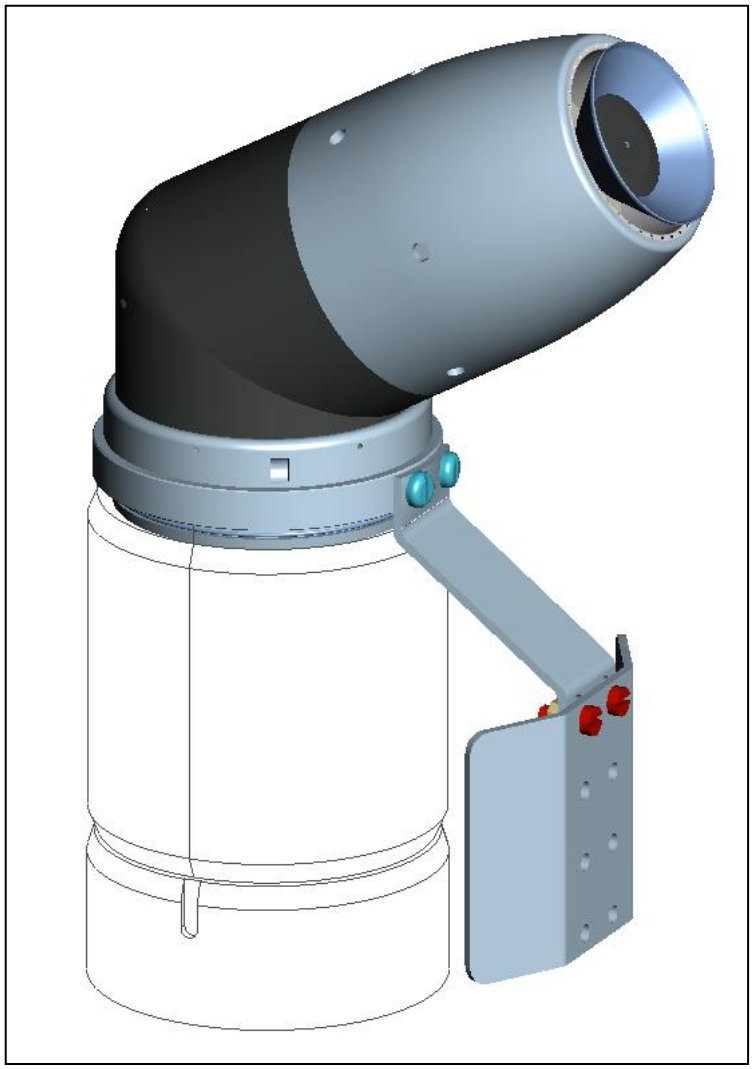
SYSTEMS, INC.

FS67
ROTARY ATOMIZER
OPERATION MANUAL



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1. INTRODUCTION

1.1 General Description

The FS67 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, before installing, operating and maintaining the FS67. 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 regulations concerning safety are followed, including but not limited to fire and environmental codes, building codes, as well as occupational safety and health acts.

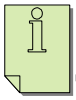
1.2 Copyrights

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 FS67.

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 FS67, and the environment in which it operates, must understand and follow all 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 FS67. Several of the components within the FS67 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 FS67 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 FS67 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 FS67 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 FS67 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 FS67 system. Persons with an implanted cardiac pacemaker should stay clear of the spray booth area because the high voltage utilized by the FS67 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 FS67 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 FS67, all components must be completely and correctly assembled. Operating an improperly assembled FS67 may result in a fire and/or bodily injury as well as equipment damage.

Proper Tooling

All personnel servicing and maintaining the FS67 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 FS67 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 FS67 with obvious system problems could lead to bodily injury and equipment damage.

System Modifications

Under no circumstances are personnel to modify the FS67 without written permission from EFC SYSTEMS, INC. This also

applies to the use of replacement parts and systems other than EFC 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 FS67. Failure to follow the maintenance procedures and checks could result in equipment failure and personal injury.

Bearing Air Drop

The FS67 utilizes an air bearing motor, which allows the shaft within the motor to "float" on a thin film 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 FS67 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
- 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
- Quick disconnect nut to easily and quickly remove the FS67 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
- Microphone speed sensing
- Pneumatic pressure switch for disabling the speed card (i.e. drive air supply) in case of loss of bearing air.

Figure 1: FS67

3.2 Finishing Characteristics

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

4. FS67

4.1 Start – Up Procedures

Once the FS67 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 FS67. 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.
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

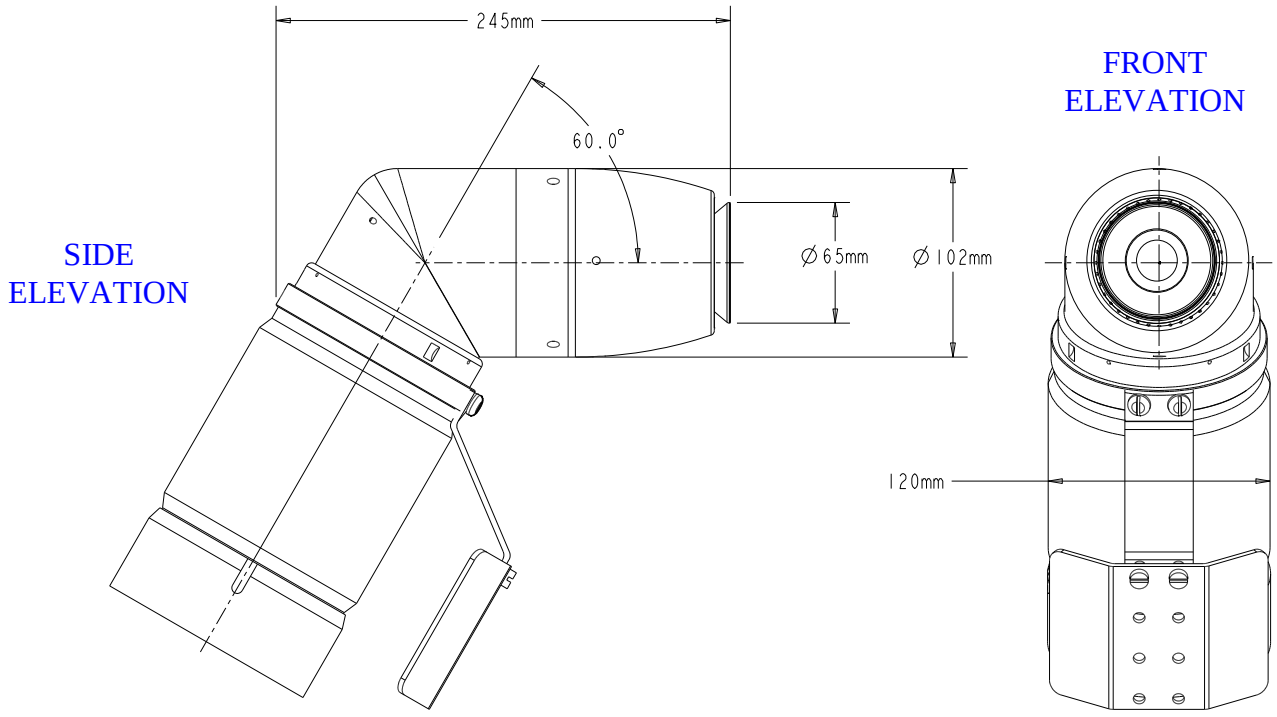


Figure 2: FS67 Overall Dimensions

4.4 FS67 Components

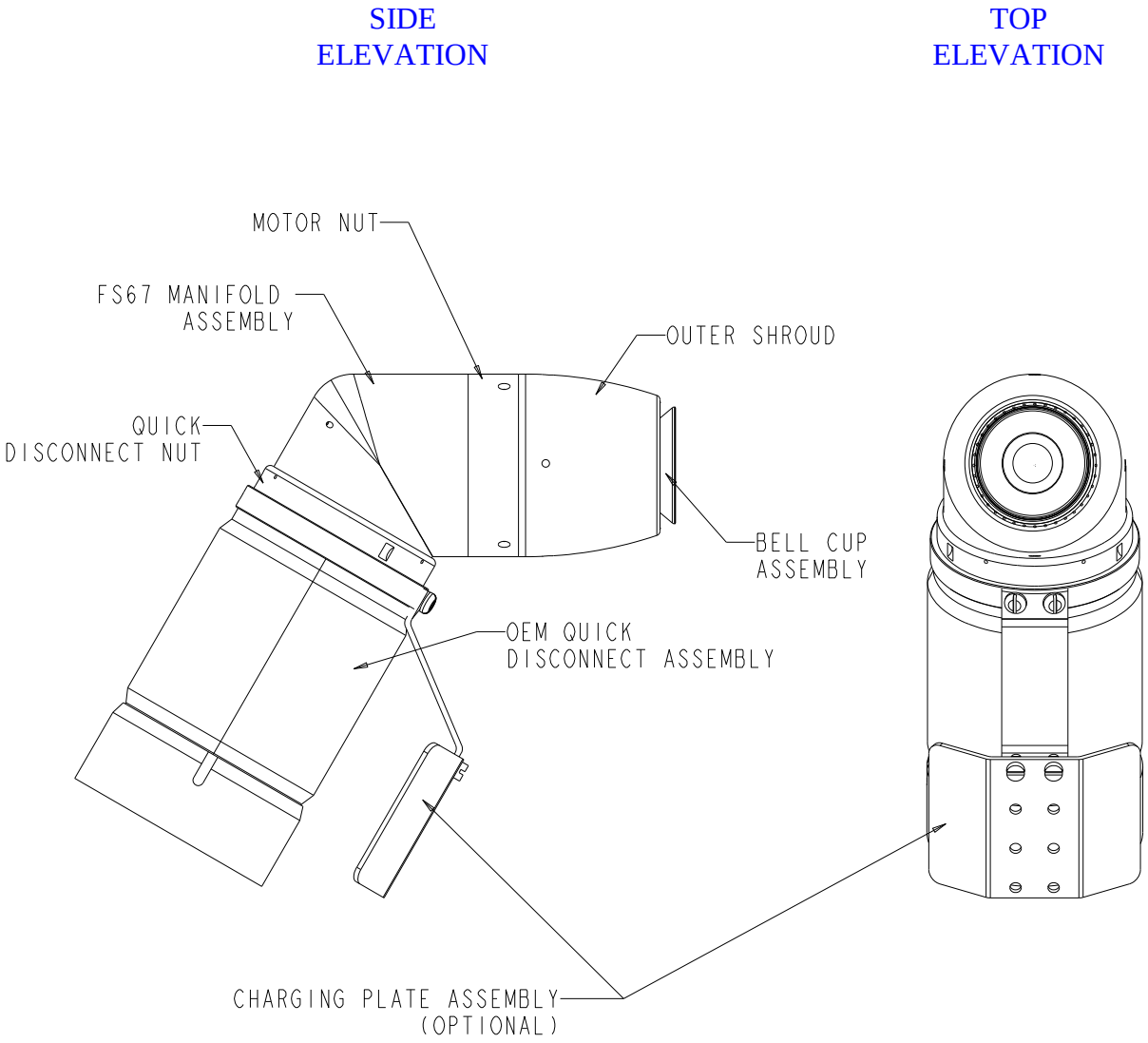


Figure 3: FS67 Components

4.4.1 FS67 Tools

Figure 4: Tools

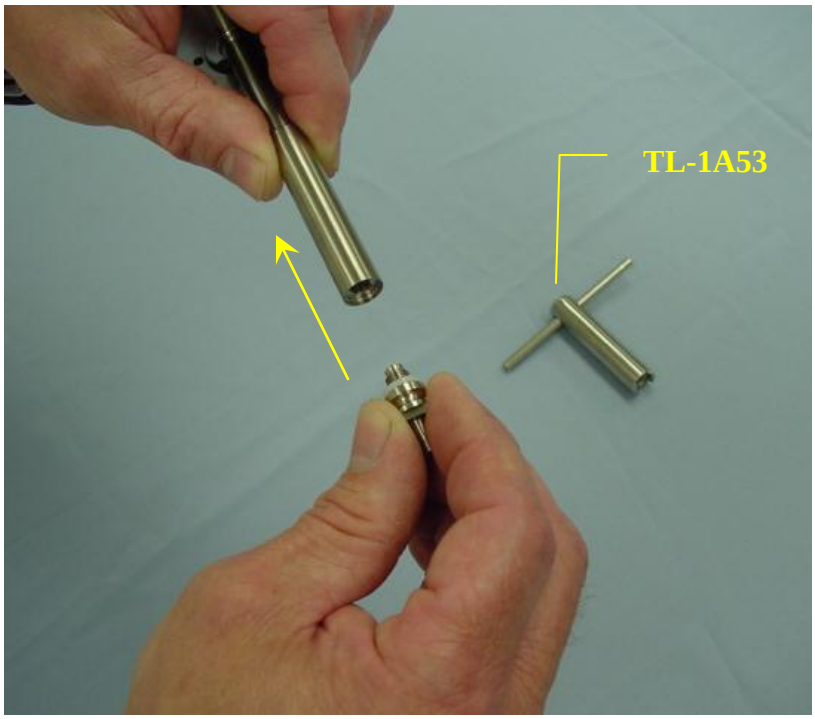


Figure 5: Injector Installation

Use the EFC injector wrench TL-1A53 to remove or install the injector. The injector has a left hand thread; therefore a counterclockwise rotation will tighten the injector.

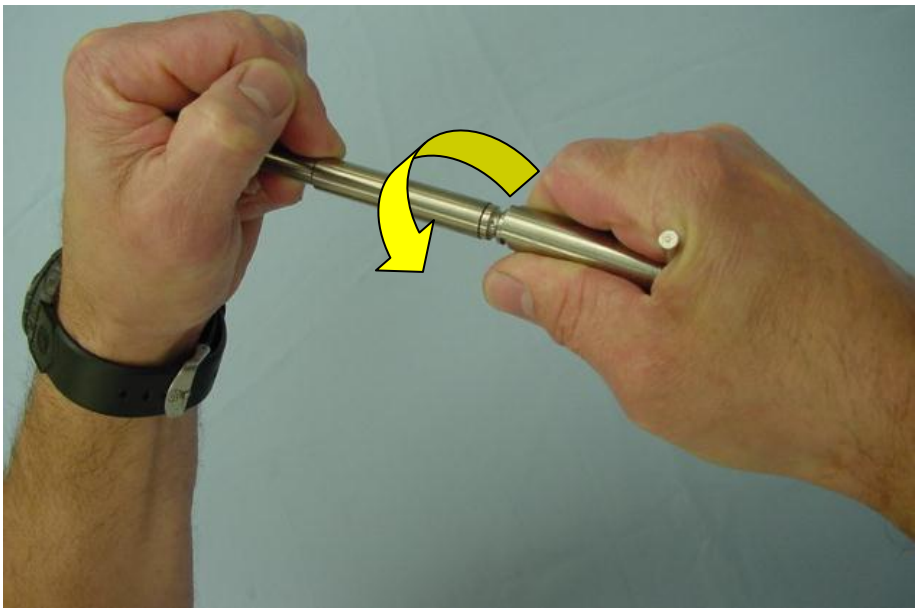


Figure 6: Injector Installation

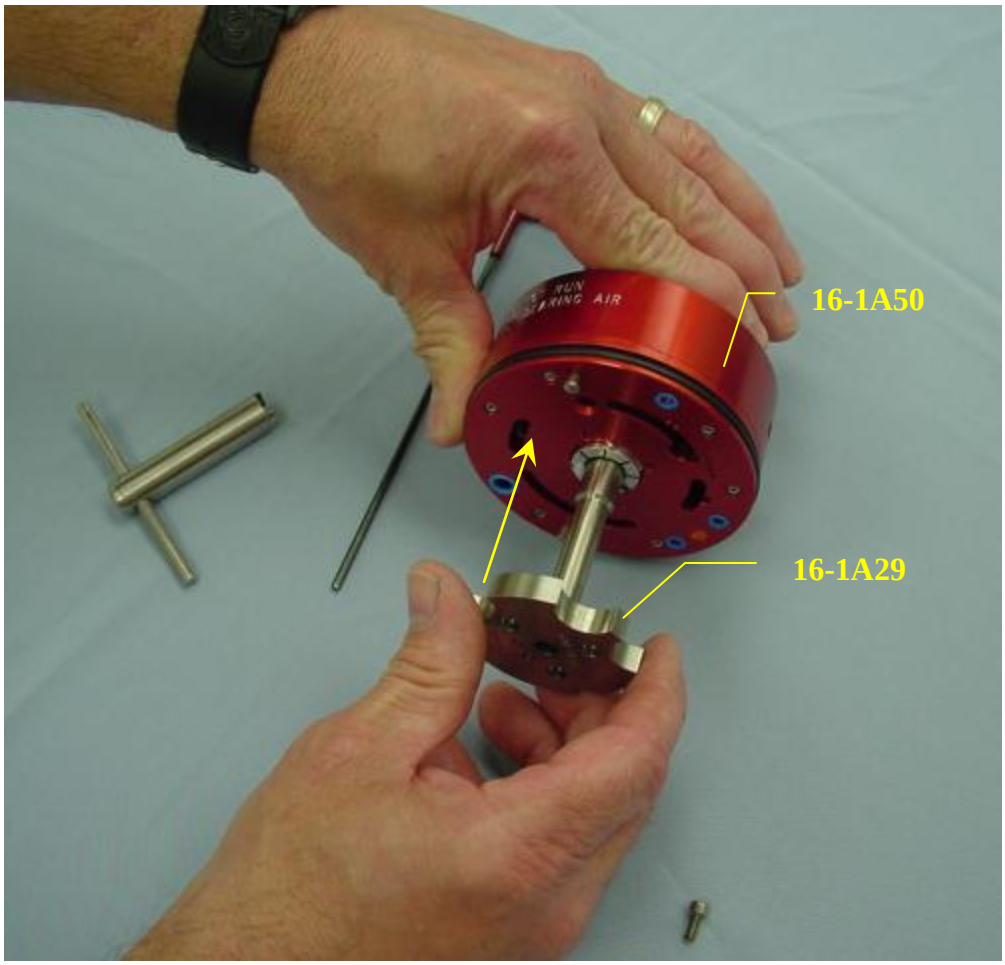
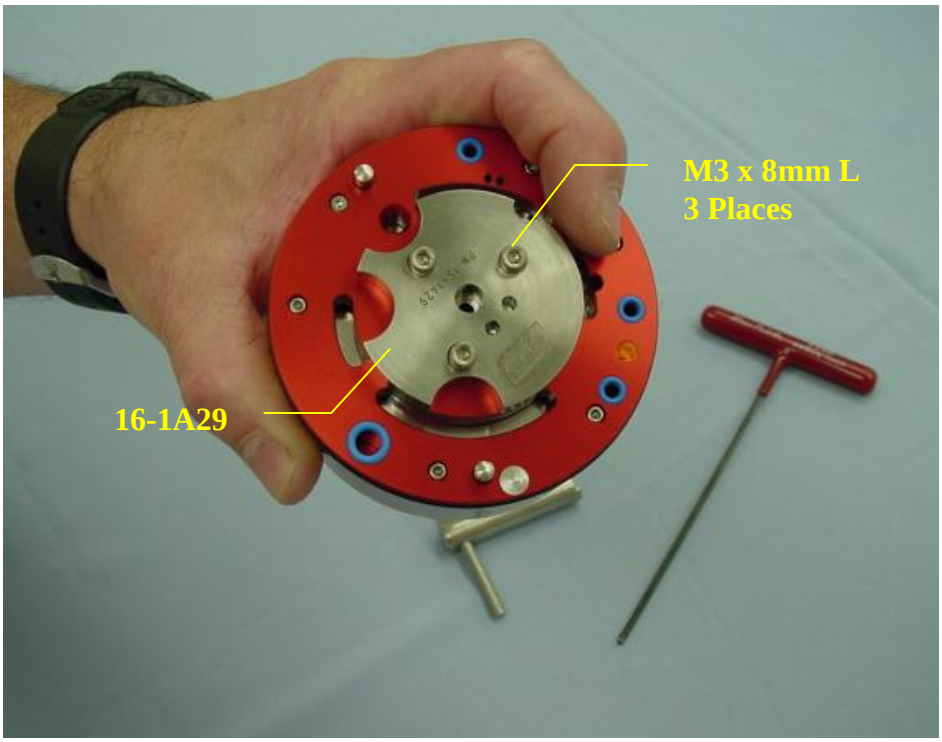
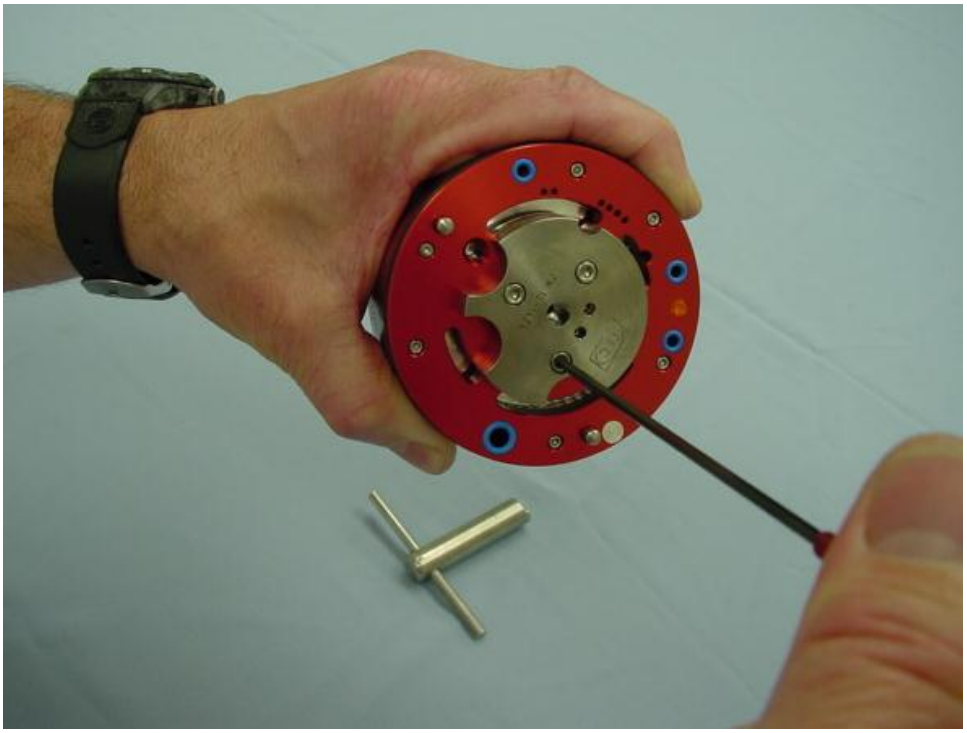


Figure 7: Injector Tube Installation

Slide the injector tube assembly into the back of the motor. The injector tube assembly will be secured to the motor with three (3) M3 x 8mm long steel cap screws.


M3 x 8mm L
3 Places
16-1A29



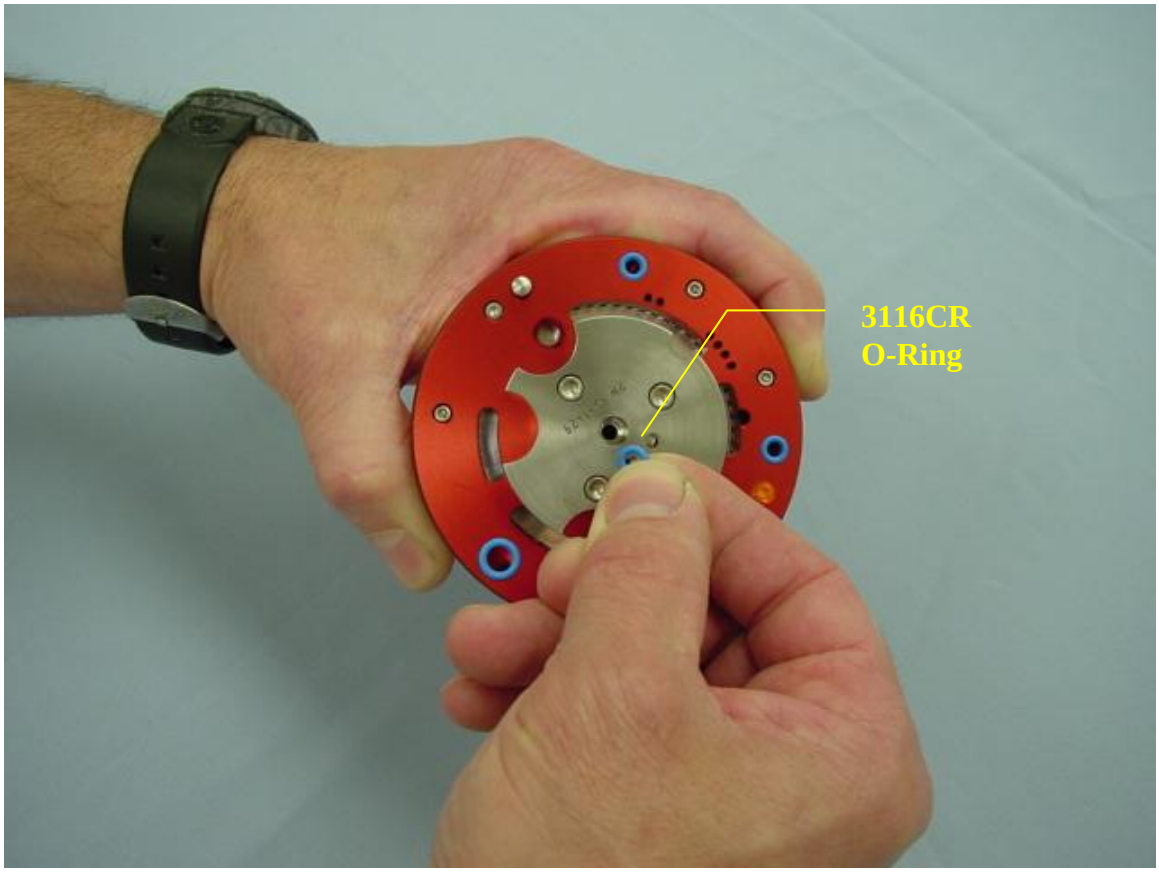
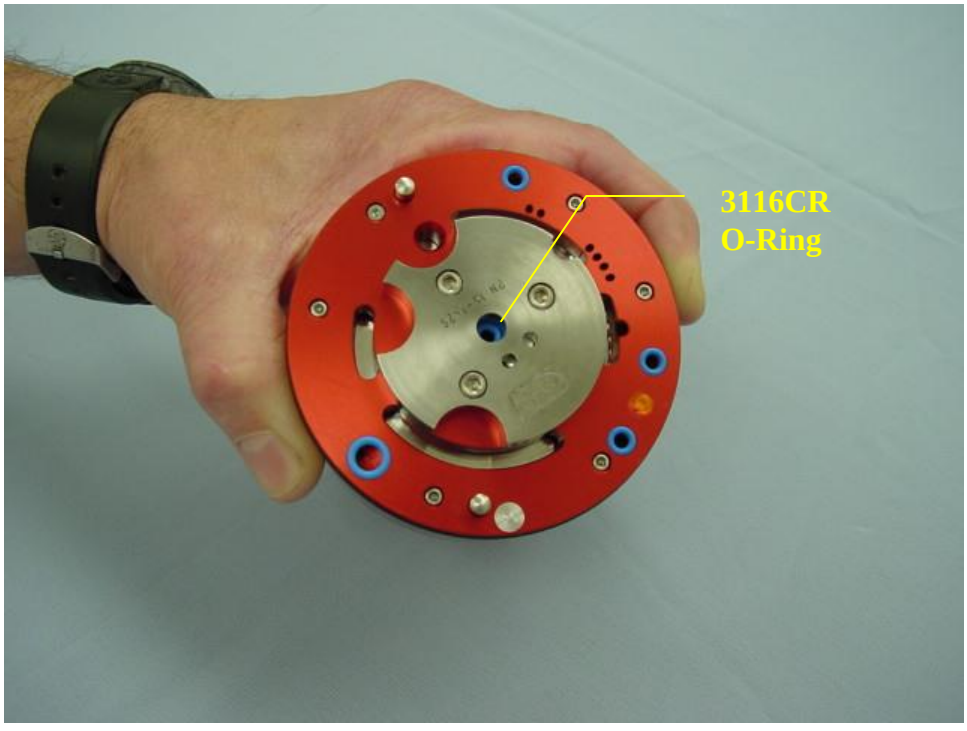
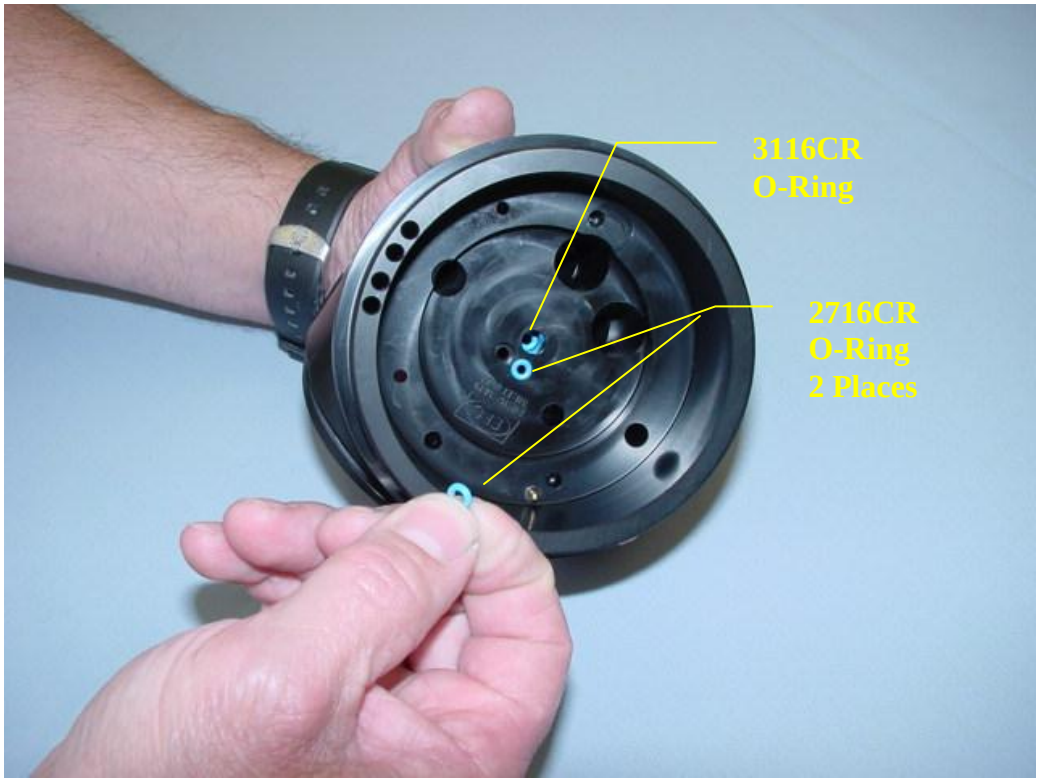


Figure 8: Restrictor O-Ring Installation




3116CR
O-Ring


3116CR
O-Ring
2716CR
O-Ring
2 Places

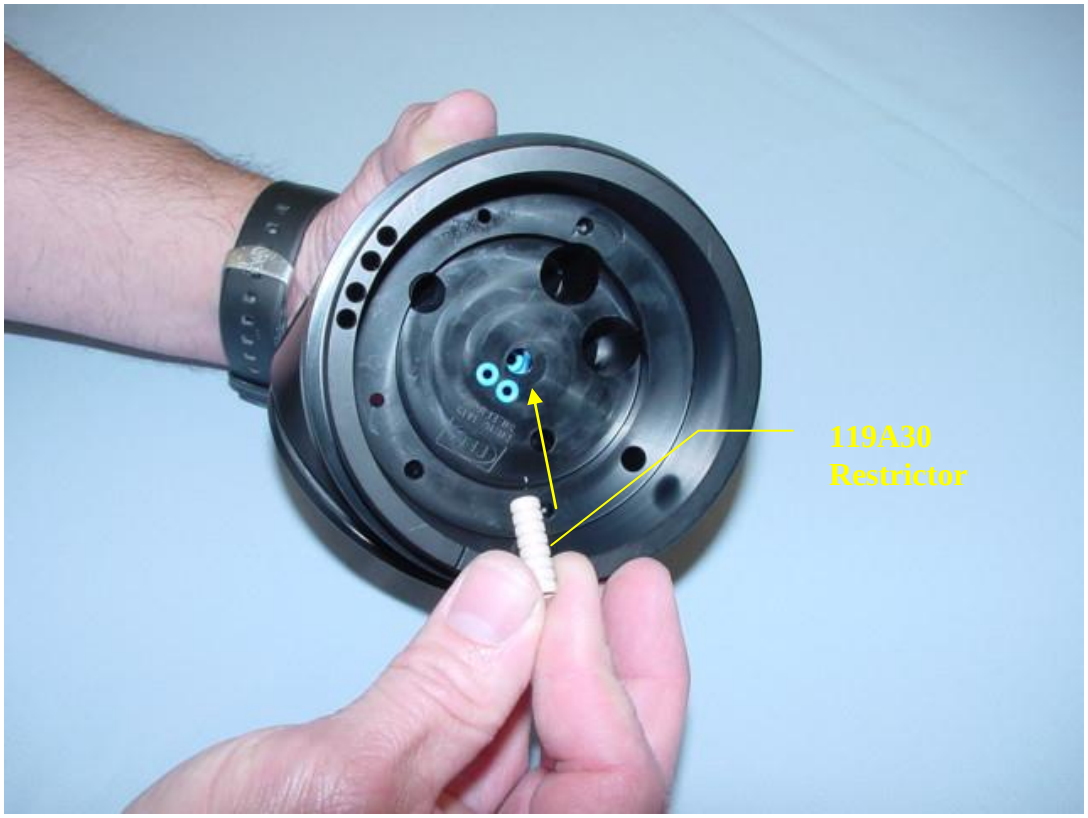


Figure 9: Restrictor Installation

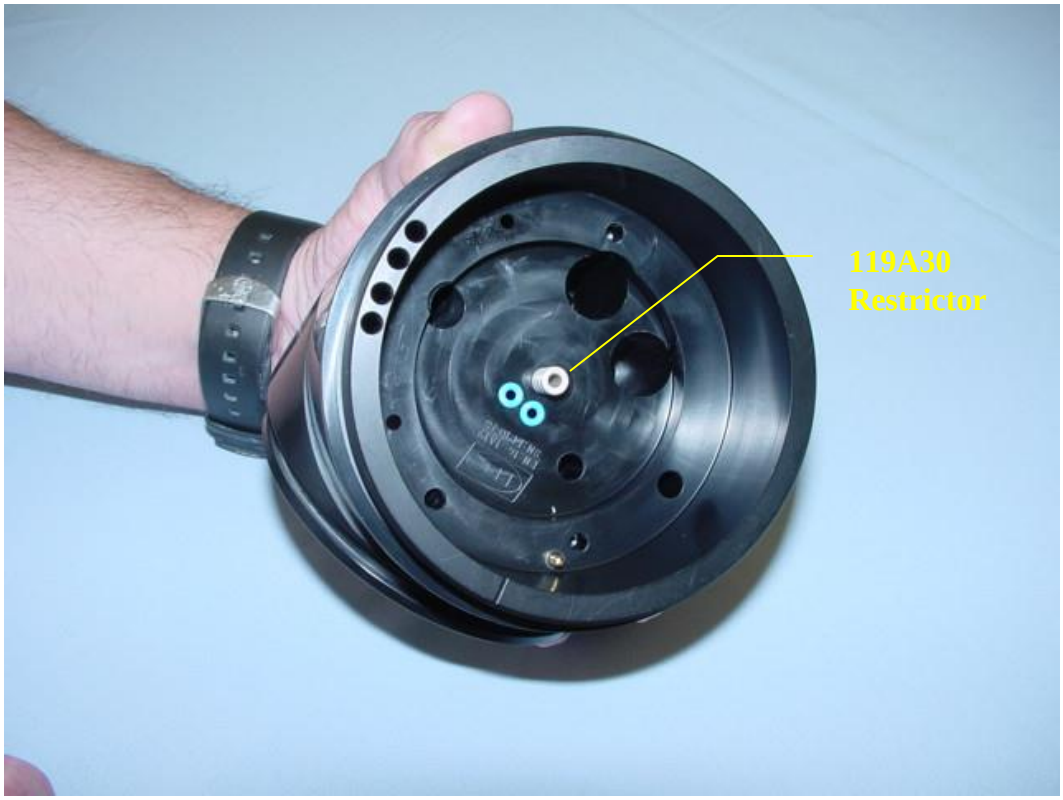


Figure 10: Vaseline® on Motor O-Ring

Figure 11: Motor Installation

The motor can be removed from the manifold assembly after the motor nut is removed. Holding the FS67 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 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 12: Motor Nut Installation

Screw the aluminum motor nut counterclockwise onto the manifold to tighten and secure the motor to the manifold.


LOOSEN
TIGHTEN

CAUTION! Grip the FS67 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 counterclockwise (to prevent cross-threading), then use the spanner wrench to tighten.

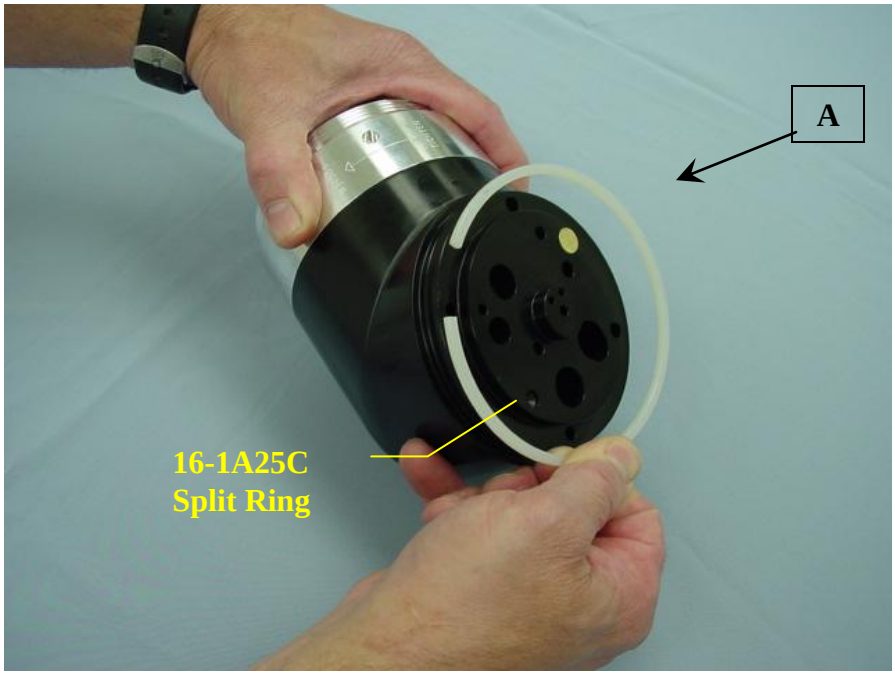


Figure 13: Split Ring Installation

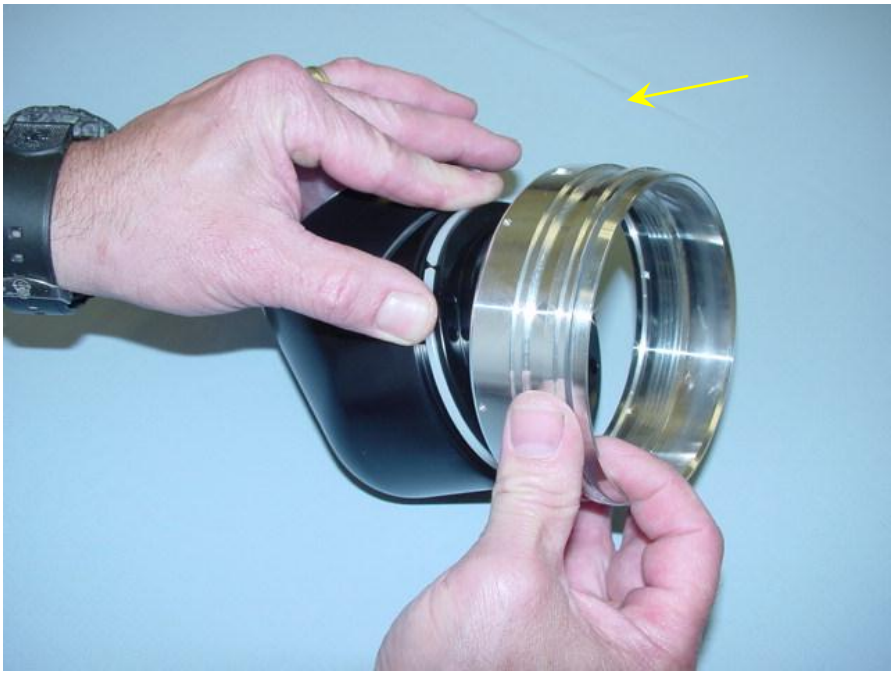
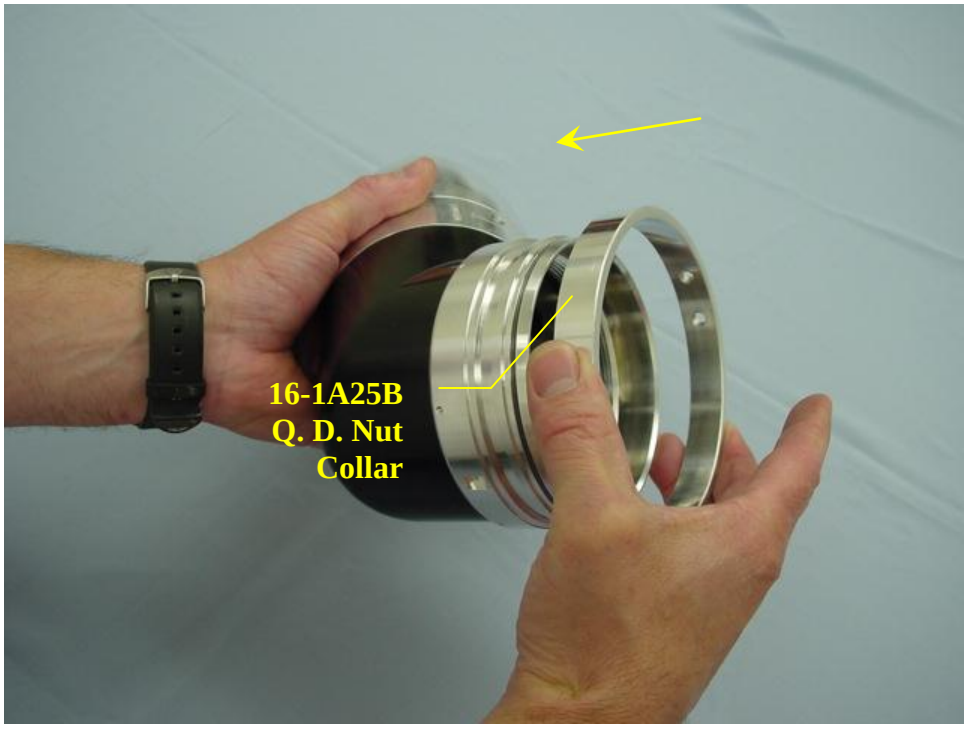
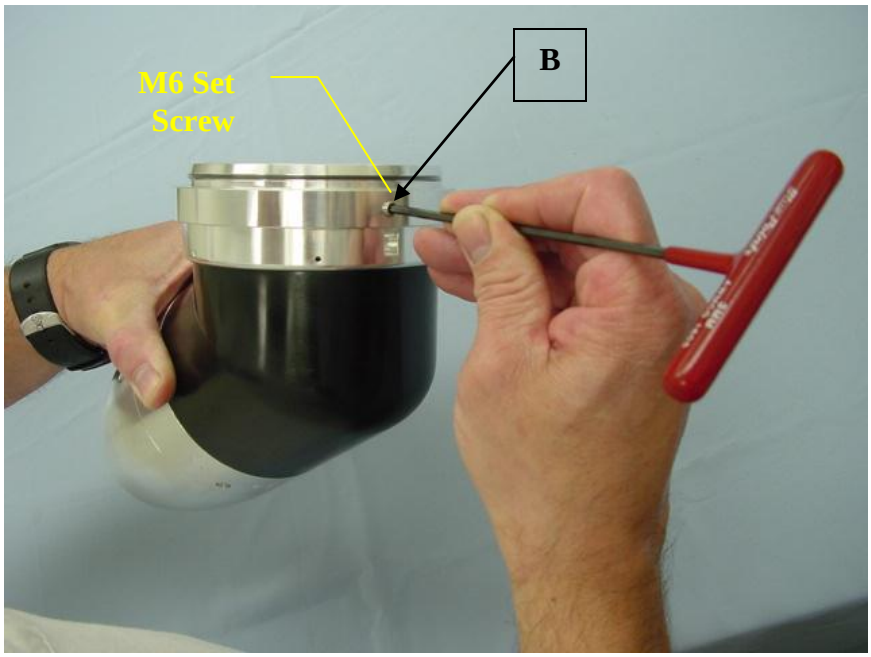


Figure 14: Q. D. Nut Installation



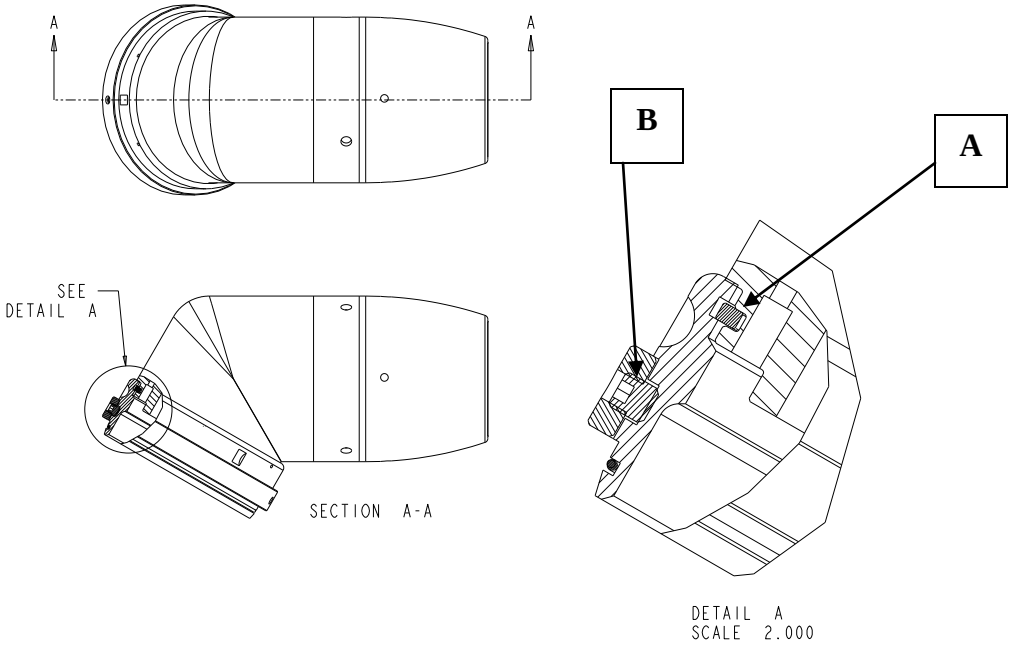


To install the manifold quick disconnect (q.d.) nut, first install the snap ring onto the manifold body.

Slide the q.d. nut over the manifold (from the bottom up) until the snap ring engages the q.d. nut.

The q.d. nut is now affixed to the manifold body.

Slide the collar ring over the q.d. nut and tighten with the M6 set screw, with the set screw oriented away from the bell cup, as shown above.



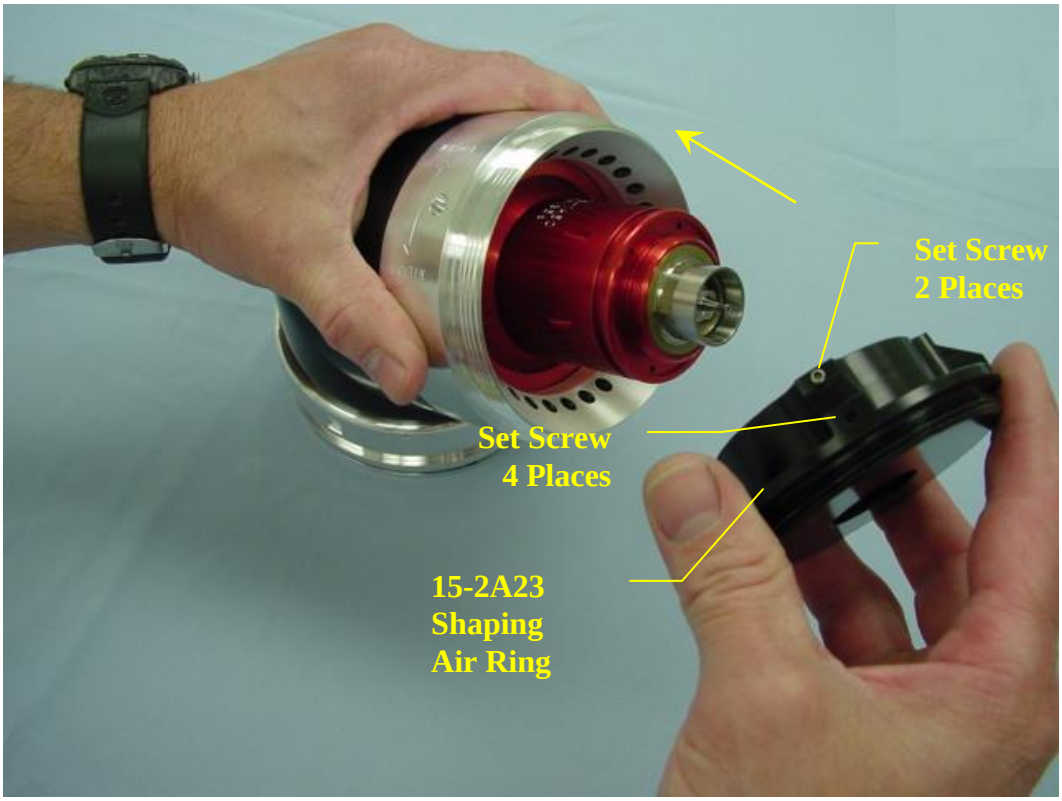
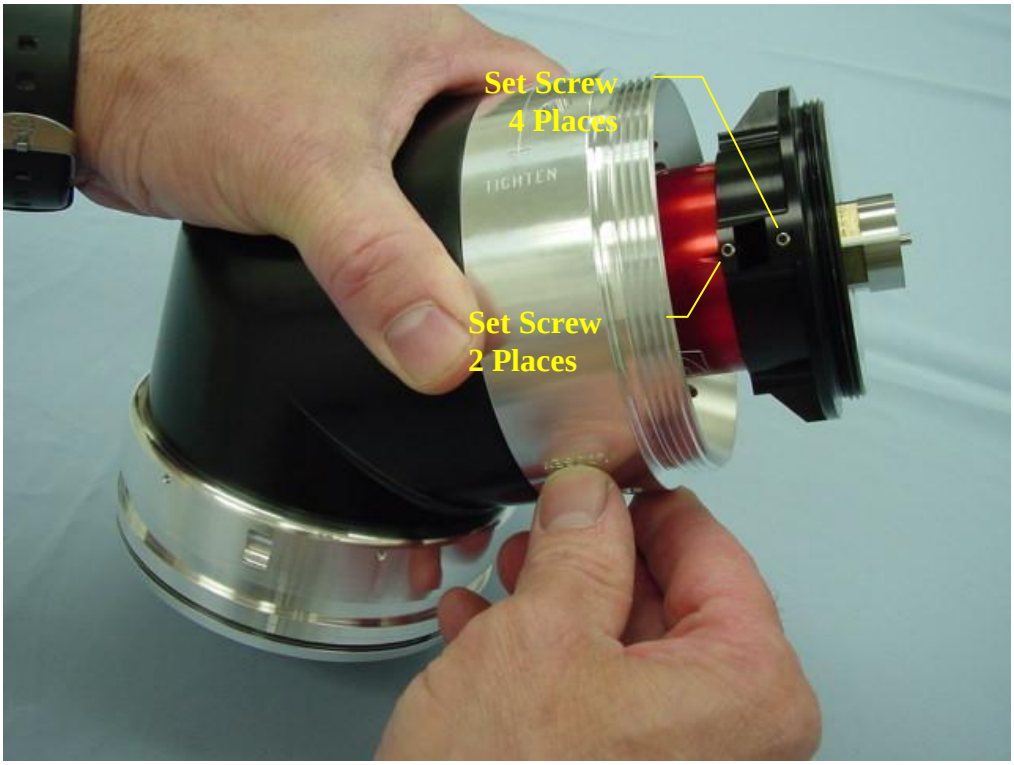


Figure 15: Shaping Air Ring Installation

Screw the shaping air ring onto the motor, clockwise. Align one of the shaping holes on the motor body with one of the set screw holes on the shaping air ring. To lock the shaping air ring in place, tighten all shaping air ring set screws, two modified set screws, four unmodified set screws.



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.

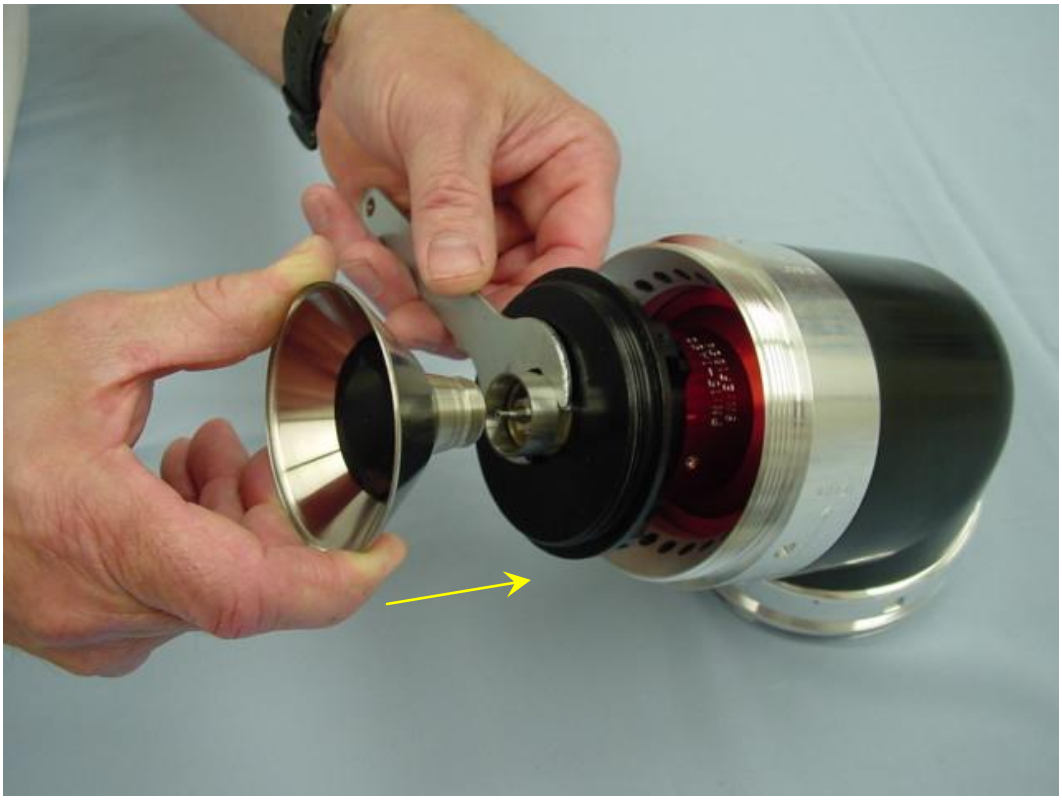


Figure 18: Bell Cup Installation

Screw the bell cup, clockwise, onto the turbine shaft. Before doing so, ensure the cup and shaft are free of debris (i.e. paint). A dirty bell cup or motor shaft could create an imbalance in the motor assembly, thereby damaging it.

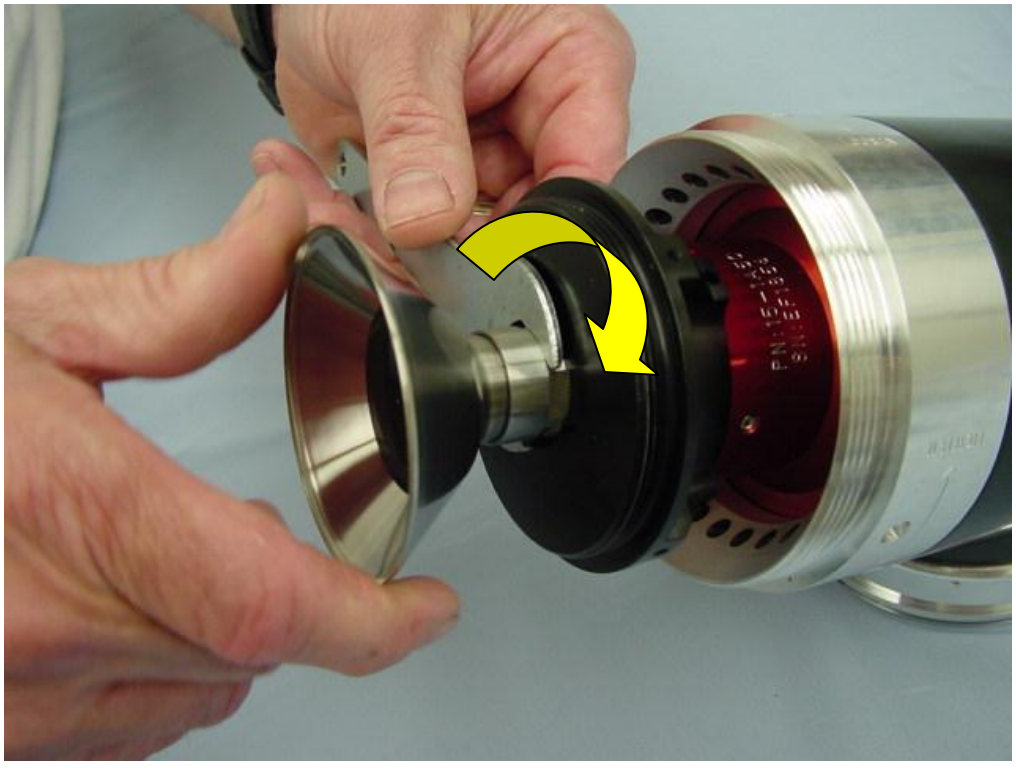
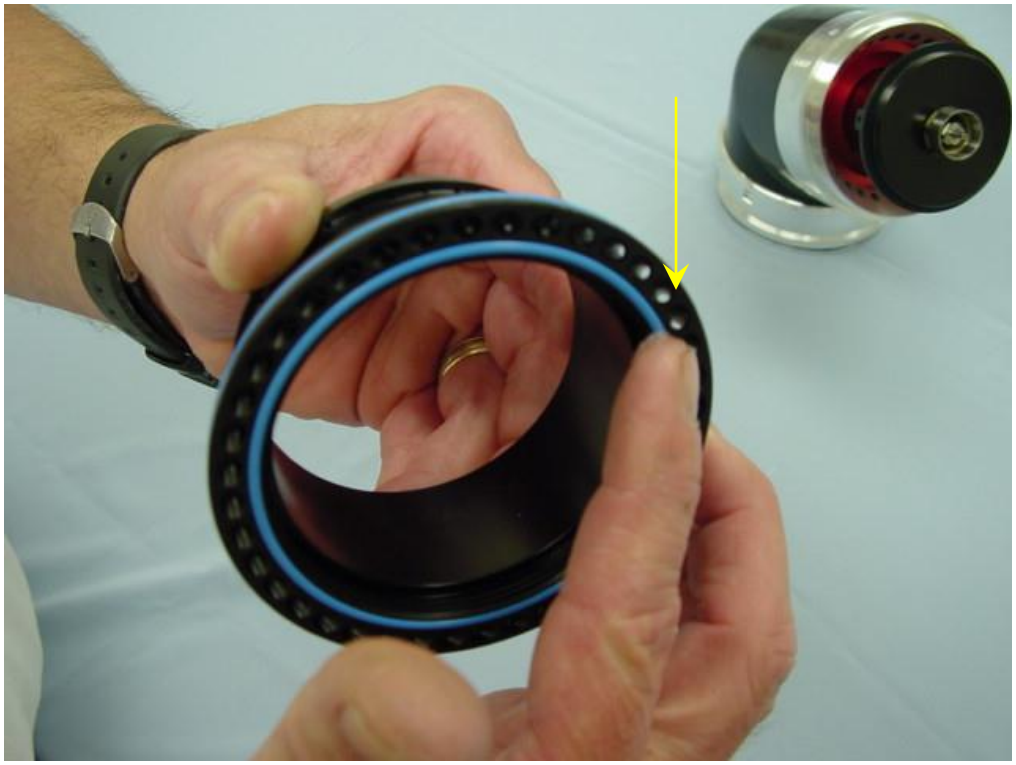


Figure 16: Inner Shroud Lubrication



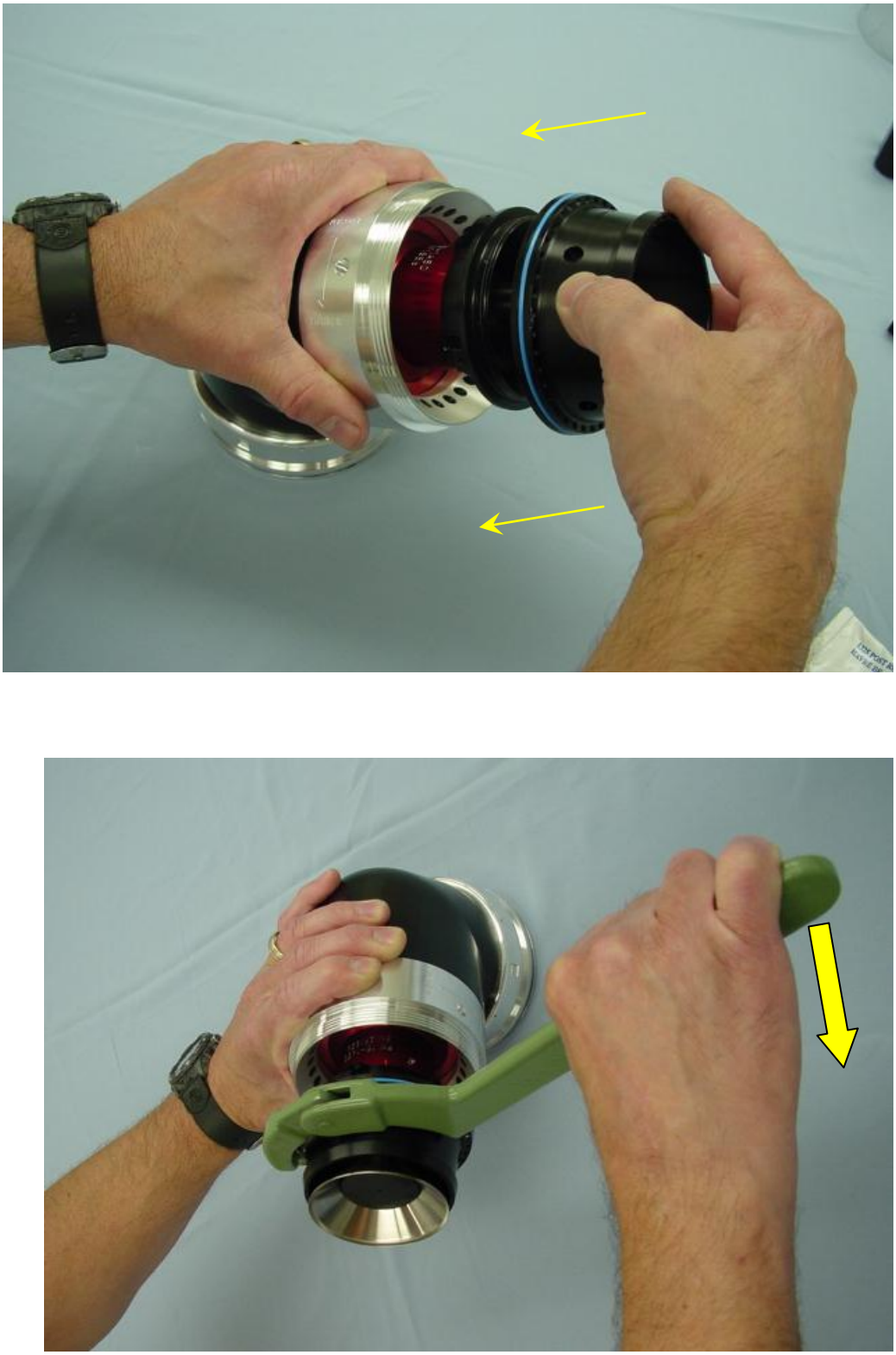


Figure 17: Inner Shroud Installation

Hand-tighten the inner shroud, clockwise with the EFC spanner wrench.

Figure 18: Outer Shroud Installation

Add a small amount of Vaseline® to the inner front edge of the outer shroud before installing.

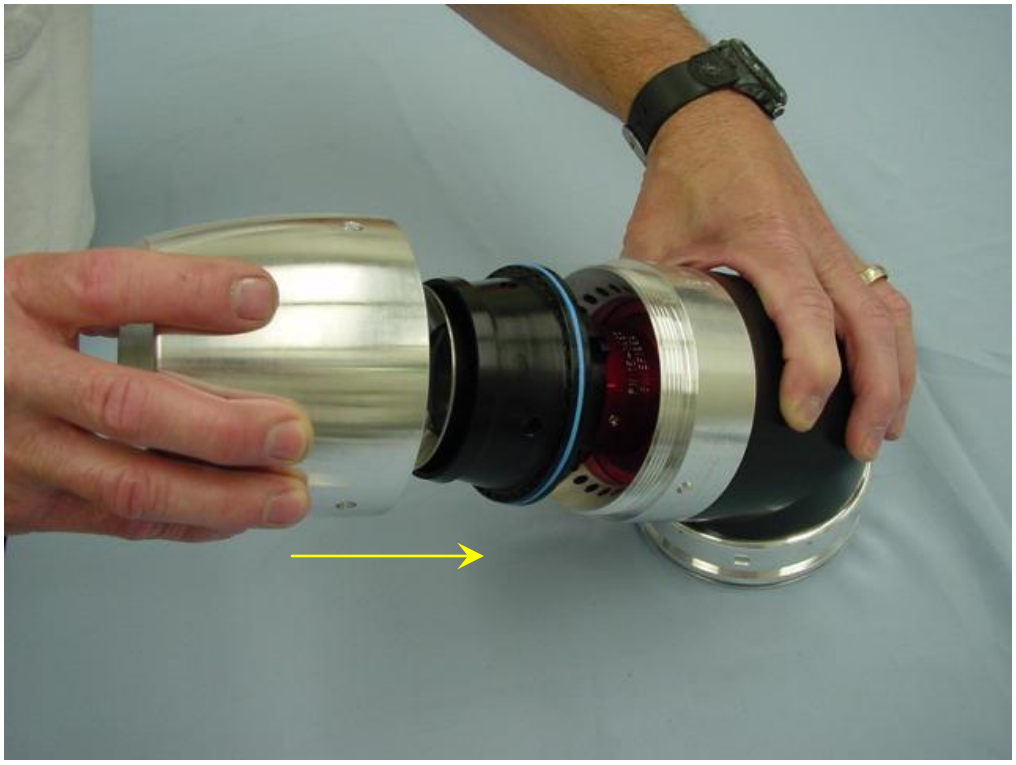


Figure 19: Complete FS67 Assembly

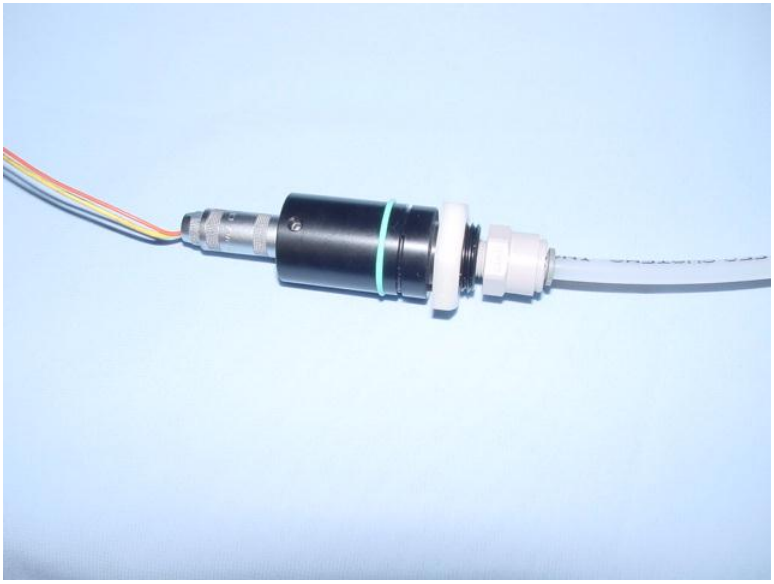


Figure 20: Microphone Assembly

The microphone assembly receives the microphone out air signal from the FS67 via a ¼" air line. The microphone converts the air signal to a low voltage signal that is sent back to the turbine speed control card.

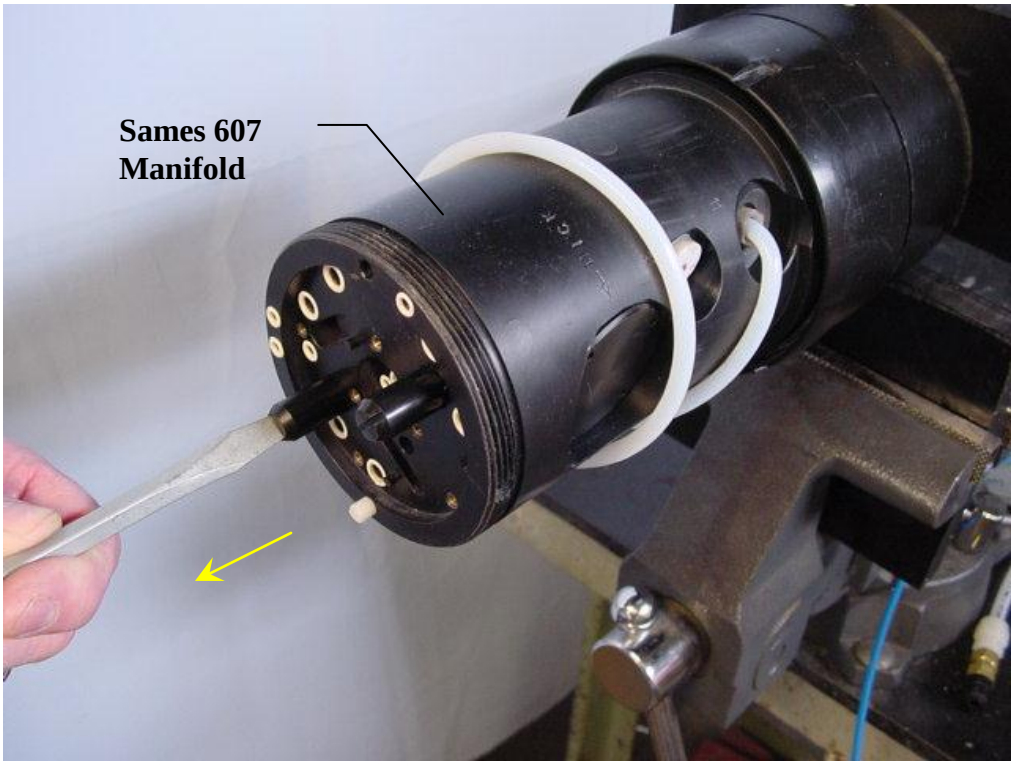


Figure 21: OEM Locating Pin Removal

Remove only the OEM locating pin shown above. Replace this pin with the shorter EFC locating pin. The other long OEM locating pin is to remain in the OEM manifold.

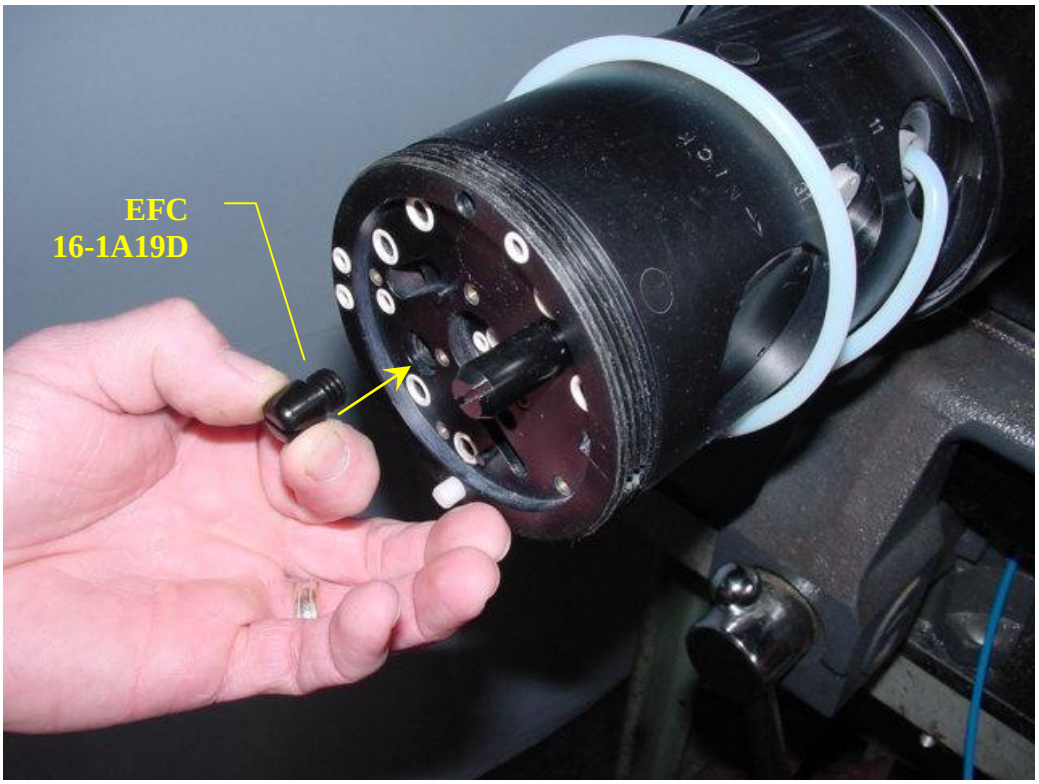
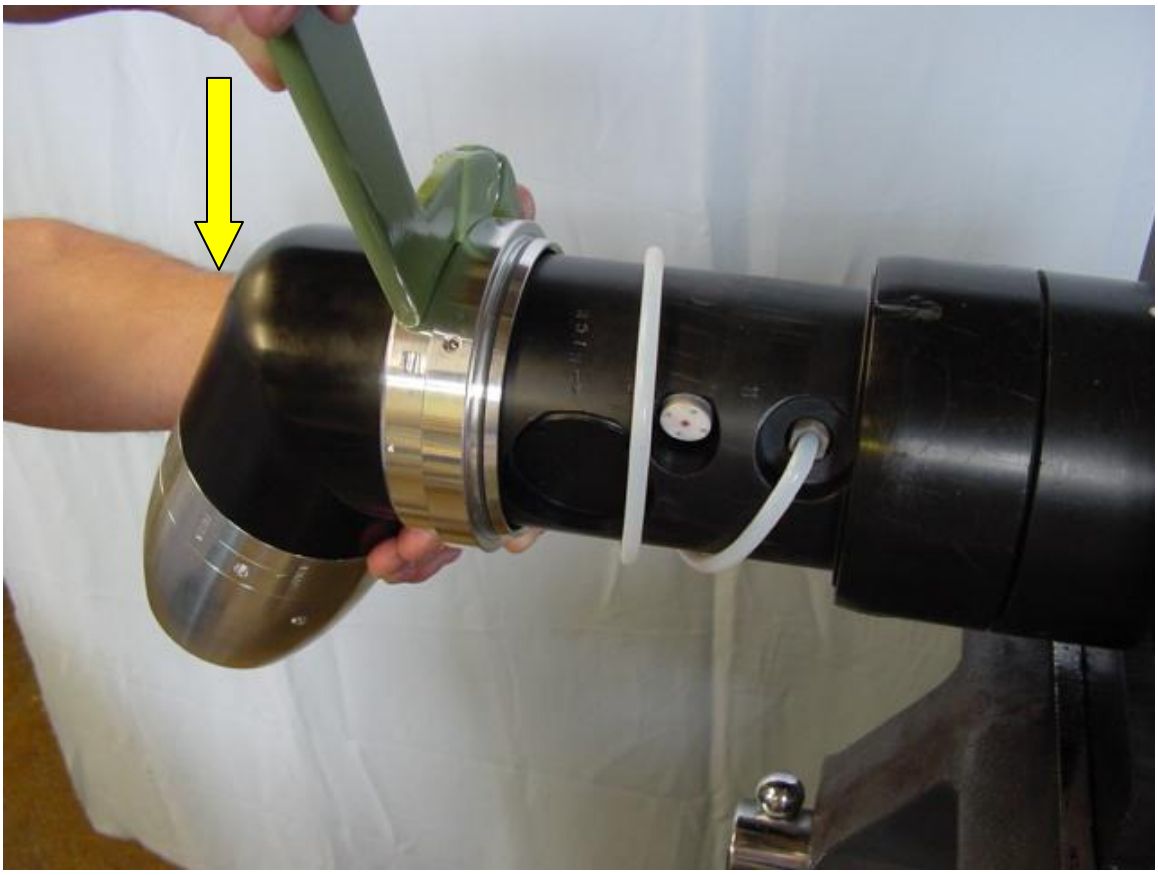


Figure 22: FS67 Installation Onto A Sames 607 Manifold



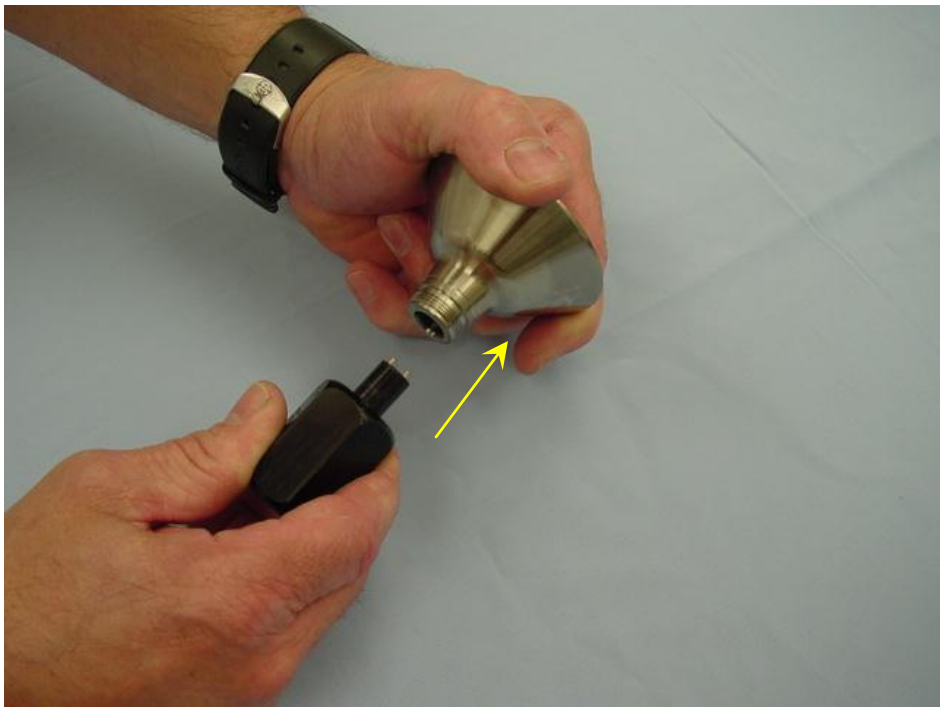
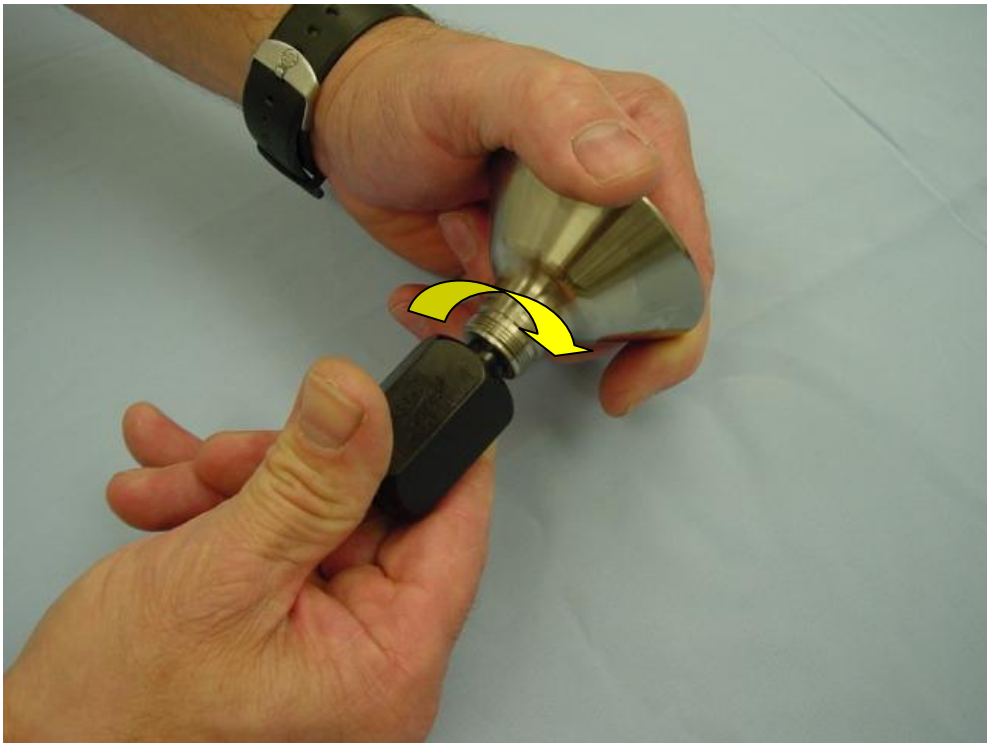
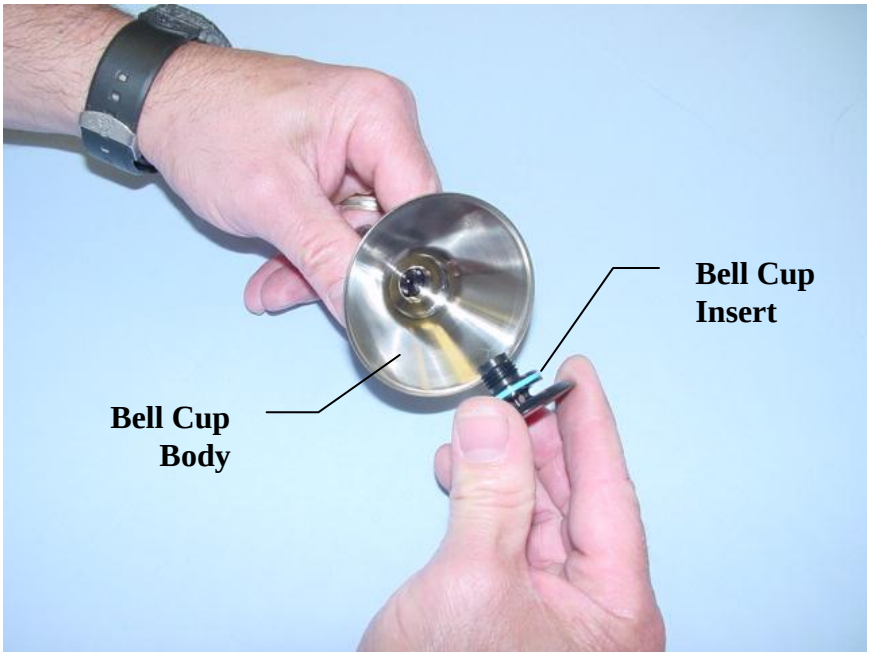


Figure 23: Bell Cup Insert Removal

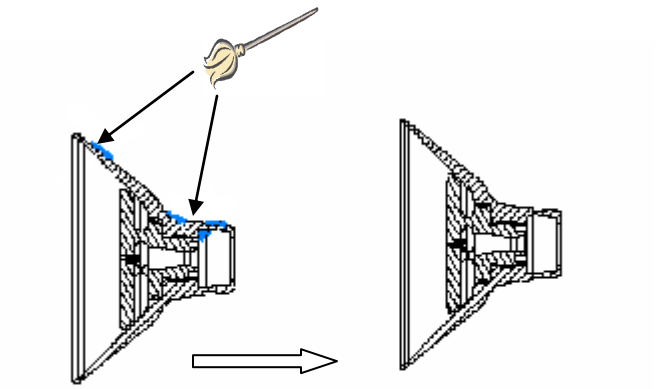


To remove the bell cup insert, place the bell cup insert tool into the back of the bell cup, engage the insert and unscrew the insert *clockwise.*



Cleaning

- Using a plant approved solvent, clean the entire cup. Do not soak the o-ring in aggressive solvents for more than one hour. The cup may be placed in an ultrasonic cleaner for additional cleaning.
- Use only soft bristled brushes and lint-free cloths to clean the cup. Remove all debris from the entire cup, paying particular attention to the bell cup threads. Remove all debris from within the serrations (if the cup has serrations) at the inner exiting edge of the cup.
- Remove any paint build-up on the bell cup's taper. The taper engages the motor shaft and should be carefully inspected and cleaned to prevent motor imbalance after reassembling it to the motor.



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 20 & 21 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.

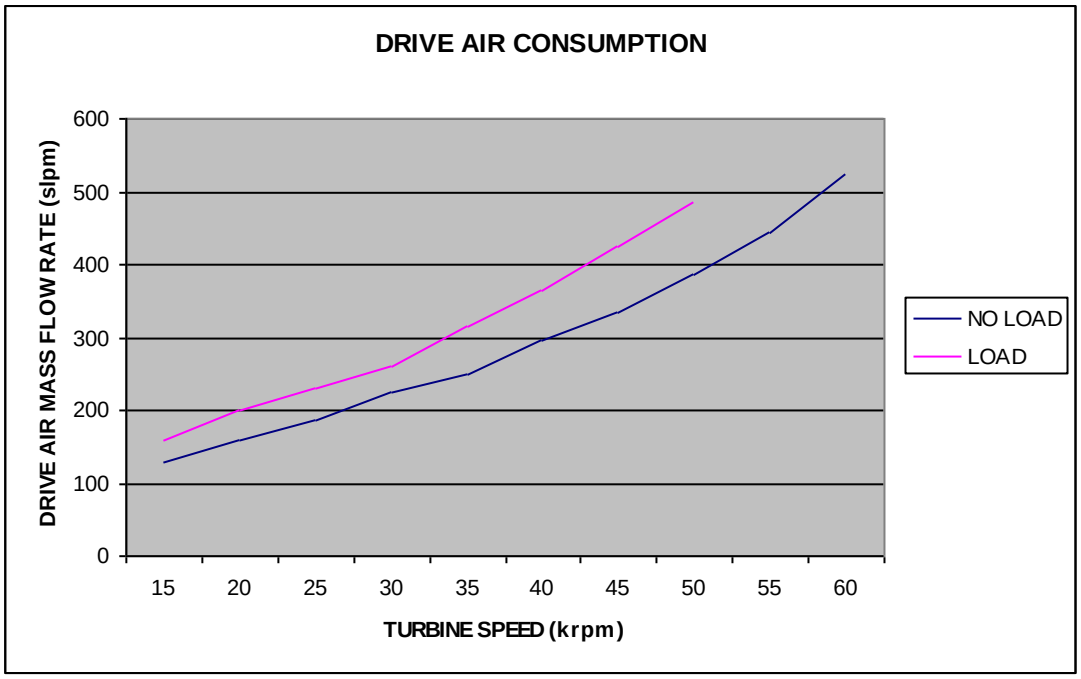


Figure 24: Drive Air Consumption

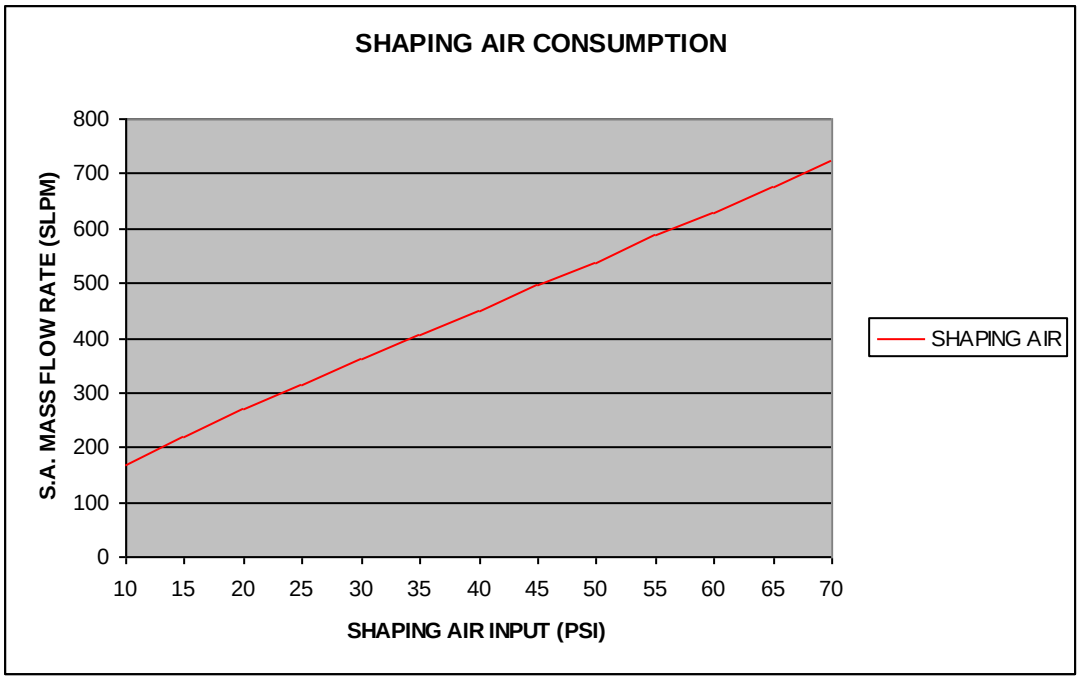


Figure 25: Shaping Air Consumption

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 FS67, 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.

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.

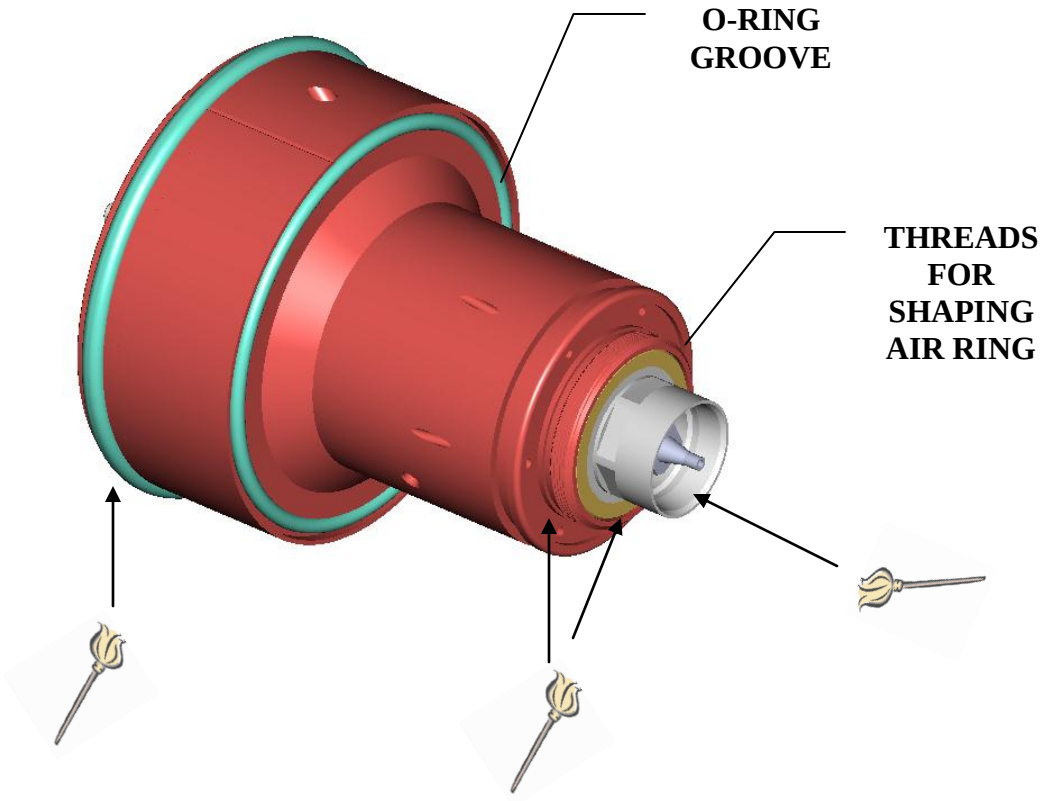


Figure 26: Front Turbine Housing Body

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-FS67 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 FS67 manual.
Change the FS67 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 FS67. 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 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	"