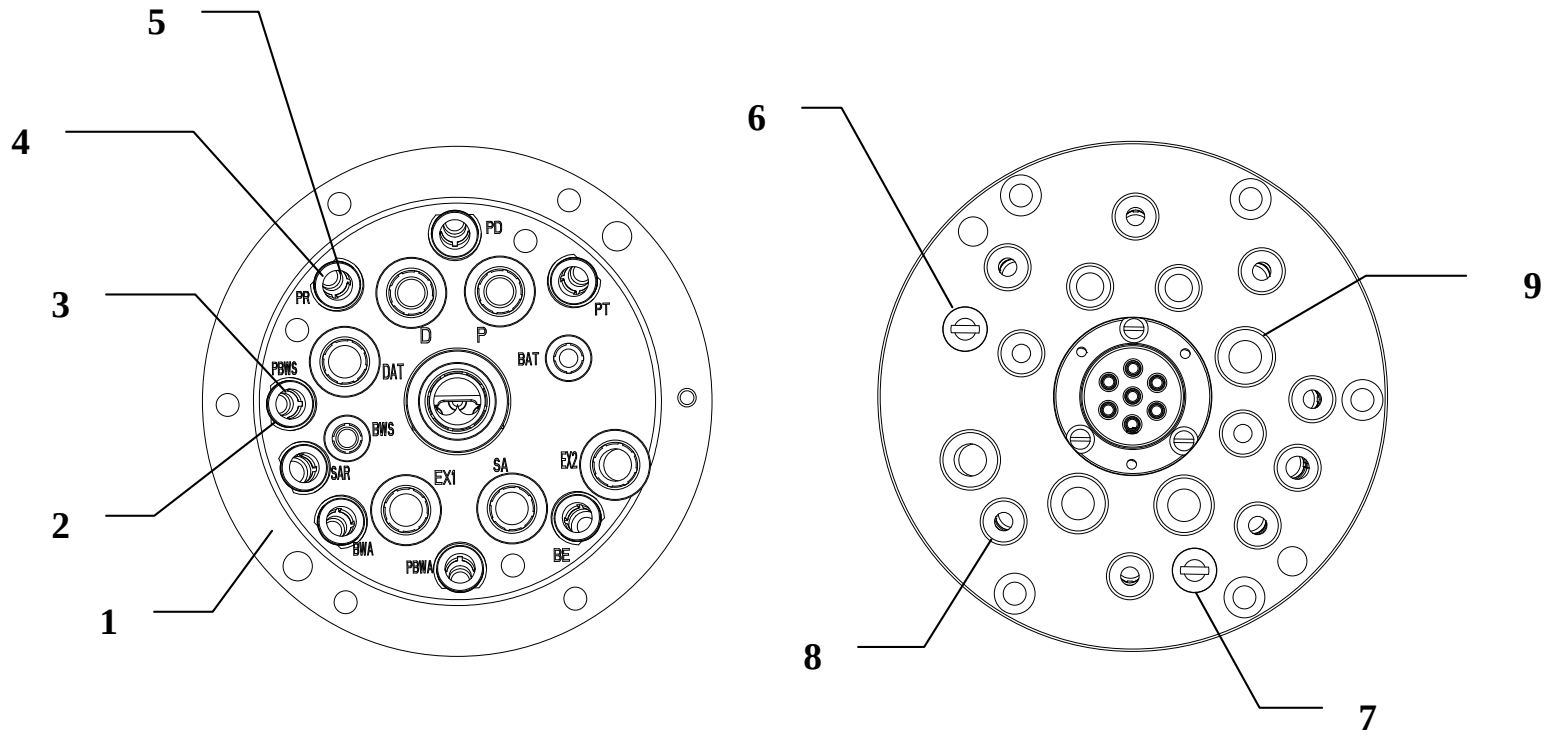
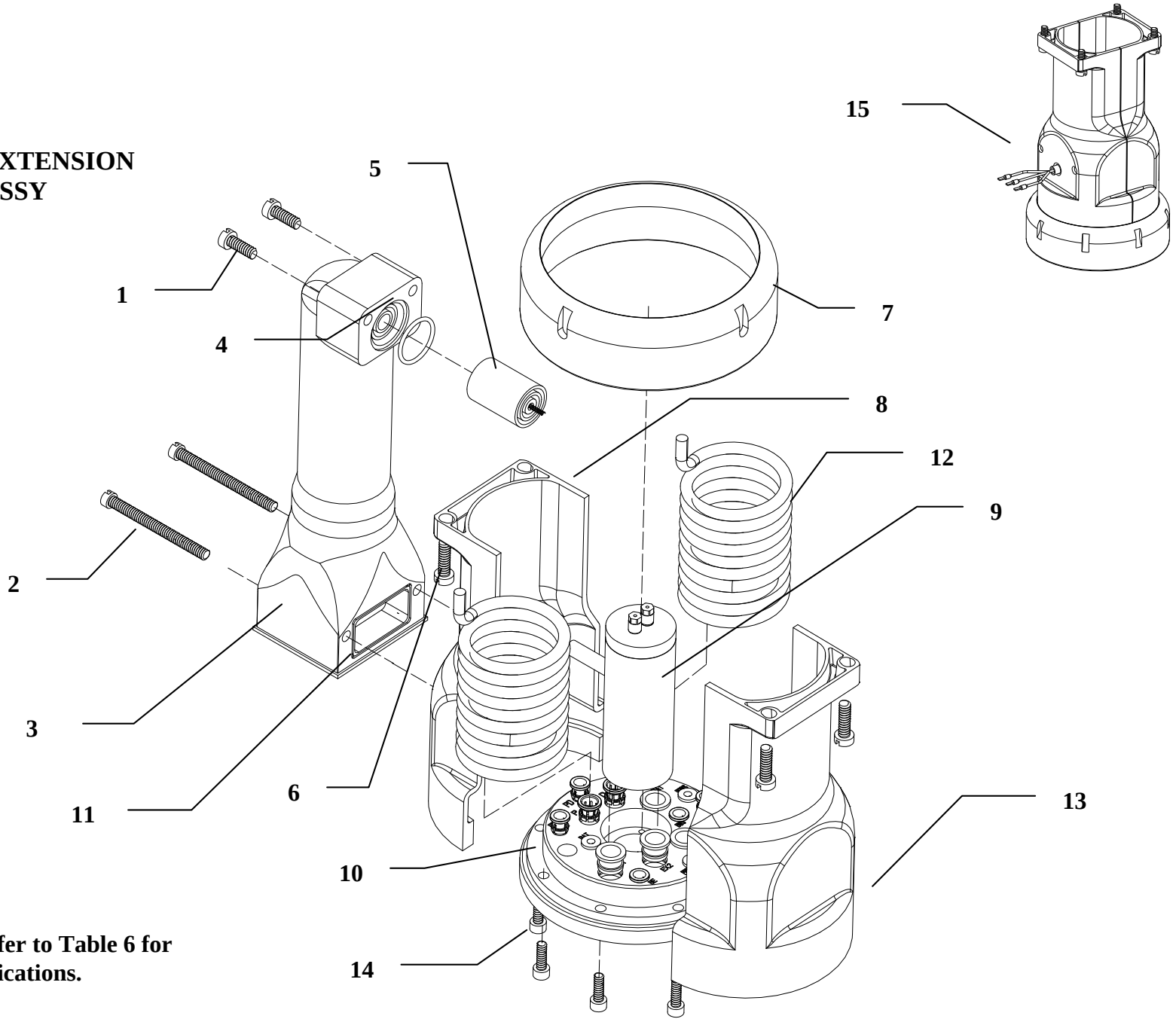


Table 5: ROBOT SIDE BASE PLATE PARTS LIST

ITEM	EFC PN	DESCRIPTION	QTY
1	45-1A46A	ROBOT SIDE BASE PLATE	1
2	316PLFT	PUSH LOCK FITTING, 3/16”	10
3	4324CR	O-RING, FOR 316PLFT, TEKREZ®, 4.0mm I.D. x 2.0mm C. S.	11
4	90-1A13	3/8” PUSH LOCK FITTING TOP	6
5	9027CR	O-RING, FOR 90-1A13 TEKREZ®, 9.0mm I.D. x 3.0mm C. S.	8
6	45-1A46B	LOCATING PIN, BLACK	1
7	45-1A46C	LOCATING PIN, WHITE	1
8	6017CR	O-RING, TEKREZ®, 6.0mm I.D. x 2.0mm C. S.	12
9	8717CR	O-RING, TEKREZ®, 8.7mm I.D. x 2.0mm C. S.	4

NOTE: P & D PORTS USE TWO (2) 9027CR O-RINGS EACH.
BW USES TWO (2) 4324CR O-RINGS.

5.4: P-EXTENSION ASSY



NOTE: Refer to Table 6 for hose specifications.

Table 6: P-EXTENSION PARTS LIST

ITEM	EFC PN	DESCRIPTION	QTY
1	535NSC	M5 x 35mm L NYLON SCREW, CHEESE HEAD	2
2	665NSC	M6 x 65mm L NYLON SCREW, CHEESE HEAD	2
3	250C50	HIGH VOLTAGE CASCADE (INCLUDES #1, 2, 3, 11)	1
4	2252VR	O-RING, VITON®, 22.0mm I.D. x 5.0mm C. S.	1
5	316P50	MAIN ISOLATOR ASSY	1
6	620NSC	M6 x 20mm L NYLON SCREW, CHEESE HEAD	4
7	40-1A31	Q.D. NUT	1
8	414P31B	P-EXTENSION HALF, CASCADE SIDE	1
9	415P30-7	LOW VOLTAGE MALE SOCKET ASSY, 7 PIN	1
10	40-1A30	TURBINE SIDE BASE PLATE ASSY	1
11	3917CR	O-RING, TEKREZ®, 39.0mm I.D. x 2.0mm C. S.	1
12	10-1A17	TEFLON® COIL	2
13	414P31A	P-EXTENSION HALF	1
14	516SSC	M5 x 16mm L CAP SCREW, STAINLESS STEEL	8
15	404P30	COMPLETE P-EXTENSION ASSY	-
NS	414P31	P-EXTENSION (2 PCS, INCLUDES #8, #13)	-

Table 6: P-EXTENSION PARTS LIST (cont.)

ITEM	EFC PN	DESCRIPTION	QTY
N/S	NTB4027-BLACK	PR – 4mm O. D. x 2.7 mm I.D. x 20 cm	1
“	“ – ORANGE	PT – 4mm O. D. x 2.7 mm I.D. x 20 cm	1
“	“ – RED	PD – 4mm O. D. x 2.7 mm I.D. x 20 cm	1
“	NTB4027-HO	PBWS – 4mm O. D. x 2.7 mm I.D. x 20 cm	1
“	NTB4027-HO	PBWA – 4mm O. D. x 2.7 mm I.D. x 20 cm	1
“	NTB4027 – RED	BAT – 4mm O. D. x 2.7 mm I.D. x 20 cm	1
“	NTB4027-GRAY	BWA – 4mm O. D. x 2.7 mm I.D. x 20 cm	1
“	NTB1436 – YELLOW	BE – ¼” O. D. x .035” WALL x 20 cm	1
“	NTB1436 – GREEN	BWS – ¼” O. D. x .035 WALL x 20 cm	1
“	NTB1436 – BLUE	SAR – ¼” O. D. x .035” WALL x 20 cm	1
“	NTB3814 – GREEN	DAT – 3/8” O. D. x .050” WALL x 20 cm	1
“	NTB3814 – BLUE	SA – 3/8” O. D. x .050” WALL x 20 cm	1
“	NTB3814-SG	EX1, EX2 – 3/8” O. D. x .050” WALL x 20 cm	1

N/S = NOT SHOWN

5.5: MANIFOLD FIBER OPTICS

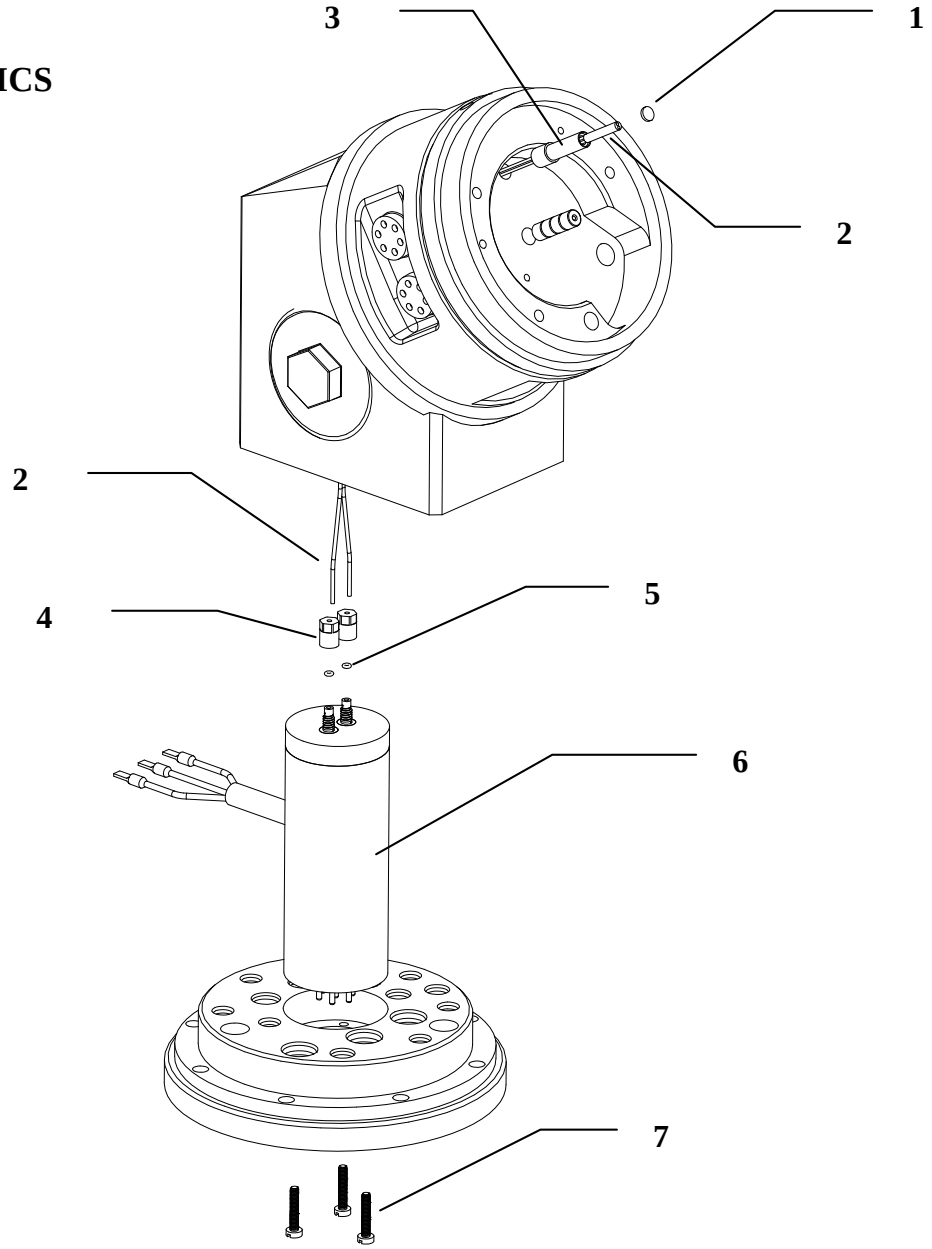
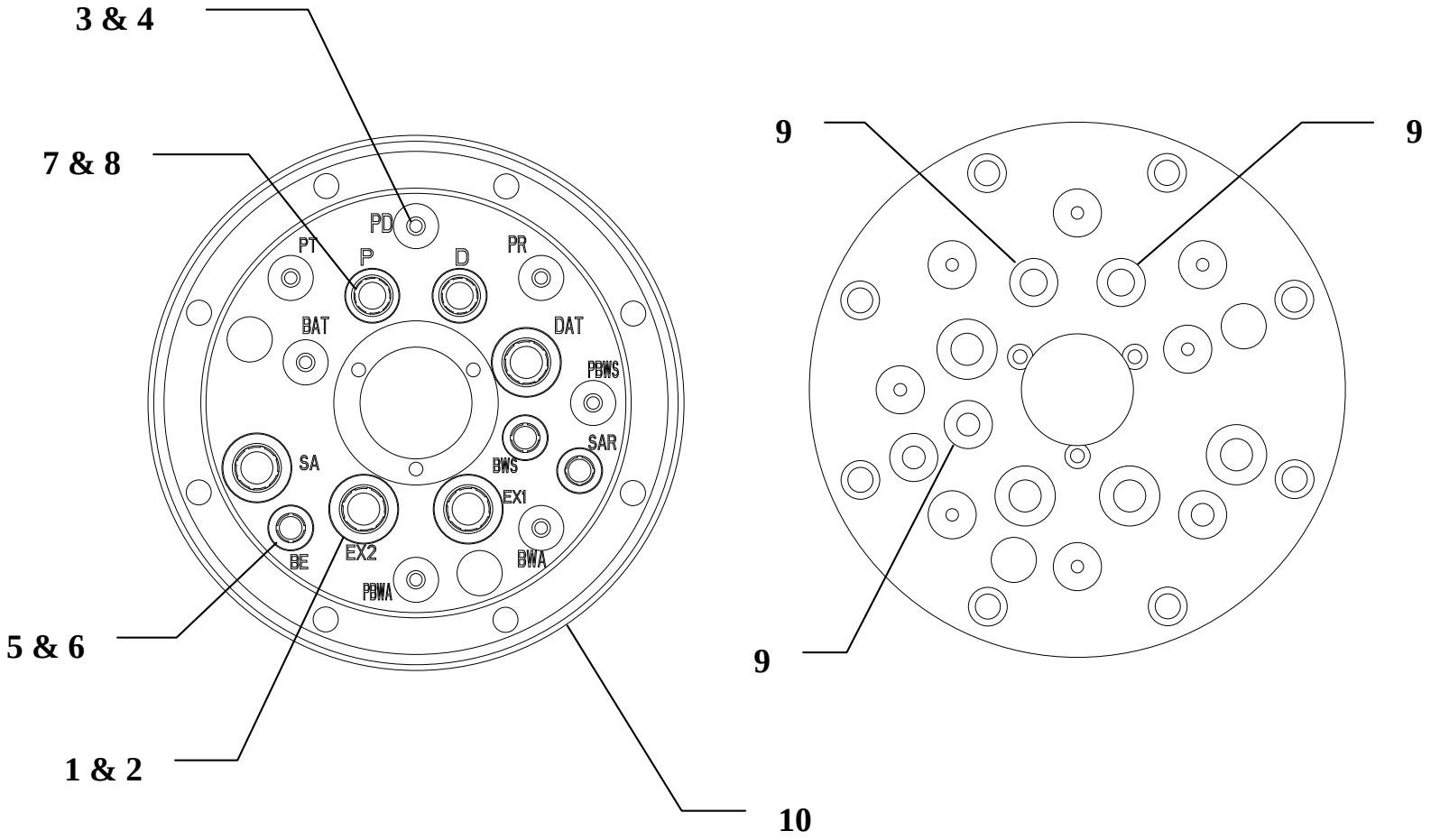


Table 7: MANIFOLD FIBER OPTIC PARTS LIST

ITEM	EFC PN	DESCRIPTION	QTY
1	11-1A10F	FIBER OPTIC GLASS PLATE	1
2	11-1A10A	FIBER OPTIC CABLE, MANIFOLD SIDE	1
3	11-1A10C	FIBER OPTIC HOUSING	1
4	11-1A10K	FIBER OPTIC NUT	2
5	1110VR	O-RING, VITON	2
6	415P30-7	MALE SOCKET ASSY, 7-PIN	2
7	316NSC	NYLON SCREW	3

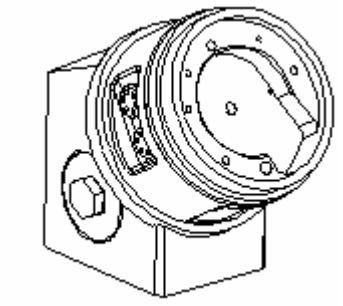
5.6: TURBINE SIDE BASE PLATE ASSEMBLY



TOP VIEW **INE SIDE BASE PLATE PA** BOTTOM VIEW

ITEM	EFC PN	DESCRIPTION	QTY
1	90-1A13	PUSH LOCK FITTING TOP, 3/8”	4
2	9027CR	O-RING FOR 90-1A13, TEKREZ®, 9.0mm I.D. x 3.0mm C. S.	4
3	144T80	PUSH LOCK FITTING TOP, 4mm	7
4	3624CR	O-RING FOR 144T80, TEKREZ®, 3.6mm I.D. x 2.0mm C. S.	7
5	90-1A11	PUSH LOCK FITTING TOP, ¼”	3
6	6026CR	O-RING FOR 90-1A11, TEKREZ®, 6.0mm I.D. x 2.6mm C. S.	4
7	90-1A35	PUSH LOCK FITTING TOP, 5/16”	2
8	7324CR	O-RING, FOR 90-1A35, TEKREZ®, 7.0mm x 2.5mm C. S.	4
9	85-1A15	FLAT WASHER, TEKREZ®	3
10	40-1A30A	BASE PLATE BODY, TURBINE SIDE	1
-	40-1A30	BASE PLATE ASSY (INCLUDES #1-10)	-

NOTES: BWS USES TWO (2) 6026CR O-RINGS.
P AND D USE TWO (2) 7324CR O-RINGS EACH.
85-1A15 IS USED ONLY ON BW, P & D PORTS.



5.7: MANIFOLD ASSEMBLY

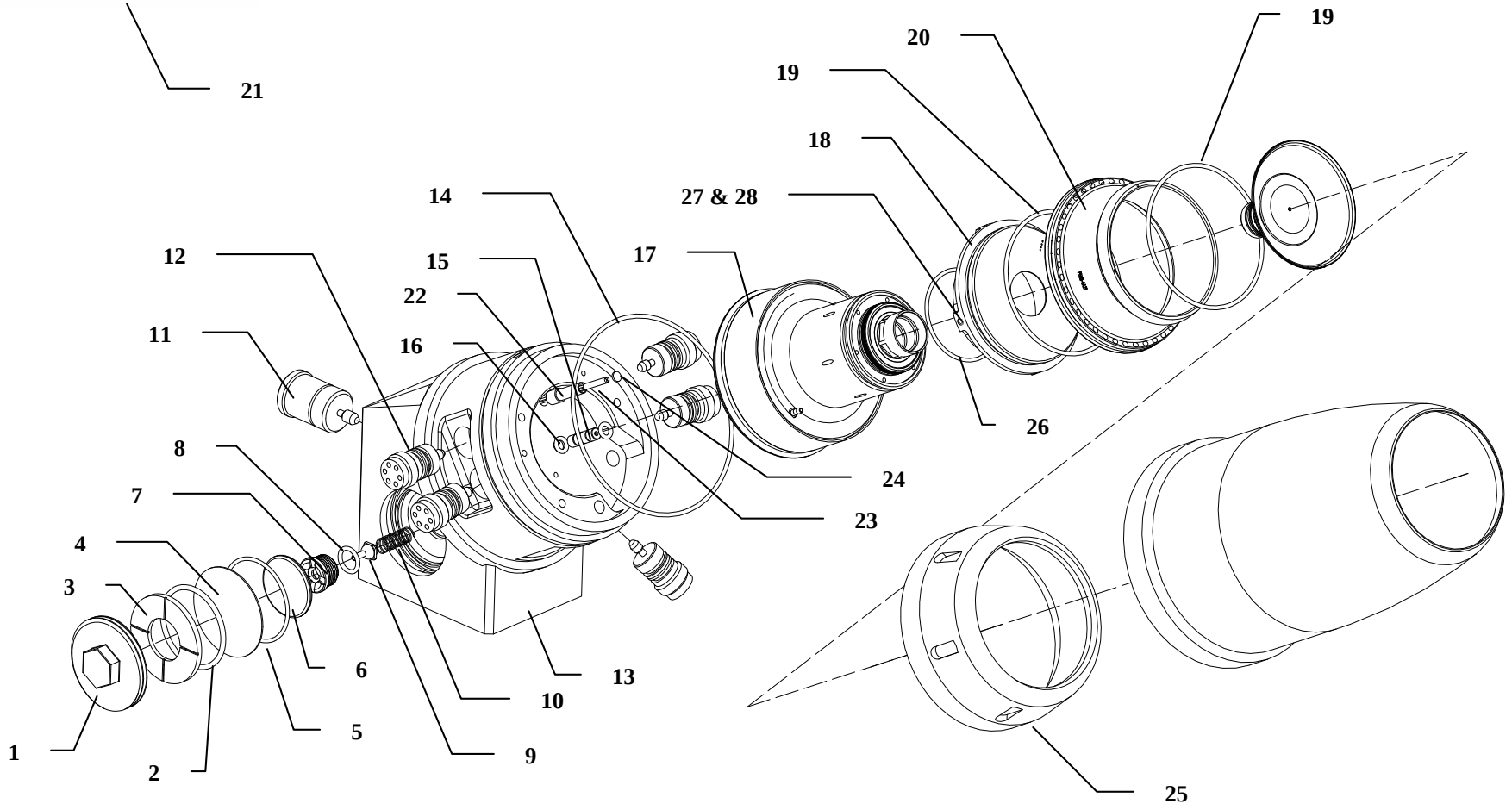


Table 9: MANIFOLD PARTS LIST

ITEM	EFC PN	DESCRIPTION	QTY
1	30-1A71	REGULATOR COVER NUT, SQUARE	1
2	3925VR	O-RING, VITON®, 39.0mm I.D. x 2.5mm C. S.	1
3	339T60	COVER SPACER	1
4	229T60	REGULATOR DIAPHRAGM	1
5	41178VR	O-RING, VITON®, 41.0mm O. D. x 2.0mm C. S.	1
6	230T60	DIAPHRAGM HOLDER	1
7	211M50	SEAT, STAINLESS STEEL	1
8	1020TR	O-RING, TEFLON®, 10.0mm I.D. x 2.0mm C. S.	1
9	210M50	POPPET, STAINLESS STEEL	1
10	204M50	REGULATOR SPRING	1
11	10-1A20	MICROVALVE ASSY	1
12	65-1A30	NANOVALVE ASSY	5
13	30-1A89A	MANIFOLD BODY	1
14	8120CR	O-RING, TEKREZ®, 81.0mm I.D. x 1.9mm C. S.	1
15	119A10	RESTRICTOR, 1.0mm	1
-	119A12	RESTRICTOR, 1.2mm	-
-	119A14	RESTRICTOR, 1.4mm	-
-	119A16	RESTRICTOR, 1.6mm	-
-	119A18	RESTRICTOR, 1.8mm	-
-	119A20	RESTRICTOR, 2.0mm	-
-	119A30	RESTRICTOR, 3.0mm	-
16	3116CR	O-RING, TEKREZ®, 3.1mm I.D. x 1.5mm C. S.	2

Table 9: MANIFOLD PARTS LIST (cont.)

ITEM	EFC PN	DESCRIPTION	QTY
17	15-2A50	MOTOR ASSY, W/EXTERNAL BELL WASH	1
-	15-4A50	MOTOR ASSY W/ EXTERNAL BELL WASH COMPLETE, W/ MI/MO & INJECTOR ASSY	-
18	15-2A23	SHAPING AIR RING ASSY	1
19	7020CR	O-RING, TEKREZ®, 70mm I.D. x 1.9mm C. S.	2
20	15-4A21	INNER SHROUD FOR 65mm CUPS	1
21	30-1A89	COMPLETE MANIFOLD ASSY	-
22	11-1A10C	FIBER OPTIC HOUSING	1
23	11-1A10A	FIBER OPTIC CABLE, MANIFOLD SIDE	1
24	11-1A10F	GLASS PLATE	1
25	15-2A20	MOTOR NUT	1
26	44178CR	O-RING, TEKREZ®, 44mm I.D. x 1.8mm C. S.	1
27	913M38	SET SCREW	4
28	913M38-M	SET SCREW, MODIFIED	2

5.8: MANIFOLD FITTINGS

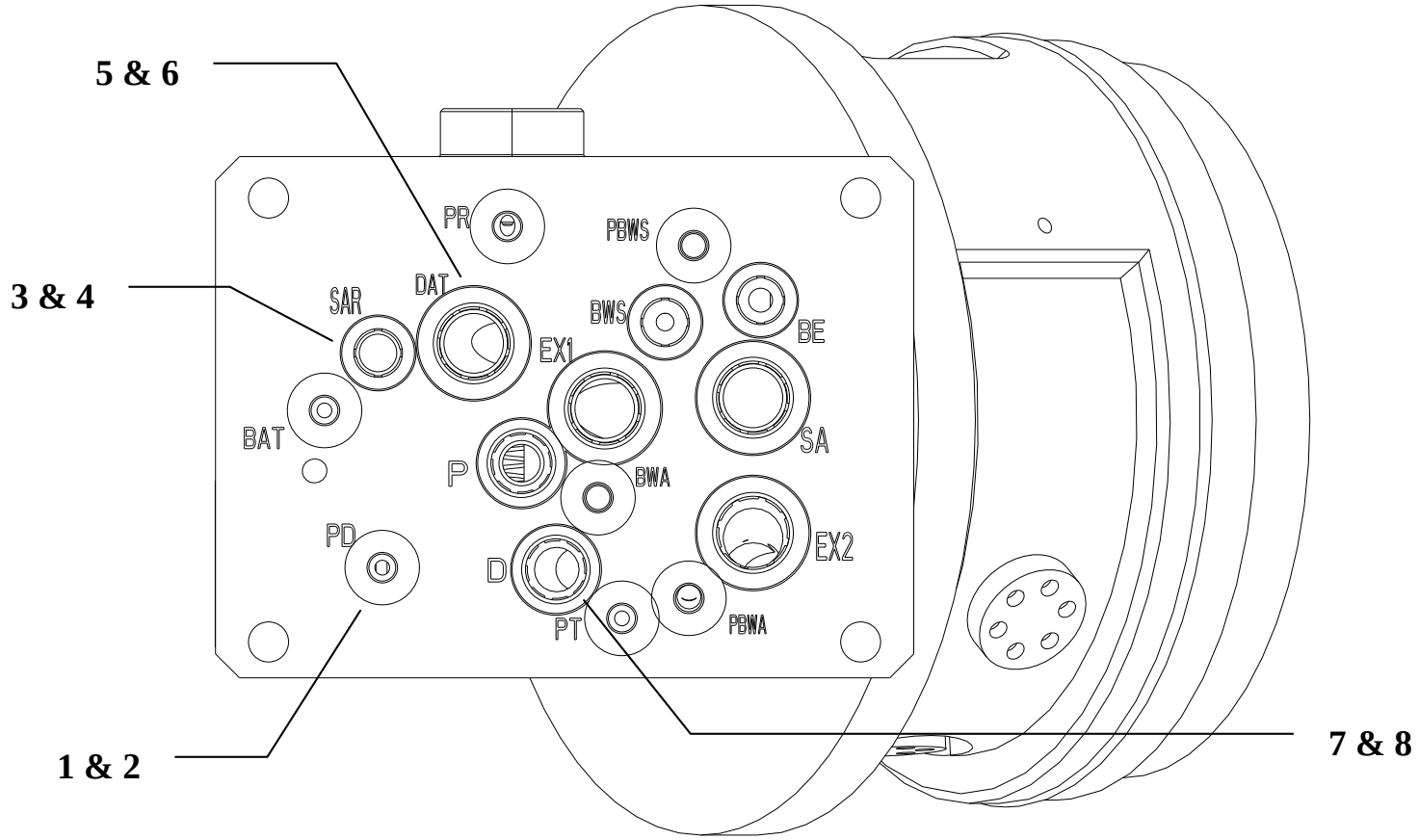


Table 10: MANIFOLD FITTINGS PARTS LIST

ITEM	EFC PN	DESCRIPTION	QTY
1	144T80	PUSH LOCK FITTING TOP, 4mm	7
2	3624CR	O-RING FOR 144T80, TEKREZ®, 3.6mm I.D. x 2.0mm C. S.	7
3	90-1A11	PUSH LOCK FITTING TOP, ¼"	3
4	6026CR	O-RING FOR 90-1A11, TEKREZ®, 6.0mm I.D. x 2.5mm C. S.	4
5	90-1A13	PUSH LOCK FITTING TOP, 3/8"	4
6	9027CR	O-RING FOR 90-1A13, TEKREZ®, 9.0mm I.D. x 3.0mm C. S.	4
7	90-1A35	PUSH LOCK FITTING TOP, 5/16"	2
8	7324CR	O-RING FOR 90-1A35, TEKREZ®, 7.3mm I.D. x 2.5mm C. S.	4

NOTES: BWS USES TWO 6026CR O-RINGS.
P & D USE TWO 7324CR O-RINGS EACH.

5.9: SHROUD / BELL CUP OPTIONS

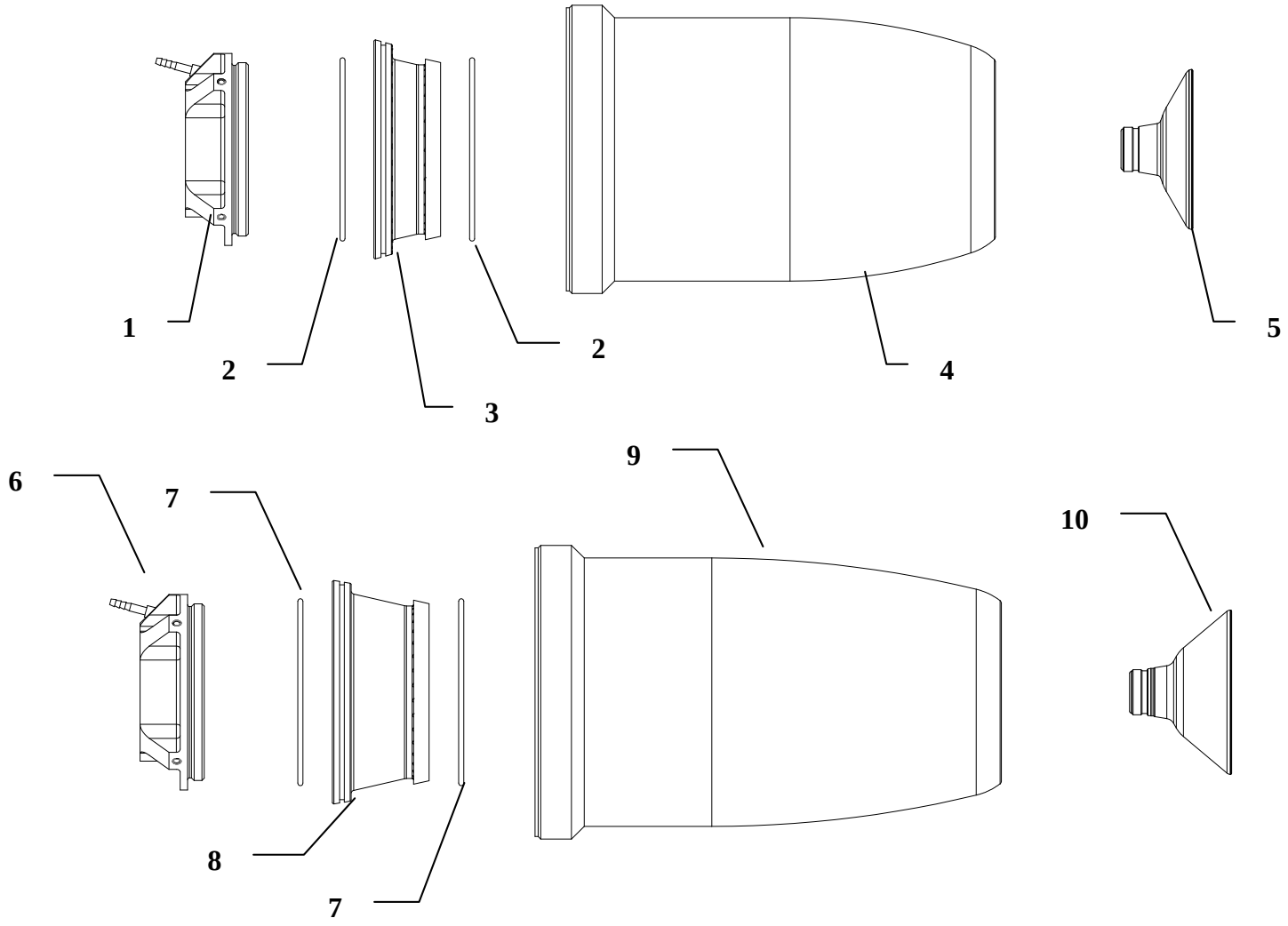


Table 11: SHROUDS & BELL CUPS PARTS LIST

ITEM	EFC PN	DESCRIPTION	QTY
1	15-2A23	SHAPING AIR RING FOR 55mm & 65mm CUPS	1
2	7020CR	O-RING FOR 15-2A23, 70.0mm I.D. x 1.9mm C. S.	2
3	15-2A17	INNER SHROUD FOR 55mm CUPS	1
4	15-2A18	OUTER SHROUD FOR 55mm CUPS	1
5	25-1A11K	BELL CUP ASSY, W/O EXTERNAL BELL WASH, 55mm SERRATED	1
-	25-1A11	BELL CUP ASSY, W/O EXTERNAL BELL WASH, 55mm, NON-SERRATED	1
6	15-2A23	SHAPING AIR RING FOR 55mm & 65mm CUPS	1
7	7020CR	O-RING FOR 15-4A21, 70.0 mm I.D. x 1.9mm C. S.	2
8	15-4A21	INNER SHROUD FOR 65mm CUPS	1
9	15-3A22AL	OUTER SHROUD FOR 65mm CUPS	1
10	25-1A33K	BELL CUP ASSY, W/O EXTERNAL BELL WASH, 65mm, SERRATED	1
-	25-1A33	BELL CUP ASSY, W/O EXTERNAL BELL WASH, 65mm, NON-SERRATED	1

5.10: AIR BEARING MOTOR ASSEMBLY

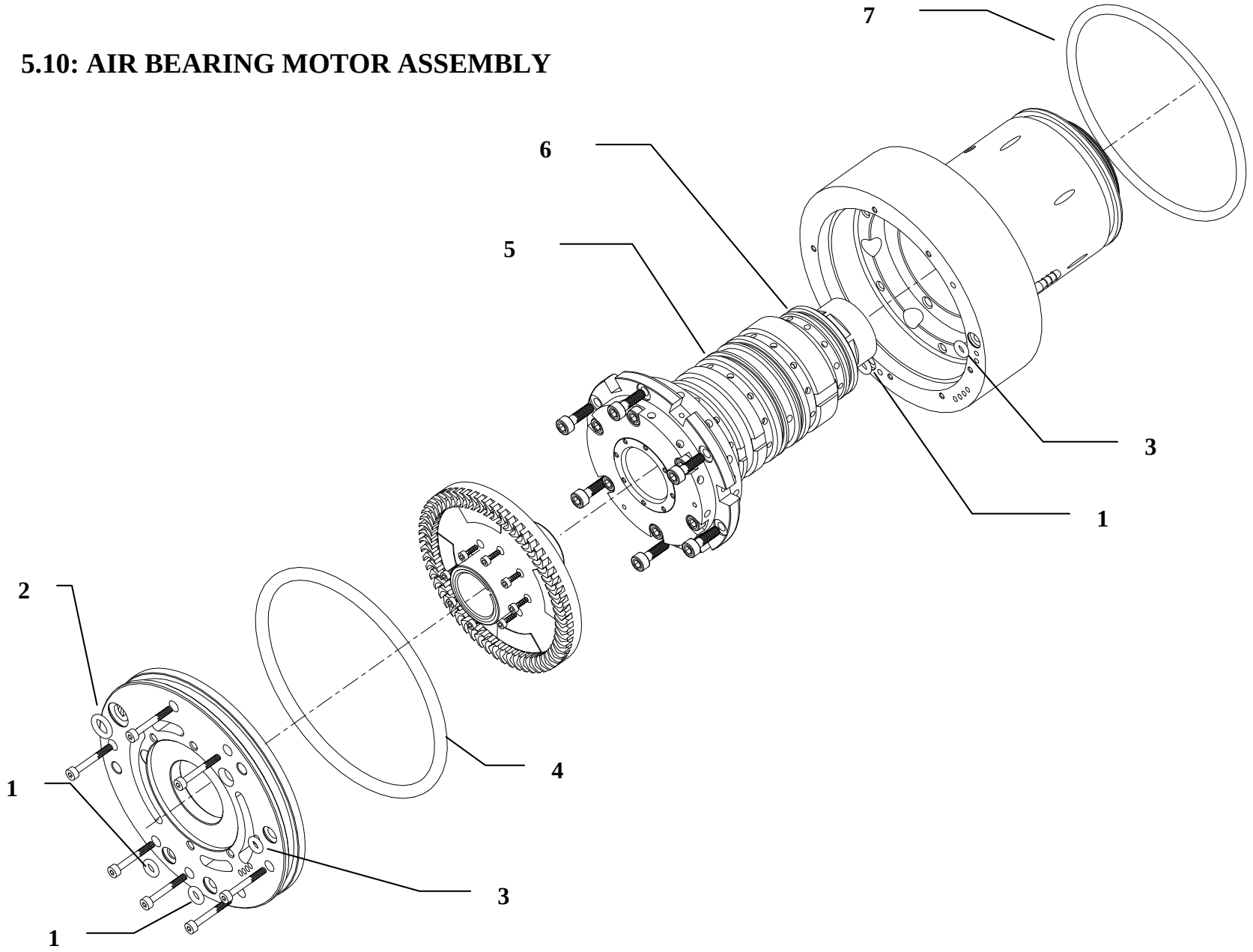


Table 12: AIR BEARING MOTOR PARTS LIST

ITEM	EFC PN	DESCRIPTION	QTY
1	3116CR	O-RING, TEKREZ®, 3.1mm I.D. x 1.6mm C. S.	3
2	5217CR	O-RING, TEKREZ®, 5.2mm I.D. x 2.0mm C. S.	1
3	2716CR	O-RING, TEKREZ®, 2.70mm I.D. x 1.5mm C. S.	2
4	7540CR	O-RING, TEKREZ®, 75.0mm I.D. x 3.9mm C. S.	1
5	3317CR	O-RING, TEKREZ®, 33mm I.D. x 2.0mm C. S.	3
6	2817CR	O-RING, TEKREZ®, 28.0mm I.D. x 2.0mm C. S.	1
7	7230CR	O-RING, TEKREZ®, 72mm I.D. x 2.9mm C. S.	1

5.11: INJECTOR ASSEMBLY

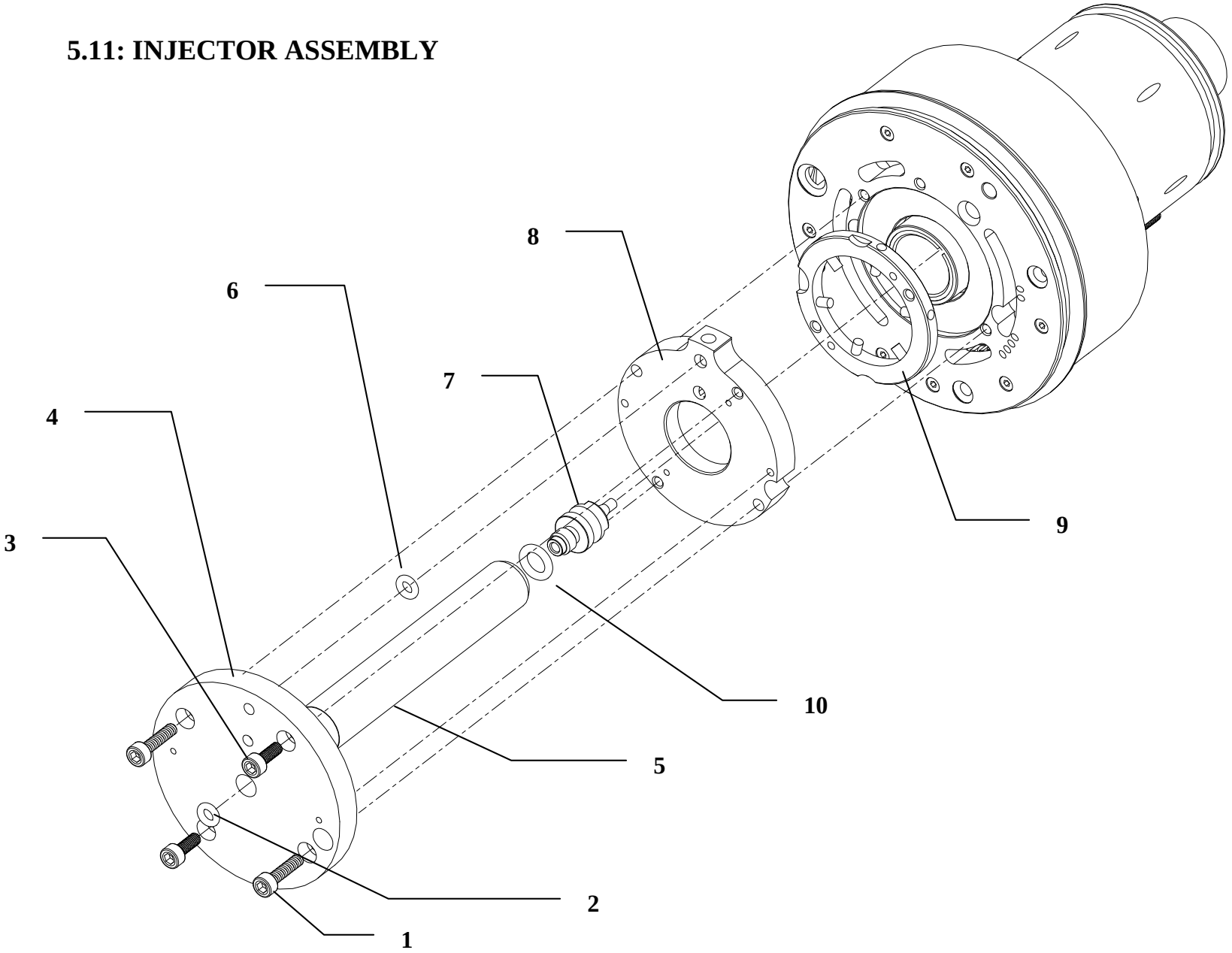


Table 13: INJECTOR PARTS LIST

ITEM	EFC PN	DESCRIPTION	QTY
1	316SSC	M3 x 12mm L SOCKET HEAD CAP SCREW, STAINLESS ST.	2
2	3116CR	O-RING, TEKREZ®, 3.1mm I.D. x 1.5mm C. S.	1
3	308SSC	M3 x 8mm L SOCKET HEAD CAP SCREW, STAINLESS ST.	2
4	15-1A45	INJECTOR BASE	1
5	15-1A24	INJECTOR TUBE	1
6	2917CR	O-RING, TEKREZ®, 2.9mm I.D. x 2.0mm C. S.	1
7	15-1A55	INJECTOR, 1.5mm	1
8	15-1A95	STATOR	1
9	15-2A31	BRUSH CHARGING RING	1
10	5719CR	O-RING, TEKREZ®, 5.7mm I.D. x 2.0mm C. S.	1

5.12: TOOLS

Table 14: TOOL LIST

ITEM	EFC PN	DESCRIPTION	QTY
1	TL-1A54	TACHOMETER	1
2	TL-1A52	STRAP WRENCH, SHAPING AIR RING	1
3	TL-1A49	DIAPHRAGM REMOVAL TOOL	1
4	TL-1A55	TOOL, O-RING REMOVAL/INSERTION	1
5	TL-1A56	TORQUE WRENCH, 3-15 IN-LBS	1
6	TL-1A44	HOSE CUTTER TOOL	1
7	TL-1A57	2.5mm ALLEN HEAD SOCKET	1
8	TL-1A58	1.5mm ALLEN HEAD SOCKET	1
9	668M60	PURE VASELINE®	1
10	TL-1A53	INJECTOR REMOVAL/INSERTION TOOL	1
11	TL-1A28	BELL CUP INSERT REMOVAL TOOL	1
12	TL-1A27	REGULATOR COVER REMOVAL TOOL	1
13	TW1001	SEAT TOOL	1
14	TL-1A59	HOSE DEBURR TOOL	1
15	TL650	SPANNER WRENCH	1
16	TL-1A39	NANOVALVE WRENCH	1
17	TL-1A45	PUSH FITTING HOSE EXTRACTOR TOOL, 3/8”	1
18	TL-1A46	PUSH FITTING HOSE EXTRACTOR TOOL, ¼”	1
19	TL-1A51	STRAP WRENCH, OUTER SHROUD	1
20	TL-1A31	BELL CUP WRENCH	1
21	TL950	MICROVALVE WRENCH	1

6.0 PREVENTATIVE MAINTENANCE SCHEDULE

The following is a suggested preventative maintenance schedule for the most important components within the FS40R-SYS. This schedule may vary from facility to facility based on production procedures used, target geometry, coatings materials, etc.

FS40R PREVENTATIVE MAINTENANCE SCHEDULE

JOB	SCHEDULE				PERSONNEL REQUIRED	TIME REQUIRED
	4HR	DAILY	WEEKLY	OTHER		
Bell Cup Inspection					Operator	1 min / bell
Bell Cup Disassembly/Cleaning					Mechanical Technician	5 min
Paint Injector Cleaning						
Regulator Diaphragm Replacement				Monthly or as needed.	Mechanical Technician	5 min
Outer Shroud Inspection					Operator	1 min / bell
Shaping Air Ring Inspection					Operator	1 min / bell
Air Bearing Motor (spinning by hand with bearing air supplied)					Operator	1 min / bell
Triggering Microvalve					Operator(s)	1 min / bell
Triggering Nanovalves					Operator(s)	1 min / bell
Components Within P-Extension Assembly				When an FS40R is removed from spray booth.	Assembler	15 min
Nipple O-Ring Inspection on Robot Side Base Plate				When an FS40R is removed from spray booth.	Assembler	5 min

7.0 TROUBLE SHOOTING

PROBLEM	POSSIBLE CAUSE	SOLUTION
System Not Spraying	Color stack not triggering properly.	Check the color stack.
	Trigger air to color stack not supplied.	Ensure color stack is receiving pilot air.
	Paint tube injector plugged.	Remove bell cup and clean injector.
	Bell cup plugged.	Remove bell cup and clean.
	Nanovalve in manifold not functioning properly.	Replace the manifold's PT nanovalve.
	Trigger air not being supplied to nanovalve.	Check pilot air entering manifold.
	Restrictor plugged.	Remove motor and check paint restrictor for blockage.
	Regulator cavity not supplied with pilot regulator air (PR).	Ensure PR is being supplied to the manifold.
	Paint supply hose kinked.	Check hose bundle to ensure none of the hoses are kinked.
Improper Atomization	Bell cup is damaged.	Check bell cup edge for damage.
	Bell cup wrong type.	Ensure the proper bell cup is spraying (i.e. serrated or non-serrated).
	E-Stats at incorrect level.	Check power supply voltage level setting.
	Proper voltage not reaching cup.	Using a voltage test wand (EFC PN 300W10) check voltage at edge of cup.
	Paint flow rate at incorrect level.	Check (beaker if necessary) flow out. Too much fluid will cause heavy wet spray. Too little will cause a dry spray.
	Shaping air too high/too low.	Make certain the shaping air is at the proper level. Shaping air does play a role in atomization.
	Paint viscosity change.	A change in viscosity will change the atomization performance of the FS40R.

7.0 TROUBLE SHOOTING (cont.)

PROBLEM	POSSIBLE CAUSE	SOLUTION
Improper Atomization (cont.)	Incorrect turbine speed.	Ensure turbine is running at proper speed. Too high a speed will over atomize. Too low a speed will under atomize.
	High voltage not reaching atomizer.	Check low voltage cable. Check for correct wiring from cascade to P-Extension. (Red – A, White – B, Black – C)
Spits on vehicle	Bell cup is damaged.	Replace bell cup.
	Bell cup insert is dirty.	Clean or replace bell cup insert.
	Paint injector is dirty.	Clean paint injector.
	Inner / outer shroud dirty and dripping or spitting on the job.	Wipe down the outer shroud. Remove outer shroud and wipe the holes on inner shroud with a lint free, solvent soaked cloth.
	Paint contaminated.	Check paint filters and replace as necessary.
	Air contaminated.	Check air filters. Ensure all air supplied to the FS40R is clean (filtered to 10 micron) and dry.
	Purge cycle not correct.	After each solvent purge, air must be pushed through the system to completely remove all residual solvent.

7.0 TROUBLE SHOOTING (cont.)

PROBLEM	POSSIBLE CAUSE	SOLUTION
Incorrect Spray Pattern	Shaping air setting incorrect.	Check shaping air setting. Shaping air that's too high will create a narrow fan pattern and vice versa.
	Inner shroud holes are plugged.	Remove the outer shroud and wipe inner shroud.
	E-Stat settings are incorrect.	Check for proper voltage settings.
	Atomizer to target distance is incorrect.	Atomizer should remain 10" ±1" from target.
	Spray booth drafting incorrect.	Check for proper spray booth down draft (or side draft).
Air bearing motor not operating or operating abnormally.	Bearing air not supplied.	Bearing air *must* be supplied for the turbine to work properly.
	Drive air not supplied to FS40R.	Check the drive air supply.
	Air bearing motor shaft out of balance.	Replace complete air bearing cartridge.
	Bell cup out of balance.	Replace bell cup.
	Motor bearings are damaged.	Replace complete air bearing cartridge.
	Turbine speed is erratic.	Ensure the fiber optic components are undamaged and working properly.
Excessive amount of paint wrapping back to atomizer.	Dirty outer/inner shrouds.	Remove and clean both inner and outer shrouds thoroughly with a solvent soaked, lint free cloth.
	Shaping air setting incorrect.	Check shaping air setting. Too low a setting will allow the paint to wrap back to the atomizer.
	Incorrect target distance.	Ensure target distance is maintained at 10". If the atomizer is too close to the vehicle, then there is a possibility of bounce back.
	Incorrect voltage at atomizer.	Check to see if the proper voltage is read at the atomizer.

7.0 TROUBLE SHOOTING (cont.)

PROBLEM	POSSIBLE CAUSE	SOLUTION
Excessive amount of paint wrapping back to atomizer. (cont.)	Turbine speed incorrect.	Check turbine speed.
	Booth conditions incorrect.	Make certain the booth conditions are correct (down/side draft, temperature, humidity, etc.)
Paint leaking around manifold or motor assembly.	An o-ring is missing on either side of the restrictor.	Remove the motor and check to see if there is an o-ring on either side of the restrictor (one in the manifold and one in the paint injector base).
	O-ring is missing between injector tube and injector.	Remove injector and ensure the injector tube o-ring is in place.
	Motor nut is loose.	A loose motor nut could cause a paint leak between the manifold and the motor.
	Pilot trigger nanovalve not operating normally.	If the nanovalve remains open, or if there is debris on the nanovalve tip or seat, then paint may leak out of the bell cup.
Paint leaking inside the P-Extension assembly.	Paint or dump line not completely seating within either the base plate or manifold push lock fitting.	Remove one of the P-extension halves and ensure the paint and dump lines are fully seated inside the push lock fitting.
	One of the push lock fitting o-rings on the paint or dump line is damaged or missing.	The paint and dump push lock fittings (on both the manifold and the turbine side base plate) use two sealing Tekrez® o-rings. Make sure each is in place and assembled correctly.
	Paint or dump line is damaged inside P-Extension.	Check for damaged lines inside P-Extension assembly.
	Regulator not assembled correctly, allowing paint to leak by cover nut or down PR line.	Make certain the regulator is assembled correctly.

8.0 CONDITIONS OF SALE

1. ACCEPTANCE: Any purchase order issued in response to this Proposal to sell is considered to be in Buyer's acceptance of the Terms and Conditions contained herein. Seller hereby objects to any additional, different or conflicting terms or conditions set forth in Buyer's purchase order. No terms, provisions, or conditions of Buyer's purchase order shall be effective unless expressly accepted by Seller in writing.

2. ENTIRE AGREEMENT: The provisions herein set forth, plus all drawings, constitute the entire contract between the Seller and Buyer and supersede all prior Proposals, purchase orders, correspondence and other communications, whether written or oral, between the Seller and the Buyer. No provisions of these Conditions of Sale shall be subject to change except by the written authorization of a properly authorized representative of the Seller.

3. PRICES-PAYMENT: Unless otherwise provided in the Proposal, terms of payment are net thirty (30) days and processes are FOB Seller's factory exclusive of sales or use taxes. All payments shall be in the legal currency of the United States unless otherwise designated in this Proposal. All prices are subject to exception or change without notice. Pricing errors may be corrected at any time. All Orders are subject to a minimum of $100.00. Any unpaid current balance shall bear interest at the rate of one and one-half percent (1½%) per month from and after the date payment is due. The seller may, at any time and without obligation, suspend performance or require payment in cash, security, or other adequate assurances satisfactory to the Seller when, in the opinion of the Seller in its sole discretion, the financial circumstances of Purchaser warrant such action.

4. TAXES AND DUTIES: The amount all applicable taxes, (federal, state, or local) will be charged unless the purchase order clearly states that the equipment of goods are tax exempt and an exemption certificate is on file at the Seller's location. Any personal property taxes assessable on the equipment or goods after delivery to FOB point shall be borne by the Buyer.

5. DELIVERY: Deliveries shall be FOB point of shipment unless otherwise provided in the Proposal. Shipping dates given by the seller are approximate and are based on prompt receipt of all necessary information regarding the order. The Seller will use its best efforts to meet the scheduled date shown on the face hereof, but does not guarantee to do so. Failure to make shipments as scheduled does not constitute a cause of cancellation and/or for damages of any character. In the event of any delay requested by the Buyer or any delay caused by lack of shipping instructions, the Seller will store all items ordered at the Buyer's expense and risk; and will invoice the Buyer for the full contract price of the equipment or goods on or after the date on which the same is ready for delivery.

6. TITLE AND RISK OF LOSS: Risk of loss or damage to the equipment or goods shall pass to Buyer F.O.B. Seller's plant. Buyer will keep the equipment or goods insured to the full purchase price with the Seller as the named loss payee and Seller retains a security interest in the equipment or goods until the purchase price is paid.

7. ENGINEERING DATA: All Engineering data, design information, engineering and shop drawings used on the completion of this order are the property of the Seller.

8. RETURNS: No Equipment or goods requiring repair or alleged to be defective is to be returned without written authorization by Seller.

9. WARRANTY AND LIMITATIONS OF LIABILITY: All equipment and goods are warranted by the Seller to be free from defects in material and workmanship as follows:

A. ALL ITEMS EXCEPT ELECTRICAL COMPONENTS FOR A PERIOD OF ONE (1) YEAR, OR TWO THOUSAND (2,000) HOURS OF USE, WHICHEVER COMES FIRST FROM THE DATE OF SHIPMENT.

B. FOR ELECTRICAL COMPONENTS FOR A PERIOD OF NINETY (90) DAYS FROM THE DATE THE EQUIPMENT OR GOODS WERE SHIPPED. THIS WARRANTY DOES NOT APPLY TO EQUIPMENT OR GOODS WHICH ARE MISUSED, ABUSED, DAMAGED FROM INSTALLATION, OR NOT USED IN ACCORDANCE WITH THE SELLER'S INSTRUCTIONS. NORMAL WEAR OF EQUIPMENT OR GOODS IS NOT INCLUDED IN THIS WARRANTY. Equipment or goods not manufactured by the seller, but supplied through the Seller shall carry the warranty of the original manufacturer. THE SELLER'S SOLE LIABILITY UNDER THIS WARRANTY SHALL BE LIMITED TO EITHER REPLACING OR REPAIRING WITHOUT CHARGE, AT ITS FACTORY OR ELSEWHERE AT ITS DISCRETION, ANY EQUIPMENT OR GOODS NOT MEETING THIS WARRANTY, OR AT SELLER'S OPTION REFUNDING THE PURCHASE PRICE. THE SELLER SHALL IN NO EVENT BE LIABLE FOR ANY OTHER DIRECT OR ANY SPECIAL INDIRECT OR CONSEQUENTIAL DAMAGES OF ANY KIND UNDER THIS CONTRACT OR OTHERWISE. The warranties of the Seller do not cover, and the Seller makes no warranty with respect to, any defect, failure, deficiency or error which is:

a) Not timely reported to Seller: or

b) Due to misapplication, modification, disassembly, abnormal conditions of temperature, dirt or corrosive matter; or

c) Due to operation, either intentional or otherwise, above rated capacities or in an otherwise improper manner.

10. Seller assumes no responsibility for the quality or performance of coatings, adhesives or other materials used with Seller's equipment or goods. All claims must be brought within one (1) year of sale or identification of a defect. THERE ARE NO OTHER WARRANTIES, EXPRESS OR IMPLIED, INCLUDING THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE.

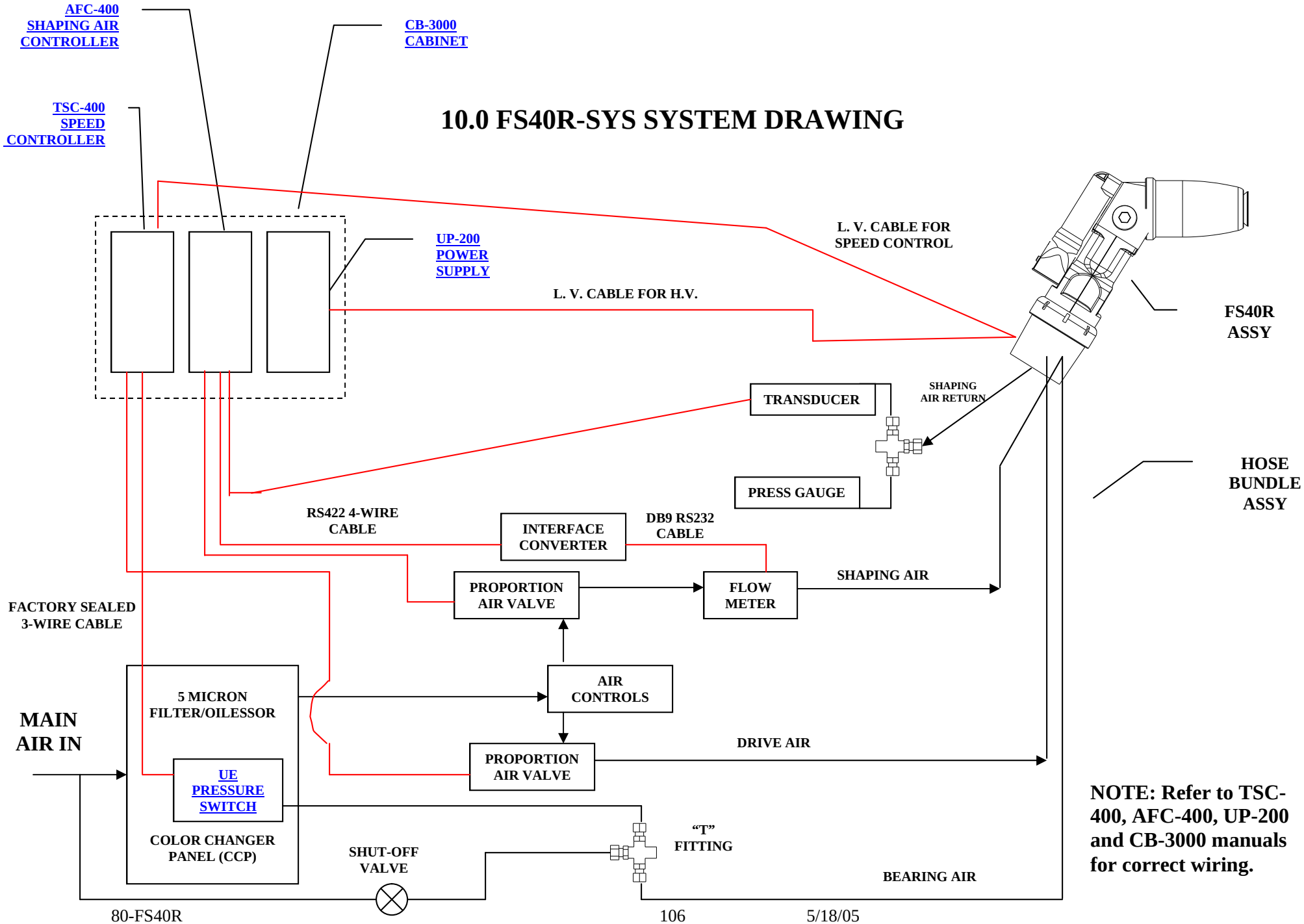
11. GOVERNING LAW: THE LAWS OF THE STATE OF DELAWARE SHALL GOVERN ANY CONTRACT RESULTING OUT OF THIS PROPOSAL. Any legal action to enforce any right granted by this contract must be filed within one (1) year of the expiration of the applicable warranty period.

9.0 PATENT INFORMATION

Several of the components within the FS40R-SYS are protected under the following patents:

Pat#: US 6, 437, 963 B1
US 6, 341, 734 B1
6, 053, 428
5, 862, 988

10.0 FS40R-SYS SYSTEM DRAWING



NOTE: Refer to TSC-400, AFC-400, UP-200 and CB-3000 manuals for correct wiring.

11.0 MEAN TIME TO REPAIR

TASK	PERSONNEL NEEDED	AVERAGE TIME TO REPAIR	NOTES
Change the bell cup.	1 Pipe fitter	3 min	Use protective gloves & safety glasses.
Change the dump microvalve.	1 Pipe fitters, 1 Electrician	5 min	Exercise care not to break off or damage the cascade pins (for the three wires).
Change a nanovalve.	1 Pipe fitter	3 min	Do not over tighten the nanovalve.
Change outer shroud.	1 Pipe fitter	2 min	Make sure outer shroud is clean and dry.
Change inner shroud	1 Pipe fitter	3 min	Ensure both o-rings are in place on the inner shroud when reinstalling.
Change the shaping air ring.	1 Pipe fitter	5 min	Do not over tighten shaping air ring set screws.
Change air bearing motor.	1 Pipe fitter	5 min	Ensure both o-rings are on either side of the restrictor when replacing the motor.
Change the restrictor.	1 Pipe fitter	5 min	Ensure both o-rings are on either side of the restrictor.
Change any of the regulator components.	1 Pipe fitter	5 min	Take care not to damage the regulator cavity when removing the diaphragm.
Change manifold assembly.	1 Mechanical Technician	30 min	Reference 80-FS40R manual for proper assembly instructions.
Change the cascade.	1 Pipe fitter 1 Electrician	3 min	Be careful not to break off any of the three cascade tabs.

11.0 MEAN TIME TO REPAIR (cont.)

TASK	PERSONNEL NEEDED	AVERAGE TIME TO REPAIR	NOTES
Replace or repair any of the components within the P-Extension assembly.	1 Mechanical Technician	10 min	Follow the proper assembly instructions within the FS40R manual.
Change the FS40R atomizer.	1 Pipe fitter	2 min	Ensure the o-rings on the robot side base plate are lubricated with pure Vaseline
Replace the female socket assembly.	1 Pipe fitter	15 min	Do not over tighten the three screws that attach the female socket assembly to the robot side base plate.
Replace an o-ring on the robot side base plate.	1 Pipe fitter	10 min	Lubricate the o-rings with pure Vaseline.
Replace a fiber optic line.	1 Pipe fitter	15 min	Use compressed air to assist routing the fiber optic line through the Teflon protection tube.

12.0 FAILURE MODES EFFECTS ANALYSIS

The purpose of this section is to present the Failure Mode Effects Analysis data for the FS40R. This document has been formatted such that it follows the requirements of the GM Bill of Process, Manufacturing System Qualification – New Technology Validation Technical Specifications, Document Number Rev: 34980, Section 2.2.3. The values for P, D and S were derived using the Severity Rating for Machinery and Equipment, Probability of Occurrence Rating, and Detection tables, respectively.

Elements of a Machinery FMEA

Component – The name of the part / subsystem under examination.

Failure Mode – An identification of how the part / subsystem can fail to perform each required function.

Cause – The agent, physical process, or hardware deficiency causing the failure.

Effect on the System – Identifies the effect on the system.

Criticality Rating – Prioritizes the various failure modes.

RPN = P • D • S = Risk Priority Number

Probability of Occurrence = P

Probability of Detection = D

Severity = S

Failure Modes Effects Analysis

Component	Potential Failure Mode	Potential Effect on System	Severity	Potential Cause of Failure	Probability Of Occurrence	Probability Of Detection	RPN	Recommended Actions
Bell cup	Bell cup clogs with paint.	Atomizer will not spray properly.	9	Purge cycle not completed properly.	1	4	36	Complete a bell cup cleaning cycle. Replace bell cup if necessary.
	Bell cup operating out of balance.	"	3	Bell cup dropped or damaged.	1	2	6	Replace bell cup.
	"	Motor seizes.	10	"	1	2	20	Replace motor air bearing cartridge.
Paint injector	Injector clogs with paint.	"	9	"	1	4	36	Complete a bell cup cleaning cycle. Replace the injector if necessary.
Motor	Motor seizes.	Atomizer stops operating.	10	Bell cup out of balance.	1	2	20	Replace motor air bearing cartridge.
	"	"	10	Bearing air not supplied.	1	2	20	"

Table 1: Failure Modes Effects Analysis (cont.)

Component	Potential Failure Mode	Potential Effect on System	Severity	Potential Cause of Failure	Probability Of Occurrence	Probability Of Detection	RPN	Recommended Actions
Motor (cont.)	Motor seizes.	Atomizer stops spraying.	10	Contaminated Bearing air.	2	2	40	Replace motor air bearing cartridge.
	"	"	10	Turbine shaft or flywheel out of balance.	1	2	20	"
	"	"	10	Improper torque on air bearing assy.	2	2	40	"
	"	"	10	Improperly assembled.	3	2	60	"
	"	"	10	Bearings were placed in an ultrasound machine for cleaning.	3	2	60	"
	"	"	10	Running above recommended speed.	2	2	40	"
	"	"	10	Improperly cleaned.	2	2	40	"

Table 1: Failure Modes Effects Analysis (cont.)

Component	Potential Failure Mode	Potential Effect on System	Severity	Potential Cause of Failure	Probability Of Occurrence	Probability Of Detection	RPN	Recommended Actions
Manifold	Paint trigger nanovalve	Atomizer stops spraying.	10	Nanovalve failure.	1	2	20	Replace the nanovalve.
	Bell wash air/solvent nanovalve	Bell cup is not cleaned.	4	Nanovalve failure.	1	2	8	“
	Dump Microvalve	Manifold will not purge properly.	8	Microvalve failure.	1	2	16	Replace microvalve.
	Regulator cavity.	Paint enters the PR line.	8	Regulator cavity was damaged.	2	3	48	Replace the manifold.
	“	“	8	Regulator not assembled correctly, improperly cleaned.	1	2	16	Clean the regulator cavity and correctly assemble regulator components.

Table 1: Failure Modes Effects Analysis (cont.)

Component	Potential Failure Mode	Potential Effect on System	Severity	Potential Cause of Failure	Probability Of Occurrence	Probability Of Detection	RPN	Recommended Actions
Manifold	Paint leaks from inside manifold.	Spits on the vehicle.	8	Damaged nanovalve trigger seat.	1	3	24	Replace manifold body.
	Solvent leaks inside manifold.	“	8	Damaged nanovalve solvent seat.	1	3	24	“
	Fiber optic signal not present.	Loss of proper turbine speed.	6	L. V. socket in PEA not properly assembled.	1	3	18	Check for proper assembly of L. V. socket assy
	Nanovalves or microvalve not triggering properly.	Improper purging, cleaning or painting.	7	Nanovalves or Microvalve not set to their proper torque spec.	2	3	42	Torque nanovalves to 15 in-lbs., microvalve to 60 in-lbs.
	PR or paint leaks from manifold cavity.	Paint enters PR line.	7	Regulator cavity not at the proper torque.	1	2	14	Torque regulator end cap to 150 in-lbs.

Table 1: Failure Modes Effects Analysis (cont.)

Component	Potential Failure Mode	Potential Effect on System	Severity	Potential Cause of Failure	Probability Of Occurrence	Probability Of Detection	RPN	Recommended Actions
FS40R	System not reaching correct voltage.	Reduction in transfer efficiency.	5	Break in low voltage line.	1	1	5	Replace or repair low voltage assembly.
	"	"	5	System operating with too much paint buildup.	1	1	5	Clean outer & inner shrouds.
	"	"	"	Cascade wires incorrectly connected.	1	1	5	Correctly attach low voltage wires to the cascade.
	System not maintaining proper speed.	"	5	Insufficient air supply.	2	2	20	Ensure sufficient amount of drive air.s
	System's spray pattern incorrect.	"	5	Inside shroud has slots clogged.	2	2	20	Clean inner shroud.

13.0 RECOMMENDED SPARE PARTS FOR FS40R-SYS

EFC PART#	DESCRIPTION	QTY	WARRANTY	LEAD TIME PARTS LIST	VENDOR STOCKED SPARE PARTS
10-1A17	TEFLON® COIL, 5/16”	2	STD	ONE WEEK	
10-1A20	MICROVALVE ASSY	5	STD		4 WEEKS
1020TR	O-RING, TEFLON®	5	STD		4 WEEKS
11-1A10A	FIBER OPTIC CABLE, MANIFOLD SIDE	5	STD		4 WEEKS
11-1A10C	FIBER OPTIC HOUSING	3	STD		4 WEEKS
11-1A10K	FIBER OPTIC NUT	5	STD		4 WEEKS
11-1A10F	FIBER OPTIC GLASS PLATE	10	STD		4 WEEKS
119A10	RESTRICTOR, 1.0mm	5	STD	ONE WEEK	
119A12	RESTRICTOR, 1.2mm	5	STD	ONE WEEK	
119A14	RESTRICTOR, 1.4mm	5	STD	ONE WEEK	
119A18	RESTRICTOR, 1.8mm	5	STD	ONE WEEK	
119A20	RESTRICTOR, 2.0mm	5	STD	ONE WEEK	
144T80	FITTING, PUSH LOCK 4mm	5	STD		4 WEEKS
15-1A55	INJECTOR 1.5mm	2	STD	ONE WEEK	
15-2A20	MOTOR NUT	1	STD	ONE WEEK	
15-2A23	SHAPING AIR RING ASSY W/EXT BELL WASH	1	STD	ONE WEEK	
15-3A22AL	SHROUD, OUTER	1	STD	ONE WEEK	
15-4A21	SHROUD, INNER	1	STD	ONE WEEK	
15-4A50	AIR BEARING MOTOR W/EXT BELL WASH & INJECTOR & MI/MO PARTS	1	6 MONTHS	ONE WEEK	
204M50	REGULATOR SPRING	5	STD		4 WEEKS
210M50	NEEDLE VALVE, STAINLESS STEEL	3	STD	ONE WEEK	
211M50	VALVE, STAINLESS STEEL	3	STD	ONE WEEK	
212DOW	DOWEL PIN	5	STD	ONE WEEK	
2252VR	O-RING, VITON®	20	STD		4 WEEKS
229T60	DIAPHRAGM	20	60 DAYS		4 WEEKS
230T60	DIAPHRAGM HOLDER	3	STD	ONE WEEK	
250C50	CASCADE	1	STD	ONE WEEK	
25-1A32E	BELL CUP INSERT ASSY	5	6 MONTHS	ONE WEEK	

13.0 RECOMMENDED SPARE PARTS FOR FS40R-SYS (cont.)

EFC PART#	DESCRIPTION	QTY	WARRANTY	LEAD TIME PARTS LIST	VENDOR STOCKED SPARE PARTS
25-1A33K	BELL CUP 65mm W/O EXT BELL WASH SERRATED	2	6 MONTHS	ONE WEEK	
2716CR	O-RING, TEKREZ®	10	STD		4 WEEKS
2912CR	O-RING, TEKREZ®	5	STD		4 WEEKS
2917CR	O-RING, TEKREZ®	10	STD		4 WEEKS
30-1A71	REGULATOR COVER NUT, 3/4 HEX	3	STD	ONE WEEK	
30-1A89	MANIFOLD ASSY, SP, TURBINE W/REGULATOR & NANOVALVE	1	STD	ONE WEEK	
308P58	FEMALE SOCKET & CABLE ASSY W/PROTECTION, 30'	10	STD	ONE WEEK	
3116CR	O-RING, TEKREZ®	10	STD		4 WEEKS
316P50	MAIN ISOLATOR	3	STD	ONE WEEK	
316PLFT	3/16" PUSH LOCK FITTING TOP	10	STD		
339T60	REGULATOR SPACER	3	STD	ONE WEEK	
3624CR	O-RING, TEKREZ® FOR 144T80	10	STD		4 WEEKS
3925VR	O-RING, VITON®	10	STD		4 WEEKS
40-1A30	BASE PLATE W/PUSH FITTINGS	1	STD	ONE WEEK	
40-1A30B	ALIGNMENT PIN WHITE, GUN SIDE BASE PLATE	5	STD	ONE WEEK	
40-1A31	Q. D. NUT	1	STD	ONE WEEK	
41178VR	O-RING, VITON®	10	STD		4 WEEKS
414P31	P-EXTENSION (2 PCS)	2	STD	ONE WEEK	
415P30-7	MALE PLUG ASSY	1	STD	ONE WEEK	
4324CR	O-RING FOR 316PLFT	10	STD		4 WEEKS
45-1A46B	LOCATING PIN BLACK, ROBOT SIDE BASE PLATE	5	STD	ONE WEEK	
45-1A46C	LOCATING PIN WHITE, ROBOT SIDE BASE PLATE	5	STD	ONE WEEK	

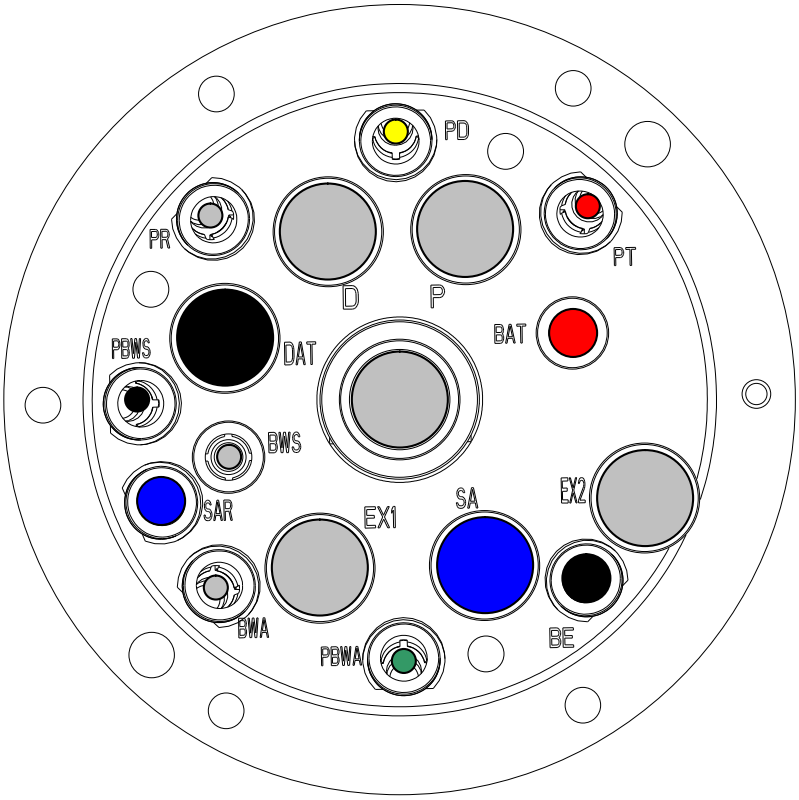
13.0 RECOMMENDED SPARE PARTS FOR FS40R-SYS (cont.)

EFC PART#	DESCRIPTION	QTY	WARRANTY	LEAD TIME PARTS LIST	VENDOR STOCKED SPARE PARTS
45-1A48	ADAPTER RING	1	STD	ONE WEEK	
45-1A49	Q. D. ASSY, ROBOT SIDE HOSE BUNDLE	1	STD	ONE WEEK	
516SSC	SCREW, SS SOCKET HEAD CAP	10	STD		4 WEEKS
5217CR	O-RING, TEKREZ®	10	STD		4 WEEKS
535NSC	SCREW, NYLON	10	STD		4 WEEKS
5719CR	O-RING, TEKREZ®	10	STD		4 WEEKS
5100SSC	SCREW, SS SOCKET HEAD CAP	10	STD		4 WEEKS
6026CR	O-RING, TEKREZ® FOR 90-1A11	10	STD		4 WEEKS
6017CR	O-RING, TEKREZ®	10	STD		4 WEEKS
65-1A30	NANOVALVE ASSY	5	STD	ONE WEEK	
665NSC	SCREW, NYLON	10	STD		4 WEEKS
7020CR	O-RING, TEKREZ®	10	STD		4 WEEKS
7324CR	O-RING, TEKREZ®	10	STD		4 WEEKS
85-1A15	FLAT WASHER, TEKREZ®	10	STD		4 WEEKS
8717CR	O-RING, TEKREZ®	10	STD		4 WEEKS
90-1A11	FITTING, PUSH LOCK, ¼", P-EXTENSION	10	STD		4 WEEKS
90-1A13	FITTING, PUSH LOCK 3/8" MFG.	5	STD	ONE WEEK	
90-1A17	FITTING, PUSH LOCK, 1/4", HOSE BUNDLE, MFG.	5	STD	ONE WEEK	
90-1A35	FITTING, PUSH LOCK, 5/16"	5	STD		4 WEEKS
9027CR	O-RING, TEKREZ® FOR 90-1A13	10	STD		4 WEEKS
913M38	SET SCREW	10	STD		4 WEEKS
913M38-M	SET SCREW	10	STD		4 WEEKS
AFC – 400	QUAD AIR FLOW CONTROLLER	1	STD		4 WEEKS

13.0 RECOMMENDED SPARE PARTS FOR FS40R-SYS (cont.)

EFC PART#	DESCRIPTION	QTY	WARRANTY	LEAD TIME PARTS LIST	VENDOR STOCKED SPARE PARTS
CB-3000	CABINET FOR 4 UP200'S, 1TSC-400, 1 AFC-400	1	STD	ONE WEEK	
TSC – 400	QUAD TURBINE SPEED CONTROLLER	1	STD		4 WEEKS
UP – 200	DIGITAL POWER SUPPLY	1	STD		4 WEEKS

HOSE COLOR KEY
ROBOT SIDE BASE PLATE



NOTE: This is a quick reference diagram showing the relative sizes and colors for each hose. Refer to Table 1 for the actual sizes and colors.