

**FANUC Robot Series**  
R-30iA MATE CONTROLLER

**P-50iB**  
**Mechanical Unit**  
**Maintenance Manual**

MARMTP50I11111E 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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**FANUC Robotics America Corporation Patent List**

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**Conventions**



**WARNING**  
Information appearing under the "WARNING" caption concerns the protection of personnel. It is boxed and bolded to set it apart from the surrounding text.



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

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



# Safety

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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 be best 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 Robotics 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.

Ensure that the robot being used is appropriate for the application. Robots used in classified (hazardous) locations must be certified for this use.

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 Safe

The safety of people is always of primary importance in any situation. When applying safety measures to your robotic system, consider the following:

- 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.

## Safety

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- 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 its 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 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 personnel 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 or pressed harder 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 SOC 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.

- 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.
  2. 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.
  3. Thoroughly clean the interior of the robot with a lint free rag to remove any accumulated dust.
  4. When the dust has been removed, the covers must be replaced immediately.
  5. 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.



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# 1 OVERVIEW

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The P-50iB is a six axis robot designed for efficient process equipment integration with feature such as a hollow-wrist -designed to integrate paint application equipment easily.

The P-50iB 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 P-50iB robot is capable of paint speeds of up to 2000 mm/sec. if the wrist payload is 5 kg or less.

The wrist payload for long arm floor, wall and invert mounted robots is 10 kg at a 50 mm radial and 300 mm axial offset and max arm payload is 10 kg.

The wrist payload for short arm floor, wall and invert mounted robots is 15 kg at a 50 mm radial and 300 mm axial offset and max arm payload is 10 kg

## 1.1 Robot Configurations

---

This manual supports the following robot configurations:

P-50iB/15 - 700mm and P-50iB/10L - 900mm Metal Outer Arm Robot.

This manual supports the following mounting configurations:

Floor, Wall, Angle and Invert mount – Standard, Pedestal Plate & Pedestal

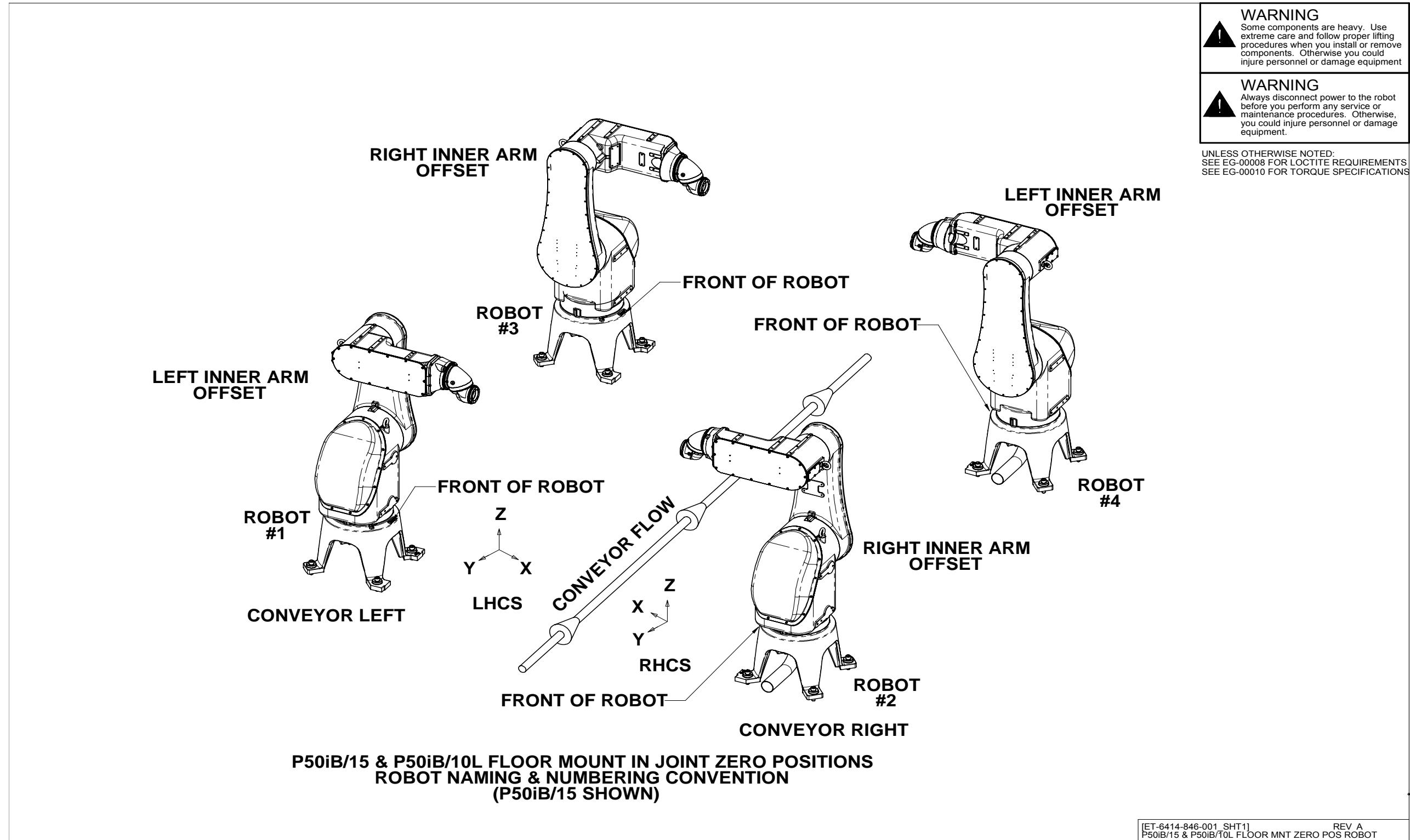
Figure 1-1 ET-6414-846-001 SHT1, P50iB/15 & P50iB/10L FLOOR MNT ZERO POS ROBOT NAMING & NUMBERING

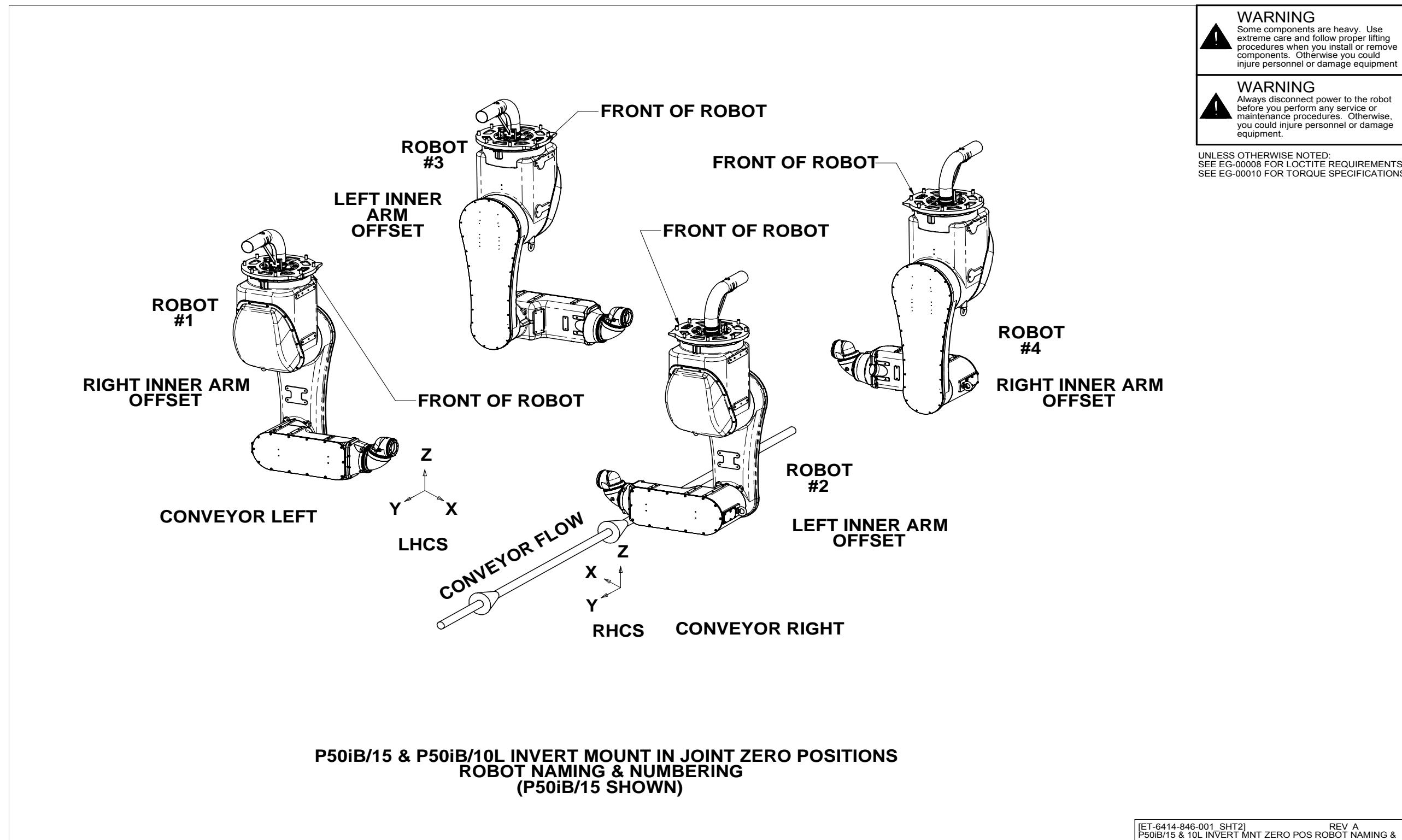
Figure 1-2 ET-6414-846-001 SHT2, P50iB/15 & 10L INVERT MNT ZERO POS ROBOT NAMING & NUMBERING

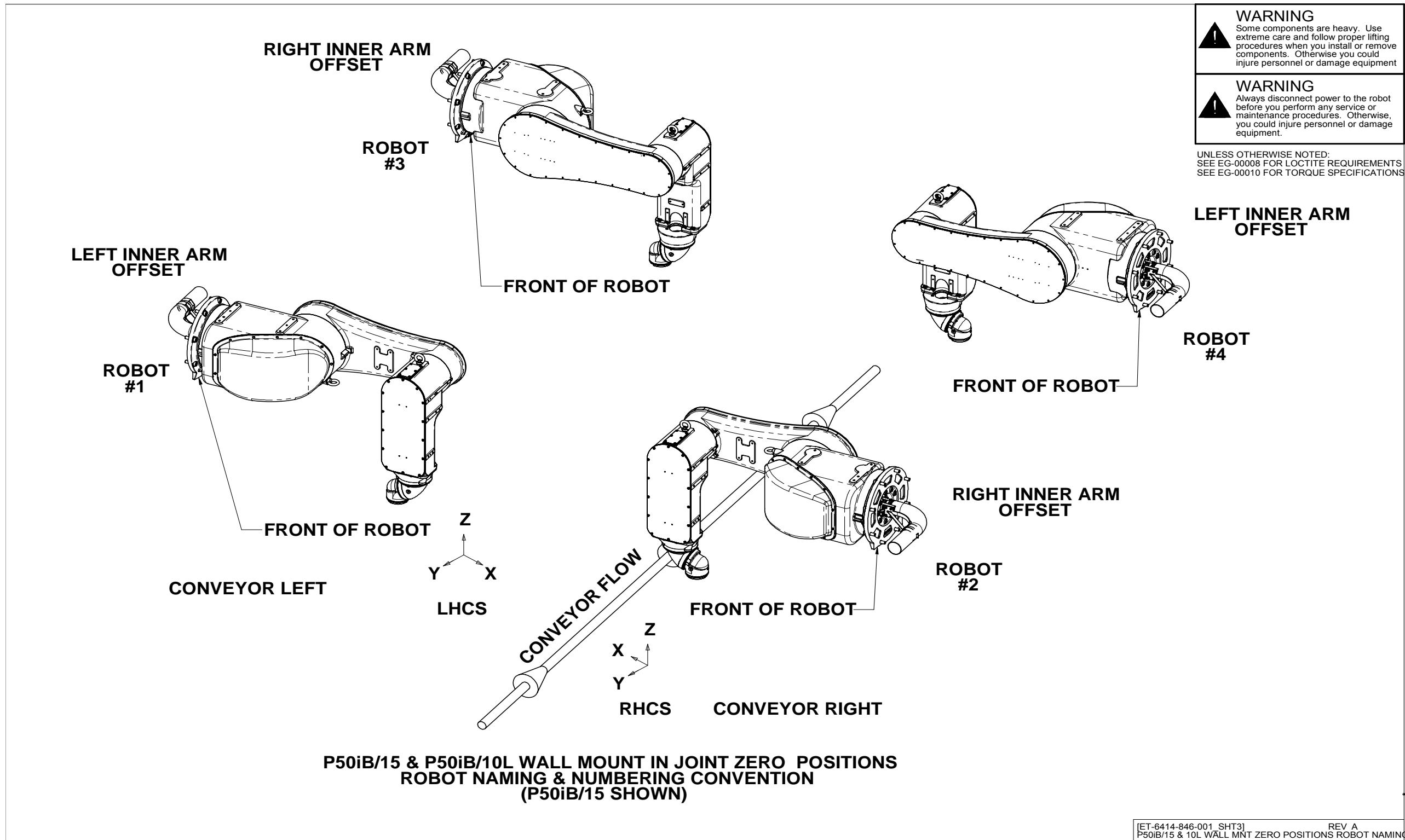
Figure 1-3 ET-6414-846-001 SHT3, P50iB/15 & 10L WALL MNT ZERO POSITIONS ROBOT NAMING & NUMBERING

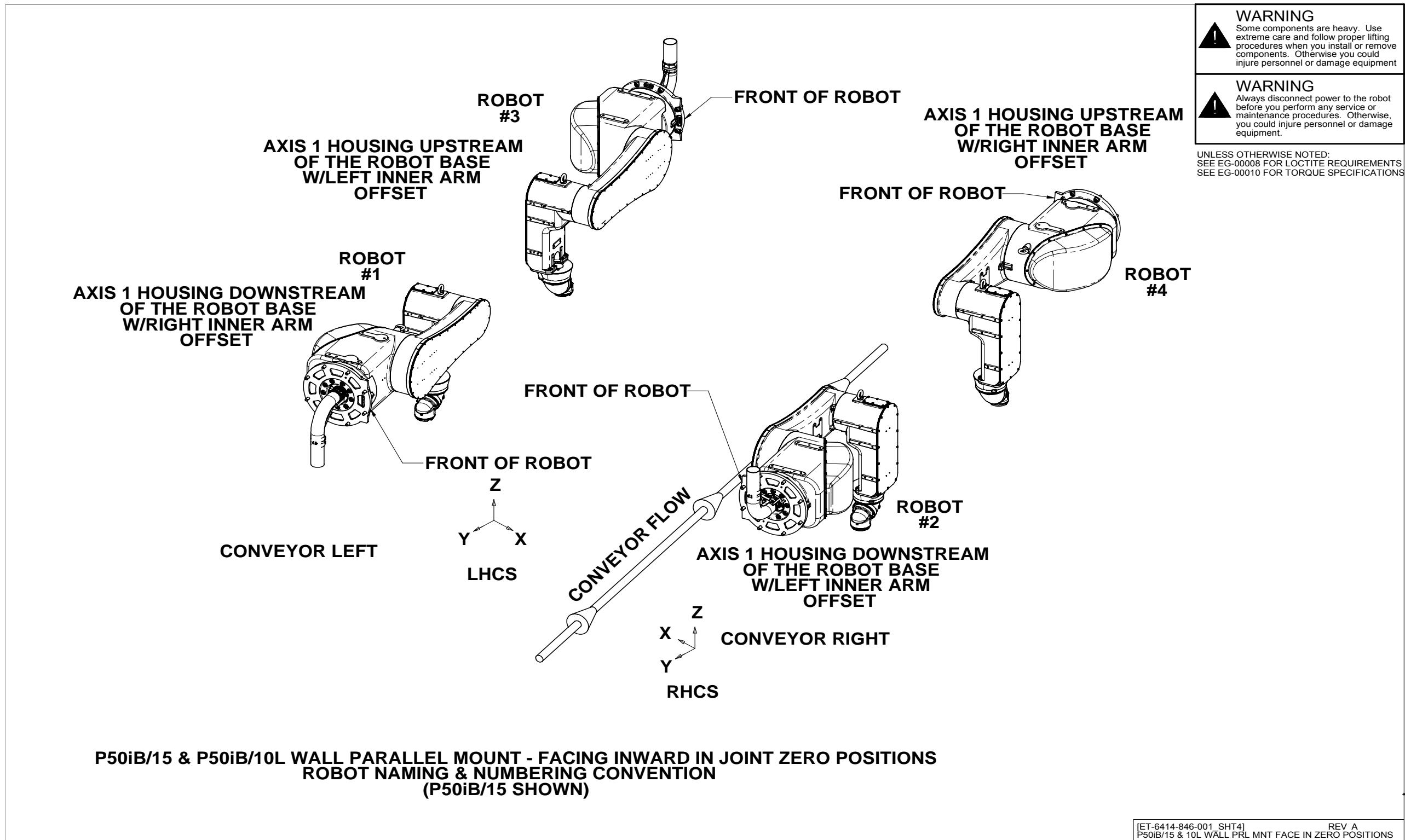
Figure 1-4 ET-6414-846-001 SHT4, P50iB/15 & 10L WALL PRL MNT FACE IN ZERO POSITIONS ROBOT NAMING & NUMBERING

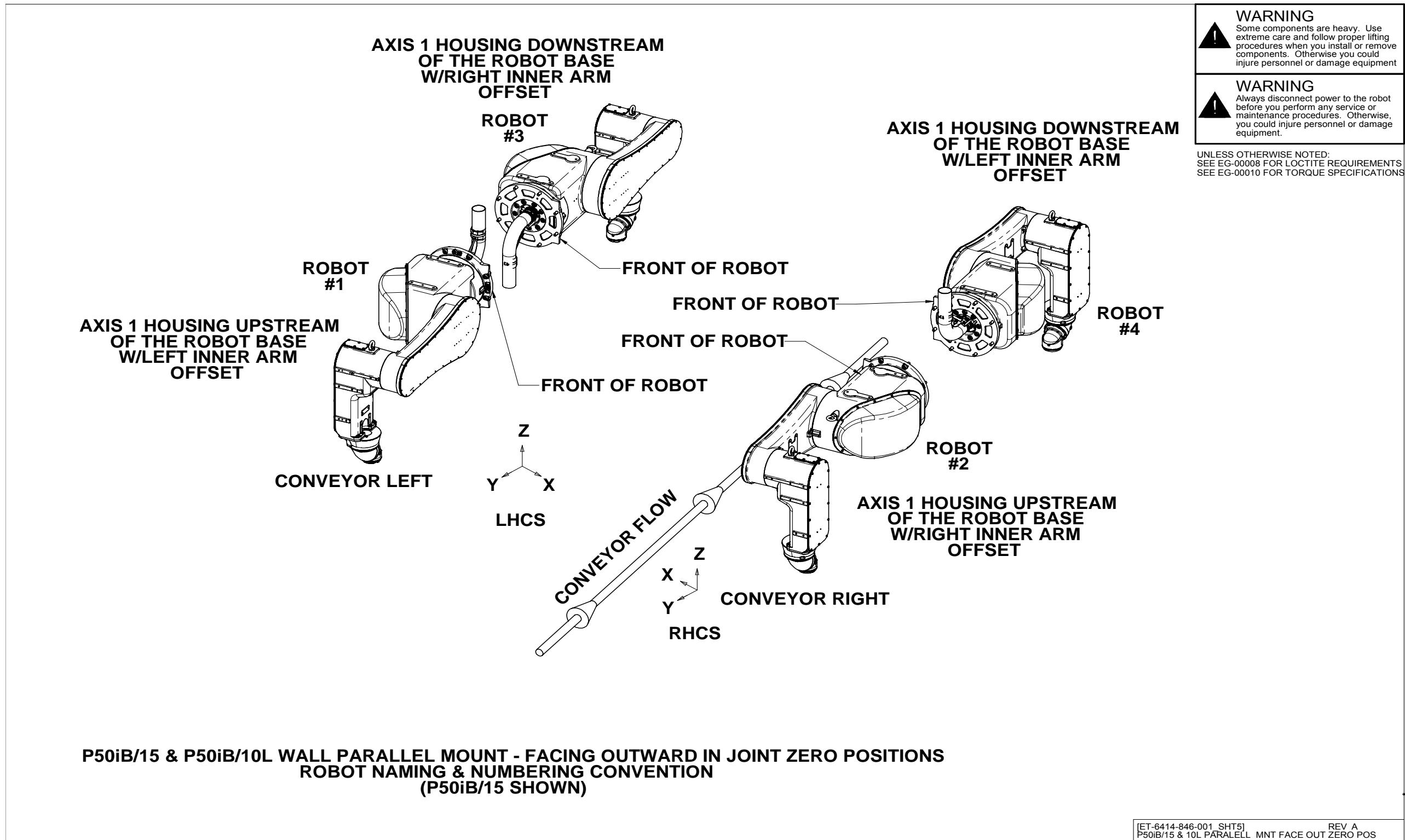
Figure 1-5 ET-6414-846-001 SHT5, P50iB/15 & 10L PARALELL MNT FACE OUT ZERO POS ROBOT NAMING & NUMBERING

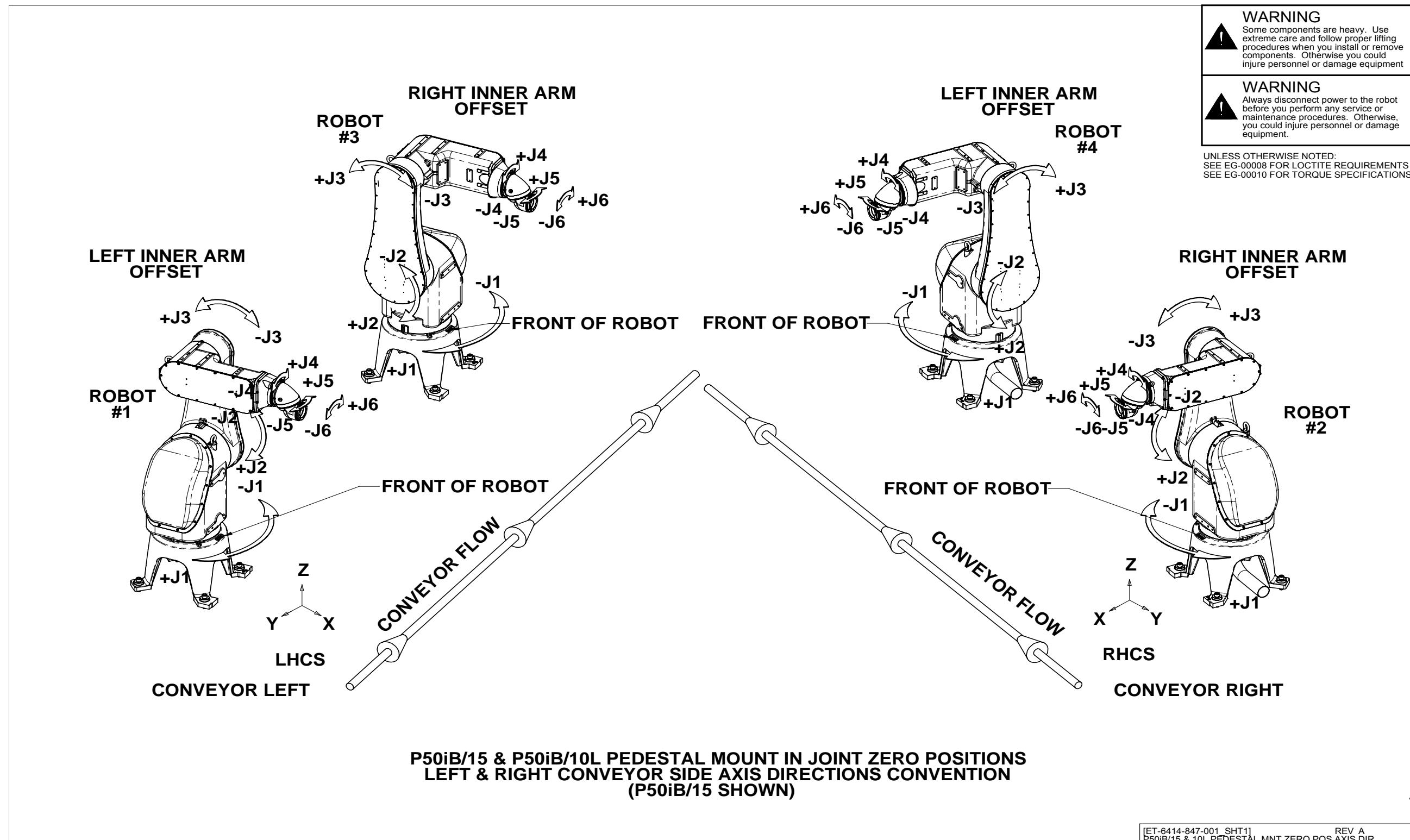
Figure 1-6 ET-6414-847-001 SHT1, P50iB/15 & 10L PEDESTAL MNT ZERO POS AXIS DIR

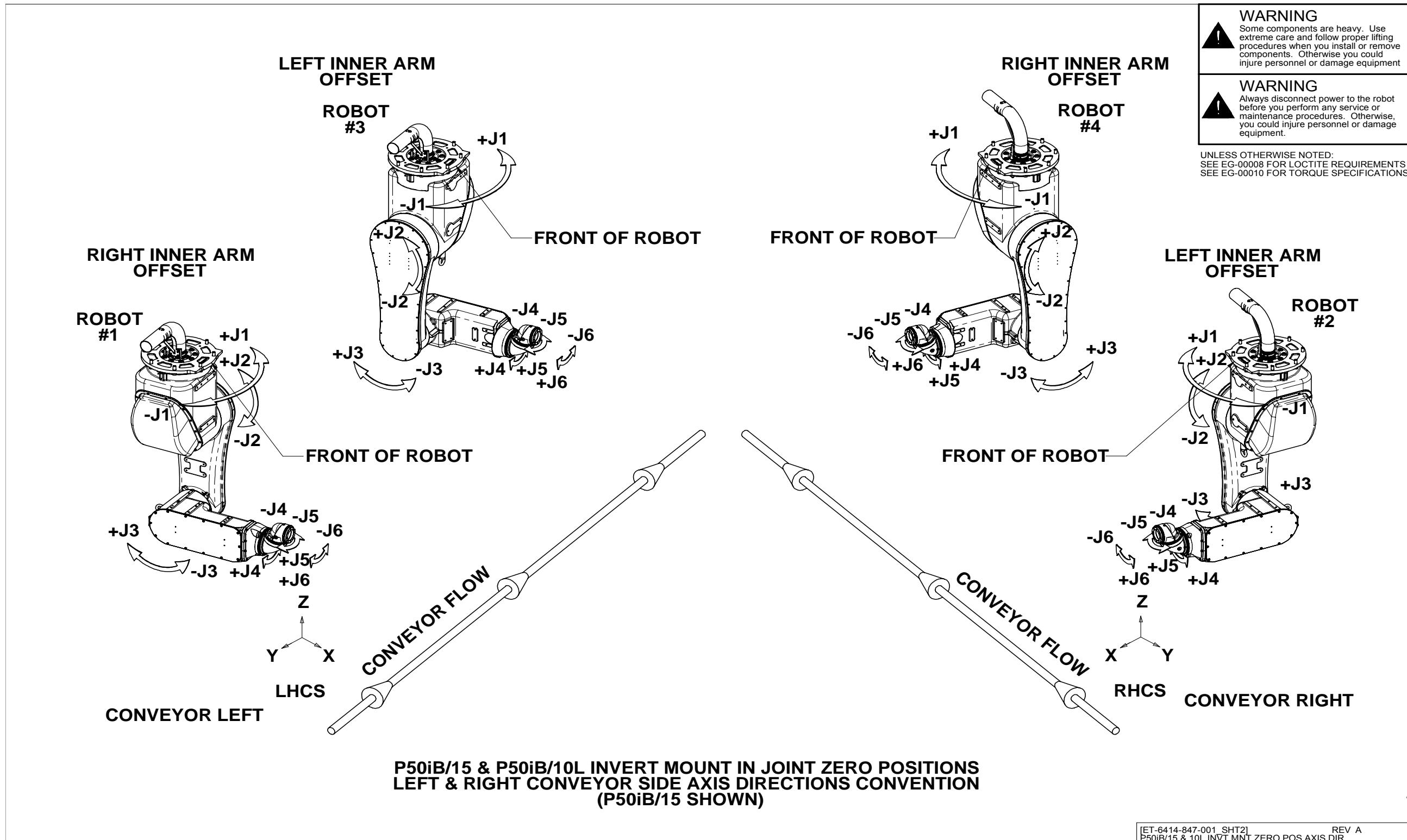
Figure 1-7 ET-6414-847-001 SHT2, P50iB/15 & 10L INVT MNT ZERO POS AXIS DIR

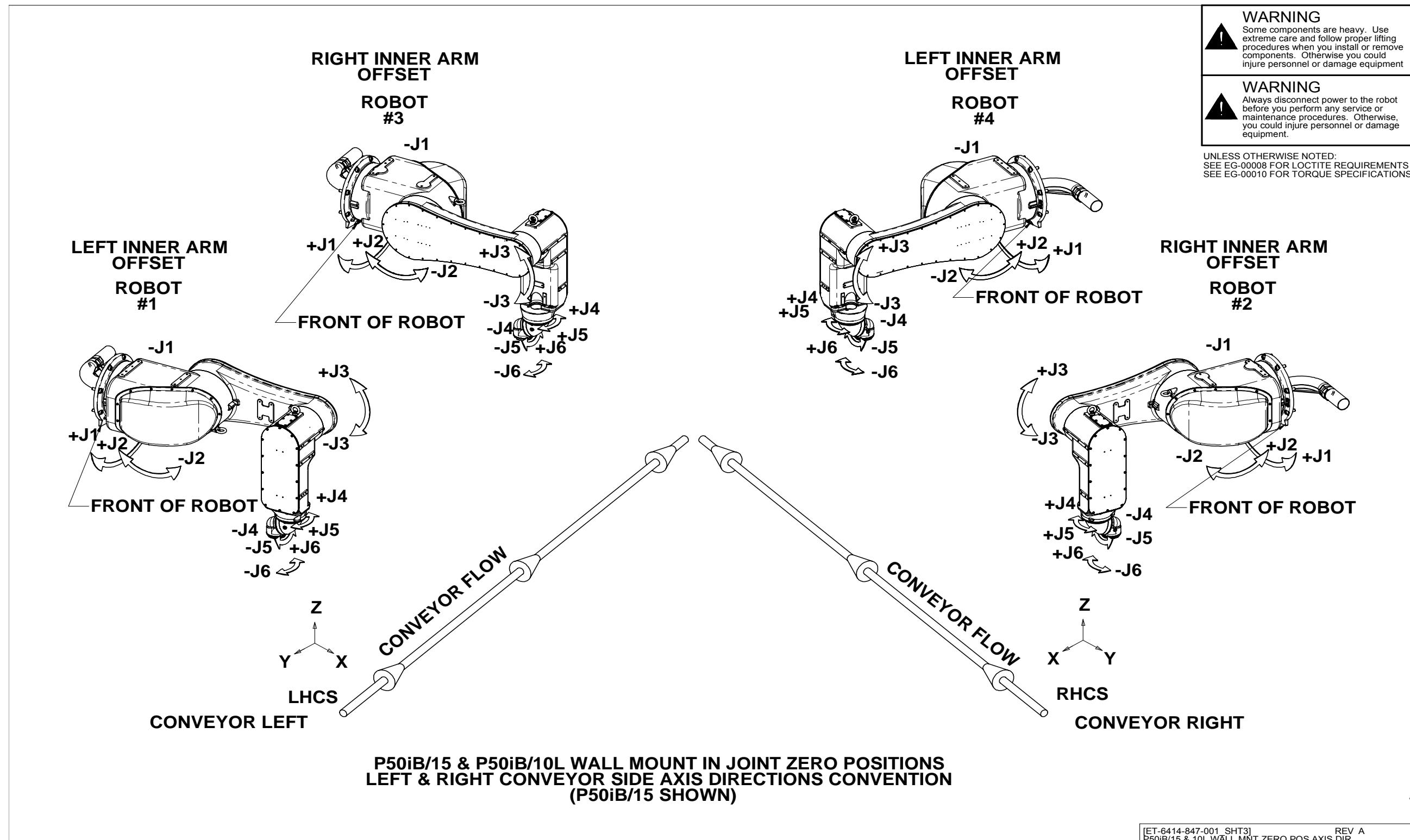
Figure 1-8 ET-6414-847-001 SHT3, P50iB/15 & 10L WALL MNT ZERO POS AXIS DIR

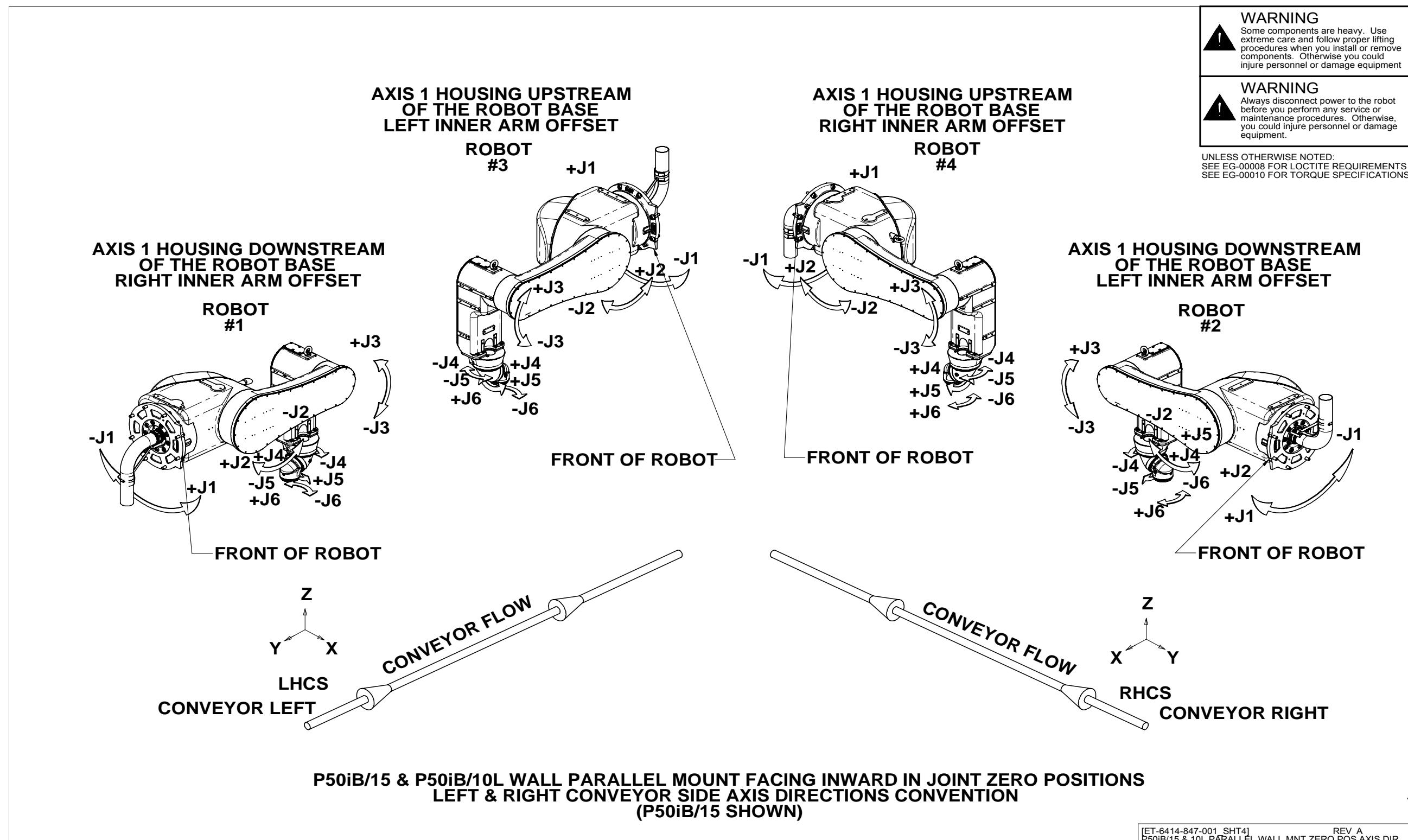
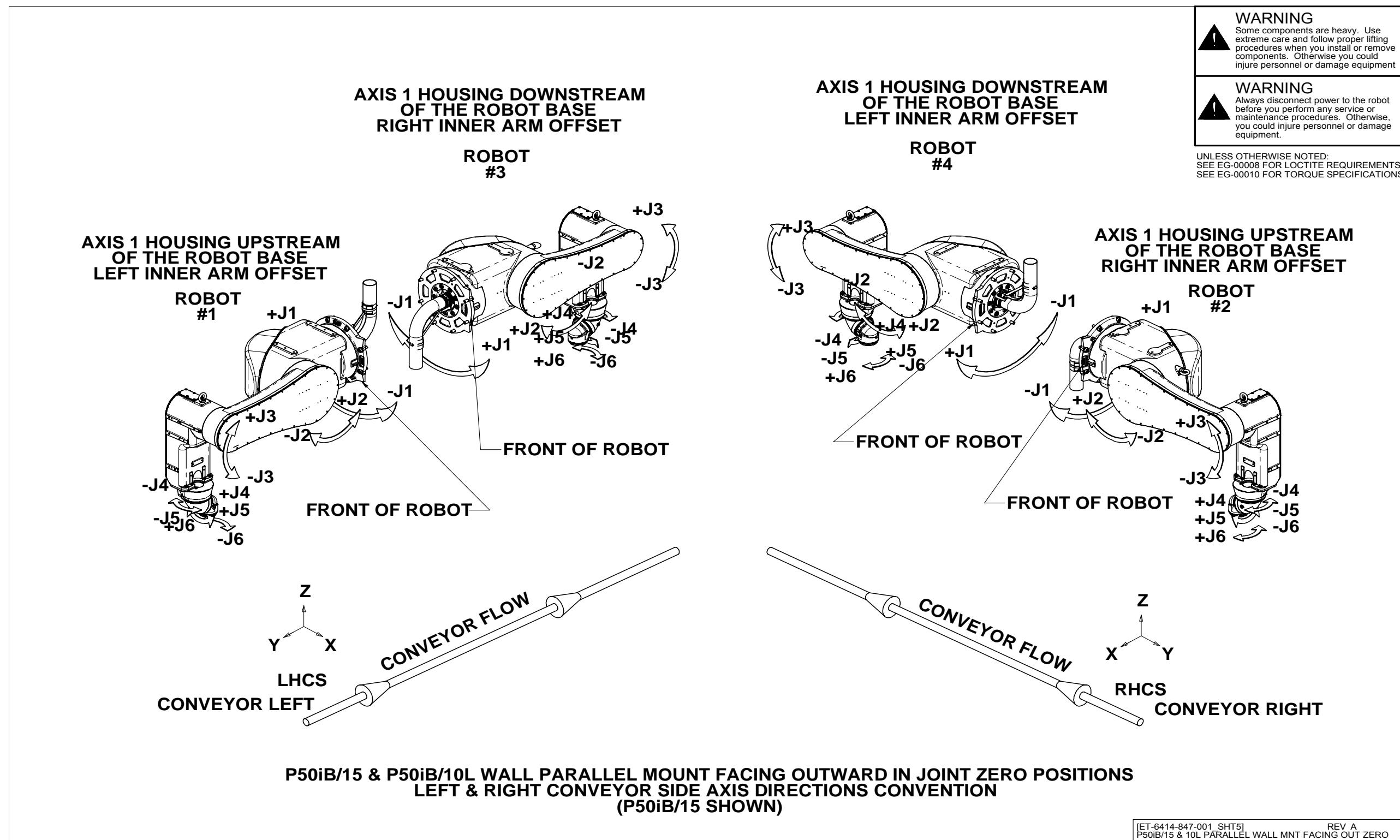
Figure 1-9 ET-6414-847-001 SHT4, P50iB/15 & 10L PARALLEL WALL MNT ZERO POS AXIS DIR

Figure 1-10 ET-6414-847-001 SHT5, P50iB/15 & 10L PARALLEL WALL MNT FACING OUT ZERO POS AXIS DIR

## 1.2 Robot Identification Tags

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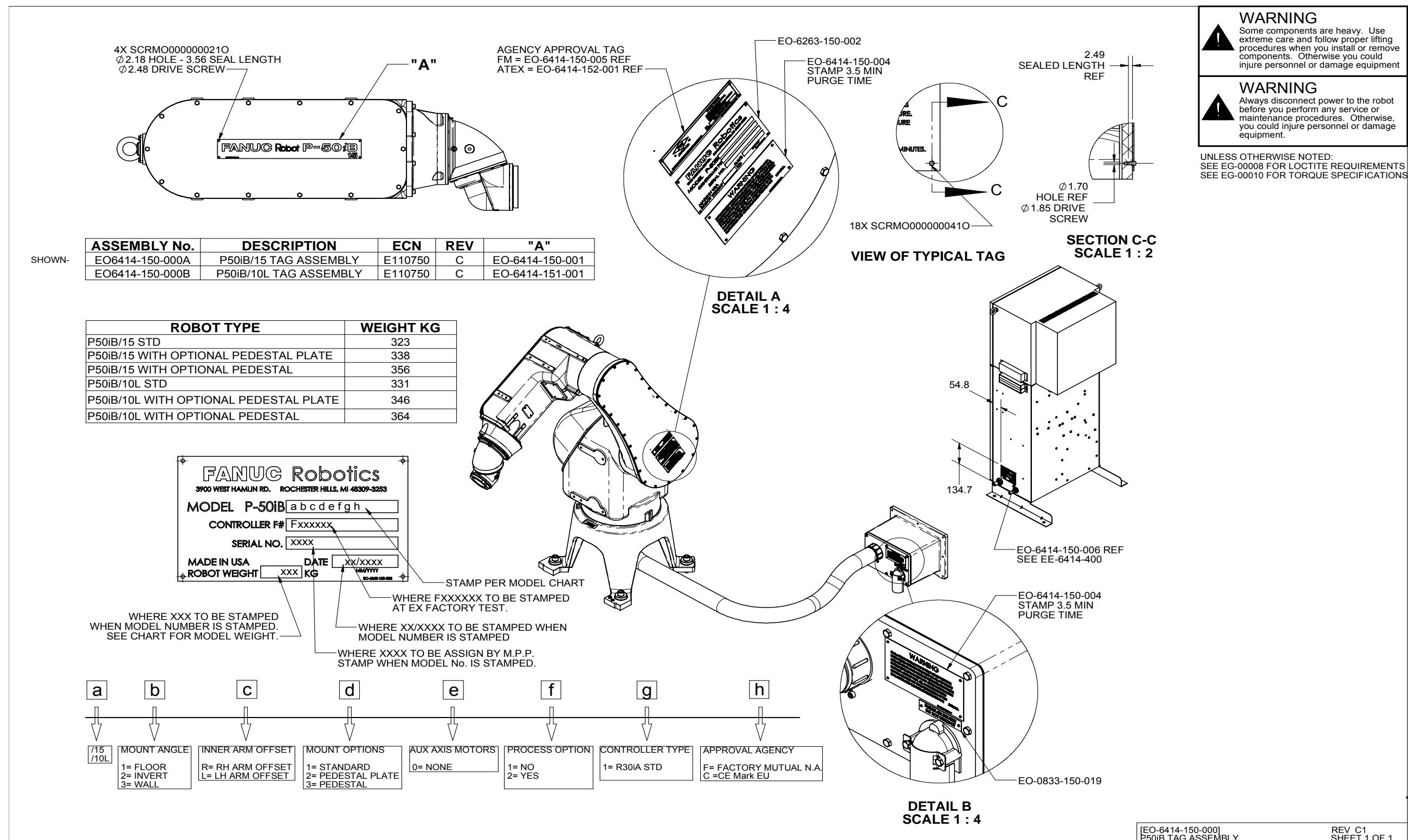
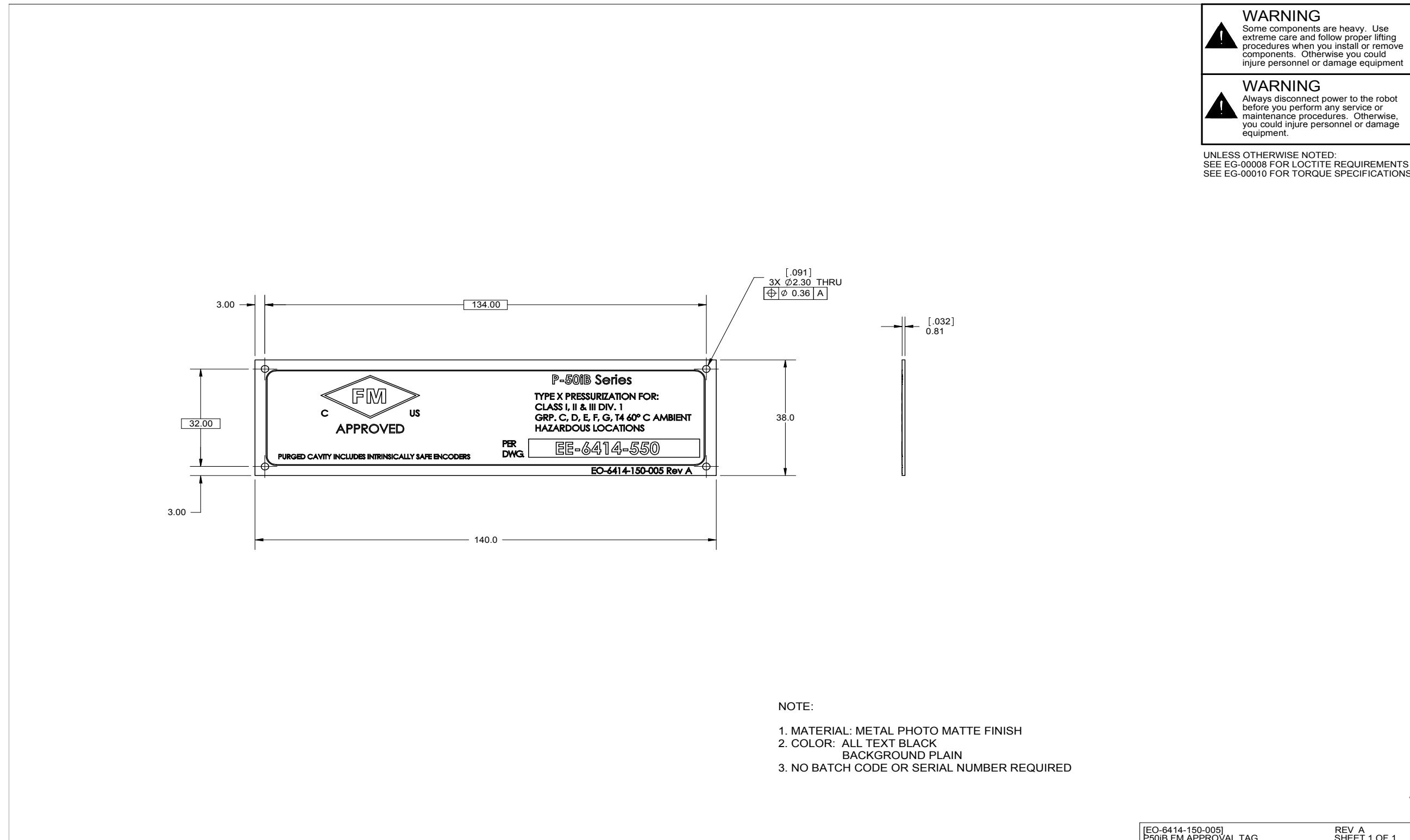
**Figure 1-11 EO-6414-150-000, P50iB TAG ASSEMBLY**

Figure 1-12 EO-6414-150-005, P50iB FM APPROVAL TAG

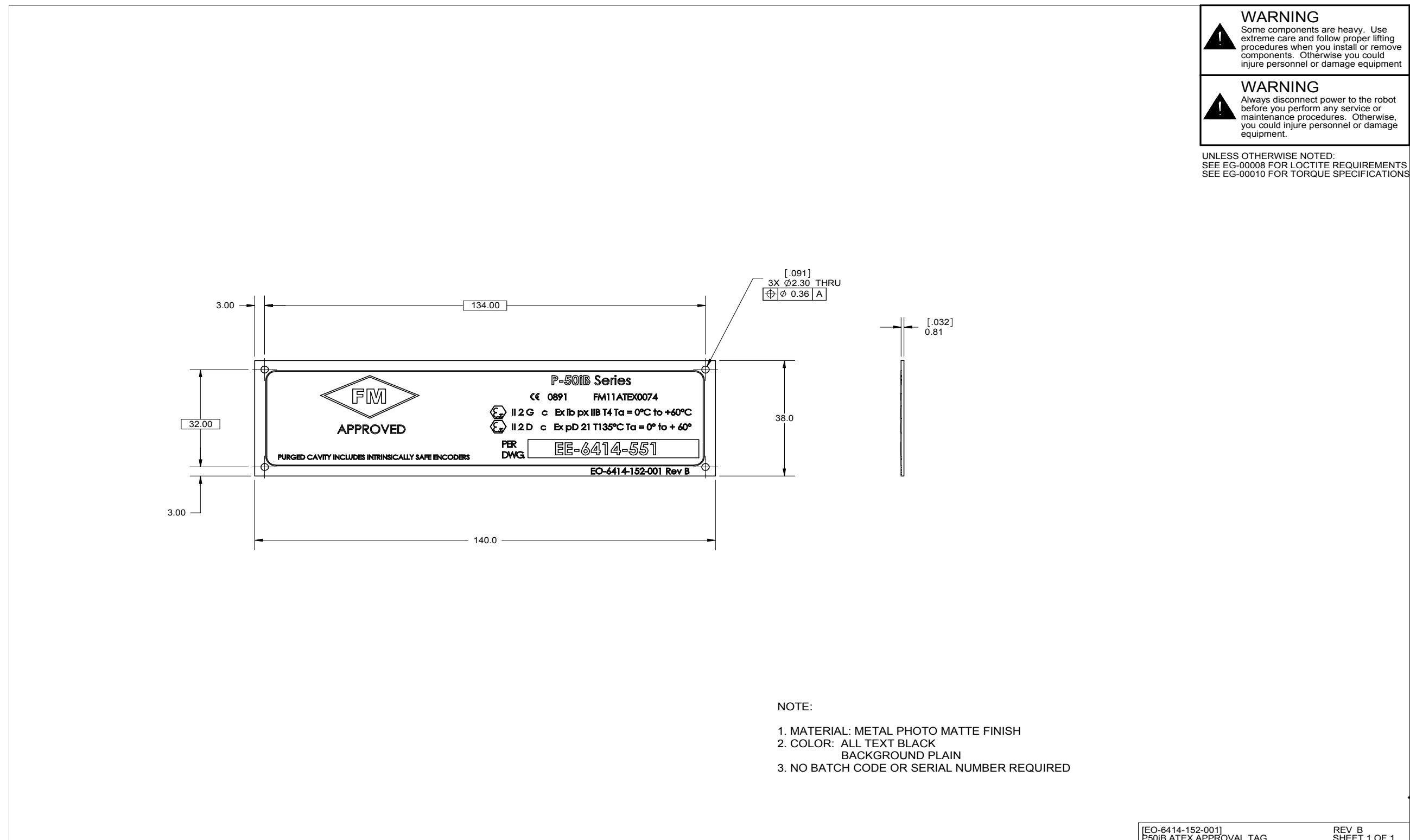
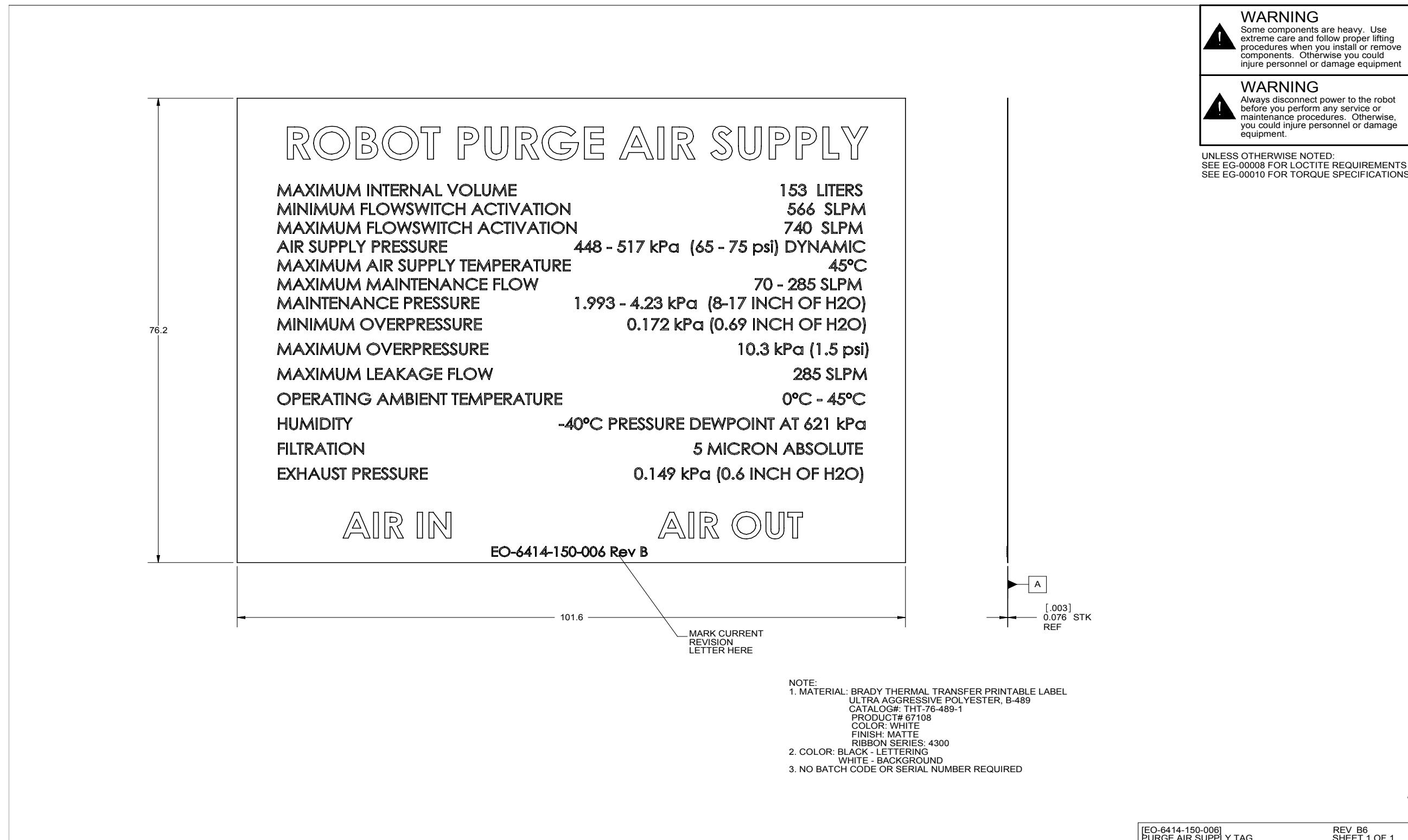
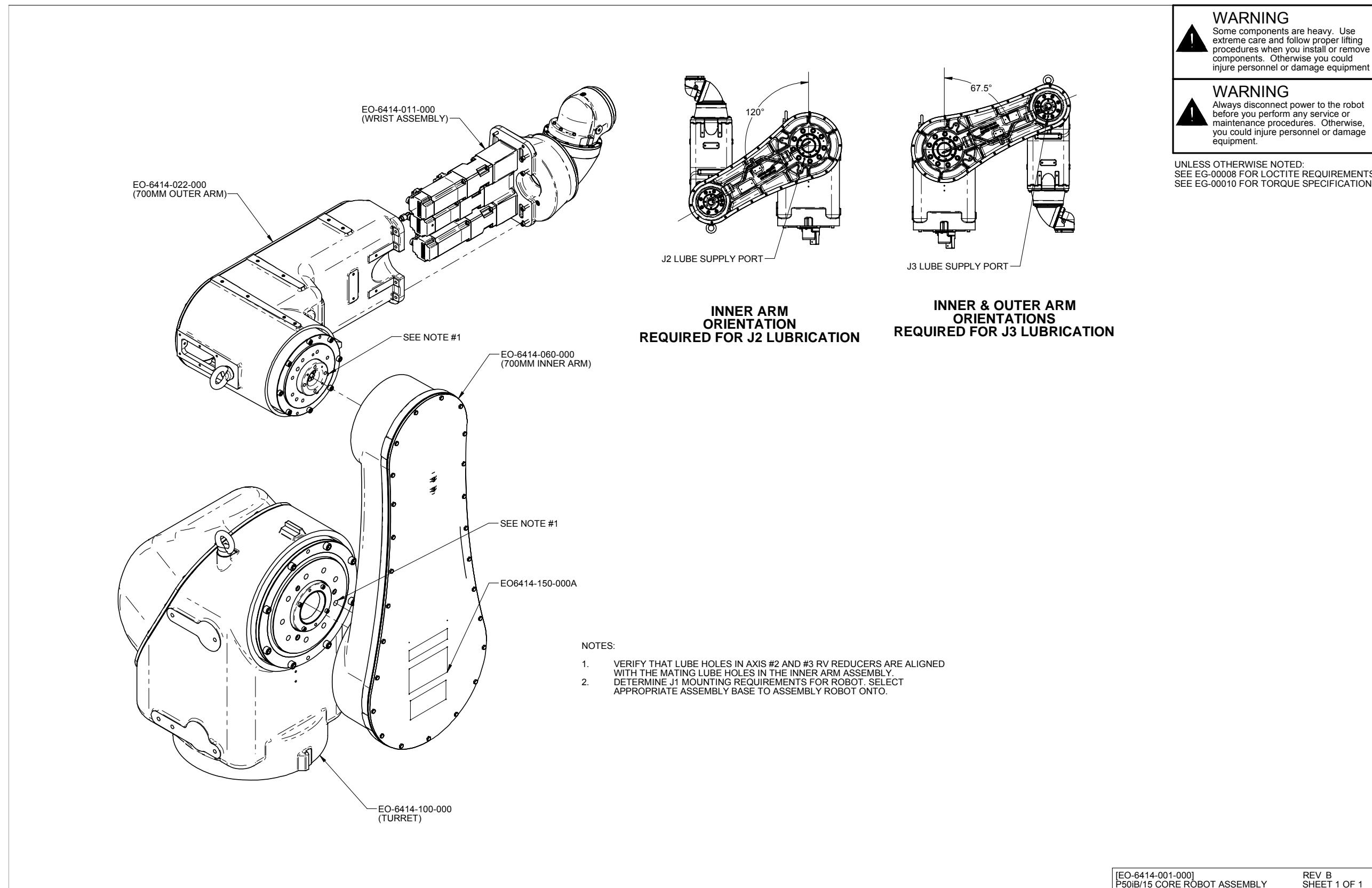
**Figure 1-13 EO-6414-152-001, P50iB ATEX APPROVAL TAG**

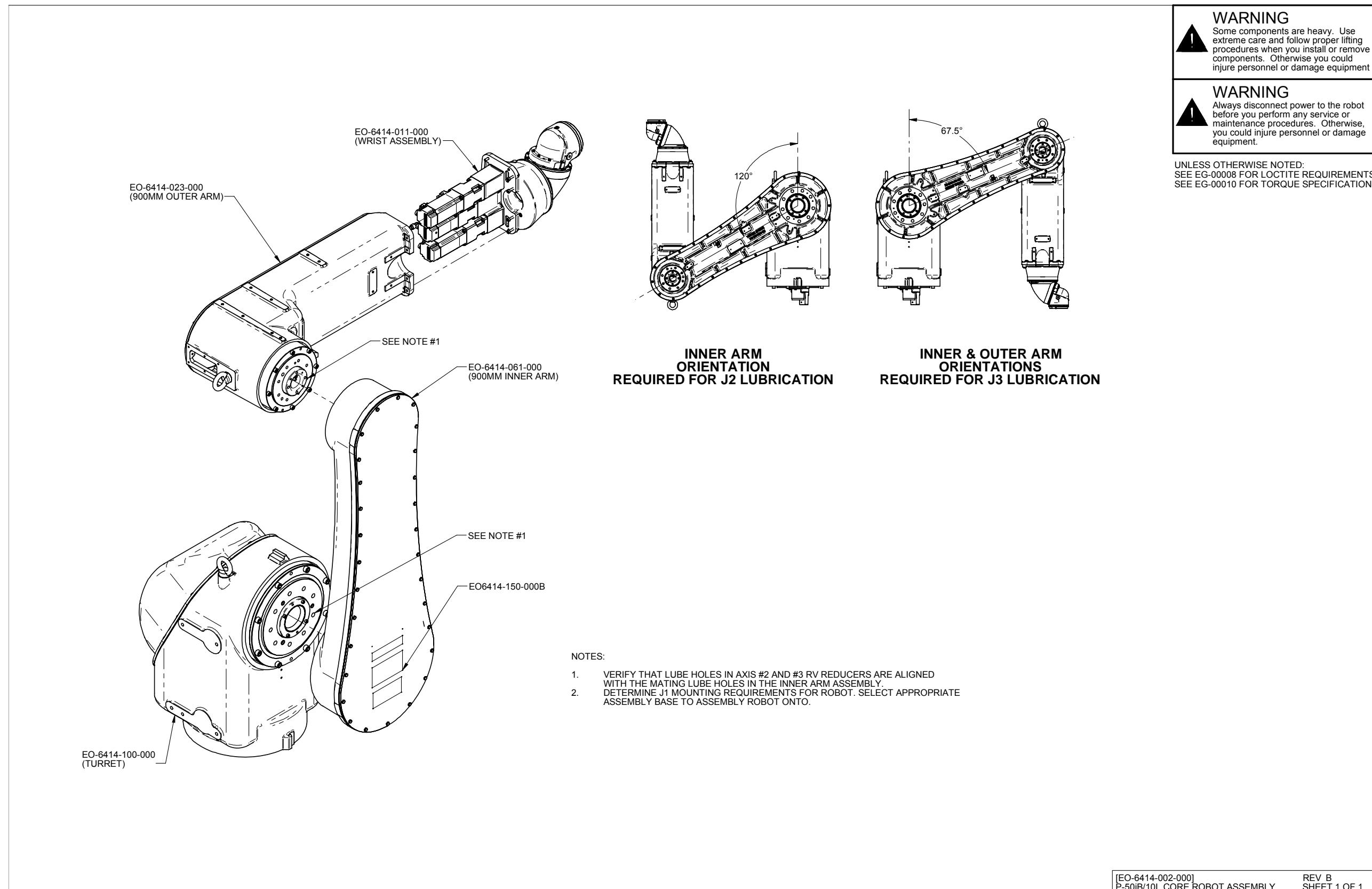
Figure 1-14 EO-6414-150-006, PURGE AIR SUPPLY TAG

### 1.3 Major Components and Drive Overview

---

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 shafts and a 140 degree offset wrist.

**Figure 1-15 EO-6414-001-000, P50iB/15 CORE ROBOT ASSEMBLY**

**Figure 1-16 EO-6414-002-000, P-50iB/10L CORE ROBOT ASSEMBLY**



## 2 CHECKS AND MAINTENANCE

---

Optimum performance of the P-50*iB* robot can be maintained by following the lubrication and periodic general maintenance procedures in this chapter.

**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.

### Lubrication Maintenance

- See the following manual pages for lubrication maintenance intervals.

### Daily Maintenance

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

### Maintenance every 1000 hours

- Check the spray gun or applicator lines and cables.
- Clean the spray gun or applicator. See the appropriate applicator manual for more detailed information.

### Maintenance every 4000 hours

- Check the robot cables.
- Check the paint lines.
- Visually check for grease leaks.
- Check the reducer grease levels.

**Figure 2-1 EB-03642, PAINT ROBOT CLEANING AND COVERING RECOMMENDATIONS – ENG BULLETIN**

 <b>ENGINEERING BULLETIN NUMBER:</b> 03642											
Release Date:	06/25/09	Document Status:	Released								
Revision Date:		Revision Level:	2.0								
Page:	1 of 7										
<b>FANUC Robotics America</b>											
<b>Paint Robot Cleaning and Covering Recommendations</b>											
ROBOT MODEL		SOFTWARE									
Paint Mate(s), P-50iA, P-250iA/10S, P-250iA/15, P-200E, P-10E, P-15E, P-500iA, P-700iA/15P, P-700iA/15, P-		N/A									
<b>SOURCE OF INFORMATION:</b> <input type="checkbox"/> FANUC <input checked="" type="checkbox"/> FRA → HEB - Hardware Engineering Bulletin											
REASON FOR ENGINEERING BULLETIN											
<input type="checkbox"/> Error Correction → N/A	<input type="checkbox"/> Material Availability	<input type="checkbox"/> Mechanical Guidelines									
<input type="checkbox"/> Product Improvement → N/A	<input type="checkbox"/> New Product Release	<input type="checkbox"/> Electrical Guidelines									
<input type="checkbox"/> Other	<input checked="" type="checkbox"/> Information	<input type="checkbox"/> Software Guidelines									
<b>Paint Robot Covers:</b> <ul style="list-style-type: none"> <li>- FANUC Robotics recommends the use of fabric covers with painting robots.</li> <li>- Most robot models have custom fabric covers that have been validated by FANUC Robotics.</li> <li>- Failure to use robot covers may allow excessive paint build-up which, over time, may cause the robot to become inoperable.</li> <li>- FANUC Robotics suggests the following typical maintenance schedule, but it is only a guideline.</li> <li>- Both re-usable and disposable covers are available.</li> <li>- On the following page is a sample cover used for the Paint Mate, P-50iA, P-250iA/15, P-250iA/10S, P-200E, P-10E, P-15E, P-500iA, P-700iA/15P, P-700iA/15, &amp; P-20iA robots.</li> </ul>											
<table border="1" style="width: 100%;"> <thead> <tr> <th>Cover</th> <th>Maintenance Frequency</th> </tr> </thead> <tbody> <tr> <td>Robot Covers</td> <td>Monthly</td> </tr> <tr> <td>Arm Covers</td> <td>Weekly</td> </tr> <tr> <td>Wrist Covers</td> <td>Daily</td> </tr> </tbody> </table>				Cover	Maintenance Frequency	Robot Covers	Monthly	Arm Covers	Weekly	Wrist Covers	Daily
Cover	Maintenance Frequency										
Robot Covers	Monthly										
Arm Covers	Weekly										
Wrist Covers	Daily										
<b>Paint Robot Cleaning:</b> <ul style="list-style-type: none"> <li>- The wrist/applicator may be cleaned using a lint free rag soaked with solvent.</li> <li>- A soft paint brush should be used on the seals to clean the paint from them without damaging the seals.</li> <li>- After cleaning, the seals of the wrist may be coated with petroleum jelly, to keep the paint from sticking to the seal and causing excessive friction in the wrist joint, which can cause collision guard or over current errors.</li> <li>- Catrac cables can be cleaned with a lint free rag soaked with solvent as well. After cleaning the cables can also be coated with a layer of petroleum jelly to keep paint from sticking and to make it easier to clean the cables in the future.</li> <li>- The front of a rail can be coated with petroleum jelly as well, to make it easier to remove paint.</li> </ul>											
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Contact TDIC for the robot covers: [www.tdic.com](http://www.tdic.com) , Tel: (586) 731-2080

**Figure 2-2 ET-6414-850-001 SHT1, MAINTENANCE**

INITIAL OR REBUILD LUBE REQUIREMENT							MAINTENANCE LUBE SCHEDULE		
LUBE POINT	ASSEMBLY LOCATION	GREASE TYPE	TOTAL AMOUNT CUBIC CENTIMETERS (CUBIC INCHES)	NO. OF LUBE POINTS	AMOUNT PER LUBE POINT CUBIC CENTIMETERS (CUBIC INCHES)	NOTES	FREQUENCY (HOURS)	TOTAL AMOUNT CUBIC CENTIMETERS (CUBIC INCHES)	
1	OUTER KNUCKLE BEARINGS & GEARS	LG-01-02	150 (9.2)	1	150.0 (9.2)	2, 4, 5	4,000	5 (0.3)	
2	INNER KNUCKLE BEARINGS & GEARS	LG-01-02	180 (11.0)	1	180.0 (11.0)	2, 4, 5	4,000	7 (0.4)	
3	WRIST HOUSING BEARINGS & GEARS	LG-01-02	200 (12.2)	1	200.0 (12.2)	2, 4, 5	4,000	5 (0.3)	
4	AXIS 3 RV	VIGO GREASE RE NO. 0	520 (31.7)	1	520.0 (31.7)	3,5,6,8	20,000	520 (31.7)	
5	AXIS 2 RV	VIGO GREASE RE NO. 0	2069 (126.3)	1	2069.0 (126.3)	4,5,8,11	20,000	2069 (126.3)	
6	AXIS 1 RV (FLOOR MOUNT)	VIGO GREASE RE NO. 0	3200 (195.3)	1	3200 (195.3)	4,5,7,8	20,000	3200 (195.3)	
7	AXIS 1 RV (INVERT MOUNT)	VIGO GREASE RE NO. 0	3200 (195.3)	1	3200 (195.3)	4,5,7,8,9	20,000	3200 (195.3)	
8	AXIS 1 RV (WALL MOUNT)	VIGO GREASE RE NO. 0	3200 (195.3)	1	3200 (195.3)	4,5,7,8,9	20,000	3200 (195.3)	

STD. FANUC PART NO.	ZINC FREE FANUC PART NO.	GREASE TYPE - SIZE
HDWMO0000041940	HDWMO0000041670	LG-01-02 TUBE - 14 OZ
HDWMO0000041950	HDWMO0000041680	LG-01-02 PAIL - 35 LB.
HDWMO0000041960	HDWMO0000041690	LG-01-02 KEG - 115 LB.
XGMF-16799		VIGO GREASE RE NO. 0 2 KG
XGMF-16156		VIGO GREASE RE NO. 0 16 KG

NOTES:

1. INITIAL & REBUILD LUBE DONE FROM FLOOR MOUNT POSITION.
2. WRIST ASSEMBLY - LUBE POINTS 1, 2 & 3:  
BRUSH THICK GREASE ON GEAR TEETH AND HAND PACK BEARINGS AT ASSEMBLY. INSTALL WRIST. REMOVE ANY ONE PLUG FROM THE WRIST HOUSING (WRIST VENT - SEE VIEW FOR J3 LUBE) AND LUBE THROUGH 1, 2 & 3 PER SPECIFICATION. REINSTALL PLUG WHEN LUBE IS COMPLETE. USE PERMATEX "NO MORE LEAKS" HDWMO0000038860.
3. FOR LUBE POINT 4:  
- INITIAL - USE GREASE VOLUME FROM THE CHART,  
- REBUILT - LUBE UNTIL CLEAN GREASE COMES OUT THE VENT.
4. LUBE WITH THE CALIBRATED GREASE PUMP PER SPECIFICATION - LUBE POINTS: 1, 2, 3, 5, 6, 7 & 8.
5. REMOVE PLUGS (LUBE & VENT) BEFORE LUBE. REINSTALL PLUGS WHEN LUBE IS COMPLETE. USE PERMATEX "NO MORE LEAKS" HDWMO0000038860.
6. AXIS 3 - ROTATE INNER ARM 67.5° DOWN FROM VERCICAL POSITION,  
- ROTATE OUTER ARM 90.0° DOWN FROM HORIZONTAL POSITION,  
WITH AXIS 3 MOTOR ORIENTATION AS SHOWN. LH ROBOT SHOWN,  
SAME OUTER ARM POSITION FOR THE RH ROBOT.
7. AXIS 1 -  
FLOOR MOUNT - REMOVE VENTING PLUG WHEN LUBE.  
- REPLACE BOTTOM RV PLUG WITH J1 RV LUBE TOOL - EO-6414-703-000  
- RE-INSTALL BOTH PLUGS AFTER LUBE IS COMPLETED.  
INVERT & WALL MOUNT - REMOVE VENT PLUG. REINSTALL AFTER INITIAL LUBE IS COMPLETE.
8. USE AXIS 3 GREASE VENT ADAPTER - EO-4696-700-043  
FOR LUBE CONVENIENCE - LUBE POINTS 4 & 5.
9. FOR ROBOTS: INVERT MOUNT (IMMEDIATELY BEFORE OR AFTER INVERTING)  
AND WALL MOUNT (IMMEDIATELY BEFORE OR AFTER WALL MOUNTING)  
- AXIS 1 GREASE CAVITY RELIEF SHOULD BE REPOSITIONED WITH THE PLUG.
10. GREASE GUN TIP PRESSURE MUST BE UNDER 0.1Mpa WHEN GREASING AXIS 1 RV,  
AXIS 2 RV AND AXIS 3 RV.
11. AXIS 2 - ROTATE INNER ARM 120° DOWN FROM VERCICAL POSITION,  
- ROTATE OUTER ARM 90.0° UP FROM HORIZONTAL POSITION,

**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.

UNLESS OTHERWISE NOTED:  
SEE EG-00008 FOR LOCTITE REQUIREMENTS  
SEE EG-00010 FOR TORQUE SPECIFICATIONS

INNER & OUTER ARM ORINTATION REQUIRED FOR J2 LUBRICATION

INNER & OUTER ARM ORINTATION REQUIRED FOR J3 LUBRICATION

P-50iB/15 & P-50iB/10L INITIAL OR REBUILD LUBE IN FLOOR POSITION FOR: FLOOR, INVERT & WALL MOUNT  
(COVERS REMOVED FOR CLARITY, P-50iB SHOWN)

[ET-6414-850-001\_SHT1]  
MAINTENANCE

REV A



# 3 TROUBLESHOOTING

## 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 Tel: 1-800-iqRobot.

**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.
	Incorrect Mastering	Remaster Robot
	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.
	Play in the mechanical unit.	Refer to the excessive play symptom in this table.
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.
	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.
	Insufficient maintenance air	Increase maintenance air supply
	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.

**Table 3-1 Problems and Causes, continued**

Symptom	Cause	Remedy
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.
	Intrusion of grease into motor due to excessive quantity of grease.	Replace the motor and ensure proper grease level.
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-50iB Purge cycle troubleshooting.

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**Figure 3-1 EB\_03648, PURGE TROUBLESHOOTING – ENG BULLETIN**

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<b>FANUC Robotics America</b>		
<b>PURGE TROUBLESHOOTING</b>		
<b>ROBOT MODEL</b>	<b>SOFTWARE</b>	
P-50iA, P-50iB, P-250iA, P-500iA, Paint Mate 200iA, and P-700iA	N/A	
<b>SOURCE OF INFORMATION:</b>	<input type="checkbox"/> FANUC <input checked="" type="checkbox"/> FRA <input type="checkbox"/> HEB - Hardware Engineering Bulletin	
<b>REASON FOR ENGINEERING BULLETIN</b>		
<input type="checkbox"/> Error Correction <input type="checkbox"/> N/A <input type="checkbox"/> Product Improvement <input type="checkbox"/> N/A <input type="checkbox"/> Other	<input type="checkbox"/> Material Availability <input type="checkbox"/> New Product Release <input checked="" type="checkbox"/> Information	<input type="checkbox"/> Mechanical Guidelines <input type="checkbox"/> Electrical Guidelines <input type="checkbox"/> Software Guidelines
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## FANUC Robotics America

### PURGE TROUBLESHOOTING

#### PURGE TROUBLESHOOTING

The purpose of this document is to explain how to troubleshoot purge problems on P-50iA, P-50iB, P-250iA, P-500iA, Paint Mate 200iA, and P-700iA FLEX painting robots. This document describes the electrical and mechanical components used to purge the robot and explains how the components work. The document also includes an explanation of the purge sequence and provides a troubleshooting flowchart to help debug purge problems.

#### PURGE MODULE II (EE-5404-001-0XX)

The Purge Module II is used on R-30iA P-50iA, P-50iB, P-250iA, P-500iA, Paint Mate 200iA, and P-700iA FLEX painting robots to control the environment inside the robot. It circulates clean air through the robot so that no potentially explosive gases are inside the robot. The purge module also maintains the air in the robot at a slightly higher pressure than the surrounding environment, so that if there are any leaks, air flows out rather than in. The purge module consists of redundant timer circuits that can be set to the different lengths of time required to purge different size robots. The Purge Module II is configured with two Fuse Daughter Boards for a single robot redundant circuit or with 4 fuse daughter boards for two or four robot redundant circuits. The module is supplied single phase 50/60 Hz 220VAC(+10% / -15%) from the servo transformer except the Paint Mate.

ROBOT MODEL	ASSEMBLY PART NUMBER	QTY FUSE BOARDS	PURGE TIME
P-250iA(US, CA, CE)	EE-5404-001-005	2	3.5 minutes
P-50iA(US, CA)	EE-5404-001-005	2	3.5 minutes
P-50iA(CE)	EE-5404-001-006	2	1.78 minutes
Paint Mate 200iA	EE-5404-001-006	2	1.78 minutes
P-250iA with P-20 PED	EE-5404-001-007	4	3.5 minutes
P-500iA(US, CA, CE)	EE-5404-001-008	4	5.3 minutes
P-700iA FLEX(US, CA)	EE-5404-001-008	4	5.3 minutes
P-50iB(US, CA, CE)	EE-5404-001-005	2	3.5 minutes

TABLE 01



PICTURE 01

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## PURGE TROUBLESHOOTING

### PURGE MODULE II LIGHTS

The Purge Module II can be connected to 1, 2, 3, or 4 robots. The diagram below shows the relationship between the field devices and the lights on the module.

PS-A Pressure switch A circuit, one pressure switch from each fuse board/robot  
PS-B Pressure switch B circuit, one pressure switch from each fuse board/robot  
FS-A Flow switch A circuit, one pressure switch from each fuse board/robot  
FS-B Flow switch B circuit, one pressure switch from each fuse board/robot

**PICTURE 02**

**PICTURE 02**

**ONE OR TWO ROBOT CONNECTION**

**THREE OR FOUR ROBOT CONNECTION**

**PICTURE 03**

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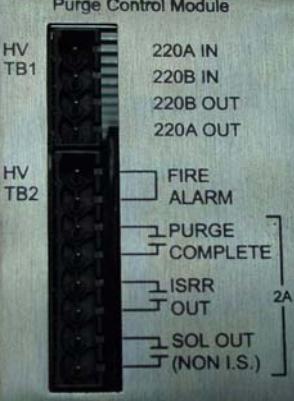
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## PURGE TROUBLESHOOTING

### PURGE MODULE II HIGH VOLTAGE TERMINAL BLOCKS

The input power, output power, fire alarm interlock, purge complete interlock, ISRR output are terminated at terminal blocks HV-TB1 and HV-TB2 on the Purge Module. The 220 VAC input power is switched on from the controller disconnect. The 220 VAC outputs are connected to the controller Power Supply Unit and other devices that are only powered on after robot purge is complete. The FIRE ALARM input signal is a 200VAC signal that shuts down power to the robot when activated. The PURGE COMPLETE signal is available for use as needed by the system but can not exceed the rating of the contacts. The (PURGE) SOLENOID OUTPUT signal is used when the purge solenoid is located outside the booth. The ISRR OUTPUT is not currently used.

**Purge Control Module**



**PICTURE 04**

**PICTURE 05**

Circuit diagram showing the connections between the Purge Control Module (HV-TB1 and HV-TB2) and various external components:

- 200A IN (200-240 VAC, 50-60 Hz) connects to HV-TB1-1 and HV-TB2-1.
- 200B IN (200-240 VAC, 50-60 Hz) connects to HV-TB1-2 and HV-TB2-2.
- 200B OUT (200-240 VAC, 50-60 Hz) connects to HV-TB1-3 and HV-TB2-3 through CR1B and CR1A relays.
- 200A OUT connects to HV-TB1-4 and HV-TB2-4 through CR1B and CR1A relays.
- FIRE ALARM (INPUT) connects to HV-TB2-1 and HV-TB2-2.
- PURGE COMPLETE connects to HV-TB2-3 and HV-TB2-4 through CR1A and CR1B relays.
- ISRR OUTPUT connects to HV-TB2-5 and CR2 relay.
- SOL OUT (NON I.S.) connects to HV-TB2-7 and CR3 relay.

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## PURGE TROUBLESHOOTING

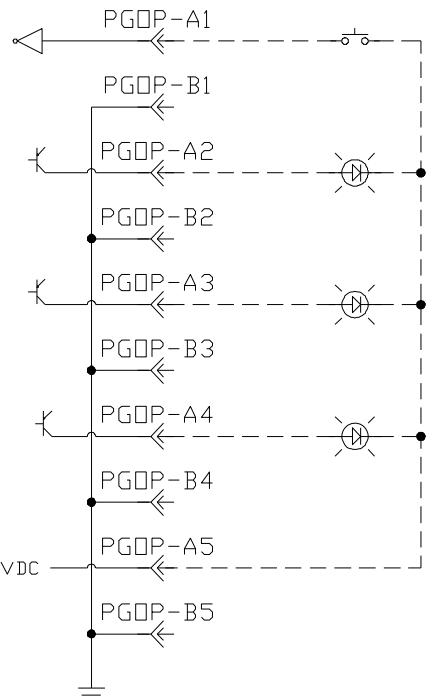
### PURGE MODULE II OPERATOR PANEL SIGNALS

The purge control operator interface is located on the operator panel. The operator panel signals connect to the Purge Module PG OP connector using a cable harness. The purge enable signal is used to initiate the purge sequence. When the purge starts, the Purge Enable light is illuminated. Once the purge sequence starts, the Purge Enable button may be released. After purge is successfully complete, the Purge Enable light turns off, the Purge Fault light turns off and the Purge Complete light is illuminated. If the purge is not successful, the Purge Fault light will turn on.

**PICTURE 06**



**PICTURE 07**



**PICTURE 08**



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## PURGE TROUBLESHOOTING

### EE-5404-001-0XX(PURGE MODULE II) ISRR INPUT

A single intrinsically safe repeater contact is provided as part of the Purge Module II. This function is not used.

**PICTURE 09**

```

    graph LR
        A[ISRR INPUT] --- B[ISTB1-1]
        A --- C[ISTB1-2]
    
```

**PICTURE 10**

**PICTURE 11**

PURGE AIR SUPPLY	
INTERNAL VOLUME =	LITERS
RATED PURGE FLOW ACTIVATION =	NLPM
MAXIMUM PURGE FLOW ACTIVATION =	NLPM
PURGE PRESSURE =	0.7 kPa
AIR SUPPLY PRESSURE =	414 - 448 kPa (60 - 65 psi @ 740 NLPM dynamic)
AIR SUPPLY TEMPERATURE =	0°C - 45°C
MAINTENANCE FLOW =	360 NLPM
MAINTENANCE PRESSURE =	1.99 - 2.49 kPa
MINIMUM OVERPRESSURE =	0.172 kPa
MAXIMUM OVERPRESSURE =	10.3 kPa
MAXIMUM LEAKAGE FLOW =	340 NLPM
AMBIENT TEMPERATURE =	0°C - 45°C
HUMIDITY =	2°C PRESSURE DEWPPOINT AT 621 kPa
FILTRATION =	5 MICRON ABSOLUTE
EXHAUST PRESSURE =	0.67 kPa

掃気用空気供給口

内容欄

掃気時の量	リットル
掃気時の量 (最大)	NLPM
掃気時の量 (最小)	NLPM
掃気時の量 (標準)	6.7 kPa
掃気時の量 (標準)	414 - 448 kPa (60 - 65 psi @ 740 NLPM dynamic)
空気供給温度	0°C - 45°C
運転時の量	90 - 360 NLPM
運転時の量	1.99 - 2.49 kPa
最小動作圧力	0.172 kPa
最大動作圧力	10.3 kPa
最大漏れ量	340 NLPM
露点温度	2°C
露点温度	621 kPaにおける露点温度 2°C
フィルター	5 μm (絶対)
排気圧	0.67 kPa

EC-5133-165-002

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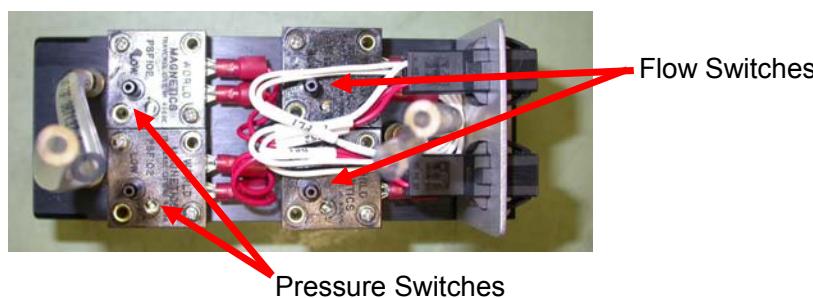
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### PURGE TROUBLESHOOTING

#### PURGE SWITCH

The pressure flow switch assembly is one multifunction device. It contains 2 pressure switches to verify maintenance air. It also contains 2 additional pressure switches that measure the differential pressure across the pilot tube to function as a flow switch. The other part of the flow switch is a pressure operated check valve. It takes approximately 7.6 in H<sub>2</sub>O of internal pressure to open the check valve. This allows for use of lower maintenance air while allowing a large flow for the required number of air exchanges during purge.

Purge Switch Assembly EO9999-703-000\_

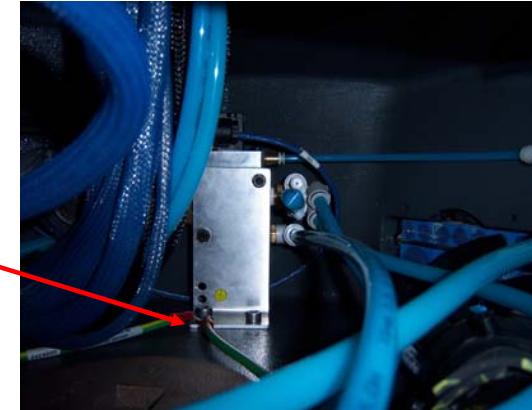


**PICTURE 12**

#### PURGE SOLENOID

The purge solenoid may be located inside the robot, inside the controller, or externally mounted. All variants of the solenoid require an air pilot to operate. When the solenoid is in the robot, an intrinsically safe solenoid must be approved for use in the hazardous location. When the solenoid is outside the booth, it does not need to be intrinsically safe and can be 24Vdc or 200Vac. The air pilot of the solenoid must have 60 PSI during flow to operate properly. If the pressure in the pilot line drops below 60 PSI, the solenoid valve will not fully open. If the solenoid valve does not fully open the required purge flow will not be established to complete the purge cycle.

Purge solenoid as seen through the P-250iA/15 pedestal access cover.



**PICTURE 13**

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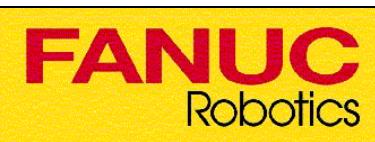
## PURGE TROUBLESHOOTING

### ROBOT PURGE AIR PRESSURE VERIFICATION

A low pressure gauge can be used to check the air pressure within the robot. Simply remove the plug from the test port and connect a pressure gauge. The maintenance air pressure should be in the range specified on the AIR SUPPLY TAG. The picture below shows tubing to make the gauge easier to read.

**PICTURE 15:** A diagram showing a pressure gauge connected to a tube that leads to the 'AIR PRESSURE TEST PORT' on the robotic arm. To the right is a detailed 'PURGE AIR SUPPLY' specification tag. The tag includes both English and Japanese text. Several parameters are circled in red, including 'MAINTENANCE PRESSURE = 1.99 - 2.49 kPa' and 'MAXIMUM OVERPRESSURE = 0.172 kPa'. The tag also lists internal volume (0.15 liters), rated purge flow activation (NLPM), maximum leakage flow (360 NLPM), ambient temperature (0°C - 45°C), and exhaust pressure (0.67 kPa). It also specifies air supply pressure (414 - 448 kPa or 60 - 65 psi) and dynamic flow rates (90 - 360 NLPM).

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ENGINEERING BULLETIN NUMBER: 03648

Release Date: 03/12/09  
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Page: 9 of 11Document Status: Released  
Revision Level: 3.0**FANUC Robotics America****PURGE TROUBLESHOOTING****ROBOT PURGE EXHAUST INSPECTION**

The purge exhaust is an integral part of the purge system. Inspection of the purge exhaust should be included when troubleshooting the purge system.

Step 1) Visually inspect the robot purge exhaust area for overspray.

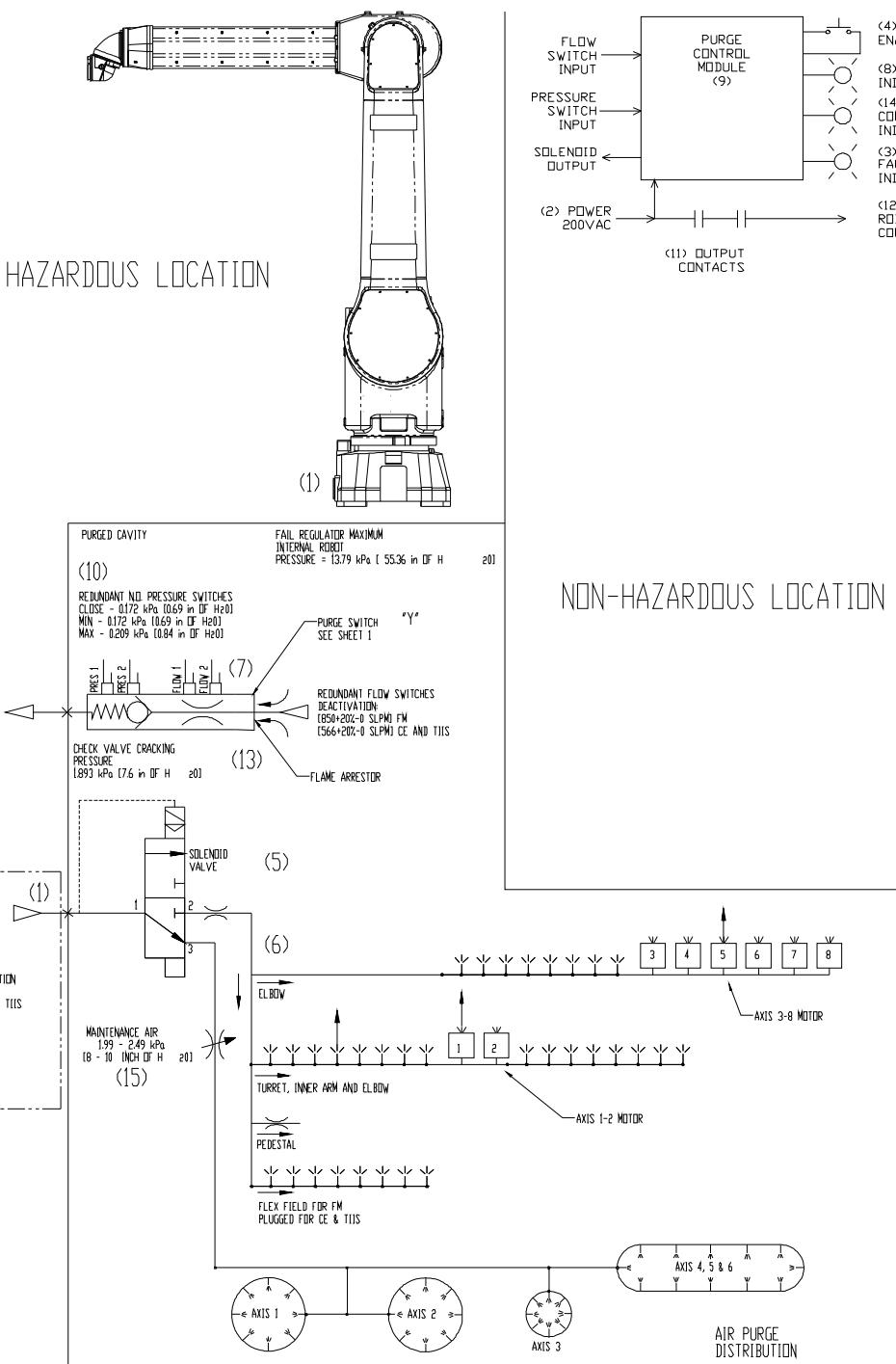
Step 2) If this area is coated in overspray please follow EB-03670, SEVERE ENVIRONMENT REMOTE PURGE EXHAUST for repair and replacement parts.

Step 3) Please provide a photograph of the purge exhaust area.

**PICTURE 16**

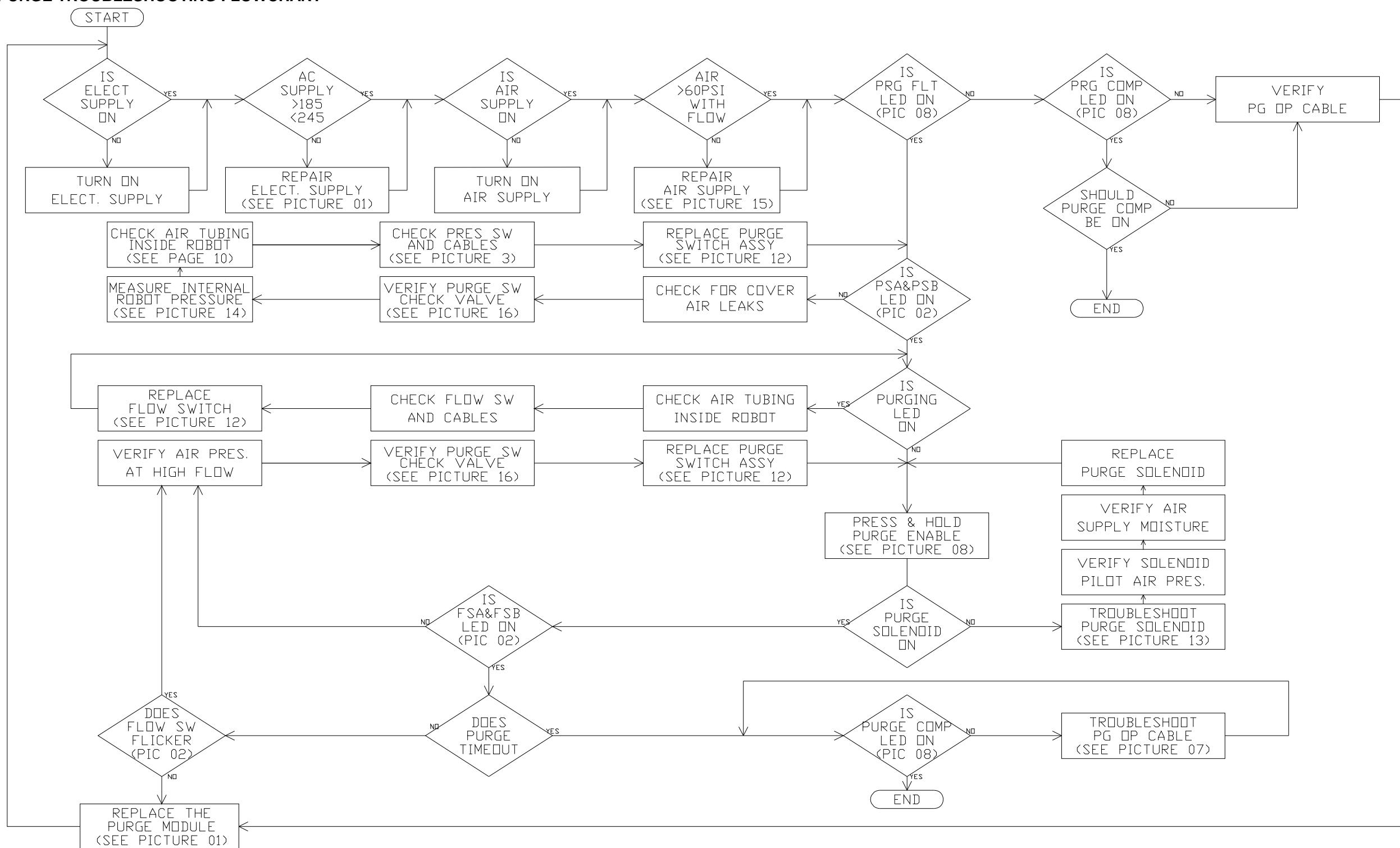
*This bulletin may be revised or updated.*

**THIS DOCUMENT CONTAINS FANUC ROBOTICS AMERICA PROPRIETARY AND CONFIDENTIAL INFORMATION.**

Engineering Bulletin Number:	EB-03648	Release Date:	03/12/2009	Revision Date:	12/14/2011	Revision Level:	3.0	Document Status:	RELEASED	Page:	10 OF 11
<b>PURGE SEQUENCE</b>											
											
<b>PURGE SEQUENCE</b> <ol style="list-style-type: none"> <li>THE OPERATOR CONNECTS AIR SUPPLY TO ROBOT(1). PRESSURE SWITCH (10) CLOSES, AND REMAINS CLOSED AS LONG AS AIR IS SUPPLIED (0.172 kPa MIN).</li> <li>THE OPERATOR PROVIDES POWER TO CONTROLLER TERMINALS (2). AFTER POWER IS PROVIDED, THE PURGE FAULT INDICATION (3) TURNS ON.</li> <li>THE OPERATOR PURES AND HOLDS PURGE ENABLE BUTTON(4).</li> <li>PURGE CONTROL MODULE (9) SWITCHES THE SOLENOID VALVE (5) TO DISTRIBUTION LINES (6) TO START FLOW OF PURGE AIR. AIR WILL BE DISTRIBUTED THROUGHOUT ROBOT CAVITY BY DISTRIBUTION LINES (6).</li> <li>FLOW IS MONITORED BY THE FLOW SWITCH (7) AT AIR OUTLET. WHEN FLOW REACHES 850 L/MIN, FLOW SWITCH (7) CLOSES THE ELECTRIC CONTACTS, FLOW INDICATION (8) WILL COME ON AND THE CONTROL MODULE (9) START TIMING. AT THE SAME TIME, PURGE FAULT INDICATION (3) TURNS OFF.</li> <li>WHEN FLOW INDICATION COMES ON (8), THE OPERATOR CAN RELEASE THE PURGE ENABLE BUTTON (4).</li> <li>PURGE FLOW CONTINUES FOR 3.5 MINUTES TO ENSURE 10 AIR CHANGES. TIME IS MEASURED BY HARDWARE LOGIC IN THE PURGE CONTROL MODULE (9). (MINIMUM PURGE TIME) = 10*(TOTAL CAPACITY OF ROBOT AND HOSE) / (FLOW RATE) = 10x259/850 = 3.04 MINUTES.</li> <li>AFTER 3.5 MINUTES, PURGE IS COMPLETE. PURGE CONTROL MODULE (9) SWITCHES THE SOLENOID VALVE (5) TO MAINTENANCE AIR (15), AND CLOSES THE OUTPUT CONTACTS (11) TO PROVIDE POWER TO ROBOT CONTROLLER, AND TURNS THE PURGE COMPLETE INDICATION (14) ON. THE AIR PRESSURE IN THE CAVITY DECREASES, AND CHECK VALVE (13) CLOSES TO PREVENT LOSS OF MAINTENANCE AIR.</li> <li>ROBOT CAN NOW BE TURNED ON. AS LONG AS PURGE IS COMPLETE, ROBOT MAY BE TURNED ON AND OFF AS DESIRED.</li> </ol>											
<b>NORMAL POWER ON/OFF SEQUENCE</b> <ol style="list-style-type: none"> <li>AS LONG AS PURGE IS COMPLETE, ROBOT MAY BE TURNED ON AND OFF AS DESIRED.</li> </ol>											
<b>ABNORMAL PROCESSING</b> <ol style="list-style-type: none"> <li>IF FLOW SWITCH (7) DOES NOT CLOSE DUE TO NOT-SUFFICIENT AIR FLOW, ETC., TIMING WILL NOT START, AND THEREFORE, YOU WILL NOT BE ABLE TO TURN THE ROBOT CONTROLLER POWER ON.</li> <li>IF THE PRESSURE SWITCH (10) IS NOT CLOSED DUE TO NOT-ENOUGH AIR PRESSURE (&lt; 0.172 kPa), TIMING WILL NOT START, AND THEREFORE, YOU WILL NOT BE ABLE TO TURN THE ROBOT CONTROLLER POWER ON.</li> <li>IF THE FLOW SWITCH (7) OPENS AFTER PURGING HAS STARTED, TIMER (9) WILL BE RESET, PURGE FAULT INDICATION (8) WILL LIGHT, AND THEREFORE, YOU WILL NOT BE ABLE TO TURN THE ROBOT CONTROLLER POWER ON.</li> <li>AFTER PURGE IS COMPLETE, IF PRESSURE SWITCH (10) OPENS, THE OUTPUT CONTACTS (11) WILL OPEN, THE PURGE COMPLETE INDICATION (14) WILL GO OUT, AND PURGE FAULT INDICATION (8) WILL BE ON. AND THEREFORE, THE ROBOT CONTROLLER POWER IS IMMEDIATELY SHUT DOWN.</li> <li>RELIEF VALVE (13) WILL OPEN AT 1.893 kPa TO PREVENT EXCESSIVE PRESSURE IN THE EVENT OF AN AIR SUPPLY FAILURE.</li> </ol>											
<i>This bulletin may be revised or updated.</i> <b>THIS DOCUMENT CONTAINS FANUC ROBOTICS AMERICA PROPRIETARY AND CONFIDENTIAL INFORMATION.</b>											

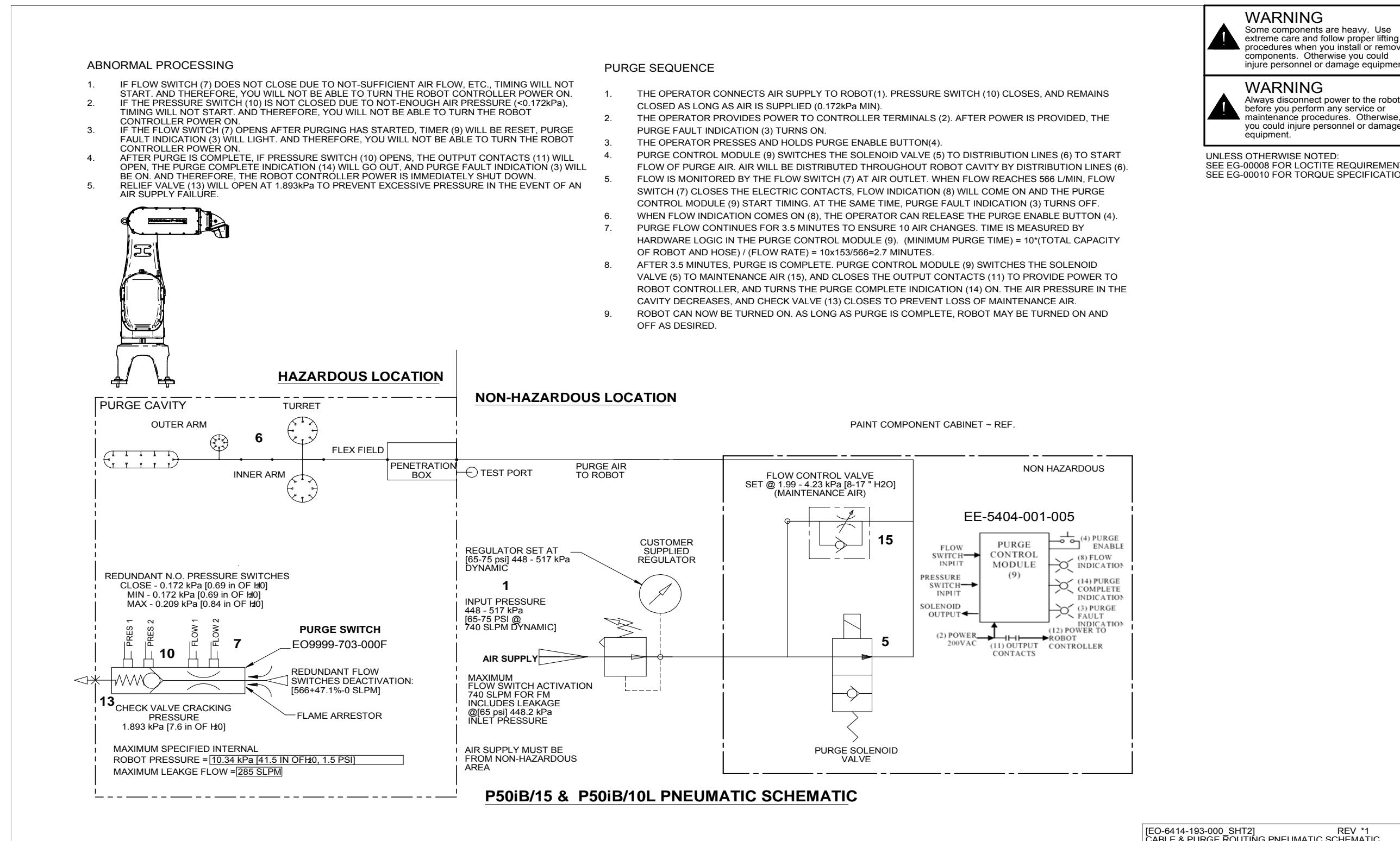
ENGINEERING BULLETIN NUMBER: EB-03648 | Release Date: 03/12/2009 | Revision Date: 12/14/2011 | Revision Level: 3.0 | Document Status: RELEASED | Page: 11 OF 11

## PURGE TROUBLESHOOTING FLOWCHART



*This bulletin may be revised or updated.*

**THIS DOCUMENT CONTAINS FANUC ROBOTICS AMERICA PROPRIETARY AND CONFIDENTIAL INFORMATION.**

**Figure 3-2 EO-6414-193-000 SHT2, CABLE & PURGE ROUTING PNEUMATIC SCHEMATIC**

**Table 3-2 Possible Purge Cycle Problems**

PROBLEM	CAUSE	WHAT TO CHECK FOR
Inadequate air flow through the robot or opener	Air supply capacity inadequate	The air supply is inadequate. Check the air pressure at the pneumatic air supply.
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.

**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.

## **4 TRANSPORTATION AND INSTALLATION**

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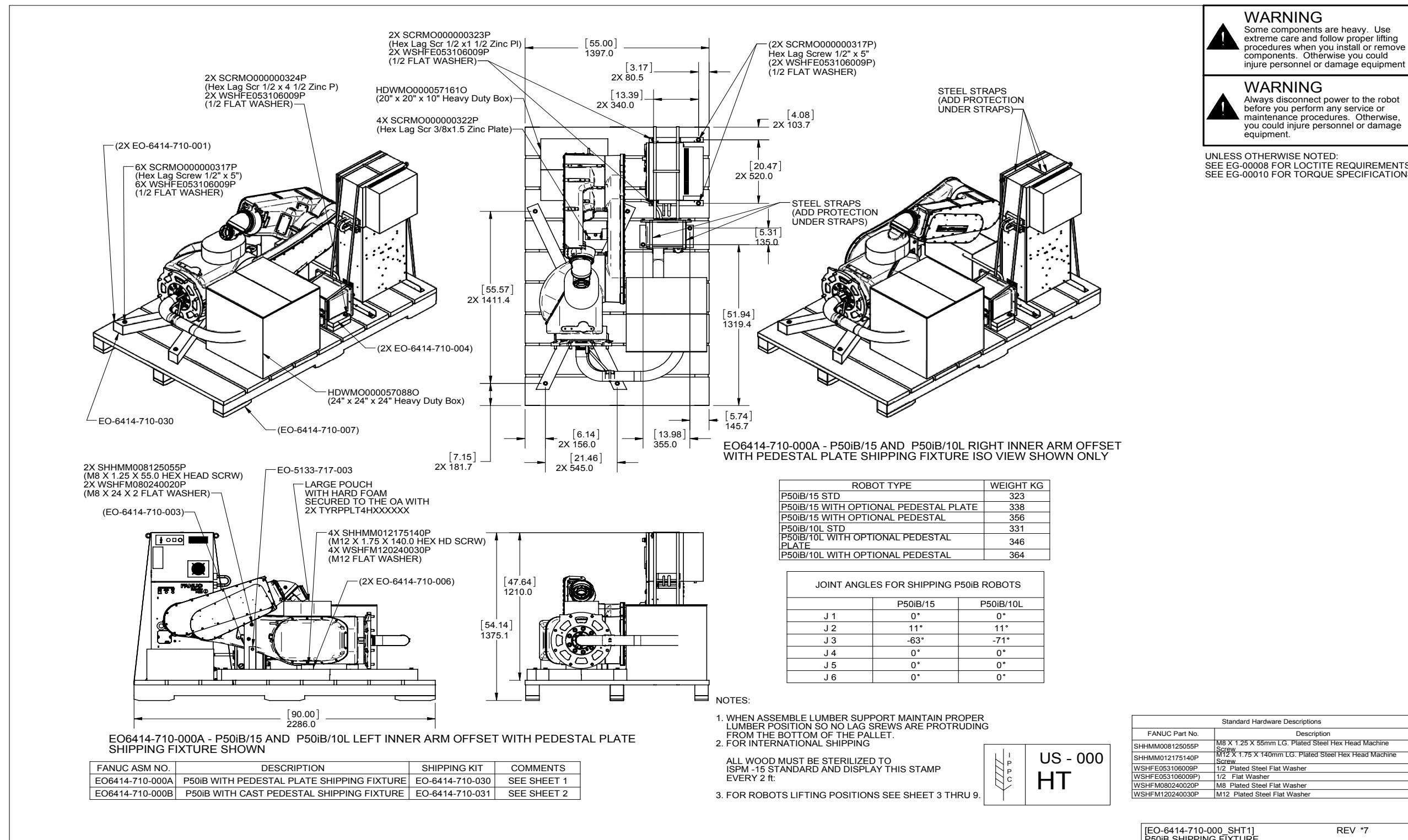
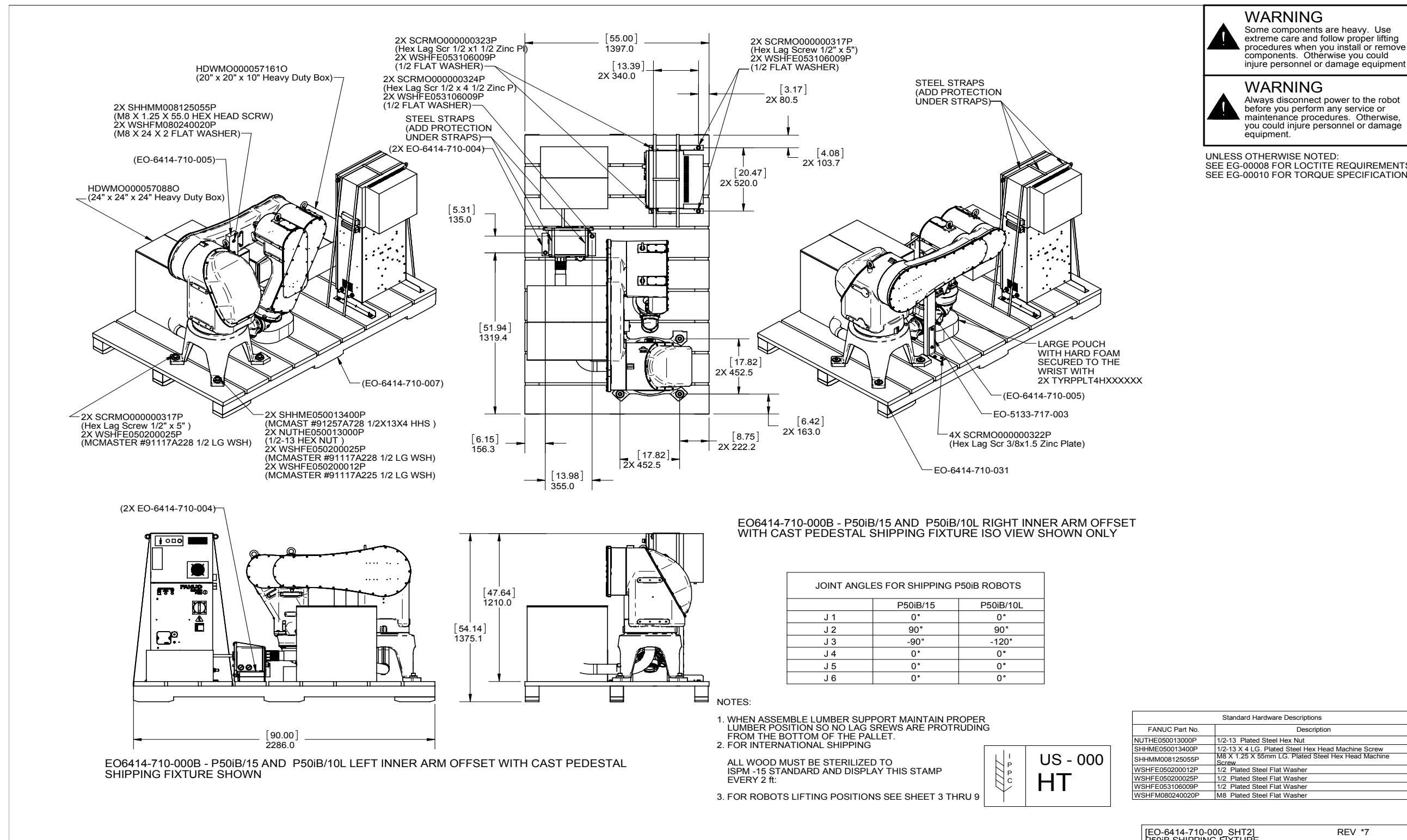
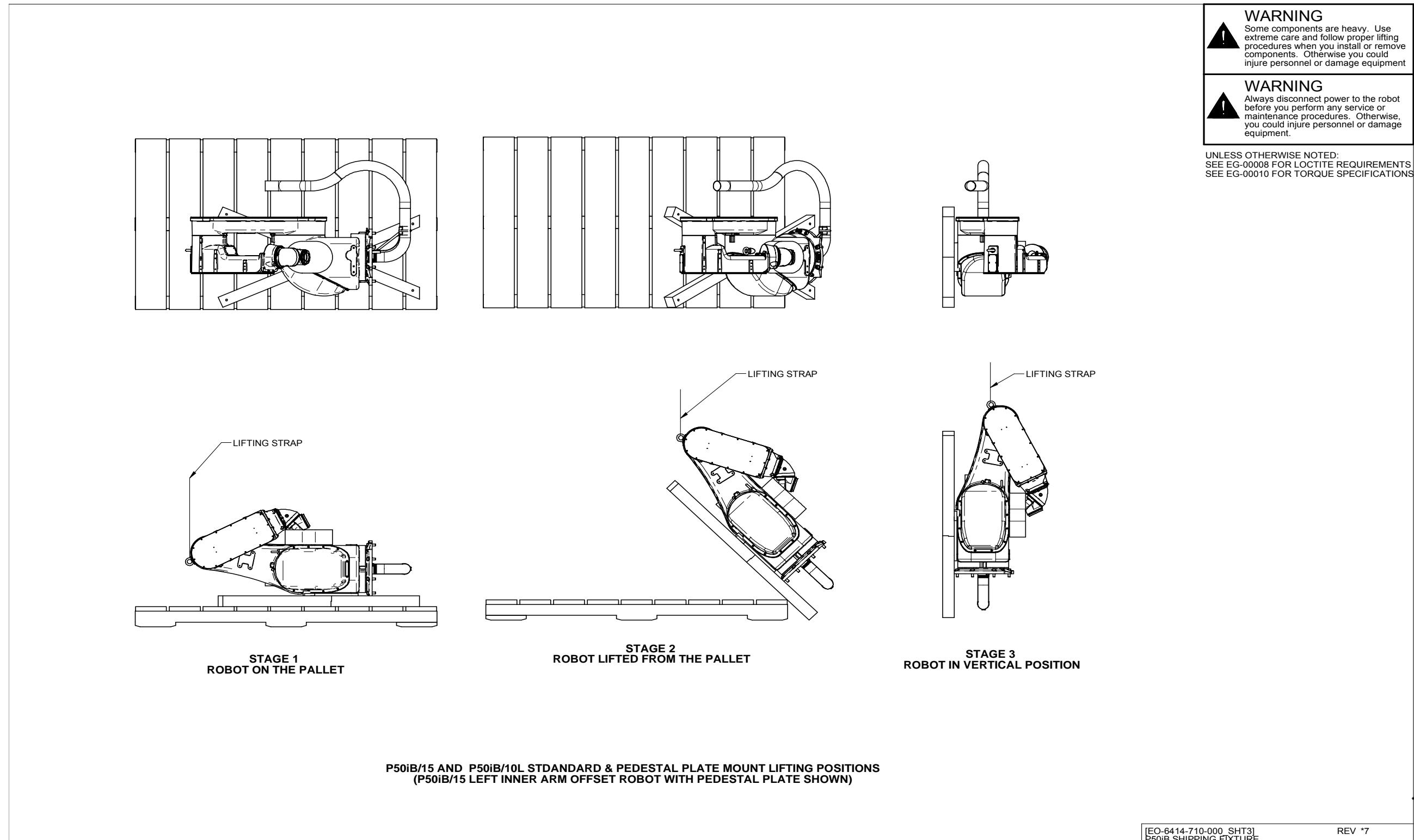
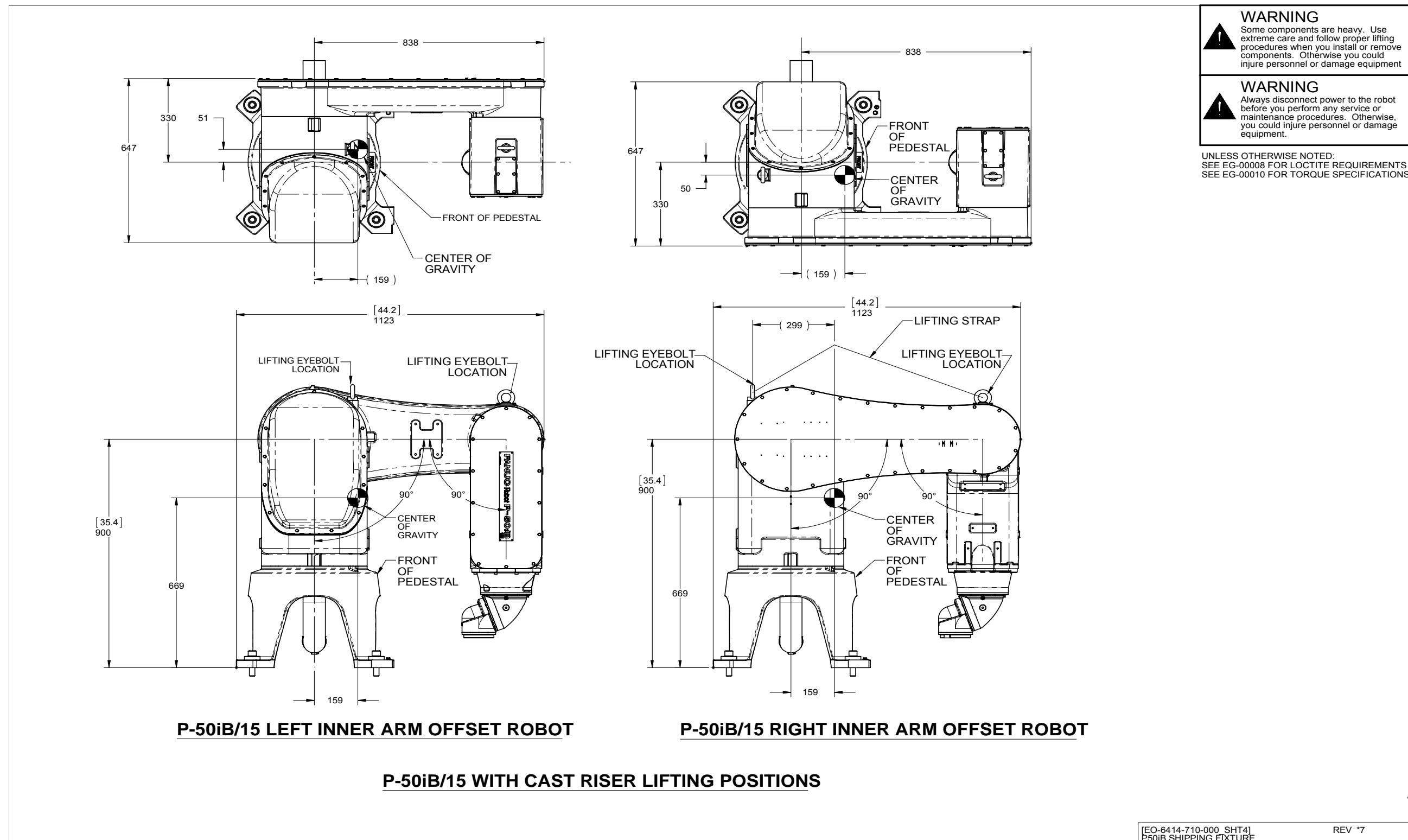
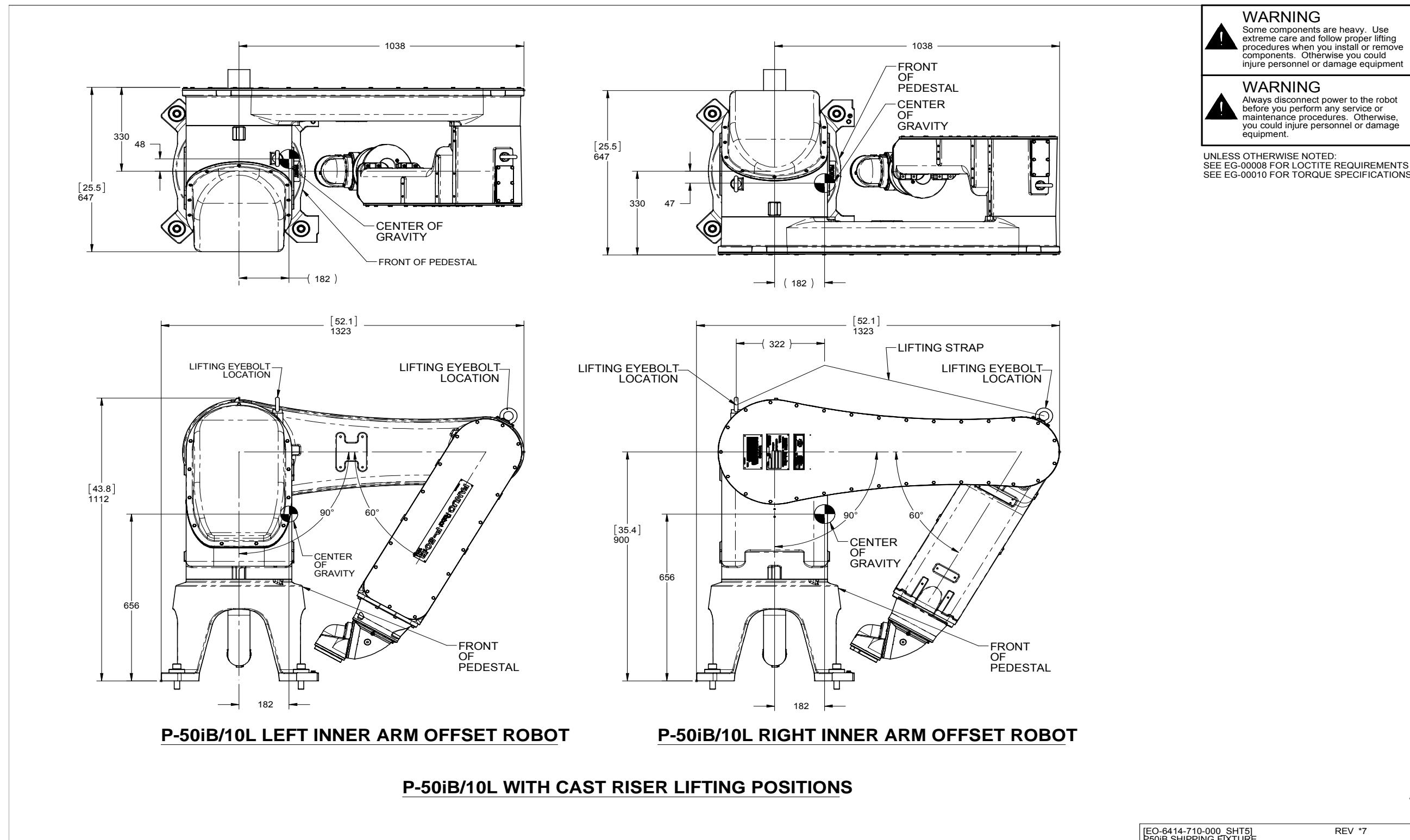
**Figure 4-1 EO-6414-710-000 SHT1, P50iB SHIPPING FIXTURE**

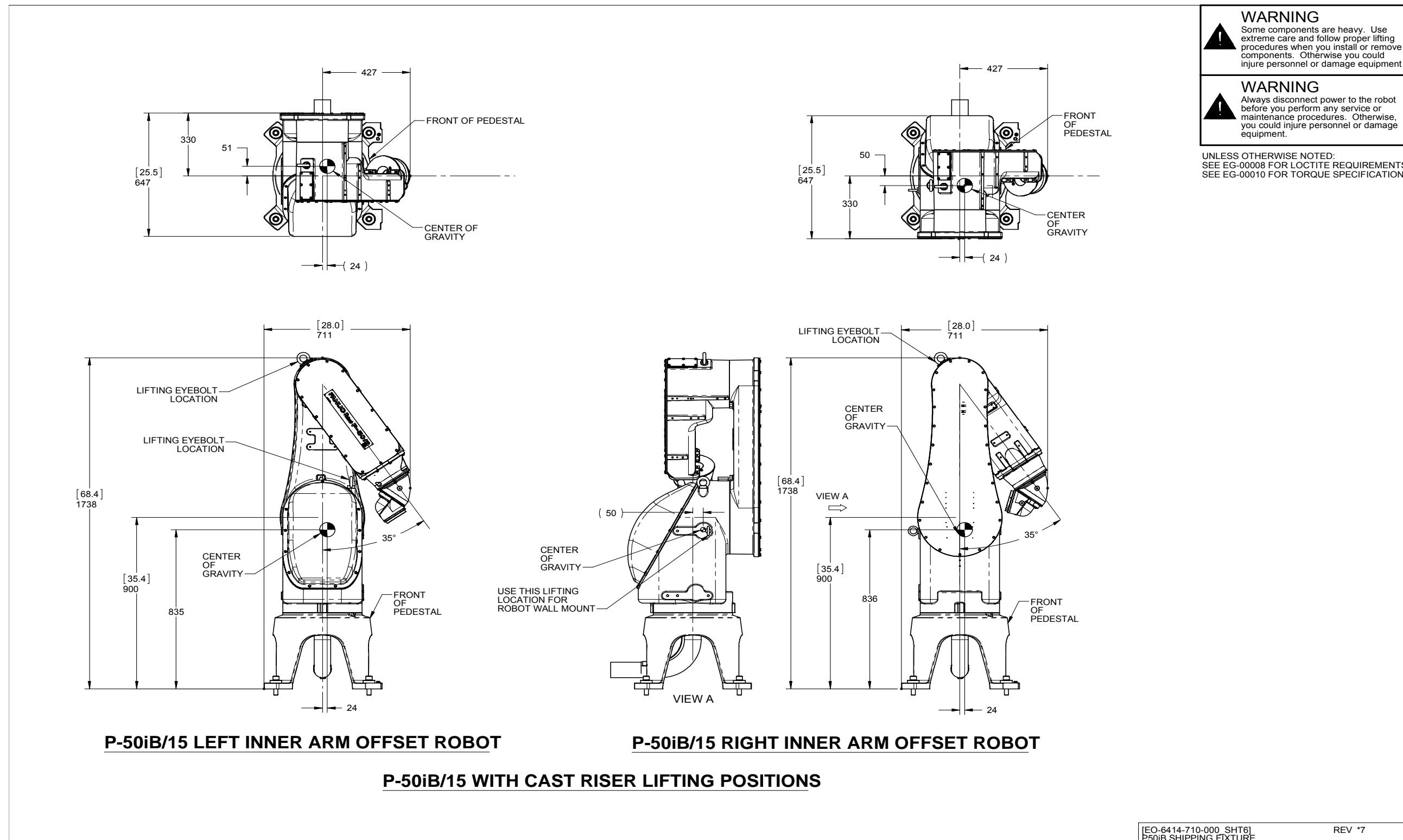
Figure 4-2 EO-6414-710-000 SHT2, P50iB SHIPPING FIXTURE



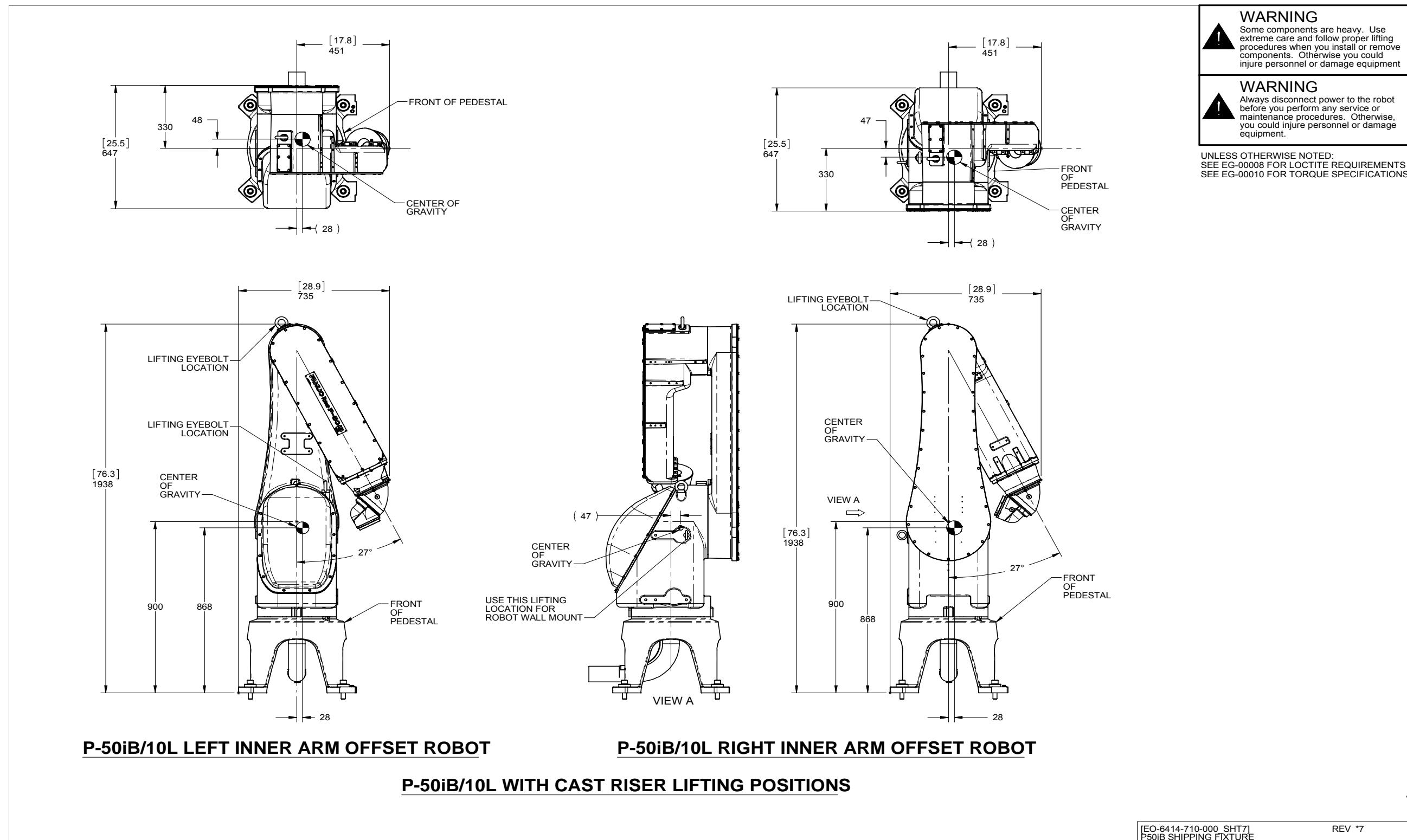
**Figure 4-3 EO-6414-710-000 SHT3, P50iB SHIPPING FIXTURE**

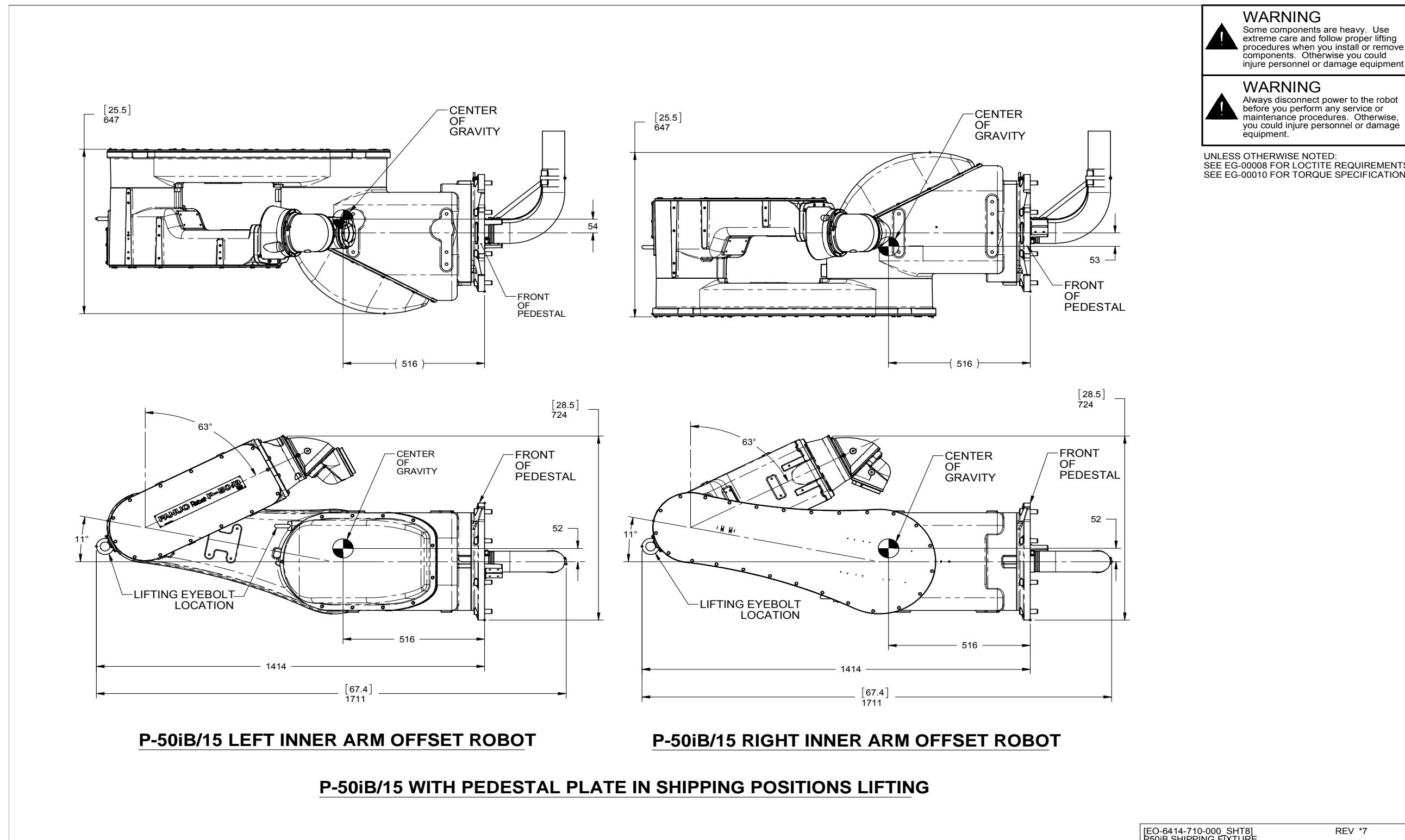
**Figure 4-4 EO-6414-710-000 SHT4, P50iB SHIPPING FIXTURE**

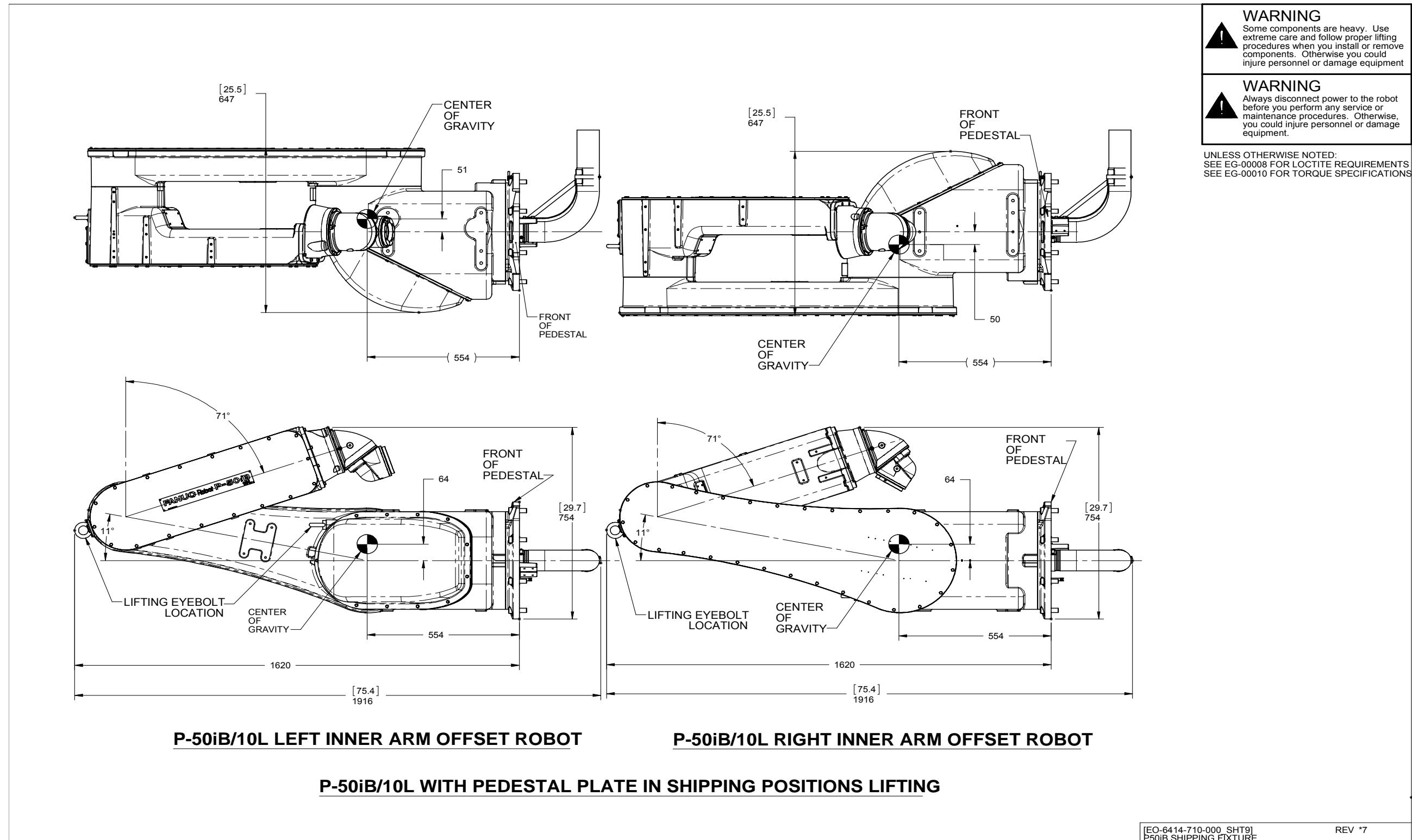
**Figure 4-5 EO-6414-710-000 SHT5, P50iB SHIPPING FIXTURE**

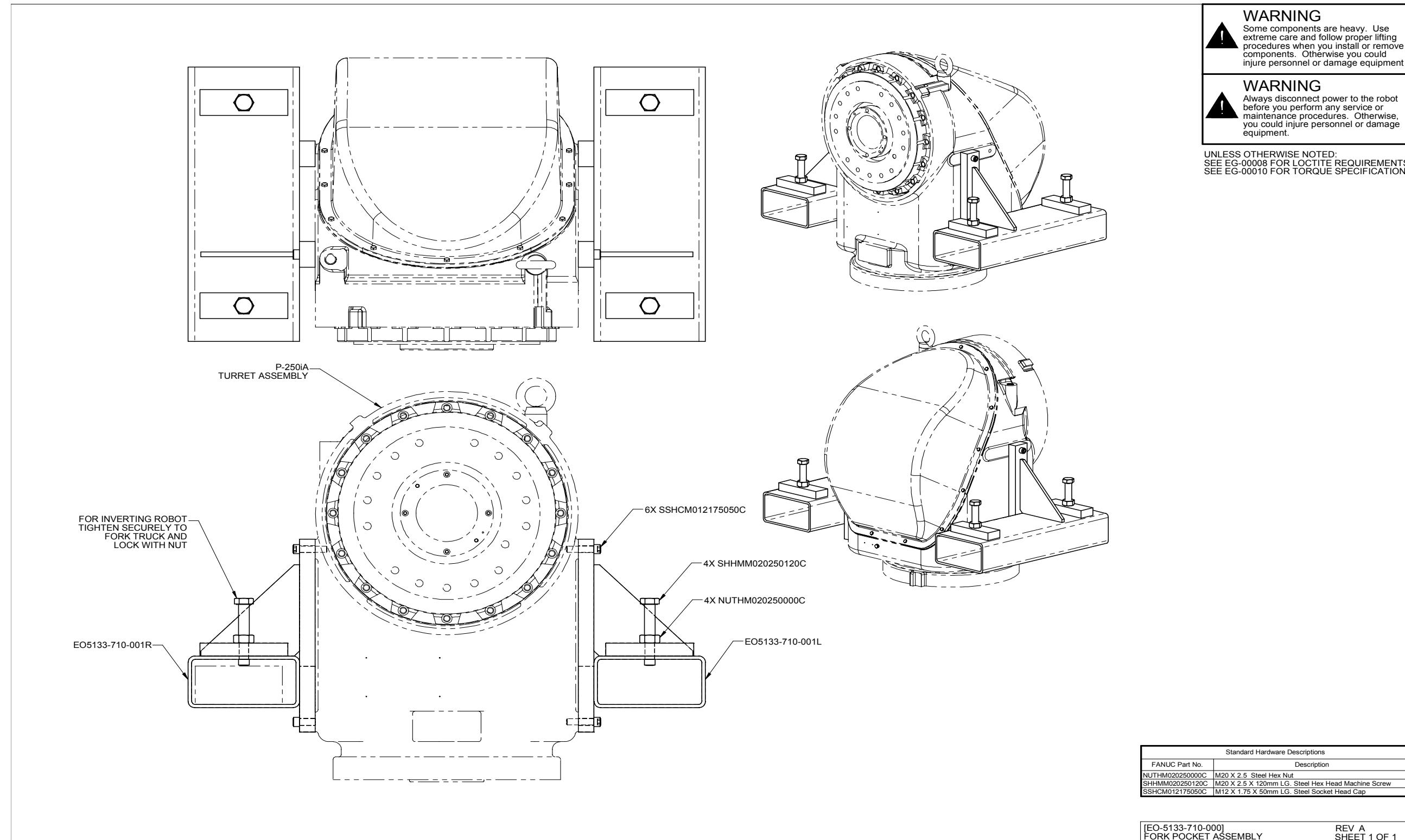
**Figure 4-6 EO-6414-710-000 SHT6, P50iB SHIPPING FIXTURE**

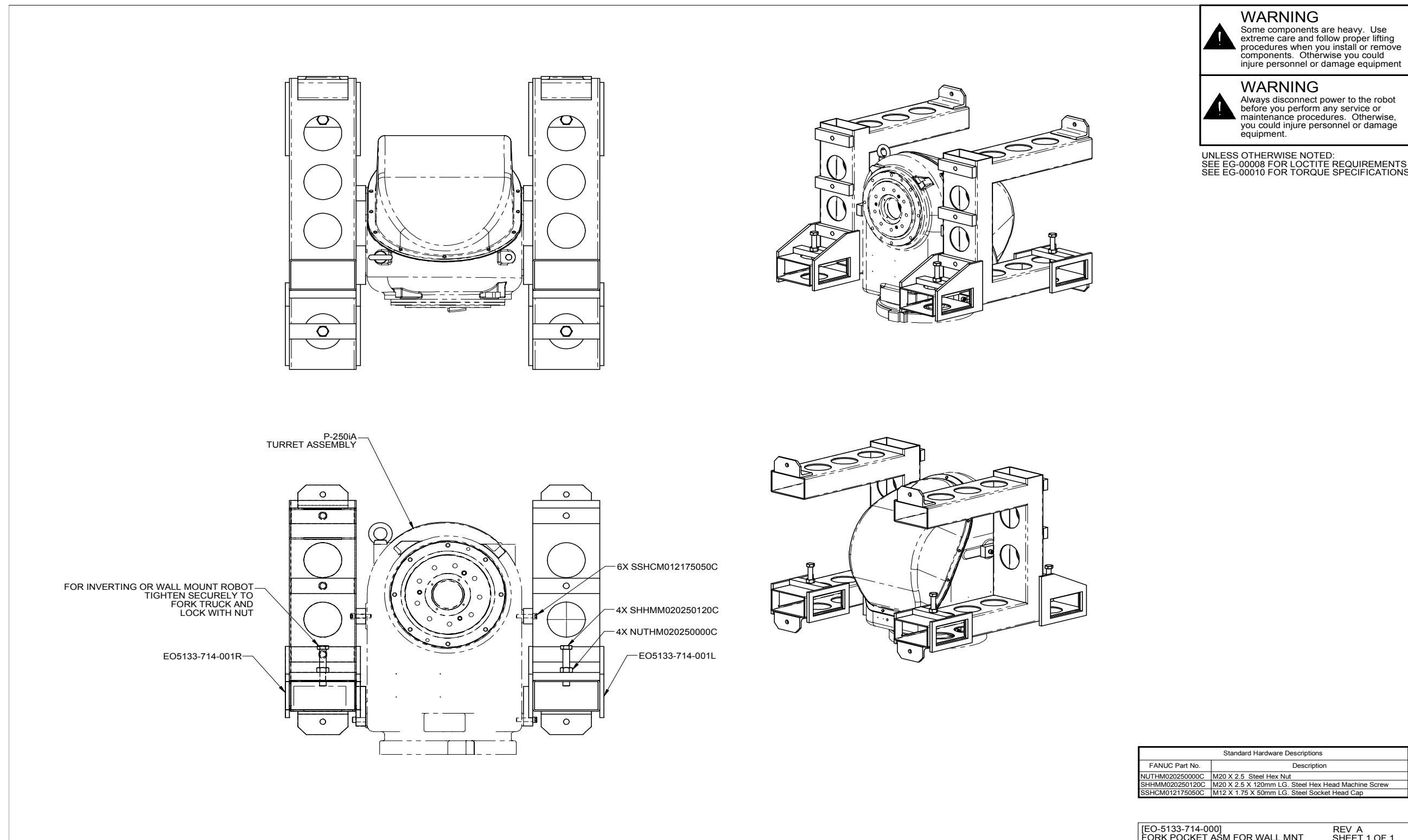
**Figure 4-7 EO-6414-710-000 SHT7, P50iB SHIPPING FIXTURE**



**Figure 4-8 EO-6414-710-000 SHT8, P50iB SHIPPING FIXTURE**

**Figure 4-9 EO-6414-710-000 SHT9, P50iB SHIPPING FIXTURE**

**Figure 4-10 EO-5133-710-000, FORK POCKET ASSEMBLY**

**Figure 4-11 EO-5133-714-000, FORK POCKET ASM FOR WALL MNT**

# **5** **REPLACING PARTS**

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## **5.1 P-50iB Robot Assemblies**

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### 5.1.1 Robot Assembly

**Figure 5-1 EO-6414-011-000, WRIST ASSEMBLY FOR SERVICE**

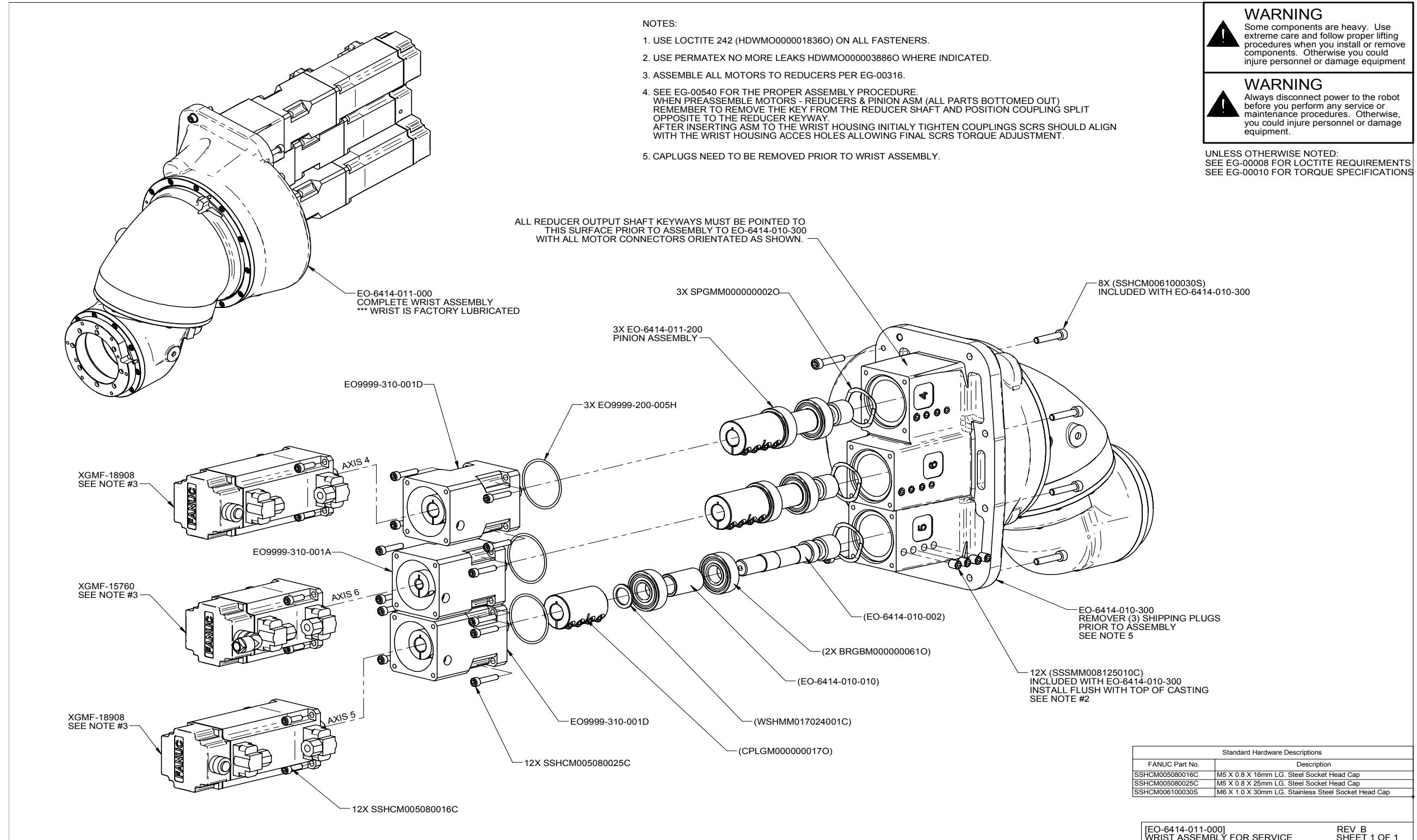


Figure 5-2 EO-6414-022-000 Sheet 1 of 2, OUTER ARM ASM - 700 MM

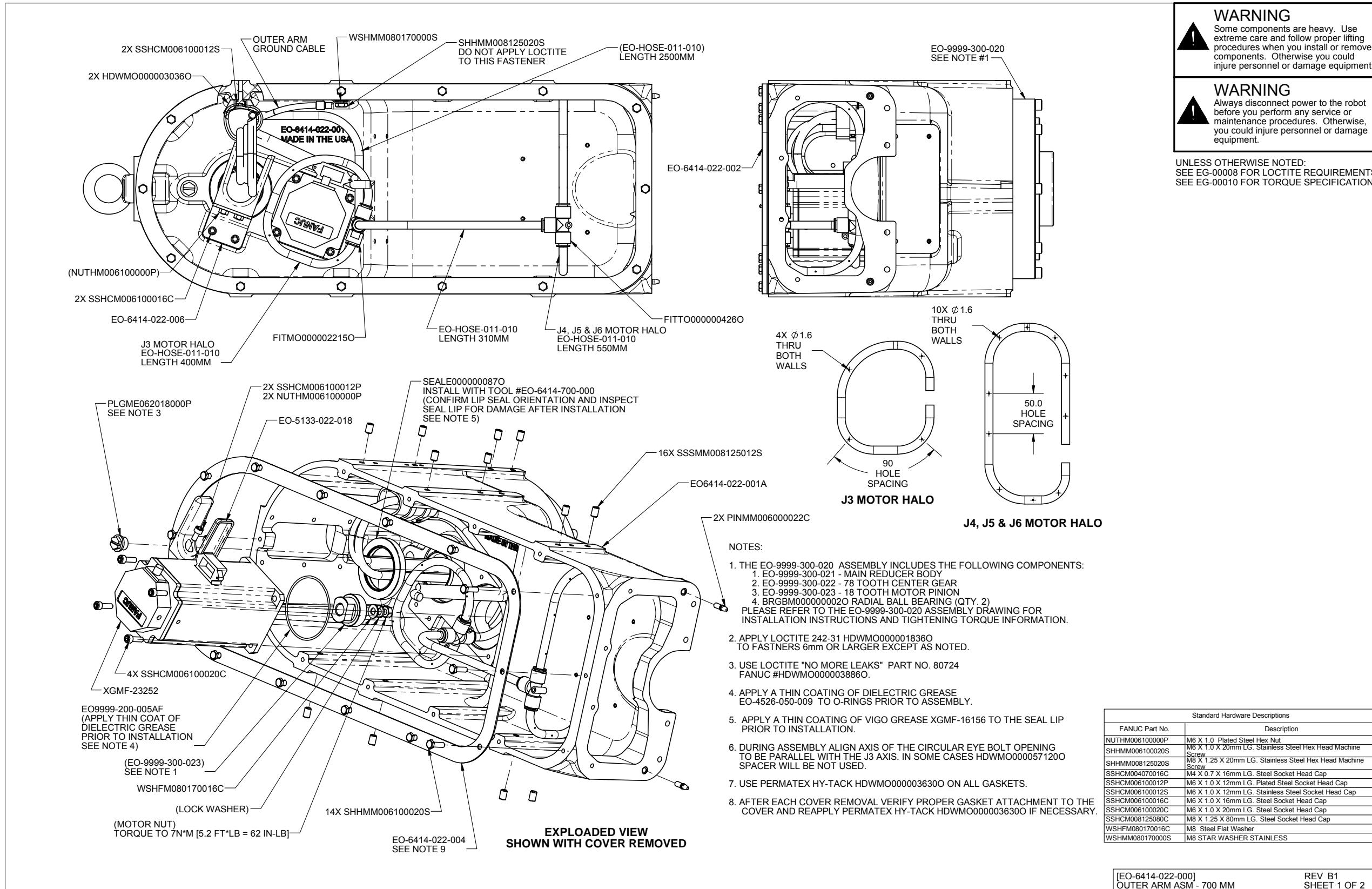


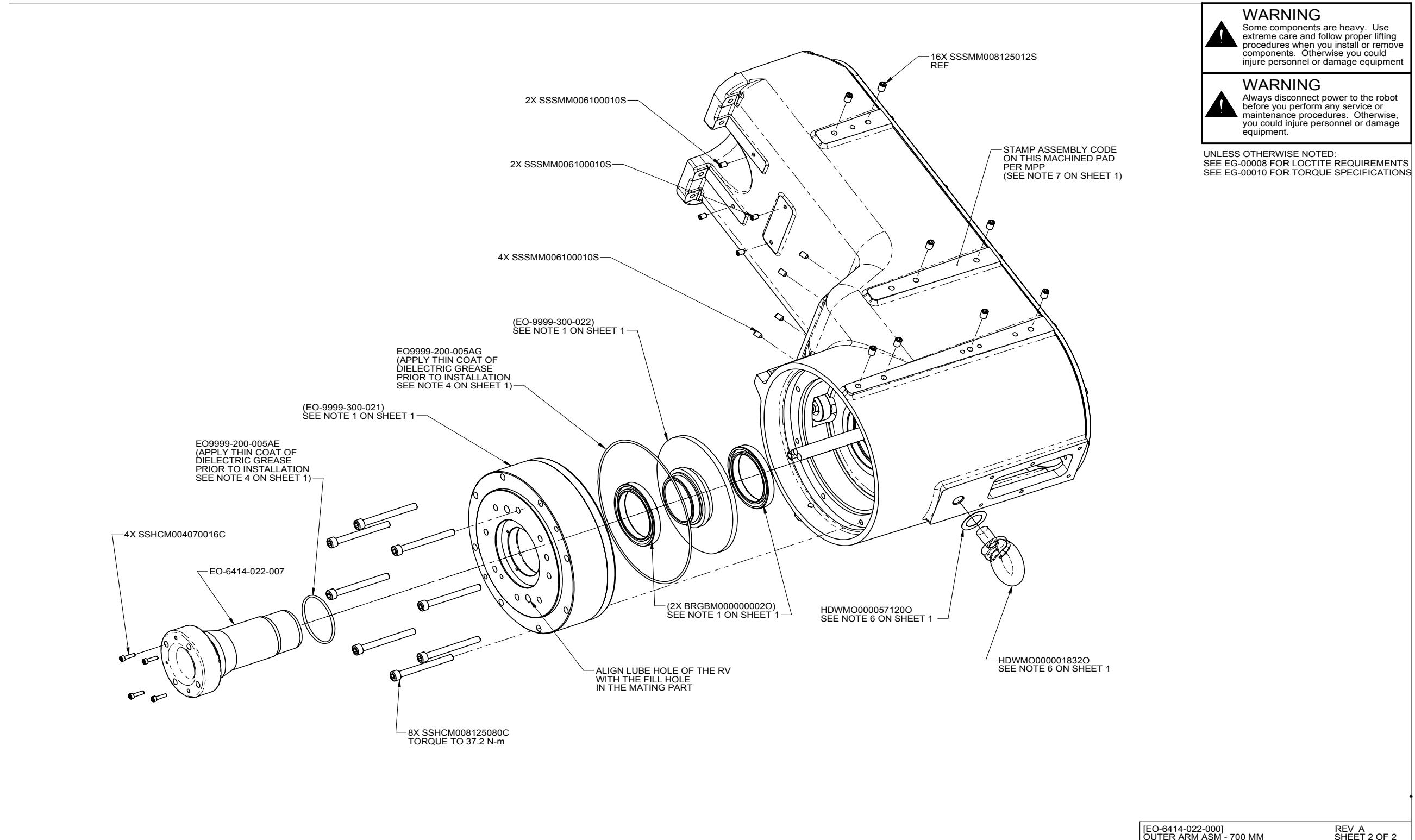
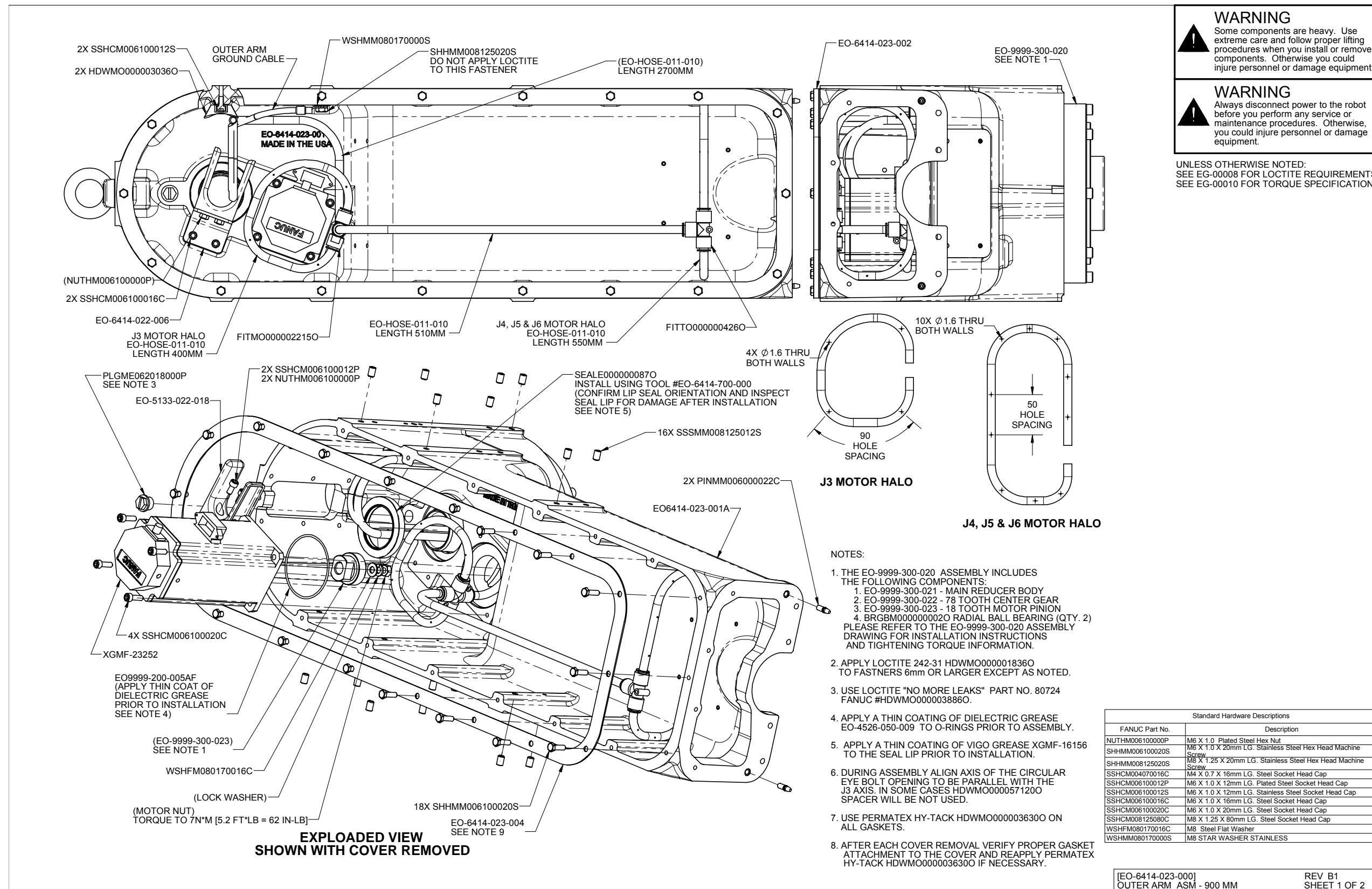
Figure 5-3 EO-6414-022-000 Sheet 2 of 2, OUTER ARM ASM - 700 MM

Figure 5-4 EO-6414-023-000 Sheet 1 of 2, OUTER ARM ASM - 900 MM



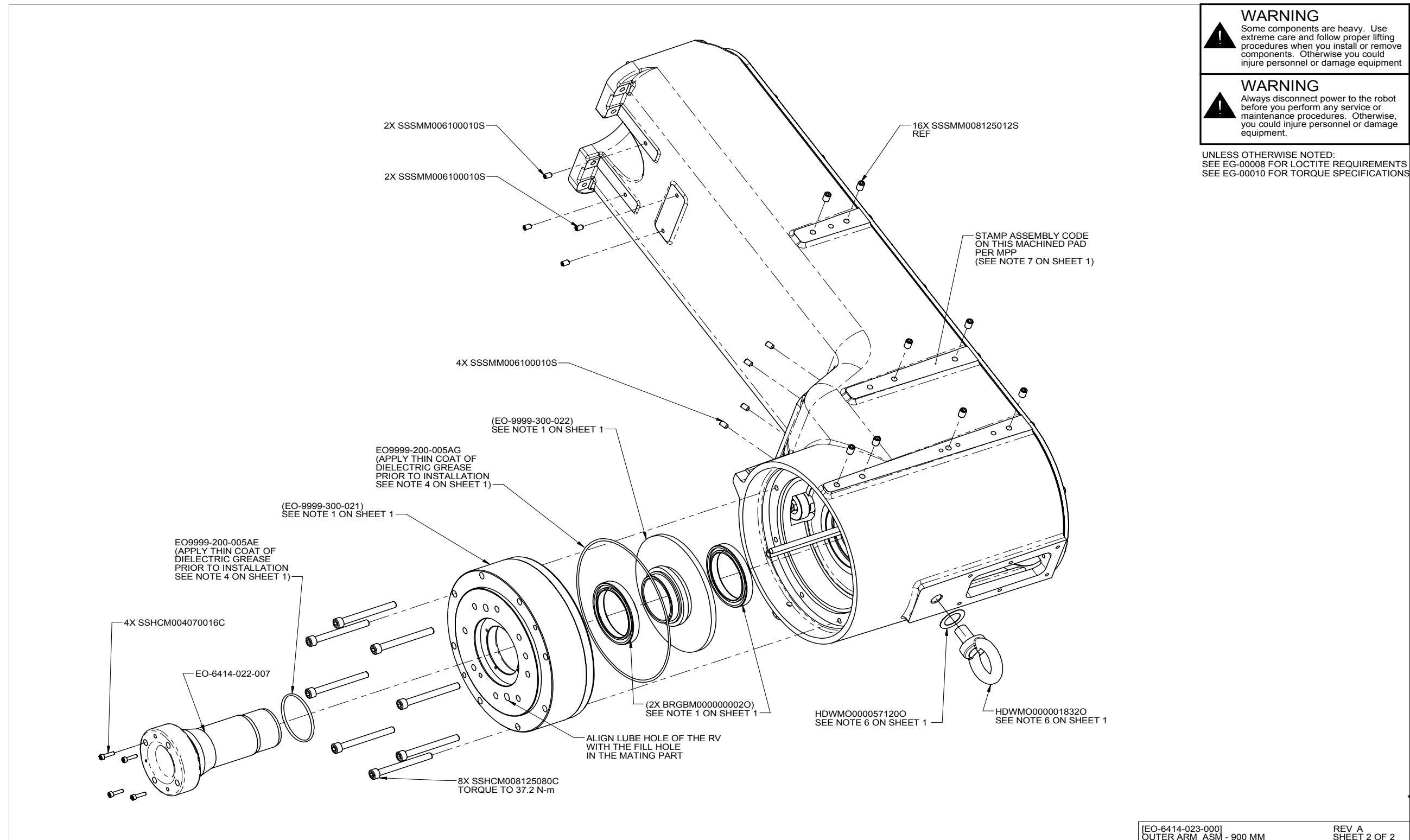
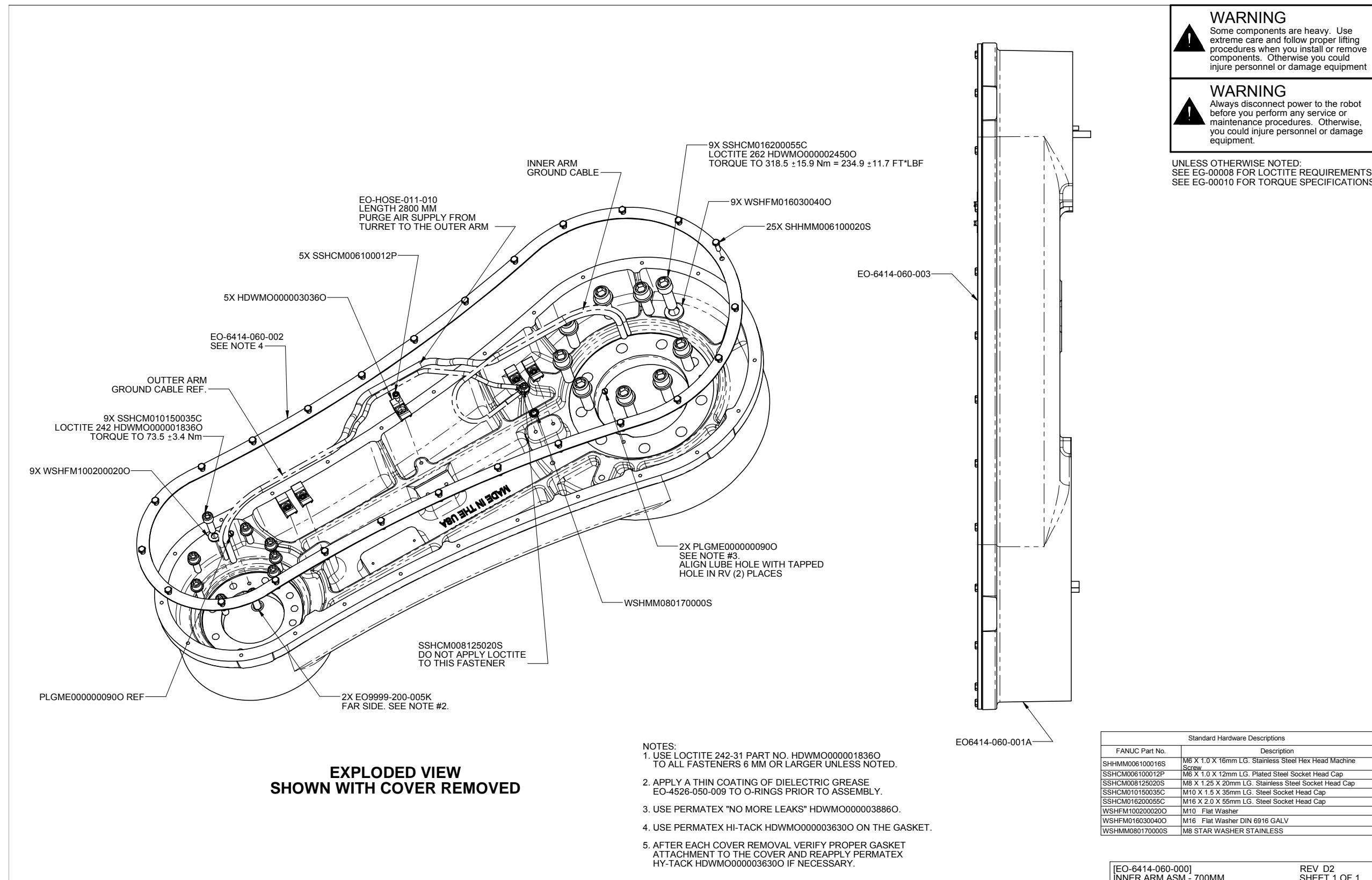
**Figure 5-5 EO-6414-023-000 Sheet 2 of 2, OUTER ARM ASM - 900 MM**

Figure 5-6 EO-6414-060-000, INNER ARM ASM - 700MM

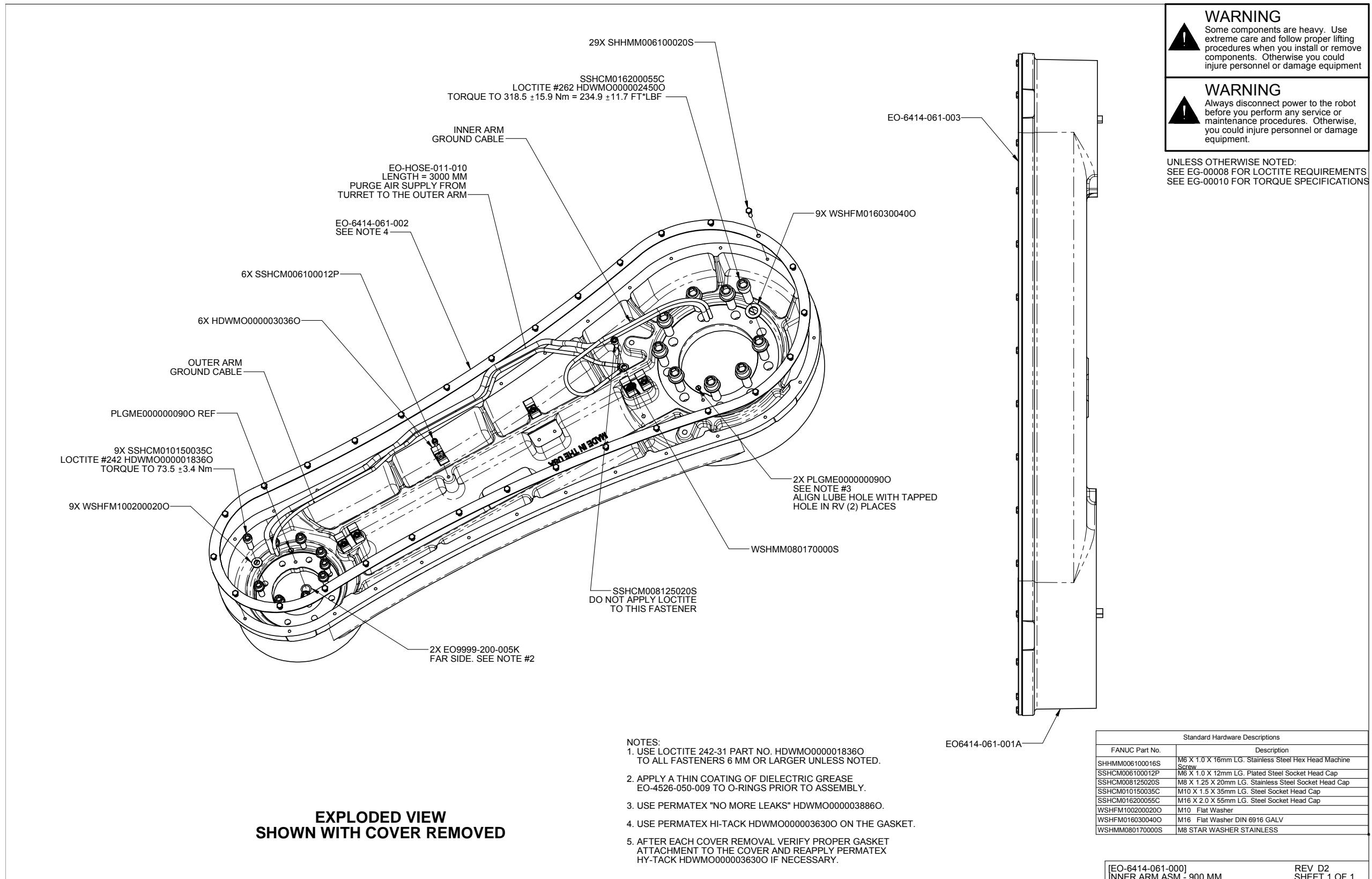
**Figure 5-7 EO-6414-061-000, INNER ARM ASM - 900 MM**

Figure 5-8 EO-6414-100-000 Sheet 1 of 4, TURRET ASSEMBLY

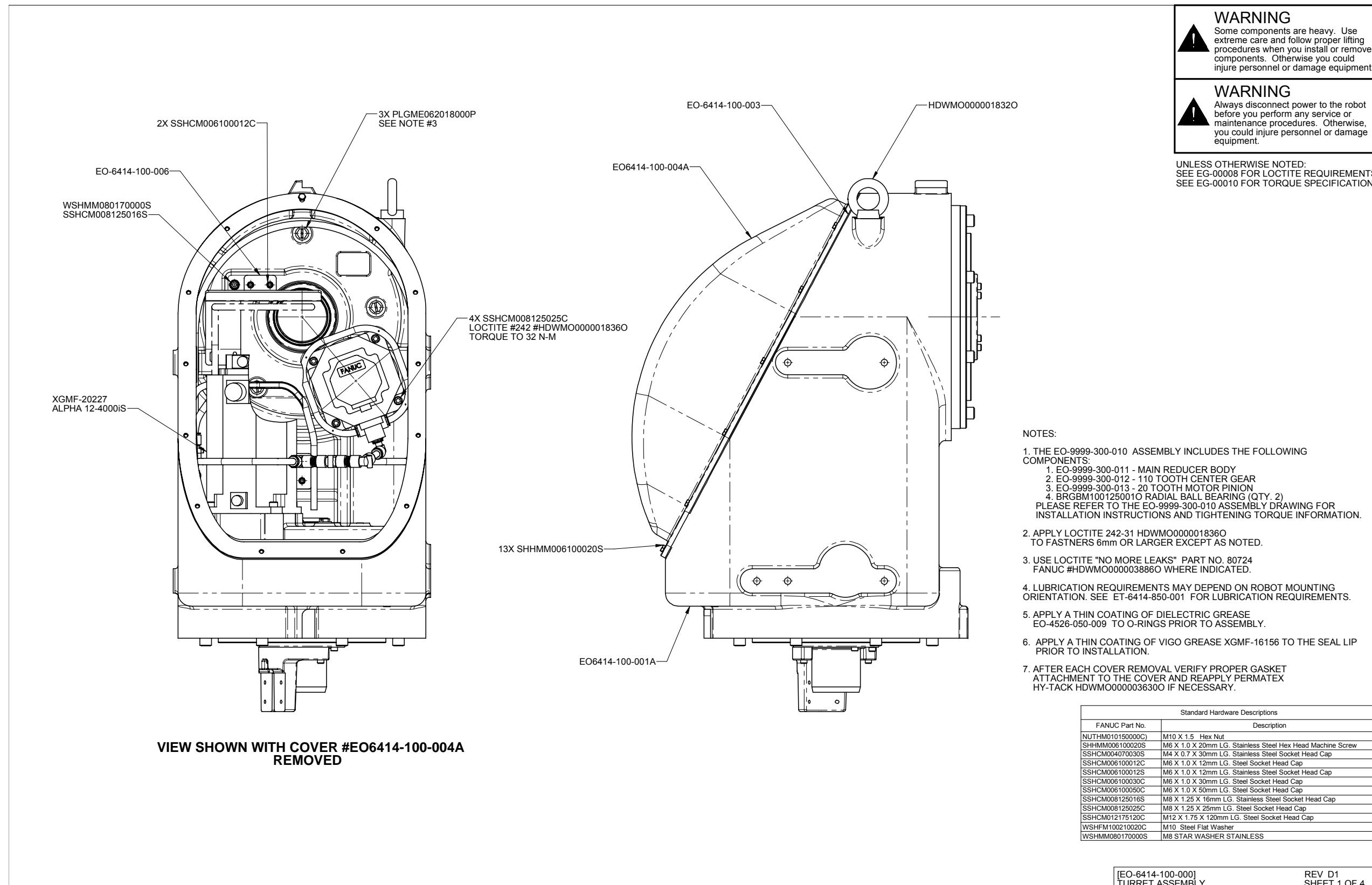
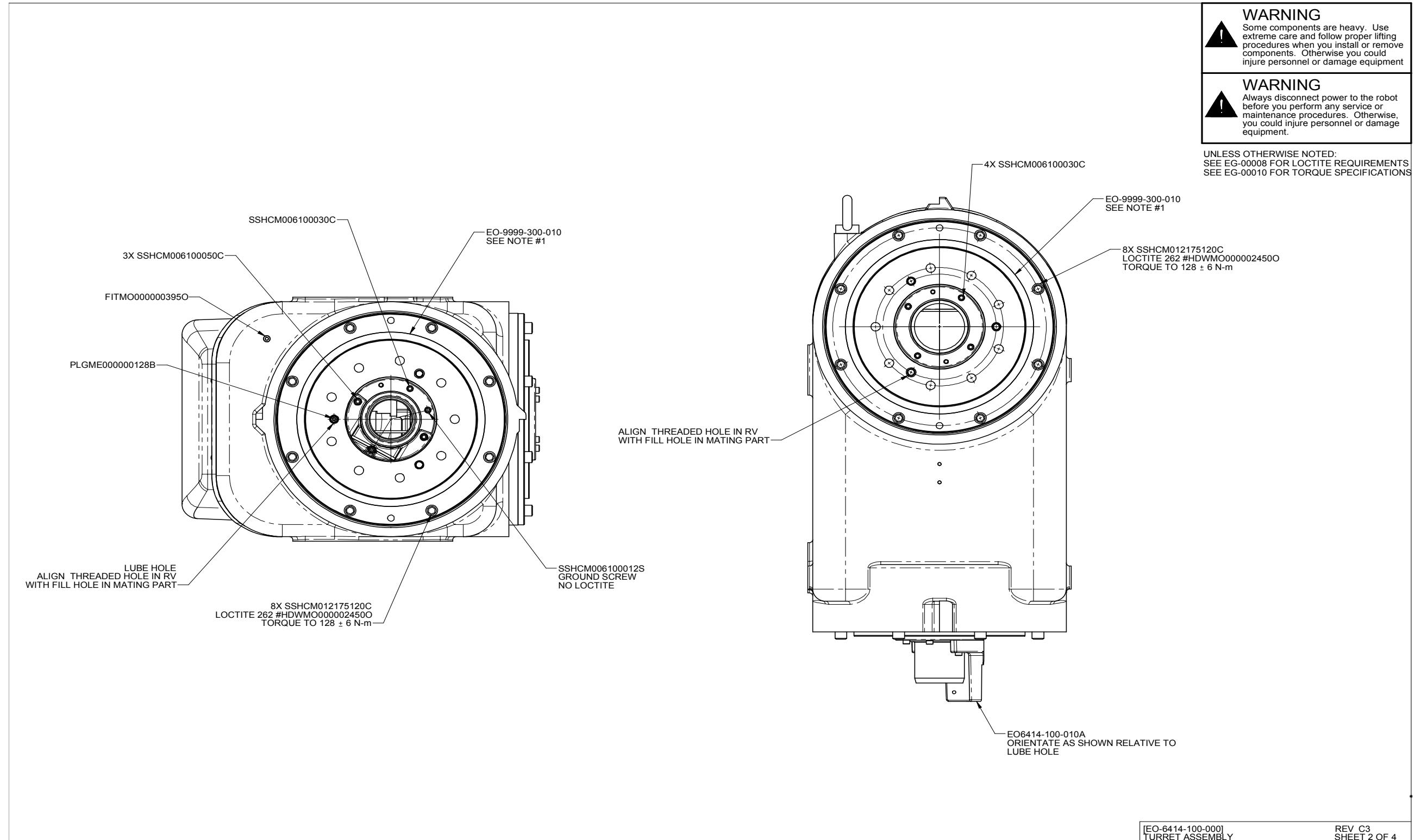
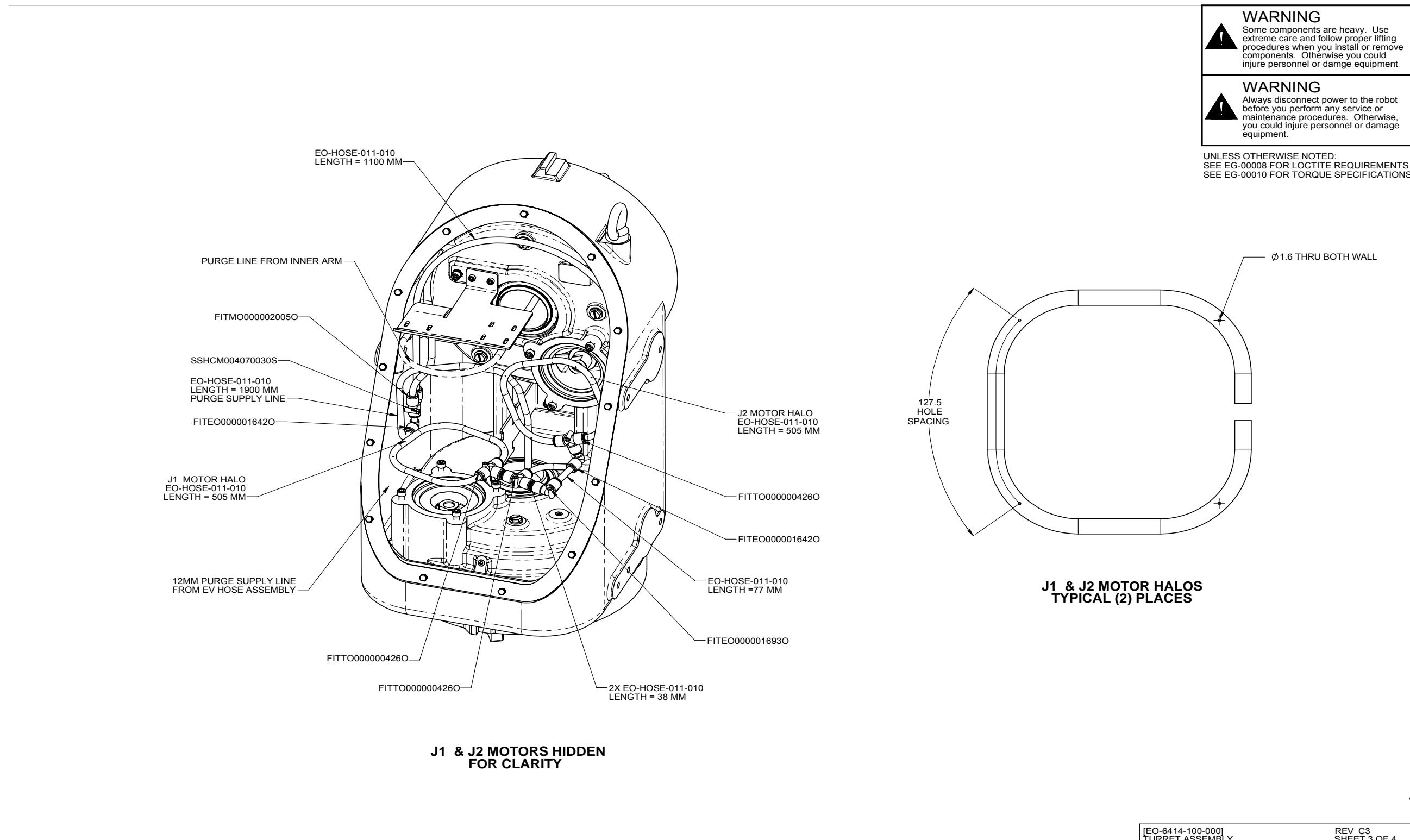
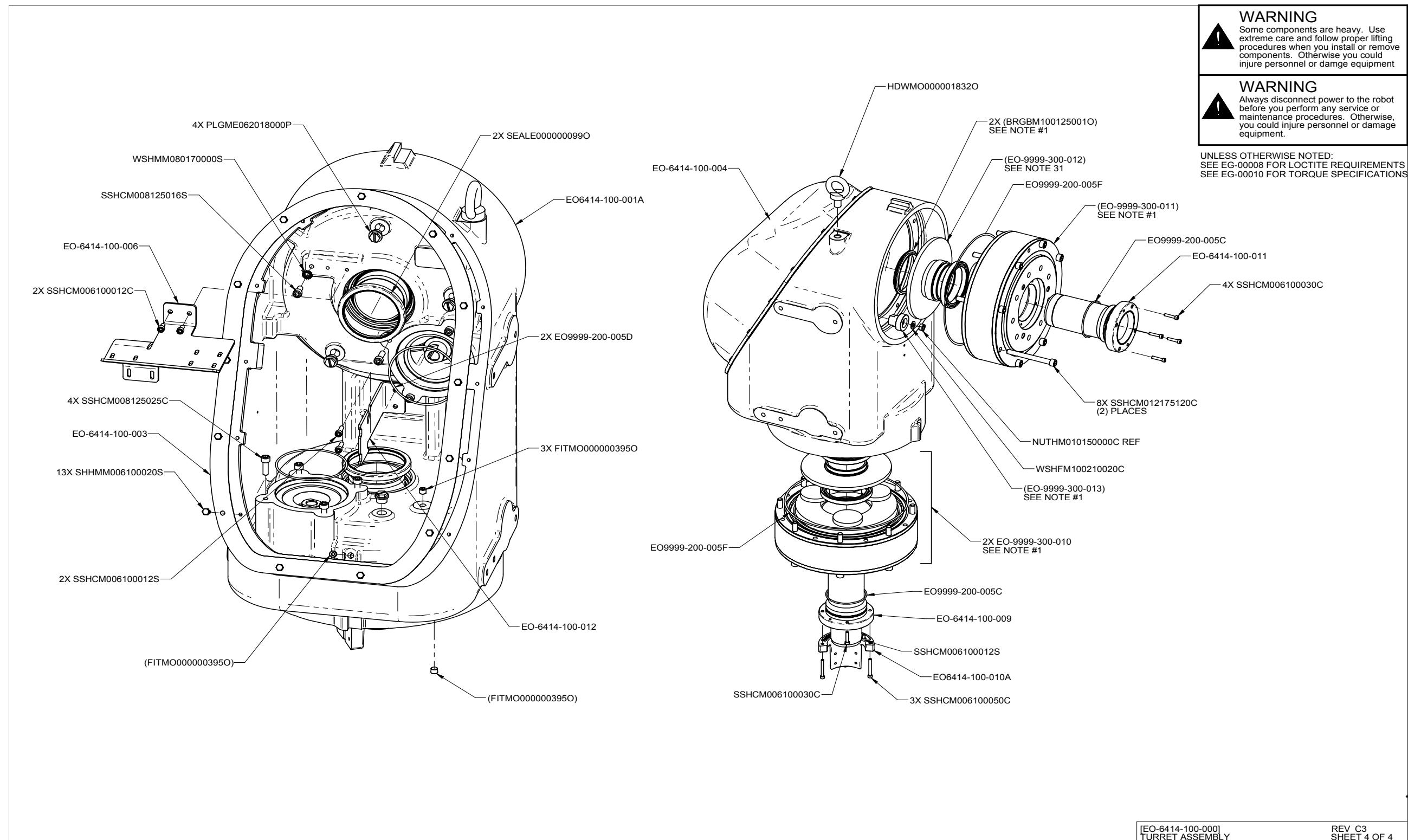
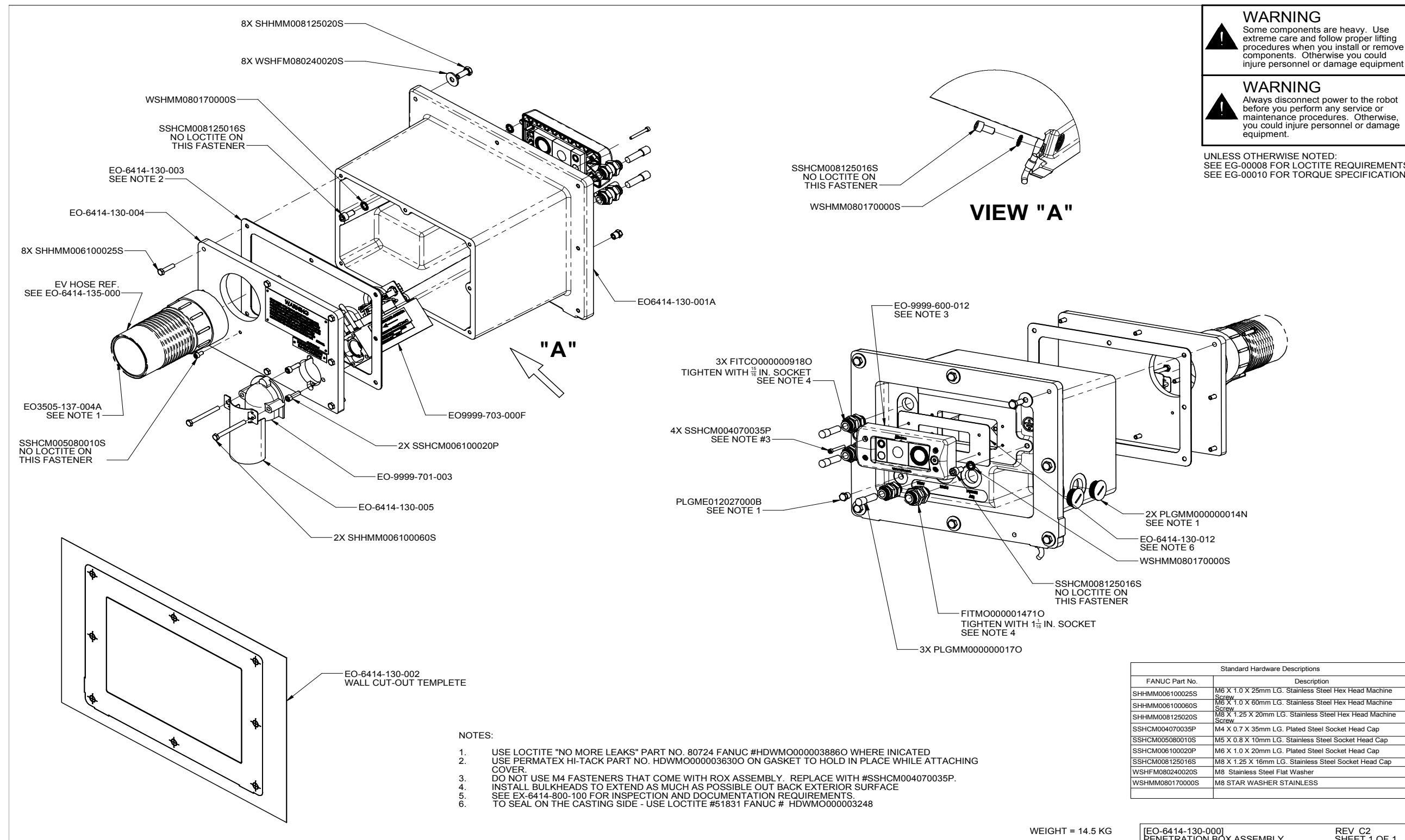


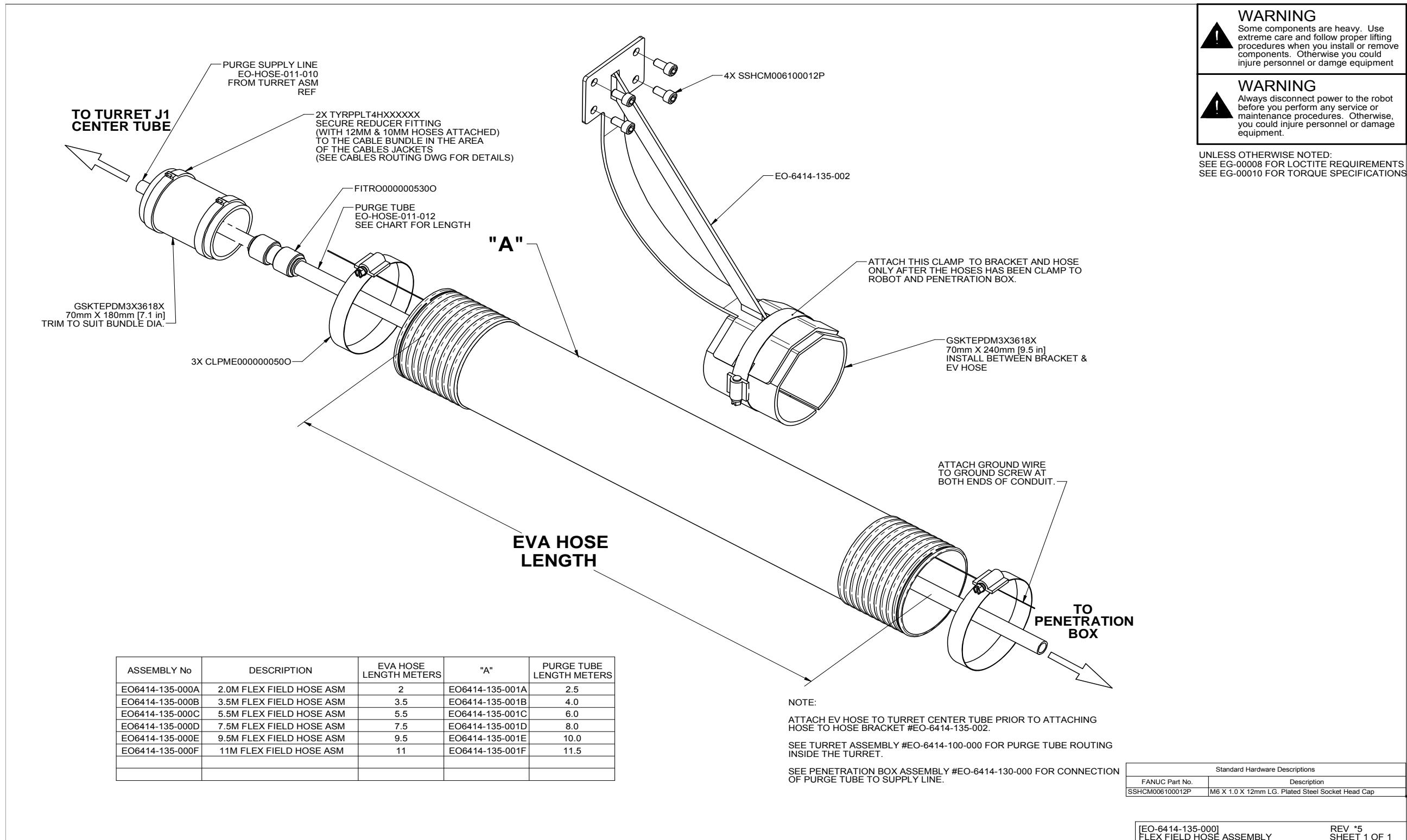
Figure 5-9 EO-6414-100-000 Sheet 2 of 4, TURRET ASSEMBLY

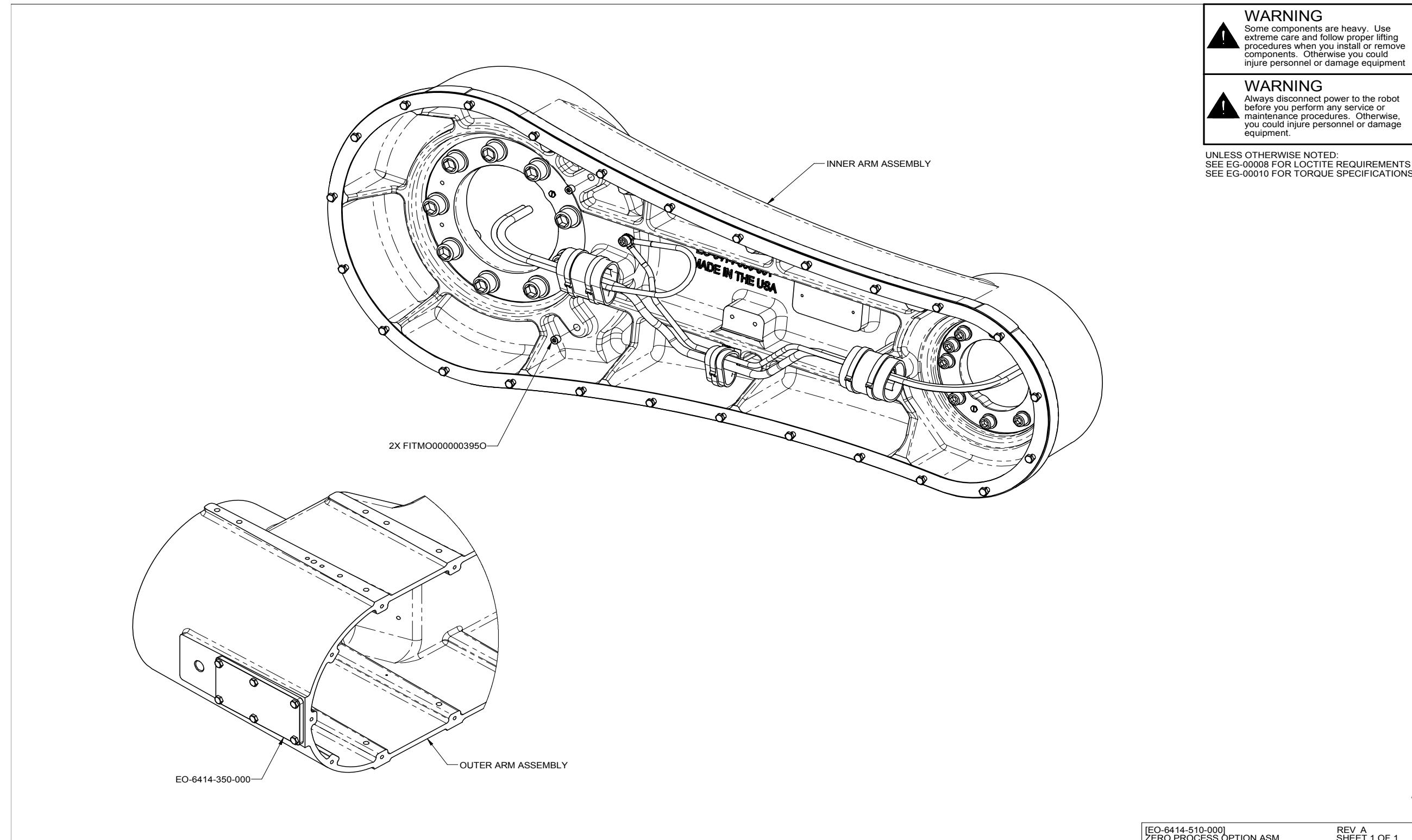


**Figure 5-10 EO-6414-100-000 Sheet 3 of 4, TURRET ASSEMBLY**

**Figure 5-11 EO-6414-100-000 Sheet 4 of 4, TURRET ASSEMBLY**

**Figure 5-12 EO-6414-130-000, PENETRATION BOX ASSEMBLY**

**Figure 5-13 EO-6414-135-000, FLEX FIELD HOSE ASSEMBLY**

**Figure 5-14 EO-6414-510-000, ZERO PROCESS OPTION ASM**

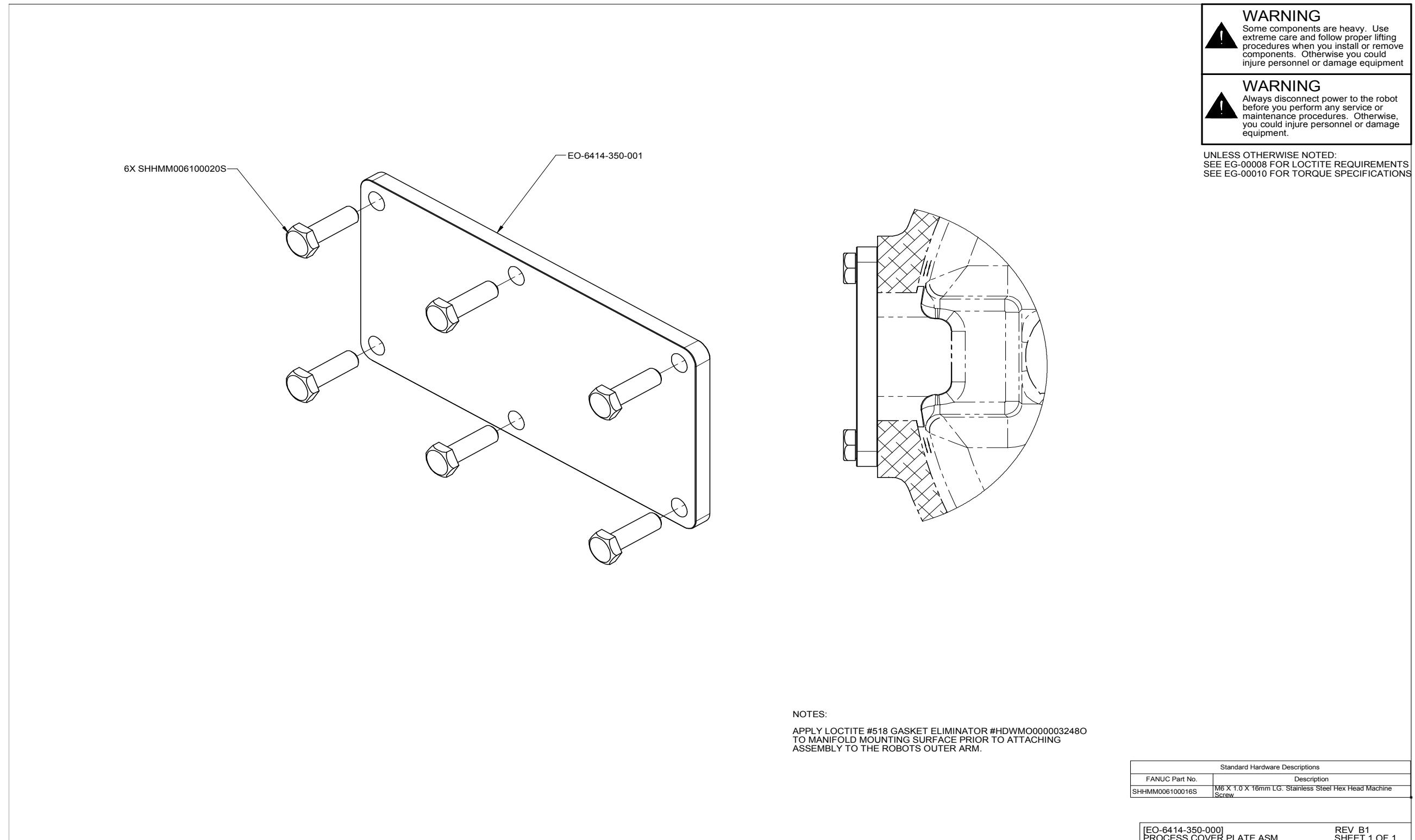
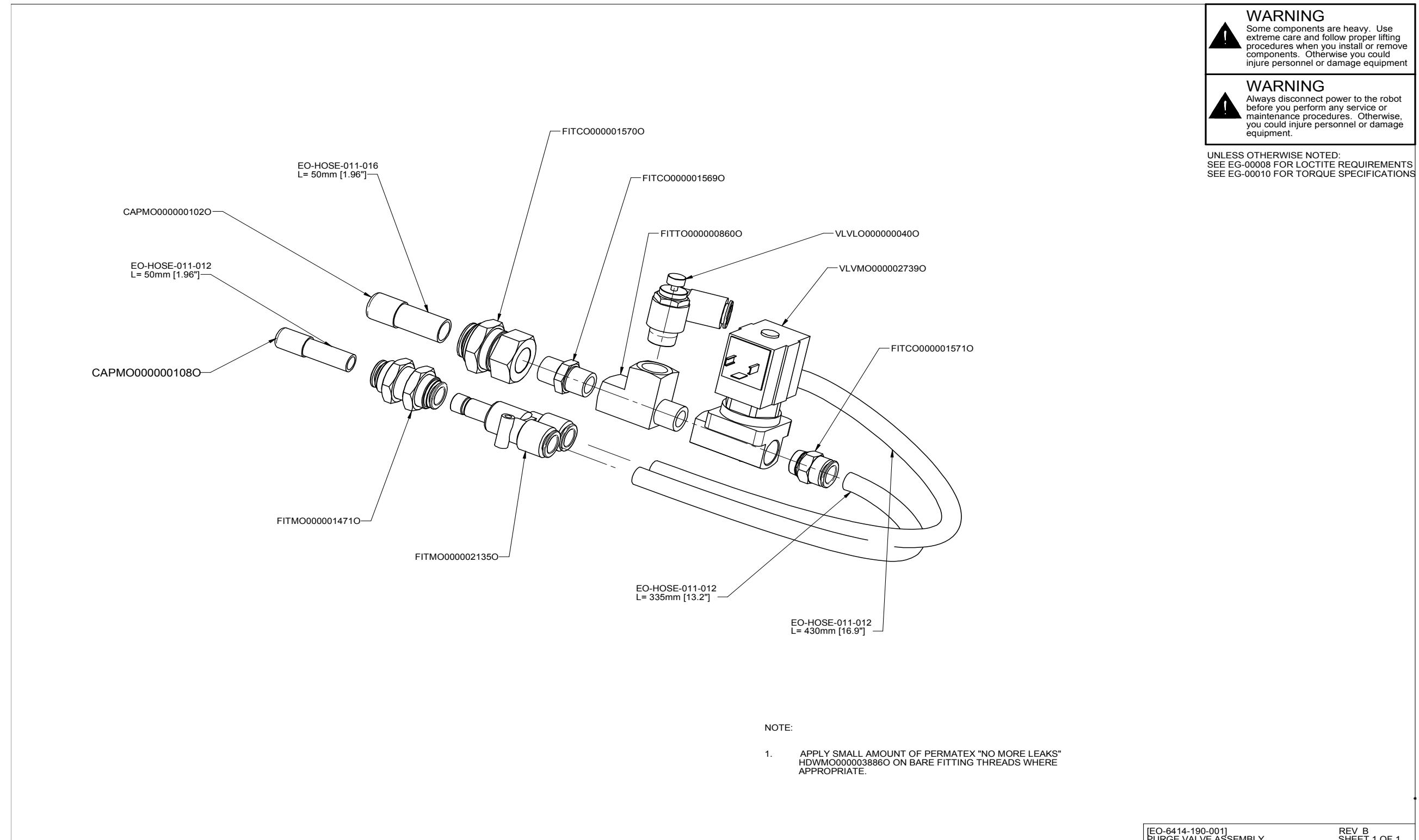
**Figure 5-15 EO-6414-350-000, PROCESS COVER PLATE ASM**

Figure 5-16 EO-6414-190-001, PURGE VALVE ASSEMBLY

### 5.1.2 Optional Assemblies

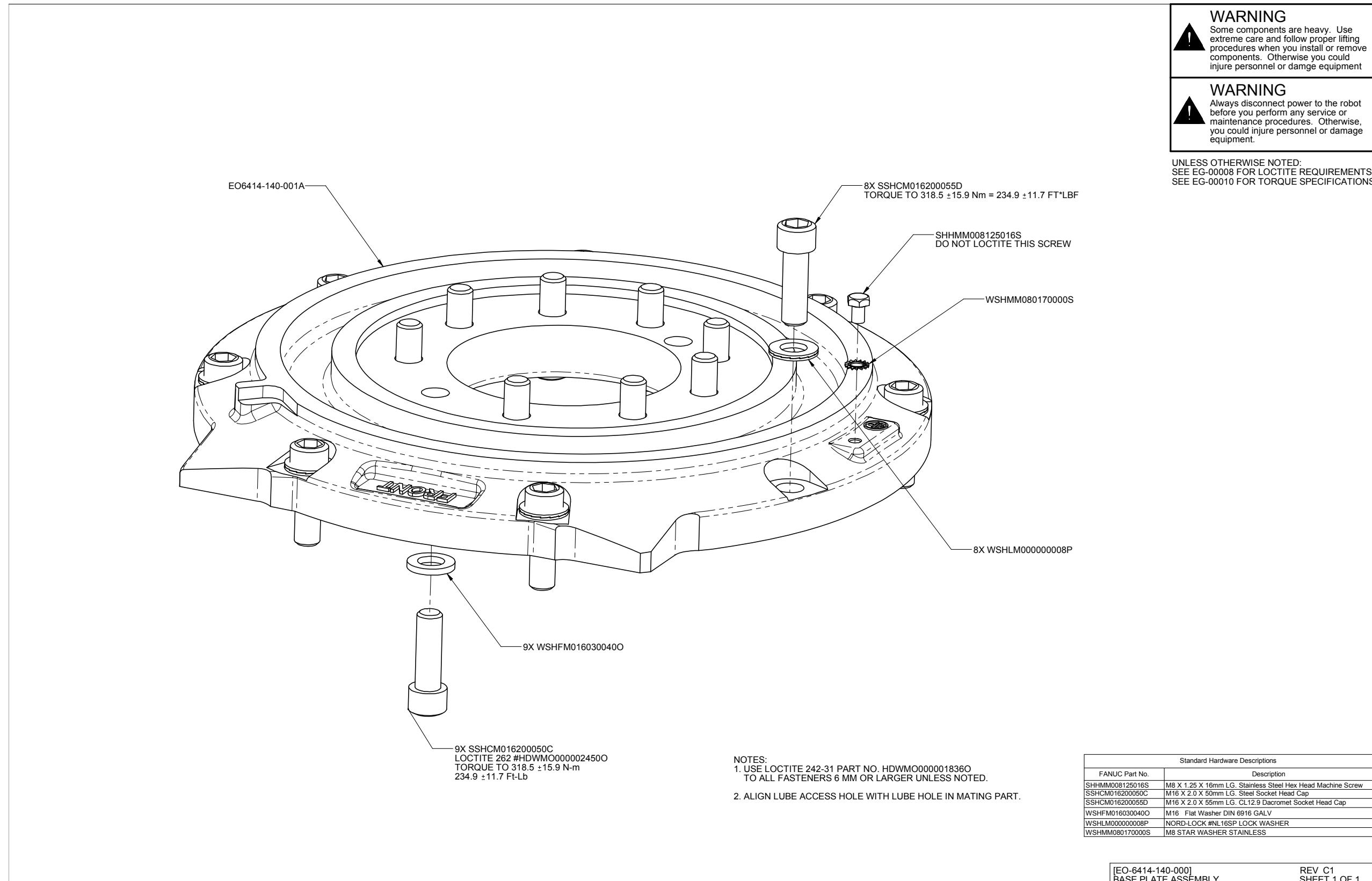
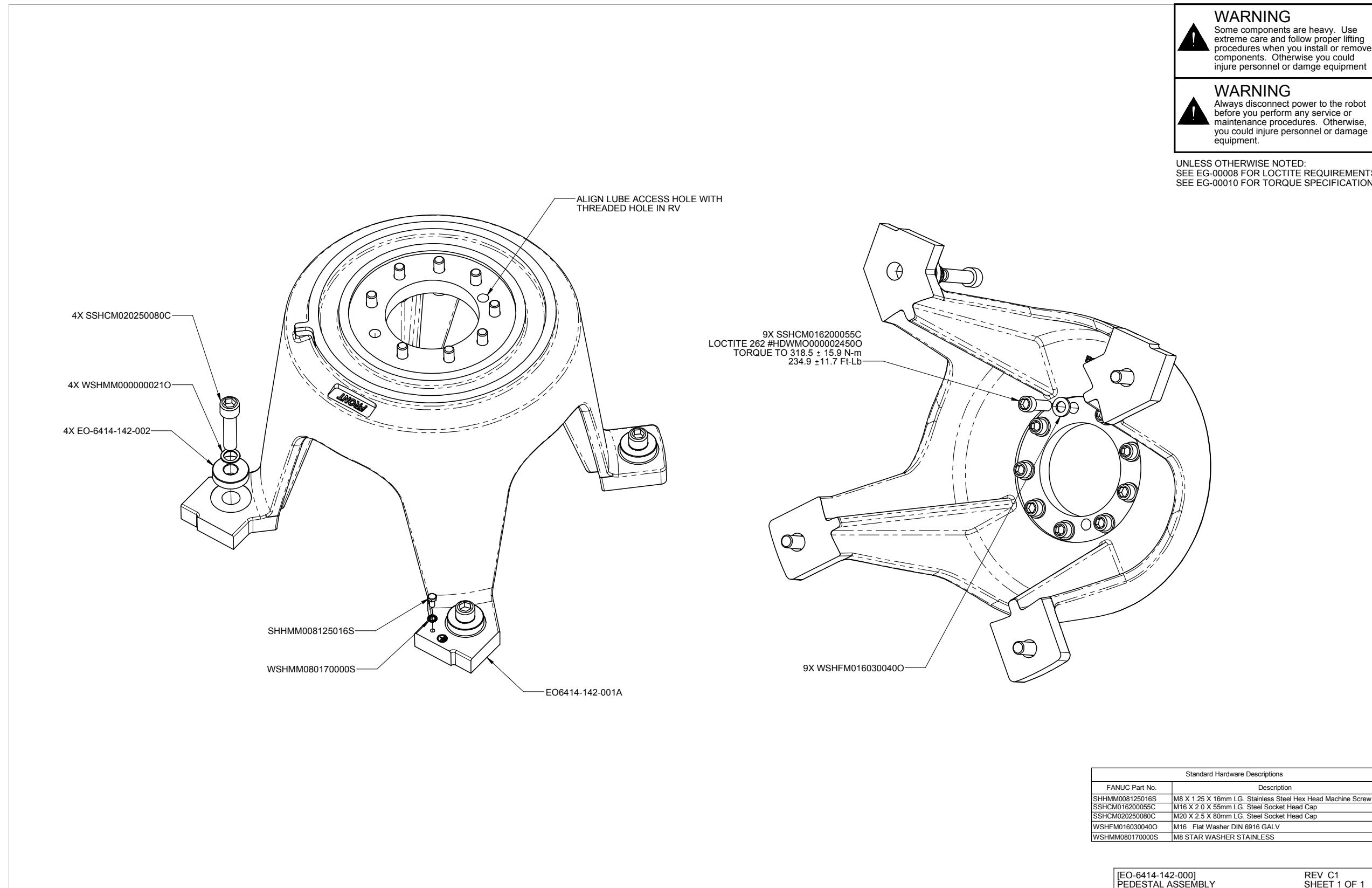
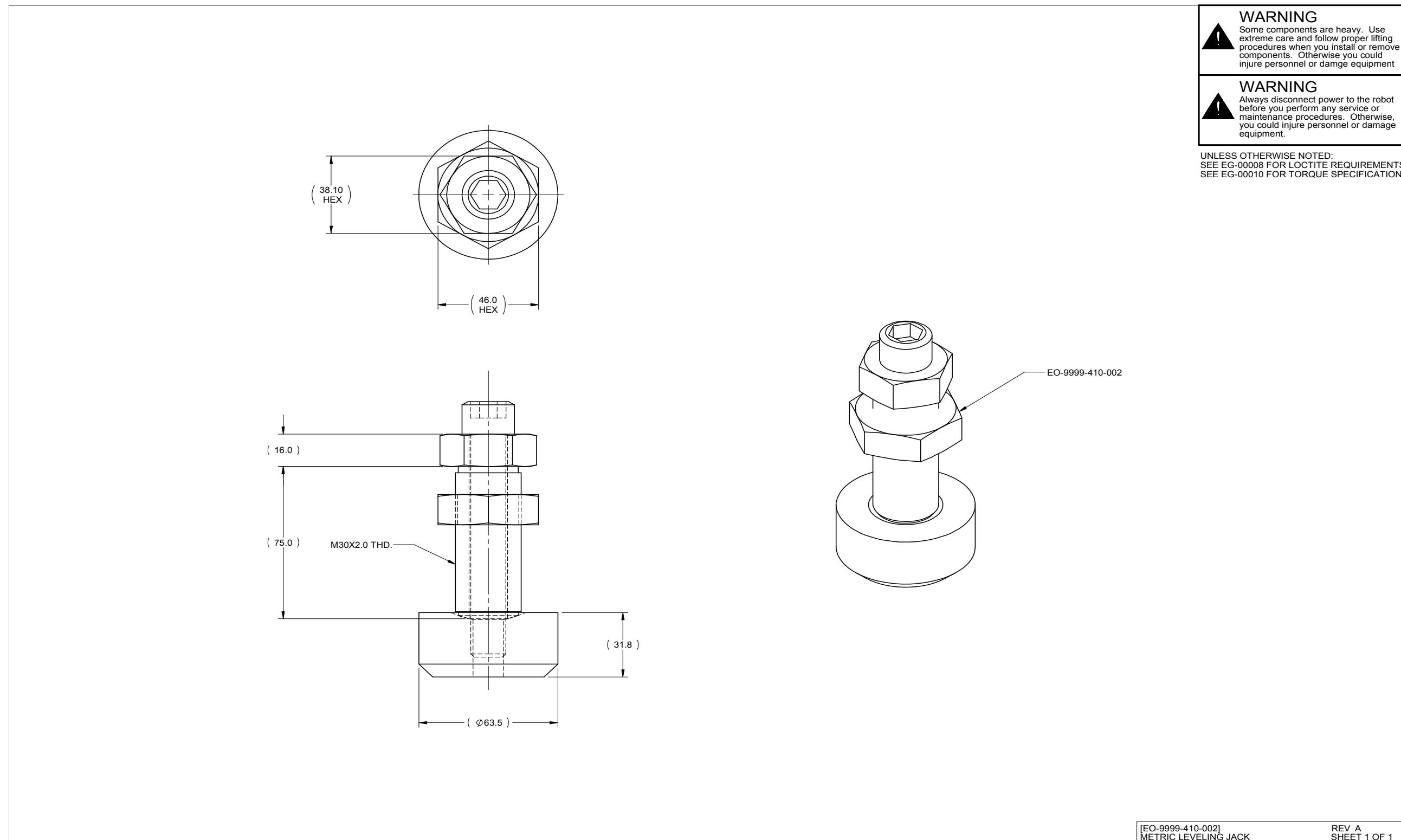
Figure 5-17 EO-6414-140-000, BASE PLATE ASSEMBLY

Figure 5-18 EO-6414-142-000, PEDESTAL ASSEMBLY

**Figure 5-19 EO-9999-410-002, METRIC LEVELING JACK**

### 5.1.3 Process

**Figure 5-20 EO-6414-511-000 Sheet 1 of 4, PROCESS OPTION HARDWARE**

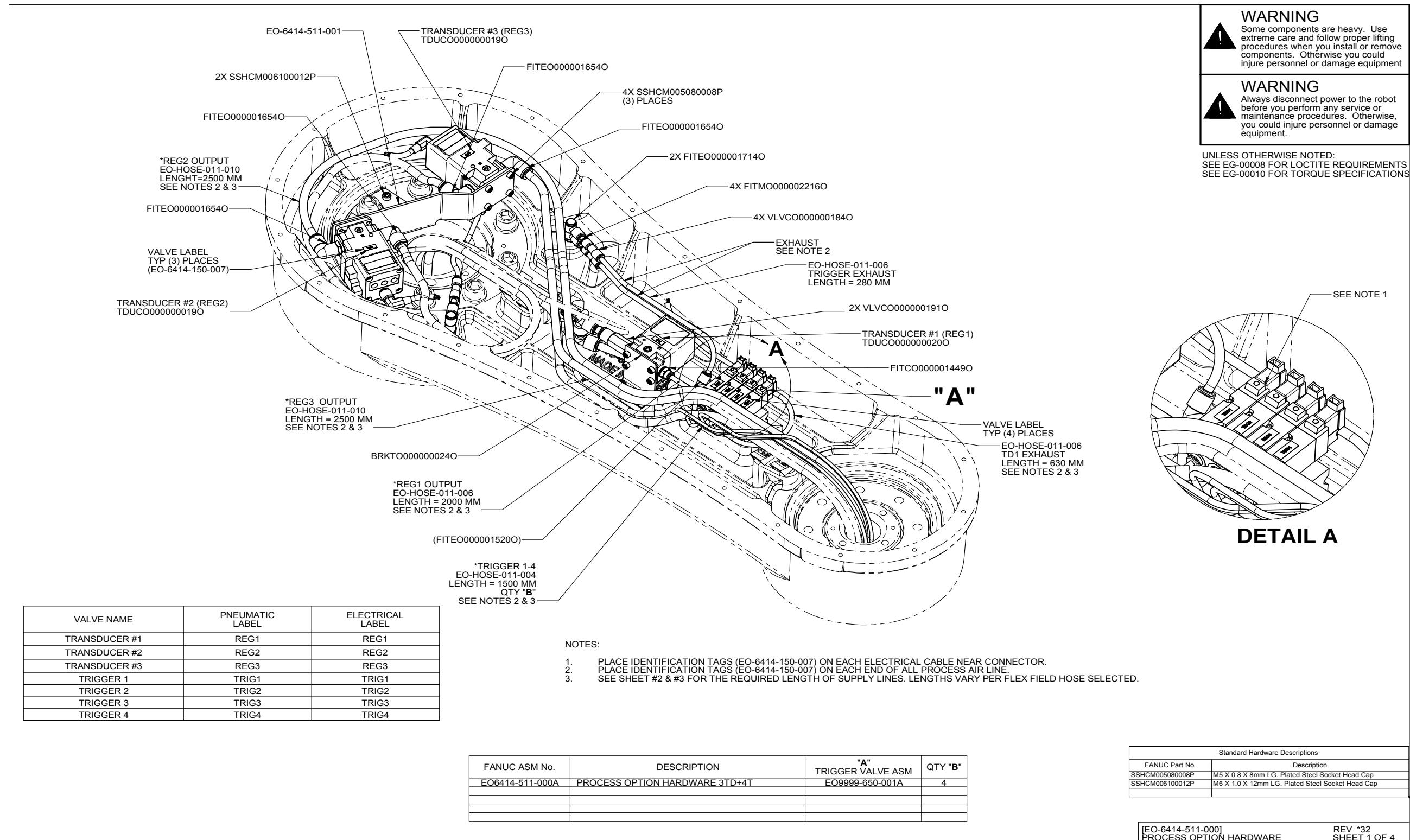
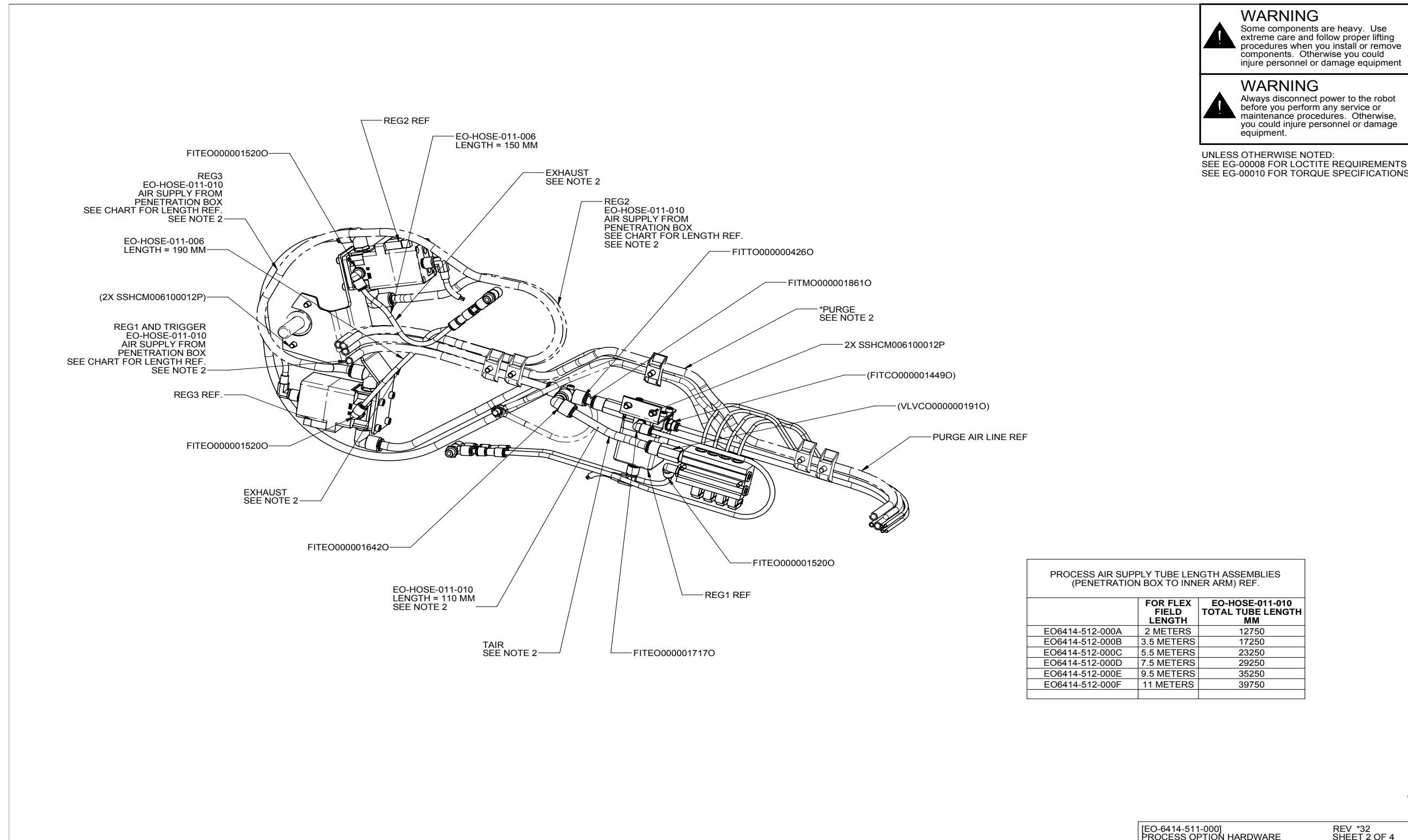
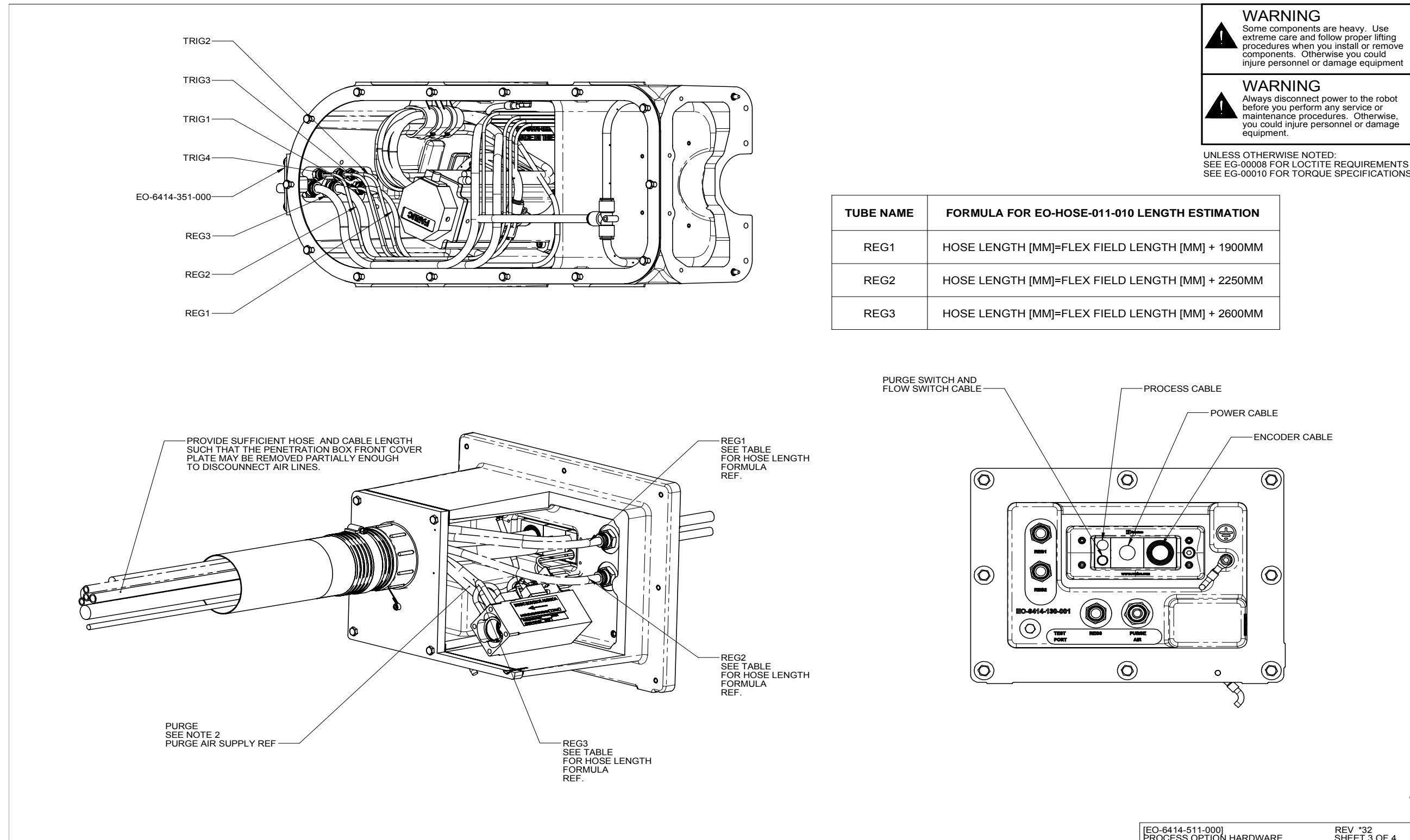


Figure 5-21 EO-6414-511-000 Sheet 2 of 4, PROCESS OPTION HARDWARE



**Figure 5-22 EO-6414-511-000 Sheet 3 of 4, PROCESS OPTION HARDWARE**

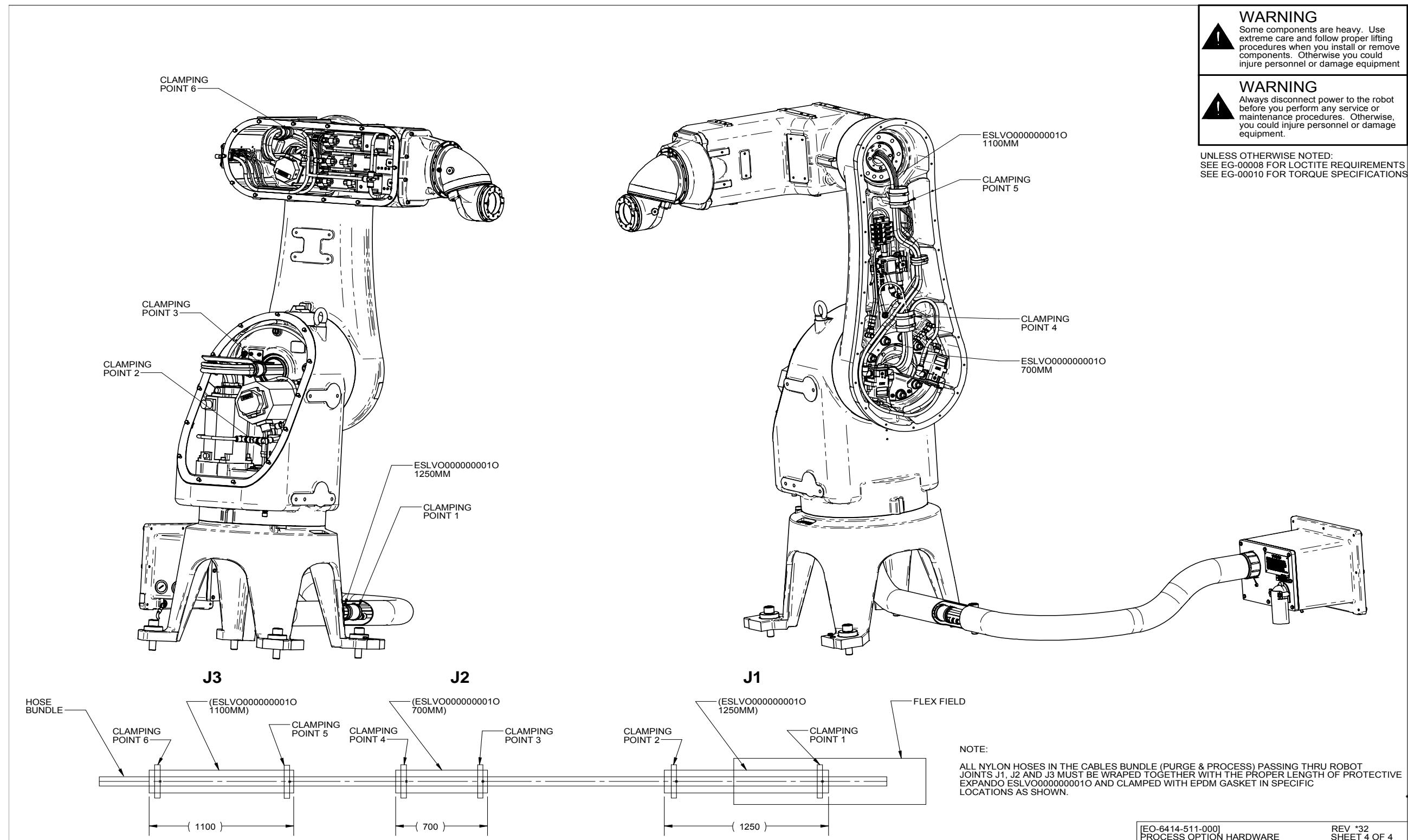
**Figure 5-23 EO-6414-511-000 Sheet 4 of 4, PROCESS OPTION HARDWARE**

Figure 5-24 EO-6414-512-000, PROCESS AIR SUPPLY ASM

FANUC ASM No.	DESCRIPTION	EO-HOSE-011-010
		TOTAL TUBE LENGTH MM
EO6414-512-000A	PROC AIR SUPPLY ASM - 2M	12750
EO6414-512-000B	PROC AIR SUPPLY ASM - 3.5M	17250
EO6414-512-000C	PROC AIR SUPPLY ASM - 5.5M	23250
EO6414-512-000D	PROC AIR SUPPLY ASM - 7.5M	29250
EO6414-512-000E	PROC AIR SUPPLY ASM - 9.5M	35250
EO6414-512-000F	PROC AIR SUPPLY ASM - 11M	39750

**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.

UNLESS OTHERWISE NOTED:  
SEE EG-00008 FOR LOCTITE REQUIREMENTS  
SEE EG-00010 FOR TORQUE SPECIFICATIONS

NOTE:  
SEE EO-6414-511-000 DRAWING FOR APPLICATION.

[EO-6414-512-000]  
PROCESS AIR SUPPLY ASM

REV A  
SHEET 1 OF 1

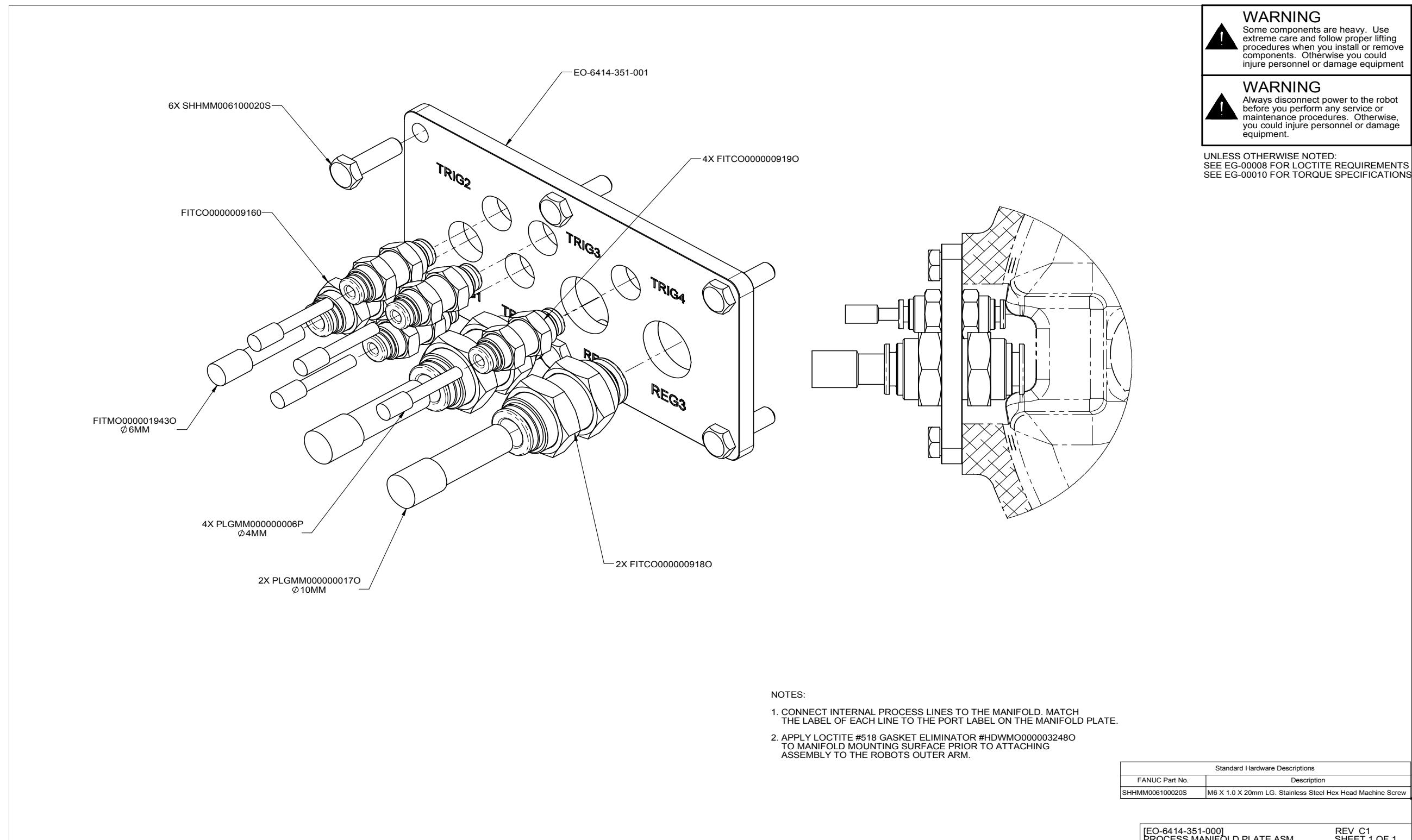
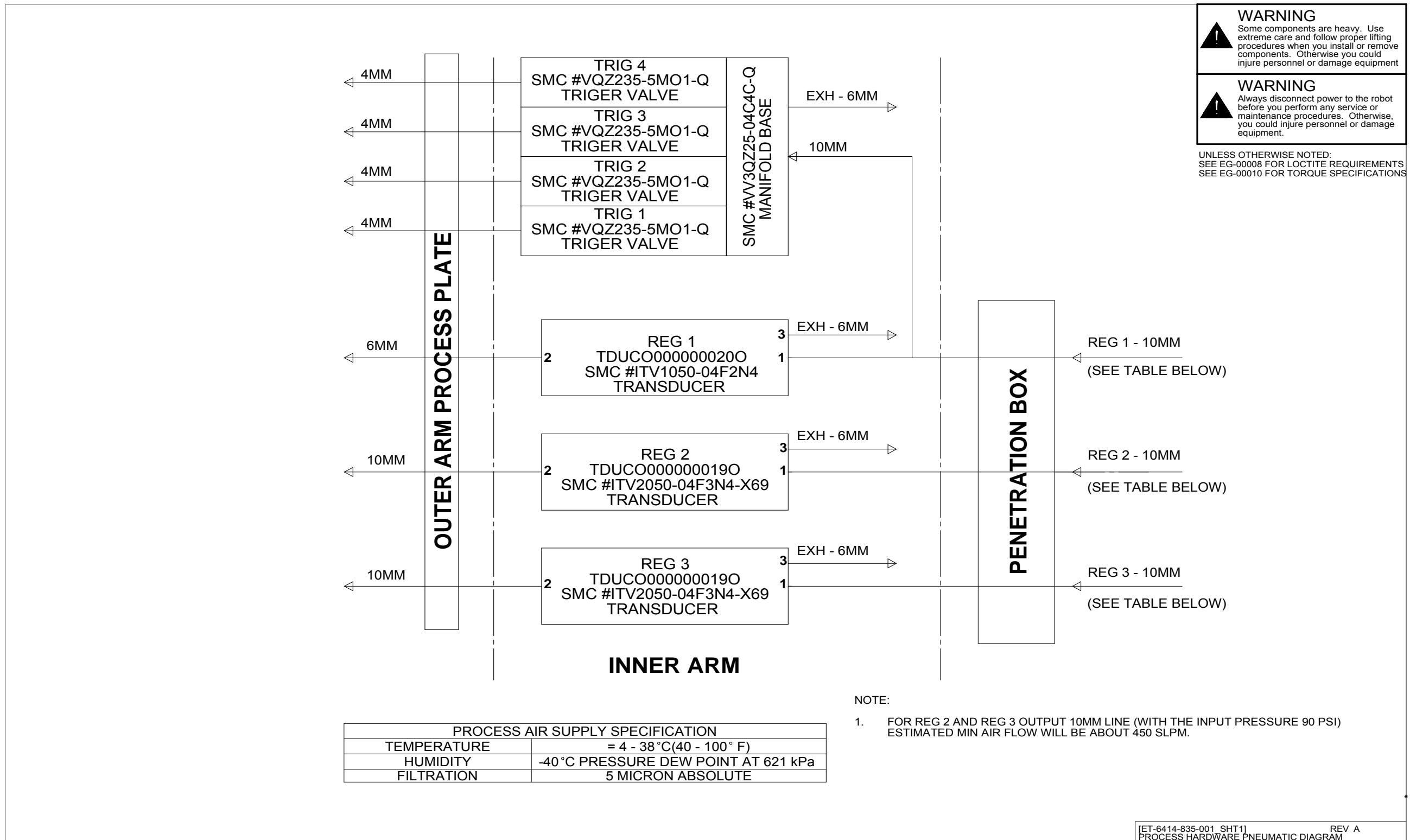
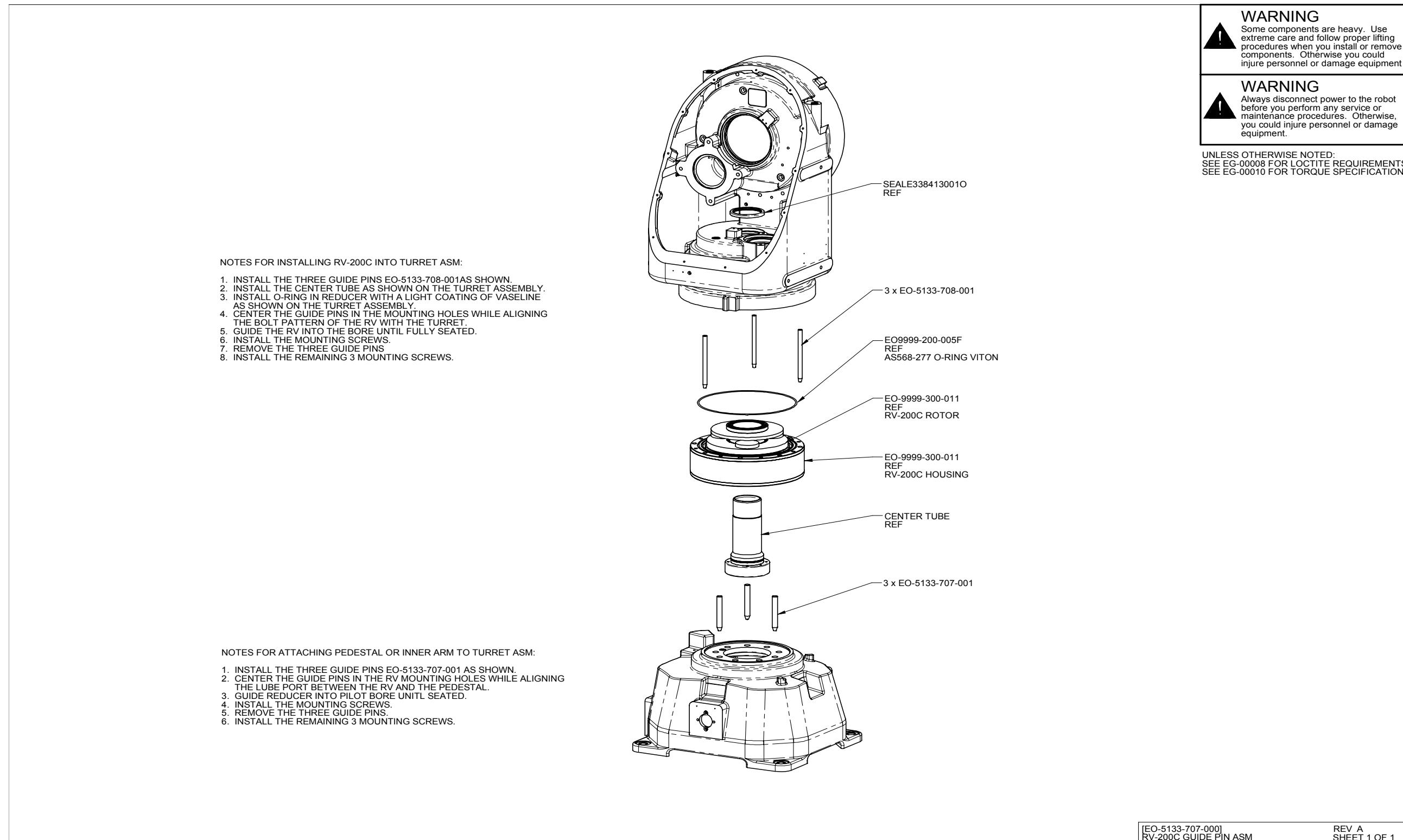
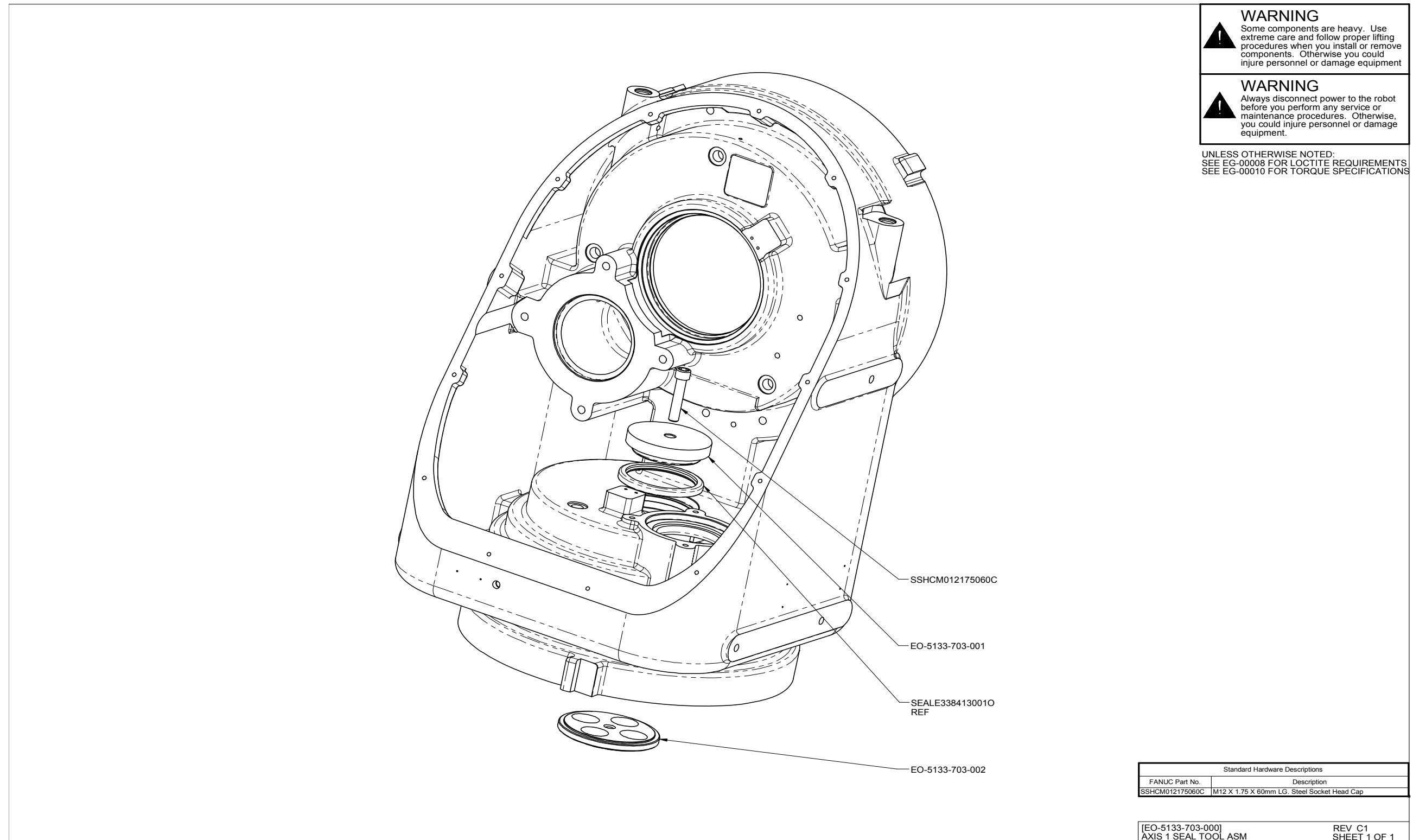
**Figure 5-25 EO-6414-351-000, PROCESS MANIFOLD PLATE ASM**

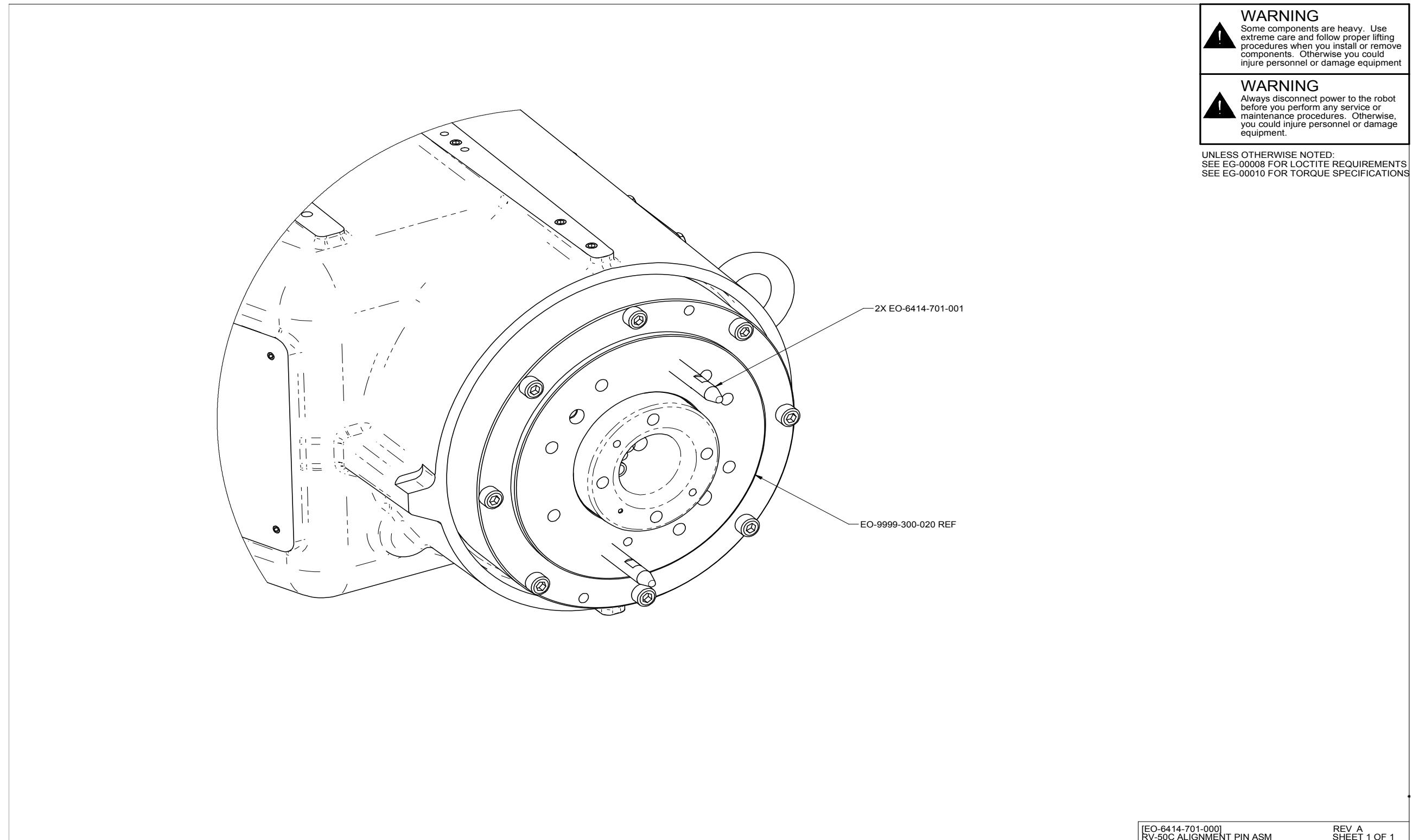
Figure 5-26 ET-6414-835-001 SHT1, PROCESS HARDWARE PNEUMATIC DIAGRAM

### 5.1.4 Tools for P-50iB Long & Short Arm Robots

**Figure 5-27 EO-5133-707-000, RV-200C GUIDE PIN ASM**



**Figure 5-28 EO-5133-703-000, AXIS 1 SEAL TOOL ASM**

**Figure 5-29 EO-6414-701-000, RV-50C ALIGNMENT PIN ASM**

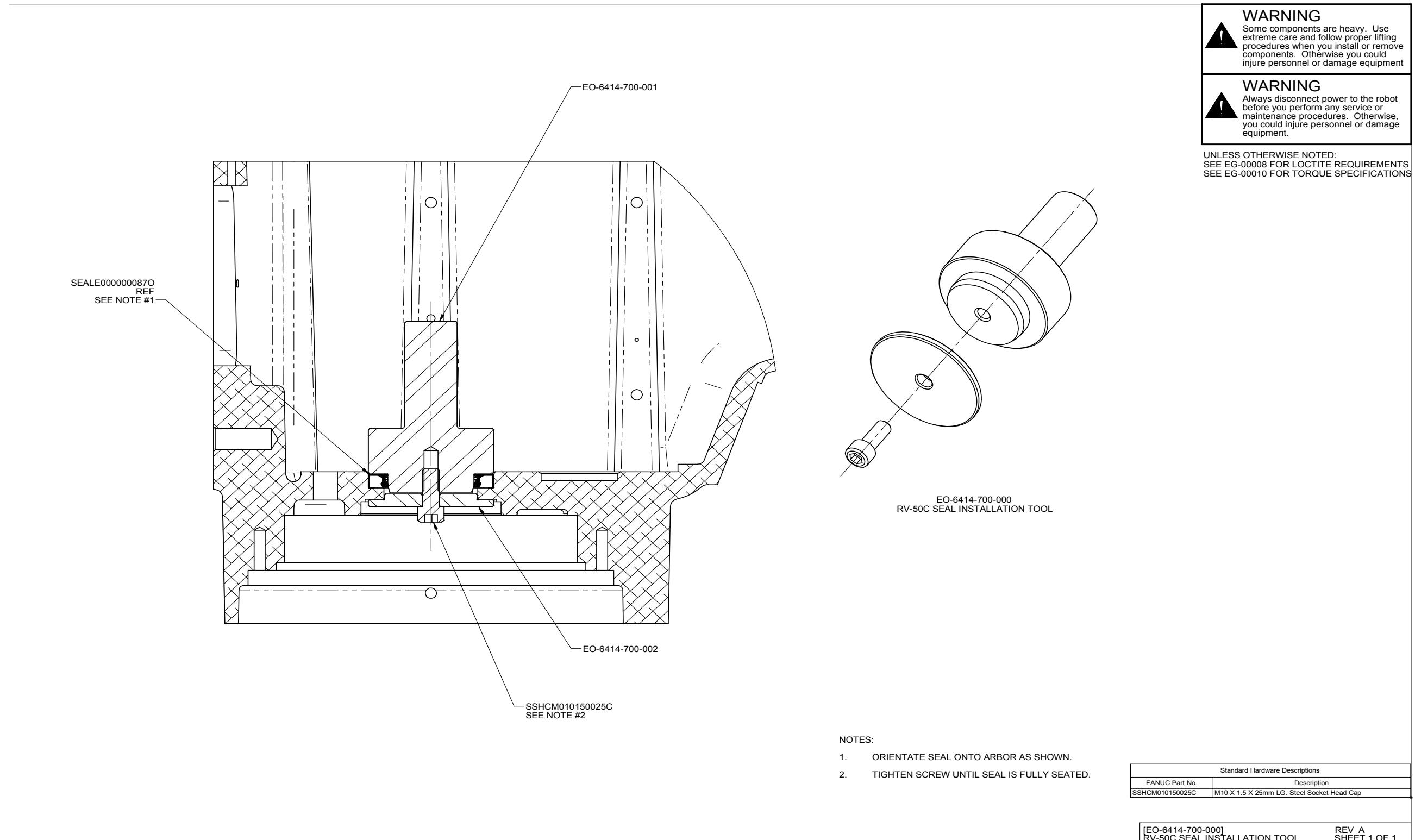
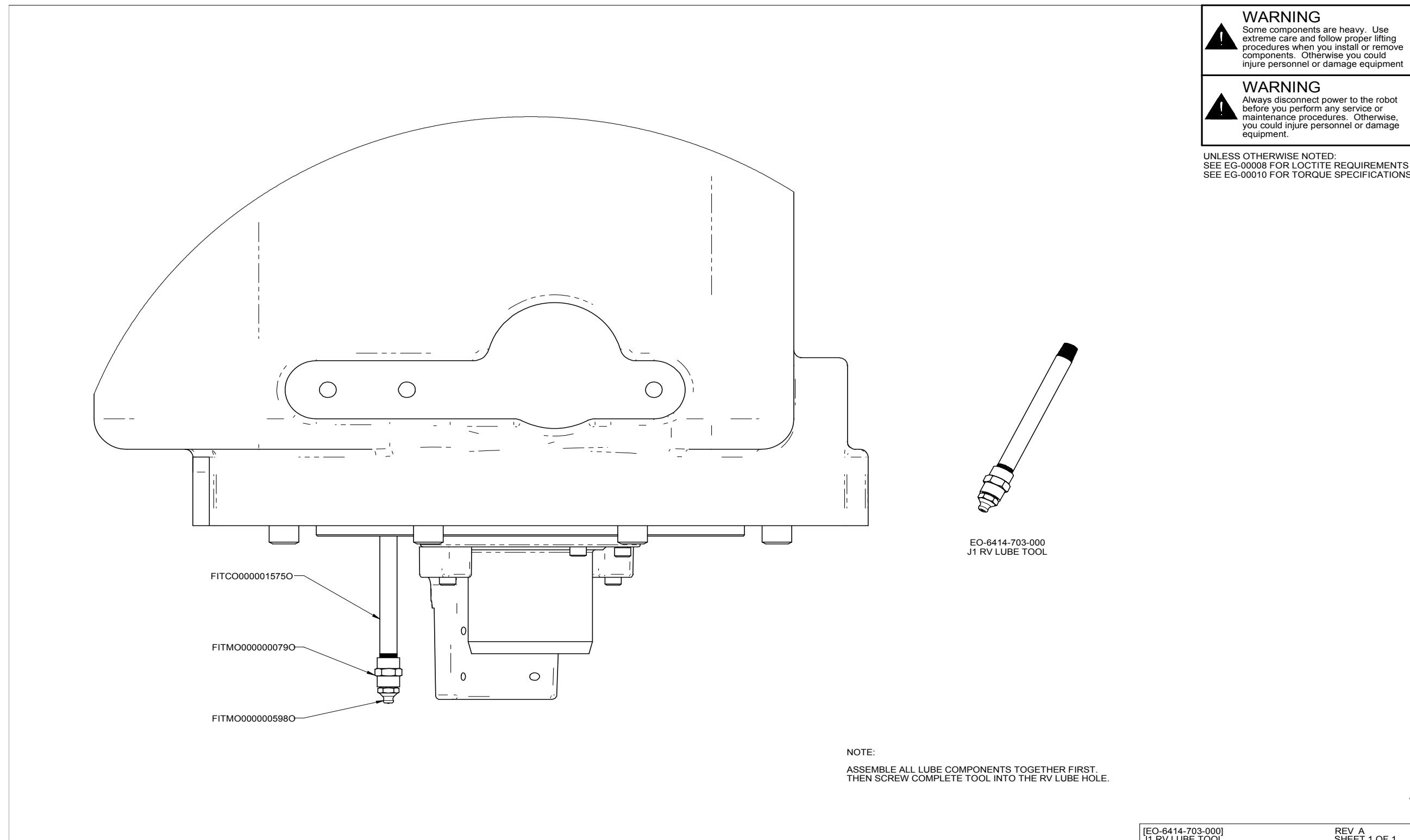
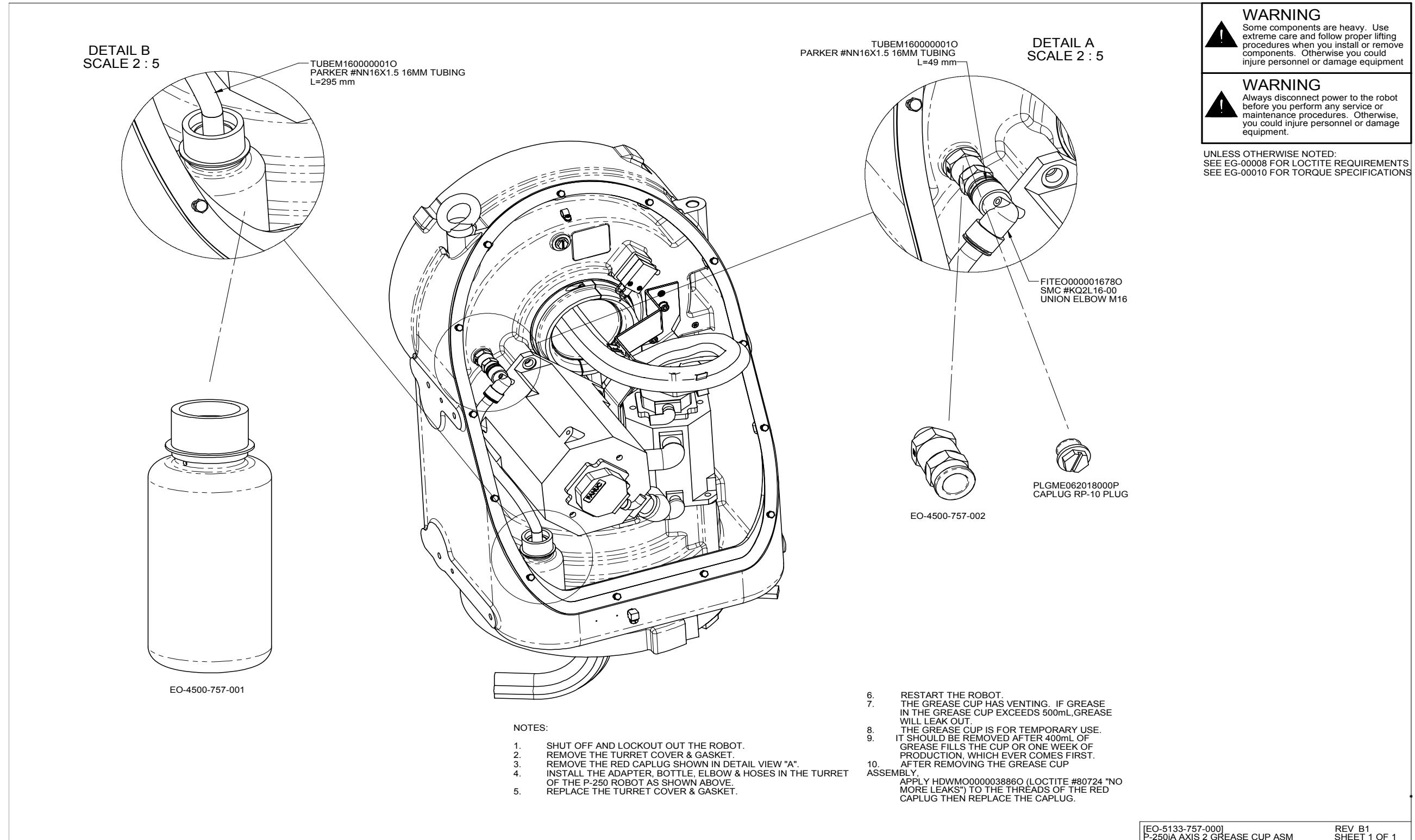
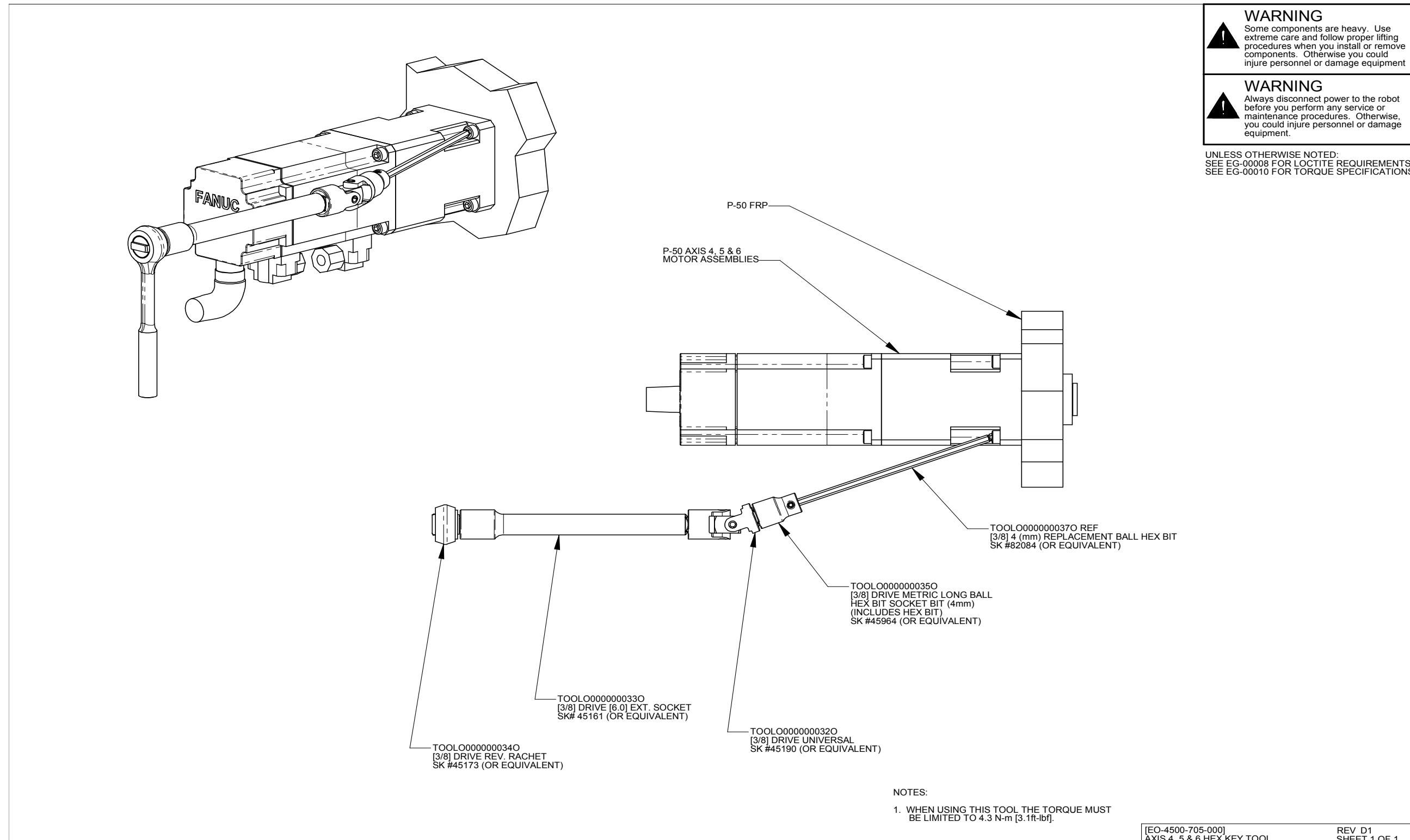
**Figure 5-30 EO-6414-700-000, RV-50C SEAL INSTALLATION TOOL**

Figure 5-31 EO-6414-703-000, J1 RV LUBE TOOL

**Figure 5-32 EO-5133-757-000, P-250iA AXIS 2 GREASE CUP ASM**

**Figure 5-33 EO-4500-705-000, AXIS 4, 5 & 6 HEX KEY TOOL**



# 6 MASTERING

## 6.1 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.**

**WARNING:**

**If the robot has been configured with DCS (Dual Check Safety), consult the DCS manual for mastering instructions.**

**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 6-1 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.

**Table 6-1 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.
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.

## 6.2 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 6-1 to reset these alarms and prepare the robot for mastering.

**Procedure 6-1 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.

## 6.3 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 6-2 to save and restore master reference position data.

### Procedure 6-2 Saving and Restoring Master Reference Position Data

#### Conditions

- The robot is mastered. Refer to Section 6.4 through Section 6.6 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 MENUS.
  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 SYSMAST.SV is copied to the default device.
7. To restore the saved file, press F2, LOAD.

## 6.4 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 6-3 to master a single axis.

### Procedure 6-3 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 6-1

#### 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* 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

## 6.5 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 6-4 to record the quick master reference position. Use Procedure 6-5 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 6-4 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* 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 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 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 6-5 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 6-1

##### **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

## 6.6 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 6-6 to master to a fixture. **Note** that not all steps refer to paint robots.

#### Procedure 6-6 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 6-1

##### **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* specific to your robot model for the procedures for setup 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 MENUS.
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:

- Press MENUS.
- 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.

## 6.7 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 6-7 to master to zero degrees

### Procedure 6-7 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 6-1

#### **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* specific to your robot model for the location of the witness marks.

**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 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

## 6.8 P-50iB Mastering Locations

### 6.8.1 P-50iB/15 & 10L Robot Mastering

Figure 6-1 ET-6414-845-001 SHT1, P50iB/15 MASTERING

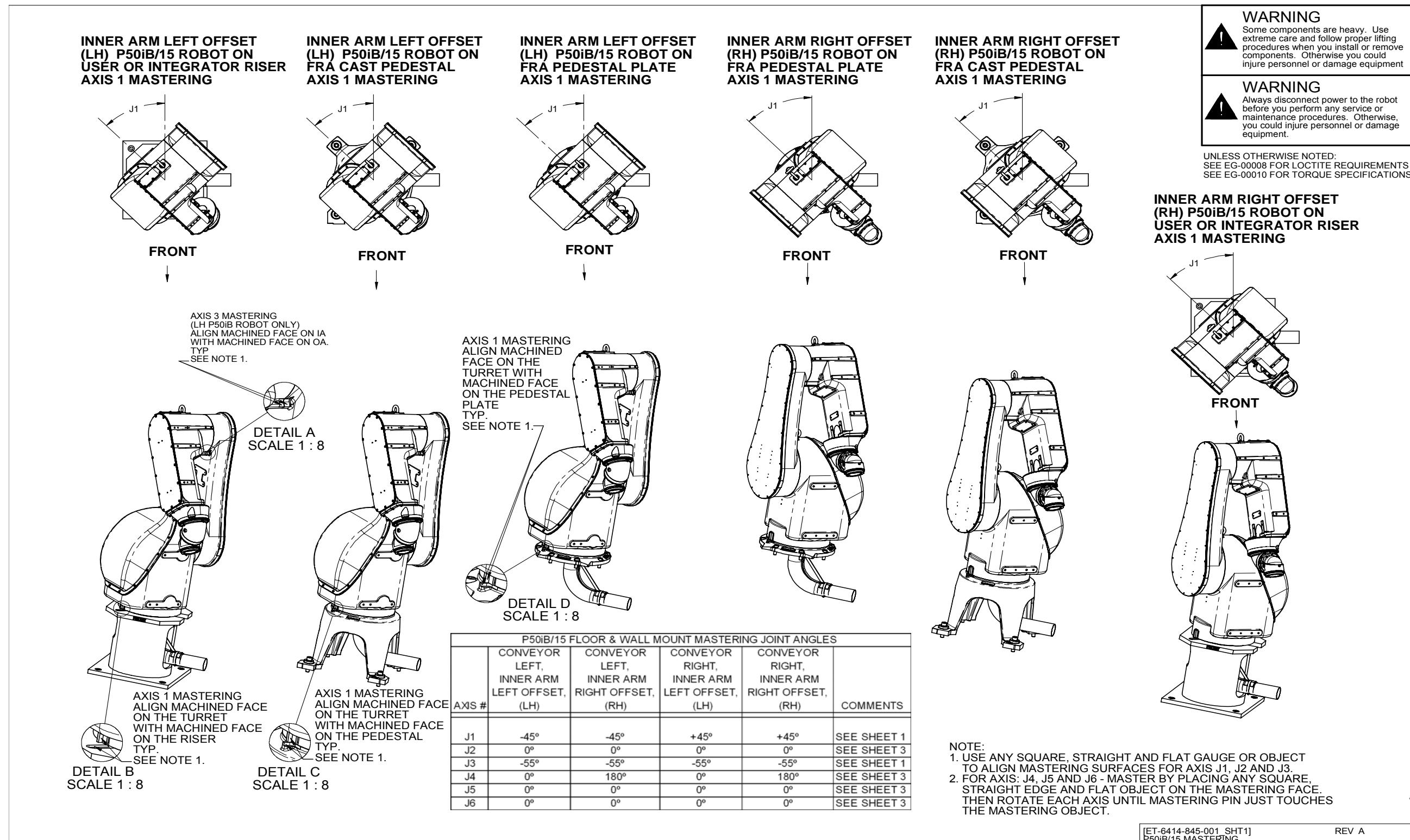
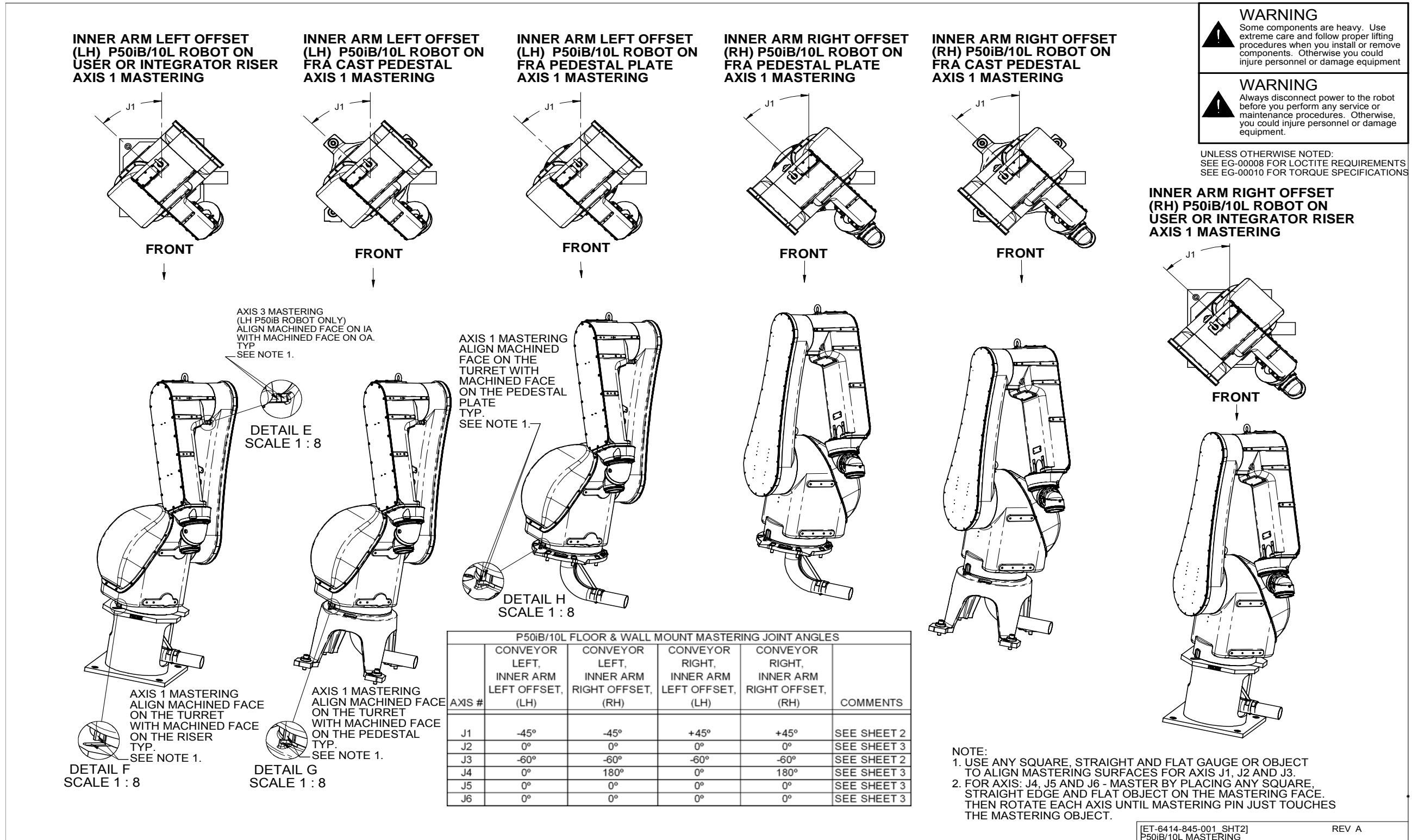


Figure 6-2 ET-6414-845-001 SHT2, P50iB/10L MASTERING

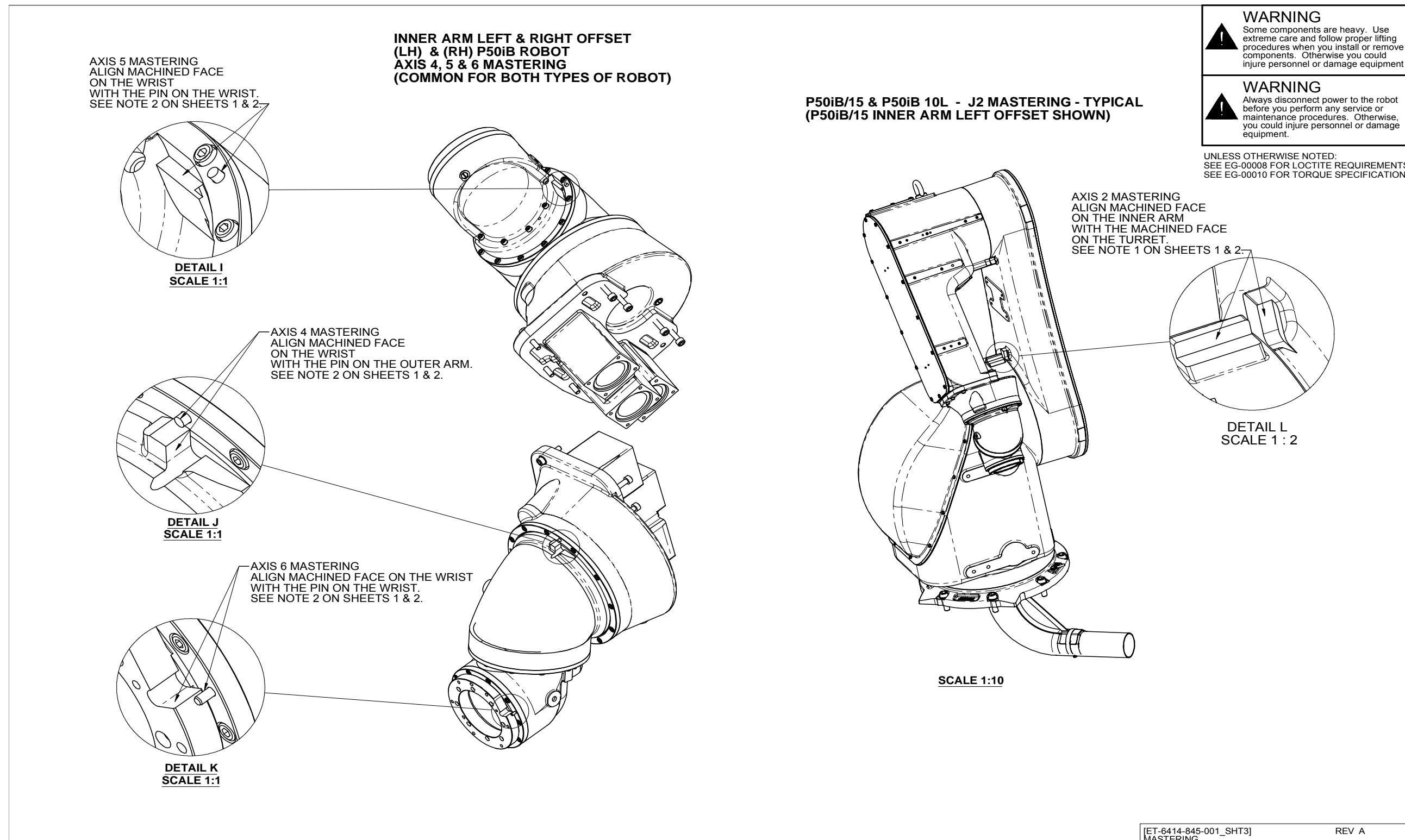
**Figure 6-3 ET-6414-845-001 SHT3, MASTERING**

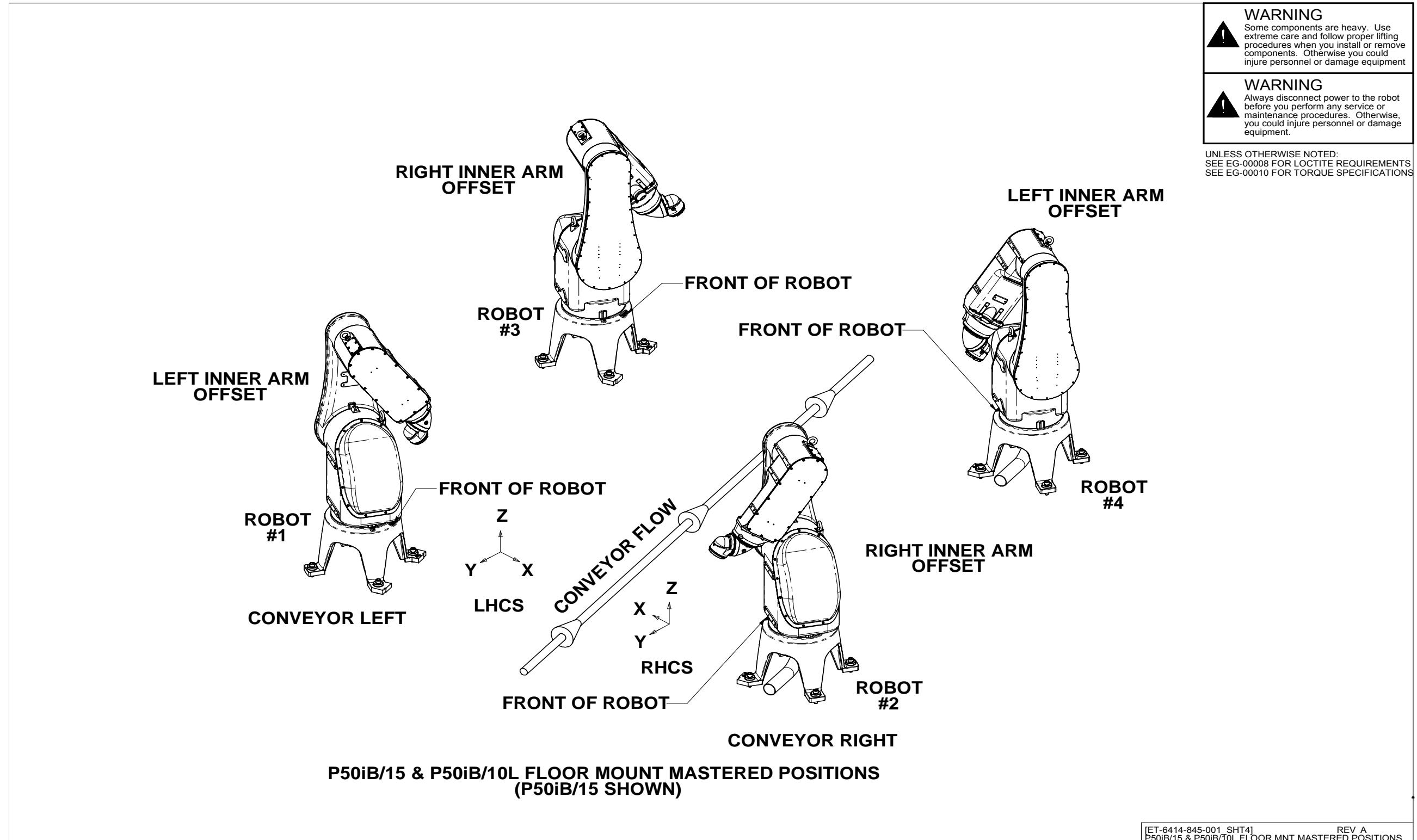
Figure 6-4 ET-6414-845-001 SHT4, P50iB/15 & P50iB/10L FLOOR MNT MASTERED POSITIONS

Figure 6-5 ET-6414-845-001 SHT5, P50iB/15 &amp; 10L INVERT MNT MASTERED POSITIONS

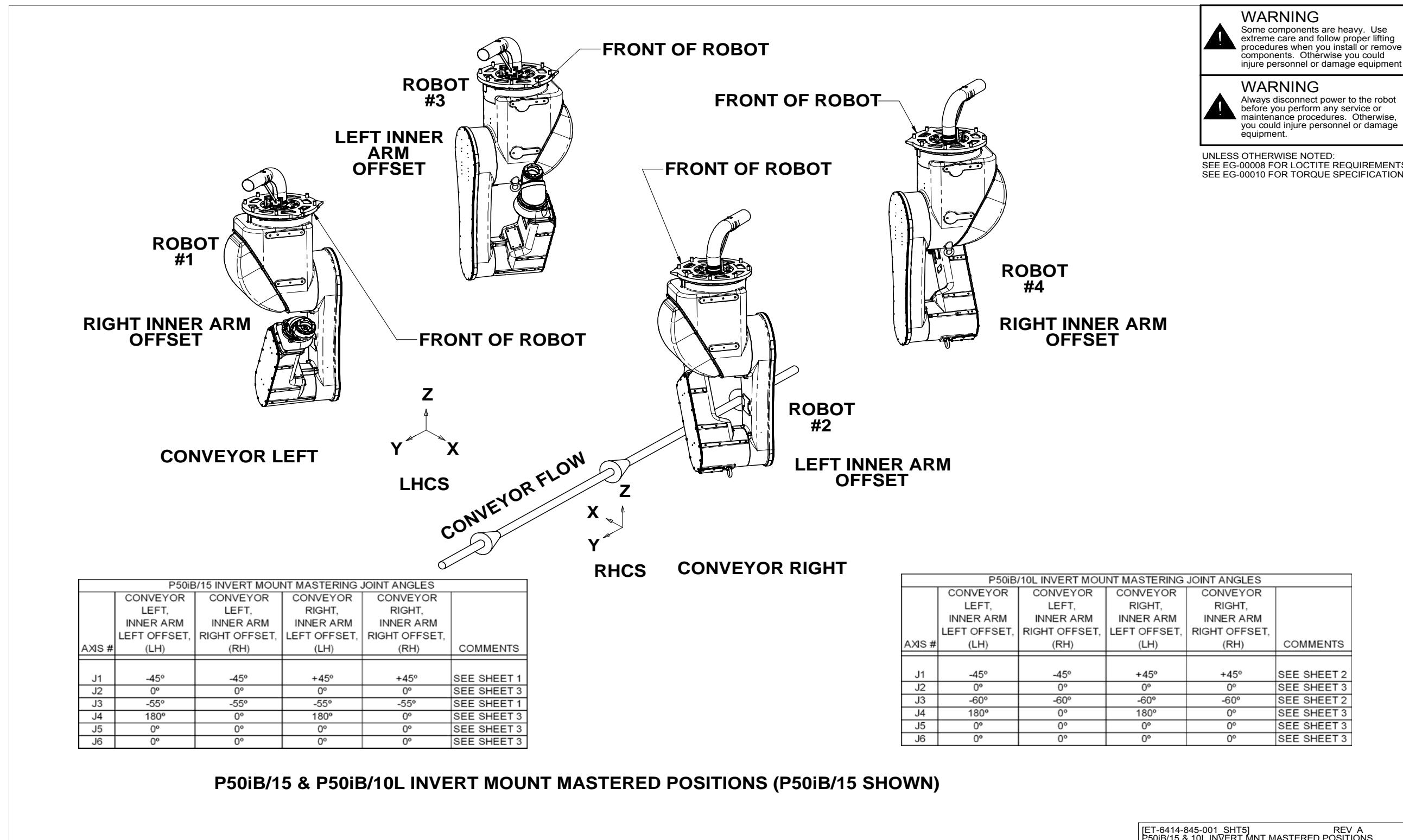


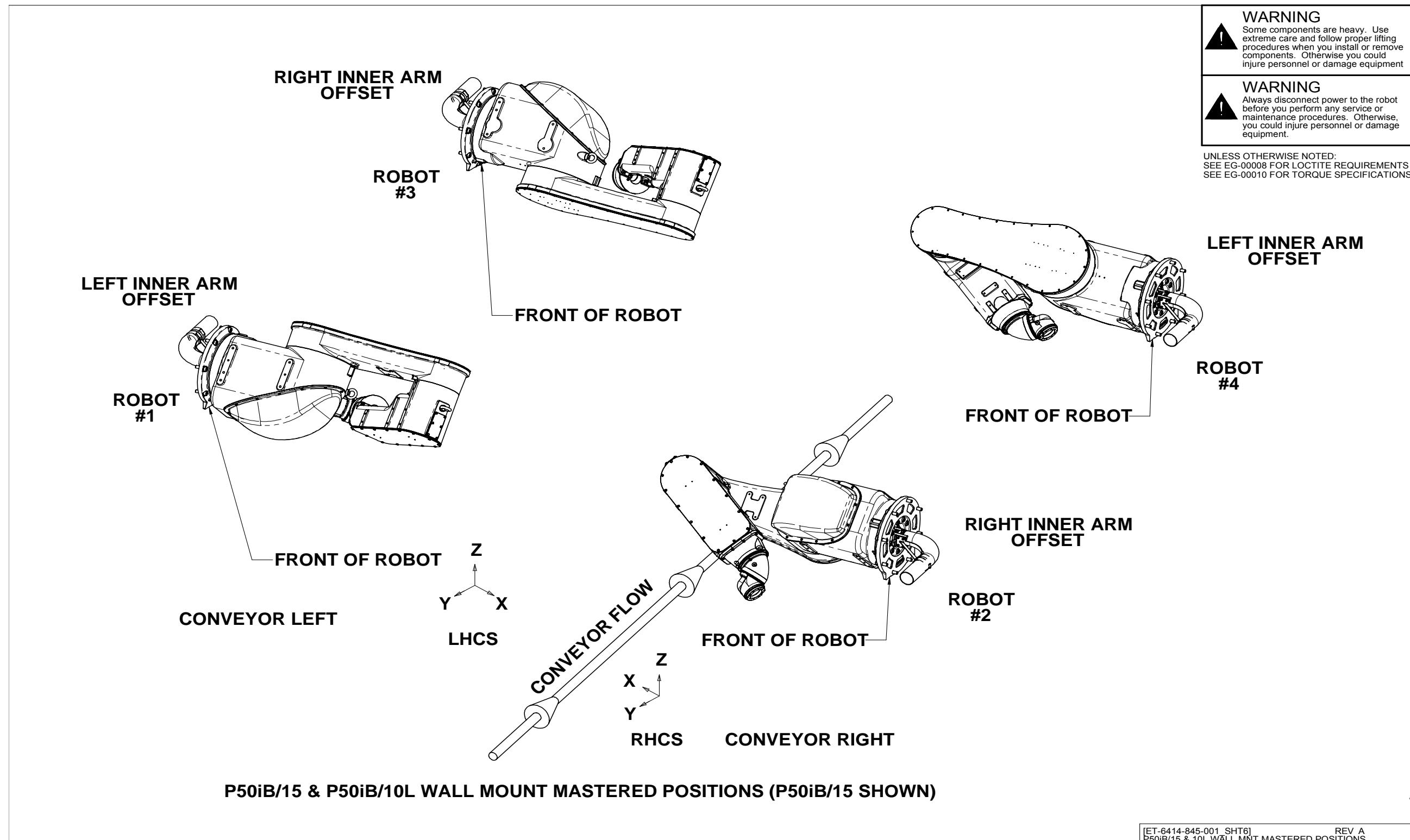
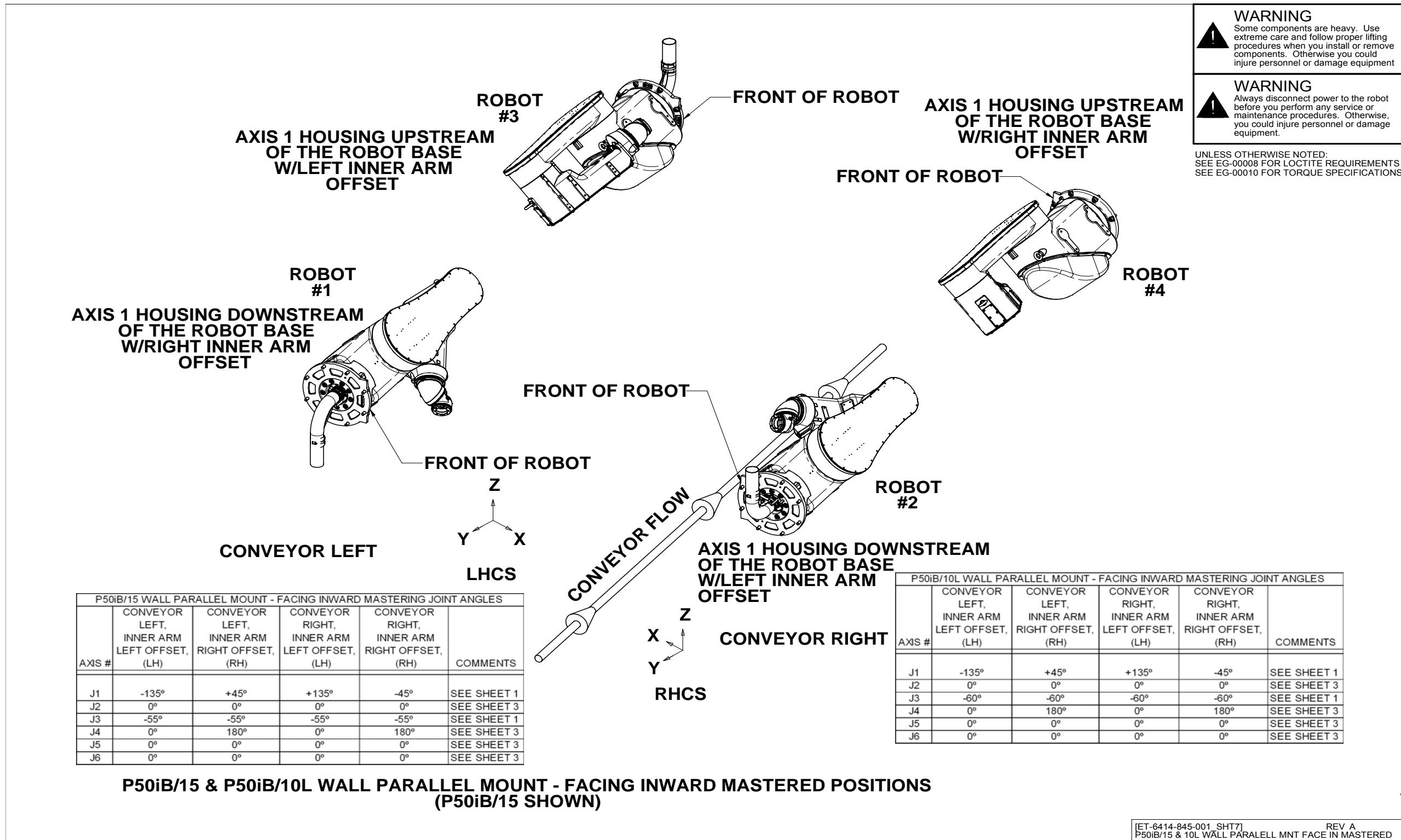
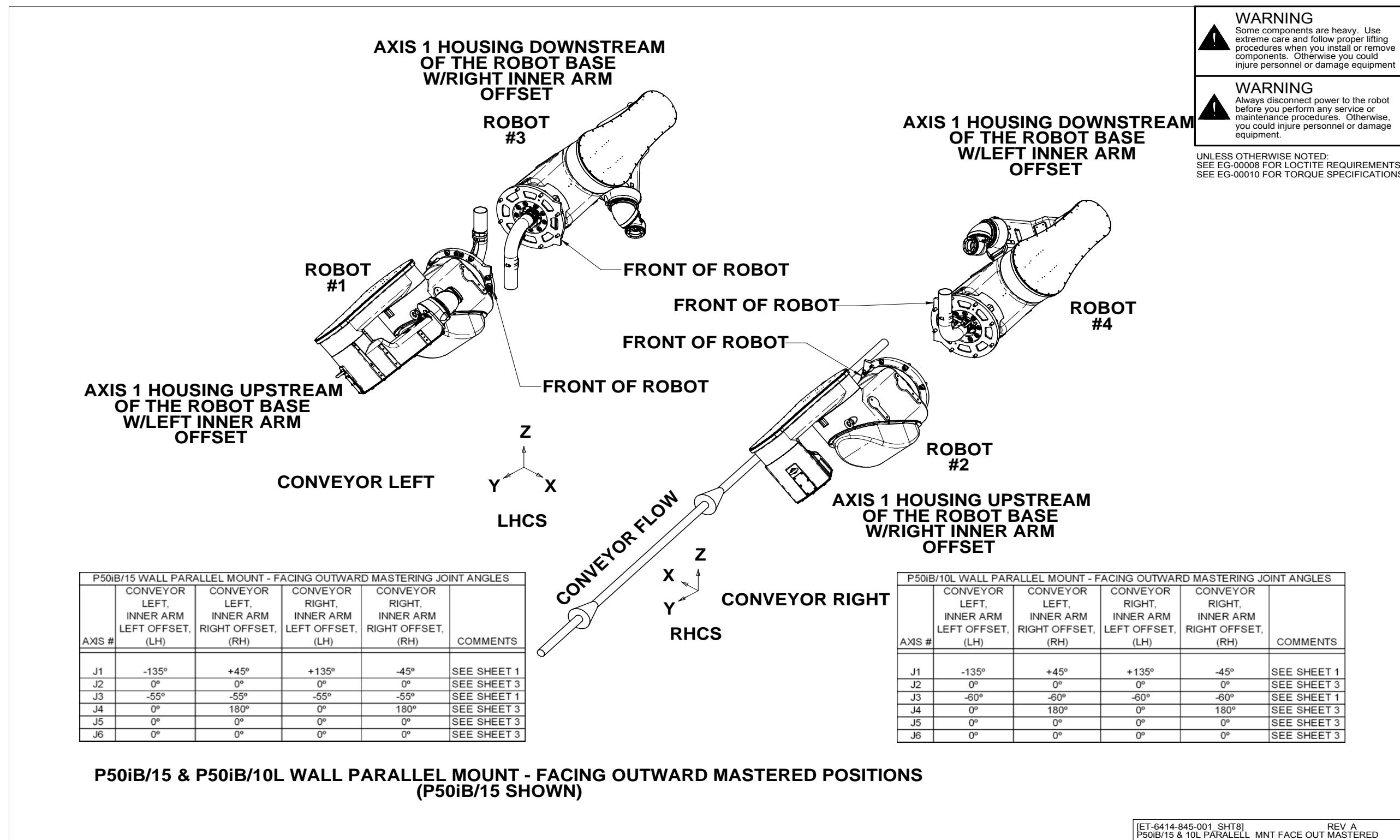
Figure 6-6 ET-6414-845-001 SHT6, P50iB/15 & 10L WALL MNT MASTERED POSITIONS

Figure 6-7 ET-6414-845-001 SHT7, P50iB/15 &amp; 10L WALL PARALELL MNT FACE IN MASTERED POSITIONS



**Figure 6-8 ET-6414-845-001 SHT8, P50iB/15 & 10L PARALELL MNT FACE OUT MASTERED POSITIONS**



## 7 PURGE SYSTEM AND CABLE ROUTING

For purge system troubleshooting, refer to Chapter 3 Troubleshooting.

The Purge and Pressurization control system for the P-50*iB* cell is based on the FANUC Robotics Purge Module II (EE-5404-001-005). This performs the following functions:

- Turn on and off the purge solenoid for the control of purge and pressurization air flow
- Monitor the status of the various pressure switches and flow switches
- Initiate and monitor the purge timing functions
- Enable the robot controller to be turned on

The major components of this system include:

- The Purge Module II in the main controller
- Purge solenoid located inside the robot base.
- Redundant pressure and flow switches in all purge cavities

The P-50*iB* robots need to be purged and pressurized.

The Purge sequence for all units is initiated at each main controller. When the Purge Enable pushbutton is activated, the purge air solenoid(s) is turned on. The Purge Module II monitors the pressure switches (PS) and flow switches (FS) for each unit.

When the purge is complete the Purge Module II turns off the purge air and allows maintenance air to flow through the robot. Additionally the Purge Complete indicator for that controller is then activated and the controller may be turned on.

All robot units have series circuits for their PS and FS functions.

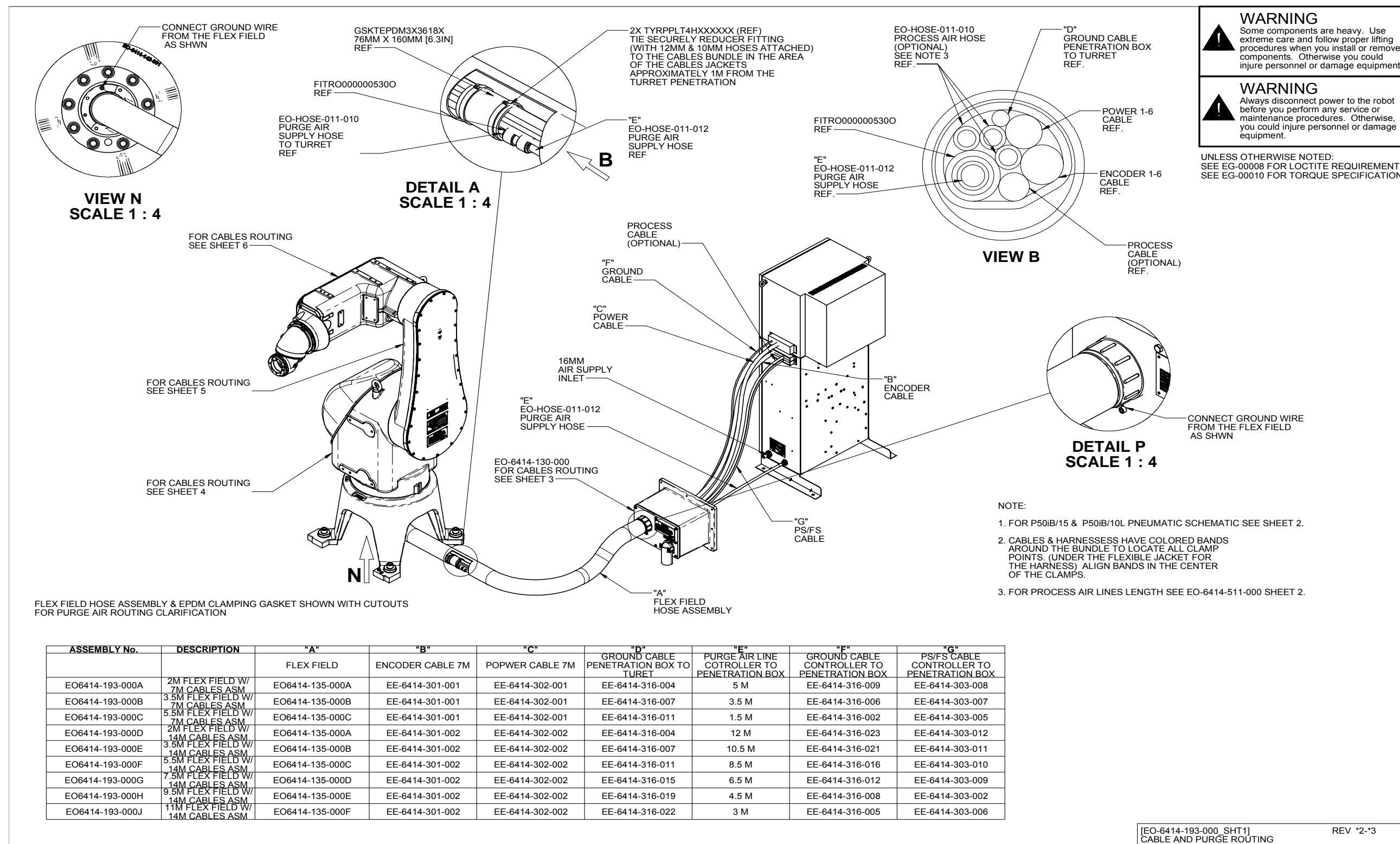
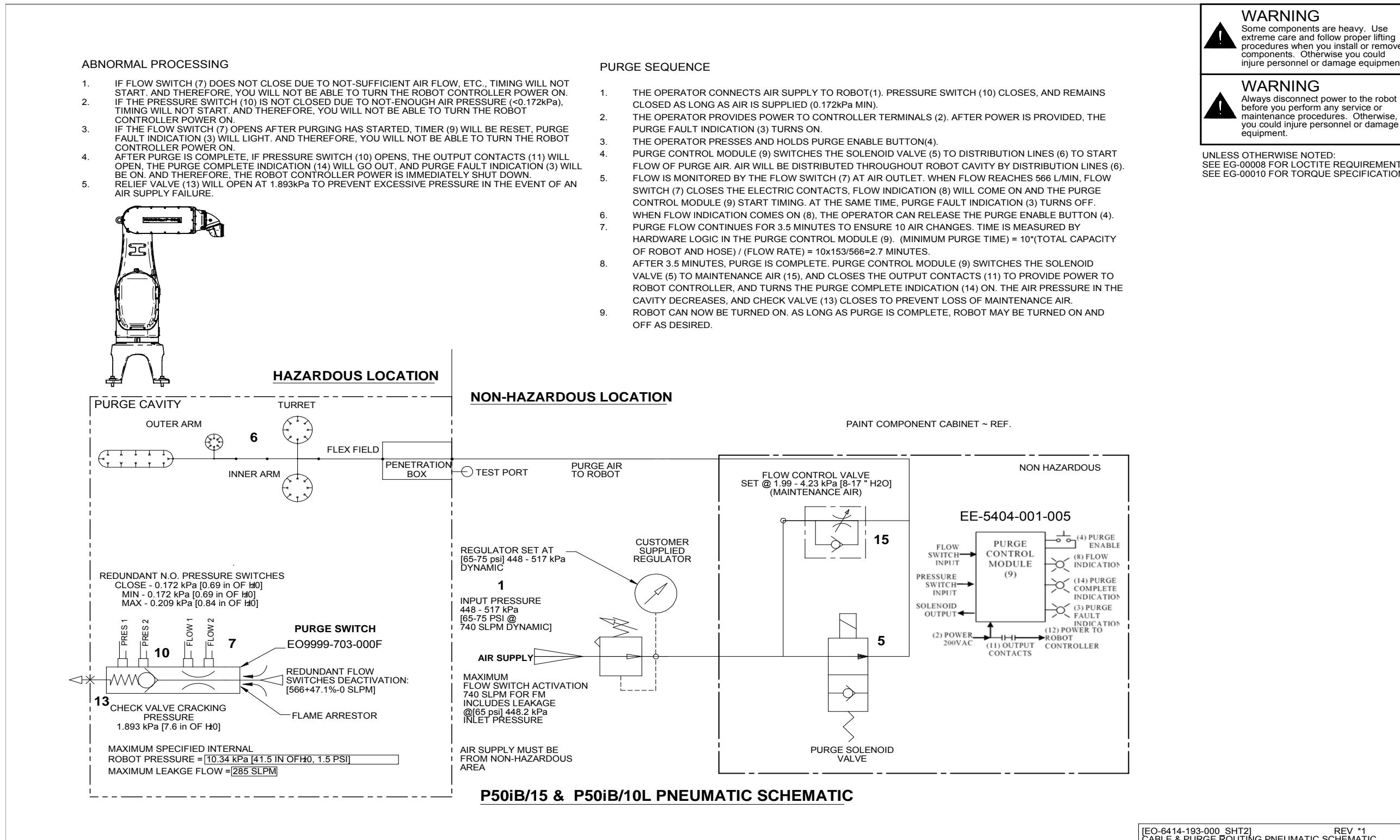
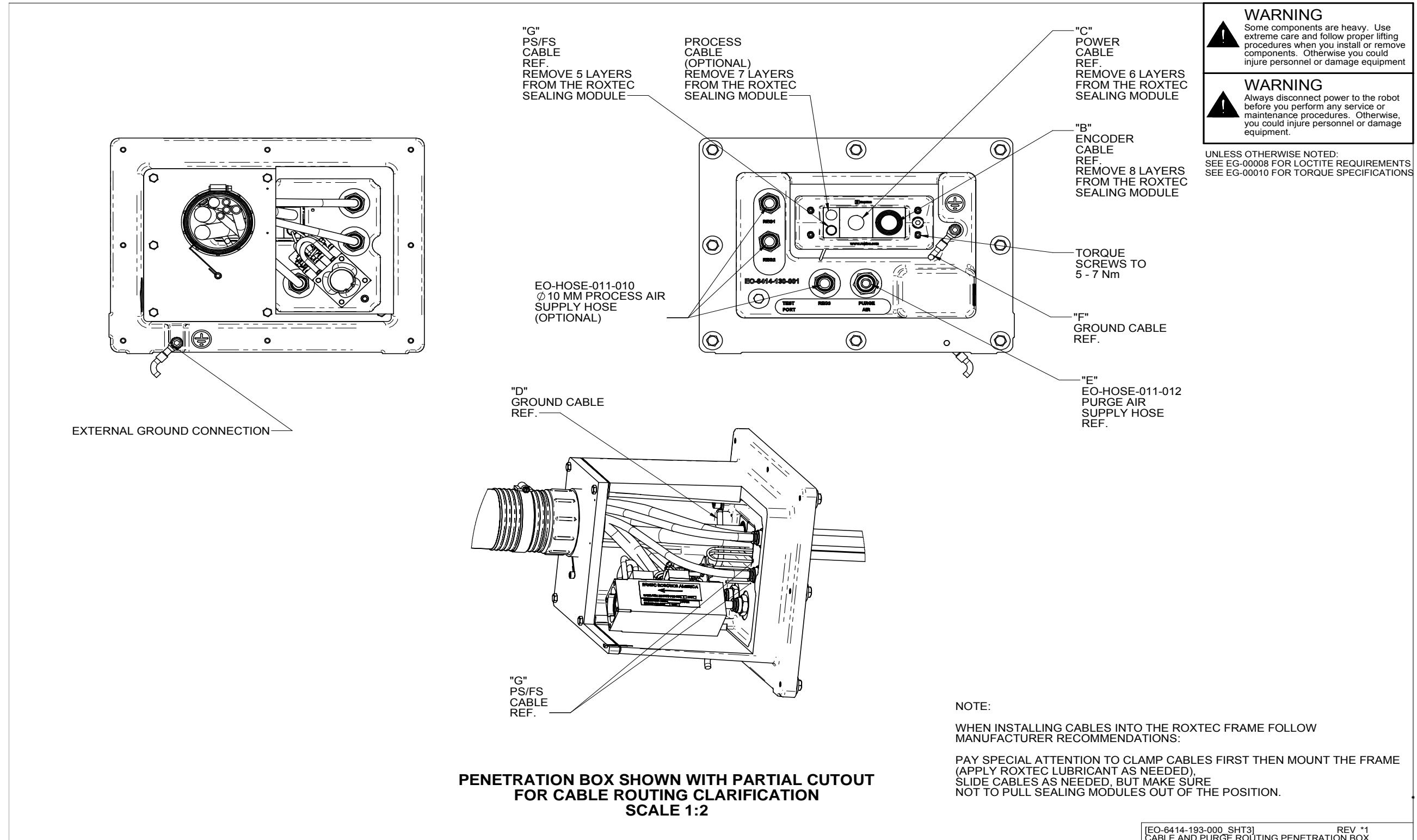
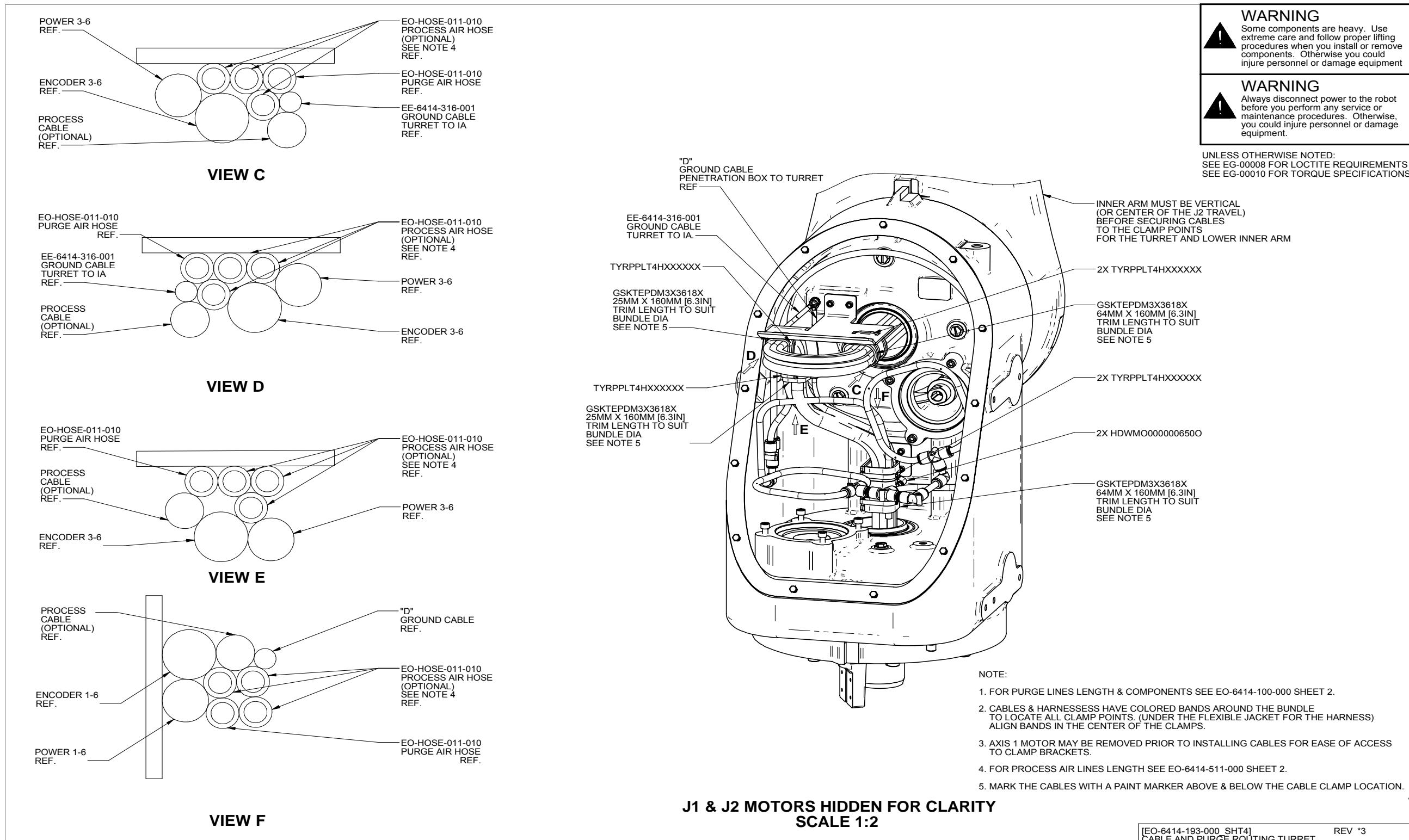
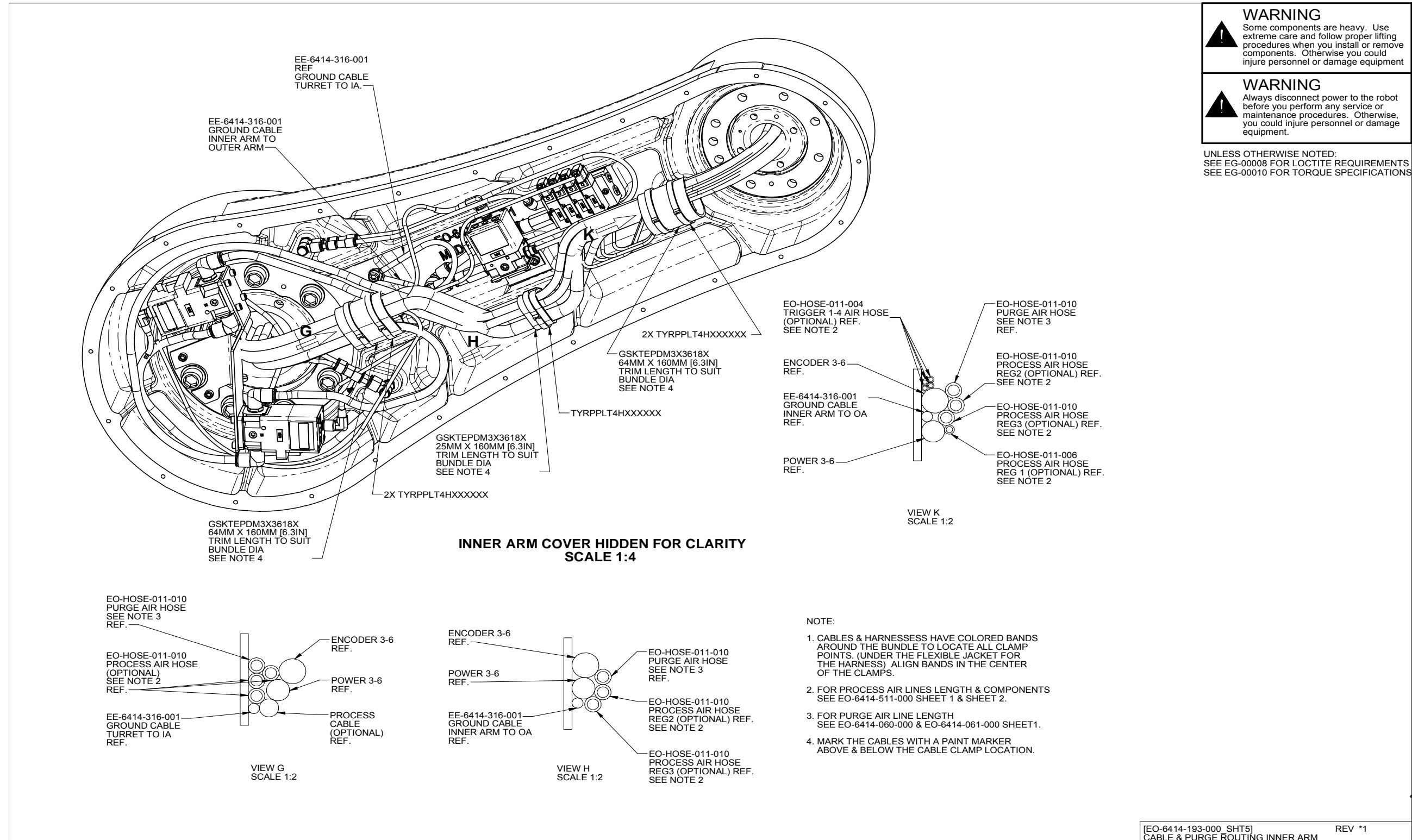
**Figure 7-1 EO-6414-193-000 SHT1, CABLE AND PURGE ROUTING**

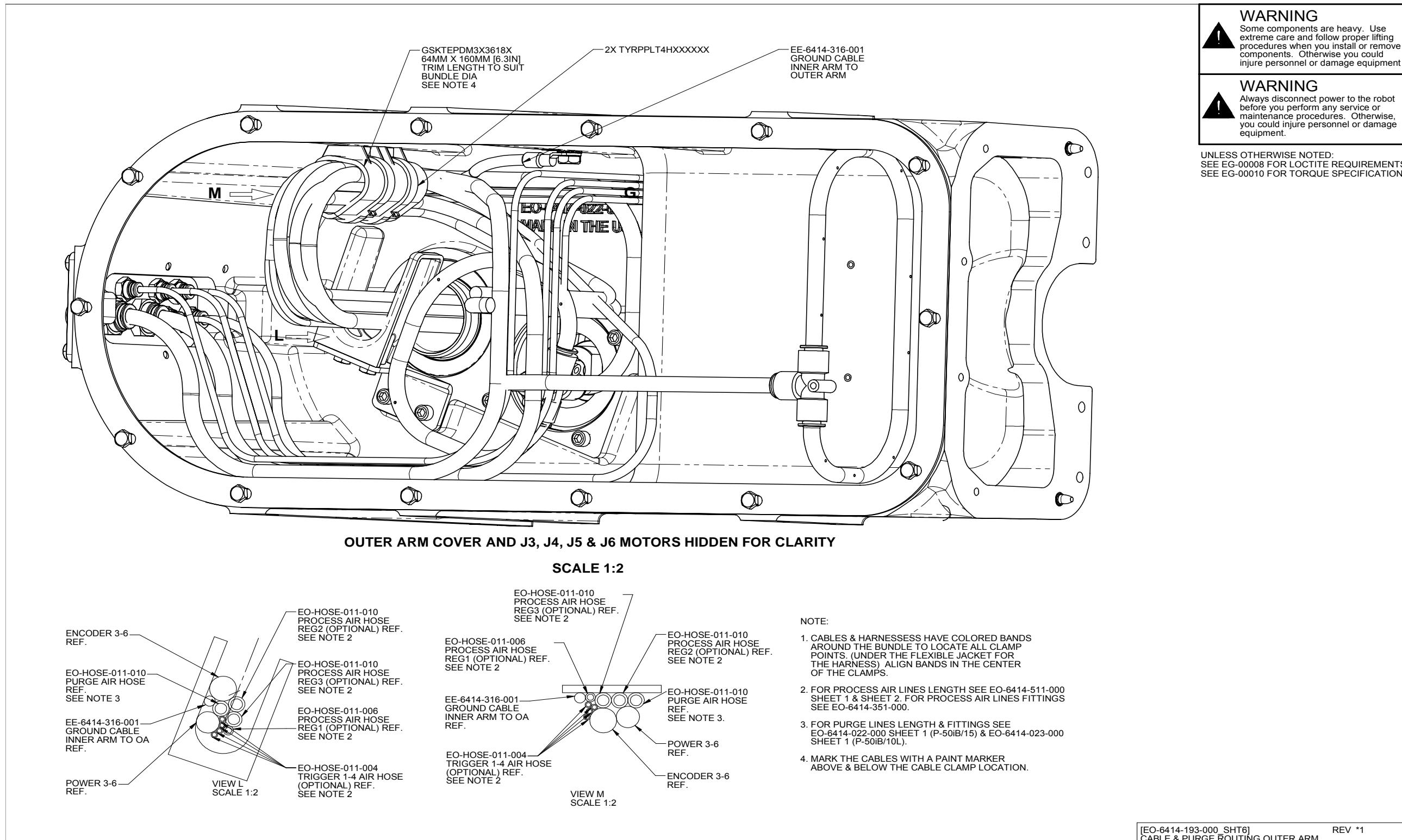
Figure 7-2 EO-6414-193-000 SHT2, CABLE &amp; PURGE ROUTING PNEUMATIC SCHEMATIC



**Figure 7-3 EO-6414-193-000 SHT3, CABLE AND PURGE ROUTING PENETRATION BOX**

**Figure 7-4 EO-6414-193-000 SHT4, CABLE AND PURGE ROUTING TURRET**

**Figure 7-5 EO-6414-193-000 SHT5, CABLE & PURGE ROUTING INNER ARM**

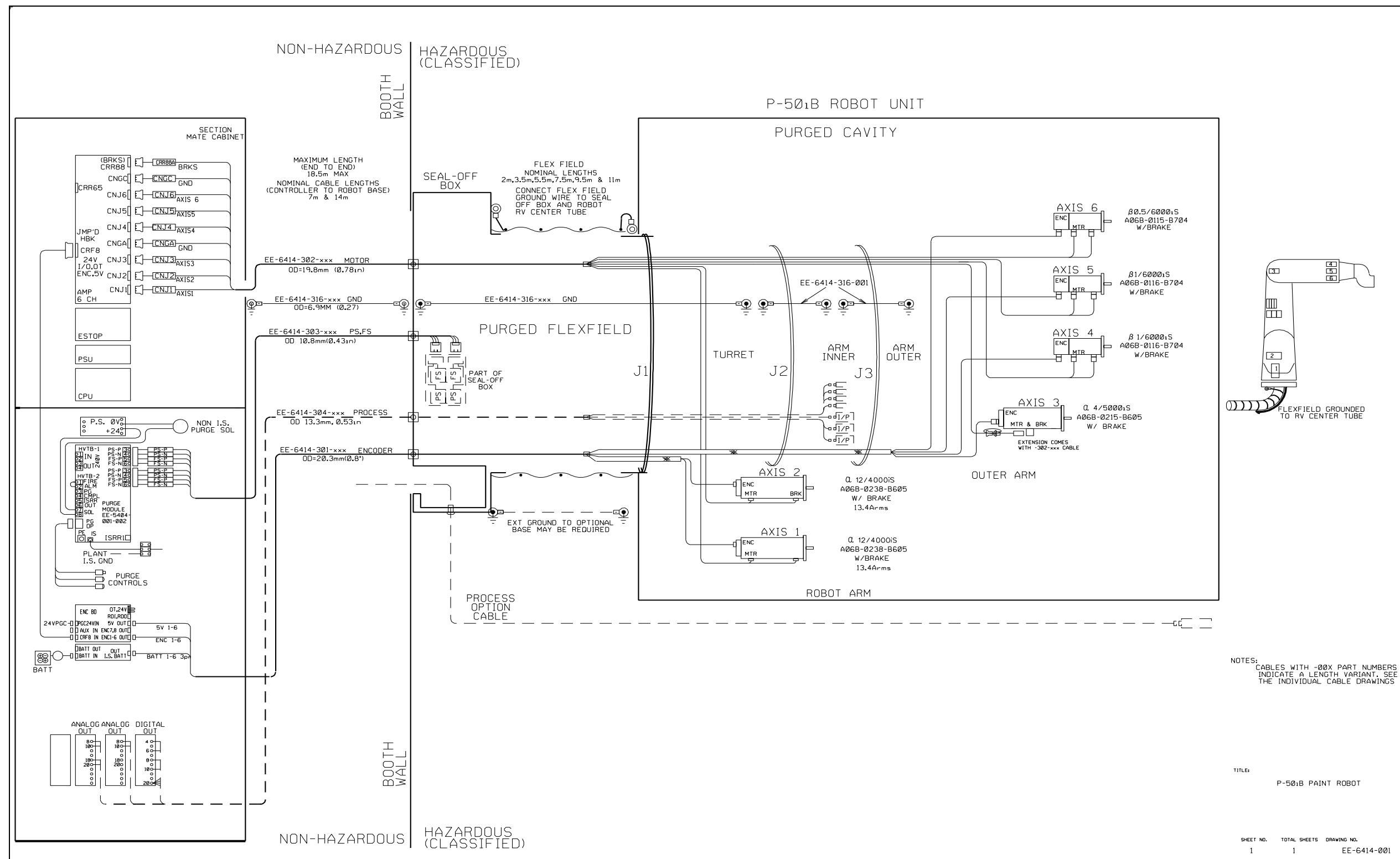
**Figure 7-6 EO-6414-193-000 SHT6, CABLE & PURGE ROUTING OUTER ARM**



# **8** ELECTRICAL

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## **Figure 8-1 EE-6414-001 Cable Layout, P-50iB Robot Cable Layout**



# **9** ENGINEERING GUIDELINES

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**Figure 9-1 EG-00008 Sheet 1 of 6, Loctite Application****FANUC ROBOTICS ENGINEERING GUIDELINE**  
**Title:** LOCTITE APPLICATIONPage 1 of 6  
EG #: EG-00008

The purpose of this engineering guideline is to define the different Loctite products used at FRA and to provide directions for proper use. This document is intended as a guideline only. Deviations are permitted and override this guideline when explicitly stated on engineering drawings/documentation.

***1. Cleaning***

Surfaces that are to have Loctite applied must be clean.

Acetone and Loctite "ODC-Free Cleaner & Degreaser" are approved cleaning agents.

Fasteners may be batch cleaned by submerging in acetone.

**Critical areas where retaining compounds are used** must be thoroughly cleaned to remove all preservative. Some preservatives are not visible and the parts may appear clean. Some preservatives contain nitrates which will stop Loctite from curing. All areas where retaining compound is used will have it's final cleaning with acetone.

The parts on which retaining compounds are used shall be thoroughly cleaned and "scrubbed" with acetone at least two times with a clean cloth. They may be washed before hand in a solvent tank. The parts must then be wiped down and blown off before cleaning twice with acetone.

***2. Primers***

The engineering drawings shall call out primer when necessary.

**Loctite 7649 (Primer N) & Loctite 7471 (Primer T)**

Loctite brand primers are used to ensure cure when applying Loctite threadlocker to two inactive metals. Primers will also speed up cure time.

**Figure 9-2 EG-00008 Sheet 2 of 6, Loctite Application**

<b>FANUC ROBOTICS ENGINEERING GUIDELINE</b>		Page 2 of 6
<b>Title: LOCTITE APPLICATION</b>		EG #: EG-00008
<hr/>		
Active Metals	Inactive Metals	
Iron Plain Steel Copper Brass Commercial Aluminum Bronze Kovar	Plated Steel Anodized Aluminum Stainless Steel Galvanized Steel Zinc Natural or Chemical Black Oxide Plastic Dacromet	

Primers are only required when one material is inactive (from above). If a primer is required for faster curing, it should be specified on the drawing.

**Directions for use**

- 1) Clean mating surfaces to ensure all contamination has been removed.
- 2) Apply primer to both mating surfaces to be bonded.
- 3) Allow the primer time to evaporate under good ventilation until surfaces are completely dry.
- 4) After primer is applied, parts should be bonded within 7 days.

**3A. Thread Locking – Conventional.**

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.

**Loctite 222:**

Loctite 222 is a low strength threadlocker designed to lock and seal threaded fasteners, which require easy disassembly. Unless explicitly stated on engineering drawings/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.

**Figure 9-3 EG-00008 Sheet 3 of 6, Loctite Application****FANUC ROBOTICS ENGINEERING GUIDELINE**  
**Title: LOCTITE APPLICATION**Page 3 of 6  
EG #: EG-00008**Loctite 242 or 248(stick):**

Loctite 242 is a medium strength threadlocker designed to lock and seal threaded fasteners that require normal disassembly with standard hand tools. Unless explicitly stated on engineering drawings/documentation, Loctite 242 is to be used on all carbon and stainless steel fasteners 6mm and above. The uncured appearance of this product is blue.

**Loctite 262 or 268(stick):**

Loctite 262 is a high strength threadlocker designed to permanently lock and seal threaded fasteners. This product should not be applied unless explicitly stated on engineering drawings/documentation. The uncured appearance of this product is red.

**Loctite 277:**

Loctite 277 is a high strength threadlocker designed to permanently lock and seal threaded fasteners. This product should not be applied unless explicitly stated on engineering drawings/documentation. The uncured appearance of this product is a red liquid.

**Directions for use**

- 1) Clean mating surfaces to ensure all contamination has been removed.
- 2) Apply primer as required and allow to dry.
- 3) Select the specified product. Shake the liquid products before use.
- 4) **For Thru Holes**, apply several drops of the product onto the bolt at the nut engagement area.
- 5) **For Blind Holes**, the application method requires that product be applied to both parts. Apply several drops of the product down the internal threads to the bottom of the hole as well as the external treads of mating fastener. If product is only applied to the fastener, air pressure will force the liquid threadlocker to escape as the fastener is tightened down. Lack of uniform coverage creates air pockets, causing incomplete cures, which lead to failures.
- 6) Assemble and tighten as required. Fasteners must be torqued within 3 minutes.

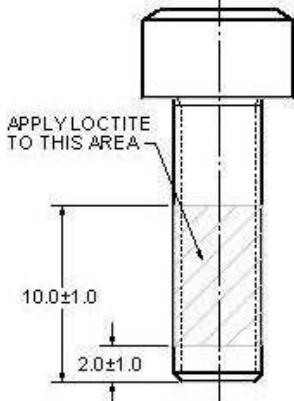
**3B. Tread Locking – Pre applied.**

Loctite Dri Loc STS can be pre applied to fasteners provided the break away torque meets the FRA torque specification EG -00010. For M5 fasteners it should be diluted 50 % by weight and applied as shown below.

**Figure 9-4 EG-00008 Sheet 4 of 6, Loctite Application**

**FANUC ROBOTICS ENGINEERING GUIDELINE**  
**Title: LOCTITE APPLICATION**

Page 4 of 6  
EG #: EG-00008



**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.

**Directions for use**

- 1) Clean mating surfaces to ensure all contamination has been removed. Parts must be cleaned completely. Use acetone and scrub with a clean rag at least two times.
- 2) If parts are inactive metals or cure speed is too slow, spray with Loctite Primer 7471 or 7649 per the engineering drawing.
- 3) **For Slip Fitted Assemblies**, apply adhesive 360 degrees around OD and ID of mating parts. Use a rotating motion during assembly to ensure good coverage.
- 4) **For Press Fitted Assemblies**, apply adhesive 360 degrees around OD and ID of mating parts to insure the surfaces are completely coated during assembly. Assemble mating parts. When an undercut is provided, the adhesive shall be applied to the shaft to insure that the undercut is completely filled as the parts are pressed together.
- 5) Parts should not be disturbed until sufficient handling strength is achieved. Parts using Loctite 680 need to remain in fixture for 10 minutes. Full cure will be developed in 24 hours.

Figure 9-5 EG-00008 Sheet 5 of 6, Loctite Application**FANUC ROBOTICS ENGINEERING GUIDELINE**  
**Title:** LOCTITE APPLICATIONPage 5 of 6  
EG #: EG-00008**5. Sealant**

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

**Loctite 567** is designed for locking and sealing 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.

**Directions for use**

- 1) Clean mating surfaces to ensure contamination has been removed.
- 2) Apply primer as required and allow to dry.
- 3) Apply a 360-degree bead of sealant to the leading threads of the male fitting, leaving the first thread free. Force the sealant into the threads to ensure all voids are filled.
- 4) Assemble and tighten fittings as required.
- 5) 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.

**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 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 0.25mm.

**Directions for use**

- 1) Clean mating surfaces to ensure all contamination has been removed. The product gives best performance when surfaces are clean and free of grease.
- 2) Apply product in a continuous bead to one of the mating surfaces.
- 3) Assemble mating parts. Parts should be tightened as soon as possible after assembly.
- 4) Low pressure can be used to confirm a complete seal immediately after assembly. Allow time for full cure before applying high pressure.

Figure 9-6 EG-00008 Sheet 6 of 6, Loctite Application

FANUC ROBOTICS ENGINEERING GUIDELINE		Page 6 of 6
Title: LOCTITE APPLICATION		EG #: EG-00008
<b>7. Gasket Adhesives</b>		
Gasket adhesives are used to bond a gasket to its cover for ease of assembly.		
<b>Loctite "High Tack"</b> is a flexible material that will bond gaskets to its cover. It can be used on all paper, rubber, cork or metal gaskets.		
<b>Directions for use</b>		
1) Clean mating surfaces to ensure all contamination has been removed. 2) Apply product with brush or spray. 3) Assemble gasket to cover. Parts should be allowed to cure for 5 minutes minimum before the cover/gasket is installed.		
<b>8. List of the ND Industries part numbers – equivalent to Loctite.</b>		
Fanuc Item Number:	Current Item Description	New Item Description
HDWMO000001145O	LOCTITE #49550 ADHSV 1 OZBOTL	LOCTITE #49550 1oz / ND #39528
HDWMO000001146O	LOCTITE #242-41 SEALANT 250CC	LOCTITE #242-41 250cc/ND#12125
HDWMO000001147O ALT:HDWMO000002362O	LOCTITE #271-41 THRDLCKR 250CC	LOCTITE #271-41 250cc/ND#14025
HDWMO000001836O	LOCTITE #242-31 SEALANT 50CC	LOCTITE #242-31 50cc/ND #12150
HDWMO000002312O	LOCTITE #515-31 GSKT SEALANT	LOCTITE #515-31 50cc/ND #73250
HDWMO000002362O ALT:HDWMO000001147O	LOCTITE #271-31 SEALANT 50CC	LOCTITE #271-31 50cc/ND #14050
HDWMO000002450O	LOCTITE #26231 RETAIN COMPOUND	LOCTITE #26231 50cc/ND #13150
HDWMO000003076O	LOCTITE #680 RETAIN COMP 50CC	LOCTITE #680 50cc/ND #54150
HDWMO000003148O	LOCTITE #290-41 SEALANT 250CC	LOCTITE #290-31 50cc/ND#15050
HDWMO000003185O	LOCTITE #PST-56747 SEALANT 50M	LOCTITE#PST56747 50ml/ND#46050
HDWMO000003186O	LOCTITE #22241 SEALANT 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 ADHES	LOCTITE #45440 20gm/ND #35420
HDWMO000056588O	LOCTITE #41650 416 INST ADHEV	LOCTITE #41650 1oz/ND #31628

**Figure 9-7 EG-00010 Sheet 1 of 5, Torque Specification**

**FANUC ROBOTICS ENGINEERING GUIDELINE**  
**Title: Mechanical Development Torque Specifications**

Page 1 of 5  
EG #: 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:** - Torque tolerance for all specified values is assumed to be +/- 6% unless otherwise specified on 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 Head Type Nuts will be grade A2.
- All Carbon Steel Socket Cap screws will be grade 12.9.
- All Dacromet plated Carbon Steel Socket Cap screws will be grade 12.9.
- All zinc plated Carbon Steel Socket Cap screws will be grade 12.9. (torqued to 10.9 spec)
- 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 carbon and stainless steel fasteners 5mm and under.
- Loctite #242 will be used on all carbon and stainless steel fasteners 6mm and over.

**Figure 9-8 EG-00010 Sheet 2 of 5, Torque Specification**

<b>FANUC ROBOTICS ENGINEERING GUIDELINE</b>																																																		
<b>Title: Mechanical Development Torque Specifications</b>																																																		
Page 2 of 5 EG #: EG-00010																																																		
<b>A. Standard Torque Specification for grade 12.9 Carbon Steel Socket Cap, grade 10.9 Hex Head Screws and grade 10 Hex Nuts (Except for Fasteners securing covers with gaskets) Dacromet coated Carbon Steel Socket Cap screws</b>																																																		
<table border="1"><thead><tr><th></th><th>Torque (N·m)</th><th>Torque (ft-lbs)</th></tr></thead><tbody><tr><td>M2 x .4</td><td>.5</td><td>0.4</td></tr><tr><td>M2.5 x .45</td><td>1.0</td><td>0.7</td></tr><tr><td>M3 x .5</td><td>1.7</td><td>1.3</td></tr><tr><td>M4 x .7</td><td>3.9</td><td>2.9</td></tr><tr><td>M5 x .8</td><td>7.9</td><td>5.9</td></tr><tr><td>M6 x 1.0</td><td>13.5</td><td>10.0</td></tr><tr><td>M8 x 1.25</td><td>32</td><td>23.6</td></tr><tr><td>M10 x 1.5</td><td>64</td><td>47.2</td></tr><tr><td>M12 x 1.75</td><td>112</td><td>82.5</td></tr><tr><td>M14 x 2.0</td><td>180</td><td>132</td></tr><tr><td>M16 x 2.0</td><td>280</td><td>206</td></tr><tr><td>M20 x 2.5</td><td>546</td><td>402</td></tr><tr><td>M24 x 3.0</td><td>944</td><td>696</td></tr><tr><td>M30 x 3.5</td><td>1825</td><td>1346</td></tr><tr><td>M36 x 4.0</td><td>3200</td><td>2360</td></tr></tbody></table>				Torque (N·m)	Torque (ft-lbs)	M2 x .4	.5	0.4	M2.5 x .45	1.0	0.7	M3 x .5	1.7	1.3	M4 x .7	3.9	2.9	M5 x .8	7.9	5.9	M6 x 1.0	13.5	10.0	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
	Torque (N·m)	Torque (ft-lbs)																																																
M2 x .4	.5	0.4																																																
M2.5 x .45	1.0	0.7																																																
M3 x .5	1.7	1.3																																																
M4 x .7	3.9	2.9																																																
M5 x .8	7.9	5.9																																																
M6 x 1.0	13.5	10.0																																																
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																																																
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M24 x 3.0	944	696																																																
M30 x 3.5	1825	1346																																																
M36 x 4.0	3200	2360																																																
<b>B. Standard Torque Specification for grade 12.9 Carbon Steel Shoulder screws.</b>																																																		
<table border="1"><thead><tr><th>Thread Diameter and Pitch</th><th>Shoulder Diameter</th><th>Torque (N·m)</th><th>Torque (ft-lbs)</th><th>Torque (in-lbs)</th></tr></thead><tbody><tr><td>M5 x .8</td><td>M6</td><td>7.9</td><td></td><td>70.0</td></tr><tr><td>M6 x 1.0</td><td>M8</td><td>13.5</td><td>10</td><td>119.4</td></tr><tr><td>M8 x 1.25</td><td>M10</td><td>32</td><td>23.6</td><td></td></tr><tr><td>M10 x 1.5</td><td>M12</td><td>64</td><td>47.2</td><td></td></tr><tr><td>M12 x 1.75</td><td>M16</td><td>112</td><td>82.5</td><td></td></tr><tr><td>M16 x 2.0</td><td>M20</td><td>280</td><td>206</td><td></td></tr></tbody></table>			Thread Diameter and Pitch	Shoulder Diameter	Torque (N·m)	Torque (ft-lbs)	Torque (in-lbs)	M5 x .8	M6	7.9		70.0	M6 x 1.0	M8	13.5	10	119.4	M8 x 1.25	M10	32	23.6		M10 x 1.5	M12	64	47.2		M12 x 1.75	M16	112	82.5		M16 x 2.0	M20	280	206														
Thread Diameter and Pitch	Shoulder Diameter	Torque (N·m)	Torque (ft-lbs)	Torque (in-lbs)																																														
M5 x .8	M6	7.9		70.0																																														
M6 x 1.0	M8	13.5	10	119.4																																														
M8 x 1.25	M10	32	23.6																																															
M10 x 1.5	M12	64	47.2																																															
M12 x 1.75	M16	112	82.5																																															
M16 x 2.0	M20	280	206																																															

**Figure 9-9 EG-00010 Sheet 3 of 5, Torque Specification**

<b>FANUC ROBOTICS ENGINEERING GUIDELINE</b>		
<b>Title: Mechanical Development Torque Specifications</b>		
<b>C. Standard Torque Specification for all Stainless fasteners and Nuts (Except for Fasteners securing covers with gaskets)</b>		
	<b>Torque (N·m)</b>	<b>Torque (ft-lbs)</b>
M2 x .4	0.33	0.25
M2.5 x .45	0.66	0.5
M3 x .5	1.1	0.8
M4 x .7	2.6	2.0
M5 x .8	5.4	4.0
M6 x 1.0	9.2	6.8
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

<b>D. Torque Specification for all Metric Carbon and Stainless Fasteners securing Covers with Gaskets</b>		
	<b>Torque (N·m)</b>	<b>Torque (ft-lbs)</b>
M4 x .7	2.0	1.5
M5 x .8	4.0	3.0
M6 x 1.0	6.3	4.6
M8 x 1.25	7.5	5.5
M10 x 1.5	8.4	6.2

Figure 9-10 EG-00010 Sheet 4 of 5, Torque Specification

<b>FANUC ROBOTICS ENGINEERING GUIDELINE</b>		
<b>Title: Mechanical Development Torque Specifications</b>		
Page 4 of 5 EG #: EG-00010		
<b>E. Standard Torque Specification for grade 8.8 Carbon Steel Hex Head screws, grade 10.9 Carbon steel Flat Head Socket Screws, grade 10.9 Button Head Socket Screws, grade 8.8 Carbon Steel Low Head Socket Cap Screws, grade 6 Carbon Steel Hex Nuts and all Carbon Steel Jam Nuts (Except for Fasteners securing covers with gaskets), grade 12.9 Zinc plated Carbon Steel Socket Cap screws</b>		
	Torque (N-m)	Torque (ft-lbs)
M2 x .4	0.4	0.3
M2.5 x .45	0.7	0.5
M3 x .5	1.0	0.7
M4 x .7	2.2	1.6
M5 x .8	4.3	3.1
M6 x 1.0	7.5	5.5
M8 x 1.25	18.0	13.2
M10 x 1.5	36.0	26.5
M12 x 1.75	67.0	49.4
M14 x 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

<b>F. Standard Torque Specification for all Nylon fasteners and Nuts</b>		
	Torque (N-m)	Torque (ft-lbs)
M3 x .5	0.1	0.07
M4 x .7	0.2	0.15
M5 x .8	0.5	0.37
M6 x 1.0	1.0	0.74
M8 x 1.25	2.0	1.4
M10 x 1.5	3.0	2.2
M12 x 1.75	4.0	3.0
M14 x 2.0	6.0	4.4
M16 x 2.0	7.5	5.5

Figure 9-11 EG-00010 Sheet 5 of 5, Torque Specification

<b>FANUC ROBOTICS ENGINEERING GUIDELINE</b>		
<b>Title: Mechanical Development Torque Specifications</b>		
<b>G. Standard Torque Specification for all Brass fasteners and Nuts</b>		
	<b>Torque (N·m)</b>	<b>Torque (ft-lbs)</b>
M2 x .4	0.14	0.10
M2.5 x .45	0.29	0.21
M3 x .5	0.5	0.37
M4 x .7	1.2	0.9
M5 x .8	2.2	1.6
M6 x 1.0	3.9	2.9
M8 x 1.25	9.0	6.6
M10 x 1.5	17.0	12.5

**Figure 9-12 EG-00167, Zinc Free Robot Grease**

**FANUC ROBOTICS ENGINEERING GUIDELINE**

**Title:** Zinc Free Robot Grease

**Page 1 of 1**

**EG #:** EG-00167

**Subject:** Zinc free Robot Greases to be used as a replacement for Fanuc Robotic standard robot greases LG-01-02 and LG-03..

**Purpose:** These zinc free greases can be used as a replacement for LG-01-02 and LG-03 robot greases for customers that require no heavy metals in the grease formulation. The corresponding zinc free robot greases will have the designations LG-01-02-ZF and LG-03-ZF. These new greases have a non metallic anti-wear additive to replace the zinc base anti-wear additives.

**Grease part number cross reference chart:**

Grease	Size	Standard Fanuc Robotics Part No.	Zinc Free Part No.
<b>LG-01-02</b>	Tube – 4.5 oz	SPARE0000000075	HDWMO0000041670
	Pail – 35 Lb	SPARE0000000505	HDWMO0000041680
	Keg – 120 lb	SPARE0000000497	HDWMO0000041690
<b>LG-03</b>	Tube – 4.5 oz	HDWMO000002580O	HDWMO0000041700
	Pail – 35 Lb	HDWMO000002324O	HDWMO0000041710
	Keg – 120 lb	HDWMO00002325O	HDWMO0000041720

**Designation:**

NLGI Grade	Standard Formulation	Zinc Free Formulation
<b>0</b>	<b>LG-01-03</b>	<b>LG-01-03-ZF</b>
<b>1</b>	<b>LG-03</b>	<b>LG-03-ZF</b>

Figure 9-13 EG-00316 Sheet 1 of 5, Gear Head Mounting Instructions

**BAYSIDE GEAR REDUCER**

**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.

UNLESS OTHERWISE NOTED:  
 SEE EG-00008 FOR LOCTITE REQUIREMENTS  
 SEE EG-00010 FOR TORQUE SPECIFICATIONS

## Gearhead Mounting Instructions

**Featuring ... Patented ServoMount Design for Optimum Servo Performance!!!**

Congratulations on your purchase of a Stealth Planetary Gearhead with the exclusive ServoMount mounting system! The following instructions will assist you in mounting the gearhead to your motor. If additional assistance is required, please call Bayside at (516) 484-5353, Monday through Friday, 8:00 am - 7:00 pm EST or visit our website at [www.baysidemotion.com](http://www.baysidemotion.com).

**Parts Supplied**

- Bayside Precision Gearhead with ServoMount option (see Fig. 1)
- Socket Head Cap Screws (4) with Lock Washers
- Allen Wrench

**Mounting Instructions**

Step 1. Remove the threaded plug from the bolt access hole in the rear housing of the gearhead.

Step 2: Rotate the pinion until the head of the pinion bolt is aligned with the pinion screw access hole.

Step 3. Insert the supplied Allen wrench through the pinion bolt access hole into the head of the pinion bolt. This bolt should be loose. Do not tighten it. (Fig 2) NOTE: If the motor shaft has a flat, rotate the motor shaft so that the flat will be opposite to the pinon bolt.

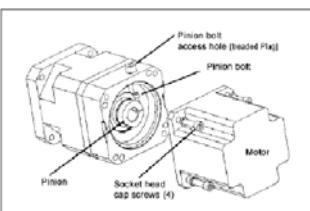


Fig. 1

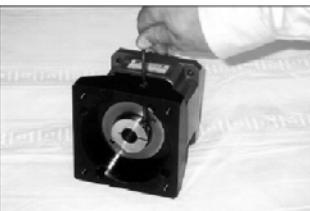


Fig. 2

Frame Size (mm)	Motor Shaft Diameter inches (mm)	Screw Size	Tightening Torque in-lbs. (Nm)		
40	<.250 (<6.35)	2.5	11	1.21	
60	.230 - .630 (5.8 - 16)	M4	41	4.6	
90	.250 - .630 (6.4 - 16.0) .630 - .748 (16.0 - 19.0)	M4 M5	41 84	4.6 9.5	
115	.375 - .751 (9.5 - 19.1) .787 - .946 (20.0 - 24.0)	M5 M6	84 140	9.5 16	
142	.500 - .945 (12.7 - 24.0) 1.00 - 1.379 (25.4 - 35.0)	M6 M8	140 345	16 39	
180	.624 - 1.378 (15.8 - 35.0) 1.496 - 1.654 (38.0 - 42.0)	M8 M10	345 681	39 77	
220	.945 - 1.388 (25.4 - 35.2) 1.496 - 2.165 (38.0 - 55.0)	M10 M12	681 1195	77 135	
300	All	All	M12	1195	135

[EG-00316]  
 Gear Head Mounting Instructions  
 REV D2  
 SHEET 1 OF 5

**Figure 9-14 EG-00316 Sheet 2 of 5, Gear Head Mounting Instructions**

# Alpha Gear Reducer

**Alpha Gear Reducers - CV models**

**Motor mounting**  
All gear reducers are treated with an anti-corrosion agent at the gear input and output.

Before mounting the gear reducer, remove any trace of anti-corrosion agent. Use a clean cloth moistened with a suitable cleaning agent (fat dissolving but non-aggressive).

Use calibrated torque wrenches for the respective torque range.

A setscrew and a slit spacer sleeve connect the motor shaft and the gear drive shaft.

Clean the mounting surfaces of the motor and gear reducer with a clean cloth. Check the surfaces for impurities and damage. Do not put any devices into operation that show evidence of damage.

Turn the clamping hub so that the setscrew can be reached through the mounting holes in the adapter flange.

Take care that the slot of the spacer sleeve is positioned 90° to the setscrew. Readjust the spacer sleeve if necessary.

Loosen the setscrew in the clamping hub by one turn.

Make sure that the motor allows itself to be moved into position "easily".

Position the motor so that the mounting surfaces fit together.

There is to be no gap between the motor and adapter flange.

Coat the motor mounting bolts with Loctite 242 and-screw the motor to the adapter flange. Torque motor mounting bolts.

Turn setscrew in the clamping hub to the tightening torque per chart.

Gear reducer size	Tightening Torque (N·M)	Hex Size mm
CV 040	5.6	3
CV 060	9.5	4
CV 080	23	5
Cv 115	45	6

**Output Shaft Mounting**

Mount gears, pulleys or drive shafts to output without forcing. Never force or hammer.

During assembly, do not exceed the axial force per table below.

Gear reducer size	040	060	080	115
Max Force (N)	230	750	1600	2100

**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.

UNLESS OTHERWISE NOTED:  
SEE EG-00008 FOR LOCTITE REQUIREMENTS  
SEE EG-00010 FOR TORQUE SPECIFICATIONS

Figure 9-15 EG-00316 Sheet 3 of 5, Gear Head Mounting Instructions

**ZF Gear Reducer**

## Assembly Instructions

ZF-Servoplan PGE - Planetary Gearboxes

 ZF Maschinenantriebe GmbH  
ZF Industrial Drives

**General:**

A torsionally rigid and backlash free connection between motor and gearbox can quickly and easily be achieved by using the following assembly instructions.

**Note:** Please only use motors with a flange face and run out accuracy class DIN 42955 N or DIN 42955 R.

To avoid misalignment inside the power train, the PGE utilizes our new "open centering" design making the laborious task of centering with the flange and pilot obsolete. Simply slip the gearbox hollow shaft (6) over the motor shaft, tighten the clamping bolt (7) on the compression coupling (5), and attach the gearbox to the motor using the mounting holes (10).

The PGE planetary gearboxes are maintenance free and have lifetime lubrication.

**Motor Mounting Instructions:**

1. If the motor shaft has a key (2), remove it. For applications with motor speeds over 3000 rpm, we recommend using a half key to completely fill the key way. The key may not stand out above the height of the motor shaft.
2. Remove vent plug (3) on the adapter flange (4) and put it aside, reserving it for later use.
3. Turn the compression coupling (5) until the head of the clamping bolt (7) is visible through the access hole.
4. If a PGE with an adapter flange (4) screwed on, is not directly mounted on the motor by using the adapter flange (4), then the adapter flange (4) must be removed from the PGE. Remove four hexagonal socket-head screws (8), then pull off the adapter flange (4) from the PGE.
5. Examine all contact surfaces on the motor flange and the adapter flange (4) to ensure they are clean and grease free. Also inspect the motor shaft and the hub to ensure they are free from damage (burrs, scoring, etc.).
6. Place motor (1) vertically on the work surface and secure it from falling. Ensure that the key way in the motor shaft is positioned opposite the slit (180°) in the compression coupling when assembled.
7. If a reduction bushing is used, ensure the slit in the bushing is aligned with the compression coupling slit.
8. If motor installation is as described under 4., then the previously removed adapter flange (4) must be placed onto the motor flange surface and then screwed on.
9. If the PGE is too heavy to lift manually, a suitable hoisting machine should be used. Slip gearbox hollow shaft (6) over motor shaft until the adapter flange mates with the motor flange over its **entire** surface. Do not strike the gearbox or use excessive force to ensure a good fit.
10. Tighten the clamping bolt (7) to the prescribed torque (see table tightening torque) using a suitable torque wrench (9).
11. Now bolt PGE with adapter flange (4) directly on motor (1) or, if you have a motor installation as described under 4., bolt the PGE onto adapter flange (4). Screws (8) must be diagonally transferred and evenly tightened.
12. Then bolt PGE and motor together using the mounting holes (10) in the adapter flange. The bolts must be diagonally transferred and uniformly tightened.
13. Insert access hole plug (3) into adapter flange (4).

**Note:** Failure to follow assembly instructions may lead to gearbox and/or motor damage and will void any warranty either explicit or implied.

**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.

UNLESS OTHERWISE NOTED:  
SEE EG-00008 FOR LOCTITE REQUIREMENTS  
SEE EG-00010 FOR TORQUE SPECIFICATIONS

tightening torque for the clamping bolt (7)	
clamping screw DIN 912	tightening torque
M3	2,1 Nm
M4	4,2 Nm
M5	8,3 Nm
M8	43 Nm

**View A**

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Version:19.07.2004

[EG-00316]  
Gear Head Mounting Instructions

REV D2  
SHEET 3 OF 5

Figure 9-16 EG-00316 Sheet 4 of 5, Gear Head Mounting Instructions

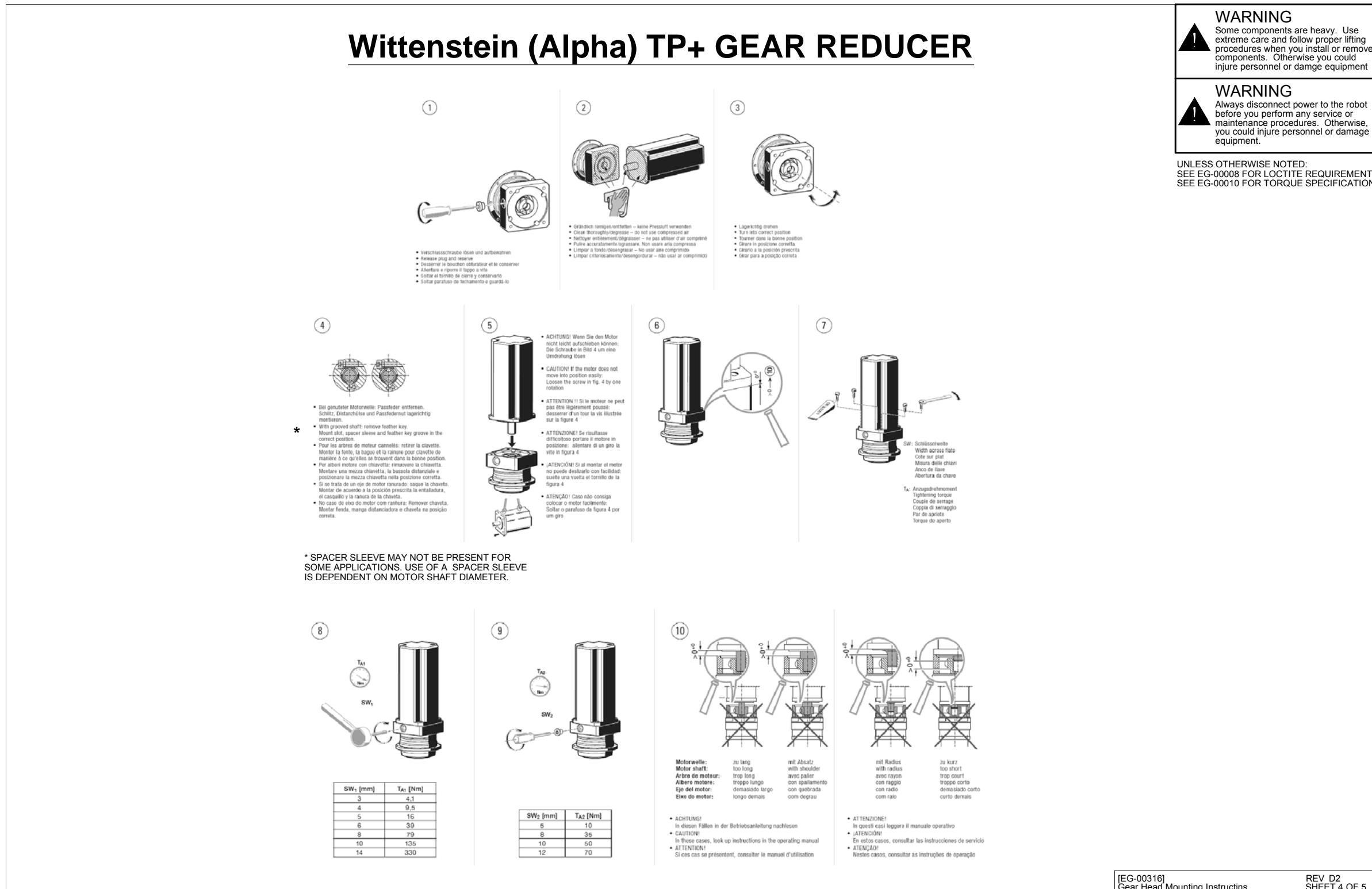
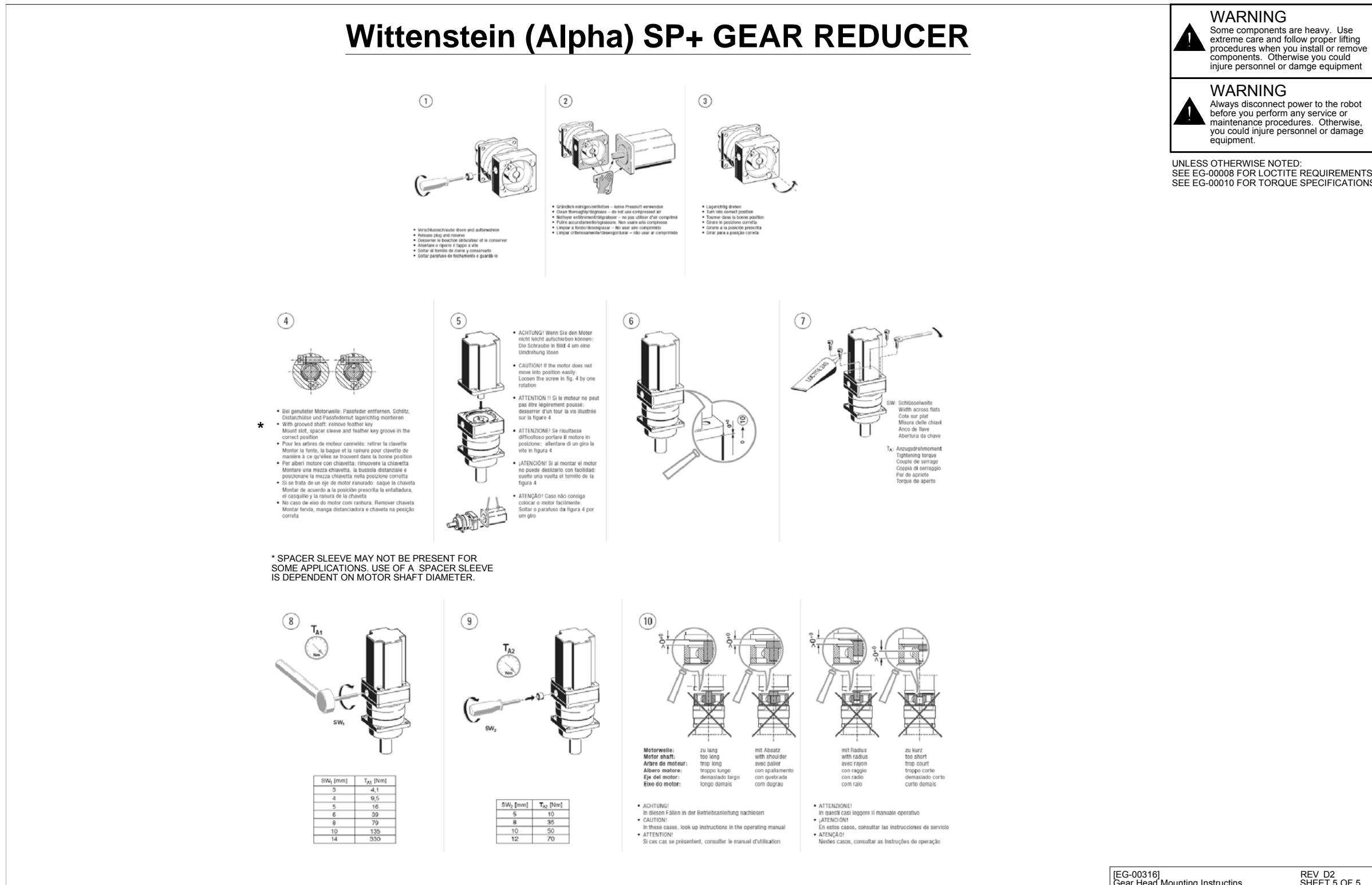


Figure 9-17 EG-00316 Sheet 5 of 5, Gear Head Mounting Instructions

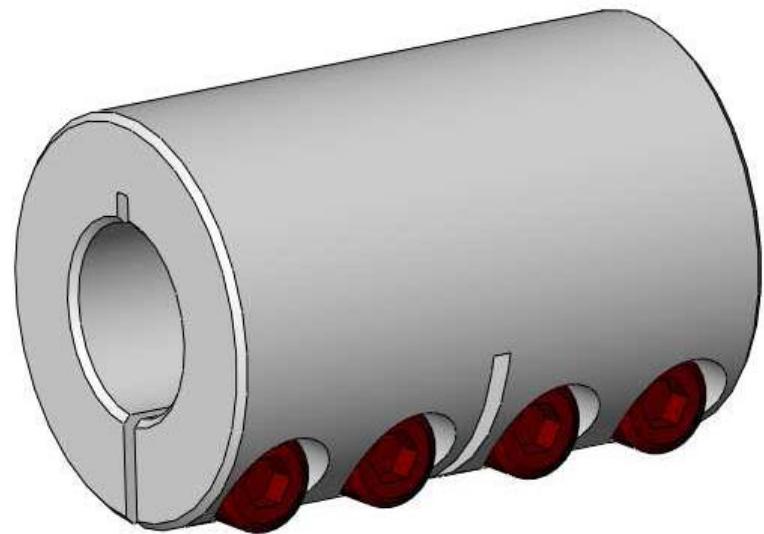


**Figure 9-18 EG-00540 Sheet 1 of 3, P50iB Ruland Rigid Couplings Installation Procedure****FANUC ROBOTICS ENGINEERING GUIDELINE**  
**Title: P50iB Ruland Rigid Couplings Installation Procedure**

Page 1 of 3

EG #: EG-00540

**Purpose:** To describe proper Ruland one piece rigid shaft couplings installation procedure in the P50iB robot

**1) Ruland rigid coupling assembly view:**

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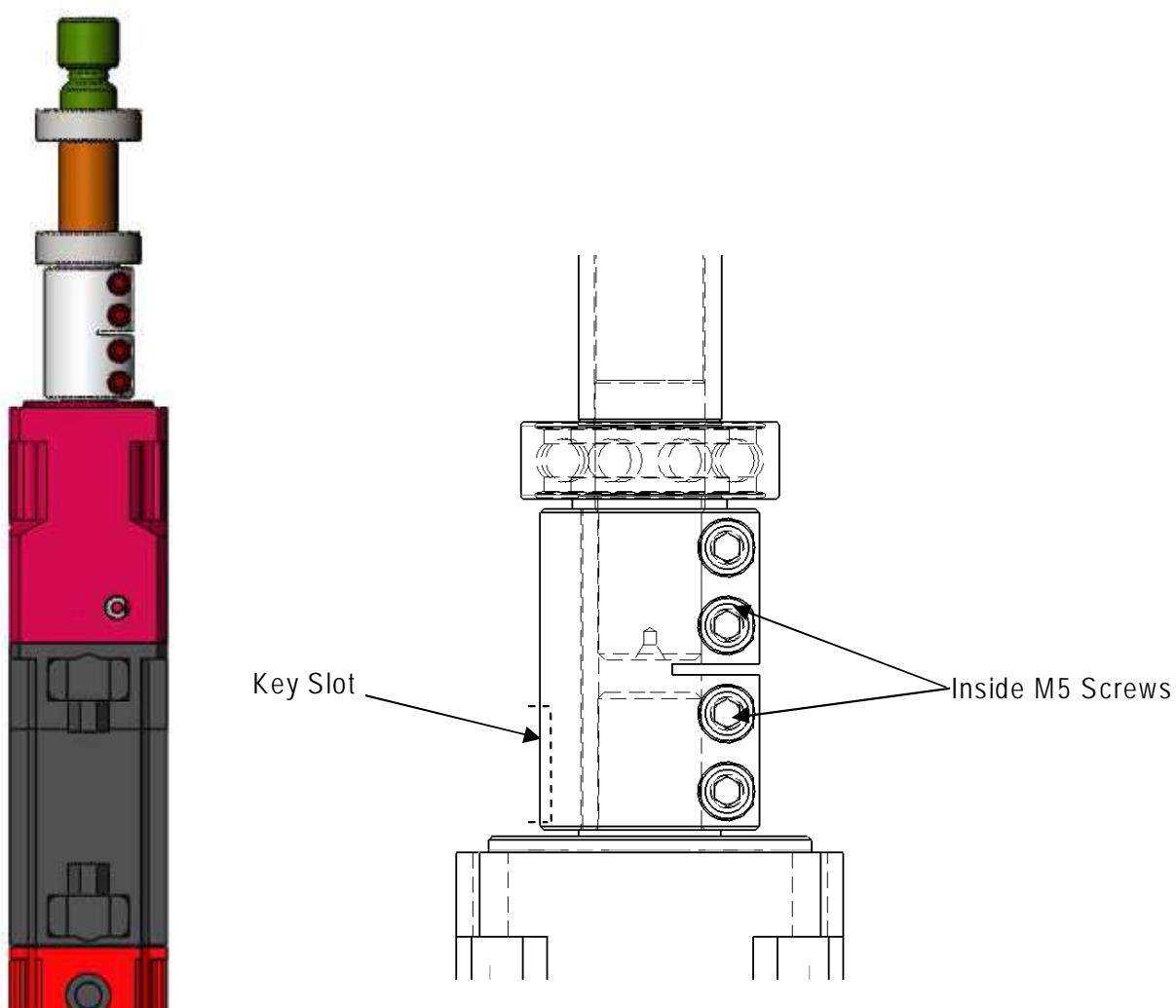
**Figure 9-19 EG-00540 Sheet 2 of 3, P50iB Ruland Rigid Couplings Installation Procedure**

**FANUC ROBOTICS ENGINEERING GUIDELINE**  
**Title: P50iB Ruland Rigid Couplings Installation Procedure**

Page 2 of 3  
EG #: EG-00540

**1) P50iB Ruland one piece rigid shaft couplings installation procedure:**

- Align the coupling on the two shafts to be connected in vertical position as shown with reducer key removed & coupling split opposite to the reducer keyway (see detail transparent view).



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**Figure 9-20 EG-00540 Sheet 3 of 3, P50iB Ruland Rigid Couplings Installation Procedure**

**FANUC ROBOTICS ENGINEERING GUIDELINE**  
**Title: P50iB Ruland Rigid Couplings Installation Procedure**

Page 3 of 3  
EG #: EG-00540

- Tighten the Nypatch® clamp screws in two stages. Starting with the inside M5 screws, tighten to half of the recommended seating torque (see Table 1). Repeat for the outside screws, again tightening to half of the recommended seating torque.
- After inserting pre-assambled wrist pinions with bearings, spacers, motors & reducers into the wrist housing using its holes corresponding to each couplings - tighten couplings M5 screws to the full recommended seating torque (see Table 1) following the same pattern, beginning with the inside screws first.

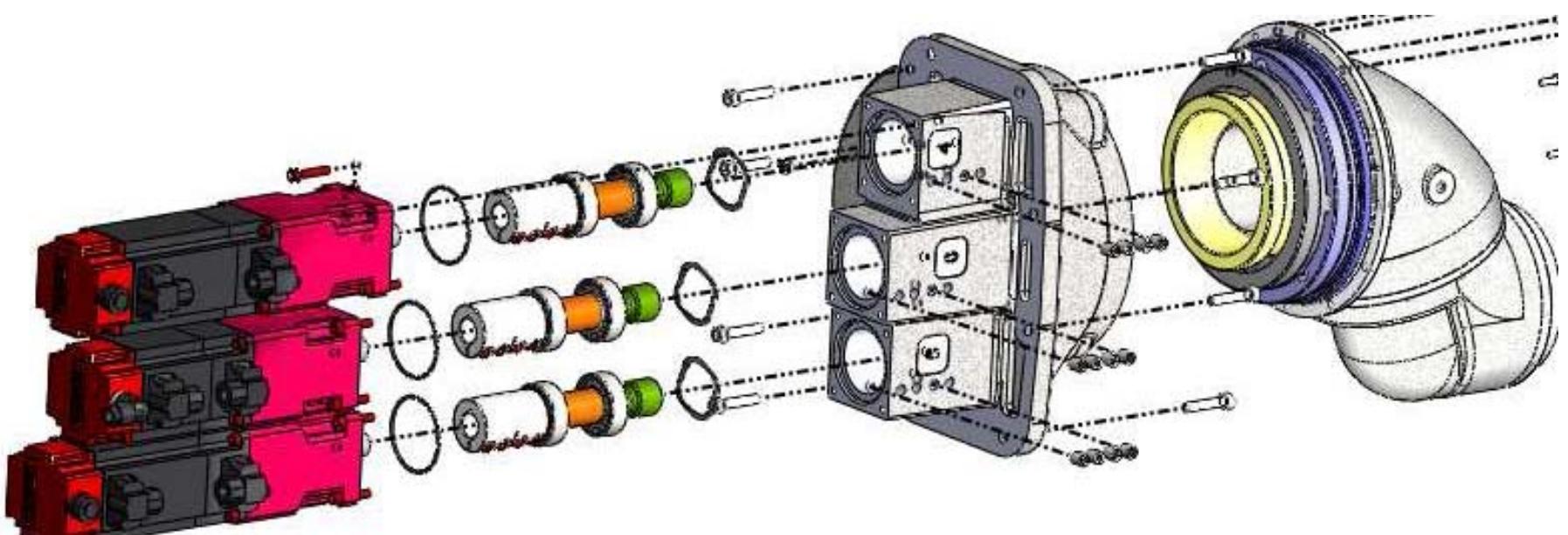


TABLE 1. Hardware Torque Chart

Metric Forged Socket Cap Screws

Metric Clamp Screw	Seating Torque (Nm) Alloyfi
M5	9.5

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## 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.
PCE	Process Control Enclosure.
PD	Purge dump
PDP	Power distribution panel
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.
PLC	Programmable logic controller
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 Polytetraflouoroethylene

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.

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