

FANUC Robot **series**
R-30iA CONTROLLER
P-700iA Robot Maintenance Manual
MARMCP70007071E REV. A

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This manual can be used with controllers labeled R-30iA or R-J3iC. If you have a controller labeled R-J3iC, you should read R-30iA as R-J3iC throughout this manual.

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Patents

One for more of the following U.S. patents might be related to the FANUC Robotics products described in this manual.

FRA Patent List

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FANUC LTD Patent List

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VersaBell, ServoBell and SpeedDock Patents Pending.

Conventions

This manual includes information essential to the safety of personnel, equipment, software, and data. This information is indicated by headings and boxes in the text.



Warning
Information appearing under **WARNING** concerns the protection of personnel. It is boxed and in bold type to set it apart from other text.



Caution
Information appearing under **CAUTION** concerns the protection of equipment, software, and data. It is boxed to set it apart from other text.

Note Information appearing next to **NOTE** concerns related information or useful hints.

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Safety

FANUC Robotics is not and does not represent itself as an expert in safety systems, safety equipment, or the specific safety aspects of your company and/or its work force. It is the responsibility of the owner, employer, or user to take all necessary steps to guarantee the safety of all personnel in the workplace.

The appropriate level of safety for your application and installation can best be determined by safety system professionals. FANUC Robotics therefore, recommends that each customer consult with such professionals in order to provide a workplace that allows for the safe application, use, and operation of FANUC Robotic systems.

According to the industry standard ANSI/RIA R15-06, the owner or user is advised to consult the standards to ensure compliance with its requests for Robotics System design, usability, operation, maintenance, and service. Additionally, as the owner, employer, or user of a robotic system, it is your responsibility to arrange for the training of the operator of a robot system to recognize and respond to known hazards associated with your robotic system and to be aware of the recommended operating procedures for your particular application and robot installation.

FANUC Robotics therefore, recommends that all personnel who intend to operate, program, repair, or otherwise use the robotics system be trained in an approved FANUC Robotics training course and become familiar with the proper operation of the system. Persons responsible for programming the system-including the design, implementation, and debugging of application programs-must be familiar with the recommended programming procedures for your application and robot installation.

The following guidelines are provided to emphasize the importance of safety in the workplace.

CONSIDERING SAFETY FOR YOUR ROBOT INSTALLATION

- Safety is essential whenever robots are used. Keep in mind the following factors with regard to safety:
- The safety of people and equipment
 - Use of safety enhancing devices
 - Techniques for safe teaching and manual operation of the robot(s)
 - Techniques for safe automatic operation of the robot(s)
 - Regular scheduled inspection of the robot and workcell
 - Proper maintenance of the robot

Keeping People and Equipment Safe

- The safety of people is always of primary importance in any situation. However, equipment must be kept safe, too. When prioritizing how to apply safety to your robotic system, consider the following:
- People
 - External devices
 - Robot(s)
 - Tooling
 - Workpiece

Using Safety Enhancing Devices

Always give appropriate attention to the work area that surrounds the robot. The safety of the work area can be enhanced by the installation of some or all of the following devices:

- Safety fences, barriers, or chains
- Light curtains
- Interlocks
- Pressure mats
- Floor markings
- Warning lights
- Mechanical stops
- EMERGENCY STOP buttons
- DEADMAN switches

Setting Up a Safe Workcell

A safe workcell is essential to protect people and equipment. Observe the following guidelines to ensure that the workcell is set up safely. These suggestions are intended to supplement and **not** replace existing federal, state, and local laws, regulations, and guidelines that pertain to safety.

- Sponsor your personnel for training in approved FANUC Robotics training course(s) related to your application. Never permit untrained personnel to operate the robots.
- Install a lockout device that uses an access code to prevent unauthorized persons from operating the robot.
- Use anti-tie-down logic to prevent the operator from bypassing safety measures.
- Arrange the workcell so the operator faces the workcell and can see what is going on inside the cell.
- Clearly identify the work envelope of each robot in the system with floor markings, signs, and special barriers. The work envelope is the area defined by the maximum motion range of the robot, including any tooling attached to the wrist flange that extend this range.
- Position all controllers outside the robot work envelope.
- Never rely on software or firmware based controllers as the primary safety element unless they comply with applicable current robot safety standards.
- Mount an adequate number of EMERGENCY STOP buttons or switches within easy reach of the operator and at critical points inside and around the outside of the workcell.
- Install flashing lights and/or audible warning devices that activate whenever the robot is operating, that is, whenever power is applied to the servo drive system. Audible warning devices shall exceed the ambient noise level at the end-use application.
- Wherever possible, install safety fences to protect against unauthorized entry by personnel into the work envelope.
- Install special guarding that prevents the operator from reaching into restricted areas of the work envelope.
- Use interlocks.
- Use presence or proximity sensing devices such as light curtains, mats, and capacitance and vision systems to enhance safety.

- Periodically check the safety joints or safety clutches that can be optionally installed between the robot wrist flange and tooling. If the tooling strikes an object, these devices dislodge, remove power from the system, and help to minimize damage to the tooling and robot.
- Make sure all external devices are properly filtered, grounded, shielded, and suppressed to prevent hazardous motion due to the effects of electro-magnetic interference (EMI), radio frequency interference (RFI), and electro-static discharge (ESD).
- Make provisions for power lockout/tagout at the controller.
- Eliminate *pinch points* . Pinch points are areas where personnel could get trapped between a moving robot and other equipment.
- Provide enough room inside the workcell to permit personnel to teach the robot and perform maintenance safely.
- Program the robot to load and unload material safely.
- If high voltage electrostatics are present, be sure to provide appropriate interlocks, warning, and beacons.
- If materials are being applied at dangerously high pressure, provide electrical interlocks for lockout of material flow and pressure.

Staying Safe While Teaching or Manually Operating the Robot

Advise all personnel who must teach the robot or otherwise manually operate the robot to observe the following rules:

- Never wear watches, rings, neckties, scarves, or loose clothing that could get caught in moving machinery.
- Know whether or not you are using an intrinsically safe teach pendant if you are working in a hazardous environment.
- Before teaching, visually inspect the robot and *work envelope* to make sure that no potentially hazardous conditions exist. The work envelope is the area defined by the maximum motion range of the robot. These include tooling attached to the wrist flange that extends this range.
- The area near the robot must be clean and free of oil, water, or debris. Immediately report unsafe working conditions to the supervisor or safety department.
- FANUC Robotics recommends that no one enter the work envelope of a robot that is on, except for robot teaching operations. However, if you must enter the work envelope, be sure all safeguards are in place, check the teach pendant DEADMAN switch for proper operation, and place the robot in teach mode. Take the teach pendant with you, turn it on, and be prepared to release the DEADMAN switch. Only the person with the teach pendant should be in the work envelope.



Warning

Never bypass, strap, or otherwise deactivate a safety device, such as a limit switch, for any operational convenience. Deactivating a safety device is known to have resulted in serious injury and death.

- Know the path that can be used to escape from a moving robot; make sure the escape path is never blocked.
- Isolate the robot from all remote control signals that can cause motion while data is being taught.
- Test any program being run for the first time in the following manner:



Warning

Stay outside the robot work envelope whenever a program is being run. Failure to do so can result in injury.

— Using a low motion speed, single step the program for at least one full cycle.

- Using a low motion speed, test run the program continuously for at least one full cycle.
- Using the programmed speed, test run the program continuously for at least one full cycle.
- Make sure all personnel are outside the work envelope before running production.

Staying Safe During Automatic Operation

Advise all personnel who operate the robot during production to observe the following rules:

- Make sure all safety provisions are present and active.
- Know the entire workcell area. The workcell includes the robot and its work envelope, plus the area occupied by all external devices and other equipment with which the robot interacts.
- Understand the complete task the robot is programmed to perform before initiating automatic operation.
- Make sure all personnel are outside the work envelope before operating the robot.
- Never enter or allow others to enter the work envelope during automatic operation of the robot.
- Know the location and status of all switches, sensors, and control signals that could cause the robot to move.
- Know where the EMERGENCY STOP buttons are located on both the robot control and external control devices. Be prepared to press these buttons in an emergency.
- Never assume that a program is complete if the robot is not moving. The robot could be waiting for an input signal that will permit it to continue activity.
- If the robot is running in a pattern, do not assume it will continue to run in the same pattern.
- Never try to stop the robot, or break its motion, with your body. The only way to stop robot motion immediately is to press an EMERGENCY STOP button located on the controller panel, teach pendant, or emergency stop stations around the workcell.

Staying Safe During Inspection

When inspecting the robot, be sure to

- Turn off power at the controller.
- Lock out and tag out the power source at the controller according to the policies of your plant.
- Turn off the compressed air source and relieve the air pressure.
- If robot motion is not needed for inspecting the electrical circuits, press the EMERGENCY STOP button on the operator panel.
- Never wear watches, rings, neckties, scarves, or loose clothing that could get caught in moving machinery.
- If power is needed to check the robot motion or electrical circuits, be prepared to press the EMERGENCY STOP button, in an emergency.
- Be aware that when you remove a servomotor or brake, the associated robot arm will fall if it is not supported or resting on a hard stop. Support the arm on a solid support before you release the brake.

Staying Safe During Maintenance

When performing maintenance on your robot system, observe the following rules:

- Never enter the work envelope while the robot or a program is in operation.
- Before entering the work envelope, visually inspect the workcell to make sure no potentially hazardous conditions exist.
- Never wear watches, rings, neckties, scarves, or loose clothing that could get caught in moving machinery.
- Consider all or any overlapping work envelopes of adjoining robots when standing in a work envelope.
- Test the teach pendant for proper operation before entering the work envelope.
- If it is necessary for you to enter the robot work envelope while power is turned on, you must be sure that you are in control of the robot. Be sure to take the teach pendant with you, press the DEADMAN switch, and turn the teach pendant on. Be prepared to release the DEADMAN switch to turn off servo power to the robot immediately.
- Whenever possible, perform maintenance with the power turned off. Before you open the controller front panel or enter the work envelope, turn off and lock out the 3-phase power source at the controller.
- Be aware that an applicator bell cup can continue to spin at a very high speed even if the robot is idle. Use protective gloves or disable bearing air and turbine air before servicing these items.
- Be aware that when you remove a servomotor or brake, the associated robot arm will fall if it is not supported or resting on a hard stop. Support the arm on a solid support before you release the brake.



Warning

Lethal voltage is present in the controller WHENEVER IT IS CONNECTED to a power source. Be extremely careful to avoid electrical shock.HIGH VOLTAGE IS PRESENT at the input side whenever the controller is connected to a power source. Turning the disconnect or circuit breaker to the OFF position removes power from the output side of the device only.

- Release or block all stored energy. Before working on the pneumatic system, shut off the system air supply and purge the air lines.
- Isolate the robot from all remote control signals. If maintenance must be done when the power is on, make sure the person inside the work envelope has sole control of the robot. The teach pendant must be held by this person.
- Make sure personnel cannot get trapped between the moving robot and other equipment. Know the path that can be used to escape from a moving robot. Make sure the escape route is never blocked.
- Use blocks, mechanical stops, and pins to prevent hazardous movement by the robot. Make sure that such devices do not create pinch points that could trap personnel.



Warning

Do not try to remove any mechanical component from the robot before thoroughly reading and understanding the procedures in the appropriate manual. Doing so can result in serious personal injury and component destruction.

- Be aware that when you remove a servomotor or brake, the associated robot arm will fall if it is not supported or resting on a hard stop. Support the arm on a solid support before you release the brake.
- When replacing or installing components, make sure dirt and debris do not enter the system.
- Use only specified parts for replacement. To avoid fires and damage to parts in the controller, never use nonspecified fuses.
- Before restarting a robot, make sure no one is inside the work envelope; be sure that the robot and all external devices are operating normally.

KEEPING MACHINE TOOLS AND EXTERNAL DEVICES SAFE

Certain programming and mechanical measures are useful in keeping the machine tools and other external devices safe. Some of these measures are outlined below. Make sure you know all associated measures for safe use of such devices.

Programming Safety Precautions

Implement the following programming safety measures to prevent damage to machine tools and other external devices.

- Back-check limit switches in the workcell to make sure they do not fail.
- Implement “failure routines” in programs that will provide appropriate robot actions if an external device or another robot in the workcell fails.
- Use *handshaking* protocol to synchronize robot and external device operations.
- Program the robot to check the condition of all external devices during an operating cycle.

Mechanical Safety Precautions

Implement the following mechanical safety measures to prevent damage to machine tools and other external devices.

- Make sure the workcell is clean and free of oil, water, and debris.
- Use software limits, limit switches, and mechanical hardstops to prevent undesired movement of the robot into the work area of machine tools and external devices.

KEEPING THE ROBOT SAFE

Observe the following operating and programming guidelines to prevent damage to the robot.

Operating Safety Precautions

The following measures are designed to prevent damage to the robot during operation.

- Use a low override speed to increase your control over the robot when jogging the robot.
- Visualize the movement the robot will make before you press the jog keys on the teach pendant.
- Make sure the work envelope is clean and free of oil, water, or debris.
- Use circuit breakers to guard against electrical overload.

Programming Safety Precautions

The following safety measures are designed to prevent damage to the robot during programming:

- Establish *interference zones* to prevent collisions when two or more robots share a work area.
- Make sure that the program ends with the robot near or at the home position.
- Be aware of signals or other operations that could trigger operation of tooling resulting in personal injury or equipment damage.
- In dispensing applications, be aware of all safety guidelines with respect to the dispensing materials.

Note Any deviation from the methods and safety practices described in this manual must conform to the approved standards of your company. If you have questions, see your supervisor.

ADDITIONAL SAFETY CONSIDERATIONS FOR PAINT ROBOT INSTALLATIONS

Process technicians are sometimes required to enter the paint booth, for example, during daily or routine calibration or while teaching new paths to a robot. Maintenance personal also must work inside the paint booth periodically.

Whenever personnel are working inside the paint booth, ventilation equipment must be used. Instruction on the proper use of ventilating equipment usually is provided by the paint shop supervisor.

Although paint booth hazards have been minimized, potential dangers still exist. Therefore, today’s highly automated paint booth requires that process and maintenance personnel have full awareness of the system and its capabilities. They must understand the interaction that occurs between the vehicle moving along the conveyor and the robot(s), hood/deck and door opening devices, and high-voltage electrostatic tools.



Caution

Ensure that all ground cables remain connected. Never operate the paint robot with ground provisions disconnected. Otherwise, you could injure personnel or damage equipment.

Paint robots are operated in three modes:

- Teach or manual mode
- Automatic mode, including automatic and exercise operation
- Diagnostic mode

During both teach and automatic modes, the robots in the paint booth will follow a predetermined pattern of movements. In teach mode, the process technician teaches (programs) paint paths using the teach pendant.

In automatic mode, robot operation is initiated at the System Operator Console (SOC) or Manual Control Panel (MCP), if available, and can be monitored from outside the paint booth. All personnel must remain outside of the booth or in a designated safe area within the booth whenever automatic mode is initiated at the SOC or MCP.

In automatic mode, the robots will execute the path movements they were taught during teach mode, but generally at production speeds.

When process and maintenance personnel run diagnostic routines that require them to remain in the paint booth, they must stay in a designated safe area.

Paint System Safety Features

Process technicians and maintenance personnel must become totally familiar with the equipment and its capabilities. To minimize the risk of injury when working near robots and related equipment, personnel must comply strictly with the procedures in the manuals.

This section provides information about the safety features that are included in the paint system and also explains the way the robot interacts with other equipment in the system.

The paint system includes the following safety features:

- Most paint booths have red warning beacons that illuminate when the robots are armed and ready to paint. Your booth might have other kinds of indicators. Learn what these are.
- Some paint booths have a blue beacon that, when illuminated, indicates that the electrostatic devices are enabled. Your booth might have other kinds of indicators. Learn what these are.
- EMERGENCY STOP buttons are located on the robot controller and teach pendant. Become familiar with the locations of all E-STOP buttons.
- An intrinsically safe teach pendant is used when teaching in hazardous paint atmospheres.
- A DEADMAN switch is located on each teach pendant. When this switch is held in, and the teach pendant is on, power is applied to the robot servo system. If the engaged DEADMAN switch is released during robot operation, power is removed from the servo system, all axis brakes are applied, and the robot comes to an EMERGENCY STOP. Safety interlocks within the system might also E-STOP other robots.



Warning

An EMERGENCY STOP will occur if the DEADMAN switch is released on a bypassed robot.

- Overtravel by robot axes is prevented by software limits. All of the major and minor axes are governed by software limits. Limit switches and hardstops also limit travel by the major axes.
- EMERGENCY STOP limit switches and photoelectric eyes might be part of your system. Limit switches, located on the entrance/exit doors of each booth, will EMERGENCY STOP all equipment in the booth if a door is opened while the system is operating in automatic or manual mode. For some systems, signals to these switches are inactive when the switch on the SCC is in teach mode. When present, photoelectric eyes are sometimes used to monitor unauthorized intrusion through the entrance/exit silhouette openings.
- System status is monitored by computer. Severe conditions result in automatic system shutdown.

Staying Safe While Operating the Paint Robot

When you work in or near the paint booth, observe the following rules, in addition to all rules for safe operation that apply to all robot systems.



Warning

Observe all safety rules and guidelines to avoid injury.



Warning

Never bypass, strap, or otherwise deactivate a safety device, such as a limit switch, for any operational convenience. Deactivating a safety device is known to have resulted in serious injury and death.



Warning

Enclosures shall not be opened unless the area is known to be nonhazardous or all power has been removed from devices within the enclosure. Power shall not be restored after the enclosure has been opened until all combustible dusts have been removed from the interior of the enclosure and the enclosure purged. Refer to the Purge chapter for the required purge time.



Warning

Remove all combustible dusts from the interior of the enclosure before connecting power to devices within the enclosure. The enclosure shall not be opened unless the area is known to be nonhazardous or all power has been removed from devices within the enclosure. After the enclosure has been opened or in the event of loss of internal pressure within the enclosure, power shall not be restored until all combustible dusts have been removed from the interior of the enclosure and the enclosure has been purged for 5.0 minutes.

- Know the work area of the entire paint station (workcell).
- Know the work envelope of the robot and hood/deck and door opening devices.
- Be aware of overlapping work envelopes of adjacent robots.
- Know where all red, mushroom-shaped EMERGENCY STOP buttons are located.
- Know the location and status of all switches, sensors, and/or control signals that might cause the robot, conveyor, and opening devices to move.
- Make sure that the work area near the robot is clean and free of water, oil, and debris. Report unsafe conditions to your supervisor.
- Become familiar with the complete task the robot will perform BEFORE starting automatic mode.
- Make sure all personnel are outside the paint booth before you turn on power to the robot servo system.
- Never enter the work envelope or paint booth before you turn off power to the robot servo system.
- Never enter the work envelope during automatic operation unless a safe area has been designated.
- Never wear watches, rings, neckties, scarves, or loose clothing that could get caught in moving machinery.
- Remove all metallic objects, such as rings, watches, and belts, before entering a booth when the electrostatic devices are enabled.
- Stay out of areas where you might get trapped between a moving robot, conveyor, or opening device and another object.
- Be aware of signals and/or operations that could result in the triggering of guns or bells.
- Be aware of all safety precautions when dispensing of paint is required.
- Follow the procedures described in this manual.

Special Precautions for Combustible Dusts (powder paint)

When the robot is used in a location where combustible dusts are found, such as the application of powder paint, the following special precautions are required to insure that there are no combustible dusts inside the robot.

- Purge maintenance air should be maintained at all times, even when the robot power is off. This will insure that dust can not enter the robot.
 - A purge cycle will not remove accumulated dusts. Therefore, if the robot is exposed to dust when maintenance air is not present, it will be necessary to remove the covers and clean out any accumulated dust. Do not energize the robot until you have performed the following steps.
1. Before covers are removed, the exterior of the robot should be cleaned to remove accumulated dust.

- When cleaning and removing accumulated dust, either on the outside or inside of the robot, be sure to use methods appropriate for the type of dust that exists. Usually lint free rags dampened with water are acceptable. Do not use a vacuum cleaner to remove dust as it can generate static electricity and cause an explosion unless special precautions are taken.
- Thoroughly clean the interior of the robot with a lint free rag to remove any accumulated dust.
- When the dust has been removed, the covers must be replaced immediately.
- Immediately after the covers are replaced, run a complete purge cycle. The robot can now be energized.

Staying Safe While Operating Paint Application Equipment

When you work with paint application equipment, observe the following rules, in addition to all rules for safe operation that apply to all robot systems.



Warning

When working with electrostatic paint equipment, follow all national and local codes as well as all safety guidelines within your organization. Also reference the following standards: *NFPA 33 Standards for Spray Application Using Flammable or Combustible Materials* , and *NFPA 70 National Electrical Code* .

- Grounding** : All electrically conductive objects in the spray area must be grounded. This includes the spray booth, robots, conveyors, workstations, part carriers, hooks, paint pressure pots, as well as solvent containers. Grounding is defined as the object or objects shall be electrically connected to ground with a resistance of not more than 1 megohms.
- High Voltage** : High voltage should only be on during actual spray operations. Voltage should be off when the painting process is completed. Never leave high voltage on during a cap cleaning process.
- Avoid any accumulation of combustible vapors or coating matter.
- Follow all manufacturer recommended cleaning procedures.
- Make sure all interlocks are operational.
- No smoking.
- Post all warning signs regarding the electrostatic equipment and operation of electrostatic equipment according to NFPA 33 Standard for Spray Application Using Flammable or Combustible Material.
- Disable all air and paint pressure to bell.
- Verify that the lines are not under pressure.

Staying Safe During Maintenance

When you perform maintenance on the painter system, observe the following rules, and all other maintenance safety rules that apply to all robot installations. Only qualified, trained service or maintenance personnel should perform repair work on a robot.

- Paint robots operate in a potentially explosive environment. Use caution when working with electric tools.
- When a maintenance technician is repairing or adjusting a robot, the work area is under the control of that technician. All personnel not participating in the maintenance must stay out of the area.
- For some maintenance procedures, station a second person at the control panel within reach of the EMERGENCY STOP button. This person must understand the robot and associated potential hazards.
- Be sure all covers and inspection plates are in good repair and in place.
- Always return the robot to the “home” position before you disarm it.

- Never use machine power to aid in removing any component from the robot.
- During robot operations, be aware of the robot’s movements. Excess vibration, unusual sounds, and so forth, can alert you to potential problems.
- Whenever possible, turn off the main electrical disconnect before you clean the robot.
- When using vinyl resin observe the following:
 - Wear eye protection and protective gloves during application and removal
 - Adequate ventilation is required. Overexposure could cause drowsiness or skin and eye irritation.
 - If there is contact with the skin, wash with water.
 - Follow the Original Equipment Manufacturer’s Material Safety Data Sheets.
- When using paint remover observe the following:
 - Eye protection, protective rubber gloves, boots, and apron are required during booth cleaning.
 - Adequate ventilation is required. Overexposure could cause drowsiness.
 - If there is contact with the skin or eyes, rinse with water for at least 15 minutes. Then, seek medical attention as soon as possible.
 - Follow the Original Equipment Manufacturer’s Material Safety Data Sheets.

OVERVIEW

Contents

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The P-700iA is a seven axis, rail mounted robot designed for efficient process equipment integration with features such as a hollow-wrist, an option for two motors on the outer arm for gear pumps, an outer arm-designed to integrate paint application equipment easily, and multiple hose routing options.

The P-700iA has the ability to “flip-over” axis 2 and 3 to provide a very large work envelope and maximum flexibility for painting.

The offset-arm design provides excellent near reach capability.

The robot uses both gear trains and RV (rotating vector) reducers. Axes 1, 2 and 3 use an RV reducer that is driven by an intermediate gear. Axes 4, 5 and 6 use planetary reducers with drive tubes and a 140 degree offset wrist.

The P-700iA robot is capable of paint speeds of up to 545 deg/sec. This speed can be obtained anywhere within the robot envelope. The payload is 15 kg at a 50 mm radial and 300 mm axial offset. With the specified payload, the static repeatability is ± 0.2 mm.

See [Figure 1–1](#) for the axes motion and major components of the P-700iA robot. See [Figure 1–2](#) and [Figure 1–3](#) for the drive train descriptions of the P-700iA robot.

AXES MOVEMENT AND DRIVE TRAINS

Figure 1–1. P-700iA Robot Axes Motion and Major Components

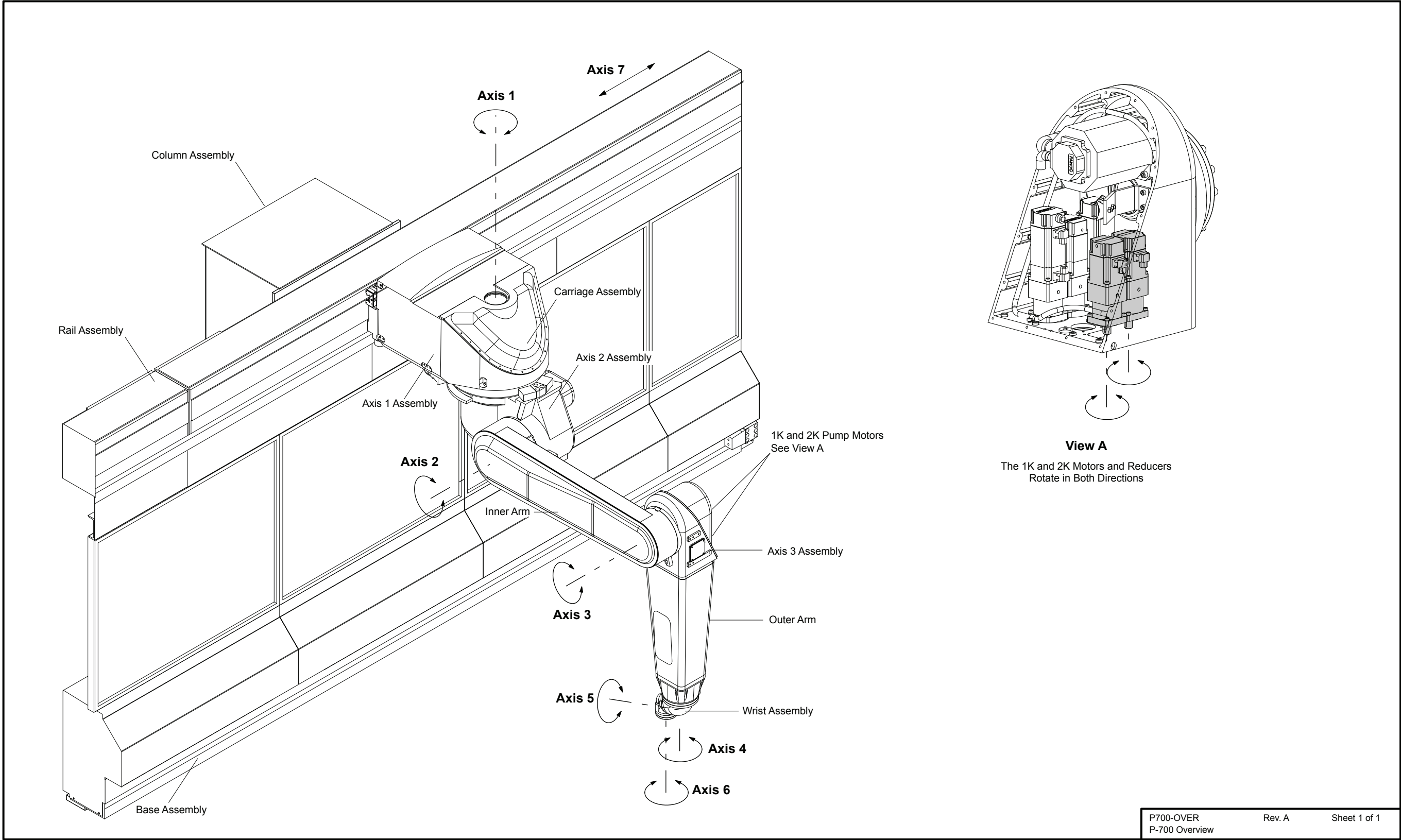


Table 1–1. Robot Drives

Robot Axis	Drive Description
Axis 1 (turret) rotation	The motor gear rotates the planetary reducer. The planetary reducer turns the reducer output gear which rotates the gear bearing (axis 1 gear).
Axis 2 (inner arm) movement	The motor gear rotates the idler gear which drives the input gear for the RV reducer. The input gear drives the reducer.
Axis 3 (outer arm) movement	The motor gear rotates the reducer input gear which drives the RV reducer
Axes 4, 5, and 6 (minor axes)	The axes 4, 5, and 6 motors drive reducers, turning the drive tubes that rotate the wrist axes
Axis 7 (carriage)	The motor drives the reducer which rotates the axis 7 output gear. The axis 7 output gear moves the robot along a gear rack.

Figure 1–2. P-700iA Drive Train, Sheet 1

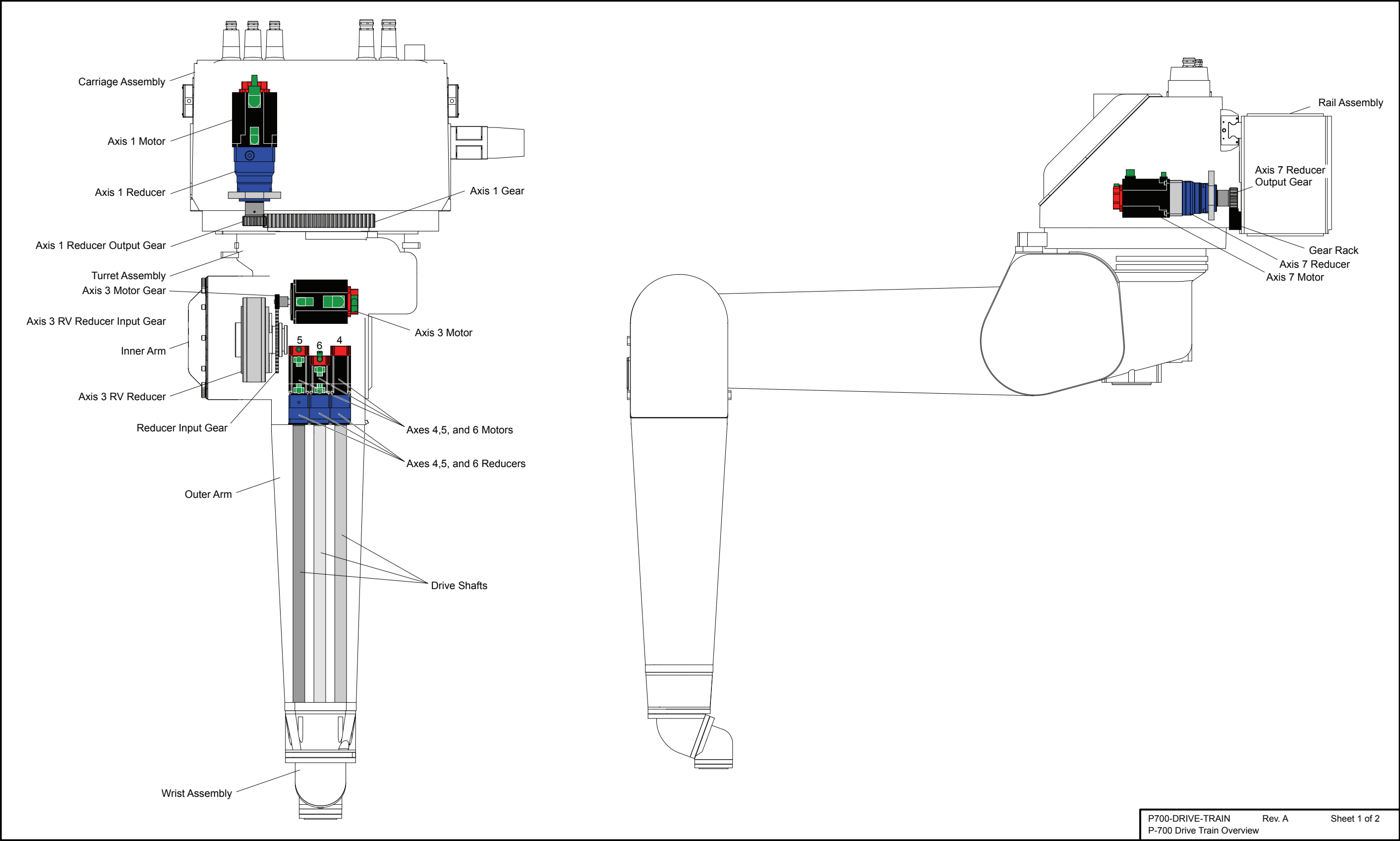
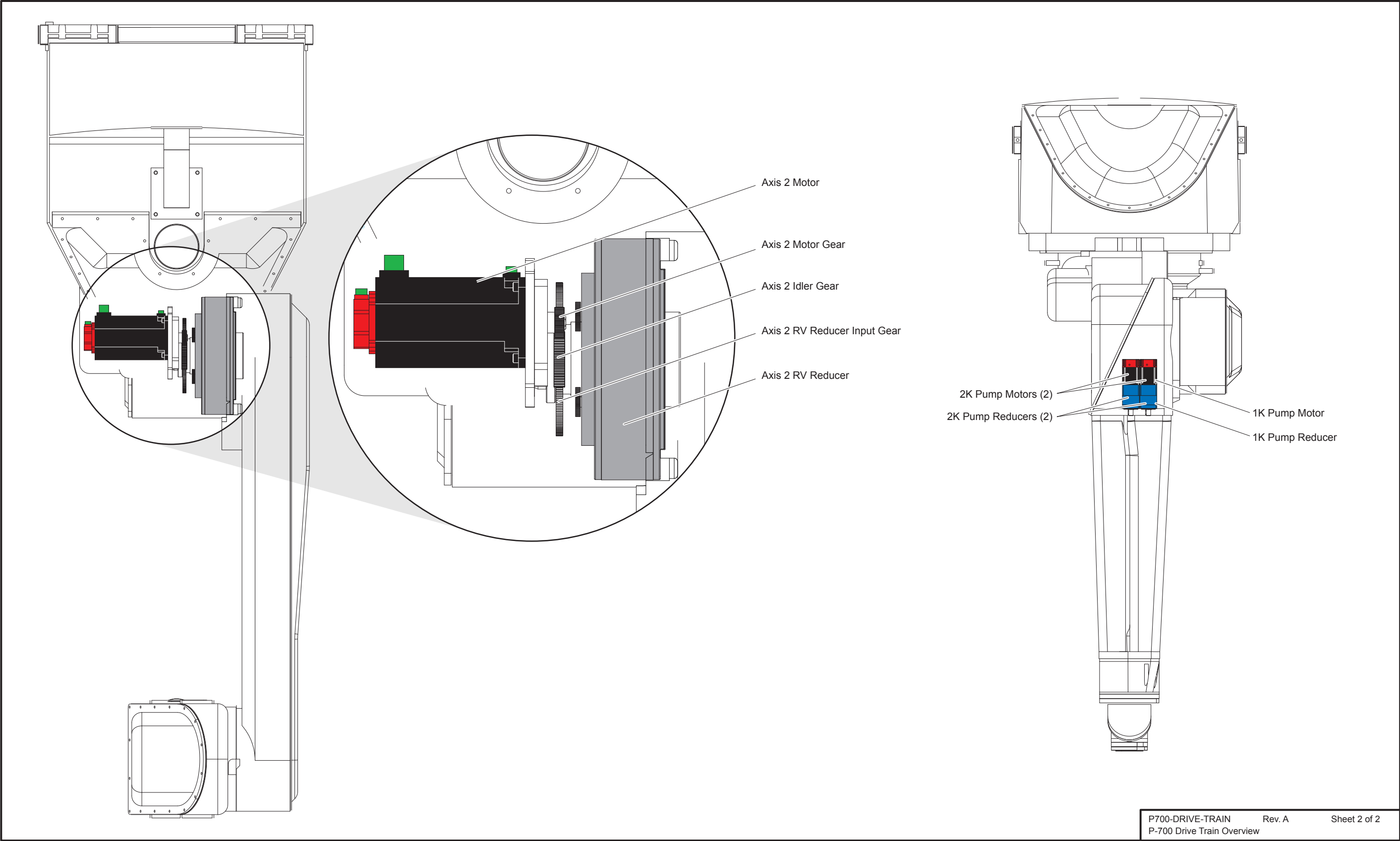


Figure 1–3. P-700iA Drive Train, Sheet 2



CHECKS AND MAINTENANCE

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2.1	PREVENTIVE MAINTENANCE	2-2
2.2	ROBOT LUBRICATION REQUIREMENTS	2-3
2.3	TOOLS	2-5

Optimum performance of the P-700iA robot can be maintained by following the lubrication and periodic general maintenance procedures in this chapter.

Table 2–1. Chapter Overview

For Information Regarding	Refer to
Preventive Maintenance	Table 2–1
Robot Lubrication Requirements	Section 2.2

2.1 PREVENTIVE MAINTENANCE

Note All cleaning procedures require skilled trades or maintenance personnel to be properly trained in performing proper maintenance procedures.

Note Follow all Lockout and Safety procedures before you enter the paint booth.

Note Wear safety glasses and protective gloves to clean the components.

Note Perform the cleaning procedures in a well ventilated area.

Daily Maintenance

- Clean the robot surface
- Clean the spray gun or applicator. See the appropriate applicator manual for more detailed information.

Maintenance for every 600 Hours of Operation

- Check the spray gun or applicator lines and cables

Maintenance for every 5000 Hours of Operation

- Check the robot cables
- Check the paint lines
- Make a visual check of the robot for grease leaks
- Check the grease levels for the reducers

2.2 ROBOT LUBRICATION REQUIREMENTS

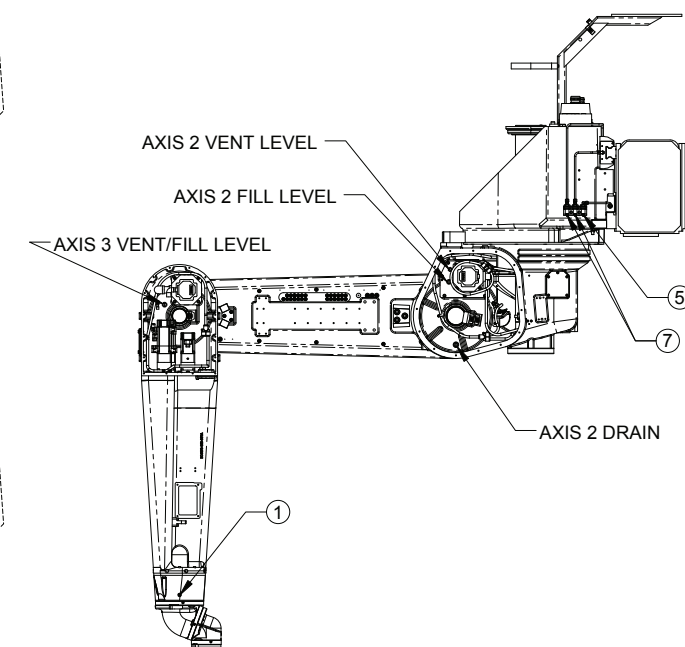
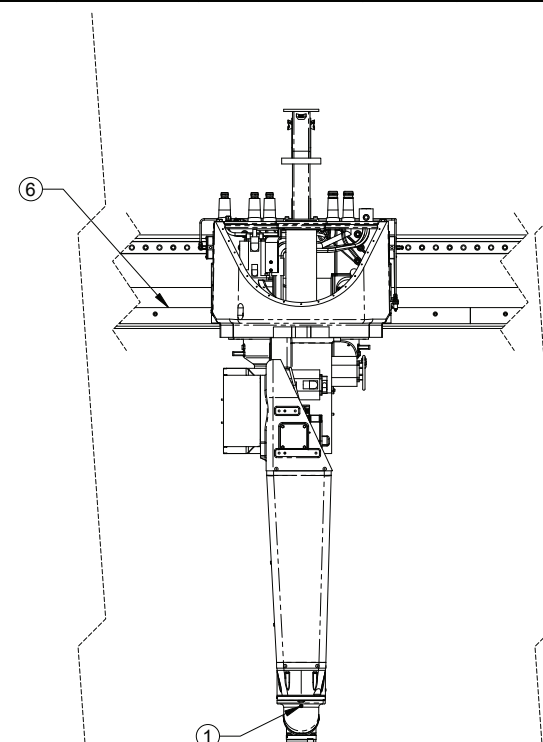
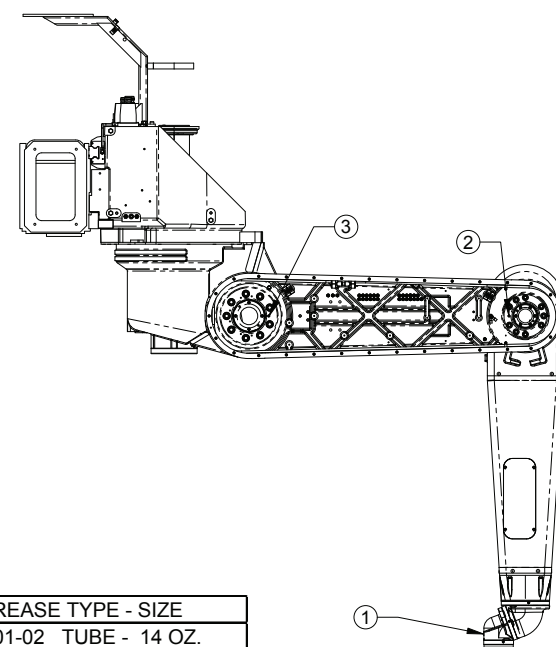
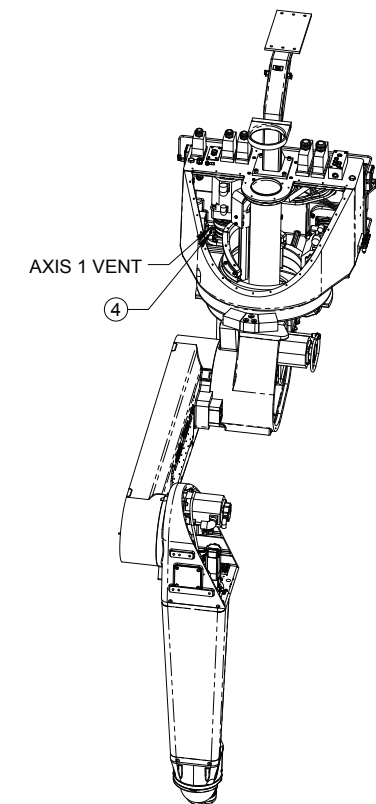
Figure 2–1. Maintenance ET-5093-800-006, Sheet 1

NOTES:

1. ALL GEARS AND BEARINGS SHOULD BE ROTATED/MOVED DURING LUBE.
2. LUBE UNTIL CLEAN GREASE COMES OUT FILL PORT. ADDITIONAL LUBE MAY BE REQUIRED. ENSURE ROBOT ARMS ARE POSITIONED AS SHOWN.
3. REMOVE BOLTS (LUBE & VENT) TO LUBE. REPLACE BOLTS WHEN DONE.
4. APPLY THIN FILM ON RACK TEETH.
5. REMOVE COVERS TO ACCESS LUBE POINTS.
6. ENSURE AIR POCKETS ARE OUT OF LINES.
7. AXIS 7 BEARINGS, RACK, AND PINION MAY NEED MORE FREQUENT LUBING IF EXCESSIVE OVER-SPRAY OR WASH DOWN OCCURS.
8. AFTER 50 HOUR RUN-OFF; WIPE OFF ALL EXCESS GREASE ON RAIL, CARRIAGE CASTING AND CAM FOLLOWER FACE PRIOR TO SHIPPING.
9. GREASE GUN TIP PRESSURE MUST BE UNDER 0.1Mpa WHEN GREASING AXIS 2 RV AND AXIS 3 RV.

INITIAL OR REBUILD LUBE REQUIREMENT						
LUBE POINT	ASSEMBLY LOCATION	GREASE TYPE	TOTAL AMOUNT (CUBIC INCHES)	NO. OF LUBE POINTS	AMOUNT PER LUBE POINT (CUBIC INCHES)	NOTES
	WRIST BEARINGS & GEARS	LG-01-02	4.0	HAND PACK DURING ASM.		10
1A	OUTER KNUCKLE	LG-01-02	2.0	1	15.3	3.9
1B	INNER KNUCKLE	LG-01-02	4.0	1	12.2	3.9
1C	WRIST HOUSING	LG-01-02	12.0	1	12.2	3.9
2	AXIS 3 RV	VIGO GREASE	71.0	1	71	2,3,5,9
3	AXIS 2 RV	VIGO GREASE	235.0	1	235	2,3,5,9
	AXIS 1 GEAR	LG-01-02	10.0	HAND PACK DURING ASM.		
4	AXIS 1 GEAR	LG-01-02	27.5	1	27.5	1,3,5
5	AXIS 7 PINION	LG-01-02	3.0	1	3.0	1,7,8
6	AXIS 7 RACK	LG-01-02	3	N/A	N/A	4.8
7	AXIS 7 BEARINGS	LG-01-02	5.2	2	2.4 LEFT/2.8 RIGHT	1.6, 7

MAINTENANCE LUBE SCHEDULE							
LUBE POINT	ASSEMBLY LOCATION	GREASE TYPE	FREQUENCY (HOURS)	TOTAL AMOUNT (CUBIC INCHES)	NO. OF LUBE POINTS	AMOUNT PER LUBE POINT (CUBIC INCHES)	NOTES
1	WRIST BEARINGS & GEARS	LG-01-02	20,000	3/4	3	1/4	1
2	AXIS 3 RV	VIGO GREASE	20,000	71	1	71	2,3,5,9
3	AXIS 2 RV	VIGO GREASE	20,000	235	1	235	2,3,5,9
4	AXIS 1 GEAR	LG-01-02	20,000	2	1	2	5
5	AXIS 7 PINION	LG-01-02	5,000	3	1	3	1,7
6	AXIS 7 RACK	LG-01-02	5,000	20	N/A	N/A	4,7
7	AXIS 7 BEARINGS	LG-01-02	5,000	4	2	2	1, 4, 7



STD. FANUC PART NO.	ZINC FREE FANUC PART NO.	GREASE TYPE - SIZE
HDWMO000004194O	HDWMO000004167O	LG-01-02 TUBE - 14 OZ.
HDWMO000004195O	HDWMO000004168O	LG-01-02 PAIL - 35 LB.
HDWMO000004196O	HDWMO000004169O	LG-01-02 KEG - 115 LB.
XGMF-16156		VIGO GREASE RE NO 0 - 16 KG.
XGMF-16799		VIGO GREASE RE NO 0 - 2 KG.

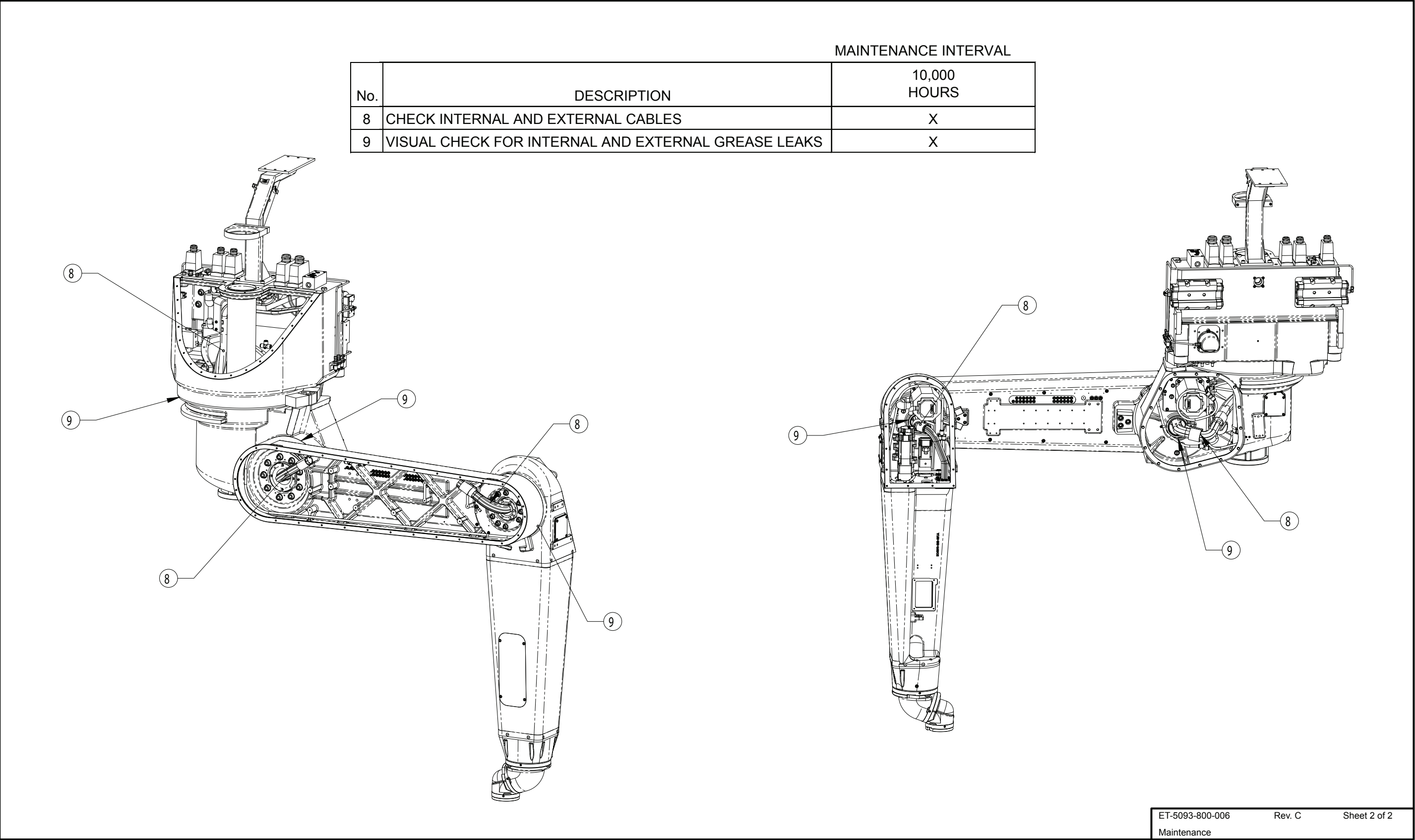
ET-5093-800-006

Rev. C

Sheet 1 of 2

Maintenance

Figure 2–2. Maintenance ET-5093-800-006, Sheet 2



2.3 TOOLS

Figure 2-3. Rack High Point Tool EO-4850-710-000

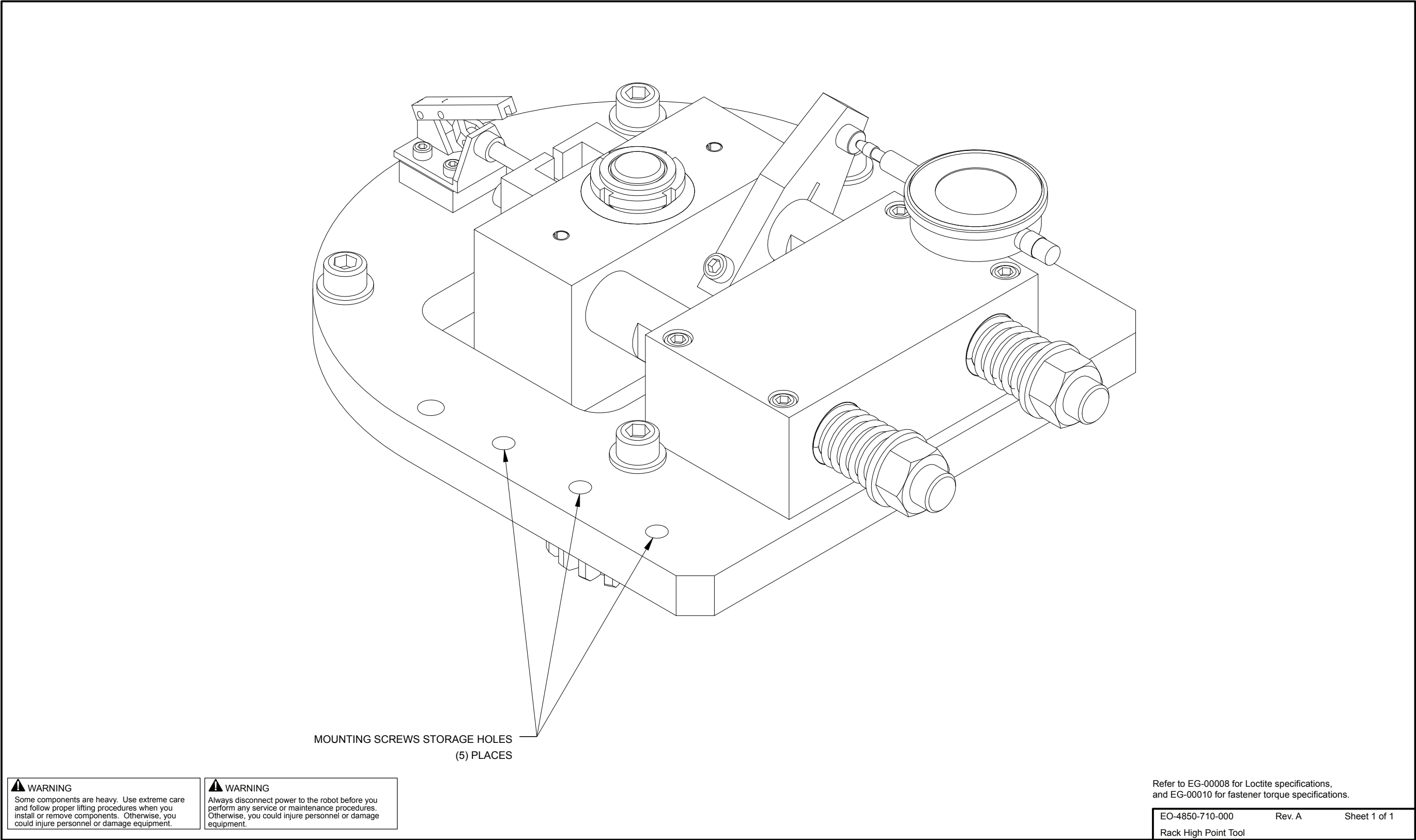


Figure 2–4. Rack High Point Tool EO-5093-755-000

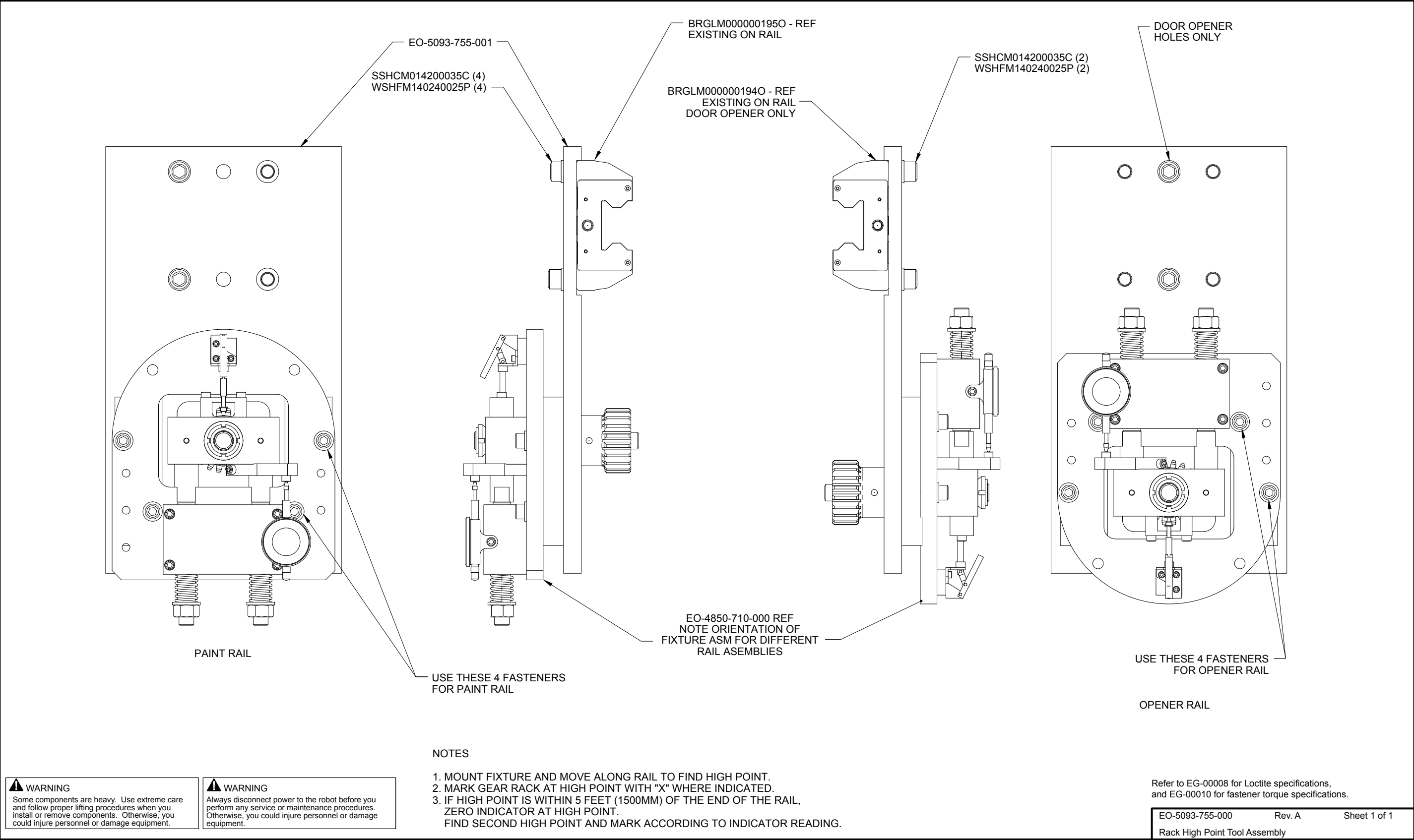
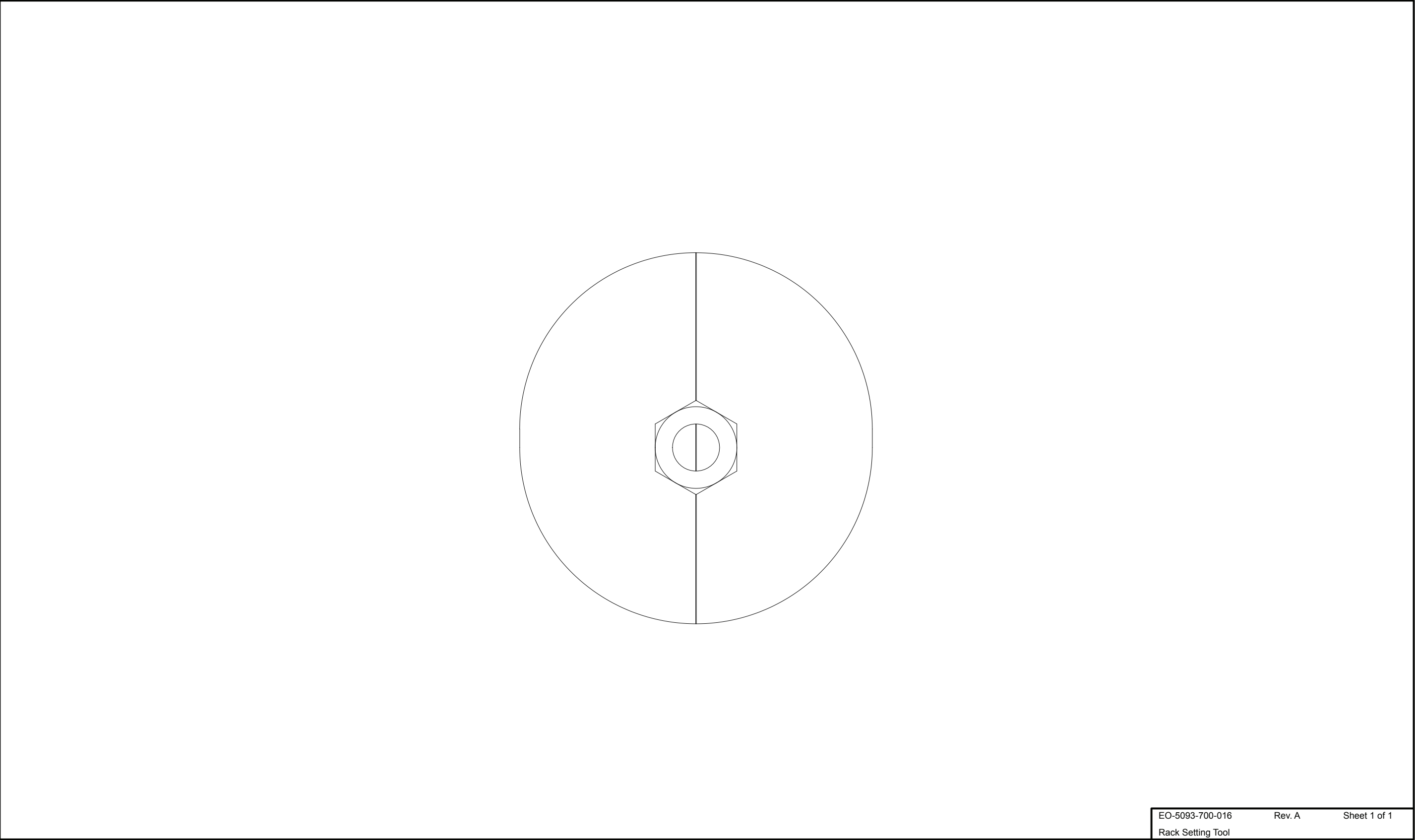


Figure 2–5. Rack Setting Tool EO-5093-700-016



TROUBLESHOOTING

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3.2.2	Purge System Testing and Calibration	3-9

3.1 MECHANICAL UNIT TROUBLESHOOTING

Table 3–1 shows the most common robot mechanical unit problems and their causes. If a cause or remedy is unclear, contact FANUC Robotics.

Table 3–1. Problems and Causes

Symptom	Cause	Remedy
The robot does not return to the zero position correctly	Low voltage of the memory backup battery.	Replace the battery.
	Unusual external start signal.	Investigate the cause.
	Incorrect parameter.	Revise parameters.
Position offset	The robot has been hit.	Revise the teaching points.
	The robot is not firmly fastened to the base plate.	Retighten.
	Peripheral device was shifted.	Reposition.
	Incorrect parameters.	Revise parameters.
	Defective pulse coder cable.	Replace the cable.
	APC (Absolute Pulse Coder) malfunction.	Replace the motor or the pulse coder.
	Play in mechanical unit.	Refer to excessive play symptom in this table.
Vibration	The robot is not firmly fastened to the base.	Retighten.
	Excessive floor vibration (especially when installed above the first floor).	Investigate the installation location and adjust the robot location if necessary.
	An incorrect servo adjustment.	Adjust the servo.
	A defective cable.	Replace the cable.
	The robot is not grounded.	Connect to ground.
	A defective motor.	Replace the motor.
	A defective reducer.	Replace the reducer.
	Incorrect time.	Revise the time.
	Play in the mechanical unit.	Refer to the excessive play symptom in this table.

Table 3–1. Problems and Causes (Cont’d)

Symptom	Cause	Remedy
Excessive play	A loose screw or pin.	Tighten and apply LOCTITE as specified.
	A defective reducer.	Replace the reducer.
	An incorrect gear backlash.	Adjust the gears.
	Worn gears.	Replace the gears.
	Worn bearings.	Replace the bearings.
	A cracked casting.	Replace cracked parts.
Unusual noise	Insufficient gear or reducer lubrications.	Lubricate.
	Foreign matter in a gear or a reducer.	Clean and lubricate.
	Excessive pressure on the bearings.	Reduce the pressure on the bearings.
	A defective reducer.	Replace the reducer.
	An incorrect gear adjustment.	Adjust the gears.
	Worn gears.	Replace the gears.
	Worn bearings.	Replace the bearings.
	Cable pair damage.	Replace the cable pair.
	An incorrect servomotor adjustment.	Adjust the servomotor.
Over heating	Insufficient gear or reducer lubrication.	Lubricate.
	The specified grease was not used.	Replace with the specified grease.
	Excessive pressure on bearings.	Reduce the pressure on the bearings.
	An excessive load on the wrist.	Reduce the load and restrict the movement conditions.
	An incorrect gear adjustment.	Adjust the gears.
	An incorrect time constant.	Revise the time constant.
The robot drops (10 mm or more) when the power supply is off	The brake gap is too large.	Replace the motor.
	Fused brake drive relay.	Replace the relay.
Grease leakage	Deteriorated O-ring, oil seal, or packing.	Replace the O-ring, oil seal, or packing.
	A cracked casting.	Replace the cracked parts.
	Loose screws.	Tighten the screws.
	Excessive quantity of grease.	Remove some of the grease.

3.2 P-700iA PURGE CYCLE TROUBLESHOOTING, DIAGNOSTICS, AND TESTING

Table 3-2. Overview

For Information Regarding	Refer to
P-700 system purge process	Chapter 6 <i>PURGE SYSTEM DESCRIPTIONS</i>
Possible purge cycle problems	Table 3-3
Testing the purge cycle	Procedure 3-2

3.2.1 P-700iA Purge Procedure and Troubleshooting

Figure 3–1. Purge Process and Troubleshooting Flow Chart

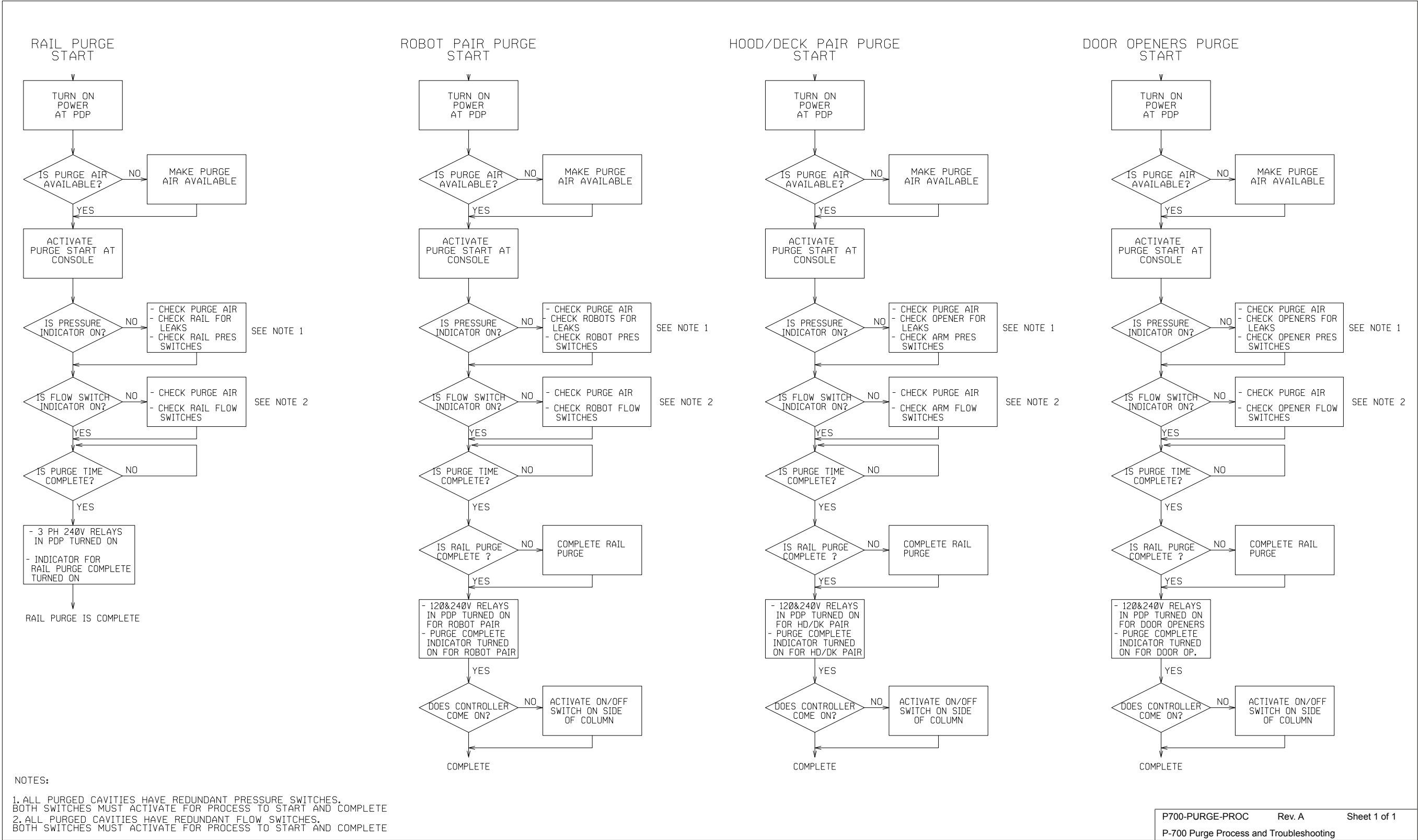


Table 3–3. Possible Purge Cycle Problems

PROBLEM	CAUSE	WHAT TO CHECK FOR
Inadequate air flow through the robot	Air supply capacity inadequate	The air supply is inadequate. Check the air pressure at the pneumatic air supply column. See Figure 3–2 or Figure 3–3 .
Air leakage from robot	Bad seal	Look for leakage around cover gaskets and bearing seals, at the cable entrance to the robot, holes where plugs or screws are missing, through unsealed conduit.
Pressure switch or air flow switch does not appear to work	Defective pressure switch or air flow switch	Perform the pressure switch test and air flow switch test to check components.
Inconsistent readings on the pressure gauge	Air leaks or other problems with the pneumatic air distribution	Check continuity of the pressure switch and air flow switch, during dynamic test conditions. Check pressure gauge.



Caution

Both the Pressure Switches and the Air Flow Switches are adjusted and sealed at the factory or authorized vendor. They are not adjustable in the field. If you break or tamper with the seal you will void FM certification on the robot.

Figure 3–2. P-700iA Single Robot Pneumatic Column Assembly

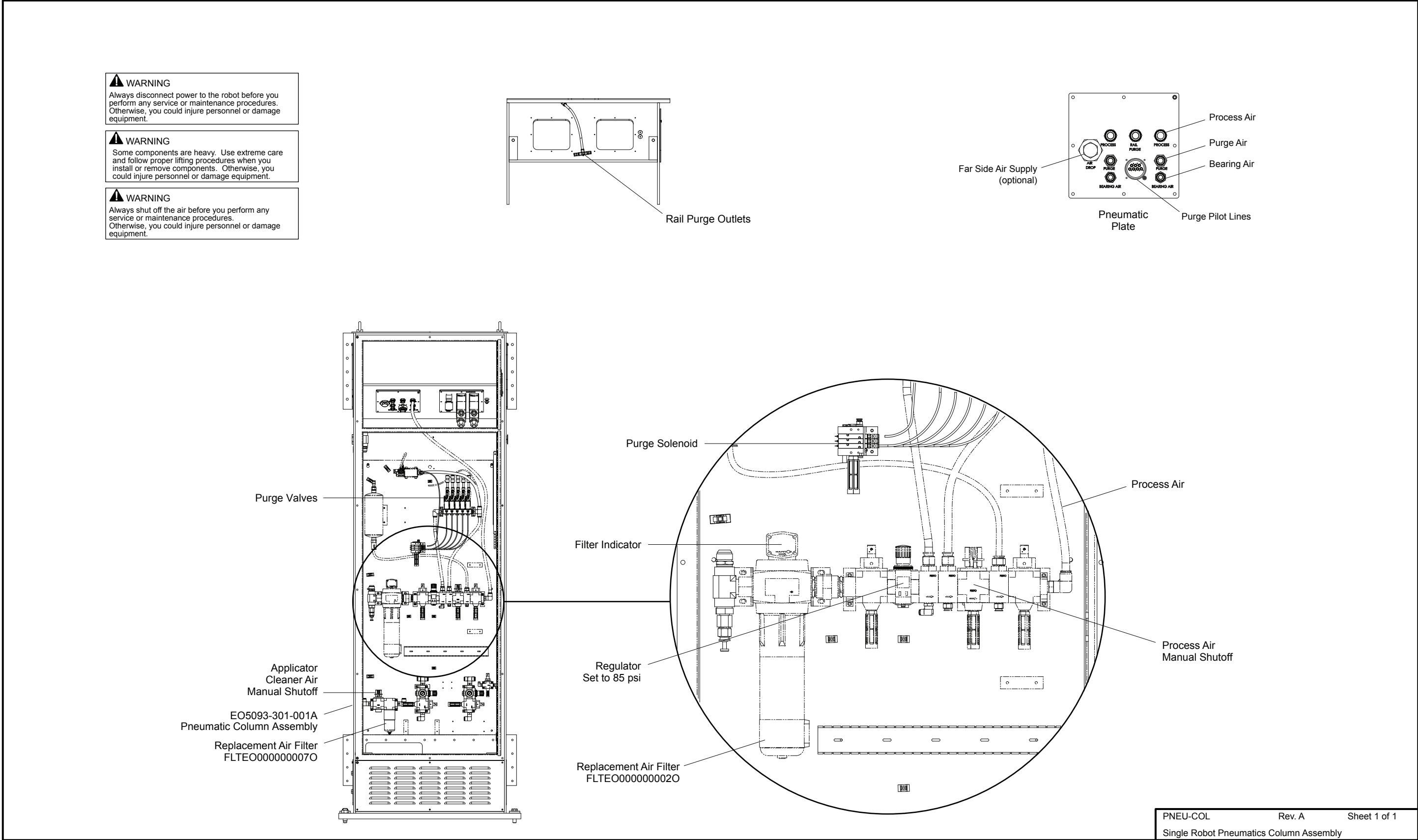
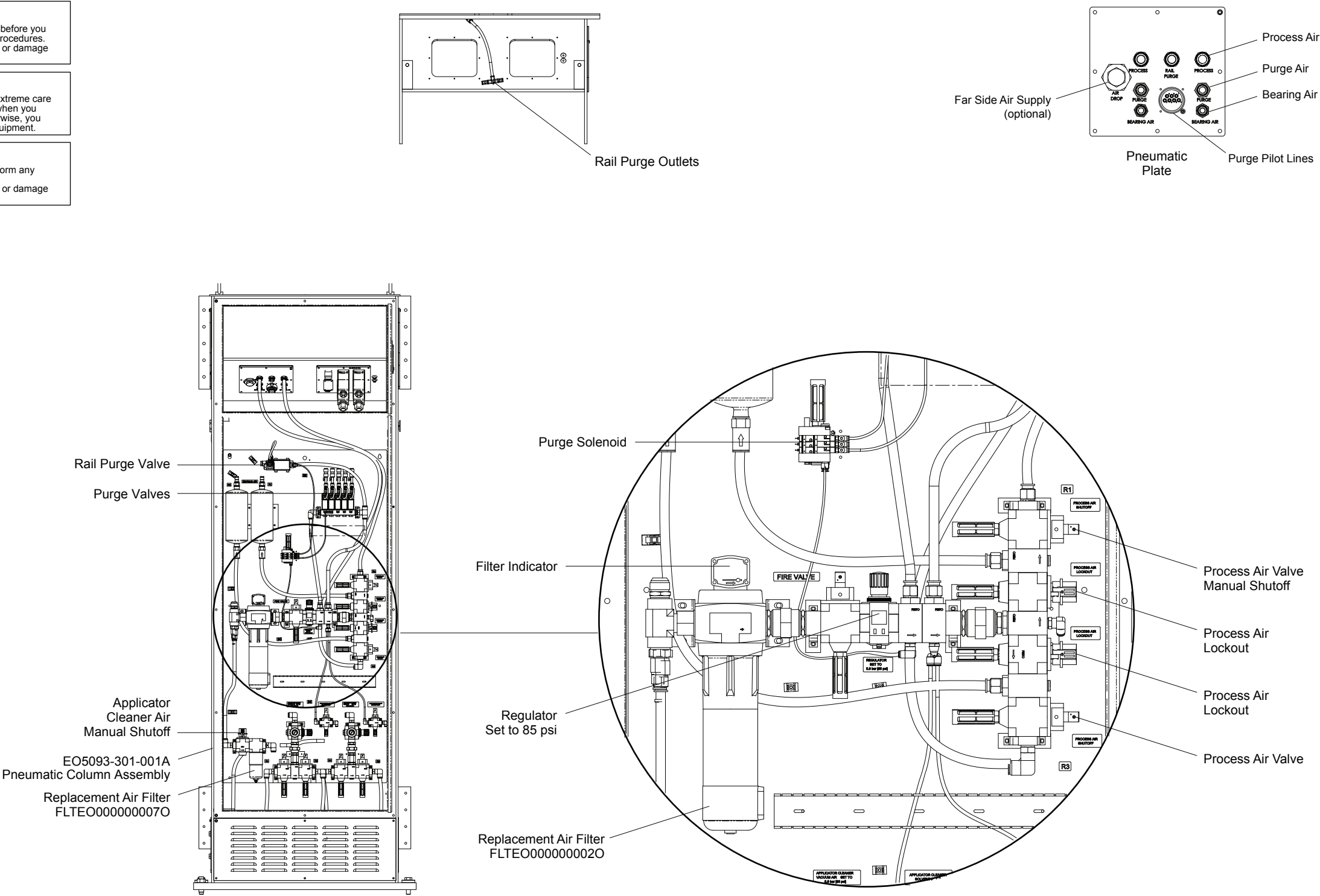


Figure 3–3. P-700iA Dual Robot Pneumatic Column Assembly

⚠ WARNING
Always disconnect power to the robot before you perform any service or maintenance procedures. Otherwise, you could injure personnel or damage equipment.

⚠ WARNING
Some components are heavy. Use extreme care and follow proper lifting procedures when you install or remove components. Otherwise, you could injure personnel or damage equipment.

⚠ WARNING
Always shut off the air before you perform any service or maintenance procedures. Otherwise, you could injure personnel or damage equipment.



3.2.2 Purge System Testing and Calibration

The following hardware listed below is necessary to perform the purge cycle test. Use [Procedure 3-1](#) to test for purge air leakage.

Required Purge Hardware

- Air source capable of supplying a minimum of 1100 slpm.
- One pressure gauge to read 0-5 inches of water (Dwyer #2005 or equivalent)
- Two air fittings, 1/8-inch NPT to 1/4 inch tubing (Parker #68C4-2 or equivalent)
- One nylon tube measuring 1/4 inch in diameter by 24 inches long (Parker #NN-4-035 or equivalent)
- Leak detector liquid (Nupro Snoop or equivalent)

Procedure 3-1 Testing for Purge Leaks

Steps

1. While the purge air is flowing, inspect the robot for leakage around all joints, seals and gaskets. No excessive air must be felt except at the purge outlet.

Note Apply a leak detection fluid, such as Nupro Snoop, to areas under inspection; check for bubbling.

2. Pay close attention to
 - Covers - Make sure each bolt is snug. Check for leaks around bolts and from cover, gasket, or surface damage.
 - Seals - Check each joint for leaks. Internal seals might be damaged or missing and internal mating surfaces, which also act as seals, might be worn or damaged.
 - Cable Penetration (Rox for CE and TIIS only) - Ensure that there is a tight seal around the cables.

Procedure 3-2 P-700iA Testing the Purge Cycle for the Robot and Rail

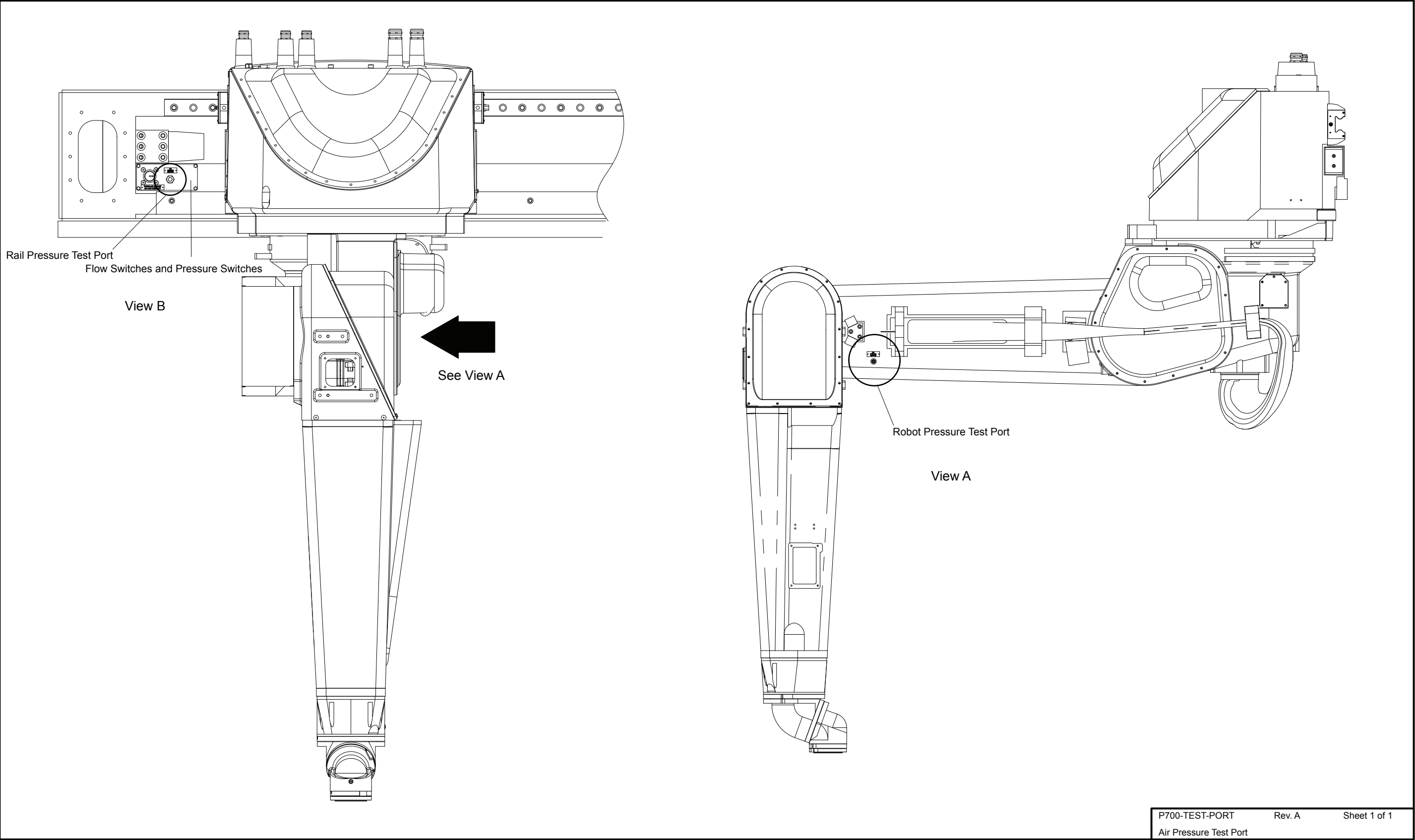
- Make sure all robot covers, plugs, and connectors at the cable entrance to the robot and rail are tight.
- Ensure that the main disconnect on the PDP is ON.
- Ensure that air is supplied to the system.
-

Steps

1. Ensure that the system air supply valve is open.
2. Tighten cover bolts where air leaks. Replace the gasket if necessary.

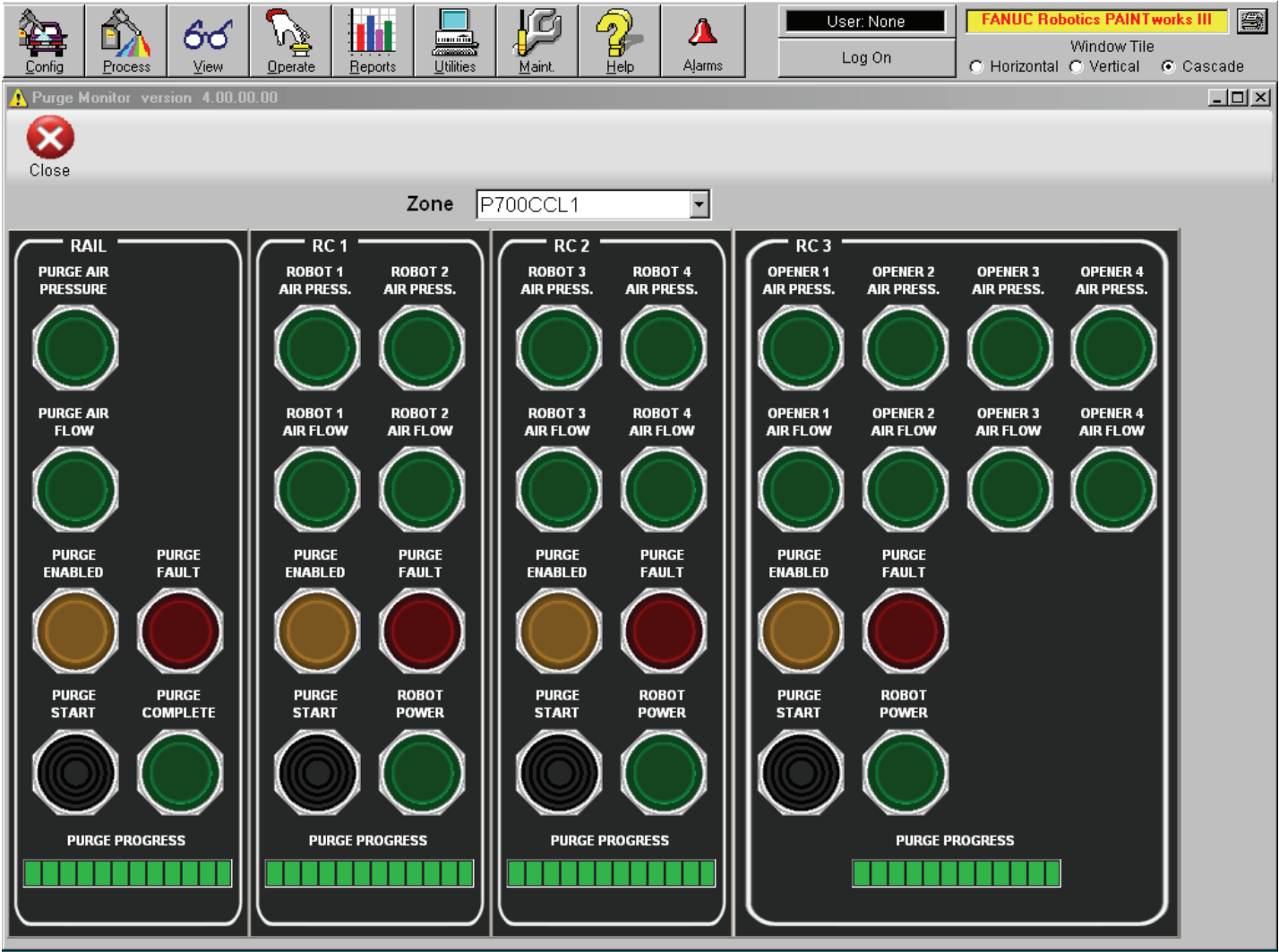
- 3. Connect a pressure gauge (0 to 5 inches H₂O) to the test port on the robot, see View A in [Figure 3–4](#) . Verify that the internal relative pressure is 2-2.5 inches H₂O. If the pressure is not at this level, verify that the regulator pressure is at 60 psi dynamic.

Figure 3–4. P-700iA Robot and Rail Purge Test Ports

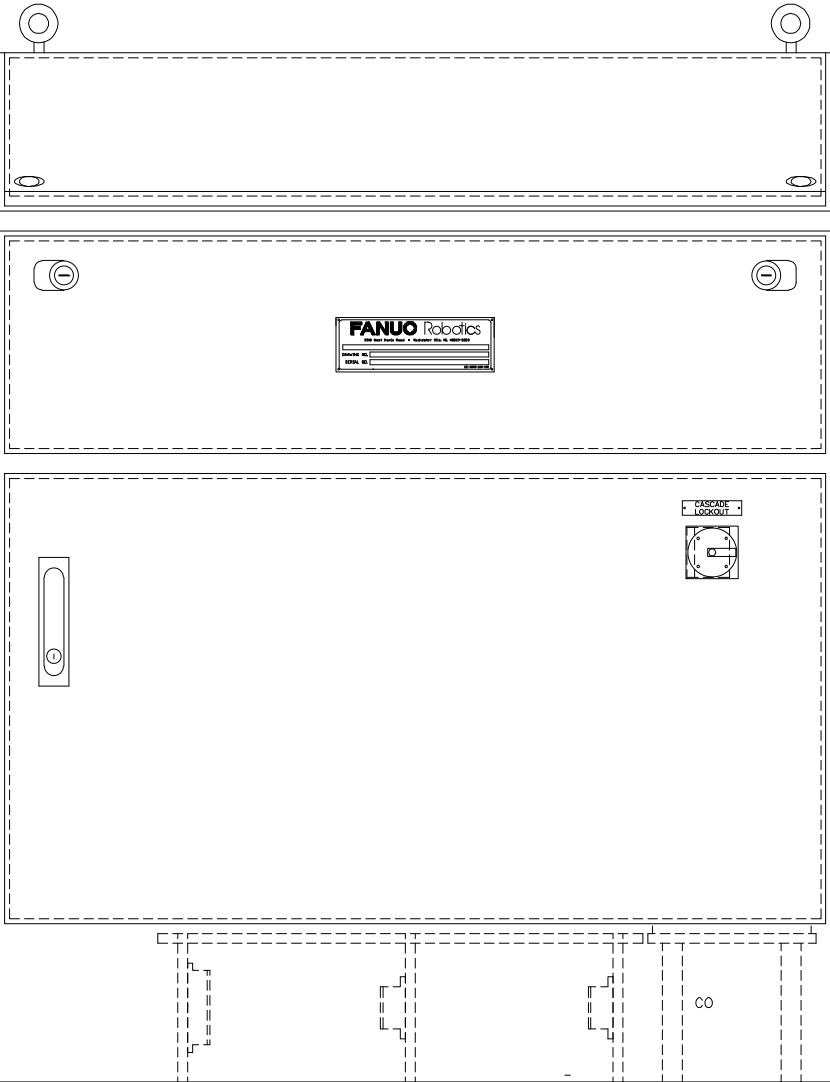


4. Connect a pressure gauge (0 to 5 inches H₂O) to the test port on the rail, see View B in [Figure 3–4](#) . Verify that the internal relative pressure is 2-2.5 inches H₂O. If the pressure is not at this level, verify that the regulator pressure is at 60 psi dynamic.
5. Be sure that the Purge Air Pressure indicator on the System Control Console is illuminated. See [Figure 3–5](#) .

Figure 3–5. Paint Application Console



Console Operator Purge Panel



System Control Console

- 6. If the Purge Air Pressure is not illuminated, refer to [Table 3-3](#) .
- 7. Press and hold the PURGE START button on the system control console until it lights (See [Figure 3-5](#)). After it is lit, the robot will purge for 3.1 minutes to 7.9 minutes depending on the rail configuration. Verify this time, beginning when the PURGE ENABLED button lights and ending when the PURGE COMPLETE LED lights. If the purge enable indicator does not light shortly after the purge button is pressed (15 to 20 seconds), or if the light flickers, an air leak in the robot or an inadequate air source is the probable cause.



Warning

Connections to the pressure, flow switches, and solenoid valve are intrinsically safe. Insure at least 50mm of clearance between intrinsically safe wiring and any other wiring. Insure any test equipment used in connection to intrinsically safe circuits is rated for use in a hazardous environment and has been certified by a nationally recognized testing laboratory such as UL, FM, CSA, and so forth. Otherwise, if you do not observe these precautions, it could cause an explosion, injuring personnel and damaging equipment.

REPLACING PARTS

Contents

Chapter 4	REPLACING PARTS	4-1
4.1	P-700iA MECHANICAL UNIT	4-2
4.2	CARRIAGE PARTS	4-25
4.3	PEDESTAL PARTS	4-40
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4.5	TOOLS	4-49

4.1 P-700iA MECHANICAL UNIT



Caution

Illustration instructions in bold type affect the robot form, fit or function. This information can include but is not limited to RV reducer fastener torque, lube requirements, and Loctite specifications. It is important that you adhere to these instructions; otherwise, you could injure personnel or damage equipment.



Caution

Proper Loctite usage and fastener torque is essential to maintain component integrity. Refer to [Appendix B](#) for proper Loctite usage and fastener torque specifications; otherwise, you could injure personnel or damage equipment.

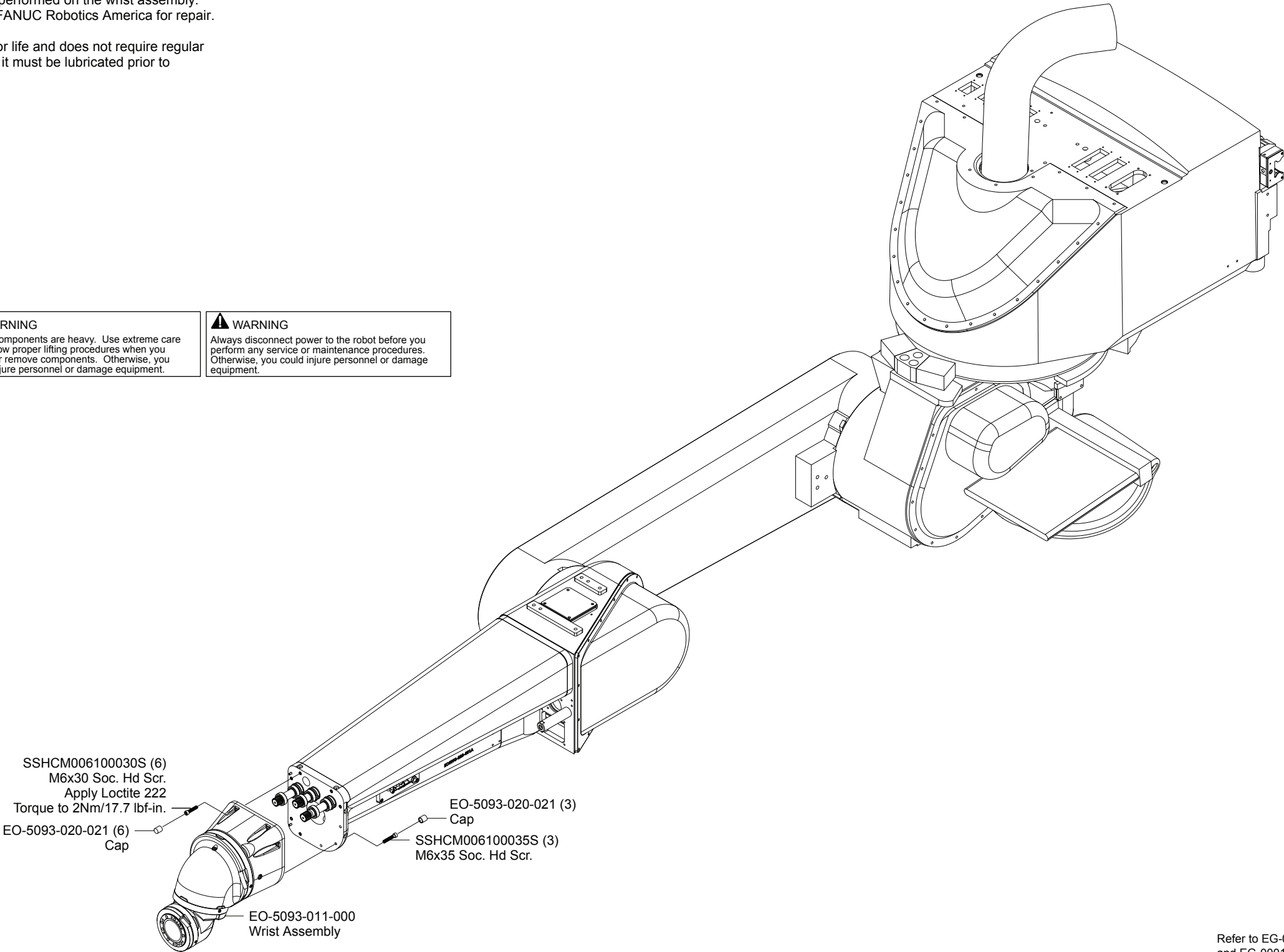
Figure 4–1. Mounting the Wrist EO-5093-011-000

Assembly Notes:

- 1. Mechanical service should not be performed on the wrist assembly.
Replace the entire unit or return it to FANUC Robotics America for repair.
- 2. This wrist assembly is lubricated for life and does not require regular lubrication. If a new wrist is installed, it must be lubricated prior to mounting it to the outer arm.

⚠ WARNING
Some components are heavy. Use extreme care and follow proper lifting procedures when you install or remove components. Otherwise, you could injure personnel or damage equipment.

⚠ WARNING
Always disconnect power to the robot before you perform any service or maintenance procedures. Otherwise, you could injure personnel or damage equipment.



Note:
The design detail of the robot shown is typical and intended for reference only.

Refer to EG-00008 for Loctite specifications, and EG-00010 for fastener torque specifications.

Figure 4–2. Solvent Borne Outer Arm Assembly EO-5093-020-000, Sheet 1

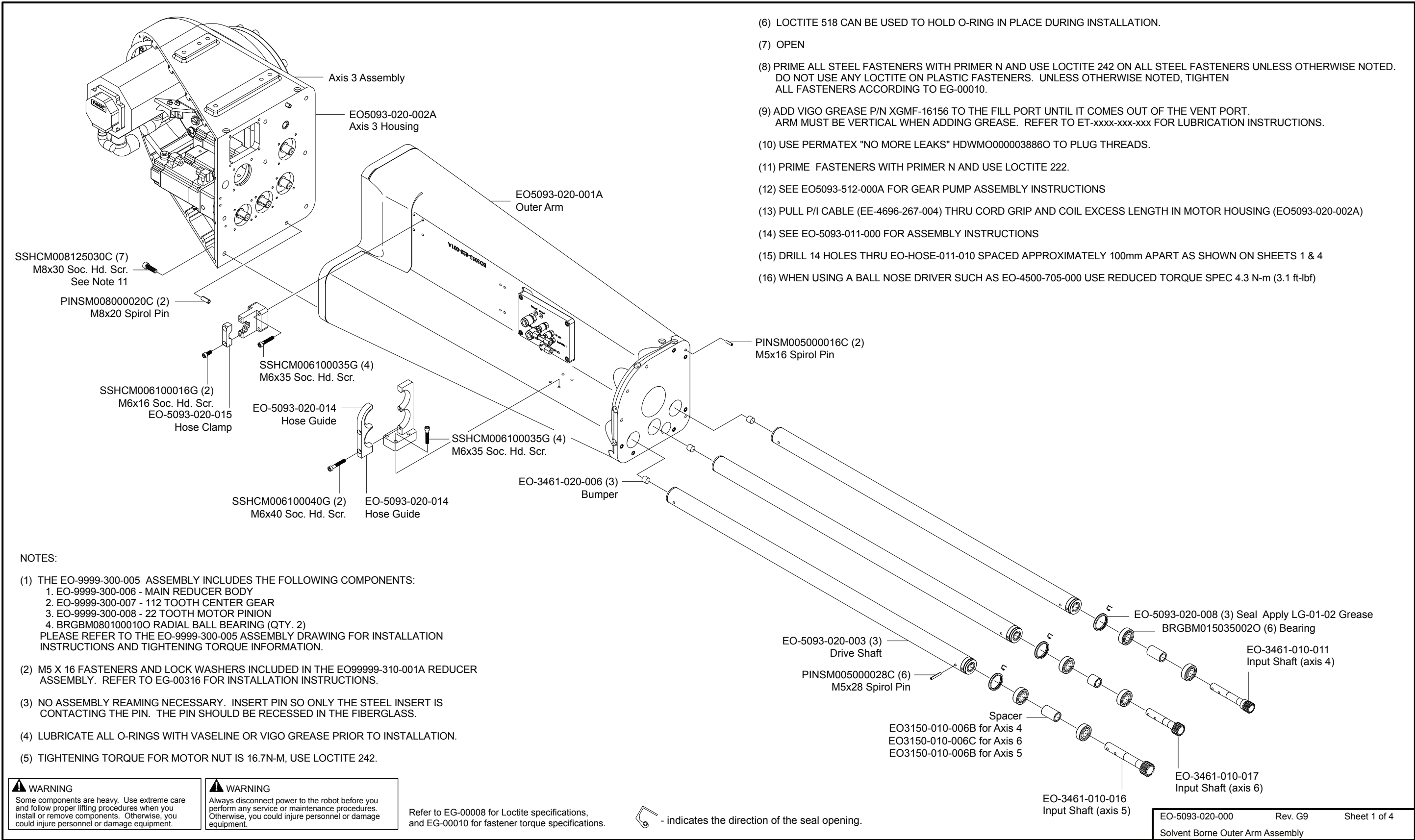


Figure 4-3. Solvent Borne Outer Arm Assembly EO-5093-020-000, Sheet 2

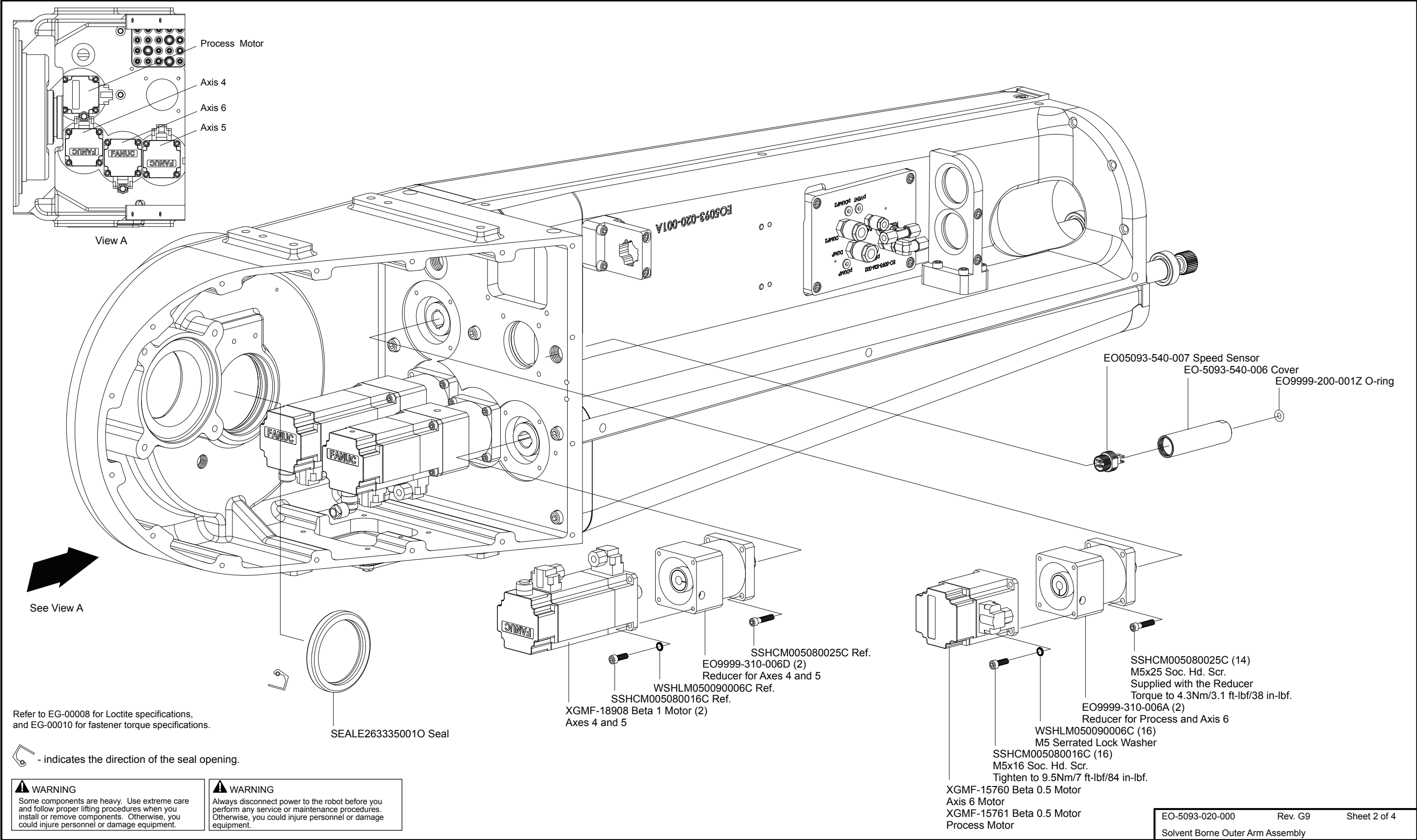


Figure 4-4. Solvent Borne Outer Arm Assembly EO-5093-020-000, Sheet 3

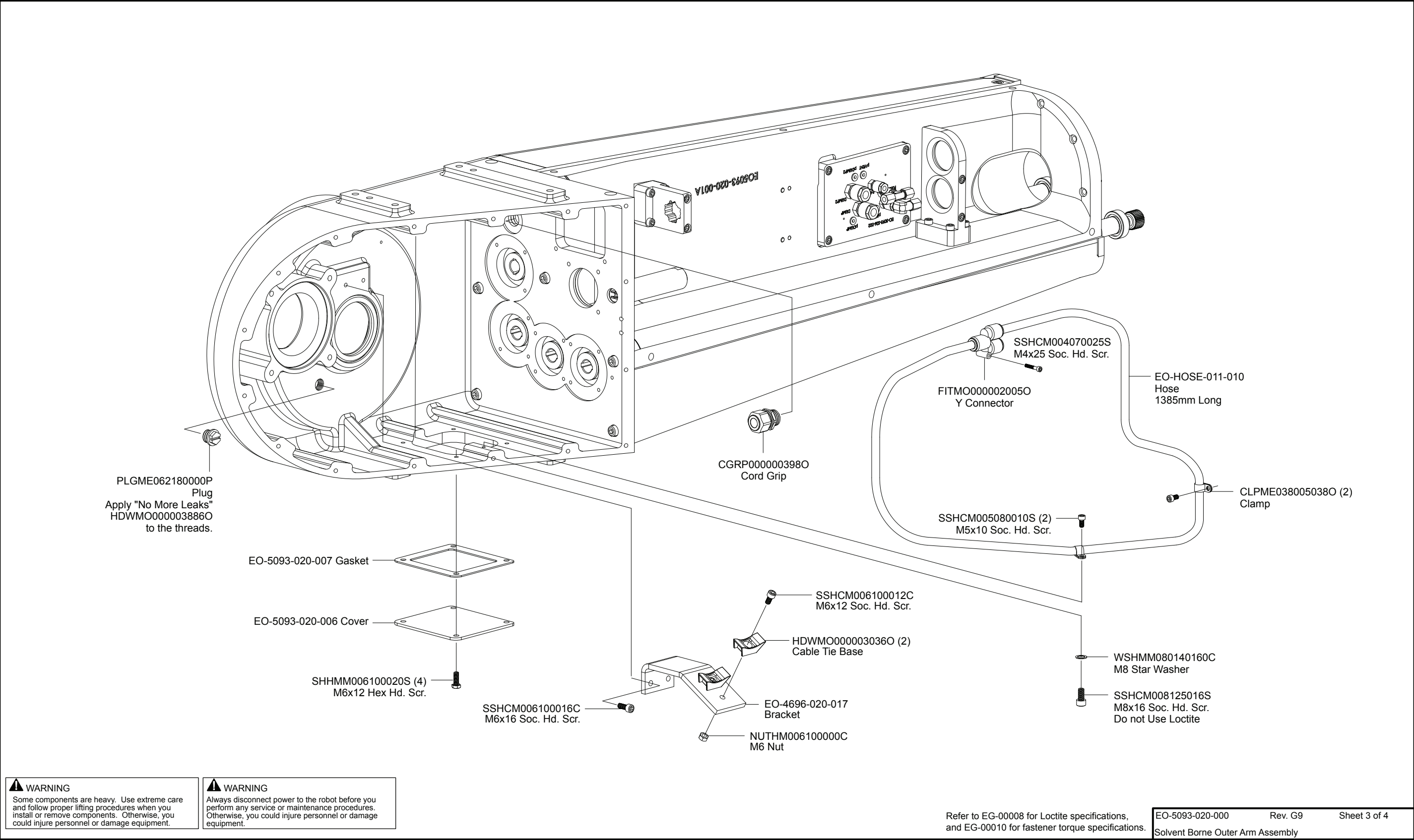


Figure 4–5. Solvent Borne Outer Arm Assembly EO-5093-020-000, Sheet 4

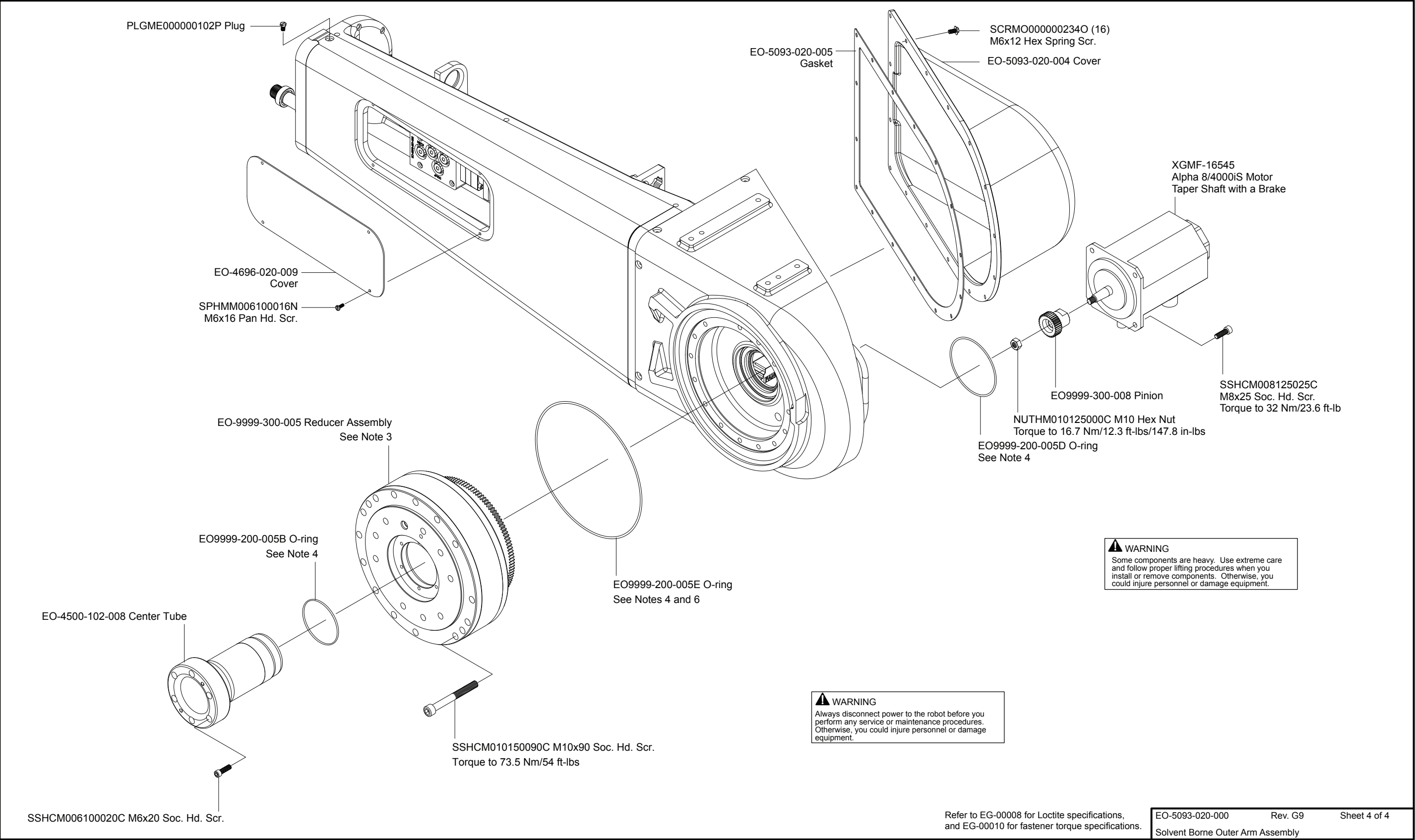


Figure 4–6. 2K Outer Arm Assembly EO-5093-022-000, Sheet 1

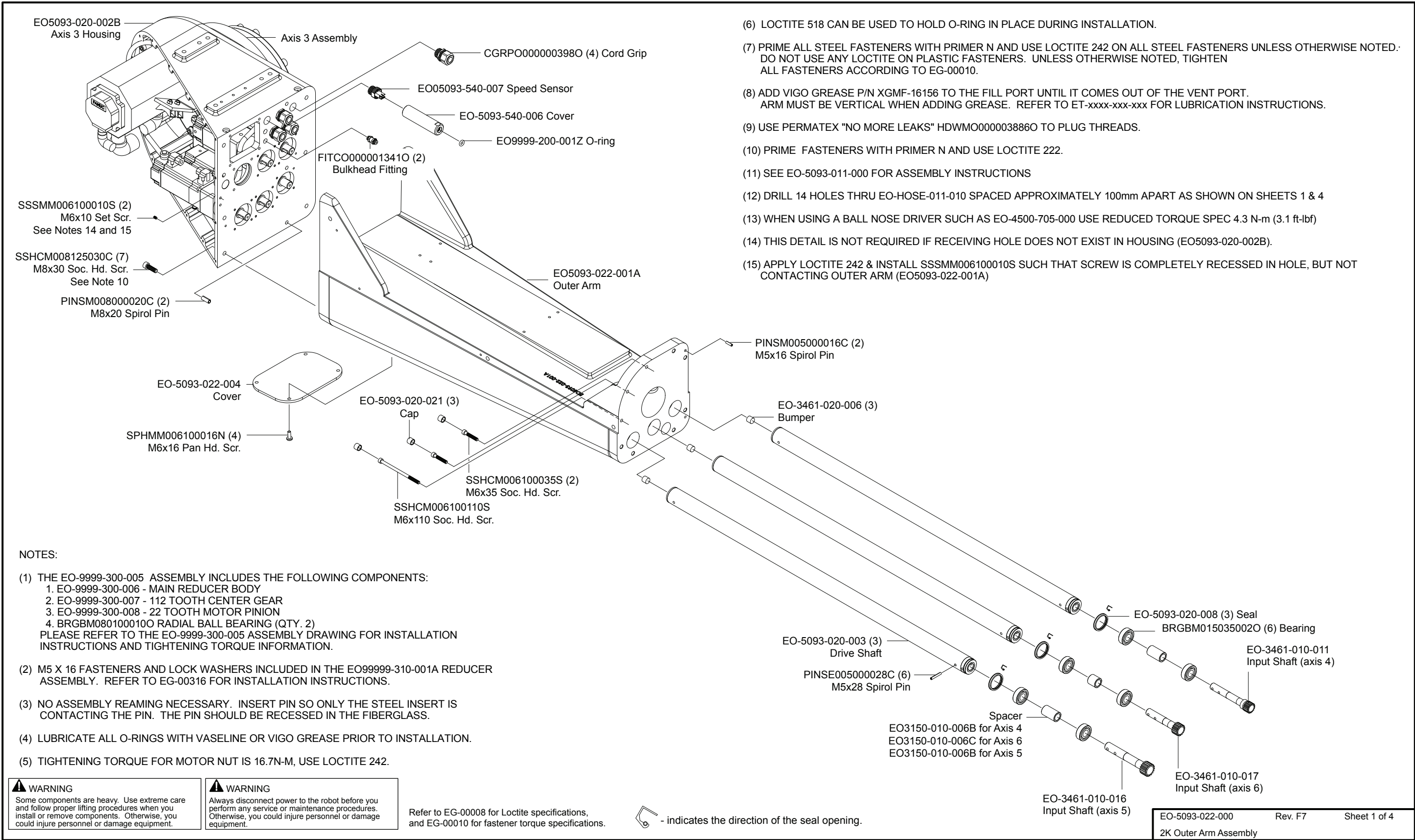


Figure 4-7. 2K Outer Arm Assembly EO-5093-022-000, Sheet 2

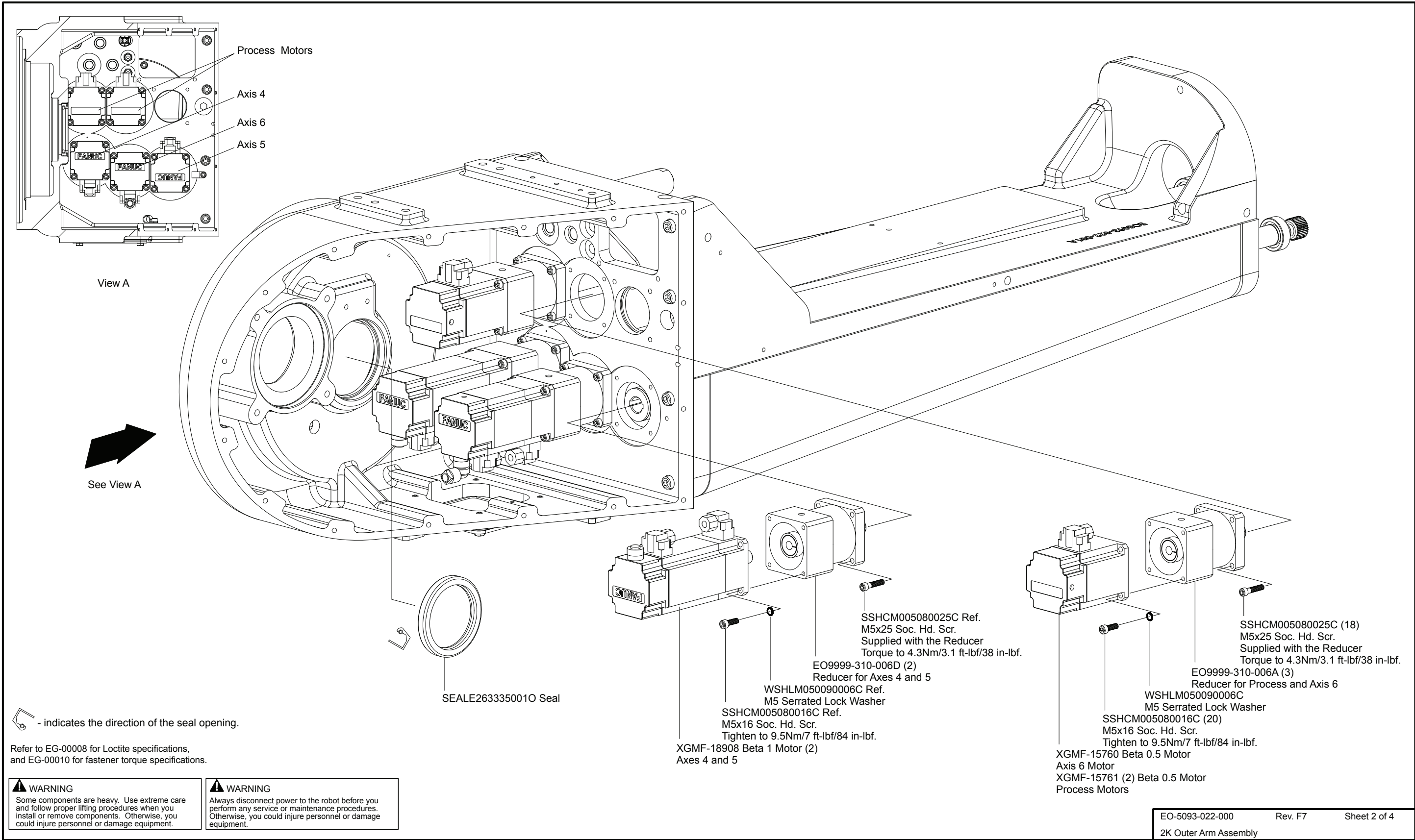


Figure 4–8. 2K Outer Arm Assembly EO-5093-022-000, Sheet 3

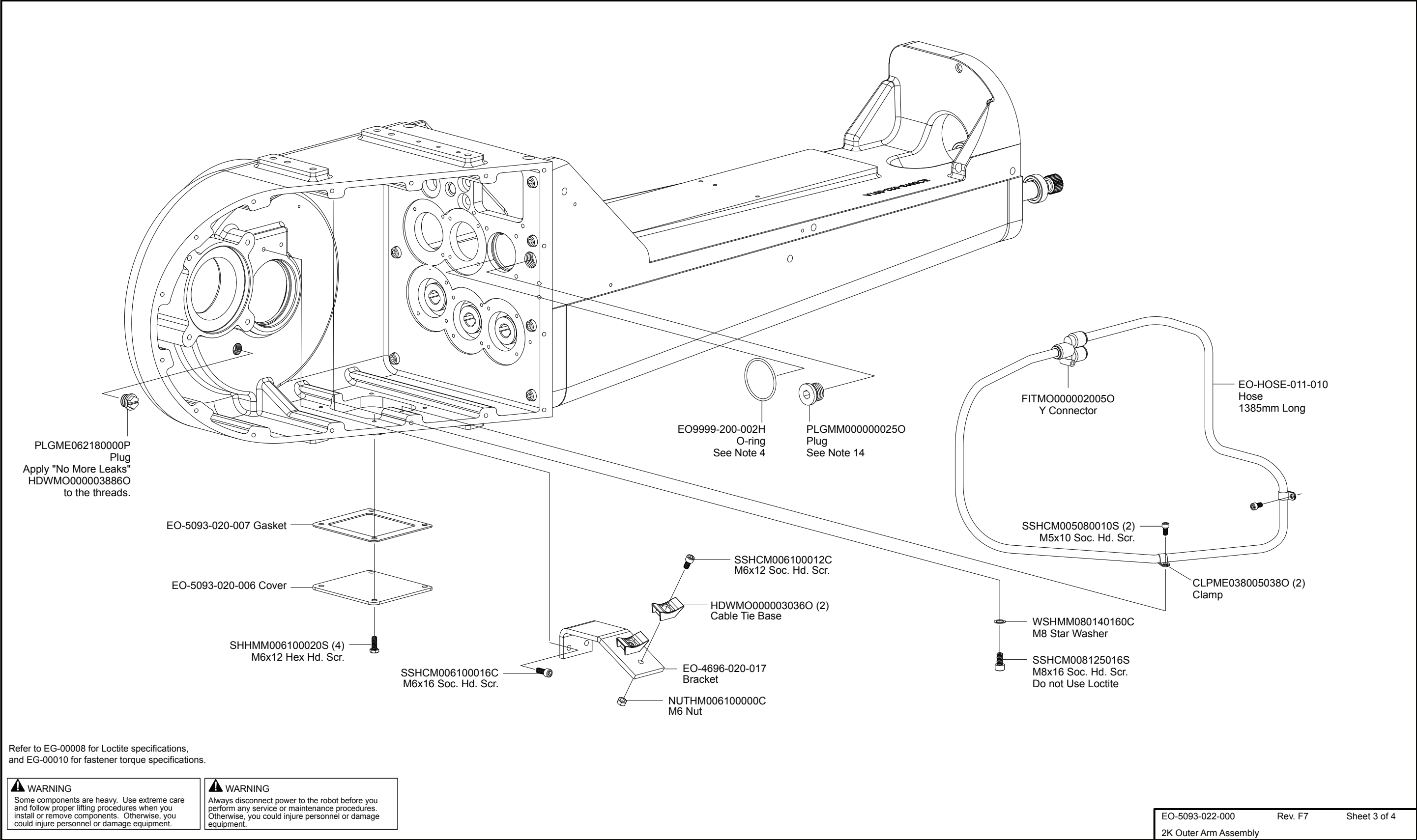


Figure 4–9. 2K Outer Arm Assembly EO-5093-022-000, Sheet 4

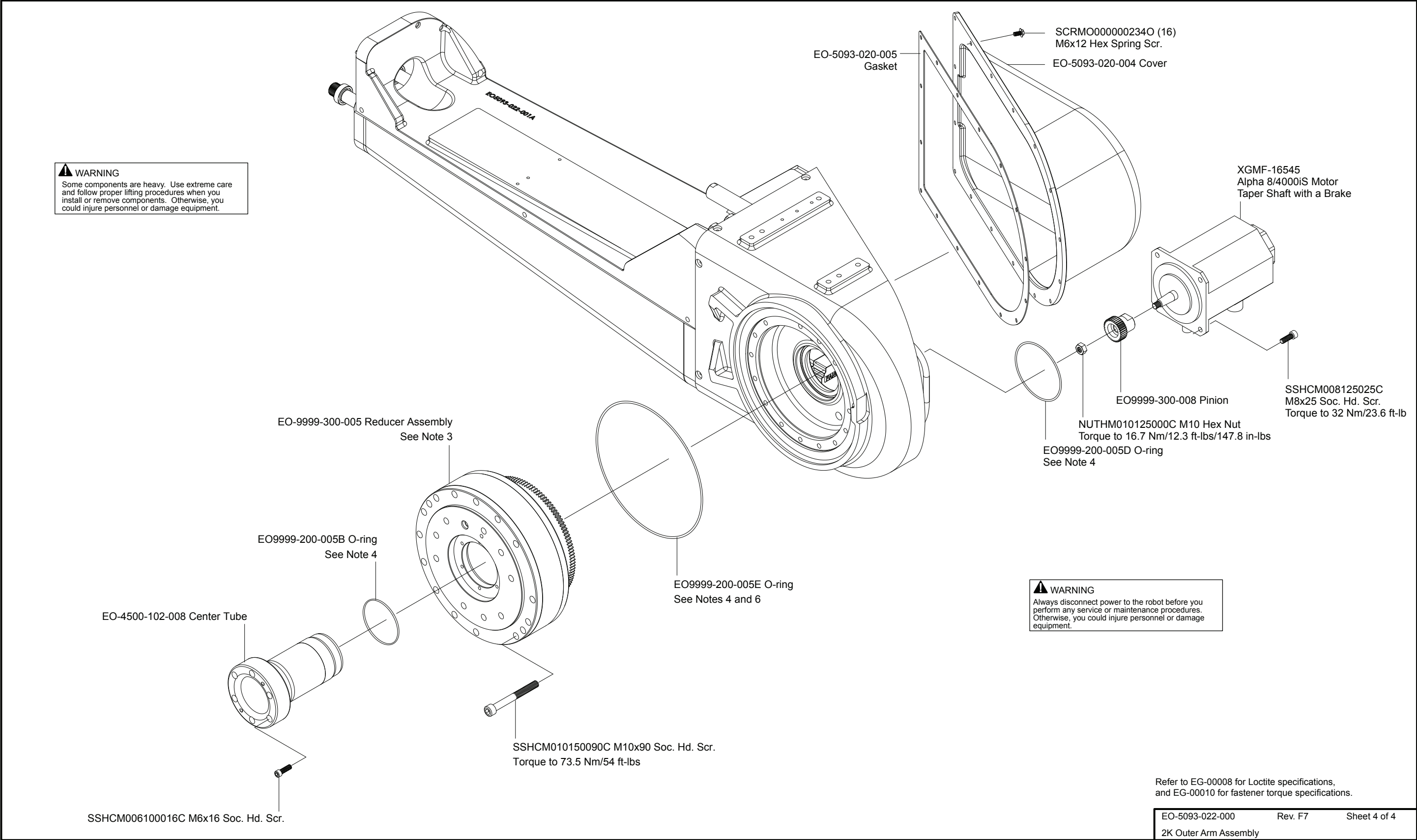


Figure 4–10. Outer Arm Cover EO-5093-022-002

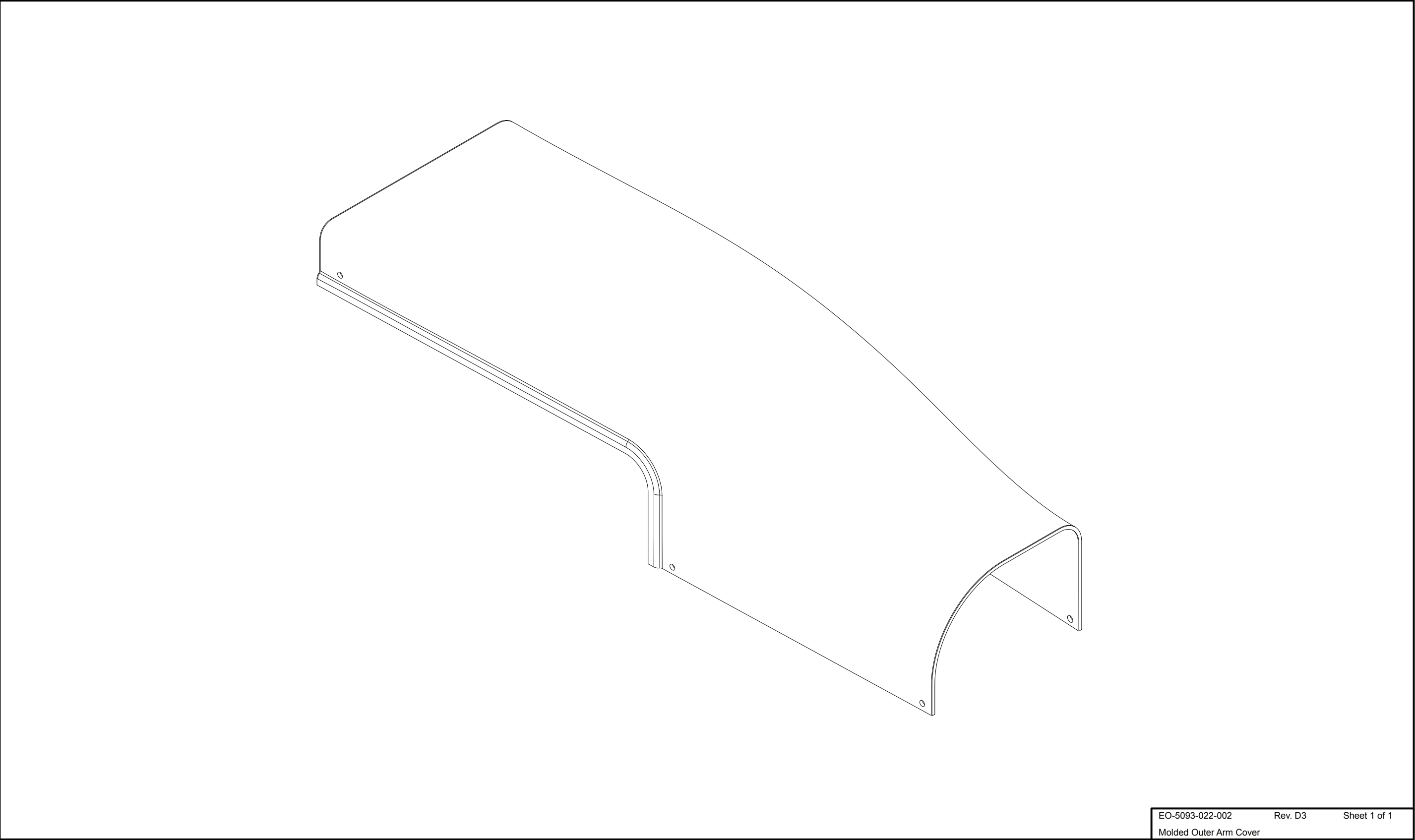


Figure 4–11. 2K Hose Tunnel EO-5093-022-003

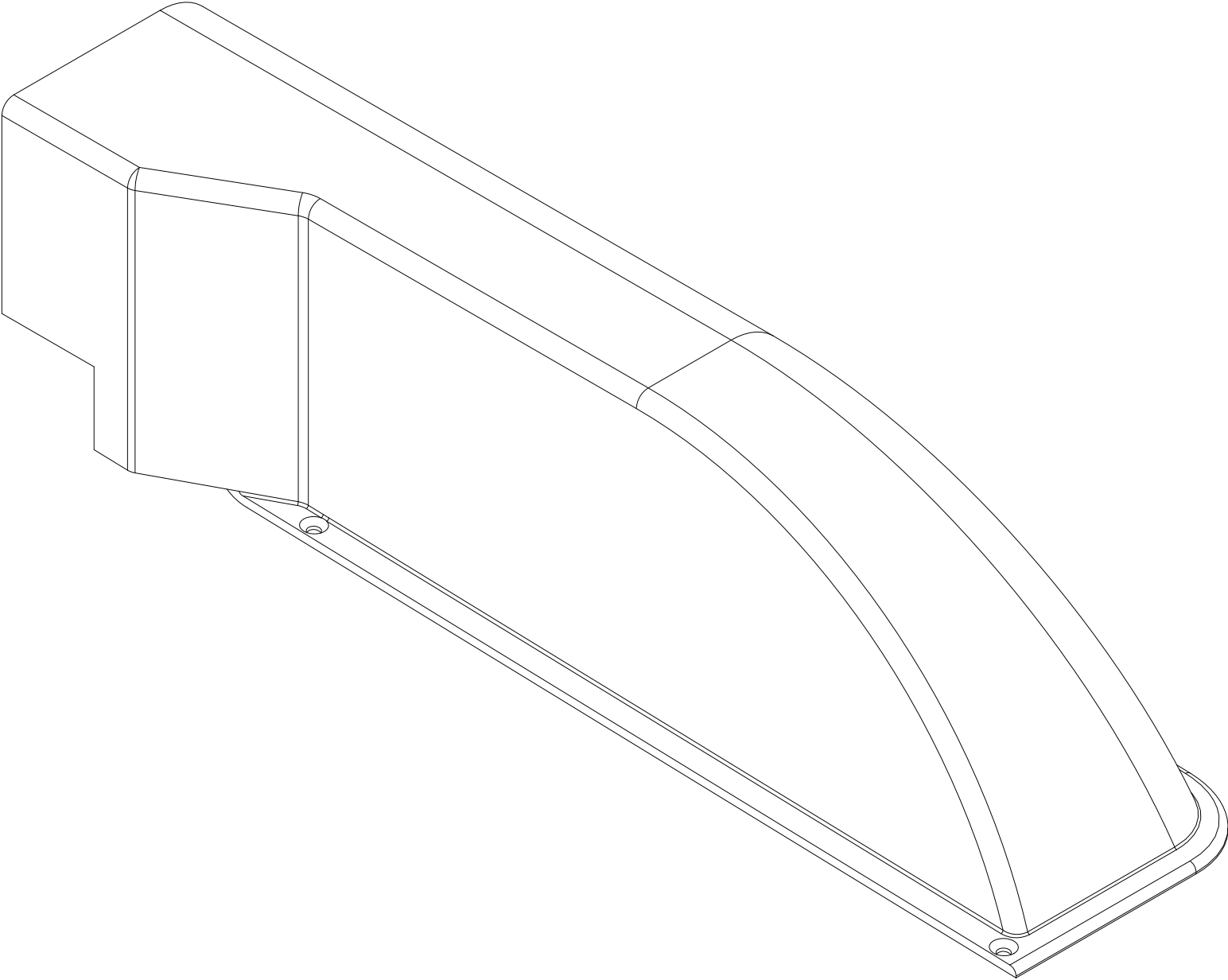


Figure 4–12. Waterborne Outer Arm Assembly EO-5093-025-000, Sheet 1

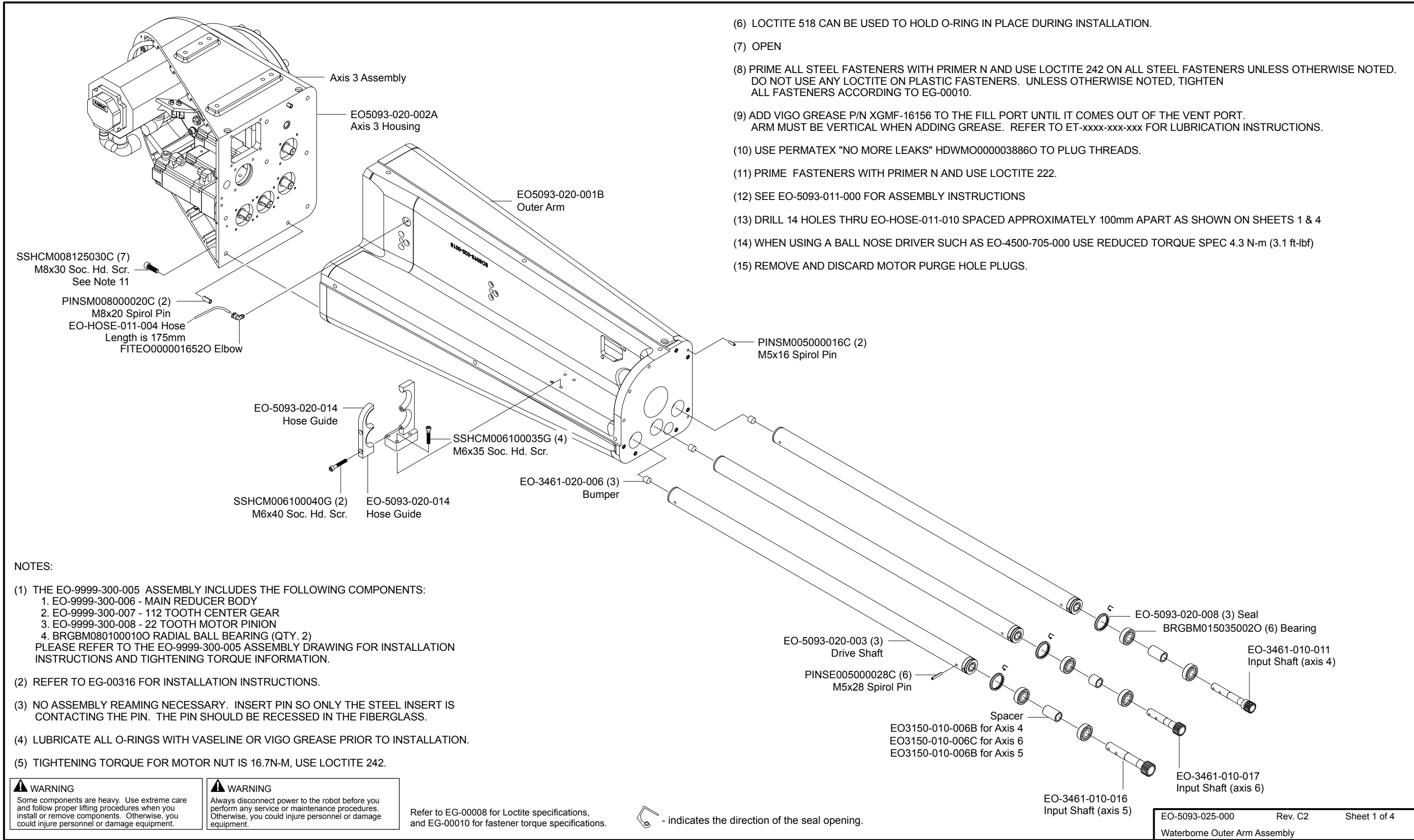


Figure 4–13. Waterborne Outer Arm Assembly EO-5093-025-000, Sheet 2

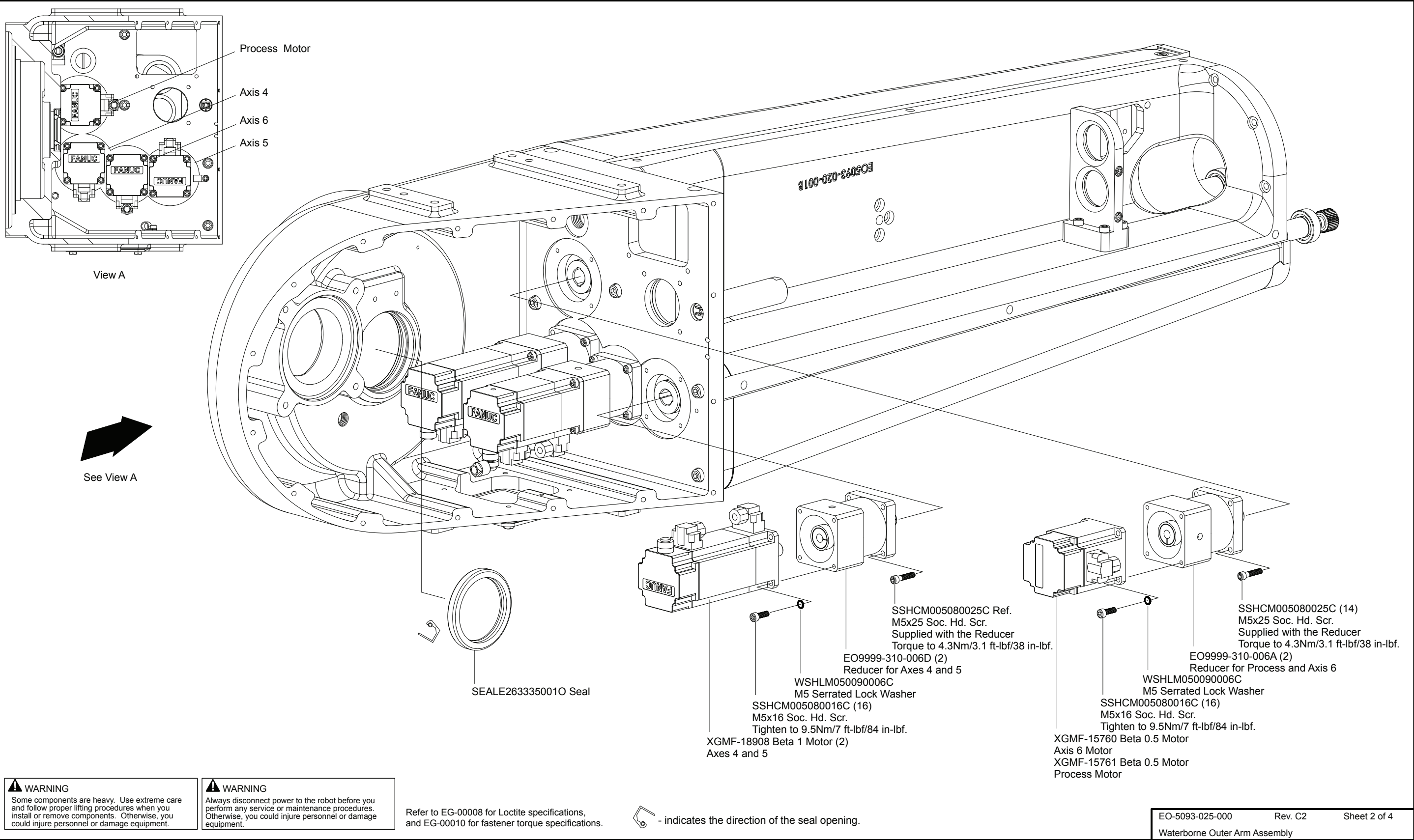


Figure 4–14. Waterborne Outer Arm Assembly EO-5093-025-000, Sheet 3

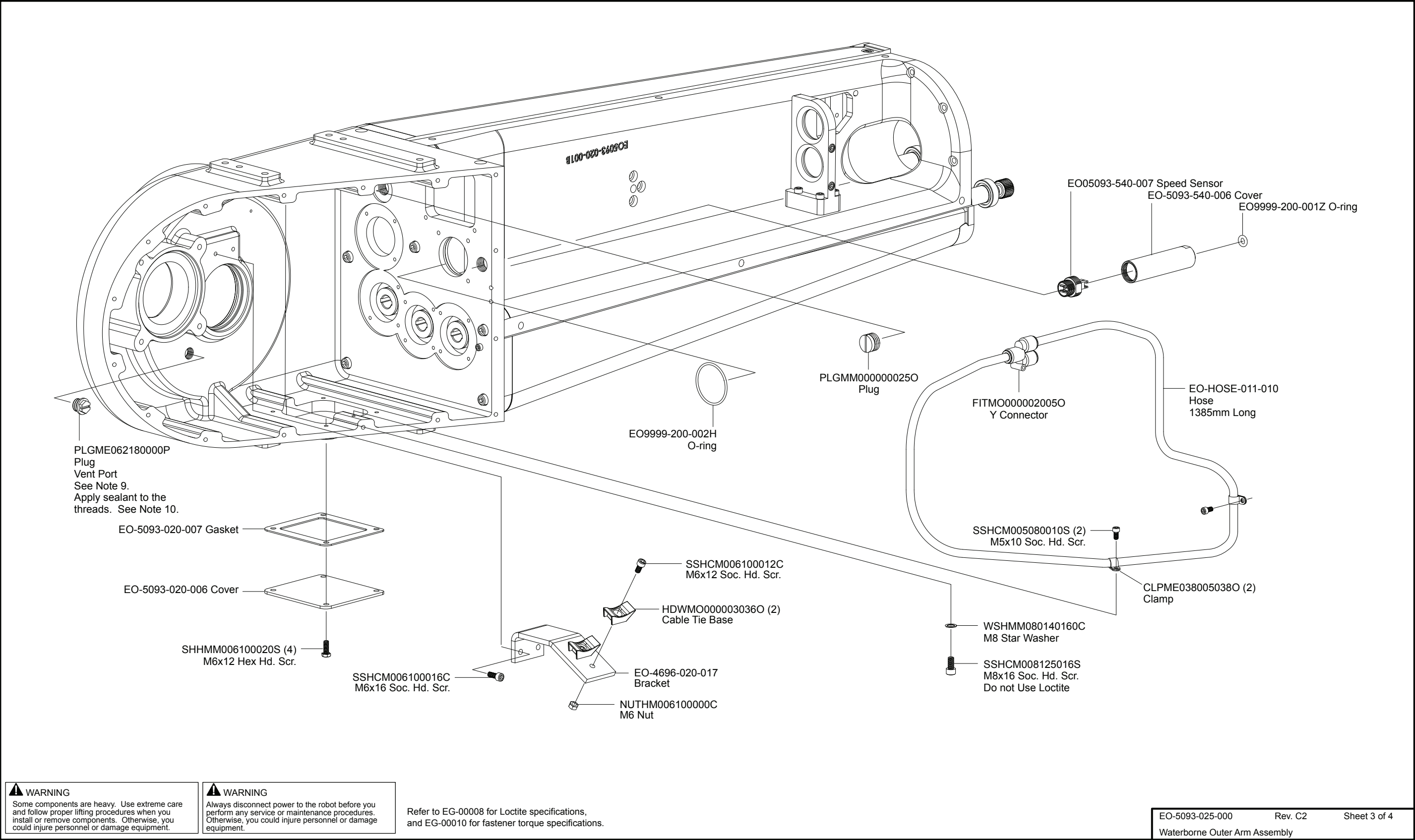


Figure 4–15. Waterborne Outer Arm Assembly EO-5093-025-000, Sheet 4

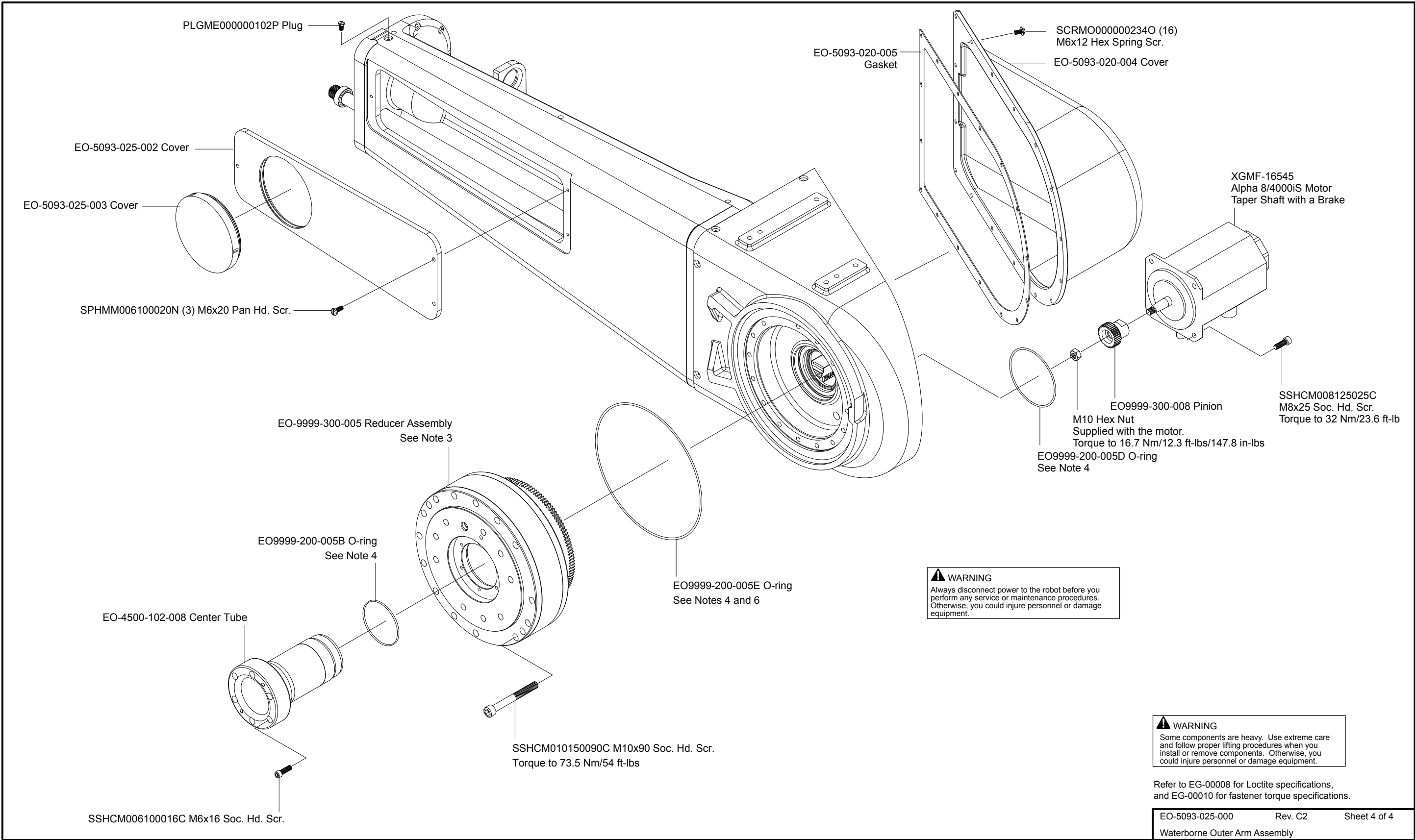


Figure 4–16. Inner Arm Assembly EO-5093-060-000, Sheet 1

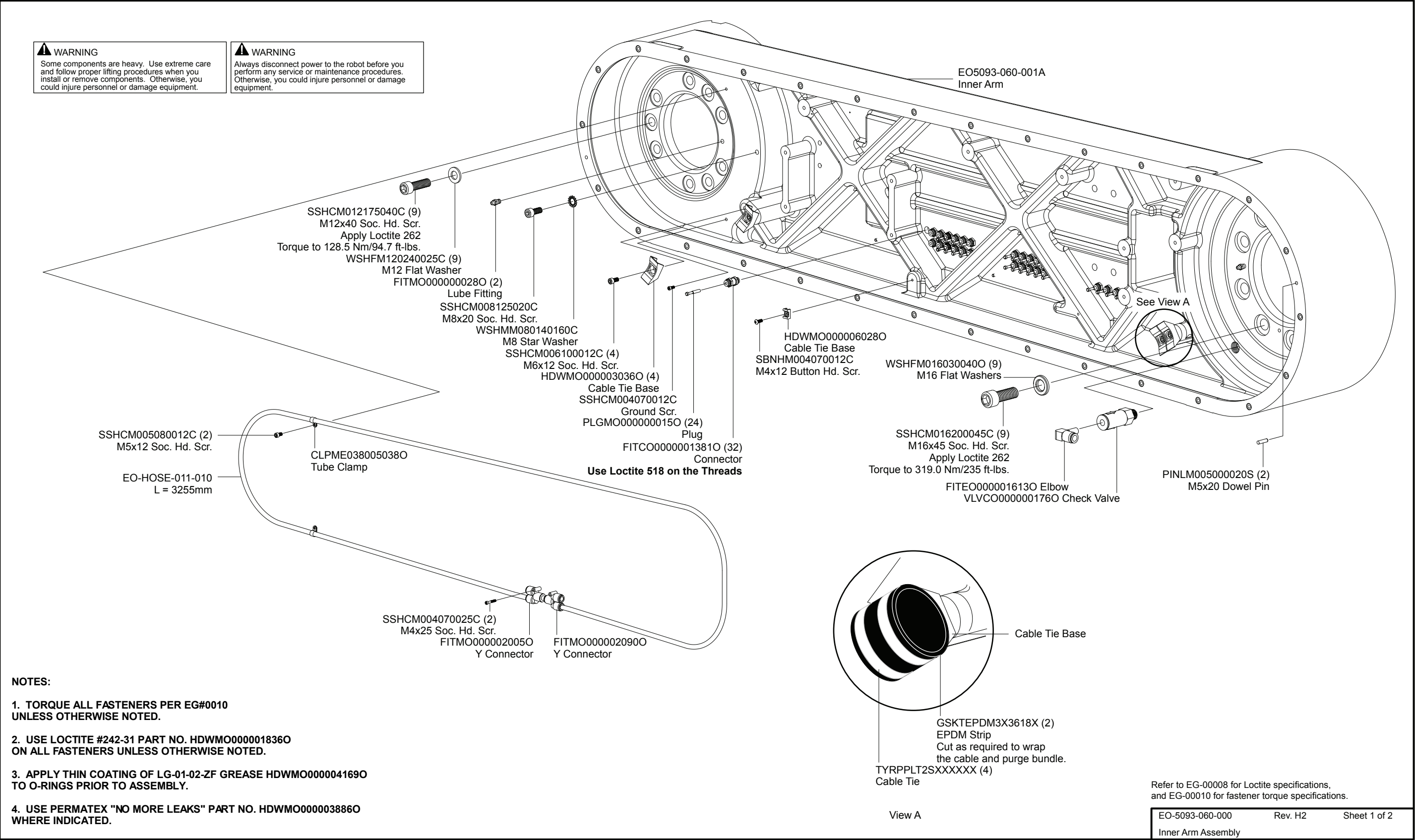


Figure 4–17. Inner Arm Assembly EO-5093-060-000, Sheet 2

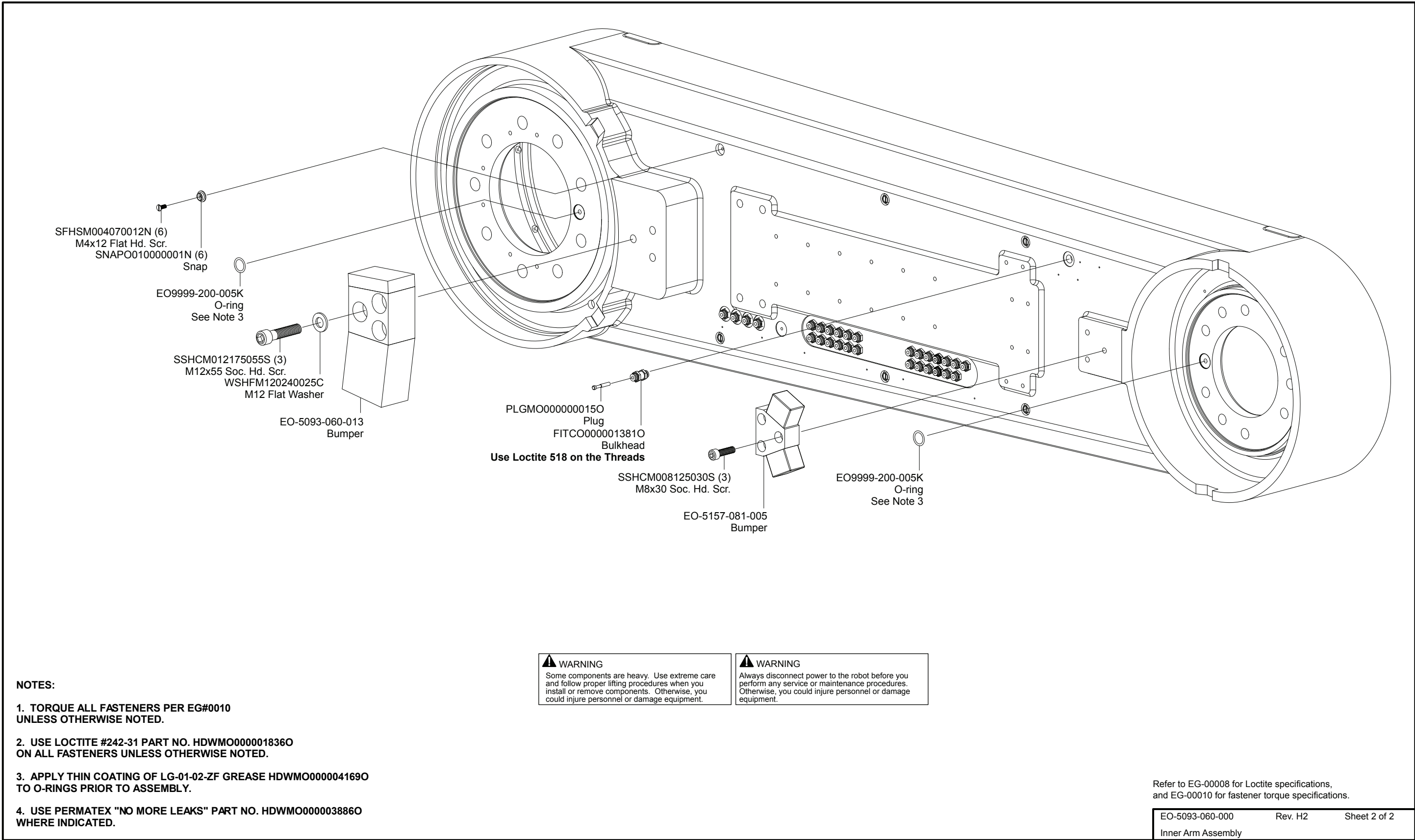


Figure 4–18. Robot and Applicator Covers EO-5093-070-001 through 011

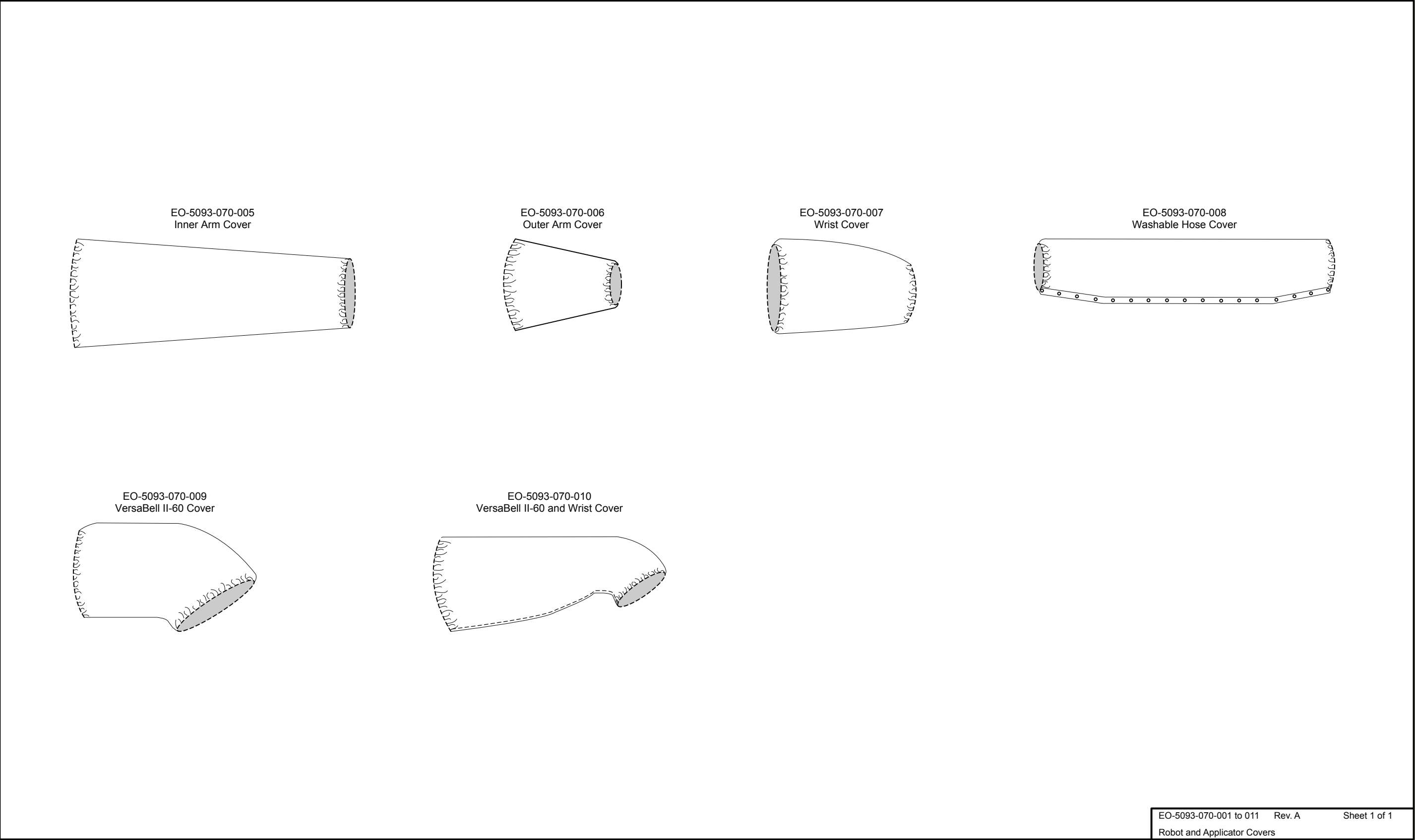


Figure 4–19. Right Hand Turret Assembly EO-5093-100-000, Sheet 1

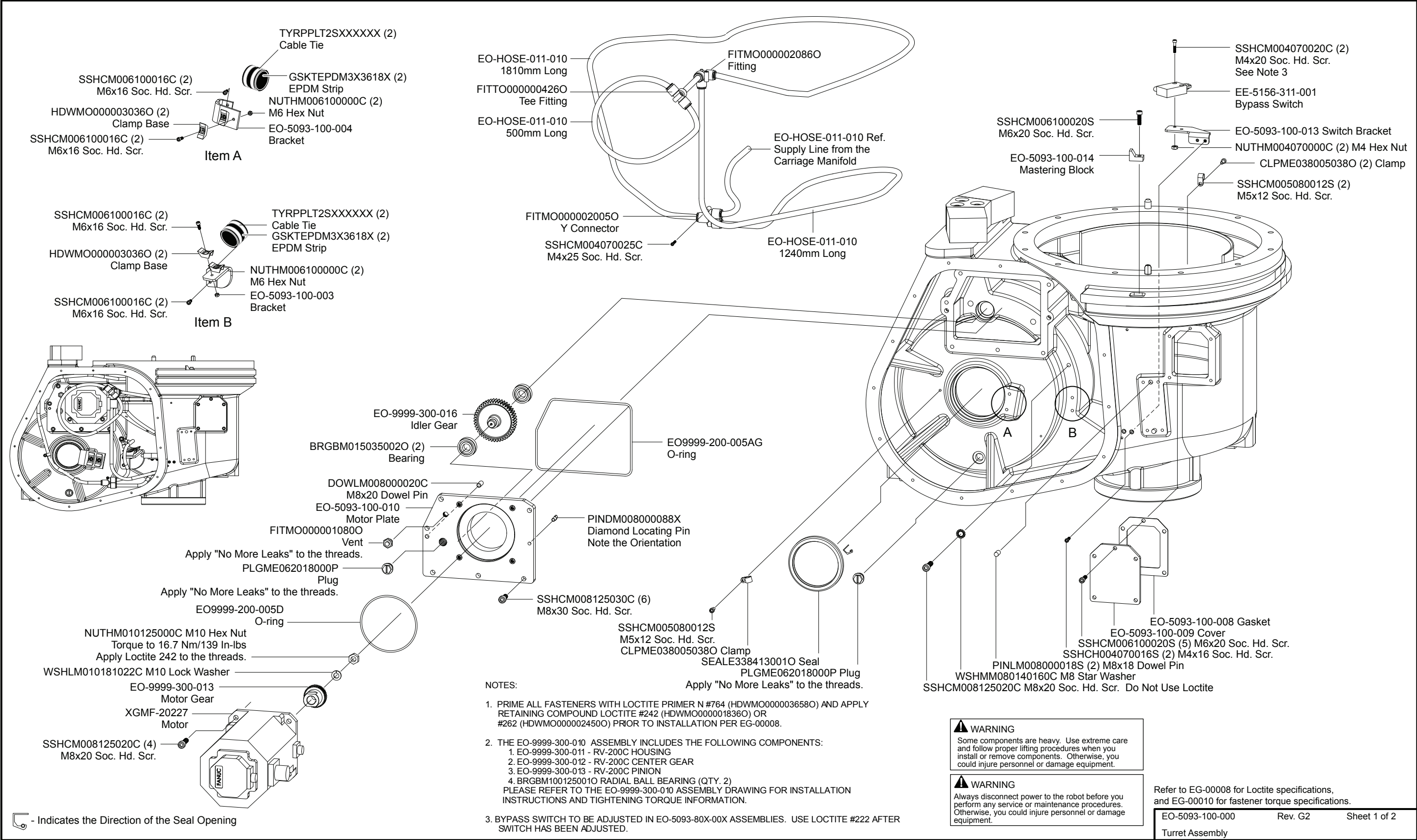


Figure 4–20. Right Hand Turret Assembly EO-5093-100-000, Sheet 2

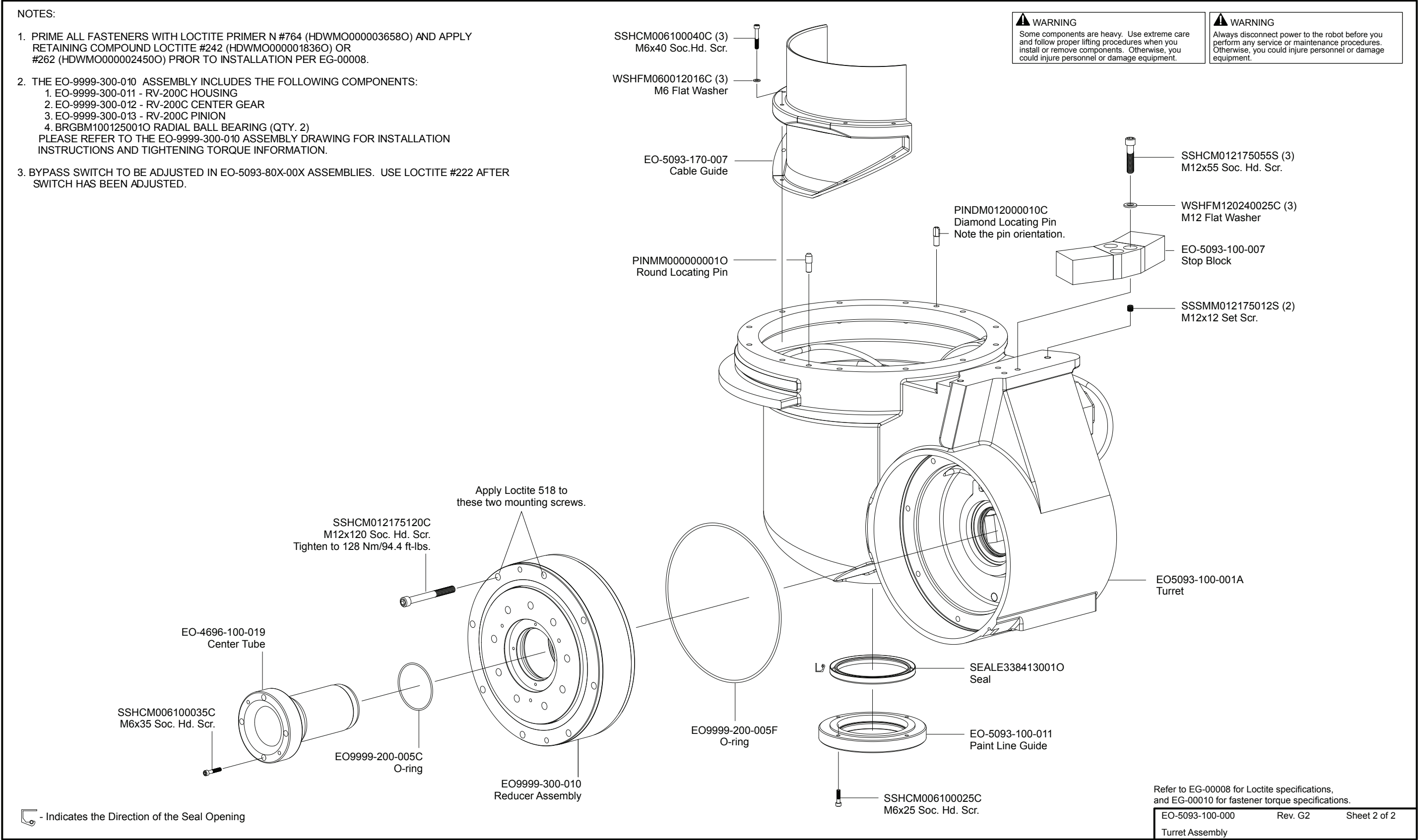


Figure 4-21. Left Hand Turret Assembly EO-5093-102-000, Sheet 1

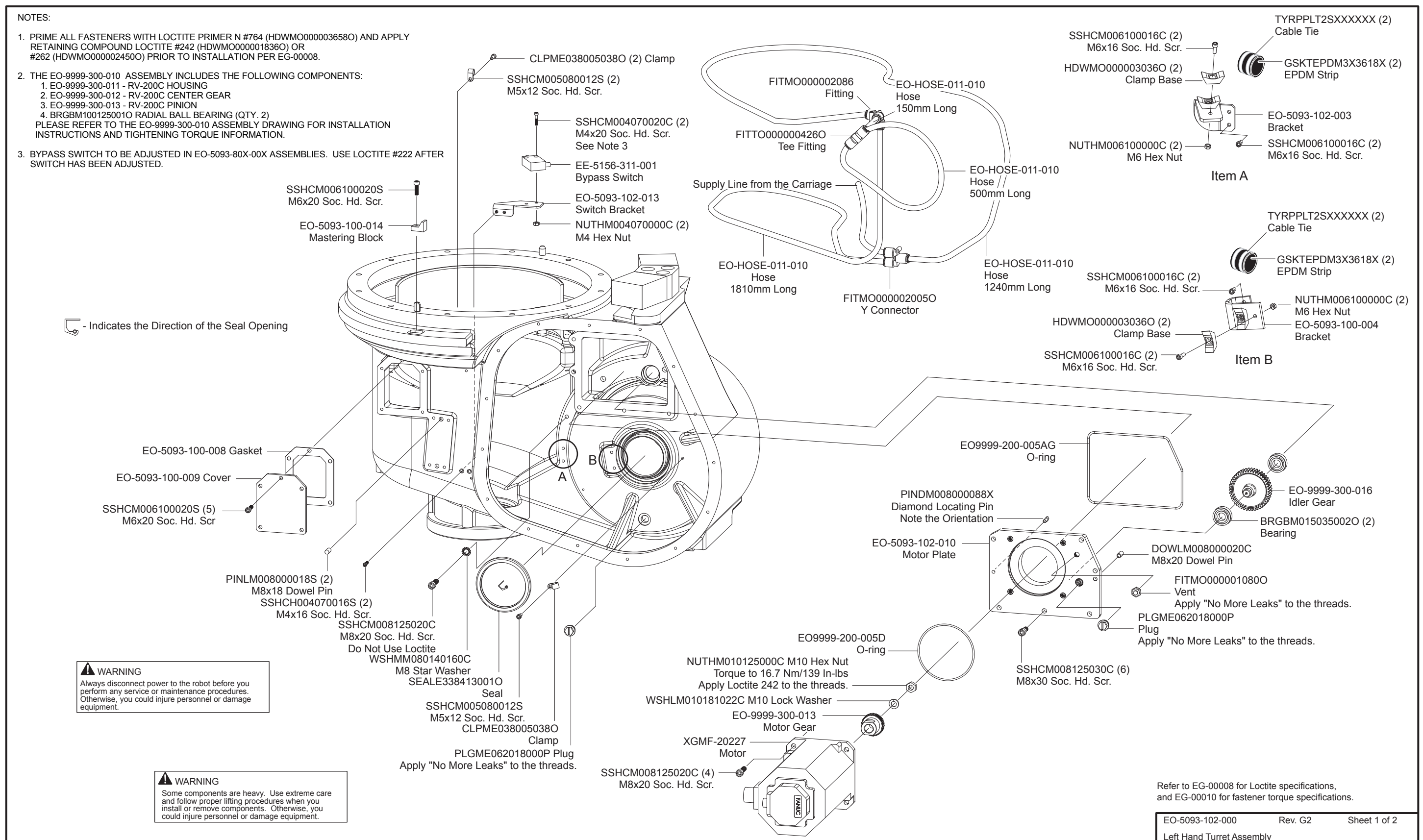
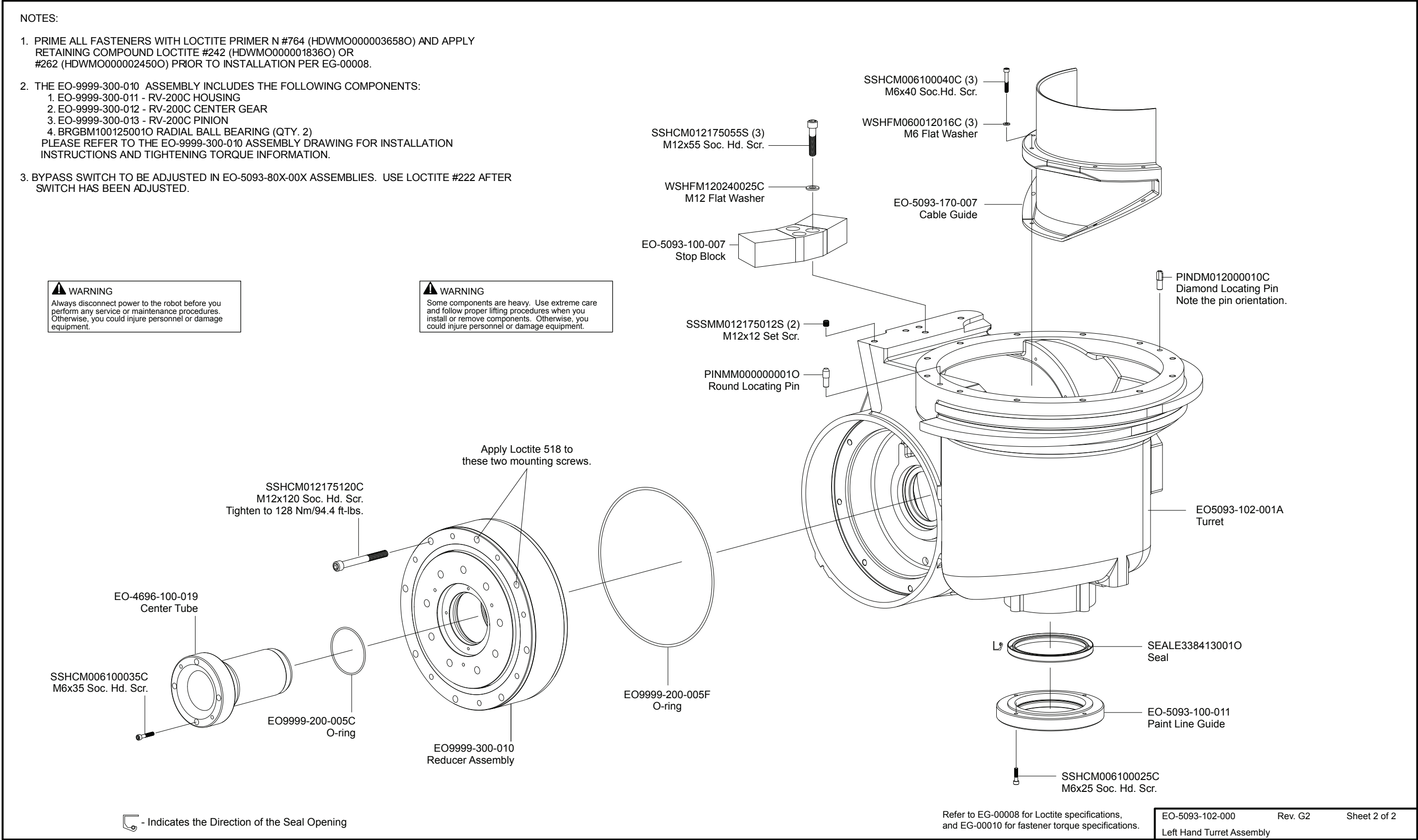


Figure 4–22. Left Hand Turret Assembly EO-5093-102-000, Sheet 2



4.2 CARRIAGE PARTS



Caution

Illustration instructions in bold type affect the robot form, fit or function. This information can include but is not limited to RV reducer fastener torque, lube requirements, and Loctite specifications. It is important that you adhere to these instructions; otherwise, you could injure personnel or damage equipment.



Caution

Proper Loctite usage and fastener torque is essential to maintain component integrity. Refer to [Appendix B](#) for proper Loctite usage and fastener torque specifications; otherwise, you could injure personnel or damage equipment.

Figure 4–23. In-booth Carriage Assembly EO-5093-170-000, Sheet 1

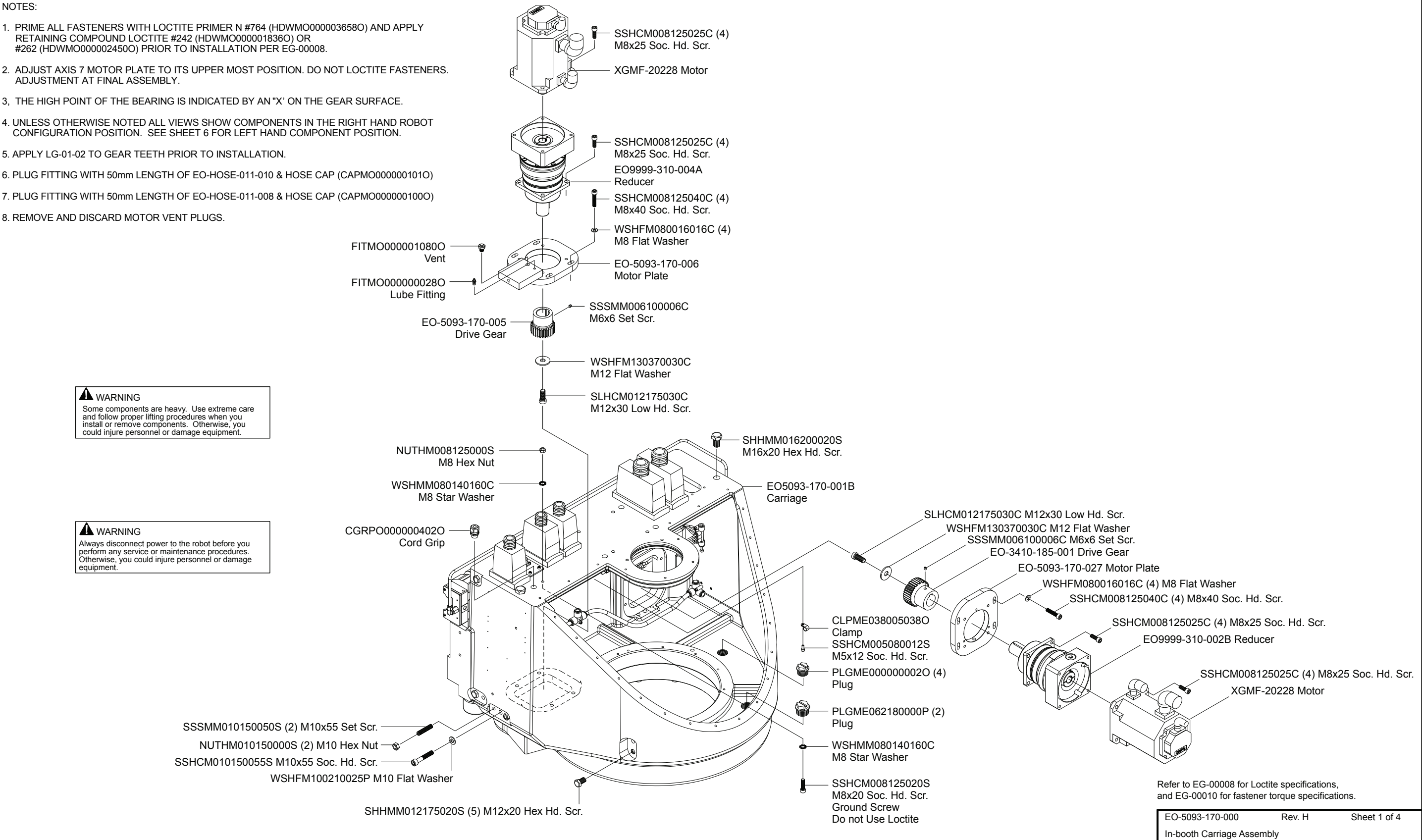


Figure 4–24. In-booth Carriage Assembly EO-5093-170-000, Sheet 2

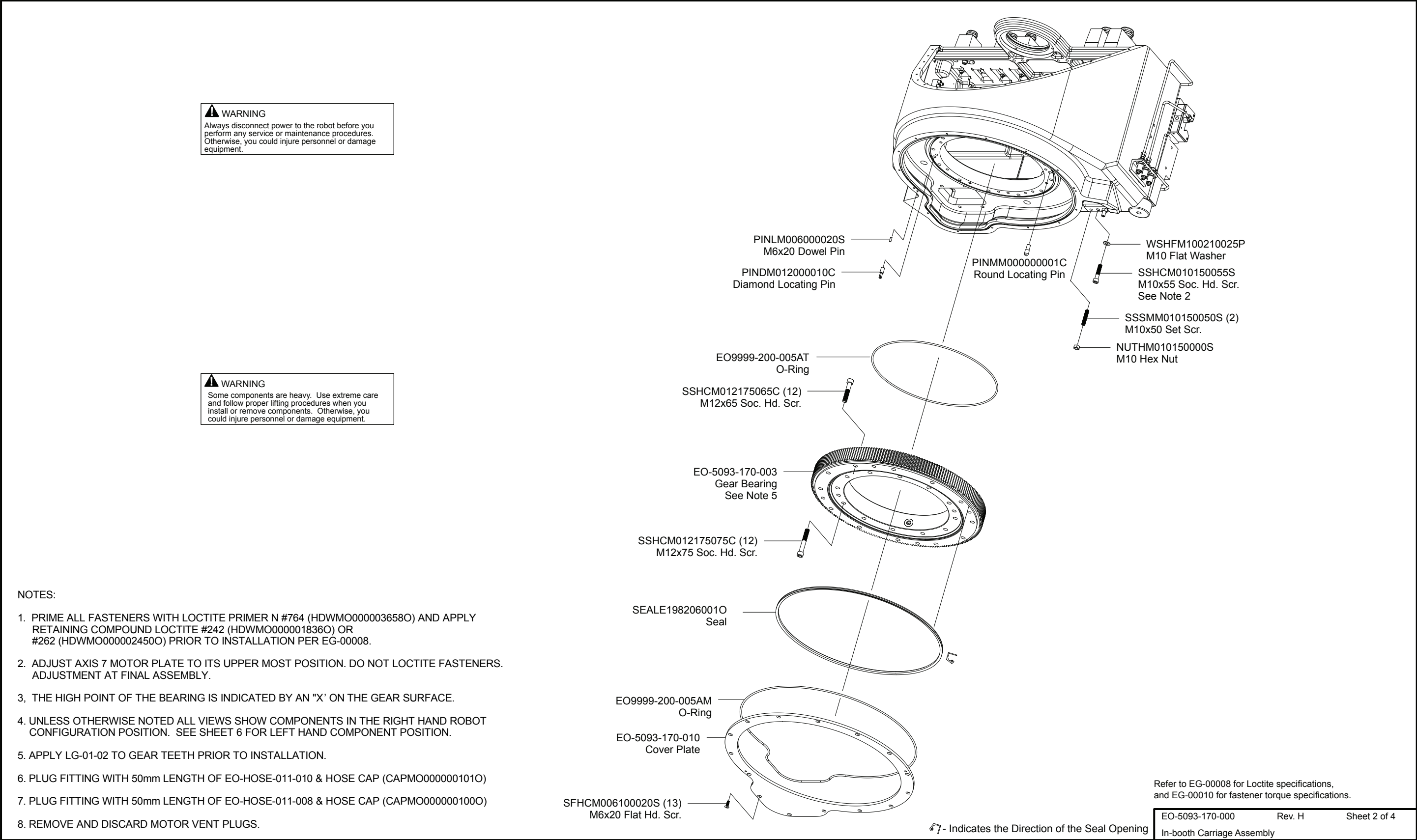


Figure 4–25. In-booth Carriage Assembly EO-5093-170-000, Sheet 3

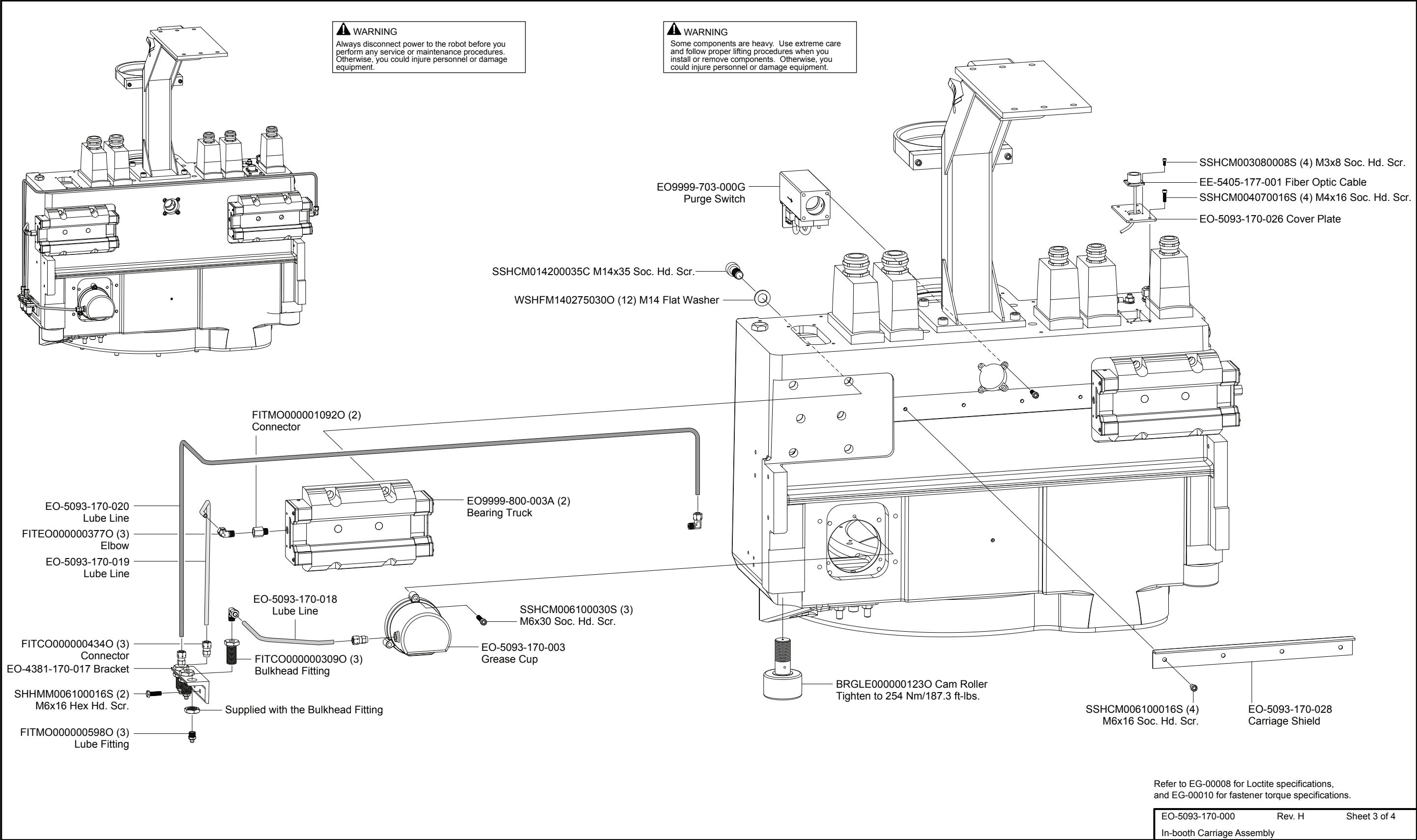


Figure 4–26. In-booth Carriage Assembly EO-5093-170-000, Sheet 4

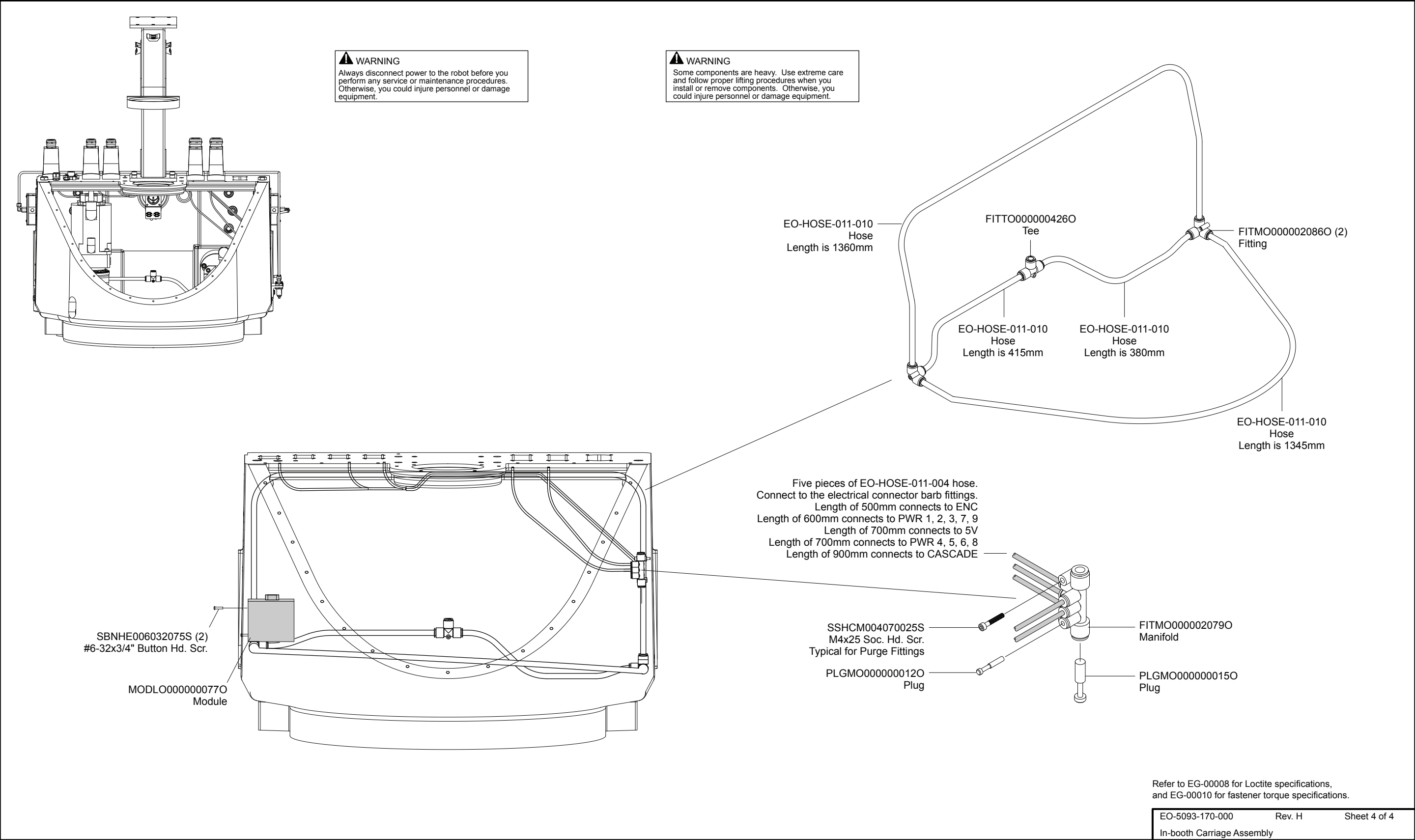
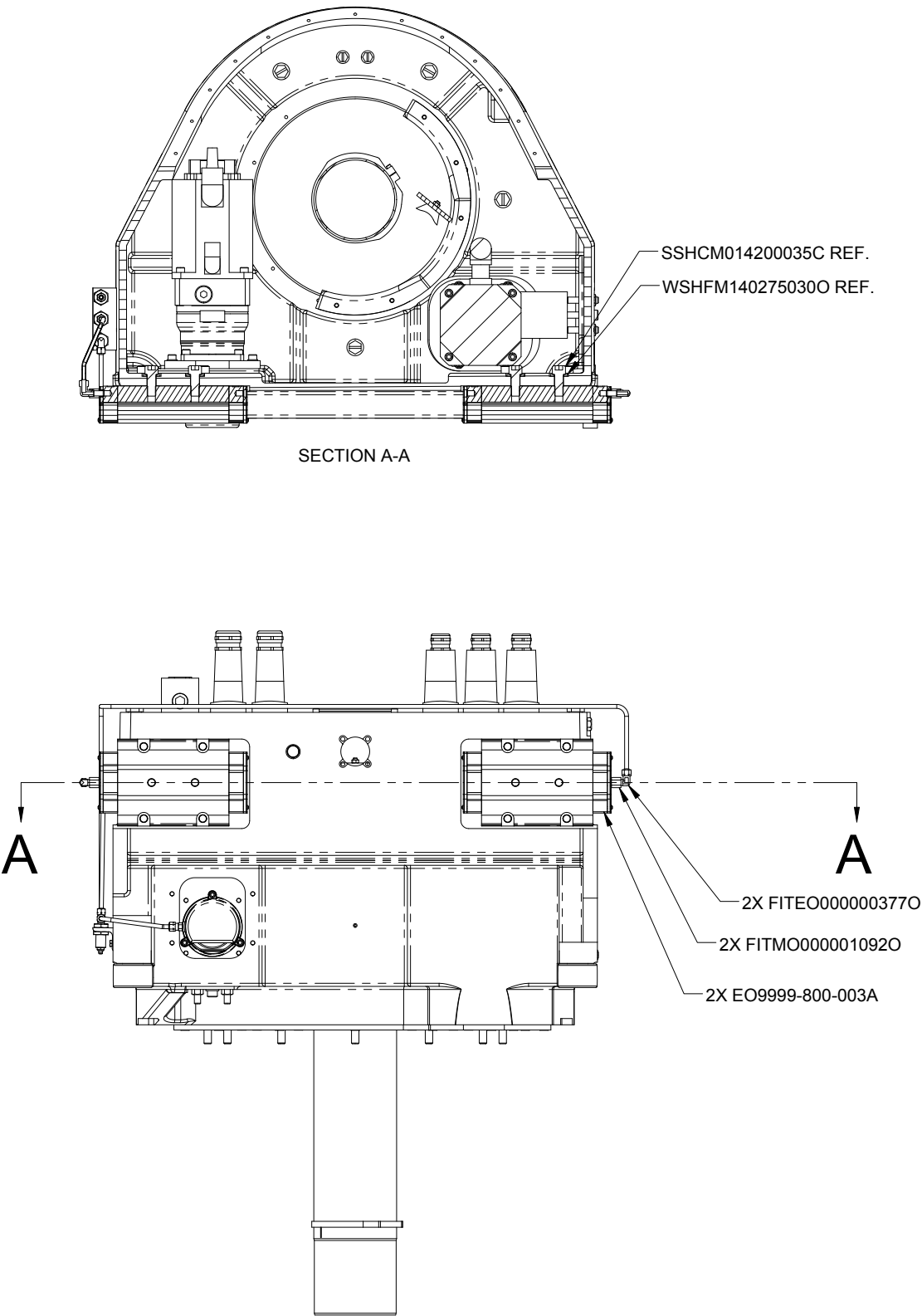


Figure 4–27. Rail Bearing Truck Assembly EO-5093-171-000



⚠ WARNING
Some components are heavy. Use extreme care and follow proper lifting procedures when you install or remove components. Otherwise, you could injure personnel or damage equipment.

⚠ WARNING
Always disconnect power to the robot before you perform any service or maintenance procedures. Otherwise, you could injure personnel or damage equipment.

Refer to EG-00008 for Loctite specifications, and EG-00010 for fastener torque specifications.

EO-5093-171-000	Rev. B	Sheet 1 of 1
Bearing Truck Assembly		

Figure 4–28. Clean Wall Carriage Assembly EO-5093-175-000, Sheet 1

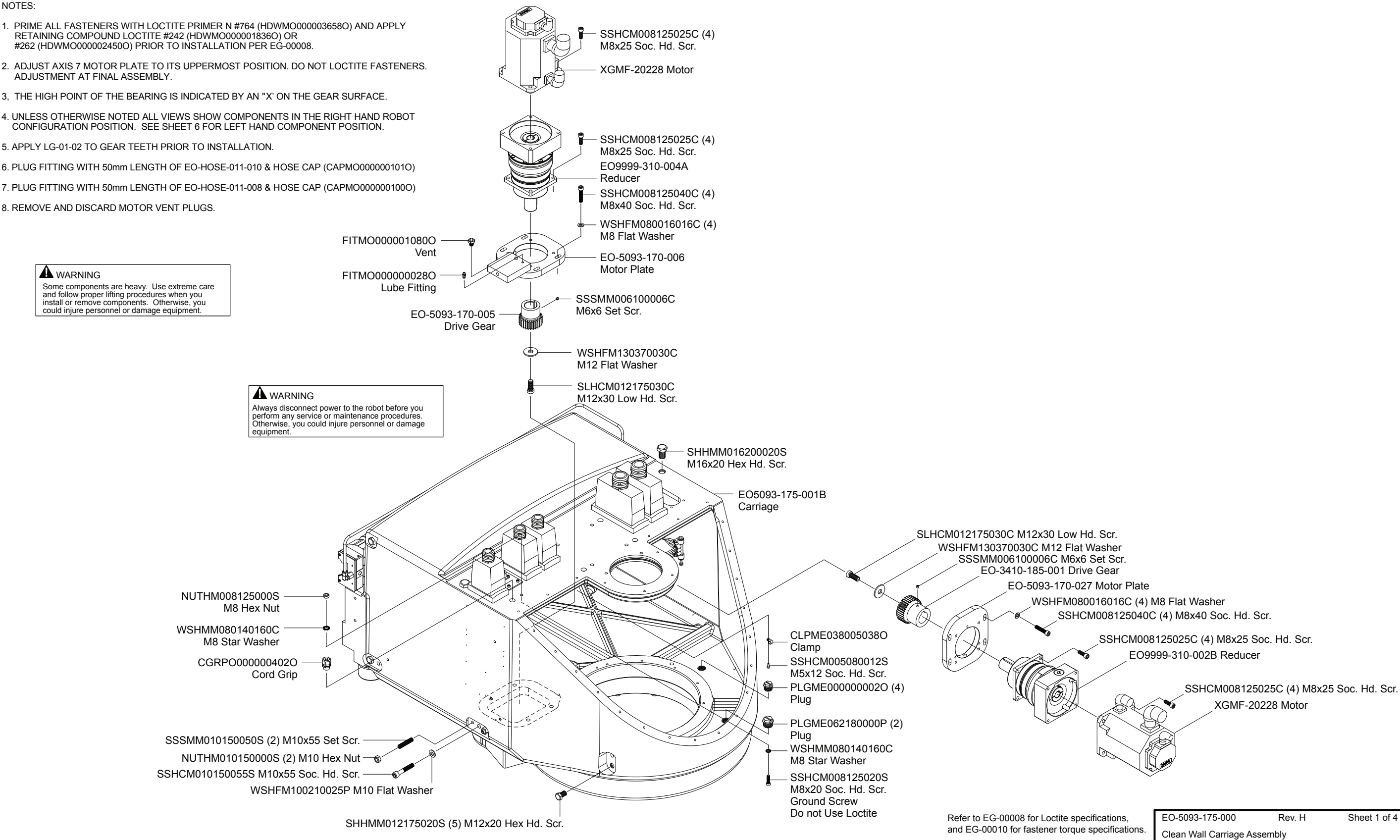


Figure 4–29. Clean Wall Carriage Assembly EO-5093-175-000, Sheet 2

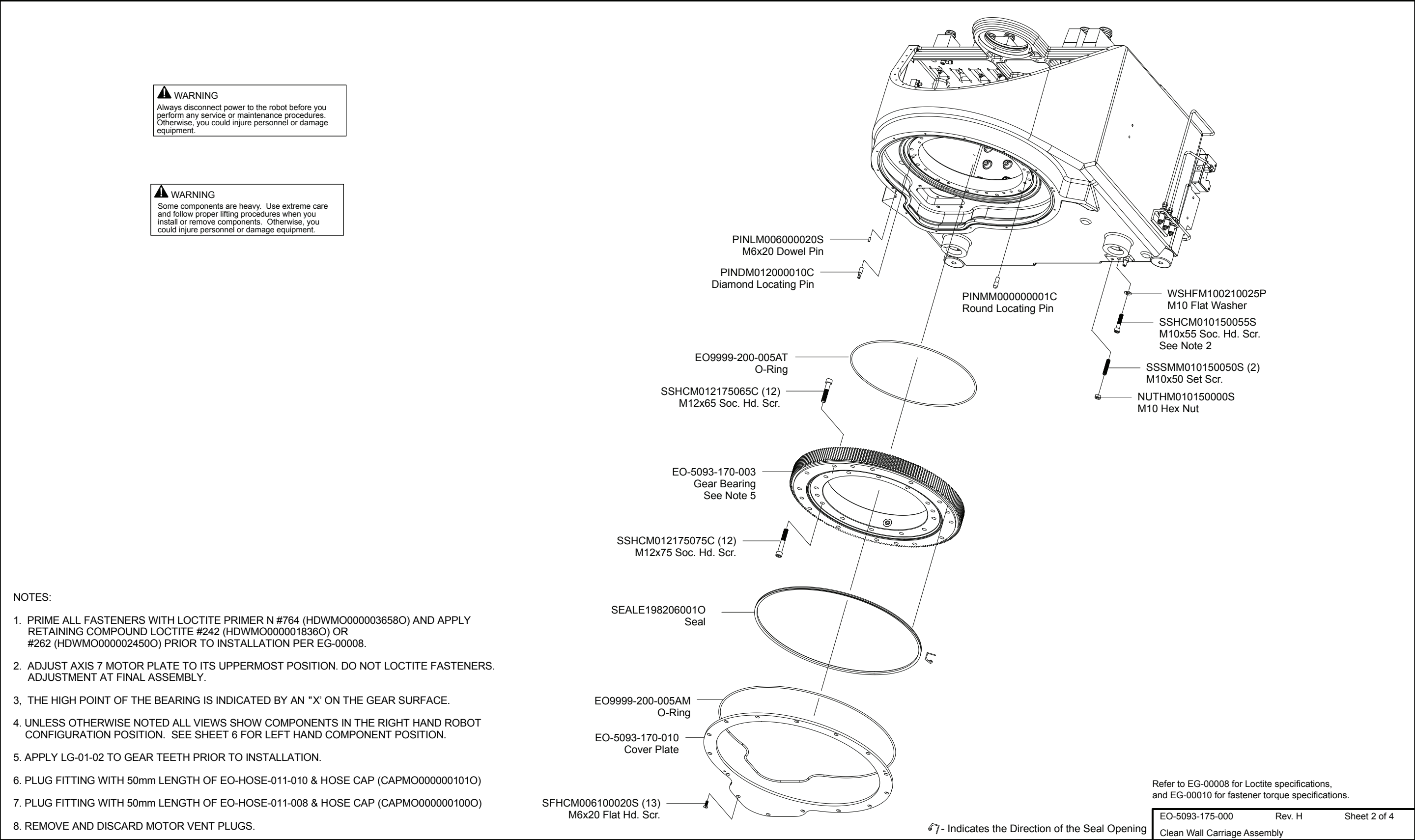


Figure 4-30. Clean Wall Carriage Assembly EO-5093-175-000, Sheet 3

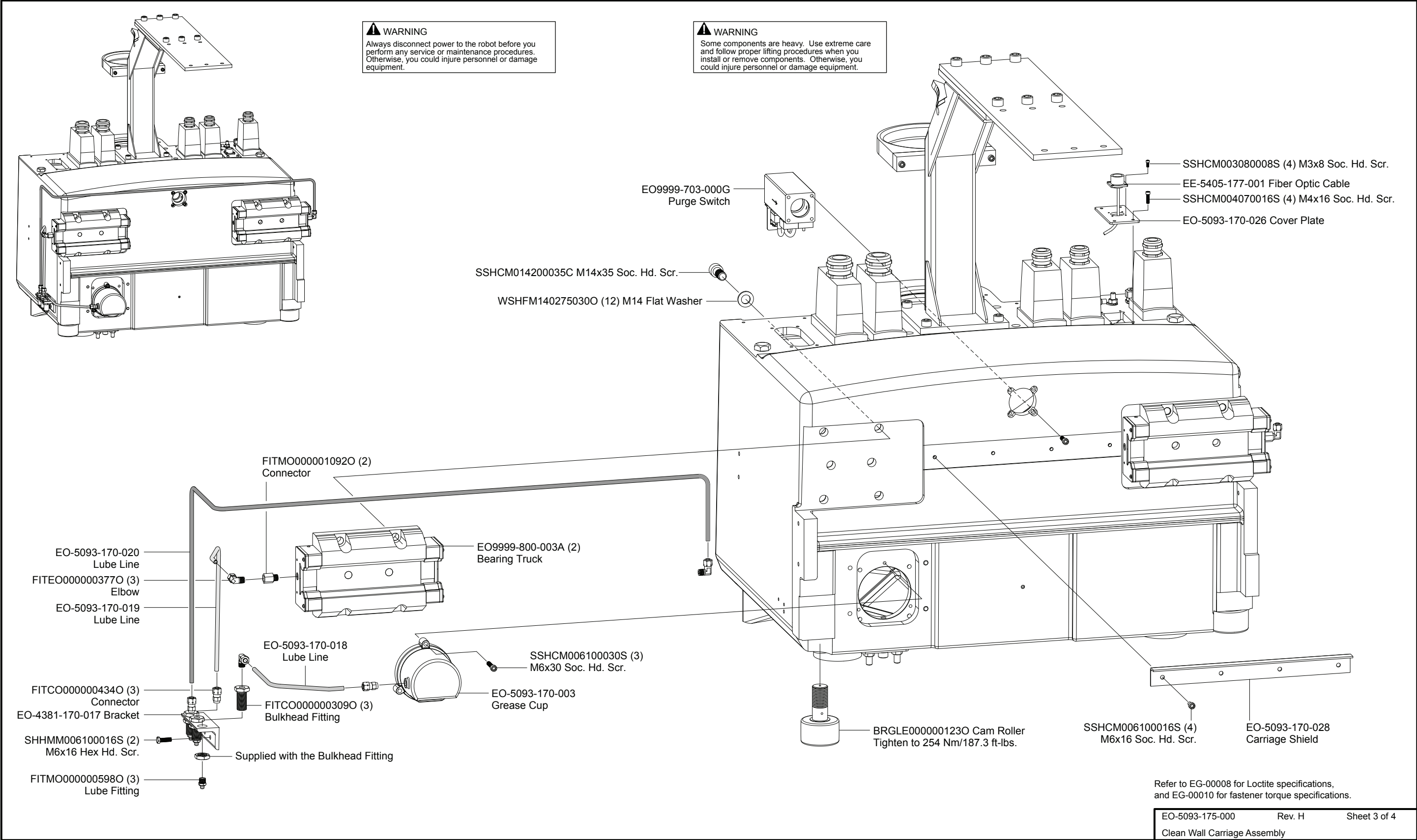


Figure 4–31. Clean Wall Carriage Assembly EO-5093-175-000, Sheet 4

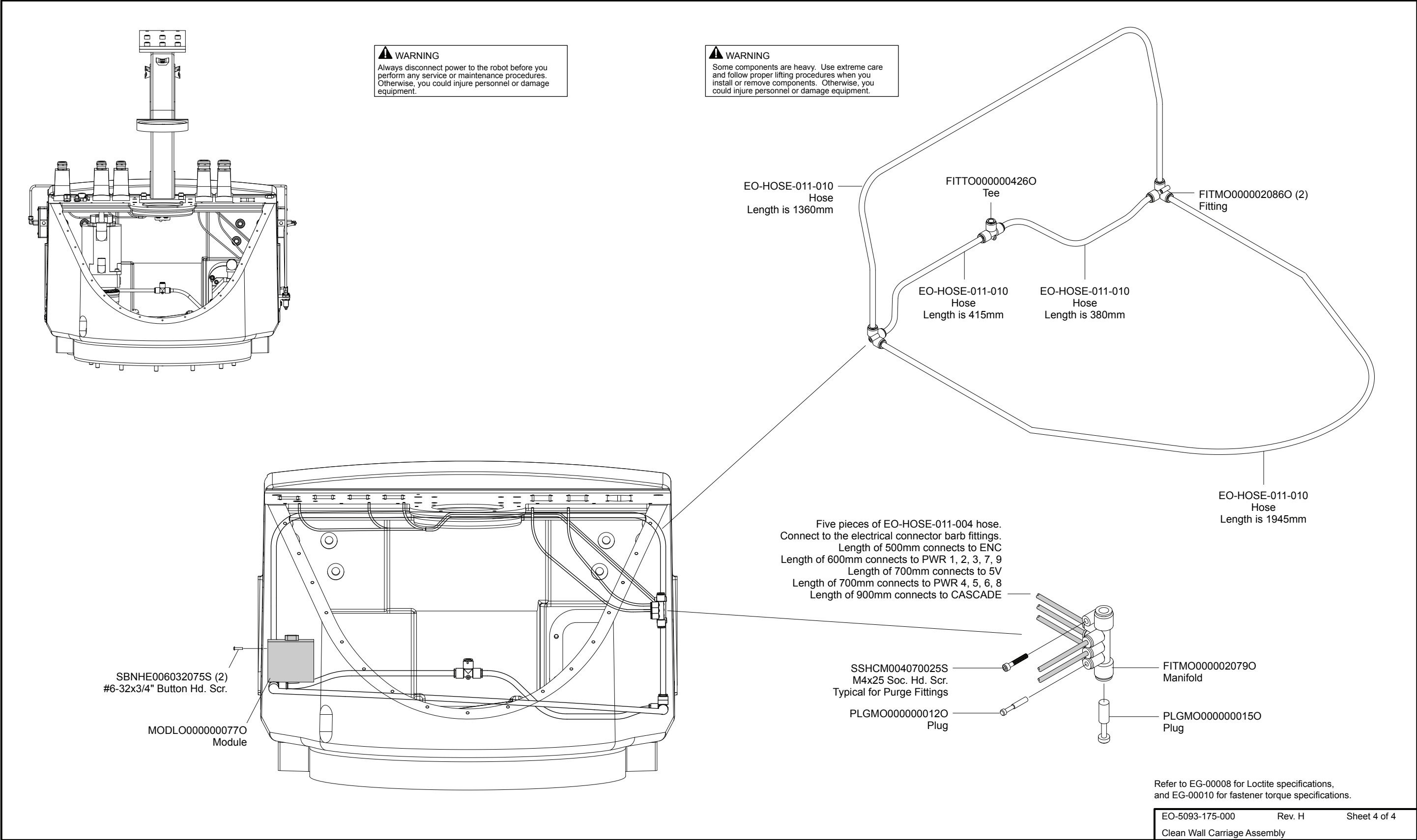


Figure 4–32. Bumper Extension EO-5093-176-000

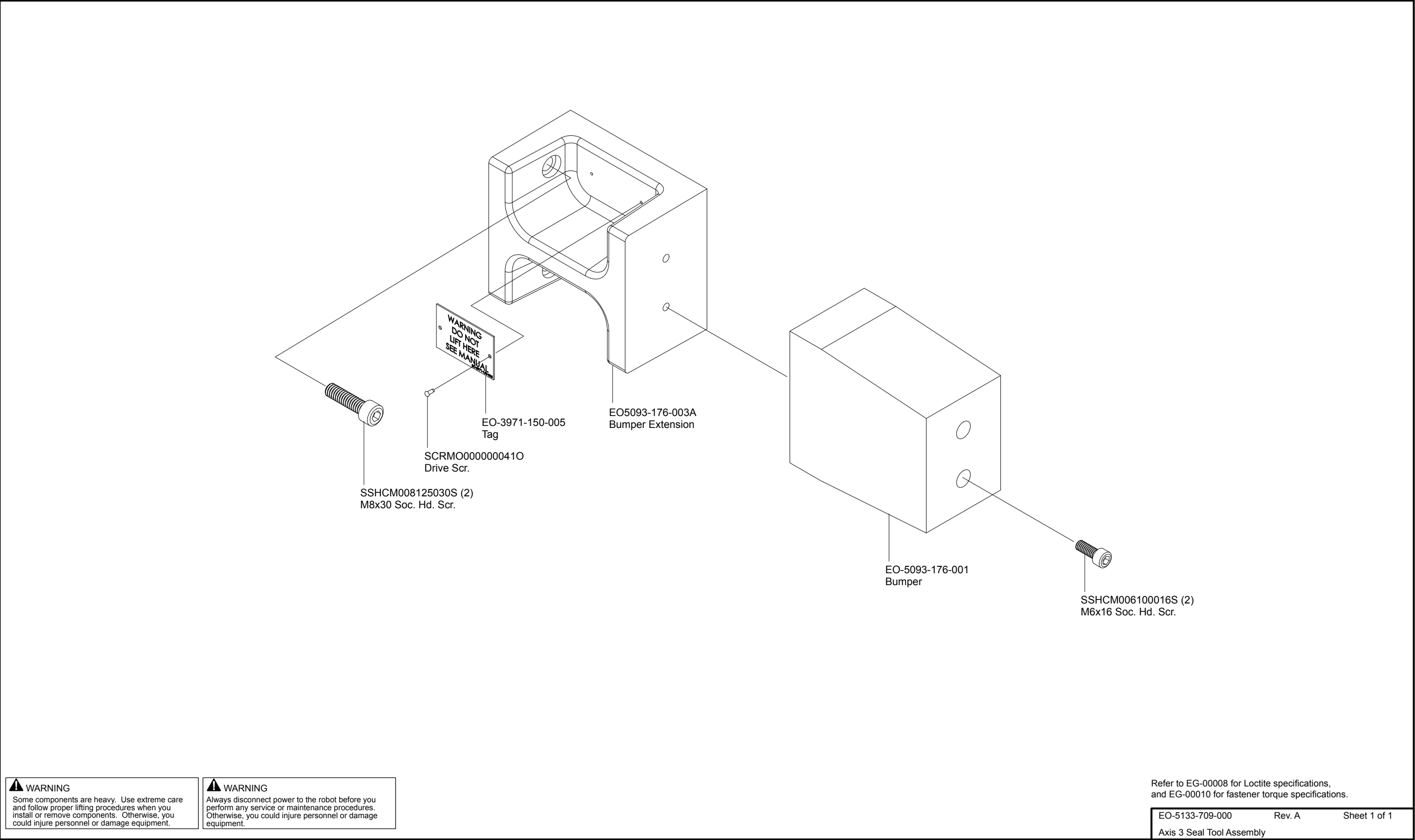


Figure 4-33. Clean Wall Rail Safety Switch Option EO-5093-182-000, Sheet 1

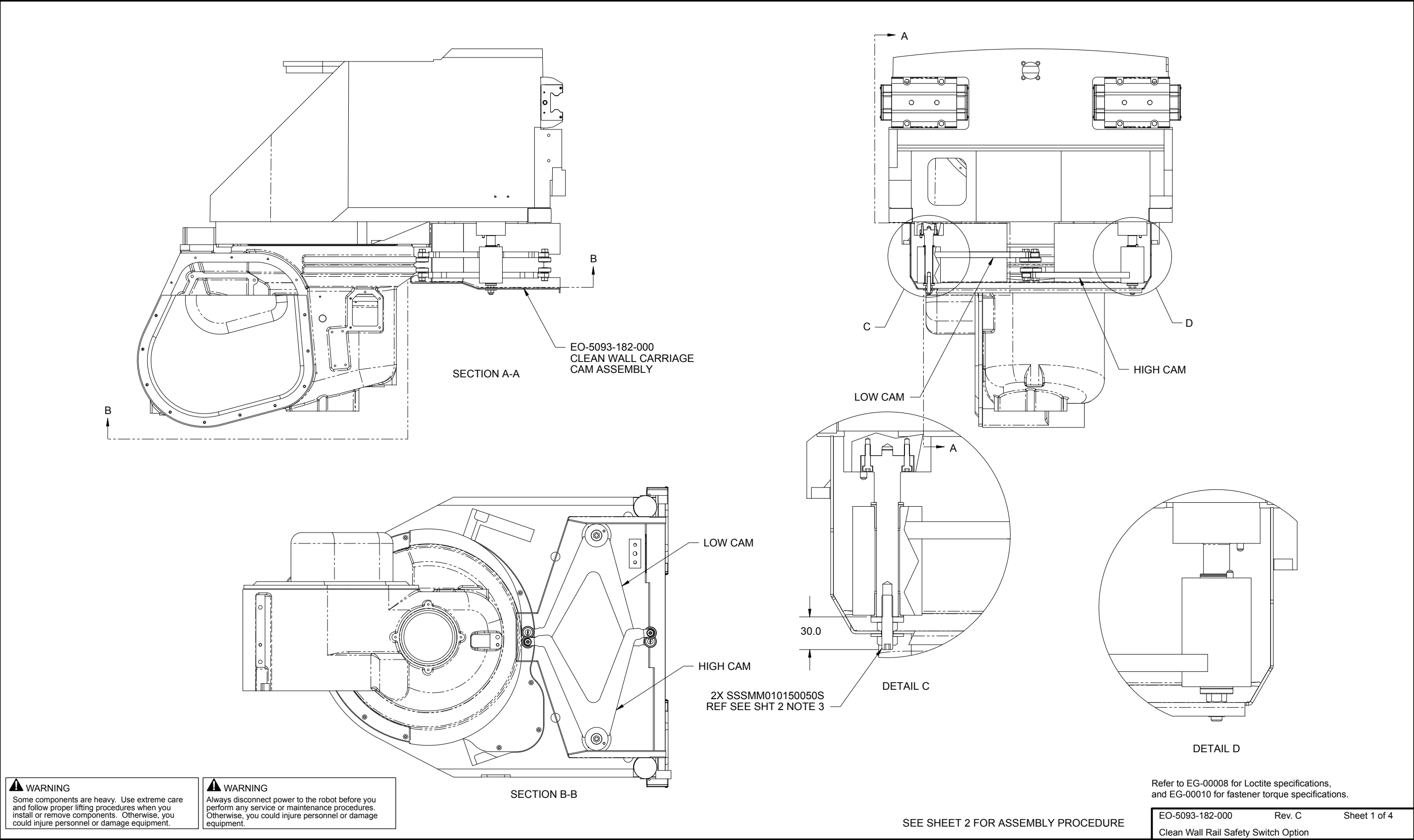


Figure 4–34. Clean Wall Rail Safety Switch Option EO-5093-182-000, Sheet 2

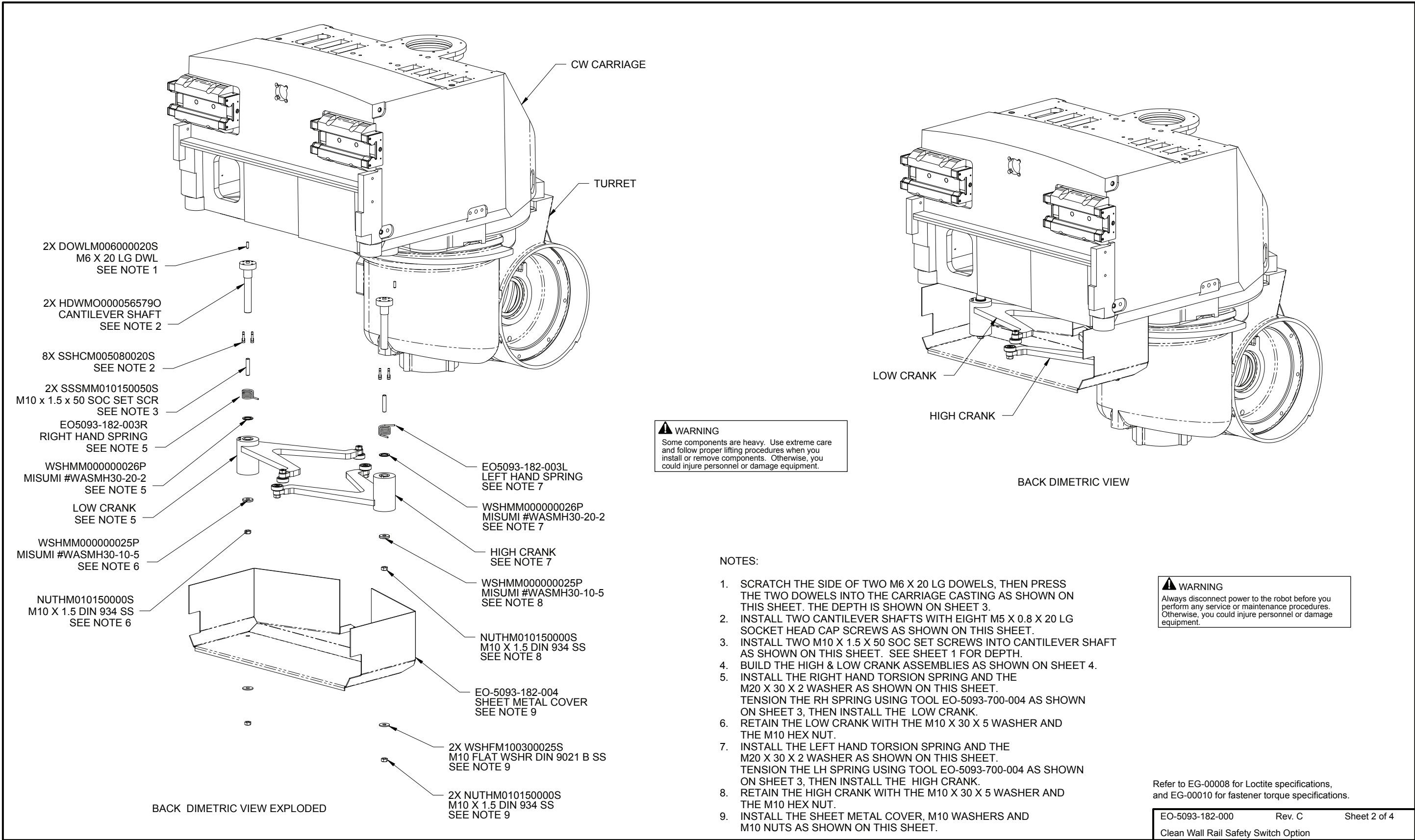


Figure 4–35. Clean Wall Rail Safety Switch Option EO-5093-182-000, Sheet 3

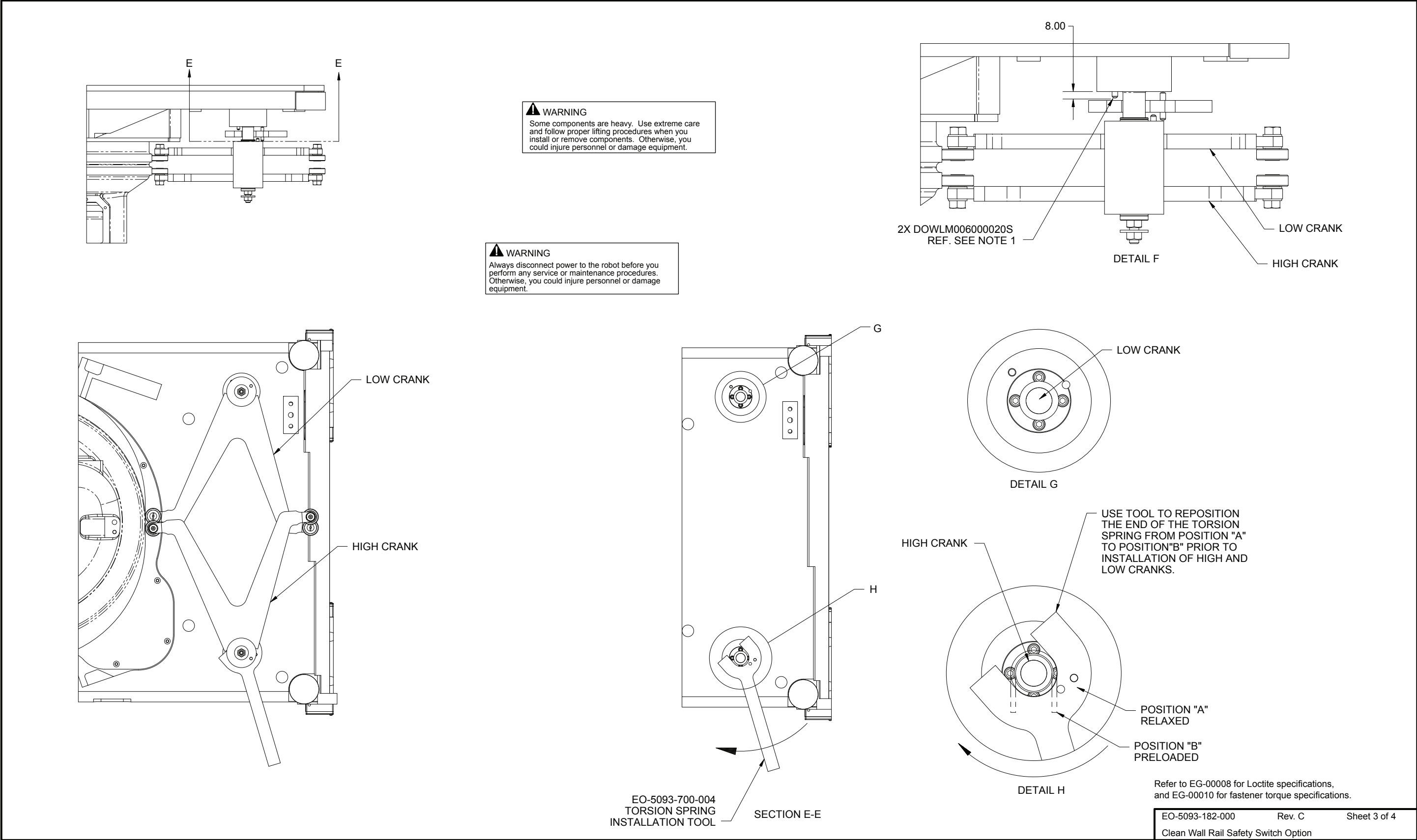
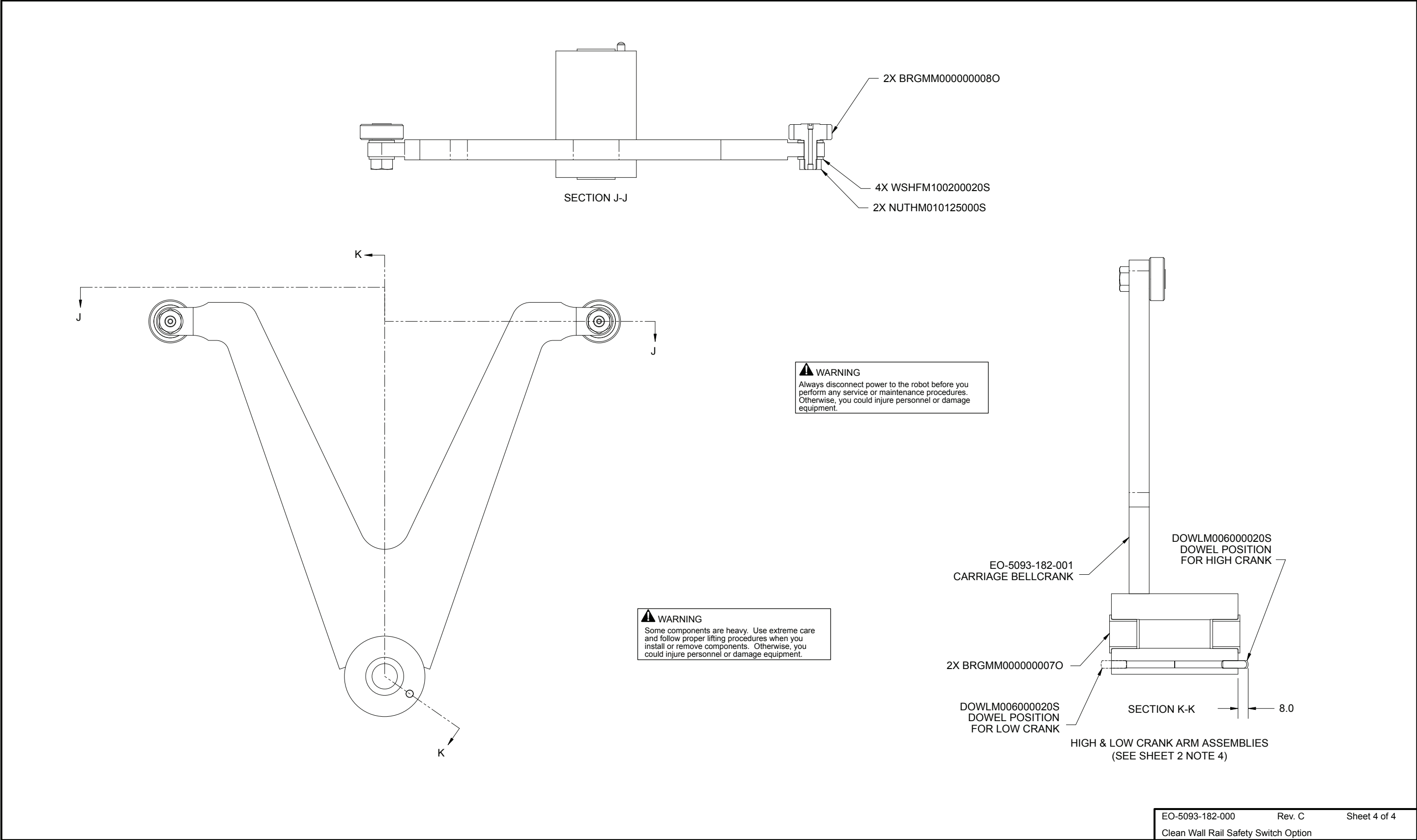


Figure 4–36. Clean Wall Rail Safety Switch Option EO-5093-182-000, Sheet 4



4.3 PEDESTAL PARTS



Caution
Illustration instructions in bold type affect the robot form, fit or function. This information can include but is not limited to RV reducer fastener torque, lube requirements, and Loctite specifications. It is important that you adhere to these instructions; otherwise, you could injure personnel or damage equipment.

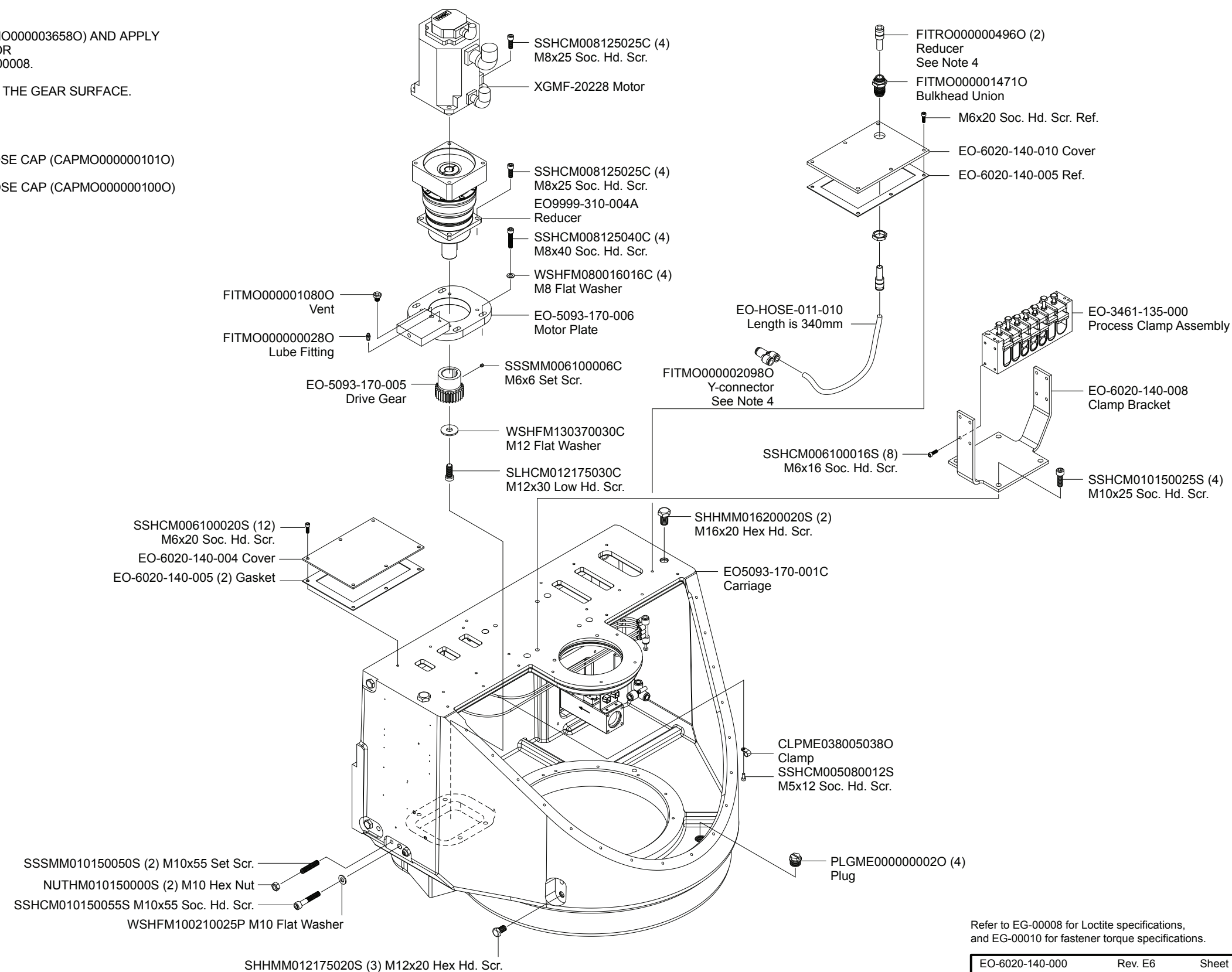
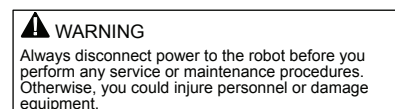
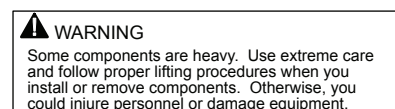


Caution
Proper Loctite usage and fastener torque is essential to maintain component integrity. Refer to [Appendix B](#) for proper Loctite usage and fastener torque specifications; otherwise, you could injure personnel or damage equipment.

Figure 4–37. Pedestal Assembly EO-6020-140-000, Sheet 1

NOTE:

1. PRIME ALL FASTENERS WITH LOCTITE PRIMER N #764 (HDWMO000003658O) AND APPLY RETAINING COMPOUND LOCTITE #242 (HDWMO000001836O) OR #262 (HDWMO000002450O) PRIOR TO INSTALLATION PER EG-00008.
2. THE HIGH POINT OF THE BEARING IS INDICATED BY AN 'X' ON THE GEAR SURFACE. MARK "X" ON SEAL PLATE EO-5093-170-010 AT HIGH POINT.
3. APPLY LG-01-02 TO GEAR TEETH PRIOR TO INSTALLATION.
4. PLUG FITTING WITH 50mm LENGTH OF EO-HOSE-011-010 & HOSE CAP (CAPMO000000101O)
5. PLUG FITTING WITH 50mm LENGTH OF EO-HOSE-011-008 & HOSE CAP (CAPMO000000100O)
6. REMOVE & DISCARD MOTOR VENT PLUGS



Refer to EG-00008 for Loctite specifications,
and EG-00010 for fastener torque specifications.

EO-6020-140-000	Rev. E6	Sheet 1 of 3
Pedestal Assembly		

Figure 4–38. Pedestal Assembly EO-6020-140-000, Sheet 2

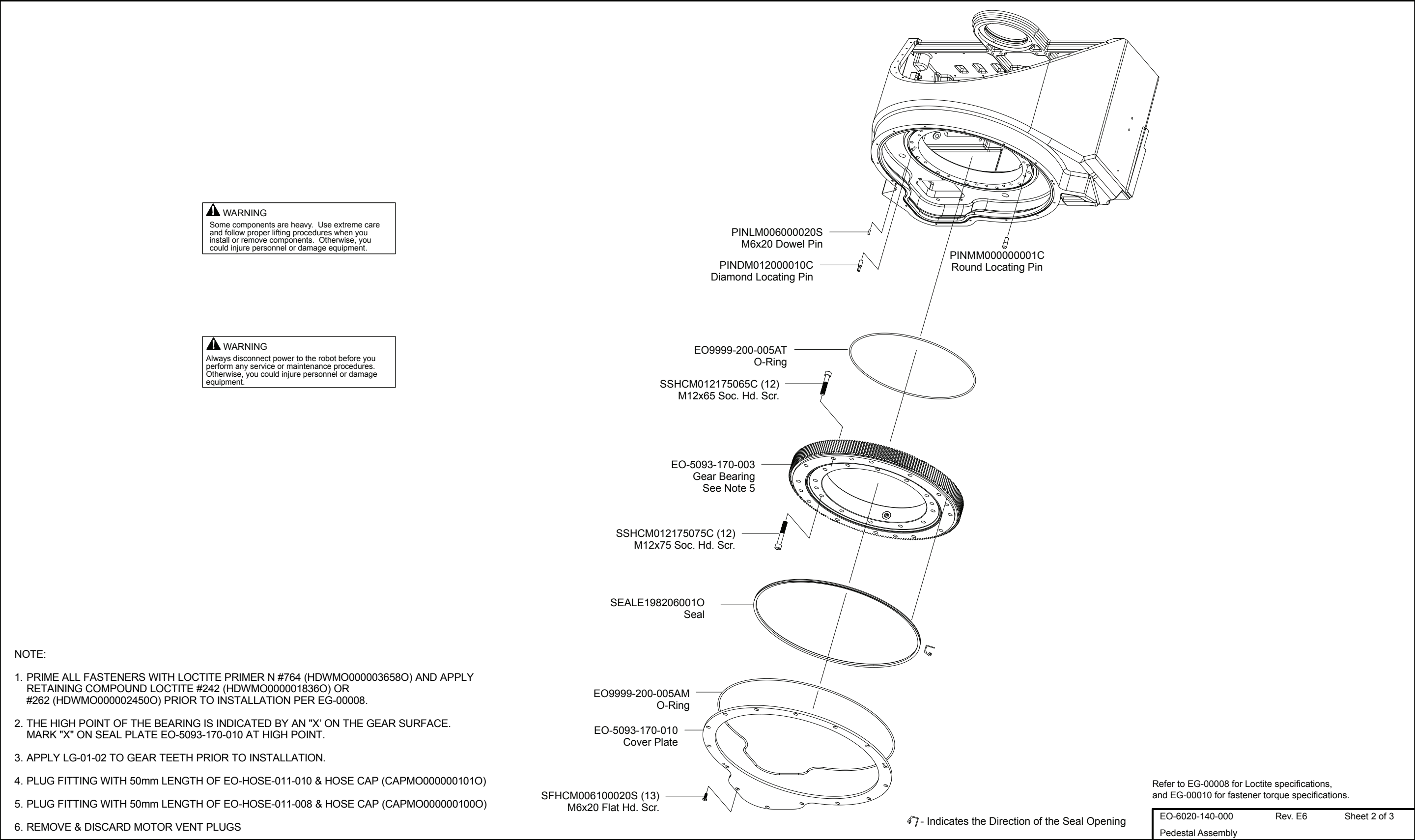
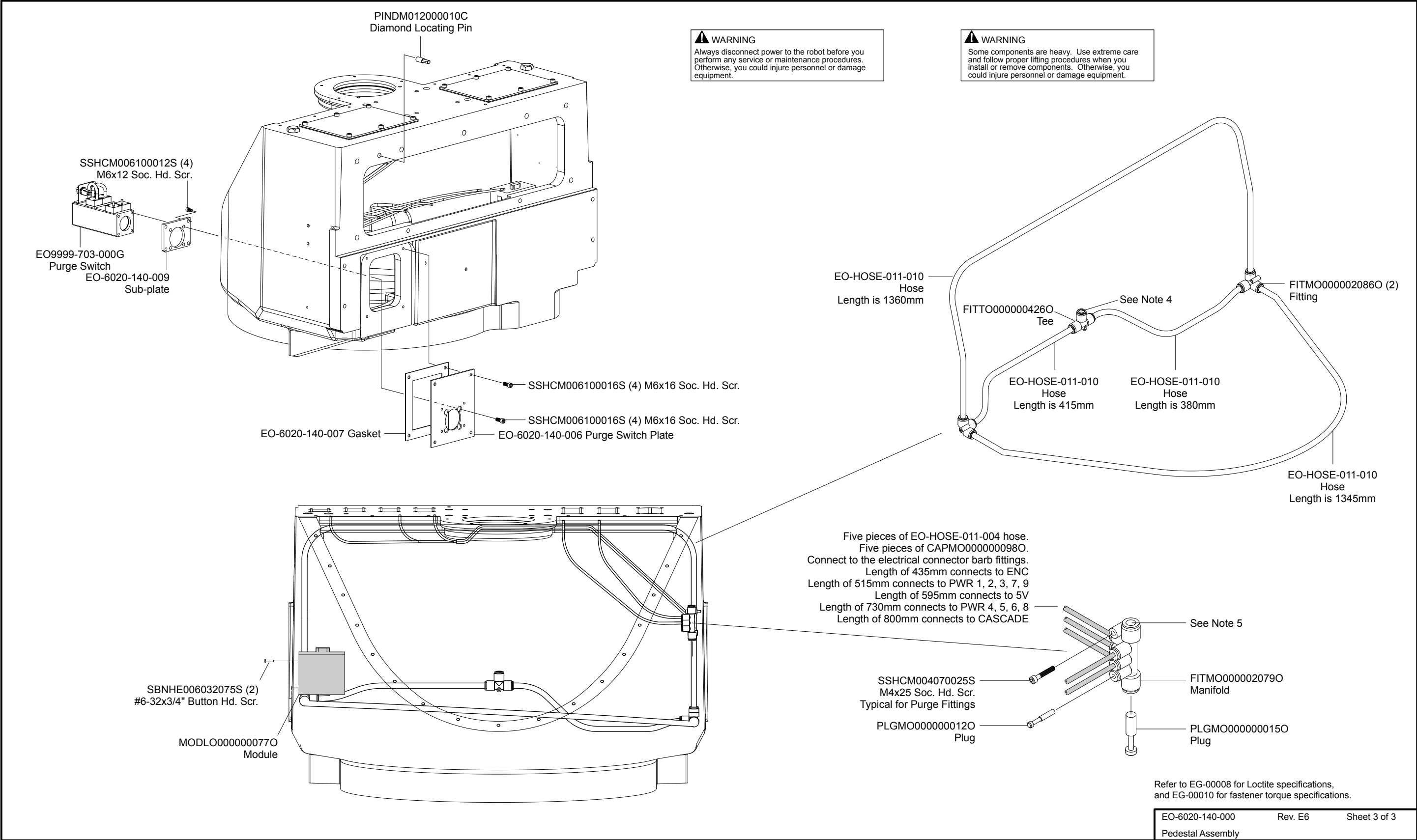


Figure 4–39. Pedestal Assembly EO-6020-140-000, Sheet 3



4.4 TAG DRAWINGS

Figure 4–40. Tag Assembly EO-5093-150-000

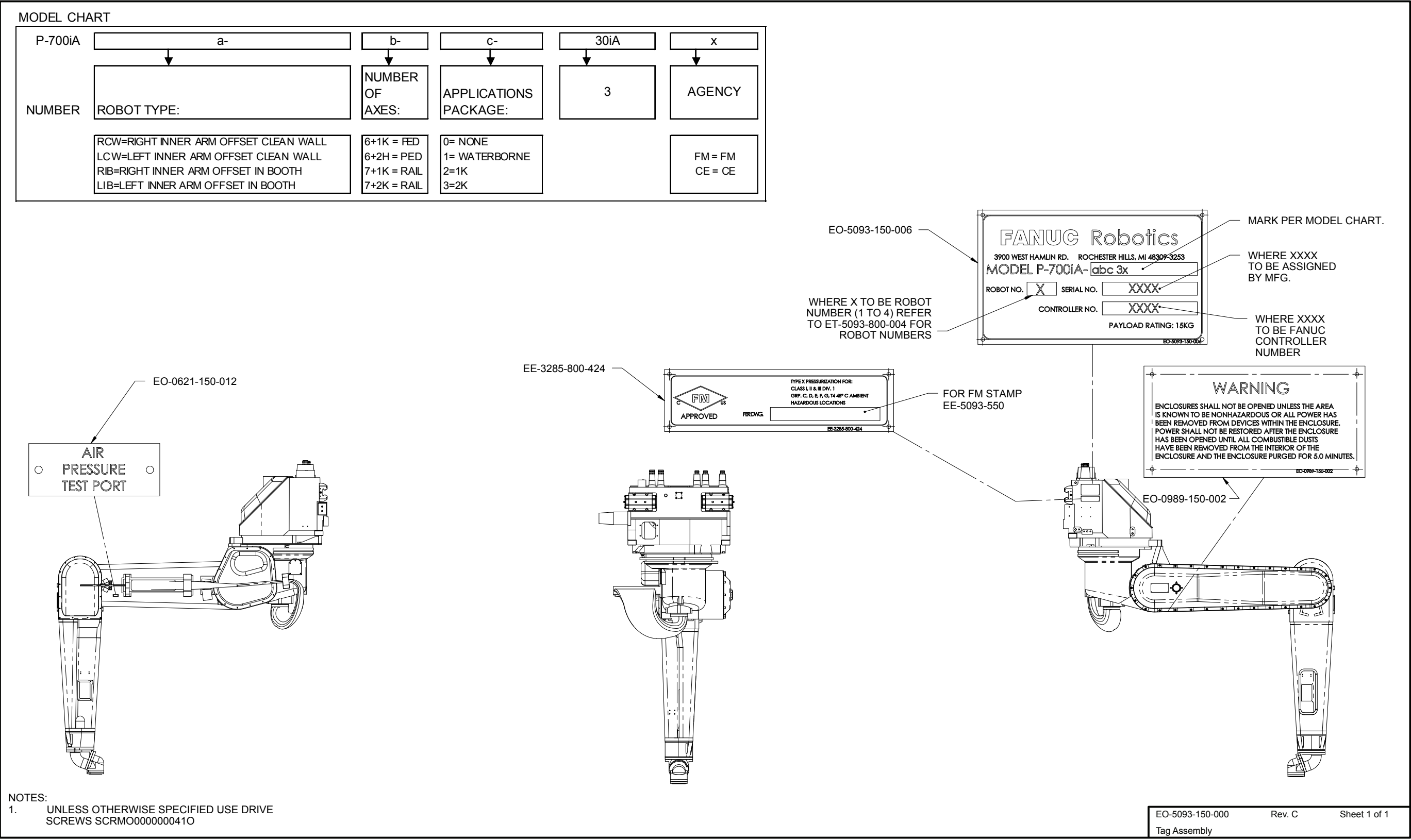


Figure 4–41. 2K Inner Arm Tag EO-5093-150-009

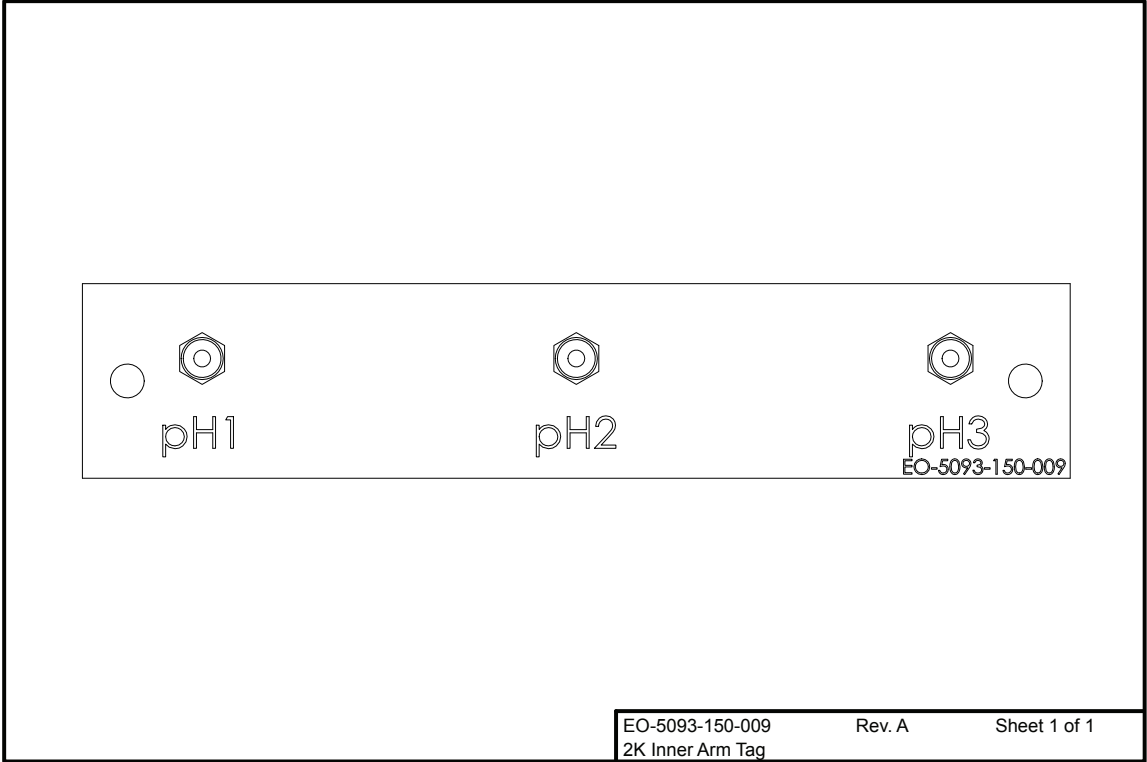


Figure 4-42. Zone Tags EO-5093-160-000, Sheet 1

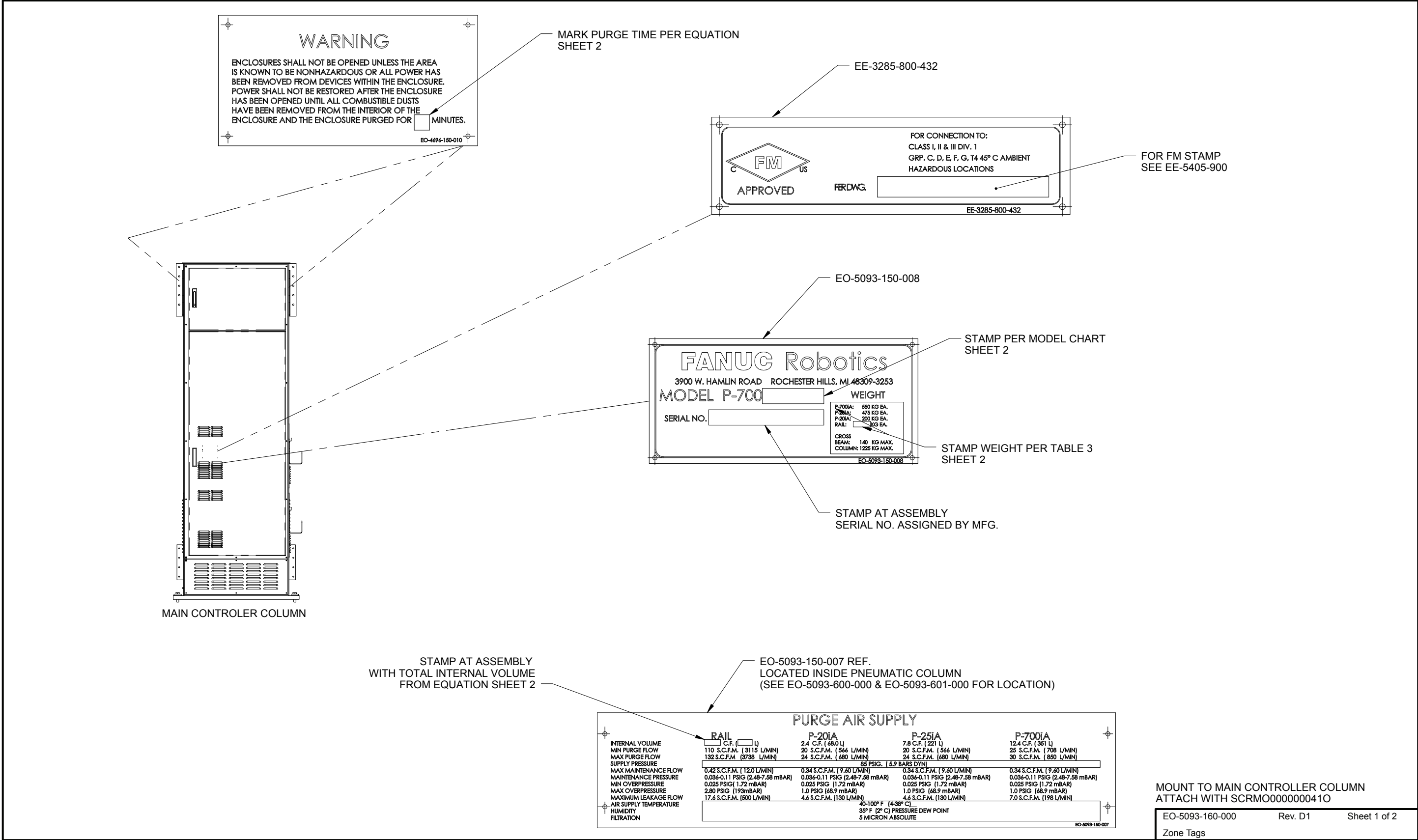
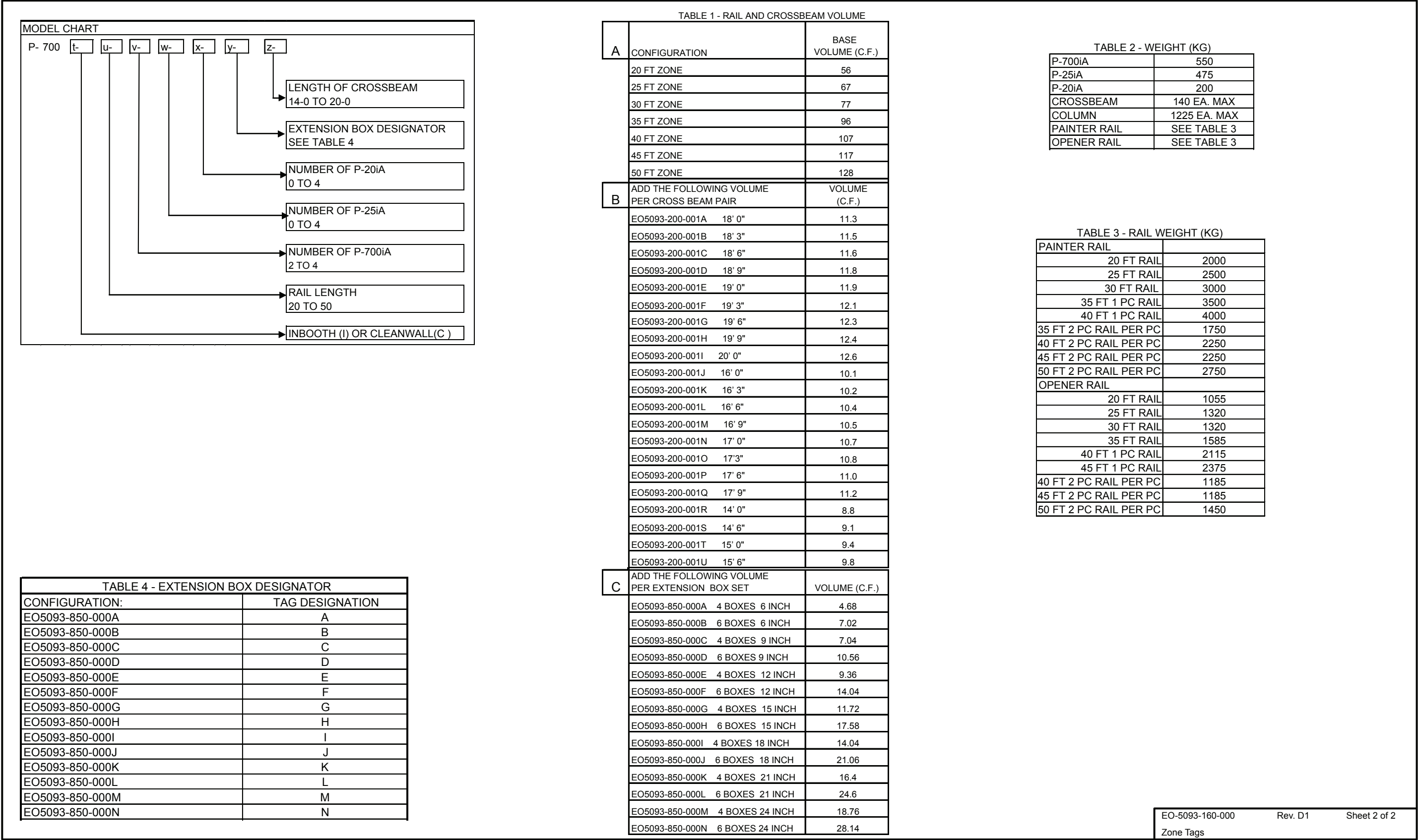


Figure 4–43. Zone Tags EO-5093-160-000, Sheet 2



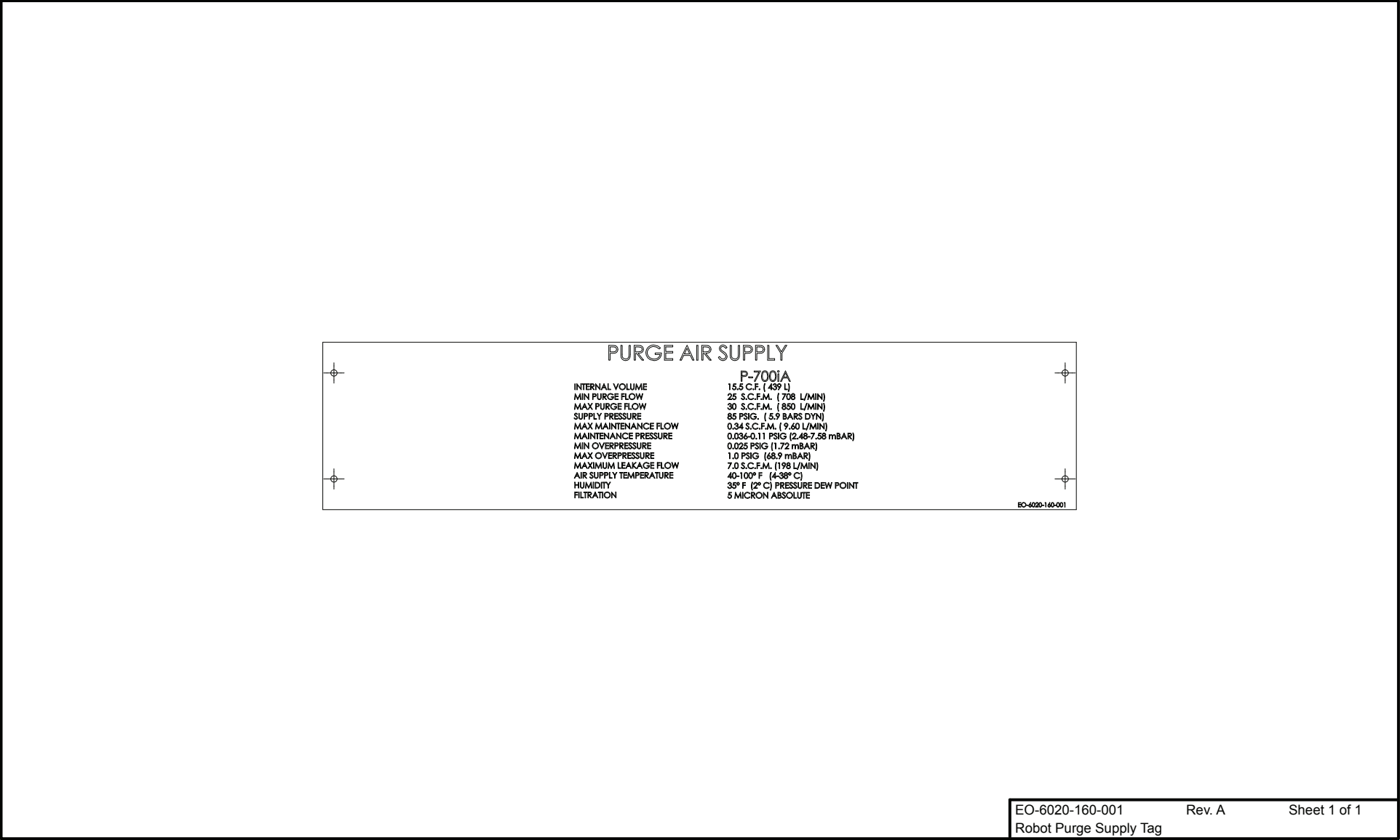
EO-5093-160-000

Rev. D1

Sheet 2 of 2

Zone Tags

Figure 4–44. Robot Purge Supply Tag EO-6020-160-001



4.5 TOOLS

Figure 4-45. Axes 4, 5 and 6 Hex Key Tool EO-4500-705-000

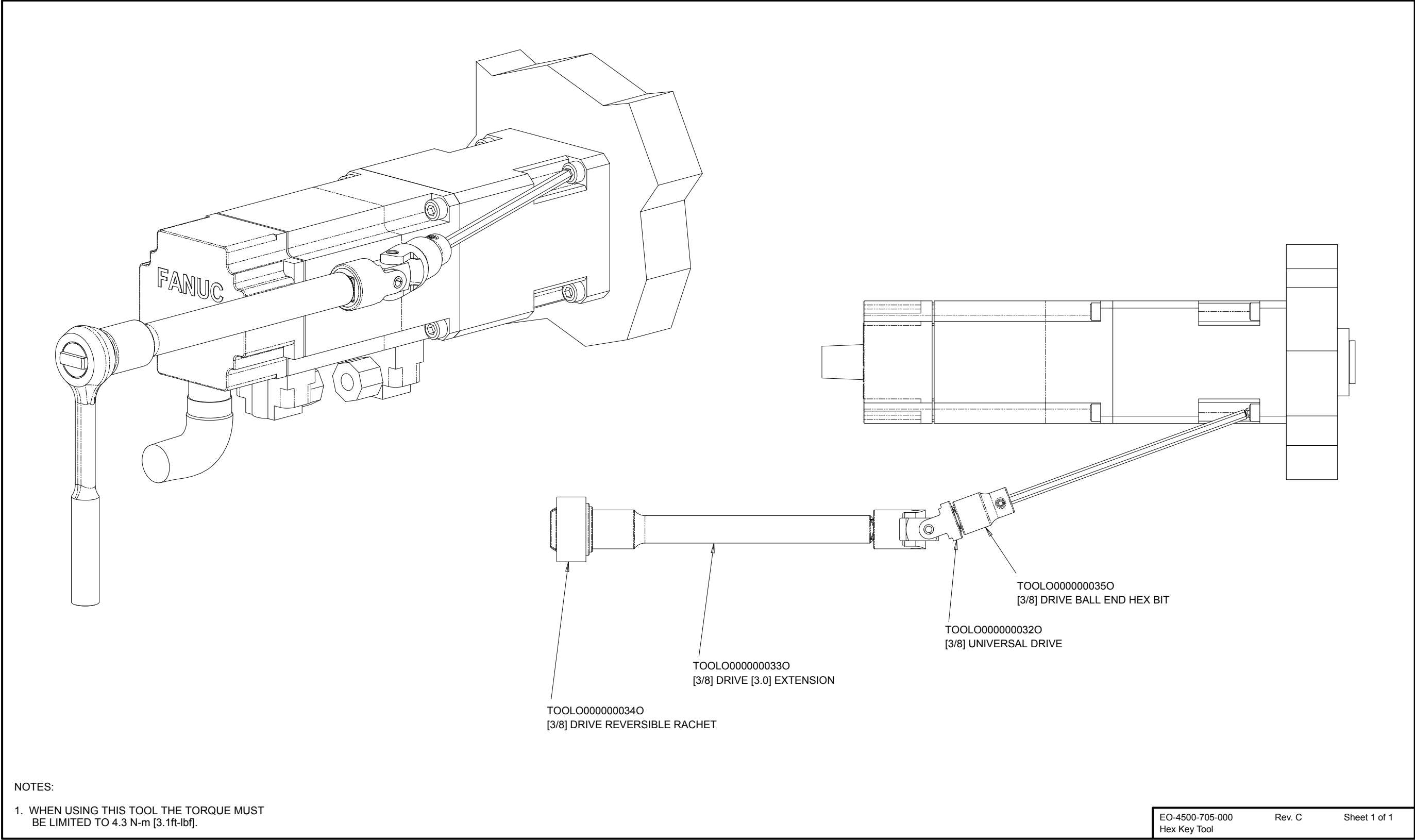
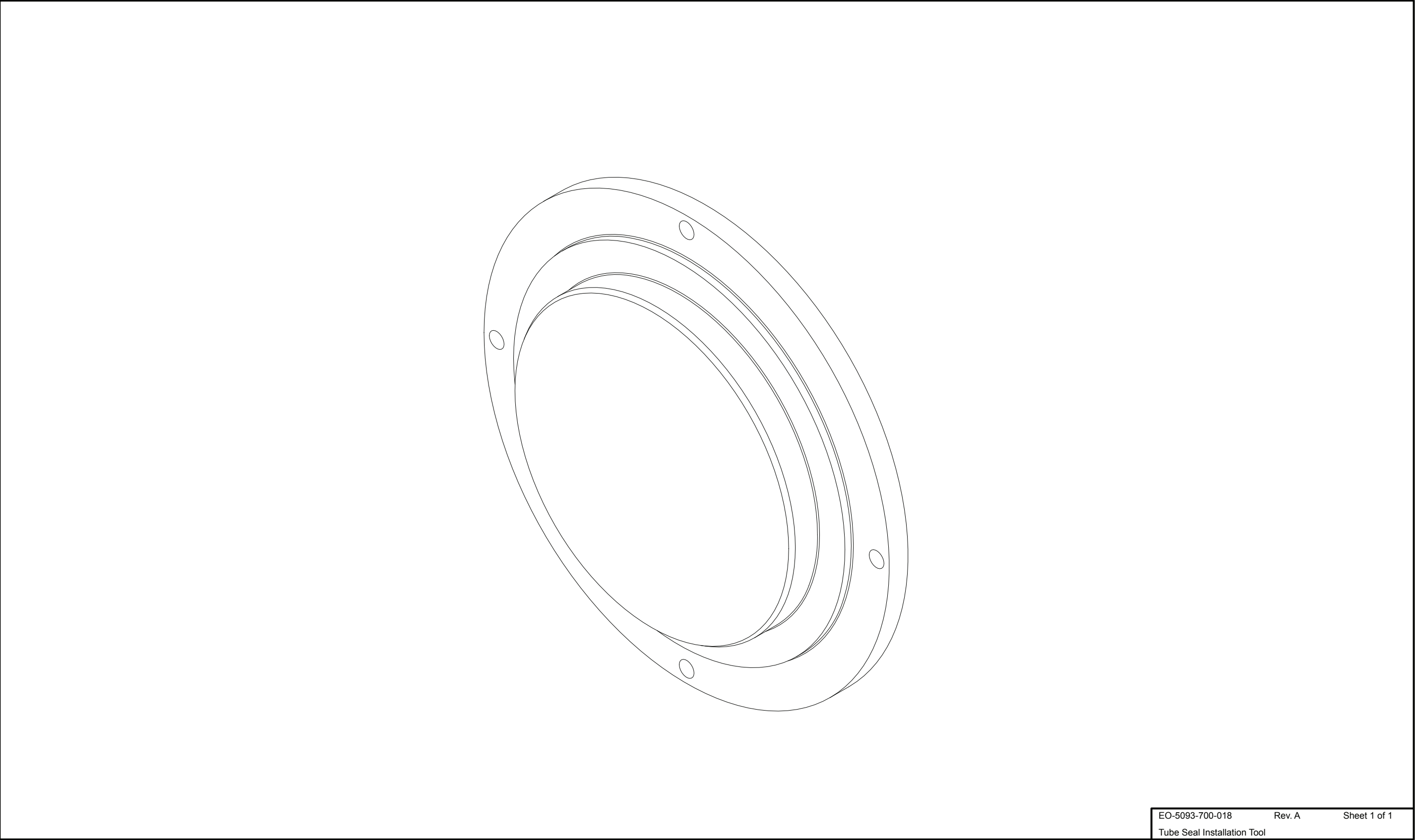


Figure 4–46. Tube Seal Installation Tool EO-5093-700-018



MASTERING

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Table 5–1. Mastering Procedures Overview

For Information Regarding	Refer to
Mastering overview	Section 5.1
Resetting alarms and preparing for mastering	Section 5.2
Saving and restoring mastering data	Section 5.3
Mastering to a fixture	Section 5.6
Single axis mastering	Section 5.4
Quick mastering	Section 5.5
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5.1 OVERVIEW

When you *master* a robot you define the physical location of the robot by synchronizing the mechanical information with the robot’s positional information. A robot must be mastered to operate properly. Robots are usually mastered before they leave FANUC Robotics. However, it is possible that a robot might lose its mastering data and need to be remastered.

The robot axes are controlled by a closed loop servo system. The controller outputs a command signal to drive each motor. A feedback device mounted on the motor, called a *serial pulse coder*, sends a signal back to the controller. During robot operation, the controller constantly analyzes the feedback signal, and modifies the command signal to maintain proper location and velocity of the end effector at all times.

For the robot to move accurately to recorded positions, the controller has to "know" the position of each axis. It does this by comparing the serial pulse coder reading during operation with a reading taken at a known mechanical reference point on the robot. Mastering records the serial pulse coder reading at a known mechanical reference point. This mastering data is stored with other user data in the controller memory and backed up by a lithium battery so that it is maintained when the controller is shut down.

When the controller is shut down under normal conditions, each serial pulse coder’s present reading is maintained in the pulse coder by backup batteries *on the robot* . (These batteries might be located in the controller or the robot auxiliary panel on P-series robots.) When the controller is turned on, the controller requests the stored reading from the serial pulse coder. When the controller receives the pulse coder reading, the servo system can operate normally. This process is called *calibration* . Calibration occurs automatically each time the controller is turned on.

When pulse coder backup battery power is interrupted while the controller is powered down, calibration fails at power up and the only robot motion possible is joint mode jogging. To restore proper operation, the robot must be mastered and calibrated.



Warning

When calibration has failed, the axis software travel limits will be ignored, allowing the robot to be jogged farther than normal. Be careful when jogging the robot in an uncalibrated condition or you could injure personnel or damage equipment.

Note The following procedures might be password-protected on your robot. If passwords have been set, you will need access at the Install level to perform mastering. Obtain the Install level password and log in at the Install level, or you will be unable to perform the following procedures.

Before mastering the robot, you must clear any faults that prevent servo power from being restored or that prevent mastering completion.

Use [Procedure 5-1](#) to clear common faults related to mastering and to prepare the robot for mastering. For more detailed information on fault recovery, refer to the *FANUC Robotics Controller Maintenance Manual*.

If you are using a FANUC Robotics A-series robot you should use a mastering fixture to master your robot. Fixture mastering is performed on FANUC Robotics P-series robots by aligning mastering pins and surfaces on the robot. Refer to the *Mechanical Unit Service Manual* specific to your robot model for procedures on how to set up and use a mastering fixture.

If you are using a FANUC Robotics M-series or S-series robot you can either master to a fixture or you can master to zero degrees. Refer to the *Mechanical Unit Service Manual* specific to your robot model for more information about either of these methods.

If you are using a FANUC Robotics P-series robot , and you have zero degree witness marks scored onto your robot, then you can master the robot to zero degrees. Refer to the *Mechanical Unit Service Manual* specific to your robot model for procedures on how to master your robot.

Quick mastering is a convenient way to master a robot **after** you have recorded a reference position. You cannot quick master a robot unless the reference position was taught before mastering was lost.



Caution

Record the quick master reference position after the robot is installed to preserve the factory mastering settings for future remastering.

Refer to [Table 5–2](#) for information on each kind of mastering procedure.

Table 5–2. SYSTEM Master/Cal Items

ITEM	DESCRIPTION
SET QUICK MASTER REF	This item allows you to set master reference positions. You can save the master reference positions to the default device in case the robot has lost mastery due to an electrical or software problem.
FIXTURE POSITION MASTER	This item allows you to master the robot to a fixture. When you master to a fixture, you use a mastering fixture to align the robot axes and then record their serial pulse coder readings. You can master any robot to a fixture.
SINGLE AXIS MASTER	This item allows you to master a single axis of the robot. You can master a single axis of any robot provided that there is a reference mark at a known position on that axis. When a single axis of a robot is mastered, mastering data for the other axes remains unchanged.
QUICK MASTER	This item allows you to quick master the robot. Quick mastering allows you to minimize the time required to remaster the robot using a reference position you established when the robot was properly mastered. You cannot quick master the robot unless you have previously recorded this quick master reference position. Record the quick master reference position when the robot is properly mastered. The best time to record the quick master reference position is when the robot is still factory-mastered. Refer to the Mastering appendix in the application-specific <i>Setup and Operations manual</i> .
ZERO POSITION MASTER	This item allows you to master the robot to zero degrees. When you master to zero degrees, you position all axes at their zero degree witness marks and record their serial pulse coder readings. You can master any M-series or S-series robot to zero degrees. If you are using a FANUC Robotics P-series robot, and you have witness marks scored onto your robot, you can master the robot to zero degrees.
CALIBRATE	This item allows you to calibrate the robot.
Message Field	This item is a status area at the bottom of the screen that lets you know when the robot has been successfully mastered or calibrated.

5.2 RESETTING ALARMS AND PREPARING FOR MASTERING

When you turn on the robot after pulse coder backup battery power has been interrupted you will see a SRVO-062 BZAL alarm. You might also see a SRVO-038 Pulse Mismatch alarm. Before mastering the robot you must reset these alarms and rotate the motor of each axis that lost battery power to prepare the robot for mastering. Use [Procedure 5-1](#) to reset these alarms and prepare the robot for mastering.

Procedure 5-1 Preparing the Robot for Mastering

Conditions

- You see a SRVO-062 BZAL or SRVO-038 Servo mismatch alarm.
- You are not mastering a P-200 robot.

Steps

1. If necessary, replace the robot batteries with four new 1.5 volt alkaline batteries, size D. Observe the direction arrows in the battery box for proper orientation of the batteries.
2. Press MENUS.
3. Select SYSTEM.
4. Press F1, [TYPE].
5. **If Master/Cal is not listed on the [TYPE] menu**, do the following; otherwise, continue to [Step 6](#)
 - a. Move the cursor to VARIABLE and press ENTER.
 - b. Move the cursor to \$MASTER_ENB.
 - c. Press the numeric key "1" and then press ENTER on the teach pendant.
 - d. Press F1, [TYPE].
6. Select Master/Cal. You will see a screen similar to the following.



Warning

For the M-6i (ARC Mate 100i), M-16i (ARC Mate 120i), and M-16iL (ARC Mate 120iL) robots, setting TORQUE to OFF using the F4, TORQUE function key on the SYSTEM Master/Cal screen releases the robot brakes. When the brakes are released, the robot arm will drop suddenly unless it is supported. DO NOT use this function key unless instructed to do so, otherwise, you could injure personnel or damage equipment.

```
SYSTEM Master/Cal
TORQUE = ON
1 FIXTURE POSITION MASTER
2 ZERO POSITION MASTER
3 QUICK MASTER
4 SINGLE AXIS MASTER
5 SET QUICK MASTER REF
6 CALIBRATE
Press 'ENTER' or number key to select.
```

Note F4, TORQUE does not appear on the Master/Cal screen for all robot models. When F4, TORQUE appears on the Master/Cal screen, it allows the robot brakes to be released.

7. Press F3, RES_PCA. You will see a screen similar to the following.

```
SYSTEM Master/Cal
1 FIXTURE POSITION MASTER
2 ZERO POSITION MASTER
3 QUICK MASTER
4 SINGLE AXIS MASTER
5 SET QUICK MASTER REF
6 CALIBRATE
Press 'ENTER' or number key to select.
Reset pulse coder alarm? [NO]
```

8. Press F4, YES. You will see a screen similar to the following.

```
SYSTEM Master/Cal
TORQUE = ON
1 FIXTURE POSITION MASTER
2 ZERO POSITION MASTER
3 QUICK MASTER
4 SINGLE AXIS MASTER
5 SET QUICK MASTER REF
6 CALIBRATE
Pulse coder alarm reset!
```

Note If you exit the Master/Cal screen by pressing F5, DONE, the Master/Cal screen will be hidden. Master/Cal will not be available by pressing F1, [TYPE]. To display the Master/Cal screen again, perform [Step 1](#) through [Step 6](#) .

- 9. Turn off the controller.
- 10. Wait a few seconds, then turn the power disconnect circuit breaker on to turn the controller on again.
- 11. If the SRVO-062 BZAL alarm is still present; there is a battery, cable or pulsecoder problem. Refer to the *FANUC Robotics Controller Maintenance Manual* for further information.
- 12. If a SRVO-038 Pulse Mismatch alarm is present at this time, repeat [Step 1](#) through [Step 8](#) to reset it. It is not necessary to restart the robot after resetting to clear this alarm.
- 13. If a SRVO-075 Pulse Not Established alarm is present at this time, press the RESET key to clear it.
- 14. Rotate each axis that lost battery power by at least one motor revolution in either direction. Failure to do so will result in the SRVO-075 Pulse Not Established alarm recurring and mastering will not be possible.
 - a. For each rotary axis, jog at least twenty degrees.
 - b. For each linear axis, jog at least thirty millimeters.
- 15. Perform any of the mastering procedures from the MASTER/CAL menu.

5.3 SAVING AND RESTORING MASTERING DATA

You can save the master reference positions to the default device in case the robot has lost mastery due to an electrical or software problem. Use [Procedure 5-2](#) to save and restore master reference position data.

Procedure 5-2 Saving and Restoring Master Reference Position Data

Conditions

- The robot is mastered. Refer to [Section 5.4](#) through [Section 5.6](#) to choose a mastering method and master your robot.
- The default device is set.
- The robot is on and is working properly.

Steps

1. Press MENU.
2. Select SYSTEM.
3. Press F1, [TYPE].
4. Select Master/Cal.

If Master/Cal is not listed on the [TYPE] menu, do the following; otherwise, continue to [Step 5](#)

- a. Select VARIABLE from the [TYPE] menu.
- b. Move the cursor to \$MASTER_ENB.
- c. Press the numeric key "1" and then press ENTER on the teach pendant.
- d. Press F1, [TYPE].
- e. Select Master/Cal. You will see a screen similar to the following.

```
SYSTEM Master/Cal
1  FIXTURE POSITION MASTER
2  ZERO POSITION MASTER
3  QUICK MASTER
4  SINGLE AXIS MASTER
5  SET QUICK MASTER REF
6  CALIBRATE
Press 'Enter' or number key to select.
```

Note F4, TORQUE does not appear on the Master/Cal screen for all robot models. When F4, TORQUE appears on the Master/Cal screen, it allows the robot brakes to be released.

5. Press FCTN.
6. Select SAVE. The file SYSMAS.TSV is copied to the default device.
7. To restore the saved file, press F2, LOAD.

5.4 SINGLE AXIS MASTERING

You can master a single axis of any robot provided that there is a reference mark at a known position on that axis. When a single axis of a robot is mastered, mastering data for the other axes remains unchanged.

Use [Procedure 5-3](#) to master a single axis.

Procedure 5-3 Mastering a Single Axis

Conditions

- You have cleared any servo faults that prevent you from jogging the robot.
- You have jogged each axis that has lost mastering at least one motor turn. See [Procedure 5-1](#)

Steps

1. Jog the unmastered axis of the robot to the single axis mastering position.
 - **For M-series or S-series robots only:** Using the joint coordinate system, jog the unmastered axis of the robot to the zero degree witness mark. If you are single axis mastering the J2-axis, the J3-axis must first be lined up at its zero degree mark. Otherwise the positions of the other axes are unimportant. Refer to the *Mechanical Service Manual* or *Mechanical Connection and Maintenance Manual* specific to your robot model for the location of the zero degree witness marks.
 - **For P-series robots only:** Using the joint coordinate system, jog the unmastered axis of the robot to the standard mastering location and align the mark, pin or surface using a mastering block or straight edge as required. If you are single axis mastering the J3-axis, the J2-axis must first be lined up at its standard mastering location. Otherwise, the positions of the other axes are not important.
2. Press MENUS.
3. Select SYSTEM.
4. Press F1, [TYPE].
5. **If Master/Cal is not listed on the [TYPE] menu,** do the following; otherwise, continue to [Step 6](#)
 - a. Select VARIABLE.
 - b. Move the cursor to \$MASTER_ENB.
 - c. Press the numeric key "1" and then press ENTER on the teach pendant.
 - d. Press F1, [TYPE].
6. Select Master/Cal. You will see a screen similar to the following.

```
SYSTEM Master/Cal
1 FIXTURE POSITION MASTER
2 ZERO POSITION MASTER
3 QUICK MASTER
4 SINGLE AXIS MASTER
5 SET QUICK MASTER REF
6 CALIBRATE
Press 'ENTER' or number key to select.
```


Note F4, TORQUE does not appear on the Master/Cal screen for all robot models. When F4, TORQUE appears on the Master/Cal screen, it allows the robot brakes to be released.

7. Move the cursor to SINGLE AXIS MASTER and press ENTER. You will see a screen similar to the following.

SINGLE AXIS MASTER				
ACTUAL	POS	(MSTR POS)	(SEL)	[ST]
J1	0.000	(0.000)	(0)	[2]
J2	3.514	(35.000)	(0)	[0]
J3	-7.164	(-100.000)	(0)	[2]
J4	-35.366	(0.000)	(0)	[2]
J5	-1.275	(-80.000)	(0)	[2]
J6	4.571	(0.000)	(0)	[2]
E1	0.000	(0.000)	(0)	[0]
E2	0.000	(0.000)	(0)	[0]
E3	0.000	(0.000)	(0)	[0]

Note A "0" in the [ST] column indicates that the axis is unmastered.

8. Move the cursor to the (MSTR POS) column and move it up or down to the unmastered axis. (Any unmastered axis will have the number 0 in the [ST] column).
9. **For M-series or S-series robots only:** Enter the position where single axis mastering is to be performed in the (MSTR POS) column for the unmastered axis.
- a. For robots where single axis mastering is performed at the zero degree position, press the numeric key "0" and press ENTER.
 - b. For robots where single axis mastering is performed at the fixture position, enter the fixture position and press ENTER.

Note Some P-series robots are single axis mastered at the fixture position. All other robots are single axis mastered at the zero degree position.

10. Continuously press and hold the DEADMAN switch and turn the teach pendant ON/OFF switch to ON.
11. Press F4, GROUP. Enter the appropriate group number. Enter 1 for a left robot or 2 for a right robot. The left and right designation is determined by looking downstream of the conveyer travel.
12. Move the cursor to the SEL column and move it up or down to the unmastered axis.
13. Press the numeric key "1" and press ENTER.
14. Press F5, EXEC. Mastering will be performed automatically. You will see a screen similar to the following.

SINGLE AXIS MASTER				
ACTUAL POS	(MSTR POS)	(SEL)	[ST]	
J1 0.000	(0.000)	(0)	[2]	
J2 3.514	(0.000)	(0)	[2]	
J3 -7.164	(-100.000)	(0)	[2]	
J4 -35.366	(0.000)	(0)	[2]	
J5 -1.275	(-80.000)	(0)	[2]	
J6 4.571	(0.000)	(0)	[2]	
E1 0.000	(0.000)	(0)	[0]	
E2 0.000	(0.000)	(0)	[0]	
E3 0.000	(0.000)	(0)	[0]	

Note The J2 axis is now mastered and a 2 is displayed in the [ST] column.

15. Press PREV.
16. Move the cursor to CALIBRATE and press ENTER. You will see a screen similar to the following.

```
SYSTEM Master/Cal
1 FIXTURE POSITION MASTER
2 ZERO POSITION MASTER
3 QUICK MASTER
4 SINGLE AXIS MASTER
5 SET QUICK MASTER REF
6 CALIBRATE
Press 'ENTER' or number key to select.
Calibrate ? [NO]
```

17. Press F4, YES. You will see a screen similar to the following.

```
SYSTEM Master/Cal
1 FIXTURE POSITION MASTER
2 ZERO POSITION MASTER
3 QUICK MASTER
4 SINGLE AXIS MASTER
5 SET QUICK MASTER REF
6 CALIBRATE
Robot Calibrated!  Cur Jnt Ang(deg):
<0.000> <0.000> <-7.164>
<-35.366> <-1.275> <4.571>
```


Note If you exit the Master/Cal screen by pressing F5, DONE, the Master/Cal screen will be hidden. Master/Cal will not be available by pressing 1, [TYPE]. To display the Master/Cal screen again perform [Step 1](#) through [Step 6](#)

5.5 QUICK MASTERING

Quick mastering allows you to minimize the time required to remaster the robot using a reference position you established when the robot was properly mastered. You cannot quick master the robot unless you have previously recorded this quick master reference position.

Record the quick master reference position when the robot is properly mastered. The best time to record the quick master reference position is when the robot is still factory-mastered.

If calibration fails because pulse coder backup battery power has been interrupted, you can use this reference position to master the robot in a minimum amount of time. When the zero position marks do not line up because of mechanical disassembly or repair, you must master to a fixture or perform zero degree mastering.

You can define a quick master reference position and perform quick mastering on any robot model.

Use [Procedure 5-4](#) to record the quick master reference position. Use [Procedure 5-5](#) to quick master the robot.



Caution

Record the quick master reference position after the robot is installed to preserve the factory mastering settings for future remastering.

Procedure 5-4 Recording the Quick Master Reference Position

Conditions

- The robot is properly mastered.

Steps

1. Align each axis of the robot with the reference mark you have chosen as a quick master reference position.

Note It is convenient to use the zero degree marks for the quick master reference position Refer to the *Mechanical Unit Service Manual* or *Mechanical Connection and Maintenance Manual* specific to your robot model for the location of the zero degree marks. But if you prefer, you can use any robot position as long as you scribe witness marks on each axis at the reference point.

2. Press MENU.
3. Select SYSTEM.
4. Press F1, [TYPE].
5. **If Master/Cal is not listed on the [TYPE] menu**, do the following; otherwise, continue to [Step 6](#)
 - a. Select VARIABLE.
 - b. Move the cursor to \$MASTER_ENB.
 - c. Press the numeric key "1" and then press ENTER on the teach pendant.
 - d. Press F1, [TYPE].

6. Select Master/Cal. You will see a screen similar to the following.

```
SYSTEM Master/Cal
1 FIXTURE POSITION MASTER
2 ZERO POSITION MASTER
3 QUICK MASTER
4 SINGLE AXIS MASTER
5 SET QUICK MASTER REF
6 CALIBRATE
Press 'ENTER' or number key to select.
```

Note F4, TORQUE does not appear on the Master/Cal screen for all robot models. When F4, TORQUE appears on the Master/Cal screen, it allows the robot brakes to be released.

7. Move the cursor to SET QUICK MASTER REF and press ENTER. You will see a screen similar to the following.

```
SYSTEM Master/Cal
1 FIXTURE POSITION MASTER
2 ZERO POSITION MASTER
3 QUICK MASTER
4 SINGLE AXIS MASTER
5 SET QUICK MASTER REF
6 CALIBRATE
Press 'ENTER' or number key to select.
Set quick master reference ? [NO]
```

8. Press F4, YES. You will see a screen similar to the following.

```
SYSTEM Master/Cal
1 FIXTURE POSITION MASTER
2 ZERO POSITION MASTER
3 QUICK MASTER
4 SINGLE AXIS MASTER
5 SET QUICK MASTER REF
6 CALIBRATE
Quick Master Reference Set!
```

Note If you exit the Master/Cal screen by pressing F5, DONE, the Master/Cal screen will be hidden. Master/Cal will not be available by pressing F1, [TYPE]. To display the Master/Cal screen again, perform [Step 1](#) through [Step 6](#)

Procedure 5-5 Quick Mastering the Robot

Conditions

- Calibration has failed because backup battery power has been interrupted.

Note If the zero degree marks do not line up because of mechanical disassembly or repair, you cannot perform this procedure. In this case, master to a fixture or master to zero degrees to restore robot mastering.

- The quick master reference position was recorded before calibration failed.
- You have cleared any servo faults that prevent you from jogging the robot.
- You have jogged each axis that has lost mastering at least one motor turn. See [Procedure 5-1](#)

Steps

1. Jog the robot to the quick master reference position that has previously been recorded.
2. Press MENUS.
3. Select SYSTEM.
4. Press F1, [TYPE].
5. **If Master/Cal is not listed on the [TYPE] menu**, do the following; otherwise, continue to [Step 6](#)
 - a. Select VARIABLE.
 - b. Move the cursor to \$MASTER_ENB.
 - c. Press the numeric key "1" and then press ENTER on the teach pendant.
 - d. Press F1, [TYPE].
6. Move the cursor to Master/Cal and press ENTER. You will see a screen similar to the following.

```
SYSTEM Master/Cal
1 FIXTURE POSITION MASTER
2 ZERO POSITION MASTER
3 QUICK MASTER
4 SINGLE AXIS MASTER
5 SET QUICK MASTER REF
6 CALIBRATE
Press 'ENTER' or number key to select.
```

Note F4, TORQUE does not appear on the Master/Cal screen for all robot models. When F4, TORQUE appears on the Master/Cal screen, it allows the robot brakes to be released.

7. Move the cursor to QUICK MASTER and press ENTER. You will see a screen similar to the following.

```
SYSTEM Master/Cal
1 FIXTURE POSITION MASTER
2 ZERO POSITION MASTER
3 QUICK MASTER
4 SINGLE AXIS MASTER
5 SET QUICK MASTER REF
6 CALIBRATE
Press 'ENTER' or number key to select.
Quick master ? [NO]
```

8. Press F4, YES. Mastering will be performed automatically. You will see a screen similar to the following.

```
SYSTEM Master/Cal
1 FIXTURE POSITION MASTER
2 ZERO POSITION MASTER
3 QUICK MASTER
4 SINGLE AXIS MASTER
5 SET QUICK MASTER REF
6 CALIBRATE
Robot Mastered! Mastering Data:
<0> <11808249> <38767856>
<9873638> <122000309> <2000319>
```

9. Move the cursor to CALIBRATE and press ENTER. You will see a screen similar to the following.

```
SYSTEM Master/Cal
1 FIXTURE POSITION MASTER
2 ZERO POSITION MASTER
3 QUICK MASTER
4 SINGLE AXIS MASTER
5 SET QUICK MASTER REF
6 CALIBRATE
Press 'ENTER' or number key to select.
Calibrate ? [NO]
```

10. Press F4, YES. You will see a screen similar to the following.

```
SYSTEM Master/Cal
1 FIXTURE POSITION MASTER
2 ZERO POSITION MASTER
3 QUICK MASTER
4 SINGLE AXIS MASTER
5 SET QUICK MASTER REF
6 CALIBRATE
Robot Calibrated!  Cur Jnt Ang(deg):
<0.003> <-0.0012> <-0.050>
<0.009> <0.015> <-0.002>
```

Note If you exit the Master/Cal screen by pressing F5, DONE, the Master/Cal screen will be hidden. Master/Cal will not be available by pressing F1, [TYPE]. To display the Master/Cal screen again, perform [Step 1](#) through [Step 6](#)

5.6 MASTERING TO A FIXTURE (FIXTURE POSITION MASTER)

When you master to a fixture, you use a mastering fixture to align the robot axes and then record their serial pulse coder readings. You can master any robot to a fixture. P-series paint robots do not use fixtures.

A mastering block, and in some cases, a steel straight edge or ruler is used to align mastering surfaces on P-series paint robots.

A mastering block is used for aligning the mastering surfaces of the modular in-booth rail.

Use [Procedure 5-6](#) to master to a fixture. Note that not all steps refer to paint robots.

Procedure 5-6 Mastering to a Fixture

Conditions

- You have the appropriate mastering fixture for your robot. (P-series robots require the robot to be put in a fixture position only. They do not actually use a fixture.)
- You have cleared any servo faults that prevent you from jogging the robot.
- You have jogged each axis that has lost mastering at least one motor turn. See [Procedure 5-1](#)

Steps

1. If automatic brake control is enabled, disable it as follows; otherwise continue to [Step 2](#) . This step is not for paint robots.
 - a. Press MENUS.
 - b. Select SYSTEM.
 - c. Press F1, [TYPE].
 - d. Select VARIABLE.
 - e. Move the cursor to \$PARAM_GROUP and press ENTER twice.
 - f. Move the cursor to \$SV_OFF_ALL and press F5, FALSE.

- g. Move the cursor to \$SV_OFF_ENB and press ENTER.
 - h. Move the cursor to each line where the value is TRUE, and press F5, FALSE.
 - i. Turn off the controller.
 - j. Turn on the controller.
2. Install the mastering fixture on the robot and jog the robot into the mastering position. Refer to the *Mechanical Service Manual* or *Mechanical Connection and Maintenance Manual* specific to your robot model for the procedures for set up and use of a mastering fixture.

For P-series robots align the mastering surfaces using the appropriate mastering block or straight edge. The modular in-booth rail uses a block.

3. Press MENU.
4. Select SYSTEM.
5. Press F1, [TYPE].
6. **If Master/Cal is not listed on the [TYPE] menu**, do the following; otherwise, continue to [Step 7](#)
- a. Move the cursor to VARIABLE and press ENTER.
 - b. Move the cursor to \$MASTER_ENB.
 - c. Press the numeric key "1" and then press ENTER on the teach pendant.
 - d. Press F1, [TYPE].
7. Select Master/Cal. You will see a screen similar to the following.

```
SYSTEM Master/Cal
1 FIXTURE POSITION MASTER
2 ZERO POSITION MASTER
3 QUICK MASTER
4 SINGLE AXIS MASTER
5 SET QUICK MASTER REF
6 CALIBRATE
Press 'ENTER' or number key to select.
```

Note F4, TORQUE does not appear on the Master/Cal screen for all robot models. When F4, TORQUE appears on the Master/Cal screen, it allows the robot brakes to be released. This step is not for paint robots.

8. Move the cursor to FIXTURE POSITION MASTER and press ENTER. You will see a screen similar to the following.


```
SYSTEM Master/Cal
1 FIXTURE POSITION MASTER
2 ZERO POSITION MASTER
3 QUICK MASTER
4 SINGLE AXIS MASTER
5 SET QUICK MASTER REF
6 CALIBRATE
Press 'ENTER' or number key to select.
Master at master position ? [NO]
```

9. Press F4, YES. Mastering will be performed automatically. You will see a screen similar to the following.

```
SYSTEM Master/Cal
1 FIXTURE POSITION MASTER
2 ZERO POSITION MASTER
3 QUICK MASTER
4 SINGLE AXIS MASTER
5 SET QUICK MASTER REF
6 CALIBRATE
Robot Mastered! Mastering Data:
<0> <11808249> <38767856>
<9873638> <122000309> <2000319>
```

10. Move the cursor to CALIBRATE and press ENTER. You will see a screen similar to the following.

```
SYSTEM Master/Cal
1 FIXTURE POSITION MASTER
2 ZERO POSITION MASTER
3 QUICK MASTER
4 SINGLE AXIS MASTER
5 SET QUICK MASTER REF
6 CALIBRATE
Press 'ENTER' or number key to select.
Calibrate ? [NO]
```

11. Press F4, YES. You will see a screen similar to the following

```
SYSTEM Master/Cal
1 FIXTURE POSITION MASTER
2 ZERO POSITION MASTER
3 QUICK MASTER
4 SINGLE AXIS MASTER
5 SET QUICK MASTER REF
6 CALIBRATE
Robot Calibrated!  Cur Jnt Ang(deg):
<0.000> <29.226> <-100.625>
<0.000> <-79.375> <0.000>
```

Note If you exit the Master/Cal screen by pressing F5, DONE, the Master/Cal screen will be hidden. Master/Cal will not appear on the SYSTEM F1, [TYPE] submenu. To see the Master/Cal screen again perform [Step 1](#) through [Step 7](#)

Steps 12 —15 are not for paint robots.

- 12. For all robots except paint robots, move the wrist clear of the mastering fixture and remove the mastering fixture from the robot. Refer to the *Mechanical Service Manual* or *Mechanical Connection and Maintenance Manual* specific to your robot model on how to use a mastering fixture.
- 13. If you have disabled automatic brake control (this step is not for paint robots) in [Step 1](#) , enable it as follows:
 - a. Press MENUS.
 - b. Select SYSTEM.
 - c. Press F1, [TYPE]
 - d. Select VARIABLE.
 - e. Move the cursor to \$PARAM_GROUP and press ENTER twice.
 - f. Move the cursor to \$SV_OFF_ALL and press F4, TRUE.
 - g. Move the cursor to \$SV_OFF_ENB and press ENTER.
 - h. Move the cursor to each line where you previously changed the value, and press F4, TRUE.
- 14. Turn off the controller.
- 15. Wait a few seconds, then press the ON/OFF button on the operator panel to turn the controller on again.

5.7 ZERO DEGREE MASTERING

When you master to zero degrees, you position all axes at their zero degree witness marks and record their serial pulse coder readings. You can master any M-series or S-series robot to zero degrees.

If you are using a FANUC Robotics P-series robot, and you have witness marks scored onto your robot, you can master the robot to zero degrees.

Use [Procedure 5-7](#) to master to zero degrees.

Procedure 5-7 Mastering to Zero Degrees

Conditions

- You have cleared any servo faults that prevent you from jogging the robot.
- You have jogged each axis that has lost mastering at least one motor turn. Refer to [Procedure 5-1](#)

Steps

1. Using the joint coordinate system, jog each axis of the robot to the zero degree witness mark. Refer to the *Mechanical Service Manual* or *Mechanical Connection and Maintenance Manual* specific to your robot model for the location of the witness marks.
2. Press MENU.
3. Select SYSTEM.
4. Press F1, [TYPE].
5. **If Master/Cal is not listed on the [TYPE] menu**, do the following; otherwise, continue to [Step 6](#)
 - a. Select VARIABLE.
 - b. Move the cursor to \$MASTER_ENB.
 - c. Press the numeric key "1" and then press ENTER on the teach pendant.
 - d. Press F1, [TYPE].
6. Select Master/Cal. You will see a screen similar to the following.

```
SYSTEM Master/Cal
1 FIXTURE POSITION MASTER
2 ZERO POSITION MASTER
3 QUICK MASTER
4 SINGLE AXIS MASTER
5 SET QUICK MASTER REF
6 CALIBRATE
Press 'ENTER' or number key to select.
```

Note F4, TORQUE does not appear on the Master/Cal screen for all robot models. When F4, TORQUE appears on the Master/Cal screen, it allows the robot brakes to be released.

7. Move the cursor to ZERO POSITION MASTER and press ENTER. You will see a screen similar to the following.

```
SYSTEM Master/Cal
1 FIXTURE POSITION MASTER
2 ZERO POSITION MASTER
3 QUICK MASTER
4 SINGLE AXIS MASTER
5 SET QUICK MASTER REF
6 CALIBRATE
Press 'ENTER' or number key to select.
Master at zero position ? [NO]
```

8. Press F4, YES. Mastering will be performed automatically. You will see a screen similar to the following.

```
SYSTEM Master/Cal
1 FIXTURE POSITION MASTER
2 ZERO POSITION MASTER
3 QUICK MASTER
4 SINGLE AXIS MASTER
5 SET QUICK MASTER REF
6 CALIBRATE
Robot Mastered! Mastering Data:
<0> <11808249> <38767856>
<9873638> <122000309> <2000319>
```

9. Move the cursor to CALIBRATE and press ENTER. You will see a screen similar to the following.

```
SYSTEM Master/Cal
1 FIXTURE POSITION MASTER
2 ZERO POSITION MASTER
3 QUICK MASTER
4 SINGLE AXIS MASTER
5 SET QUICK MASTER REF
6 CALIBRATE
Press 'ENTER' or number key to select.
Calibrate ? [NO]
```

10. Press F4, YES. You will see a screen similar to the following.

```
SYSTEM Master/Cal
1 FIXTURE POSITION MASTER
2 ZERO POSITION MASTER
3 QUICK MASTER
4 SINGLE AXIS MASTER
5 SET QUICK MASTER REF
6 CALIBRATE
Robot Calibrated!  Cur Jnt Ang(deg):
<0.000> <0.000> <0.000>
<0.000> <0.000> <0.000>
```

Note If you exit the Master/Cal screen by pressing F5, DONE, the Master/Cal screen will be hidden. Master/Cal will not be available by pressing F1, [TYPE]. To display the Master/Cal screen again perform [Step 1](#) through [Step 6](#)

5.8 P-700iA MASTERING LOCATIONS

Figure 5–1. Mastering a Right Hand Robot

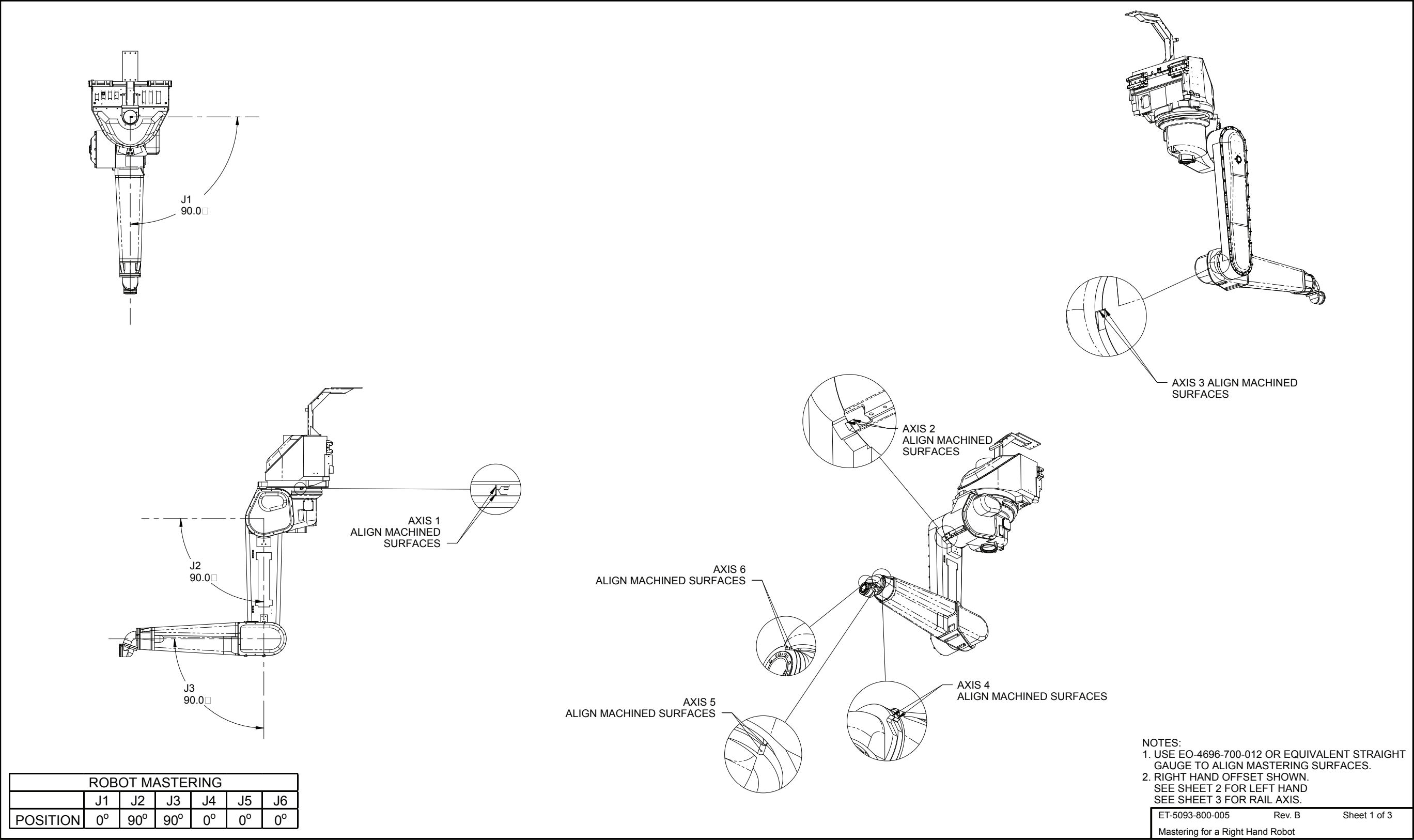


Figure 5–2. Mastering a Left Hand Robot

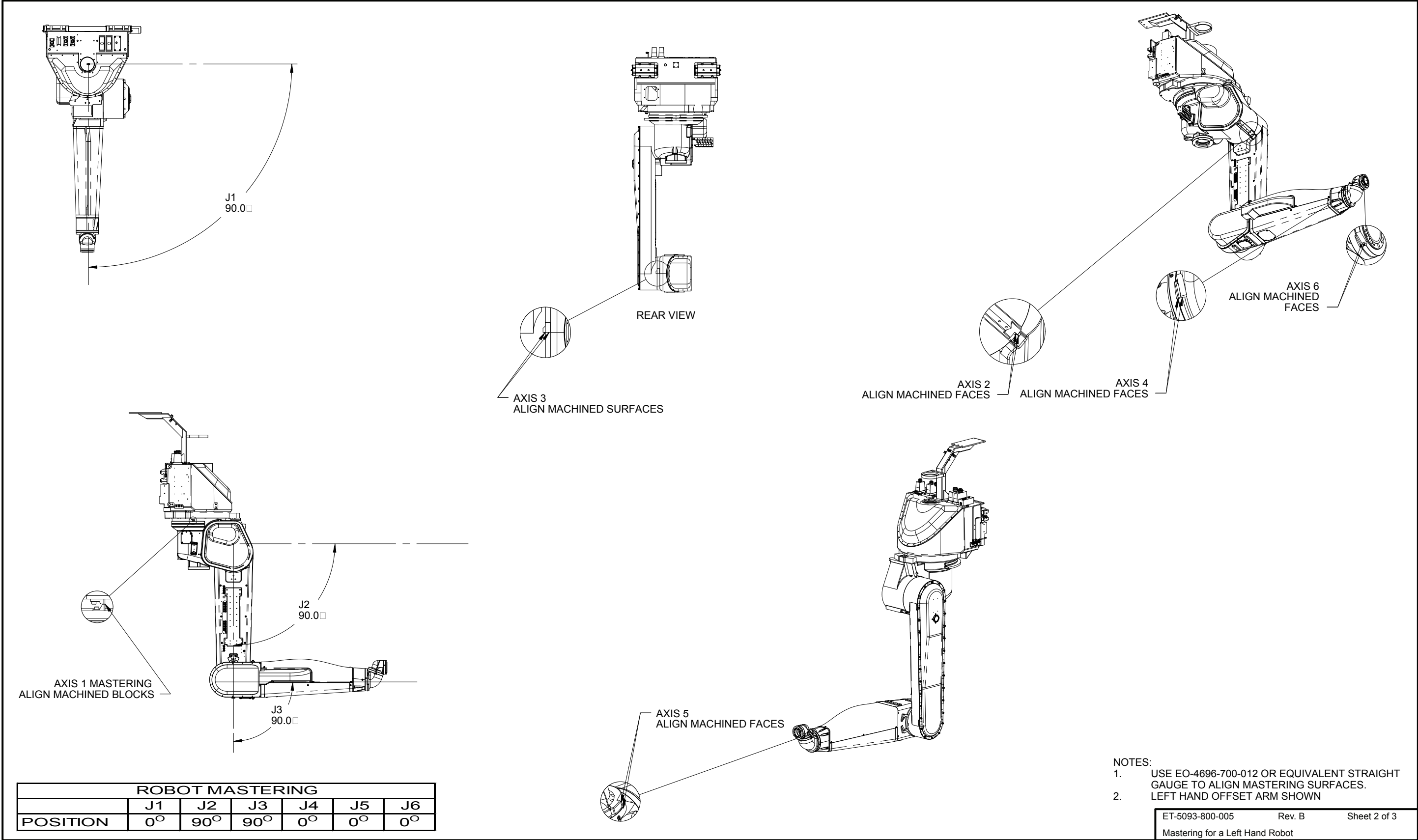
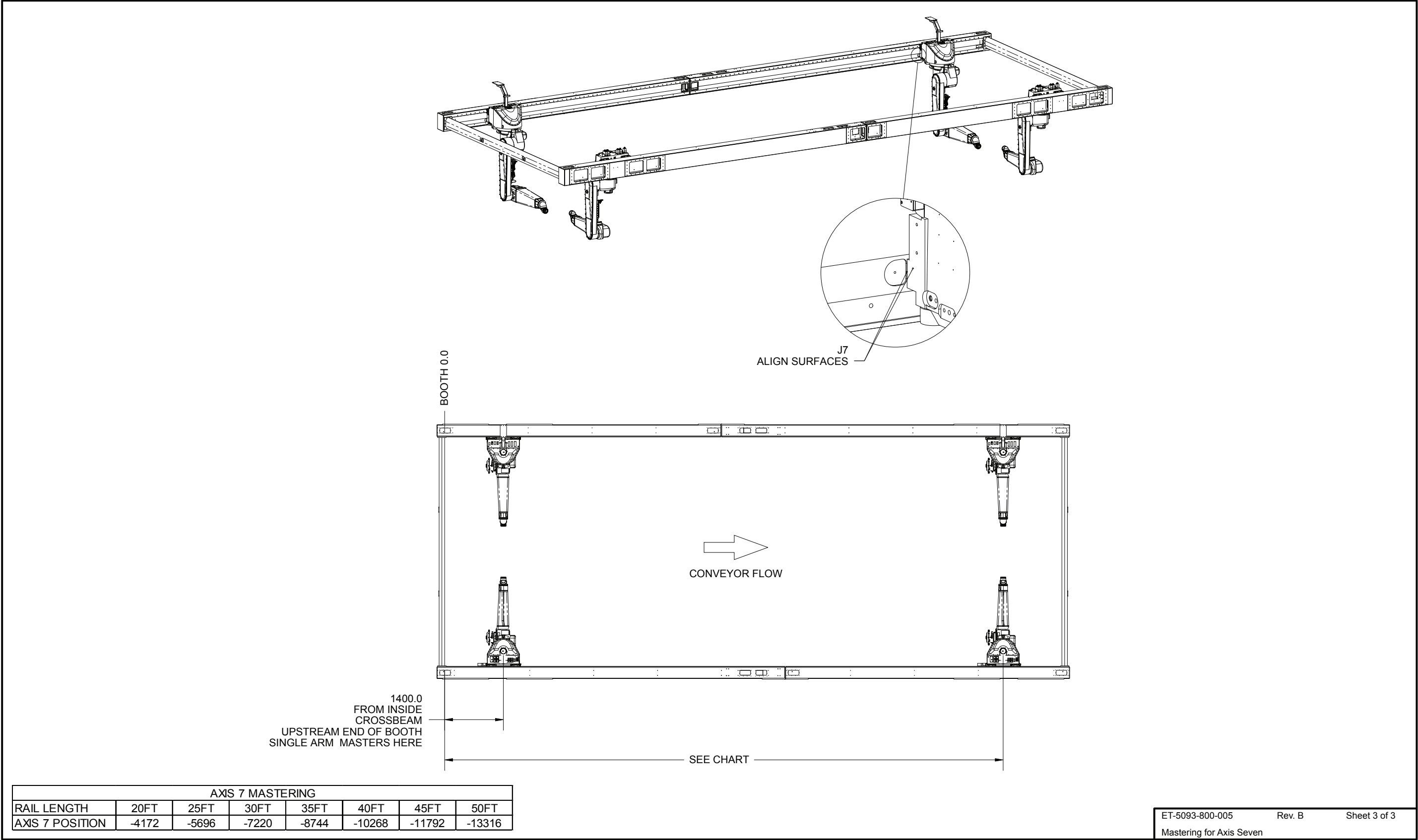


Figure 5–3. Mastering Axis Seven



PURGE SYSTEM DESCRIPTIONS

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6.1 P-700iA PURGE SYSTEM DESCRIPTIONS

The P-700*i*A robot is designed to operate in a Class I, Division I, Group C and D and a Class II, III, Division I Group E, F and G classified hazardous environment as defined by Article 500 of the National Fire Protection Association (NFPA 70 2005 edition). The mechanical unit is equipped with a Type X purge system. This means that the interior of an enclosure is reduced from hazardous to nonhazardous. When these components are electrically powered, the atmosphere in the purge cavity must be nonhazardous.

The purge system on the P-700*i*A robot uses a monitored exhaust method to purge the robot cavity of hazardous fumes. The monitored exhaust method uses a purge air distribution network to ensure all areas of the robot cavity are properly purged.

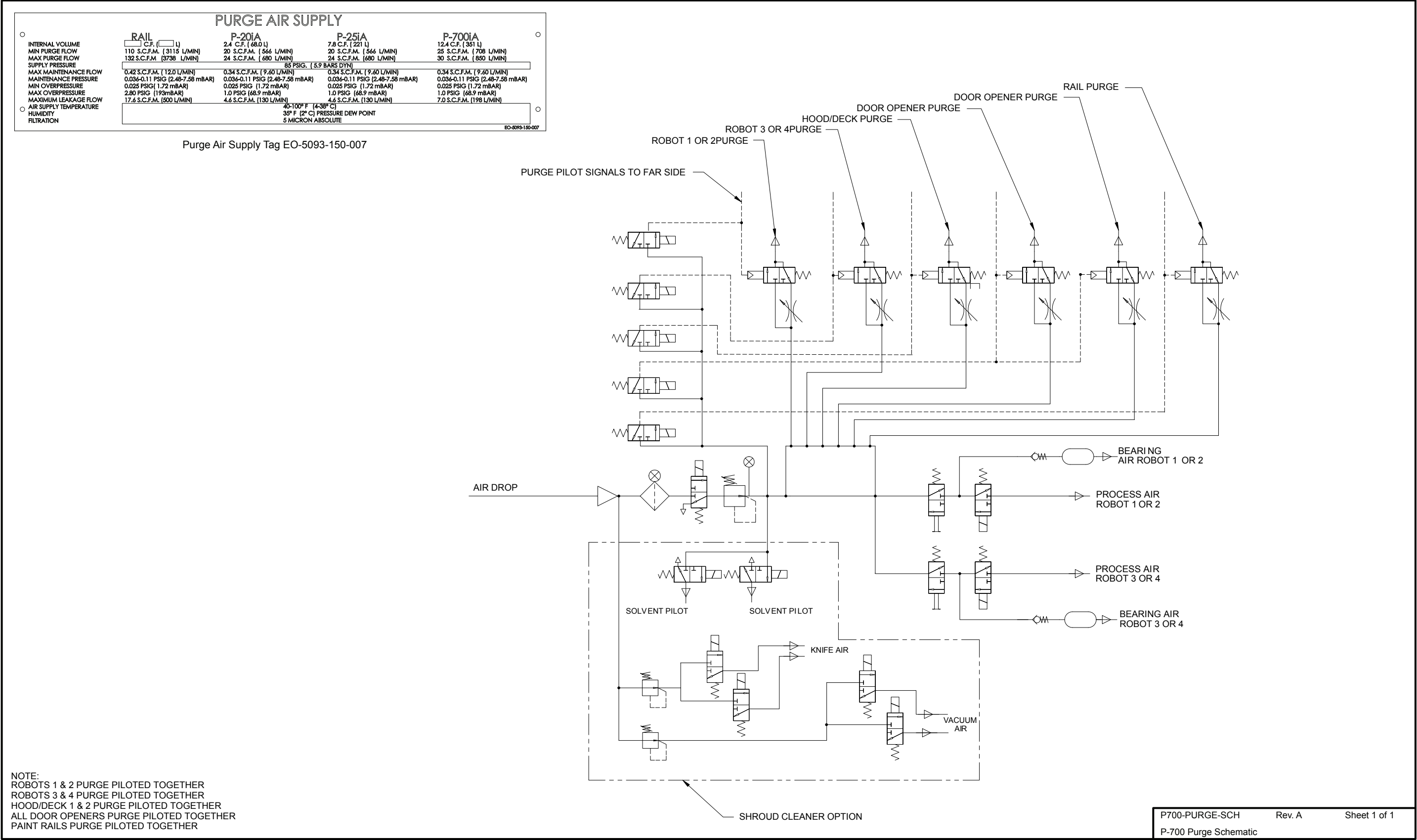
The system control console controls the purge and the pressurization of the paint robot, openers and rail. The system control console ensures that the interior of all purged cavities does not contain any hazardous gases and that it is safe to turn on the power to the controller and the robot. The system control console continuously monitors the pressurization of all purged cavities to ensure it is safe for continued operation.

Usually the robots are purged in pairs. If one robot loses purge, that robot pair is shut down and all power is turned off to that pair. This is also true for the openers. If rail purge is lost, all robotic units are turned off and their power is disconnected.

The purge air distribution network is a network of tubing that delivers purifying air to strategic locations throughout the robot system. During purging, the purge air is vented into the outside atmosphere through an exhaust conduit. See [Figure 6-1](#) .

The CE and TIIS purge system features are identical to the North American features, except for the setting of the flow switches.

Figure 6–1. P-700iA Purge System Pneumatic Circuit Diagram



The following functions are included with the system control console:

Purge System Functions

- (2) Intrinsically Safe (I.S.) Outputs for purge solenoid control (robot and opener).
- I.S. input circuits for sensing Pressure and Flow switches.
- Purge timer and logic functions.
- On board dc power supply circuits.
- Contacts to energize 220 VAC to controller power supply.
- Operator panel interface (Start push button and LEDs).
- I.S. ground terminations

The intrinsically safe Pressure and Flow switch input circuits are monitored by the system control console logic circuits. When the robot mechanical unit is pressurized and the Purge Enable button on the operator panel is pressed, the system control console activates the Purge Solenoid in the robot. When the flow switches close, the timing circuits begin a preset time out. The Purge Enable button must be held until one of the flow switches responds to the increased flow rate caused by the activation of the Purge Solenoid. After this occurs, the button can be released. The Purging light on the operator panel will light during this phase.

When the timing circuit completes its cycle, and no pressure or flow faults have occurred, the Purge Complete light will turn on. At this time, relay contacts will close which will allow the power to the controller to be turned on. Additional Purge Complete contacts (PGA-1 and PGA-2) are available on the HV terminal block. If the Pressure switch signal is lost, the Purge Fault light will be illuminated and the controller will be turned off. The PCU is equipped with I.S. Ground terminals for connection of the main I.S. ground (PA) wire as well as for the shields of the cables and the connection of the battery box and ISB unit. The unit includes input line fuses, power supply circuit, pressure and flow switch indicators and terminals for the Fire Alarm input.

The system control console also includes small, internally mounted Fuse Modules. The Fuse Module operates to protect the lines going to the purge air solenoid in the robot. In the event that the wiring going to the solenoid is shorted, the Fuse Module limits the current. If the on board fuse on a Fuse Module opens, the Module must be replaced by a unit with the same part number. There are no user serviceable parts on the Fuse Module. The Fuse Module is accessible by removing the side cover of the system control console. For installations with an opener or a second purged cavity, a second set of Fuse Modules is installed.

6.2 PURGE DRAWINGS

Figure 6–2. Rail Purge Assembly EO-5093-195-000, Sheet 1

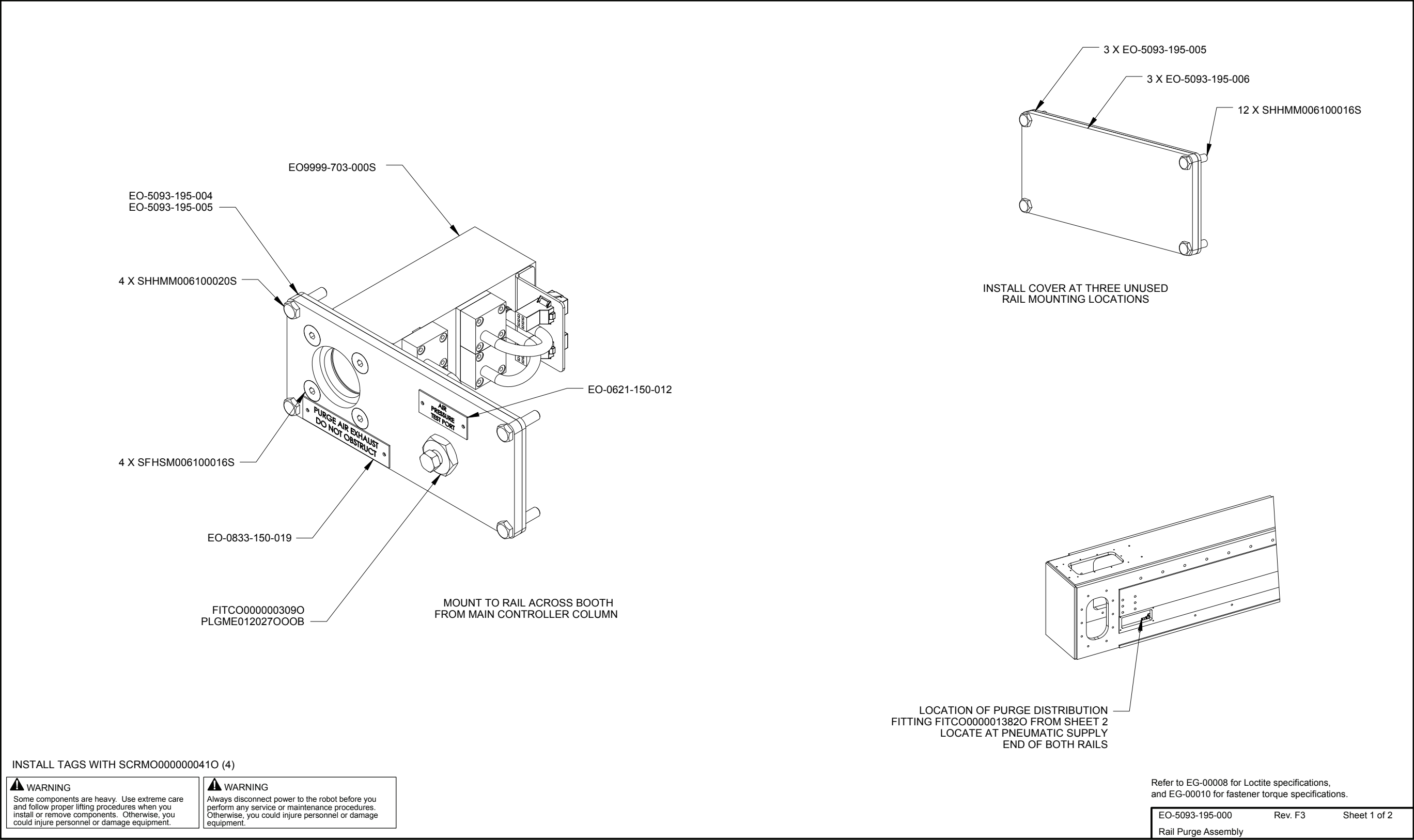
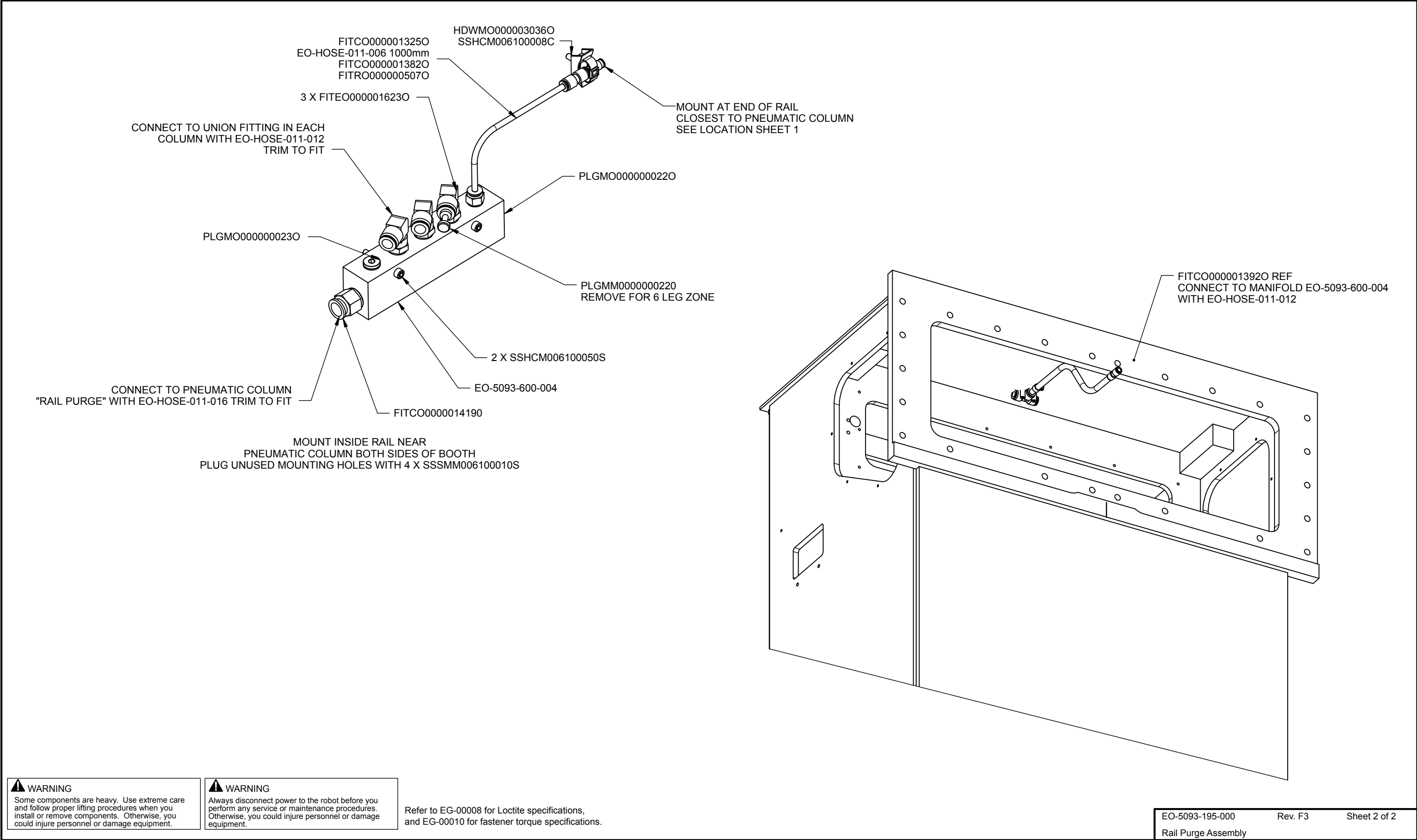


Figure 6–3. Rail Purge Assembly EO-5093-195-000, Sheet 2

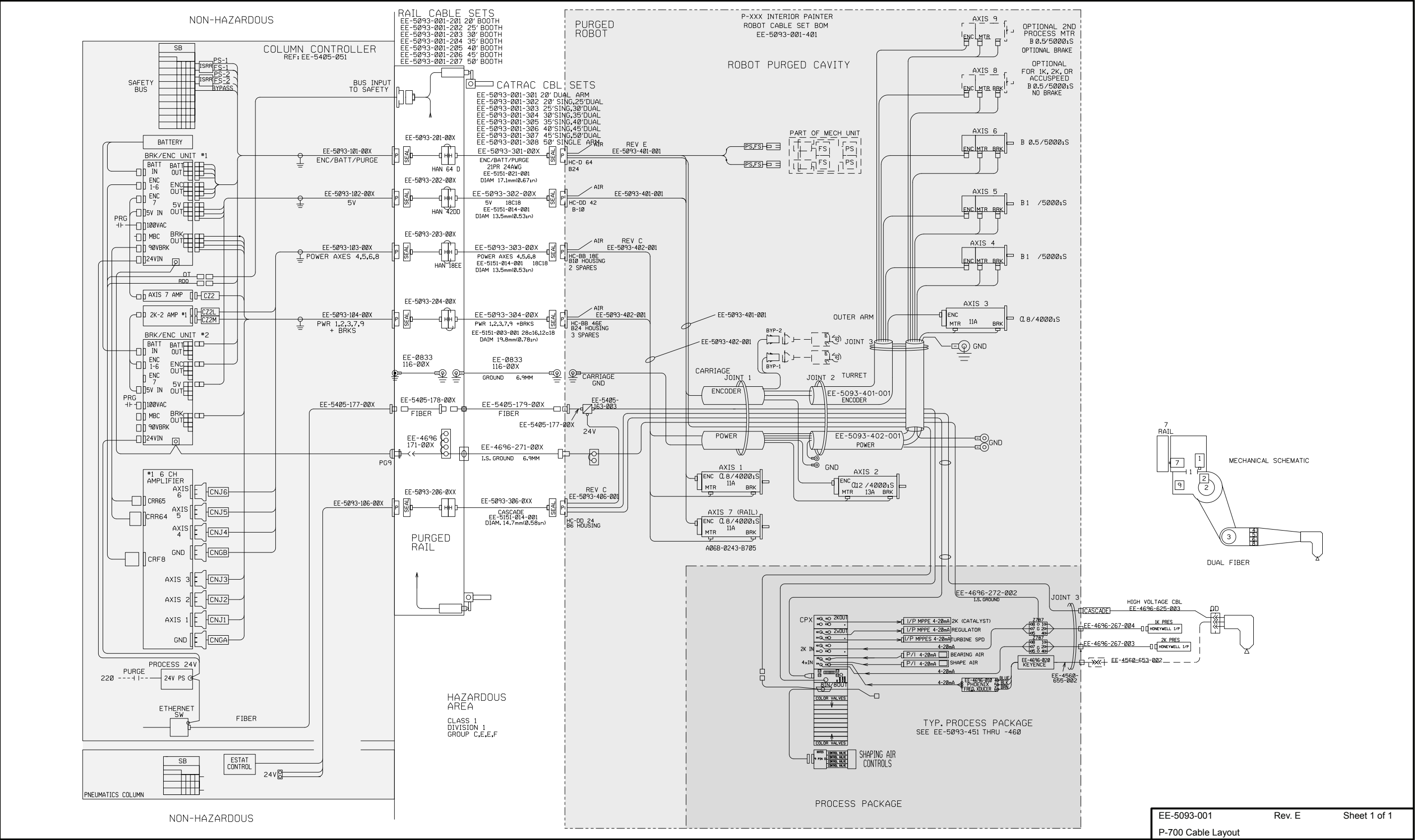


ELECTRICAL

Contents

Chapter 7 ELECTRICAL 7-1

Figure 7-1. P-700 Cable Layout



MECHANICAL UNIT SPARE PARTS LISTS

Contents

Appendix A MECHANICAL UNIT SPARE PARTS LISTS A-1

Table A-1. Overview

For Information Regarding	Refer to
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Gears	Table A-5
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Priority Descriptions

1. A priority 1 item must be replaced or replenished if it fails. These items can be, but are not limited to, grease, timing belts, flex cables, and so on.
2. A priority 2 item must be replaced if it fails. However the probability of failure is low. These items can be but are not limited to a motor, RV reducer, wrist unit, and so on.
3. A priority 3 item must be replaced if it fails. However, failure of these items will not prevent the robot from running. These items can be, but are not limited to, O-rings, oil seals, and so on.
4. A priority 4 item is a maintenance item. It is not usually a failure.

Table A–2. Wrist Assembly

Description	Part Number	Quantity used per Robot	Priority				Notes
			1	2	3	4	
Wrist assembly	EO-5093–011–000	1		X			

Table A–3. Bearings

Description	Part Number	Quantity used per Robot	Priority				Notes
			1	2	3	4	
Bearing	BRGBM015035002O	6		X			Used on the axes 4, 5, and 6 drive shafts
Bearing	BRGBM015035002O	2		X			Used on the axis 2 idler gear assembly
Gear bearing	EO-5093–170–003	1		X			Mounted on the carriage and turret assemblies
Cam roller	BRGLE000000123O	2		X			Used on the carriage assembly
			1	2	3	4	
Bearing truck	EO9999–800–003A	2		X			Used on the carriage assembly

Table A–4. Reducers

Description	Part Number	Quantity used per Robot	Priority				Notes
			1	2	3	4	
Axis 2 RV reducer	EO9999–300–010	1		X			
Axis 3 RV reducer	EO9999–300–005	1		X			
Axis 1 Alpha reducer	EO9999–310–004A	1		X			
Axes 4 and 5 Alpha reducer	EO9999–310–006D	2		X			
Alpha reducer	EO9999–310–006A	2		X			Used on axis 6 and 1 process pump on assembly EO-5093–020–000 and EO-5093–025–000
Alpha reducer	EO9999–310–006A	3		X			Used on axis 6 and 2 for the process pumps on assembly EO-5093–022–000
Axis 7 Alpha reducer	EO9999–310–002B	1		X			

Table A-5. Gears

Description	Part Number	Quantity used per Robot	Priority				Notes
			1	2	3	4	
Axis 4 wrist input gear	EO-3461-010-011	1		X			
Axis 5 wrist input gear	EO-3461-010-016	1		X			
Axis 6 wrist input gear	EO-3461-010-017	1		X			
Axis 1 drive gear	EO-5093-170-005	1		X			
Axis 2 drive gear	EO-9999-300-013	1		X			
Axis 7 drive gear	EO-3410-185-001	1		X			
Axis 3 motor gear	EO-9999-300-008	1		X			
Axis 2 idler gear	EO-9999-300-016	1		X			

Table A-6. O-rings

Description	Part Number	Quantity used per Robot	Priority				Notes
			1	2	3	4	
O-ring	EO9999-200-005D	1			X		Used between the axis 2 motor and the motor plate
O-ring	EO9999-200-005AG	1			X		Used between the axis 2 motor mounting plate and the turret
O-ring	EO9999-200-005C	1			X		Used on the axis 2 center tube
O-ring	EO9999-200-005F	1			X		Used between the axis 2 RV reducer and the turret
O-ring	EO9999-200-005B	1			X		Used on the axis 3 center tube
O-ring	EO9999-200-005E	1			X		Used between the axis 3 RV reducer and the turret
O-ring	EO9999-200-005K	2			X		Used for the inner arm lube holes
O-ring	EO9999-200-002H	1			X		Used in the axis 3 housing
O-ring	EO9999-200-005AT	1			X		Used on the top of the axis 1 gear bearing
O-ring	EO9999-200-005AM	1			X		Used between the axis 1 gear bearing and the bottom cover

Table A-7. Seals

Description	Part Number	Quantity used per Robot	Priority				Notes
			1	2	3	4	
Seal	EO-5093-020-008	3			X		Used on the axes 4, 5, and 6 drive shafts in the wrist housing
Seal	SEALE263335001O	1			X		Used in the axis 3 housing to seal the axis 3 RV reducer center tube

Table A–7. Seals (Cont’d)

Description	Part Number	Quantity used per Robot	Priority				Notes
Seal	SEALE338413001O	1			X		Used in the axis 2 turret side to seal the axis 2 RV reducer center tube and in the bottom of the turret near the paint line guide
Seal	SEALE198206001O	1			X		Used between the axis 1 gear bearing and the bottom cover

Table A–8. Maintenance Items

Description	Part Number	Quantity	Priority				Notes
			1	2	3	4	
LG-01–02 grease	HDWMO000004194O	14 oz. tube				X	Standard grease
LG-01–02 grease	HDWMO000004167O	14 oz. tube				X	Zinc free grease
LG-01–02 grease	HDWMO000004195O	35 pound pail				X	Standard grease
LG-01–02 grease	HDWMO000004168O	35 pound pail				X	Zinc free grease
LG-01–02 grease	HDWMO000004196O	115 pound keg				X	Standard grease
			1	2	3	4	
LG-01–02 grease	HDWMO000004169O	115 pound keg				X	Zinc free grease
Vigo grease No. 0	XGMF-16156	16 Kg				X	
Vigo grease No. 0	XGMF-16799	2 Kg				X	
Loctite 222 threadlocker	HDWMO000003186O	250 cc				X	
Loctite 242 threadlocker	HDWMO000001836O	50 cc				X	
Loctite 248 threadlocker	TOOLO000000098O					X	Stick
Loctite 262 threadlocker	HDWMO000002450O					X	
Loctite 268 threadlocker	TOOLO000000099O					X	Stick
Loctite 271 threadlocker	HDWMO000001147O	250 cc				X	
Loctite primer N 764	HDWMO000003658O					X	
Loctite 518 sealant	HDWMO000003249O	300 ml				X	
Loctite PST sealant	HDWMO000003185O	50 ml				X	
Loctite degreaser	HDWMO000003659O	16 oz				X	
Permatex No More Leaks sealant	HDWMO000003886O						

Table A–9. Robot Internal Cables

Description	Part Number	Quantity used per Robot	Priority				Notes
			1	2	3	4	
Encoder harness	EE-5093-401-001	1		X			
Power harness	EE-5093-402-001	1		X			
Cascade control cable	EE-5093-406-001	1		X			
Fiber optic ethernet cable	EE-5405-177-001	1	X				
Ground cable	EE-4696-272-002	1			X		

Table A–10. Individual Cable Carrier Cables

Description	Part Number	Quantity used per Robot	Priority				Notes
			1	2	3	4	
ENC/BATT/PURGE	EE-5093–301–00X	1		X			
5V cable	EE-5093–302–00X	1		X			
Axes 4, 5, 6, 8 power cable	EE-5093–303–00X	1		X			
			1	2	3	4	
Axes 1, 2, 3, 7, 9 power cable	EE-5093–304–00X	1		X			
Ground cable	EE-0033–116–00X	1			X		
Fiber optic cable	EE-5405–179–00X	1	X				
I.S. ground cable	EE-4696–271–00X	1			X		
Cascade cable	EE-5093–306–0XX	1		X			

Table A–11. Rail Purge

Description	Part Number	Quantity used per Rail	Priority				Notes
			1	2	3	4	
Manifold	EO-5093-600-004	2	X				
Blue nylon tube 6x1	EO-HOSE-011-006	16 meters	X				
Blue nylon tube 16x1	EO-HOSE-011-016	10 meters	X				
1/8" NPT bulkhead fitting	FITCO000000309O	1	X				
6 mm connector	FITCO000001325O	2	X				
6 mm straight union	FITCO000001382O	2	X				
16 mm connector	FITCO000001419O	2	X				

Table A–11. Rail Purge (Cont’d)

Description	Part Number	Quantity used per Rail	Priority				Notes
12 mm elbow	FITEO000001623O	6	X				
6H–4 reducer	FITRO000000507O	2	X				
218P-2 hex head plug	PLGME012027000B	1	X				
12 mm plug	PLGMM000000022O	2	X				
1/2” plug	PLGMO000000022O	2	X				
1/4” plug	PLGMO000000023O	4	X				
Purge switch	EO9999-703-000S	1	X				

Table A–12. Carriage Purge

Description	Part Number	Quantity used per Carriage	Priority				Notes
			1	2	3	4	
Blue nylon tube 4x.65	EO-HOSE-011-004	9 meters	X				
Blue nylon tube 8x1	EO-HOSE-011-008	1 meter	X				
Blue nylon tube 10x1.5	EO-HOSE-011-010	14 meters	X				
Manifold fitting	FITMO000002079O	1	X				
10mm Delta fitting	FITMO000002086O	2	X				
10mm tube union	FITTO000000426O	1	X				
Module	MODLO000000077O	1	X				
Plug	PLGMO000000012O	1	X				
4 mm plug	PLGMO000000015O	1	X				
Purge switch	EO9999-703-000G	1	X				25 SCFM, 708 SLPM

Table A–13. Pedestal Purge

Description	Part Number	Quantity used per Carriage	Priority				Notes
			1	2	3	4	
Blue nylon tube 4x.65	EO-HOSE-011-004	9 meters	X				
Blue nylon tube 8x1	EO-HOSE-011-008	1 meter	X				
Blue nylon tube 10x1.5	EO-HOSE-011-010	14 meters	X				
Manifold fitting	FITMO000002079O	1	X				
10mm Delta fitting	FITMO000002086O	2	X				

Table A–13. Pedestal Purge (Cont’d)

Description	Part Number	Quantity used per Carriage	Priority				Notes
10mm tube union	FITTO000000426O	1	X				
Module	MODLO000000077O	1	X				
Purge switch	EO9999-703-000G	1	X				25 SCFM, 708 SLPM
Purge switch	EO9999-703-001C1	1	X				25 to 40 SCFM

Table A–14. Turret Purge

Description	Part Number	Quantity used per Turret	Priority				Notes
			1	2	3	4	
Blue nylon tube 10x1.5	EO-HOSE-011–010	12 meters	X				
Plug-in Y connector	FITMO000002005O	1	X				
10 mm Delta fitting	FITMO000002086O	1	X				
10 mm tube union	FITTO000000426O	1	X				

Table A–15. Inner Arm Purge

Description	Part Number	Quantity used per Inner Arm	Priority				Notes
			1	2	3	4	
Blue nylon tube 10x1.5	EO-HOSE-011-010	11 meters	X				
Bulkhead fitting	FITCO000001381O	33	X				
Elbow	FITEO000001613O	1	X				
Plug-in Y connector	FITMO000002005O	1	X				
10 mm plug-in Y connector	FITMO000002090O	1	X				
4 mm plug	PLGMO000000015O	25	X				
Valve	VLVCO000000176O	1	X				

Table A–16. Solvent Borne Outer Arm Purge

Description	Part Number	Quantity used per Outer Arm	Priority				Notes
			1	2	3	4	
Blue nylon tube 10x1.5	EO-HOSE-011-010	5 meters	X				

Table A–16. Solvent Borne Outer Arm Purge (Cont’d)

Description	Part Number	Quantity used per Outer Arm	Priority				Notes
Plug-in Y connector	FITMO000002005O	1	X				
Blue nylon tube 4x.65	EO-HOSE-011-004	9 meters	X				

Table A–17. 2K Outer Arm Purge

Description	Part Number	Quantity used per Outer Arm	Priority				Notes
			1	2	3	4	
Blue nylon tube 10x1.5	EO-HOSE-011-010	5 meters	X				
Bulkhead fitting	FITCO000001381O	2	X				
Plug-in Y connector	FITMO000002005O	1	X				

Table A–18. Waterborne Outer Arm Purge

Description	Part Number	Quantity used per Outer Arm	Priority				Notes
			1	2	3	4	
Blue nylon tube 10x1.5	EO-HOSE-011-010	4 meters	X				
Elbow	FITEO000001605O	1	X				
Plug-in Y connector	FITMO000002005O	1	X				
6 mm connector	FITCO000001488O	1	X				
6 mm elbow	FITEO000001664O	1	X				

Table A–19. Nord-lock Installation Kits

Kit Part Number	Component Description	Quantity
EO5093–KIT-001A	Kit box	1
	Anti-seize stick	1
	M10 washers	350
	M8 washers	0

Table A–19. Nord-lock Installation Kits (Cont’d)

Kit Part Number	Component Description	Quantity
EO5093–KIT-001B	Kit Box	1
	Anti-seize stick	1
	M10 washers	250
	M8 washers	0
EO5093–KIT-001C	Kit Box	1
	Anti-seize stick	1
	M10 washers	200
	M8 washers	0
EO5093–KIT-001D	Kit Box	1
	Anti-seize stick	1
	M10 washers	150
	M8 washers	0
EO5093–KIT-001E	Kit Box	1
	Anti-seize stick	1
	M10 washers	0
	M8 washers	150
EO5093–KIT-001F	Kit Box	1
	Anti-seize stick	1
	M10 washers	0
	M8 washers	100

Table A-20. Engineering Guidelines (EG)

EG Number	Description	Refer to
EG-00008	Loctite Application	Section B.1
EG-00010	Fastener Torque Specifications	Section B.2

ENGINEERING GUIDELINES

Contents

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B.1 LOCTITE APPLICATION EG-00008

Be sure to use the following guidelines to prepare for Loctite application.

B.1.1 Preparation

- Be sure all surfaces are clean.
- Clean each surface with acetone or Loctite Ozone Depleting-free cleaners (ODC) or degreasers.
- Fasteners can be batch-cleaned by submerging them in acetone.
- Loctite Retaining Compounds fill the inner space between components and cure to form a strong precision assembly. All parts must be cleaned thoroughly to remove any preservatives or residue. Some preservatives can not be seen and can cause the part to appear clean. Also, some preservatives contain nitrates which will stop a Loctite product from curing properly. All areas where retaining compound is used must be cleaned properly with acetone.
- Before using a retaining compound, wash the parts in a wash tank. Then, wipe down and blow off any excess dirt or preservatives with pressurized air. Finally, be sure to clean and scrub the part with acetone at least two times with a clean cloth.

B.1.2 Primers

Primers are only required when one material is inactive. Refer to [Table B–1](#) . If a primer is required for faster curing, it will be specified on the drawing. The primers used are Loctite 7649 (Primer N) and Loctite 7471 (Primer T). Refer to [Procedure B-1](#) for proper Loctite primer application.

Table B–1. Active and Inactive Materials

Active Materials	Inactive Materials
Iron	Plated steel
Plain steel	Anodized aluminum
Copper	Stainless steel
Brass	Galvanized steel
Commercial Aluminum	Zinc
Bronze	Natural or chemical black oxide
Kovar	Plastic
	Dacromet

Primers are only required when one material is inactive. See [Table B–1](#) . If a primer is required for faster curing, it should be specified on the drawing.

Procedure B-1 Primer Directions

1. Clean the mating surfaces to ensure any residue or preservatives has been removed.
2. Apply primer to both mating surfaces to be bonded.

- 3. Allow the primer time to evaporate under good ventilation. Verify that the mating surfaces are completely dry.

Note You can bond the parts up to seven days after the primer is applied.

B.1.3 Thread Locking

Loctite thread lockers are anaerobic and cure when confined in the absence of air between close fitting metal surfaces. Application of the product will prevent loosening of assembled parts that are subject to shock and vibration. Refer to [Table B–2](#) for various types of Loctite thread lockers used at FANUC Robotics America. Refer to [Procedure B-2](#) for proper Loctite thread locker usage.

Table B–2. Loctite Thread Lockers

Product Name	Description
Loctite 222	Loctite 222 is a low strength thread locker designed to lock threaded fasteners which require easy disassembly. Unless explicitly stated on engineering drawings or documentation, Loctite 222 is to be used on all carbon and stainless steel fasteners 5mm and smaller. The uncured appearance of this product is a purple liquid or stick.
Loctite 242 or 248 (stick)	Loctite 242 or 248 (stick) is a medium strength thread locker designed to lock threaded fasteners that require normal disassembly with standard hand tools. Unless explicitly stated on engineering drawings or documentation, Loctite 242 is to be used on all carbon and stainless steel fasteners 6mm and above. The uncured appearance of this product is a blue liquid.
Loctite 262 or 268 (stick)	Loctite 262 or 268 (stick) is a high strength thread locker designed to lock threaded fasteners permanently. This product should not be applied unless explicitly stated on engineering drawings or documentation. The uncured appearance of this product is a red liquid.
Loctite 271	Loctite 271 is a high strength thread locker designed to lock threaded fasteners permanently. This product should not be applied unless explicitly stated on engineering drawings or documentation. The uncured appearance of this product is a red liquid.

Procedure B-2 Directions for Applying Loctite Thread Locker Products

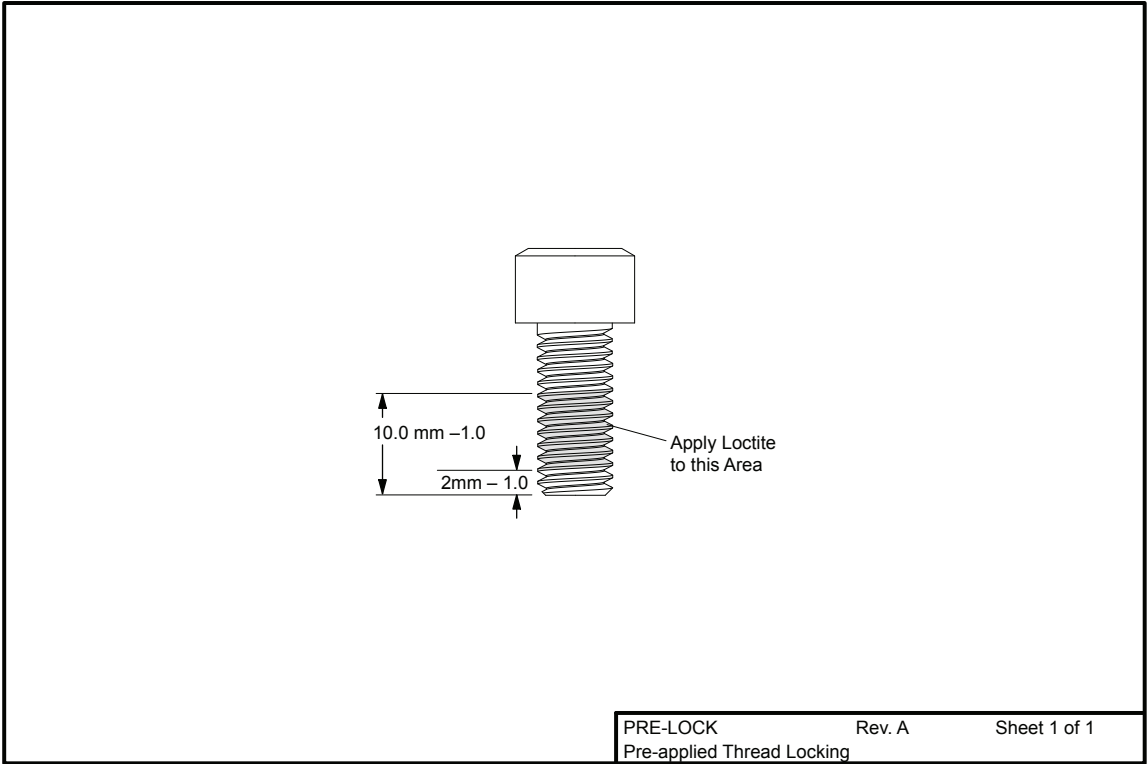
- 1. Clean all mating surfaces and verify that all residue or preservatives have been removed.
- 2. Apply primer as required. Allow it to dry.
- 3. Select the specified Loctite product and shake the liquid product before use.
- 4. For through holes, apply several drops of the product onto the bolt at the nut engagement area.
- 5. For blind holes, apply the specified Loctite product to both parts. Apply several drops of the product down the internal threads to the bottom of the hole as well as the external threads of the mating fastener. If the product is only applied to the fastener, air will force the liquid thread locker to escape as the fastener is tightened. A lack of uniform coverage creates air pockets, causing incomplete cures, which can lead to failures.
- 6. Assemble the component and tighten the fastener as required. The fasteners must be tightened to the specified torque within three minutes. Refer to EG-00010 for fastener tightening torque values.

Procedure B-3 Pre-applied Thread Locking

Loctite Dri Loc STS can be pre-applied to fasteners provided that the break away torque meets the FANUC Robotics America torque specifications found in EG-00010.

- 1. Dilute the Loctite Dri Loc STS 50 percent when it is applied to 5 mm fasteners. See [Figure B–1](#) for proper application on a 5 mm fastener.

Figure B-1. Loctite Dri Loc STS Application on a 5mm Fastener



B.1.4 Retaining

Loctite retaining compounds form a strong bond between press-fitted and slip-fitted parts. The product fills the inner space between components and cures to form a strong bond.

Loctite 680 is a high viscosity retaining compound for joining fitted cylindrical parts. The product cures when confined in the absence of air between close fitting metals. Refer to [Procedure B-4](#) for proper Loctite 680 retaining compound application.

Procedure B-4 Applying Loctite 680 Retaining Compound

1. The parts must be cleaned completely. Use acetone and scrub the surfaces with a clean rag at least two times. Verify that all contamination has been removed.
2. If the parts are inactive materials (refer to [Table B-1](#)) or the cure speed is too slow, spray with Loctite Primer 7471 or Loctite 7649 according to the engineering drawing.
3. For slip fitted assemblies, apply Loctite 680 retaining compound 360 degrees around the inside diameter (I.D.) and outside diameter (O.D.) of the mating parts. Use a rotating motion during the assembly to ensure good coverage.
4. For press fitted assemblies, apply Loctite 680 retaining compound 360 degrees around the I.D. and O.D. of the mating parts. Use a rotating motion during the assembly to ensure good coverage. Assemble the mating parts. When an undercut is provided, the retaining compound will be applied to the shaft to ensure that the under cut is completely filled as the parts are pressed together.

Note The parts should not be disturbed until sufficient handling strength is achieved. The parts using Loctite 680 need to remain in a fixture for at least ten minutes. Full cure will be developed in 24 hours.

B.1.5 Sealant

A thread sealant will seal and secure metal pipes and fittings, filling the space between threaded metal parts, to prevent leakage.

Loctite 567 is designed to lock and seal metal tapered threads and fittings. The product cures when confined in the absence of air between close fitting metal surfaces and prevents loosening and leakage from shock and vibration. The product also provides lubrication, preventing galling between metal pipe threads and fittings. Refer to [Procedure B-5](#) for proper Loctite 567 Sealant application.

Procedure B-5 Directions for using Loctite 567 Sealant

- 1. Clean all mating surfaces and verify that any residue or preservatives have been removed.
- 2. Apply primer as required. Allow it to dry.
- 3. Apply a 360° bead of sealant to the leading threads of the male fitting, leaving the first thread free of sealant. Force the sealant into the threads to ensure that all voids are filled.
- 4. Assemble and tighten the fittings.

Note Properly tightened fittings will seal instantly and can withstand moderate pressure. For maximum pressure and solvent resistance, allow the sealant to cure a minimum of 24 hours.

B.1.6 Gasketing

Gaskets are used to prevent fluid or gas leaks by forming impervious barriers that must remain intact and leak free for a prolonged period of time. Form-in-place gaskets are applied as a liquid sealant before parts are assembled. After assembly, the form-in-place gasket spreads and cures between assembled parts filling gaps, scratches and surface irregularities to provide a durable seal.

Loctite 518 Gasket Eliminator is a medium strength, solvent resistant flexible seal that will not tear or decay. The product cures when confined in the absence of air between close fitting metals. The product will fill gaps up to .25mm (.009 inch). Loctite 518 comes in a tube or a stick. Refer to [Procedure B-6](#) for proper Loctite 518 gasket eliminator application.

Procedure B-6 Directions for using Loctite 518 Gasket Eliminator

- 1. Clean all mating surfaces and verify that any residue or preservatives have been removed. The product gives the best performance when the surfaces are clean and free of grease.
- 2. Apply a continuous bead to one of the mating surfaces.
- 3. Assemble the mating parts. The parts should be tightened as soon as possible after assembly.

Note Low pressure can be applied to the assembly to confirm that a complete seal has been made immediately after assembly. Allow time for full cure (24 hours) before applying high pressure.

B.1.7 Gasket Adhesives

Gasket adhesives are used to bond a gasket to its cover for ease of assembly.

Loctite High Tack is a flexible material that will bond gaskets to its cover. It can be used on all paper, rubber, cork or metal gaskets.

Procedure B-7 Applying Loctite High Tack Adhesive

- 1. Clean the mating surfaces to ensure all contamination has been removed.
- 2. Apply Loctite High Tack with a brush or spray.

- 3. Assemble the gasket to the cover. The parts should be allowed to cure for five minutes minimum before the cover and gasket are installed.

B.1.8 ND Industries Loctite Equivalent Part Numbers

Table B–3. ND Industries Loctite Equivalent Part Numbers

FANUC Part Number	Current Description	New Description
HDWMO000001145O	Loctite #49550 adhesive 1 oz bottle	Loctite #49550 1oz / ND #39528
HDWMO000001146O	Loctite #242-41 sealant 250CC bottle	Loctite #242-41 250cc/ND#12125
HDWMO000001147O ALT:HDWMO000002362O	Loctite #271-41 threadlocker 250CC bottle	Loctite #271-41 250cc/ND#14025
HDWMO000001836O	Loctite #242-31 sealant 50CC bottle	Loctite #242-31 50cc/ND #12150
HDWMO000002312O	Loctite #515-31 gasket sealant	Loctite #515-31 50cc/ND #73250
HDWMO000002362O ALT:HDWMO000001147O	Loctite #271-31 threadlocker 50CC bottle	Loctite #271-31 50cc/ND #14050
HDWMO000002450O	Loctite #26231 retaining compound	Loctite #26231 50cc/ND #13150
HDWMO000003076O	Loctite #680 retaining compound 50CC bottle	Loctite #680 50cc/ND #54150
HDWMO000003148O	Loctite #290-41 sealant 250CC	Loctite #290-31 50cc/ND#15050
HDWMO000003185O	Loctite #PST-56747 sealant 50ML	Loctite #PST56747 50ml/ND#46050
HDWMO000003186O	Loctite #22241 threadlocker 250CC	Loctite #22241 250cc/ND #11125
HDWMO000003248O	Loctite #51831 sealant tube	Loctite #51831 50ml/ND #73050
HDWMO000003249O	Loctite #51845 sealant 300ML	Loctite #51845 300ml/ND#73025
HDWMO000003367O	Loctite #222-31 sealant 50 ML	Loctite #222-31 50ml/ND #11150
HDWMO000003658O	Loctite #21348 Primer N	Loctite #21348 PRI N/ND #61118
HDWMO0000060324O	Loctite #45440 prism 454 adhesive	Loctite #45440 20gm/ND #35420
HDWMO000056588O	Loctite #41650 416 adhesive	Loctite #41650 1oz/ND #31628

B.2 FASTENER TORQUE SPECIFICATIONS EG-00010

Purpose

- To define the torque and Loctite specifications for the most common fasteners used.

Scope

- This torque specification applies only to Products designed in the Mechanical Development department (EO, ET drawing series). Deviations are permitted and override this specification when explicitly stated on the engineering drawing/documentation.

Tolerance

- The torque tolerance for all specified values is assumed to be +/- 6% unless it is otherwise specified on the drawing.

Specification

- For metric fasteners only.

Note

Unless otherwise specified:

- All threaded fasteners have coarse threads.
- All stainless socket head fasteners and stainless hex head screws and all hex type nuts will be grade A2.
- All carbon steel socket cap screws will be grade 12.9.
- All carbon steel shoulder screws will be grade 12.9.
- All carbon steel socket flat head screws and carbon steel socket button head fasteners will be grade 10.9.
- All carbon steel low head socket cap screws will be grade 8.8.
- All carbon steel hex head screws will be grade 8.8.
- All carbon steel hex nuts M6 and larger will be grade 10.
- All carbon steel hex nut M5 and smaller will be grade 6.
- All carbon steel jam nuts will be grade 4.
- All nylon fasteners are Polyamide 6.6 (nylon 6.6).
- All brass fasteners are brass Ms 63 (cold formed).
- Loctite #222 will be used on all fasteners 5mm and under.
- Loctite #242 will be used on all fasteners 6mm and over.

Refer to [Table B–4](#) for standard torque values for grade 12.9 carbon steel socket cap screws, grade 10.9 hex head screws and grade 10 hex nuts (except for fasteners securing covers and gaskets).

Table B–4. Standard Torque Specifications for Carbon Steel

Diameter and Pitch	Torque (N-m)	Torque (ft-lbs)	Torque (in-lbs)	Torque (oz-in)
M2 x .4	0.5			70.8
M2.5 x .45	1.0		8.8	141.6
M3 x .5	1.7		15.0	
M4 x .7	3.9		34.5	
M5 x .8	7.9		70.0	
M6 x 1.0	13.5	9.9	119.4	
M8 x 1.25	32	23.6		
M10 x 1.5	64	47.2		
M12 x 1.75	112	82.5		
M14 x 2.0	180	132		
M16 x 2.0	280	206		
M20 x 2.5	546	402		
M24 x 3.0	944	696		
M30 x 3.5	1825	1346		
M36 x 4.0	3200	2360		

Refer to [Table B–5](#) for standard torque values for grade 12.9 carbon steel shoulder screws.

Table B–5. Standard Torque Specifications for Carbon Steel

Shoulder Diameter	Thread Diameter and Pitch	Torque (N-m)	Torque (ft-lbs)	Torque (in-lbs)
M6	M5 x .8	7.9		70.0
M8	M6 x 1.0	13.5	9.9	119.4
M10	M8 x 1.25	32	23.6	
M12	M10 x 1.5	64	47.2	
M16	M12 x 1.75	112	82.5	
M20	M16 x 2.0	180	206	

Refer to [Table B–6](#) for standard torque specifications for all stainless steel fasteners and nuts (except for fasteners securing covers with gaskets).

Table B–6. Standard Torque Specifications for Stainless Steel

Diameter and Pitch	Torque (N-M)	Torque (ft-lbs)	Torque (in-lbs)	Torque (oz-in)
M2 x .4	0.33			46.7
M2.5 x .45	0.66			93.4
M3 x .5	1.1		9.7	155.7
M4 x .7	2.6		23.0	
M5 x .8	5.4		47.7	
M6 x 1.0	9.2	6.7	81.4	
M8 x 1.25	22.0	16.2		
M10 x 1.5	43.5	32.0		
M12 x 1.75	76.0	56.0		
M14 x 2.0	121	89.0		
M16 x 2.0	189	138		
M20 x 2.5	368	271		
M24 x 3.0	636	469		
M30 x 3.5	1263	932		
M36 x 4.0	2207	1628		

Refer to [Table B–7](#) for standard torque specifications for all metric carbon and stainless fasteners securing covers with gaskets.

Table B–7. Standard Torque Specifications for Covers

Diameter and Pitch	Torque (N-M)	Torque (in-lbs)
M4 x .7	2.0	17.7
M5 x .8	4.0	35.4
M6 x 1.0	6.3	55.7
M8 x 1.25	7.5	66.3
M10 x 1.25	8.4	74.3

Refer to [Table B–8](#) for standard torque specifications for grade 8.8 carbon steel hex head screws, grade 10.9 carbon steel flat head screws, grade 10.9 button head socket screws, grade 8.8 carbon low head socket cap screws, grade 6 carbon steel hex nuts and all carbon steel jam nuts (except for fasteners securing covers with gaskets).

Table B–8. Standard Torque Specifications

Diameter and Pitch	Torque (N-m)	Torque (ft-lbs)	Torque (in-lbs)	Torque (oz-in)
M2 x .4	0.4			56.6
M2.5 x .45	0.7			99.1
M3 x .5	1.0		8.8	141.6
M4 x .7	2.2		19.4	
M5 x .8	4.3		38.0	
M6 x 1.0	7.5		66.3	
M8 x 1.25	18.0	13.2	159.3	
M10 x 1.5	36.0	26.5		
M12 x 1.75	67.0	49.4		
M14 . 2.0	106.0	78.0		
M16 x 2.0	161.0	118.5		
M20 x 2.5	315.0	232		
M24 x 3.0	544.0	401		
M30 x 3.5	1080.0	796		
M36 x 4.0	1890.0	1394		

Refer to [Table B–9](#) for standard torque specifications for all nylon fasteners and nuts.

Table B–9. Standard Torque Specifications for Nylon

Diameter and Pitch	Torque (N-M)	Torque (in-lbs)	Torque (oz-in)
M3 x .5	0.1		14.1
M4 x .7	0.2		28.3
M5 x .8	0.5		70.8
M6 x 1.0	1.0	8.8	141.6
M8 x 1.25	2.0	17.7	
M10 x 1.5	3.0	26.5	
M12 x 1.75	4.0	35.4	
M14 x 2.0	6.0	53.1	
M16 x 2.0	7.5	66.3	

Refer to [Table B–10](#) for standard torque specifications for all brass fasteners and nuts.

Table B–10. Standard Torque Specifications for Brass

Diameter and Pitch	Torque (N-M)	Torque (ft-lbs)	Torque (in-lbs)	Torque (oz-in)
M2 x .4	0.14			19.8
M2.5 x .45	0.29			41.0
M3 x .5	0.5			70.8
M4 x .7	1.2		10.6	169.9
M5 x .8	2.2		19.4	
M6 x 1.0	3.9		34.5	
M8 x 1.25	9.0		79.6	
M10 x 1.5	17.0	12.5	150.4	

Figure B–2. Fastener Marking Rules, Sheet 1

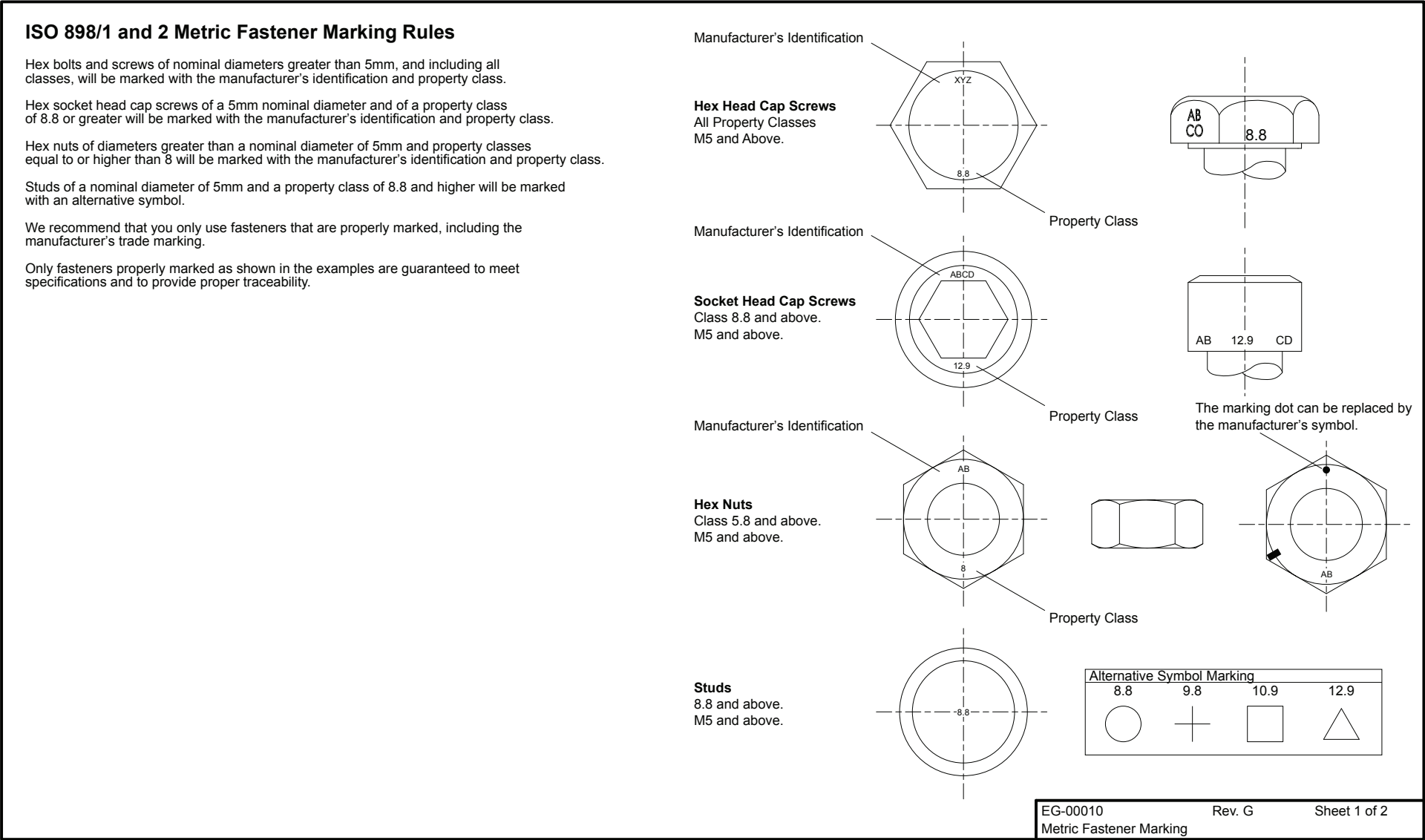


Figure B–3. Fastener Marking Rules, Sheet 2

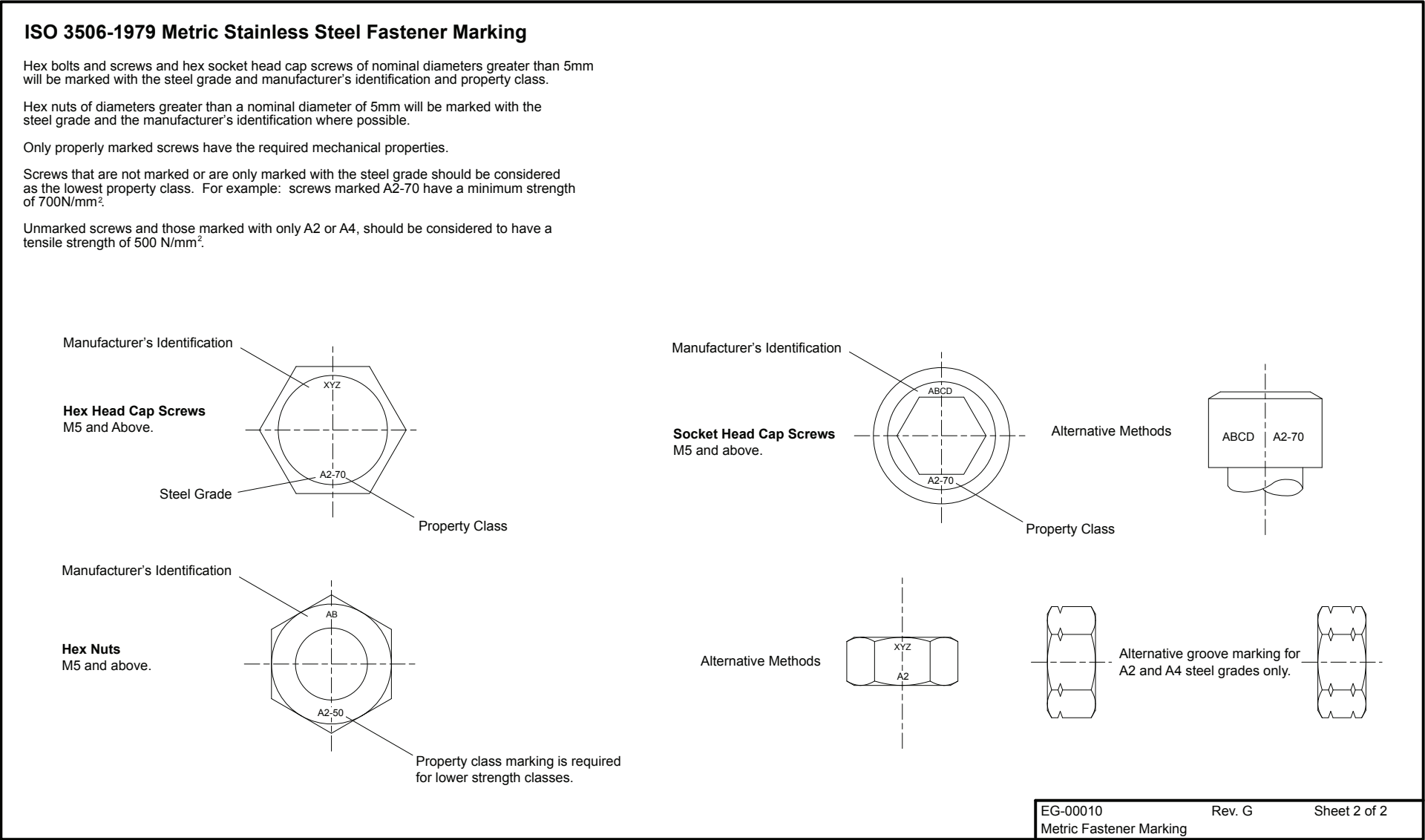
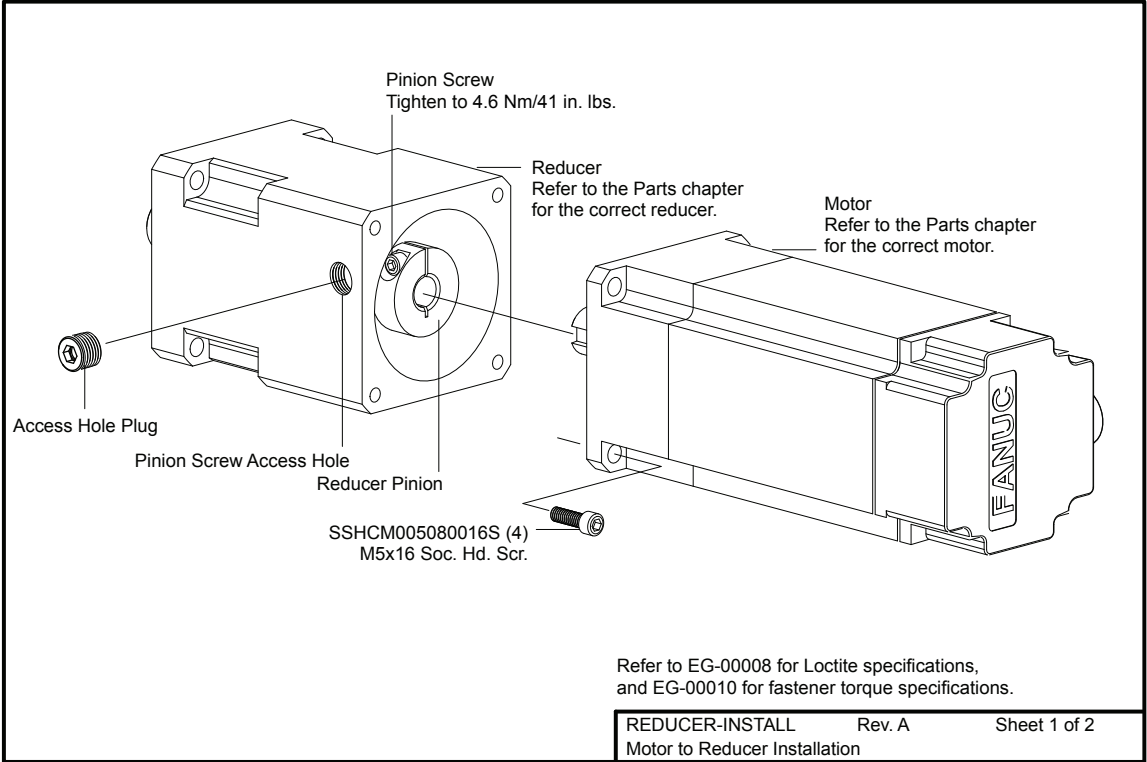


Figure B-4. Reducer Mounting, Sheet 1

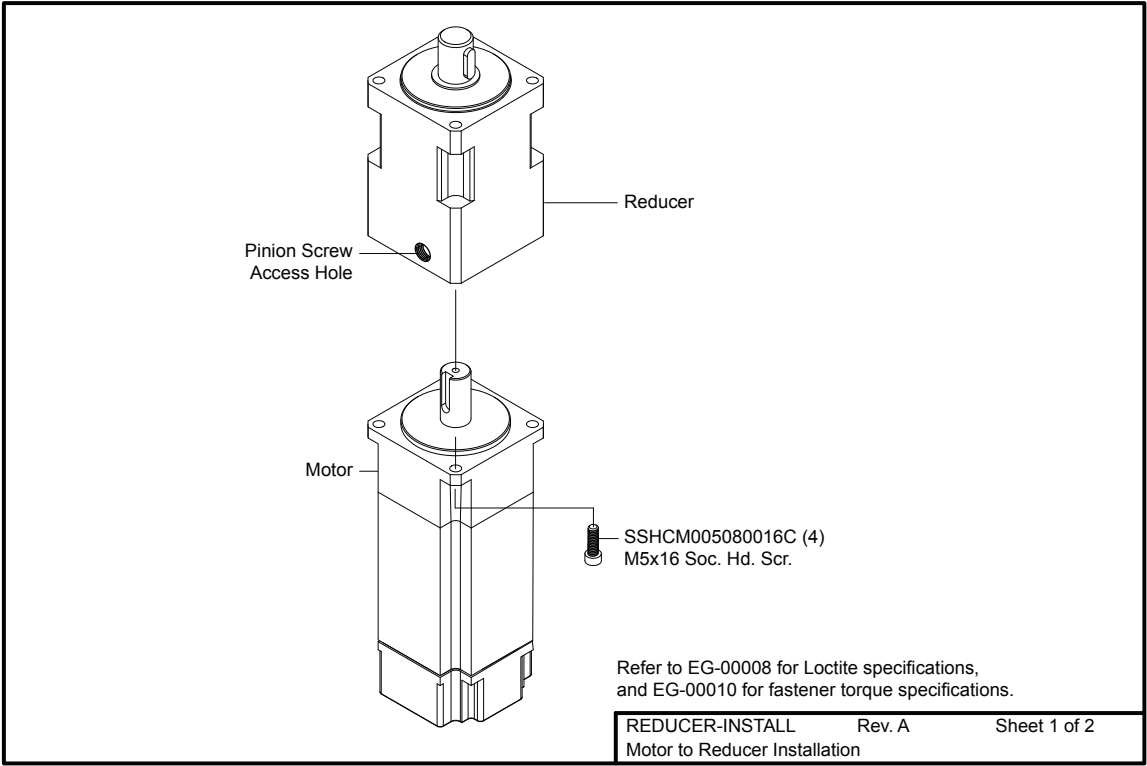


- 2. Rotate the pinion until the head of the pinion screw is aligned with the pinion screw access hole.
- 3. Check the pinion screw through the access hole and verify that it is loose. The pinion screw must be loose in order to install the motor.

Note If the motor shaft has a flat, rotate the motor shaft so that the flat will be opposite to the pinon screw.

4. For easy mounting, position the motor vertically with the shaft pointing upward. The motor shaft should be clean and dry. Insert the motor shaft into the reducer pinion. Align the motor mounting holes to the threaded holes on the reducer flange. See [Figure B-5](#) .

Figure B-5. Reducer Mounting, Sheet 2



- 5. Apply Loctite 242 to the motor mounting screw threads and secure the reducer to the motor.
- 6. With the reducer fully seated onto the motor flange, back off the motor mounting screws one complete turn.
- 7. Apply Loctite 222 to the pinion screw threads and tighten them to the specified torque.
- 8. Fully tighten the motor mounting screws to the specified torque.
- 9. Reinsert and tighten the threaded plug in the pinion screw access hole.

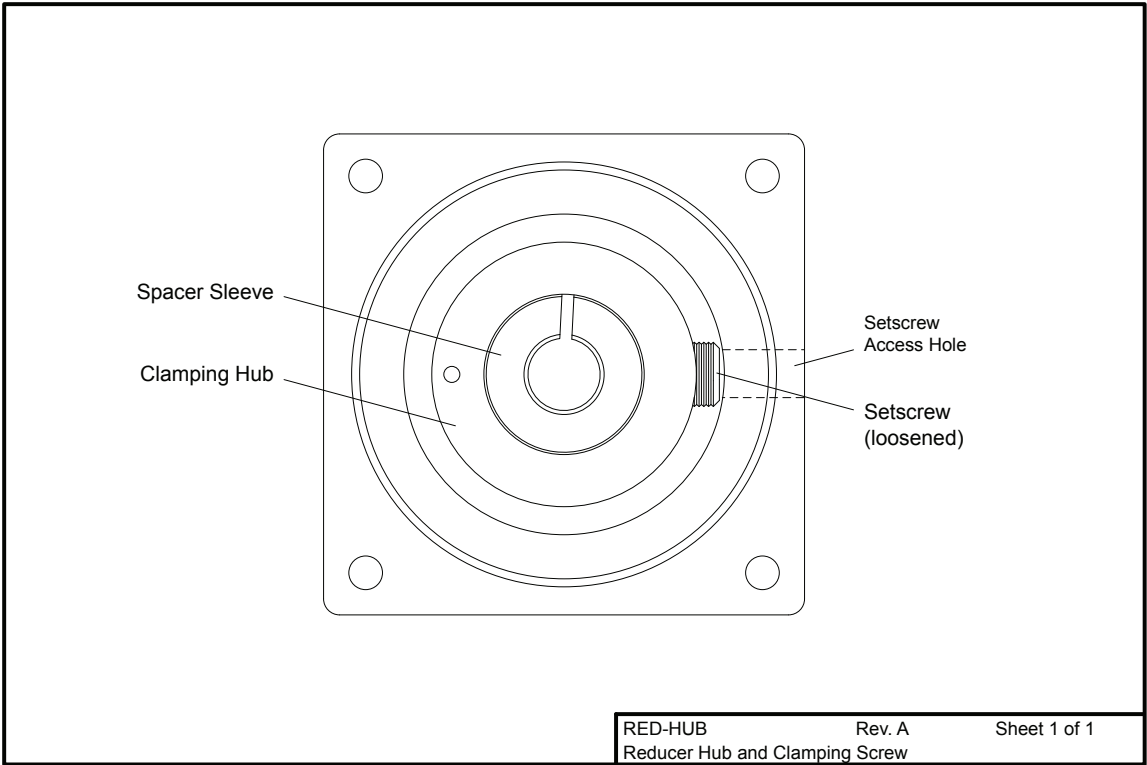
B.3.1 Alpha Reducers

Procedure B-9 Mounting the Motor to the Alpha Reducer

Note All Alpha gear reducers are treated with an anticorrosion agent at the gear input gears and output shaft.

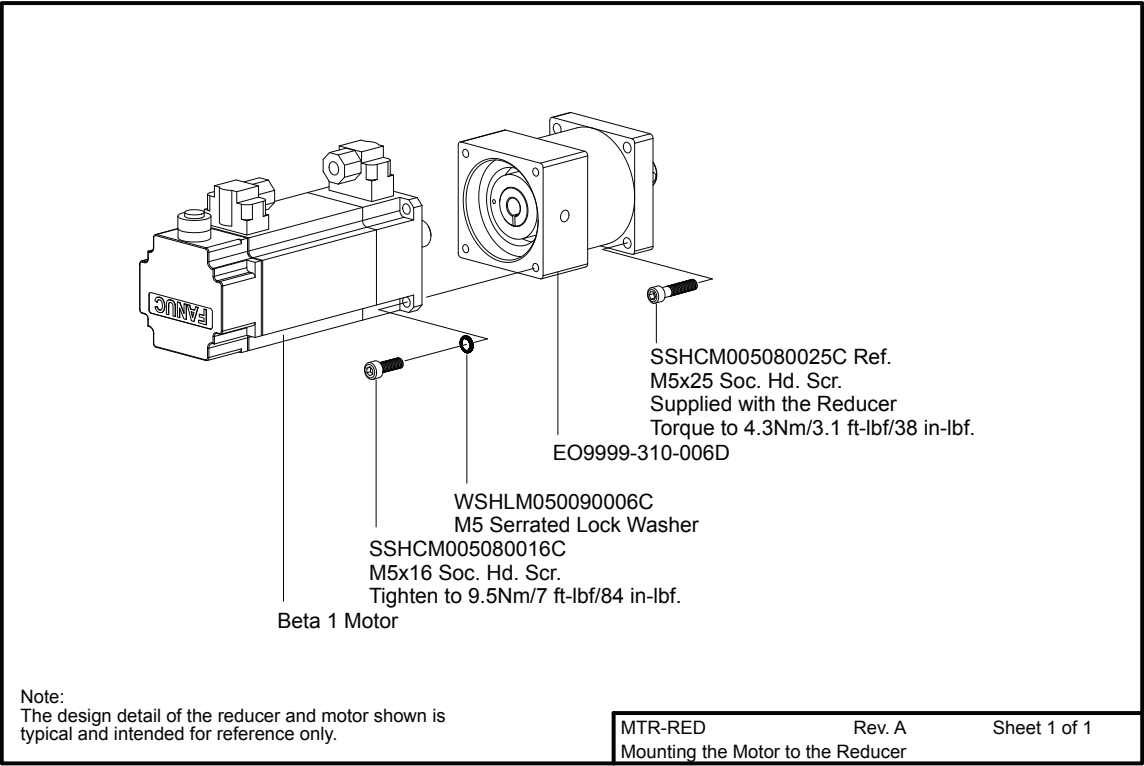
- 1. Remove any trace of the anticorrosion agent on the reducer using a fat dissolving, but not aggressive cleaner, on a clean cloth.
- 2. Clean the mounting surfaces of the reducer and motor with a clean cloth.
- 3. Inspect the reducer and motor for any contaminants or damage. Do not use any reducer or motor that is damaged.
- 4. Turn the clamping hub so that the setscrew can be reached through the mounting holes in the adapter flange.

Figure B–6. Reducer Clamping Hub and Setscrew



- 5. Take care that the slot of the spacer sleeve is positioned 90 degrees to the setscrew. Adjust the spacer sleeve if necessary.
- 6. Tighten the setscrew and then loosen the setscrew one turn.
- 7. Make sure that the motor moves into the spacer sleeve easily.

Figure B–7. Mounting the Motor to the Reducer



- 8. Position the motor so the reducer mounting surfaces fit together. Verify that there is no gap between the motor and reducer before installing the motor mounting screws.
- 9. Apply Loctite 242 to the motor mounting screws and tighten them to the specified torque. Refer to [Section B.2](#) .
- 10. Tighten the setscrew clamping the hub according to the table. Refer to [Table B–11](#) .

Table B–11. Reducer Setscrew Torque

Gear Reducer Size	Tightening Torque (N-M)	Setscrew Hex Size (mm)
CV 040	5.6	3
CV 060	9.5	4
CV 080	23	5
CV 115	45	6

Procedure B-10 Mounting Details on the Alpha Reducer Output Shaft

- 1. Thoroughly clean the reducer output shaft and the inside diameter of items to be mounted on the shaft.

2. Make sure that the gears, pulleys or drive shafts mount on the reducer shaft freely. Do not force anything on the drive shaft. Do not exceed the axial force listed in [Table B–12](#) .

Table B–12. Maximum Axial Force

Gear Reducer Size	Maximum Force (N)
040	230
060	750
080	1600
115	2100

B.4 P-700 Cable Routing EG-00399

Figure B-8. Cable Routing EG-00399, Sheet 1

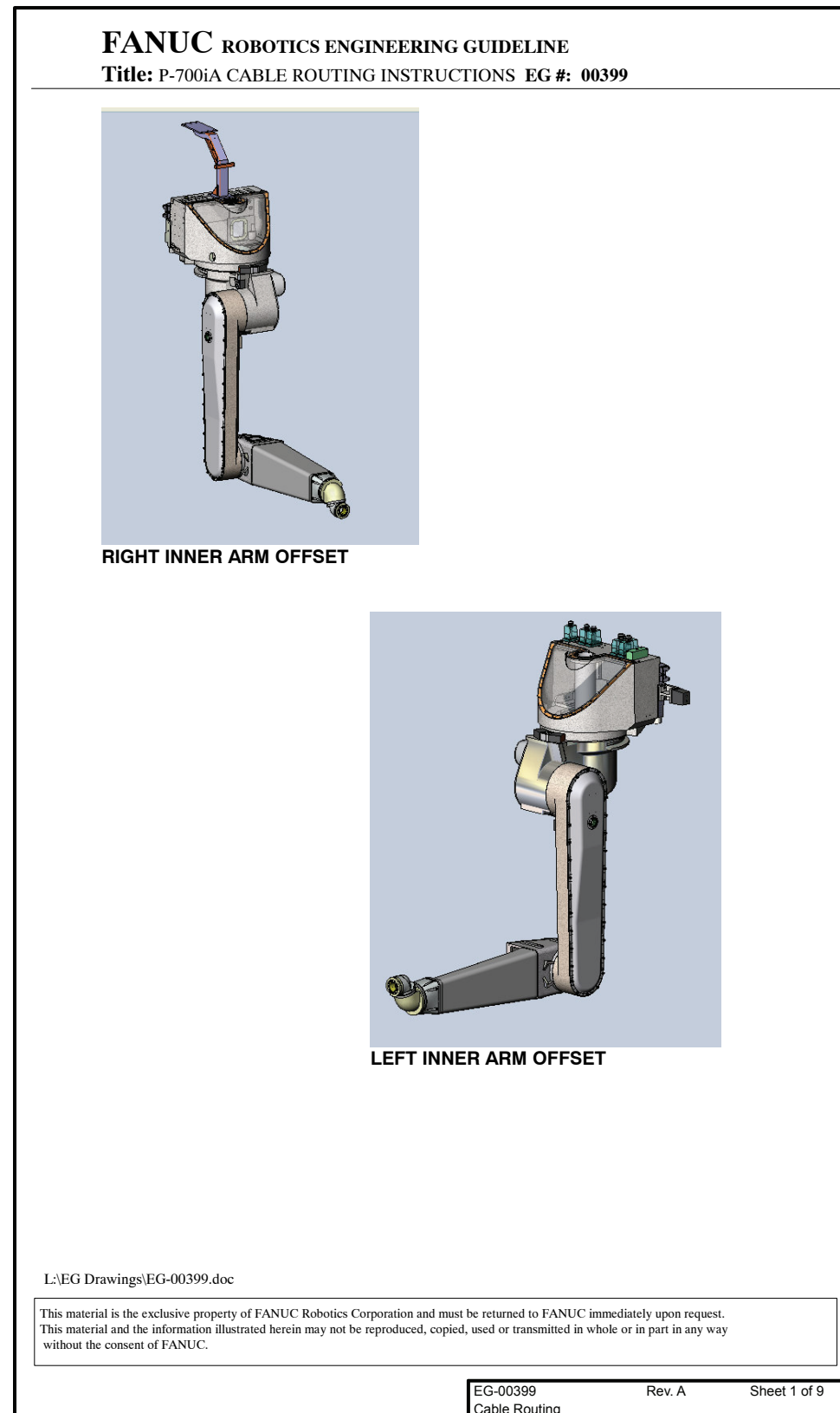


Figure B-9. Cable Routing EG-00399, Sheet 2

FANUC ROBOTICS ENGINEERING GUIDELINE

Title: P-700iA CABLE ROUTING INSTRUCTIONS EG #: 00399

Steps 1 through 7 are common for all types of P-700iA robots. The initial position for J1 right offset and left offset is opposite.

1.) Initial Step:

- J1 Turret must be at + or- 89° as shown in Figure 1. Right offset arm shown. Left offset arm rotated in opposite direction.
- Axis 2 is positioned approximately 45 degrees above horizontal (not critical).
- Axis 3 is positioned horizontally.
- Position the unrolled cables in the proper relationship inside the arm.



Figure 1
Left inner arm offset shown

L:\EG Drawings\EG-00399.doc

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EG-00399
Cable Routing

Rev. A

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Figure B–10. Cable Routing EG-00399, Sheet 3

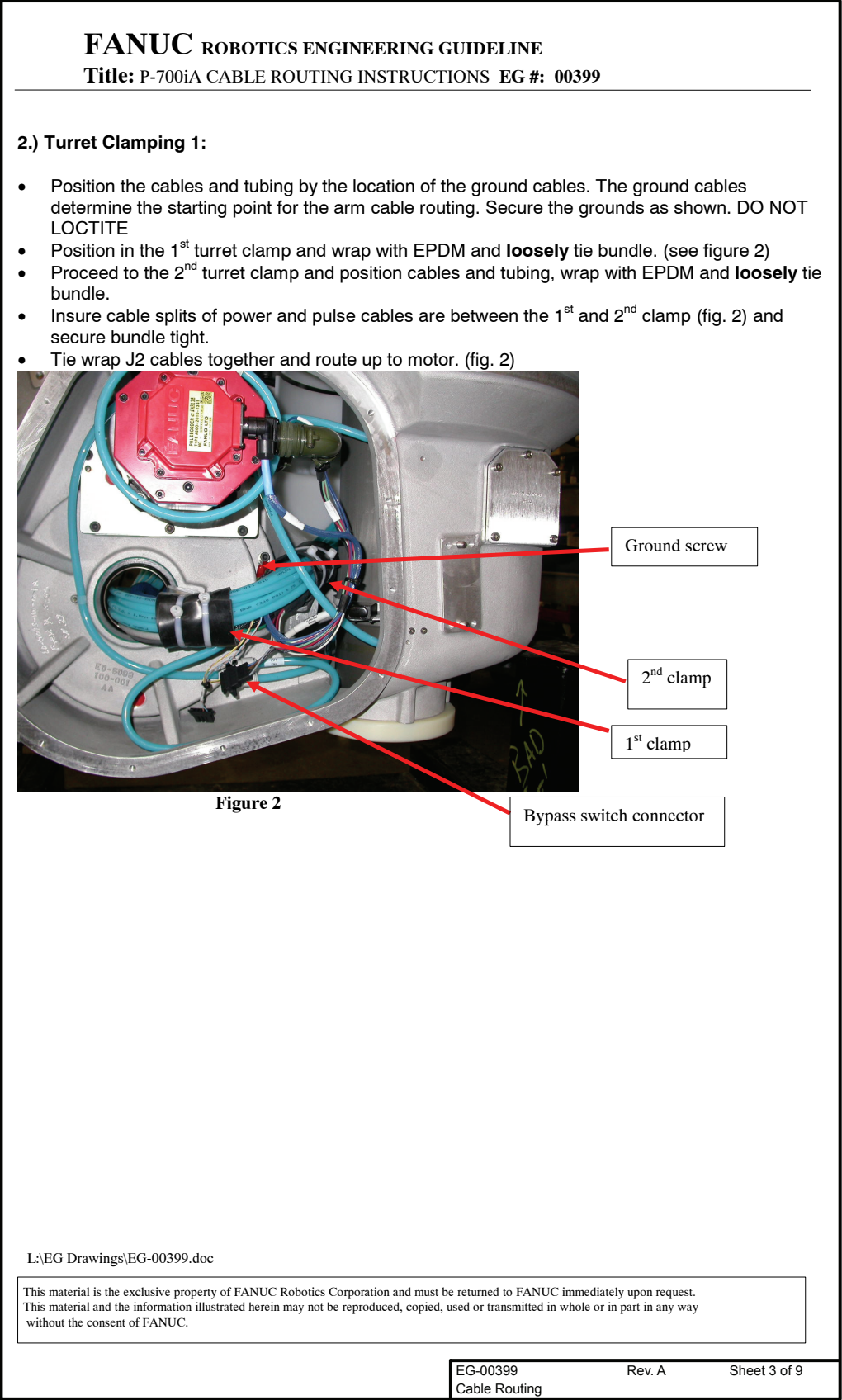


Figure B-11. Cable Routing EG-00399, Sheet 4

FANUC ROBOTICS ENGINEERING GUIDELINE

Title: P-700iA CABLE ROUTING INSTRUCTIONS **EG #: 00399**

3.) Turret / Carriage Clamping:

- Feed cables and hoses up to the 1st carriage clamp and tie wrap loosely (fig.3.) The bundle should follow a neat helix from below up to the carriage clamps.
- Loosely tie wrap the cables and hoses to the 2nd clamp. (fig 3 or 4)
- Ensure cable splits of power and pulse cables are outside the 2nd clamp.
- Connect all J1 and J7 power and brake connectors & encoder connector. Tie power, brake cables and pulse cables together. (fig 3,4,5)
- Comb bundle, position loop and wrap EPDM around clamp points and secure in screw clamp on
- Connect Phoenix connectors to carriage housing.
- Insert purge tubes into Phoenix connectors.
- Connect IS ground cable and N-tron unit cables per fig 5.

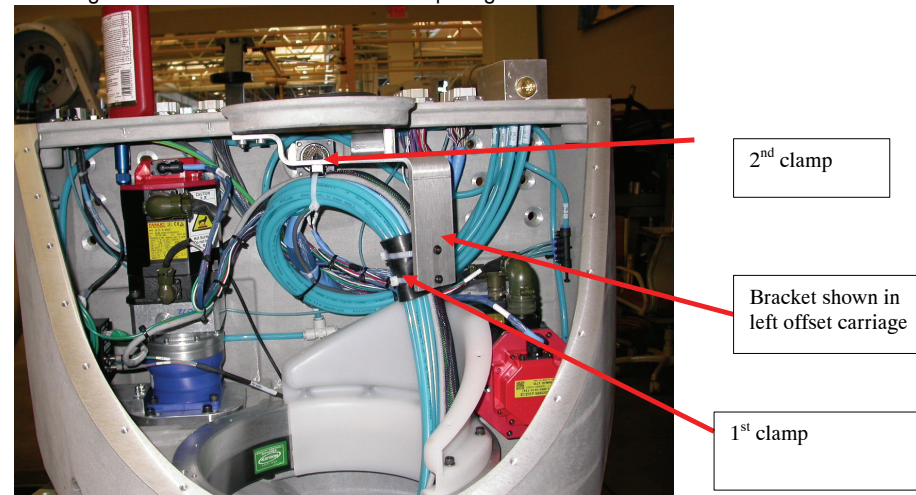


Figure 3
Left Inner Arm Offset without center tube

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Figure B-12. Cable Routing EG-00399, Sheet 5

FANUC ROBOTICS ENGINEERING GUIDELINE
Title: P-700iA CABLE ROUTING INSTRUCTIONS EG #: 00399



Figure 4
Right Inner Arm Offset

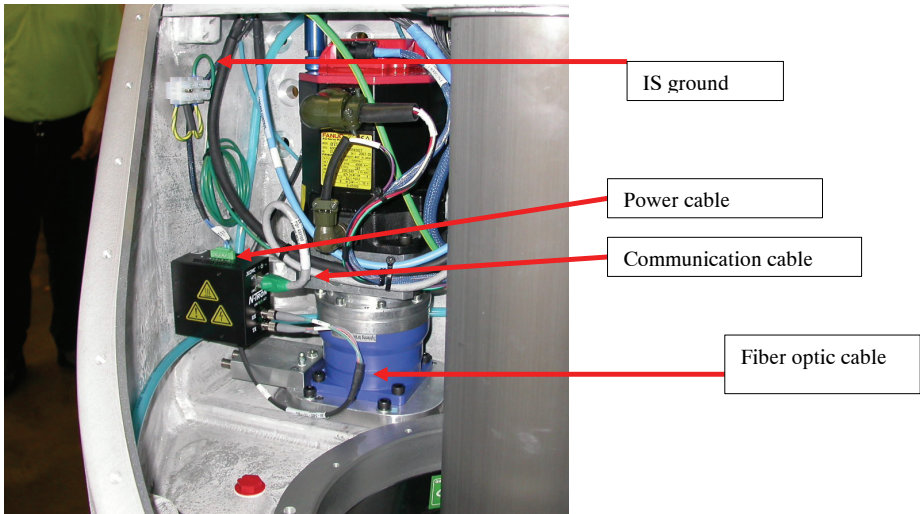


Figure 5

L:\EG Drawings\EG-00399.doc

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Figure B–14. Cable Routing EG-00399, Sheet 7

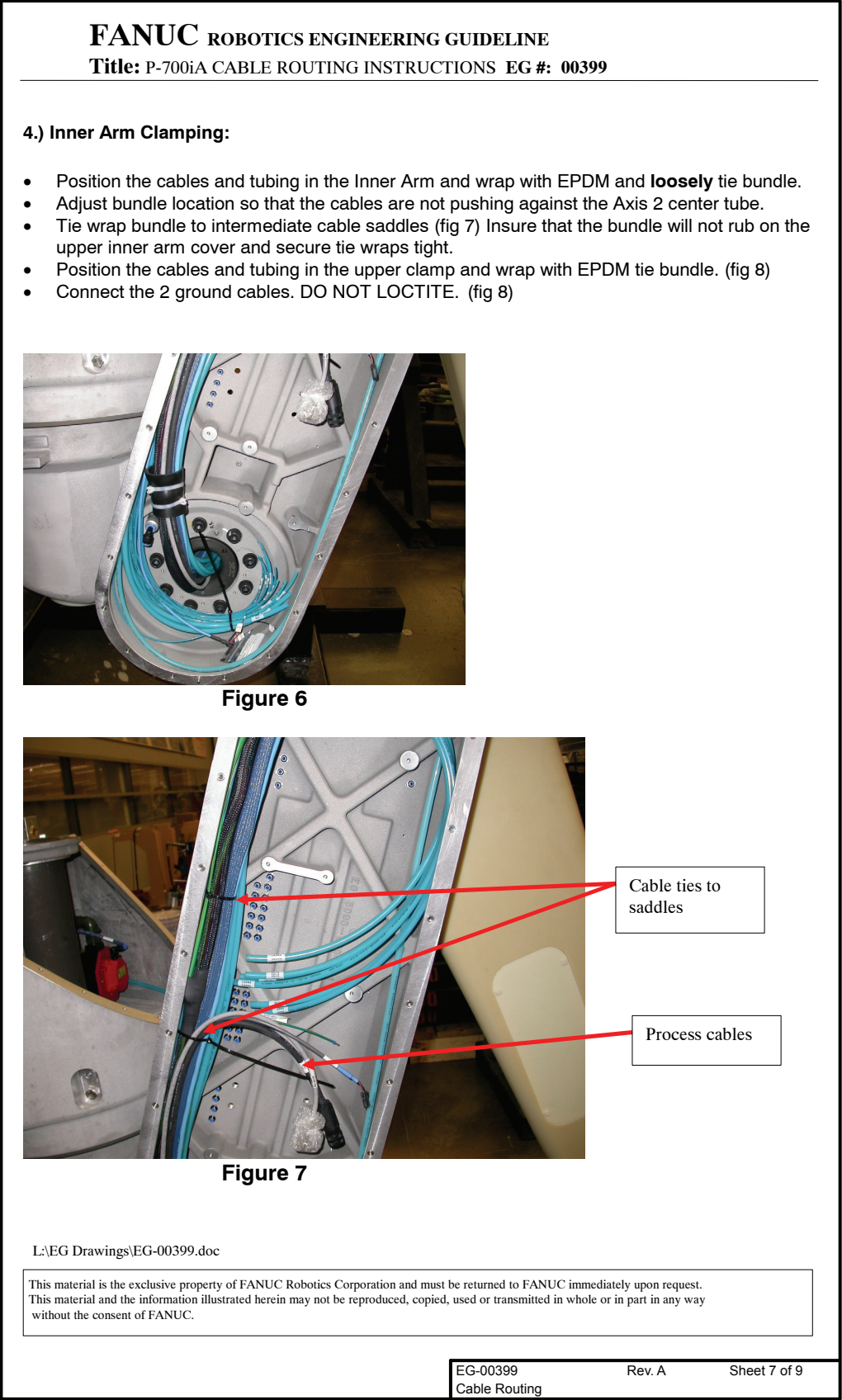


Figure B-15. Cable Routing EG-00399, Sheet 8

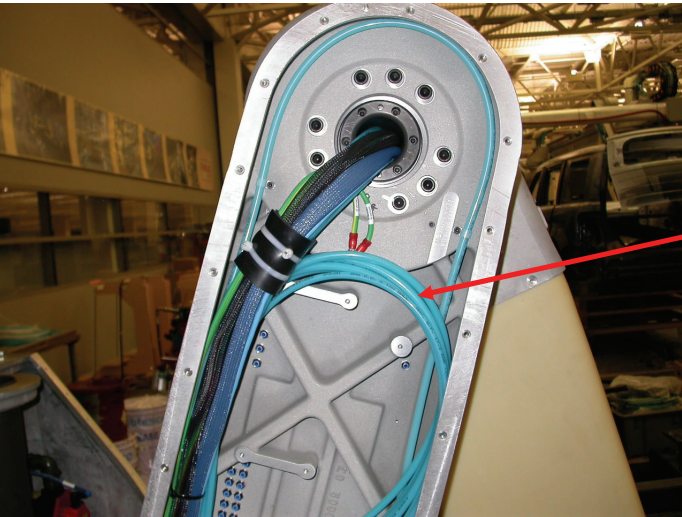
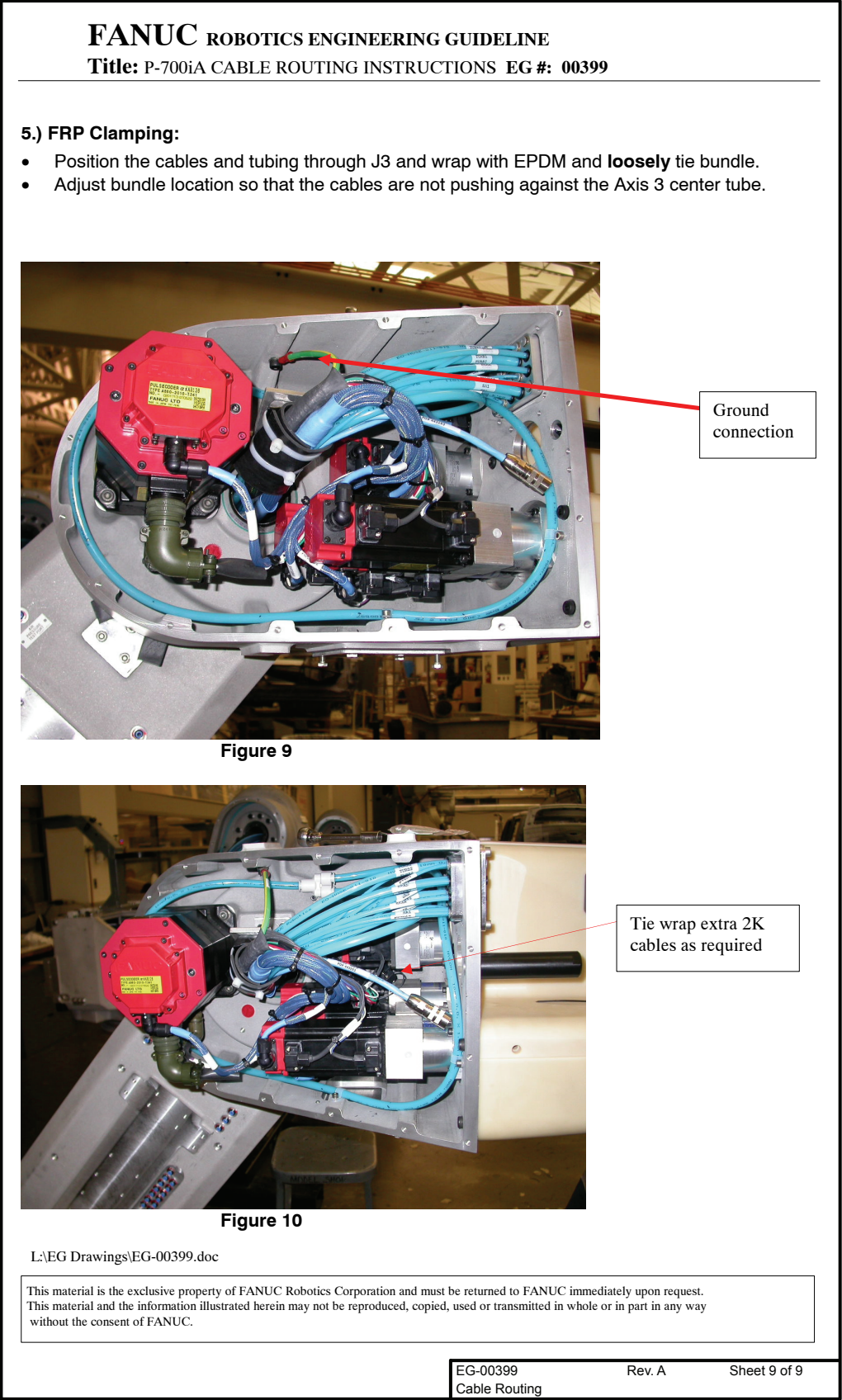


Figure B–16. Cable Routing EG-00399, Sheet 9



GLOSSARY

A

AA

Atomizing air.

AAP

Atomizing air pilot.

AAS

Atomizing air supply.

abrasive.

A substance used for smoothing or polishing.

ACAS

Applicator cleaner air supply.

accurate.

Conforming to a recognized standard.

ACSP

Applicator cleaner solvent pilot.

ACSS

Applicator cleaner solvent supply.

ACVS

Applicator cleaner vacuum supply.

anaerobic.
Pertaining to the absence of oxygen.

angular contact.
Contact which is at an angle to the axis of rotation.

apex dimension (gear).
The apex is the point where, for example if the teeth of a bevel gear were extended, they would meet.

apex dimension (bearing).
The point where for example if the angled working surfaces of a bearing were extended, they would meet.

arc.
A continuous portion of a curved line.

AVP
Application valve panel.

axial load.
A load parallel to the axis of rotation.

B

BA
Bearing air.

backlash.
The space between the thickness of a gear tooth and the space between gear teeth in the mating gear.

BAO
Bearing air okay.

BAT
Brake air turbine.

bearing.
A support and guide for a rotating object.

bell applicator high voltage cascade.
A component used to charge paint passing through a bell paint applicator.

bell applicator turbine.
The high speed (20,000 to 60,000 R.P.M.) turbine rotates the bell cup.

bell cup.
A bell applicator component that uses centrifugal force to force paint up the sides of the cup. The paint flows through the cup forming small threads of paint.

belt. A continuous flexible band that transmits motion from one pulley to another.

bevel gear. A gear having the teeth cut into a conical surface.

blind hole. A hole that is closed at one end.

bonding. Attaching a material to a surface.

brinelling. A small indentation left by the pressure of a hardened steel ball.

burr. A raised edge on the surface of a piece of metal.

bushing. A cylindrical component used to resist wear or act as a guide.

BWP Bell wash pilot.

BWS Bell wash supply.

C

CA Compensation air.

caliper. An instrument used to measure thickness or a diameter.

cam. An element which changes a rotary motion to a linear motion.

casting. Something cast in a mold.

CCAS Color change air supply.

CCSS Color change solvent supply.

clearance.
The distance between two objects.

clevis.
A U-shaped device with a hole at each end to receive a pin or bolt.

CO2
Carbon dioxide supply.

concentricity.
Having a common center.

CP#
Color pilot (# = color)

cps (viscosity)
Centipoises per second

cycloidal gear teeth.
Gear teeth resembling a circle.

D

D
Dump.

DAT
Drive air turbine.

docking station.
Used with the waterborne paint applicator to change the paint color.

dowel pin.
A round pin (usually) that provide alignment or prevents slipping between two mating surfaces.

drill.
A tool used to create holes.

dump cycle
To remove impurities or other elements.

duplex.
Having two parts, double.

E

engagement.

Interlocked.

E-stat

Electrostatics.

expansion reamer.

A reamer with an adjusting screw to change the outside diameter of the reamer.

F

FA

Fan air.

FAP

Fan air pilot.

FAS

Fan air supply.

flared fitting.

A fitting that connects and seals a tube with a flared end.

flute.

One of the grooves in a drill or reamer.

F.E.P.

Flourinated Ethylene Propylene

G

gasket.

An item placed at a joint to make it water or air tight.

gauge.

A measuring instrument.

gear.

A disk or shaft with teeth cut to mesh with another gear to transmit motion.

grinding.

A process for removing material.

H

harmonic drive reducer.

A speed reducer that operates by radial, rather than a rotating, tooth mesh. The tooth mesh is created by flexing one element to create an inward and outward tooth motion, which allows a spline-like tooth engagement.

helical.

Spiral.

high voltage cascade.

The high voltage cascade provides an electrostatic charge.

high voltage control unit (hvcu).

The High Voltage Control Unit (HVCU) controls electrostatics for the FANUC Robotics VersaBell and ServoBell applicators.

I

I.D.

Inside diameter.

I.M.L.T.

Infant Mortality Life Test

indicator.

An instrument to measure variations.

involute.

Intricate.

IWP

Injector wash pilot.

IWS

Injector wash supply.

J

jig.

A device used to hold work.

joint.

The place where two items are joined.

K

key.

An item used to drive a shaft or gear.

keyway.
A groove used to locate a key.

knurl.
A raised surface on a diameter.

L

labyrinth.
A series of paths that make it difficult to enter or exit.

lapping.
A polishing process.

linear way
A precision guide for a linear bearing.

lubricant.
A substance that is used to reduce friction.

L. H.
Left hand

M

mating gear.
A gear meshing with another gear or rack.

MCP
Master control panel.

MI
Microphone in.

MIS
Manual input station.

MO
Microphone return air.

micrometer.
An instrument used to measure thickness or diameter.

mounted wheels.
An abrasive mounted to a shaft.

N

needle roller bearing.

A cylindrical roller bearing used to accept thrust.

nominal.

A name, number or dimension assigned to an object.

O

O.D.

Outside diameter.

O.D.C.

Ozone Depleting Chemical

O-ring.

A continuous ring of material to seal between two surfaces.

oilstone.

An abrasive tool that uses oil to help remove metal.

P

P

Paint.

Pa

A unit of pressure equal to one newton per square meter.

paint valve.

A valve used to start and stop the flow of paint or solvent.

PAP

Paint application panel.

PAP

Purge air pilot.

PCC

Pilot color change.

PD

Pilot dump.

PCE

Process Control Enclosure.

PFAP	Purge funnel air pilot.
PFAS	Purge funnel air supply.
PIE	Process interface enclosure.
pinion.	A gear with a small number of teeth usually engaging with a larger gear or a rack.
pitch diameter.	The diameter between the centers of adjacent gear teeth.
plain bearings.	A cylindrical component used to reduce friction or guide an object.
PPVE	Paint process valve enclosure.
PPVP	Paint process valve panel.
PR	Pilot regulator.
PR#	Paint return (# = color).
precision.	The quality or state of being accurate or exact.
PS#	Paint supply (# = color).
psi	Pounds per square inch
PSP	Purge solvent pilot.
PT	Pilot trigger.
PTFE	Polytetraflouroethylene

PTS

Pilot trigger supply.

pulley.

A wheel with grooves around the outside diameter that rotates to transmit force.

purge

To remove impurities or other elements.

Q

Q.D.

Quick disconnect

quality.

A degree of excellence.

R

rack.

An item with teeth on one side to mesh with a pinion or gear.

radial load.

A load to the side of an object.

reamer.

A round tool with straight or helical flutes to finish or enlarge a hole.

retaining ring.

A retaining ring is used as an artificial shoulder. It can be either inserted into a housing or on a shaft. It is stamped from tempered steel (snap ring) or spiral-wound with usually two or three turns.

R. H.

Right hand

rotary file or rotary burr.

A metal removing tool mounted to a shaft usually made of high speed steel, carbide or diamond dust coated metal.

RP

Robot purge.

runout.

Variation.

RV reducer.

Rotating vector reducer.

S

SA

Shaping air.

SAP

Shaping air pilot.

SAS

Shaping air supply.

SCC

System control console.

SCE

System control enclosure.

scfm

Standard cubic feet per minute

SDP

System distribution panel.

sealed bearing.

A bearing with a device to prevent dirt, liquids or gasses from entering the bearing.

shaping air.

A bell applicator component used to shape the pattern of the paint threads being forced from the bell cup.

shielded bearing.

A bearing with a device to prevent dirt from entering the bearing.

slpm

Standard liters per minute

spiral bevel gears.

A gear having curved teeth cut into a conical surface.

sprocket.

A toothed wheel.

spur gear.

A gear that has teeth on the outside diameter that are cut straight and are parallel to the axis of rotation.

swage.

To form or shape.

swaged fitting.
A fitting that seals by shaping the tube end as it is tightened.

T

tandem.
A group of two or more arranged one behind the other or used in conjunction.

taper dowel pin.
A tapered pin used to locate or prevent an object from slipping.

TDP
Turbine drive pilot.

TDS
Turbine drive supply.

thru hole.
A hole that passes through an object.

thrust bearings.
A roller bearing used to accept a thrust load.

tolerance.
An allowable amount of error.

torque.
A force that tends to cause rotation.

total indicator reading.
The total amount of a dial indicator needle movement.

turbine.
A machine in which the kinetic energy of a moving fluid is converted into mechanical energy by causing a bladed rotor to rotate.

U

UHMW.
Ultra high molecular weight plastic.

universal joint.
A connection used when two shafts are not inline.

V

vernier scale.
A scale used to provide additional accuracy.

W

Woodruff key.
A key with a semi-circular shape.

worm gearing.
Gearing used where accuracy is of importance rather than speed.

Y

yoke.
A device which holds items on location.