

Motoman NX100 Controller

Process World

System Manual

Part Number:	156579-1
Release Date:	April 28, 2009
Document Version:	0



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Chapter 1

Introduction

The Process World system is part of the Process World family of standardized Process World solutions. It is a fully integrated system, and is fully supported by Motoman, Inc.

1.1 Scope and Intended Use

This Process World is intended to perform quality inspection of machine components within the equipment capacity limits stated in this manual. Component inspection is accomplished by mounting the component to be tested on the rotating positioner table. Using an industrial robot synchronized to the rotation of the positioner table, the robot maneuvers a test probe along the inside and outside of the component's surfaces detecting imperfections.

1.2 About This Document

This manual is intended as an introduction and overview for personnel who have received operator training from Motoman, and who are familiar with the operation of this Motoman robot model. For more detailed information, refer to the manuals listed in Section 1.3. This manual contains the following sections:

SECTION 1 - INTRODUCTION

This section provides general information about the Process World and its components, a list of reference documents, and customer service information.

SECTION 2 - SAFETY

This section provides information regarding the safe use and operation of the Process World system.

SECTION 3 - DESCRIPTION OF EQUIPMENT

This section provides a detailed description of the major components of the Process World system. This section also includes a table of component specifications.

SECTION 4 - INSTALLATION

This section provides instructions for set up and installation of the Process World system.

SECTION 5 - OPERATION

This section provides instructions for basic operation of the Process World system. This section also provides procedures for start-up, loading, normal operation, fault recovery, and shutdown. Sample robot programs are also included in this section.

SECTION 6 - MAINTENANCE

This section contains a table listing periodic maintenance requirements for the components of the Process World cell.

1.3 System Overview

Motoman's classic robotic solutions are high-performance, pre-engineered workcells that are ideal for part inspection at medium to high volumes. Fully integrated Process World series workcells feature a high-speed, servo-driven, rotary positioner, one high performance Motoman robot, a controller, operator interface, and a total safety environment. Safety features include load station(s) interlocked with dual-channel safeguards, interlocked access doors on each side of the cell, safety fencing, and safety barrier.

Figure 1 illustrates the system layout of the Process World cell.

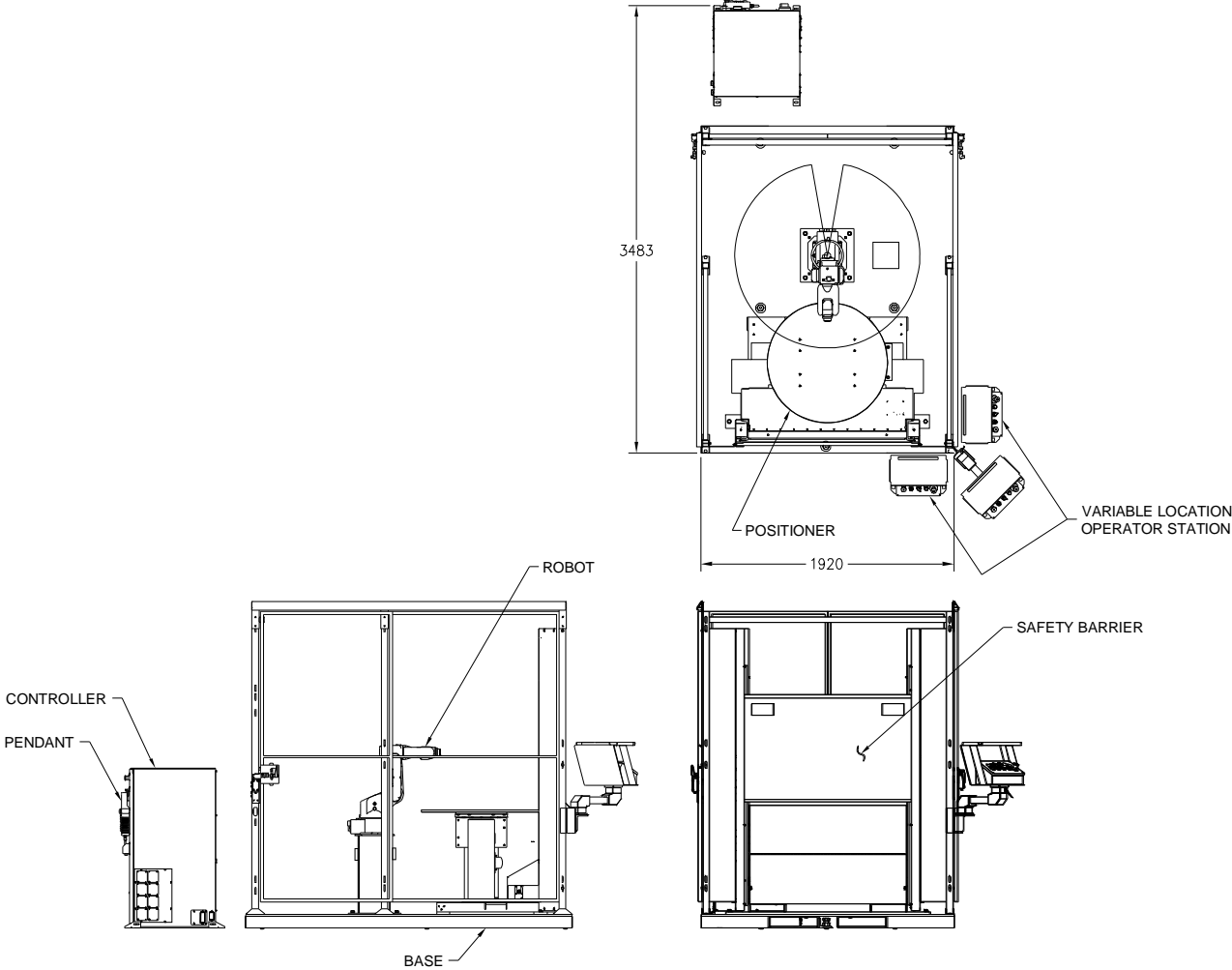


Figure 1 System Layout



Note: This manual is for a standard Motoman system. If your system is a custom or modified system, please use the drawing and Bill of Material (BOM) provided with the system for troubleshooting and spares provisioning.

1.3.1 System Layout

The main components of Process World are attached to the platform work cell base. The robot and positioner are fully enclosed by safety fencing and interlocking doors on each side of the work cell. A roll-up safety barrier in front of the cell provides a safety zone preventing the operator from entering the operating zone of the robot and positioner while in operation. All operator controls, including those in the controller are accessible from the outside of the robotic enclosure.

1.3.2 Major Components

The Process World includes the following major components:

- A Motoman manipulator and controller
- MSR-200 rotary positioner
- Operator station
- Safety equipment, including the following:
 - Safety fencing with safety barrier
 - Safety barrier interlock
 - Interlocked cell door

1.4 Reference to Other Documentation

For additional information refer to the following:

- Motoman Manipulator Manual
- Motoman Controller Manual
- Motoman Concurrent I/O Parameter Manual
- Motoman Positioner Manual
- Vendor manuals for system components not manufactured by Motoman

1.5 Customer Service Information

If you are in need of technical assistance, contact the Motoman service staff at (937) 847-3200. Please have the following information ready before you call:

- Robot Type
- Application Type (General)
- System Type (Process World)
- Software Version (access using MAIN MENU, SYSTEM INFO, VERSION on programming pendant)

- Robot Serial Number (located on back side of robot arm)
- Robot Sales Order Number (located on front door of controller)

NOTES

Chapter 2

Safety

2.1 Introduction

It is the purchaser's responsibility to ensure that all local, county, state, and national codes, regulations, rules, or laws relating to safety and safe operating conditions for each installation are met and followed.

We suggest that you obtain and review a copy of the ANSI/RIA National Safety Standard for Industrial Robots and Robot Systems. This information can be obtained from the Robotic Industries Association by requesting ANSI/RIA R15.06-1999. The address is as follows:

Robotic Industries Association
900 Victors Way
P.O. Box 3724
Ann Arbor, Michigan 48106
TEL: (734) 994-6088
FAX: (734) 994-3338
INTERNET: www.roboticsonline.com

Ultimately, the best safeguard is trained personnel. The user is responsible for providing personnel who are adequately trained to operate, program, and maintain the robot cell. **The robot must not be operated by personnel who have not been trained!**

We recommend that all personnel who intend to operate, program, repair, or use the robot system be trained in an approved Motoman training course and become familiar with the proper operation of the system.

This safety section addresses the following:

- Standard Conventions (Section 2.2)
- General Safeguarding Tips (Section 2.3)
- Mechanical Safety Devices (Section 2.4)
- Installation Safety (Section 2.5)
- Programming, Operation, and Maintenance Safety (Section 2.6)

2.2 Standard Conventions

This manual includes the following alerts – in descending order of severity – that are essential to the safety of personnel and equipment. As you read this manual, pay close attention to these alerts to insure safety when installing, operating, programming, and maintaining this equipment.



DANGER!

Information appearing in a DANGER concerns the protection of personnel from the immediate and imminent hazards that, if not avoided, will result in immediate, serious personal injury or loss of life in addition to equipment damage.



WARNING!

Information appearing in a WARNING concerns the protection of personnel and equipment from potential hazards that can result in personal injury or loss of life in addition to equipment damage.



CAUTION!

Information appearing in a CAUTION concerns the protection of personnel and equipment, software, and data from hazards that can result in minor personal injury or equipment damage.



Note: Information appearing in a Note provides additional information which is helpful in understanding the item being explained.

2.3 General Safeguarding Tips

All operators, programmers, plant and tooling engineers, maintenance personnel, supervisors, and anyone working near the robot must become familiar with the operation of this equipment. All personnel involved with the operation of the equipment must understand potential dangers of operation. General safeguarding tips are as follows:

- Improper operation can result in personal injury and/or damage to the equipment. Only trained personnel familiar with the operation of this robot, the operator's manuals, the system equipment, and options and accessories should be permitted to operate this robot system.
- Do not enter the robot cell while it is in automatic operation. Programmers must have the teach pendant when they enter the robot cell.
- Improper connections can damage the robot. All connections must be made within the standard voltage and current ratings of the robot I/O (Inputs and Outputs).
- The robot must be placed in Emergency Stop (E-STOP) mode whenever it is not in use.
- In accordance with ANSI/RIA R15.06-1999, section 4.2.5, Sources of Energy, use lockout/tagout procedures during equipment maintenance. Refer also to Section 1910.147 (29CFR, Part 1910), Occupational Safety and Health Standards for General Industry (OSHA).

2.4 Mechanical Safety Devices

The safe operation of the robot, positioner, auxiliary equipment, and system is ultimately the user's responsibility. The conditions under which the equipment will be operated safely should be reviewed by the user. The user must be aware of the various national codes, ANSI/RIA R15.06-1999 safety standards, and other local codes that may pertain to the installation and use of industrial equipment. Additional safety measures for personnel and equipment may be required depending on system installation, operation, and/or location. The following safety equipment is provided as standard:

- Safety fences and barriers
- Door interlocks
- Emergency stop palm buttons located on operator station, robot controller, and programming pendant

Check all safety equipment frequently for proper operation. Repair or replace any non-functioning safety equipment immediately.

2.5 Installation Safety

Safe installation is essential for protection of people and equipment. The following suggestions are intended to supplement, but not replace, existing federal, local, and state laws and regulations. Additional safety measures for personnel and equipment may be required depending on system installation, operation, and/or location. Installation tips are as follows:

- Be sure that only qualified personnel familiar with national codes, local codes, and ANSI/RIA R15.06-1999 safety standards are permitted to install the equipment.
- Identify the work envelope of each robot with floor markings, signs, and barriers.
- Position all controllers outside the robot work envelope.
- Whenever possible, install safety fences to protect against unauthorized entry into the work envelope.
- Eliminate areas where personnel might get trapped between a moving robot and other equipment (pinch points).
- Provide sufficient room inside the workcell to permit safe teaching and maintenance procedures.

2.6 Programming, Operation, and Maintenance Safety

All operators, programmers, plant and tooling engineers, maintenance personnel, supervisors, and anyone working near the robot must become familiar with the operation of this equipment. Improper operation can result in personal injury and/or damage to the equipment. Only trained personnel familiar with the operation, manuals, electrical design, and equipment interconnections of this robot should be permitted to program, operate, and maintain the system. All personnel involved with the operation of the equipment must understand potential dangers of operation.

- Inspect the robot and work envelope to be sure no potentially hazardous conditions exist. Be sure the area is clean and free of water, oil, debris, etc.
- Be sure that all safeguards are in place. Check all safety equipment for proper operation. Repair or replace any non-functioning safety equipment immediately.
- Do not enter the robot cell while it is in automatic operation. Be sure that only the person holding the programming pendant enters the workcell.
- Check the E-STOP button on the programming pendant for proper operation before programming. The robot must be placed in Emergency Stop (E-STOP) mode whenever it is not in use.
- Back up all programs and jobs onto suitable media before program changes are made. To avoid loss of information, programs, or jobs, a backup must always be made before any service procedures are done and before any changes are made to options, accessories, or equipment.

- Any modifications to PART 1, System Section, of the robot controller concurrent I/O program can cause severe personal injury or death, as well as damage to the robot! Do not make any modifications to PART 1, System Section. Making any changes without the written permission of Motoman will VOID YOUR WARRANTY!
- Some operations require standard passwords and some require special passwords. Special passwords are for Motoman use only. YOUR WARRANTY WILL BE VOID if you use these special passwords.
- The robot controller allows modifications of PART 2, User Section, of the concurrent I/O program and modifications to controller parameters for maximum robot performance. Great care must be taken when making these modifications. All modifications made to the controller will change the way the robot operates and can cause severe personal injury or death, as well as damage the robot and other parts of the system. Double-check all modifications under every mode of robot operation to ensure that you have not created hazards or dangerous situations.
- Check and test any new or modified program at low speed for at least one full cycle.
- This equipment has multiple sources of electrical supply. Electrical interconnections are made between the controller and other equipment. Disconnect and lockout/tagout all electrical circuits before making any modifications or connections.
- Do not perform any maintenance procedures before reading and understanding the proper procedures in the appropriate manual.
- Use proper replacement parts.
- Improper connections can damage the robot. All connections must be made within the standard voltage and current ratings of the robot I/O (Inputs and Outputs).

NOTES

Chapter 3

Equipment Description

3.1 Controller

The robotic controller features a Windows® CE programming pendant with color touch screen, high-speed processing, built-in Ethernet, and a robust PC architecture. The Controller can easily handle multiple tasks and I/Q devices. Advanced Robot Motion (ARM) control provides high-performance accuracy and vibration control.

The Controller coordinates the operation of the Process World system. It controls manipulator movement, processes input and output signals, and provides the signals to operate the system. It maintains variable data and performs numeric processing to convert to and from different coordinate systems. In addition, the controller provides main logic functions, servo control, program and constant data memory, and power distribution. For more information refer to the controller manual that came with your system.

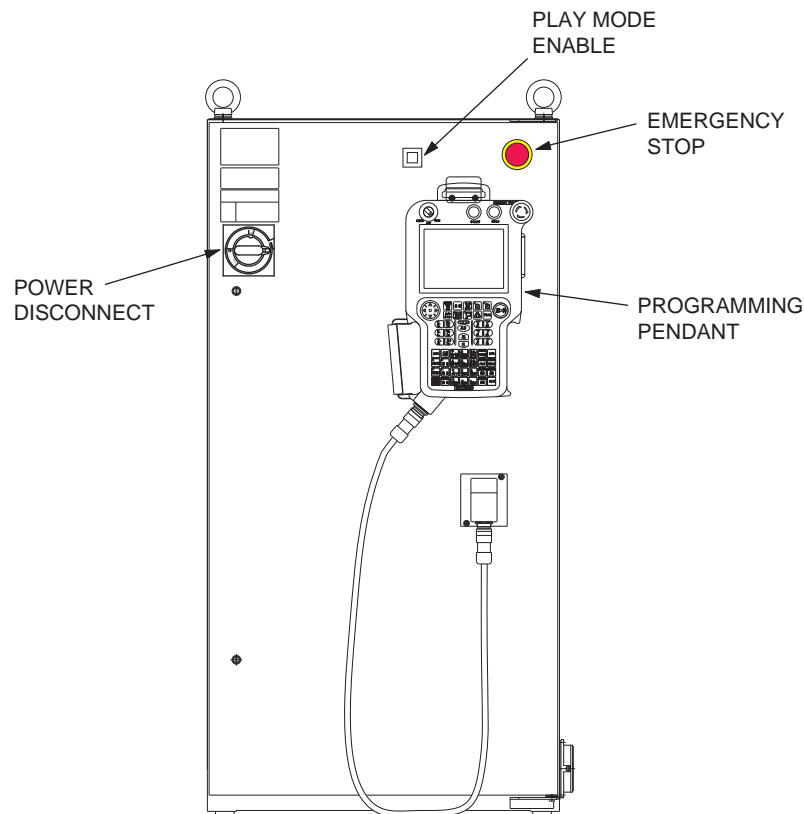


Figure 2 The NX100 style Controller shown is for reference only. Your controller may vary slightly depending on controller platform

3.1.1 Programming Pendant

The programming pendant (see Figure 3) is the primary user interface for the system and features a cross-shaped navigation cursor that reduces teaching time by 30 percent. The pendant has a full color touch screen display and provides a convenient Compact Flash slot for easy memory back-ups. The system uses the INFORM III robot language and a menu-driven interface to simplify operator interaction with the robot.

Most operator controls are located on the pendant, allowing the control cabinet to be mounted remotely. An optional on-line troubleshooting guide for expert system maintenance is also available on the pendant. By using the pendant, the operator can teach robot motion, and perform programming, editing, maintenance, and diagnostic functions. For more information, refer to the operator's manual that came with your system.



Note: The programming pendant display goes into screen saver mode after a few minutes of inactivity. Press any key to restore screen.

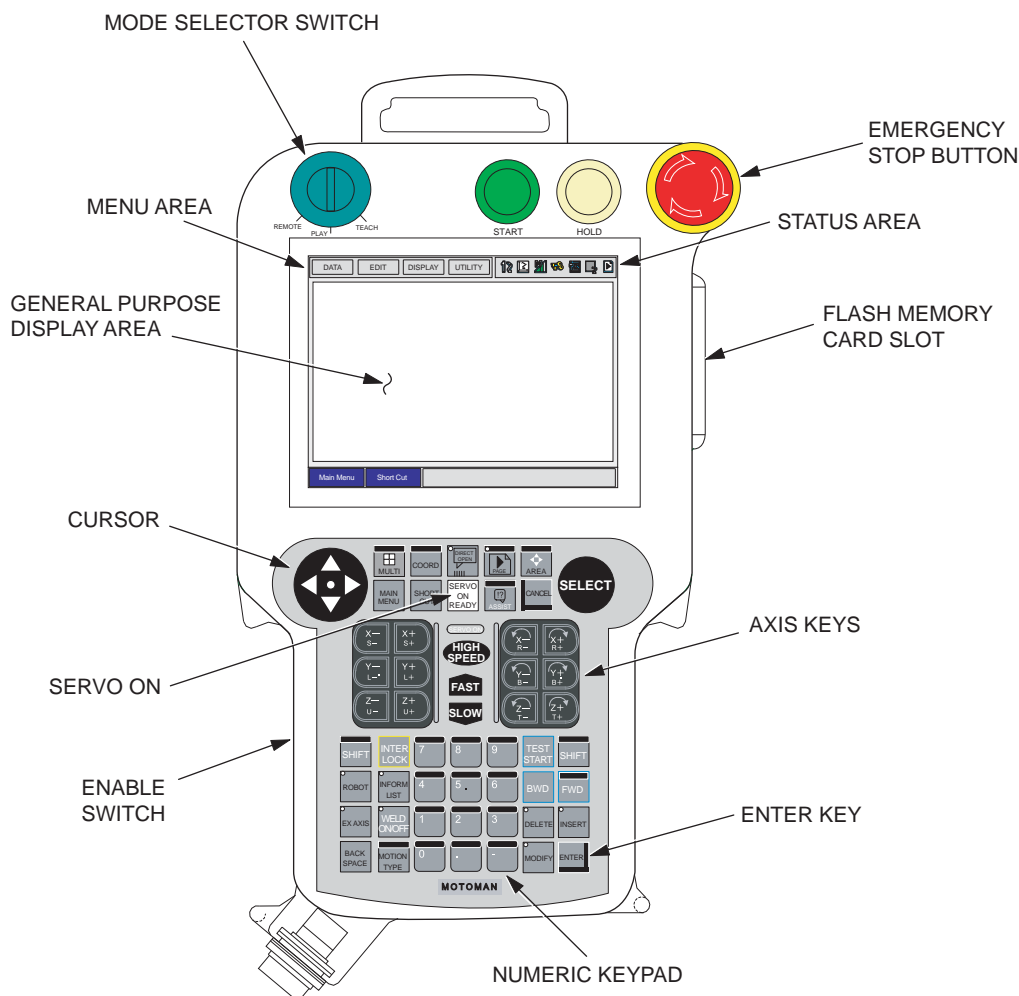


Figure 3 The NX style Programming Pendant is shown for reference only. Pendant may vary depending on controller platform.

Mode Selector Switch

The Mode Selector Switch allows the operator to select Remote, Play or Teach mode. In Remote mode, control of the system is transferred to the operator station. When Play or Teach is selected, the programming pendant controls system operation. When Play mode is selected on the programming pendant, the operator must also press the PLAY ENABLE button on the controller door to initiate Play mode.

Menu Area

The Menu Area contains menu selections for the currently selected screen.

General Purpose Display Area

The General Purpose Display Area displays the currently selected menu choice.

Emergency Stop (E-STOP)

Pressing the E-STOP button puts the controller in Emergency Stop and stops all system operation.

Keypad

The user keypad on the programming pendant serves as an input device. The keys are grouped into different functional sections to simplify operator use.

Status Area

The Status Area shows system status via the following symbols:

- Active Robot, External Axis, or Base Axis
R1, R2, R3; S1, S2, etc.; or B1, B2, etc.
- Coordinate System
Joint, World, Cylindrical, Tool, or User Frame
- Manual Speed Setting
Inching, Low, Medium, or High
- Cycle Mode
Step, 1-Cycle, or Auto
- System Status
E-Stop, Stop, Running/Start, Hold, or Alarm
- Additional Pages (when applicable)

MAIN MENU Key

The MAIN MENU key returns the pendant display to the initial start-up menu. Use the cursor key or the touch screen to choose from the following menu options:

- JOB
This option accesses job selections including: Master Job, Select Job, Job Capacity, and Create New Job while in TEACH mode.
- VARIABLE
This option accesses the display and editing menu for the arithmetic variables and display of position variables.
- IN/OUT
This option accesses DETAIL and SIMPLE displays of all XRC I/O signals. In EDITING or MAINT. mode, Universal Outputs can be forced ON or OFF.
- ROBOT
This option accesses robot information including: CURR.POS, POWER ON/OFF, POS, COMMAND POS, SECOND HOME POS, OPE ORIGIN POS, and TOOL and USER COORDINATE.
- SYSTEM INFO
This option provides Version information for both hardware and software, Alarm History, and Monitoring Time.
- FD/CF
This option accesses menu choices for FD (floppy disk) or CF (compact flash) program backup.
- SETUP
This allows the user to set up system conditions and assign hot keys.

AREA Key

The Area key moves the cursor to the different areas of the display screen.

CURSOR Key

The Cursor key is an 8-way, directional key that moves the up, down, left or right to highlight a desired item that can then be chosen using the SELECT key.

SELECT Key

The SELECT key is used to choose the item currently highlighted by the cursor.

FLASH MEMORY Slot

The compact FLASH MEMORY card slot allows for easy memory backups.

ENABLE Switch

The ENABLE switch (see Figure 4) is a three-position switch located on the left rear of the programming pendant. It is a safety feature that controls servo power while in TEACH mode. When pressed in, this switch enables servo power to be turned on. However, should the operator release the switch, or grasp it too tightly, servo power is immediately removed, preventing further robot movement.

SERVO ON Key

When the pendant is in TEACH mode, The SERVO ON key turns servo power ON when the ENABLE switch is activated. When the pendant is in PLAY mode, the SERVO ON key turns servo power on.

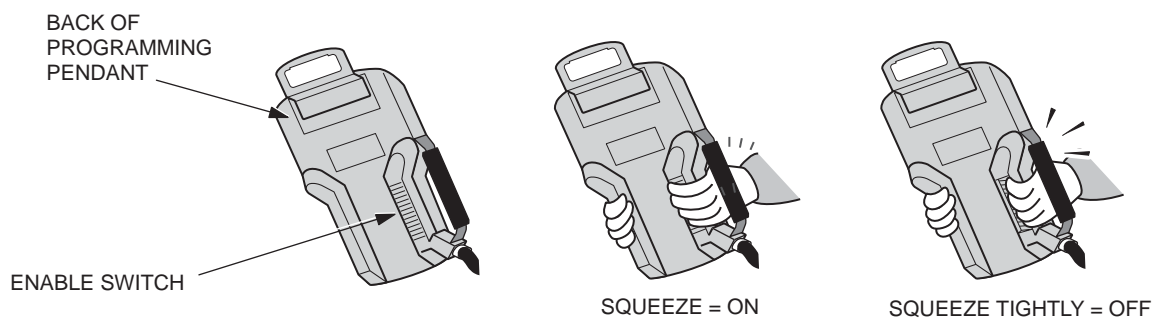


Figure 4 Enable Switch

3.2 Operator Station

The operator station (see Figure 5) includes a NEMA enclosure that is fence mounted. The following paragraphs describe the operator station controls.

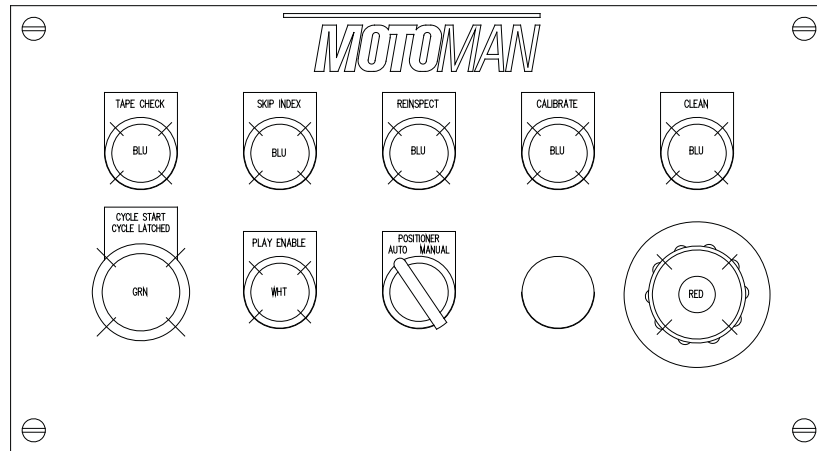


Figure 5 Operator Station

Cycle Start/Cycle Latched

The operation of the CYCLE START/CYCLE LATCHED button is dependent on the structure of the Master job. Altering the Master job could result in injury to personnel or damage to the equipment.

The green CYCLE START/CYCLE LATCHED button, located on the operator station, initiates a job cycle if the robot is in Home position. If the CYCLE START button is pressed while the robot is outside Home position, the CYCLE START command does not execute and the cycle does not start until the robot returns to Home position.

The CYCLE LATCHED lamp illuminates when the CYCLE START button is pressed during operation. When the lamp is illuminated, the job will execute and the robot will begin to move immediately after the current weld cycle is complete. It is not necessary to wait for the robot to finish welding and return to Home position before pressing the CYCLE START button to sweep the positioner. Pressing the CYCLE START button while the robot is still in motion latches the CYCLE START command into the controller. If a person enters the safety zone created by the light curtains, the CYCLE START command will unlatch and the positioner will not sweep.

Emergency Stop (E-STOP)

Pressing an E-STOP button removes servo power and stops all system operation. Brakes are applied to the robot and all positioner motion is stopped.

Positioner Auto/Manual

The POSITIONER AUTO/MANUAL selector switch is used to select AUTOMATIC or MANUAL mode for the positioner. When the selector switch is in the AUTOMATIC position, the robot processes the part after the barrier door raises. In MANUAL mode, the robot does not process the part after the barrier door raises, but remains in Home position.



Note: The Positioner Auto/Manual signal is dependent on the structure of the Master job.

3.3 MSR Positioner

The MSR positioner uses a reciprocating motion to sweep each side of the circular turntable from the operator's loading zone, into the robot's work zone, and back to the operator again. Do not operate this equipment unless the safety barrier is in the full “up” position.



DANGER!

Do not operate this equipment unless the safety barrier is in the full “up” position or damage can occur.

For detailed positioner information, including illustrated parts lists, refer to the Positioner Manual.



Note: In high humidity areas, use surface protection to prevent corrosion of the tooling plates.

3.4 Safety Features

The Process World system includes a total safety environment. When all standard safety precautions are taken, the safety equipment helps to ensure safe operation of the robotic cell. The ANSI/RIA R15.06-1999 Robot Safety Standard stipulates the user is responsible for safeguarding.



Note: Users are responsible for determining whether the provided safeguards are adequate for plant conditions. Users must also ensure that safeguards are maintained in working order.

3.4.1 Fencing

The safety fencing provided with the Process World system encloses the entire robotic cell. It forms a physical barrier preventing entry into the robot cell during automatic operation.

3.4.2 Safety Barrier

The safety barrier helps prevent serious injury to anyone entering the loading zone of the positioner area during the loading process. In PLAY mode, if the positioner is sweeping and the safety zone is violated, servo power is removed from the system and all positioner motion stops. Servo power can be reapplied and the operation resumed by pressing SERVO ON and START.

3.4.3 Emergency Stops (E-STOPS)

In addition to the safety features described above, the Process World has strategically placed E-STOPS. These are operator-actuated devices that, when activated, immediately stop all system operation. Brakes are applied to the robot and all servo power is removed from the system. The following is a list of E-STOP locations:

- The controller door
- The programming pendant
- The operator station

3.4.4 ENABLE Switch

The ENABLE switch is a safety feature which controls servo power while in TEACH mode. When pressed in, this switch allows the operator to turn servo power ON. However, should the operator release the switch or grasp it too tightly, servo power is immediately removed, preventing further robot movement. For detailed information about the operation of the ENABLE switch, refer to the controller manual that came with your system.

3.4.5 Brake Release

The robot brakes are designed to protect the robot and other system components from damage in event of a system or robot failure. The brake release is a safety feature that allows the operator to release the brake of a specific robot axis when drive power has been removed from the system. Use the programming pendant to access the brake release function. Refer to paragraph 3.4.5 for brake release procedures.

3.4.6 Interlocked Cell Door

A safety interlock on the cell entrance door prevents entry into the cell during PLAY mode. If the cell door is opened when the robot is in PLAY mode, brakes are applied to the robot, all servo power is removed from the system, and all positioner motion is stopped.

NOTES

Chapter 4

Installation

The Process World system can be installed easily in just a short amount of time. Follow established safety procedures **at all times** throughout the installation process. Failure to use safe work practices can result in damage to the equipment and injury to the workers.



CAUTION!

Installation of the Process World system is not a task for the novice. The Process World system is not fragile, but it is a highly sophisticated robotic system. Handle components with care. Rough handling can damage system electronic components.

Selected installation equipment should be capable of handling the mass of the Process World components as listed below operated by qualified personnel.

Table 1 Estimated Process World Component Mass

Component Description	Estimated Component Mass (Kg)
Process World Base	700 Kg
Fence	300 Kg
Barrier Assembly	500 Kg
Robot	50 Kg
Controller	250 Kg
Robot Riser	450 Kg
Common Equipment Base & Components	200 Kg
Total	2450 Kg

4.1 Materials Required

All hardware necessary for installing the Process World is included with the system. This section identifies customer-supplied items and tools required to complete installation.

4.1.1 Customer-Supplied Items

- Three-phase power
- One earth ground cable
- Incoming air supply: 0.04 ccm at 620.5 kPa (1.5scfm at 90 psi) for tool changer
- Stepladder
- Forklift and/or overhead crane
- Appropriate hand tools

4.1.2 List of Tools

- Safety glasses
- Face shields
- Gloves
- Level
- Ratchet with 3/4-inch socket
- Adjustable wrench set
- Hammer drill with appropriate concrete bits
- Phillips and flat screwdrivers
- Hammer
- Socket set
- Forklift and/or overhead crane
- Air-impact gun with 3/4-inch socket
- Open-end wrench set
- Two socket-heads (Allen)
- Wrench sets (standard and metric)

4.2 Site Preparation

To prepare your site, proceed as follows:

1. Clear floor space needed for unit (see Figure 6).



Note: To make installation easier, allow an additional 1.2 to 1.5 m (4 to 5 ft) on all sides of cell.

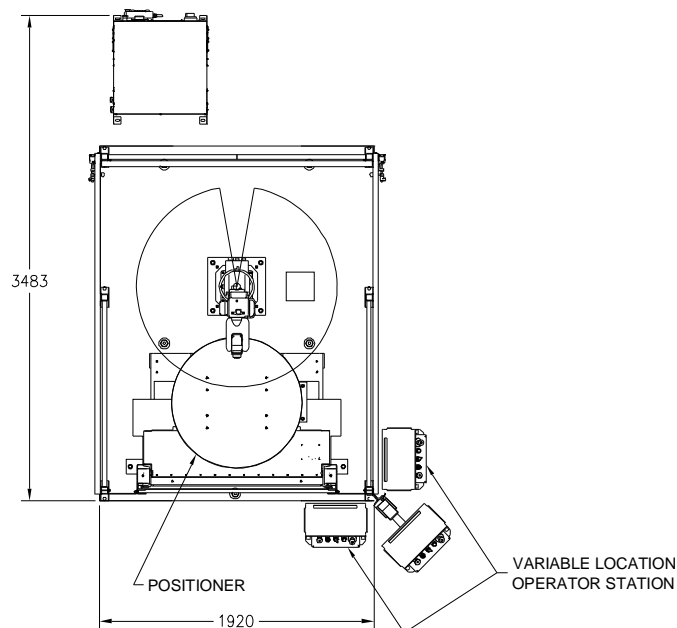


Figure 6 Area Needed for Installation

2. Gather all customer-supplied items and required tools listed in Section 4.1.

4.2.1 Removing the Shipping Bracket



CAUTION!

Failure to remove shipping brackets from robot before operating the Process World may result in damage to the robot drive mechanisms.

A yellow bracket (see Figure 7) prevents the robot from moving during shipping. The bracket secures the lower arm assembly to the S-axis housing. After the robot is in place, remove the shipping bracket.

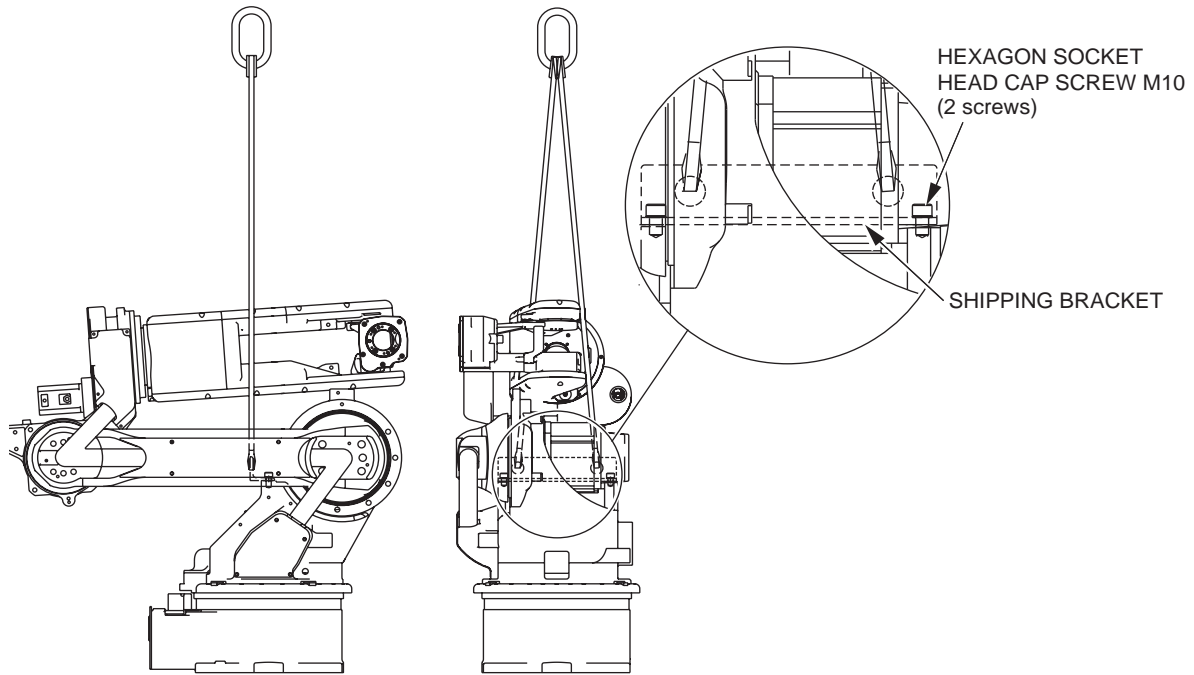


Figure 7 Location of Shipping Brackets

4.2.2 Barrier Shipping Brackets

See Barrier Manual for exact location and shipping bolts removal.

4.3 Installing the Controller

The controller is shipped on a separate wooden shipping skid. To install the controller, proceed as follows:

1. Unbolt the controller from the wooden shipping skid by removing the four shipping bolts.



WARNING!

The controller can weigh as much as 150 kg (330 lbs). Be sure your crane or forklift is capable of handling this much weight or damage to the equipment or injury to personnel can result.

2. Using a forklift, lift the controller and remove from wooden shipping crate.
3. Place controller approximately 0.6 m (2 ft) behind Process World cell (See Figure 8).
4. Carefully remove protective plastic wrapping and cardboard from controller.
5. Inspect controller for shipping damage.



Note: If damage is found, notify shipper immediately.

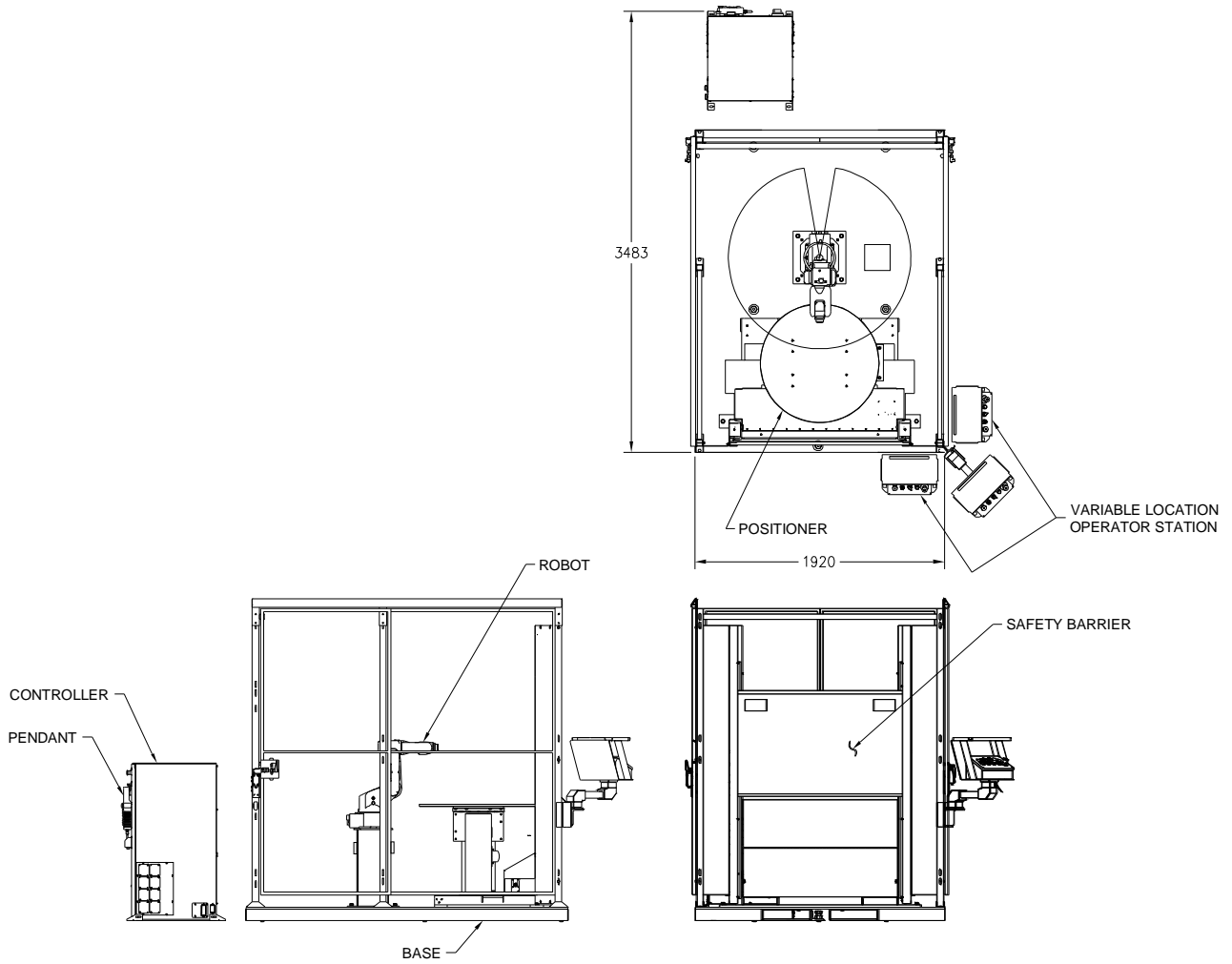


Figure 8 Location of the Controller

4.4 Connecting the Cables

After components are level and securely in place, the cables should be unwrapped from around the equipment and laid out according to the cable diagram included in the system drawing package. Each cable connection is clearly identified for ease of installation.

4.4.1 Connecting the Earth Ground

Each robot and controller must each be connected to an earth ground. A ground stake may be driven a minimum of 2.43 m (8 ft) into the earth, and the earth must be treated with chemicals in order to reduce resistance to the ground stake. Deeper ground stakes may be required depending on area soil conditions. A maximum of 100 ohms ground resistance is recommended. To ground the robots and controller, proceed as follows:



WARNING!

If proper earth grounds cannot be provided, do not use the equipment! Serious injury or death can occur.



Note: If the robot and the controller are within 4.57 m (15 ft) of each other, a common earth ground may be used. Otherwise, separate earth grounds must be used.

1. Connect one end of each robot earth ground cable to lug marked EARTH GROUND on bottom back of robot.
2. Connect other end of robot earth ground cable to earth ground stake.
3. Connect one end of second earth ground cable to common ground bus bar inside the controller.
4. Connect other end of second earth ground cable to earth ground stake.
5. For bonding requirements reference Controller Manual.

4.4.2 Connecting the Robot Cables

Two cables, 1BC and 2BC, connect the robot to the controller. The 1BC cable provides position feedback from the robot to the controller. The 2BC cable provides power to the robot servo motors. To connect the robot cables, proceed as follows:



Note: The right side of the controller is on your right as you are facing the front of it.

1. Unpack programming pendant and plug connector into receptacle on front door of controller.
2. Unpack two large black manipulator cables and route to controller and back of robot.
3. Carefully engaging connectors, connect one end of each cable (labeled 1BC and 2BC) to 1BC and 2BC connections on back of robot (see Figure 9). Connect other ends of 1BC and 2BC cables to the 1BC and 2BC connections on side of controller.

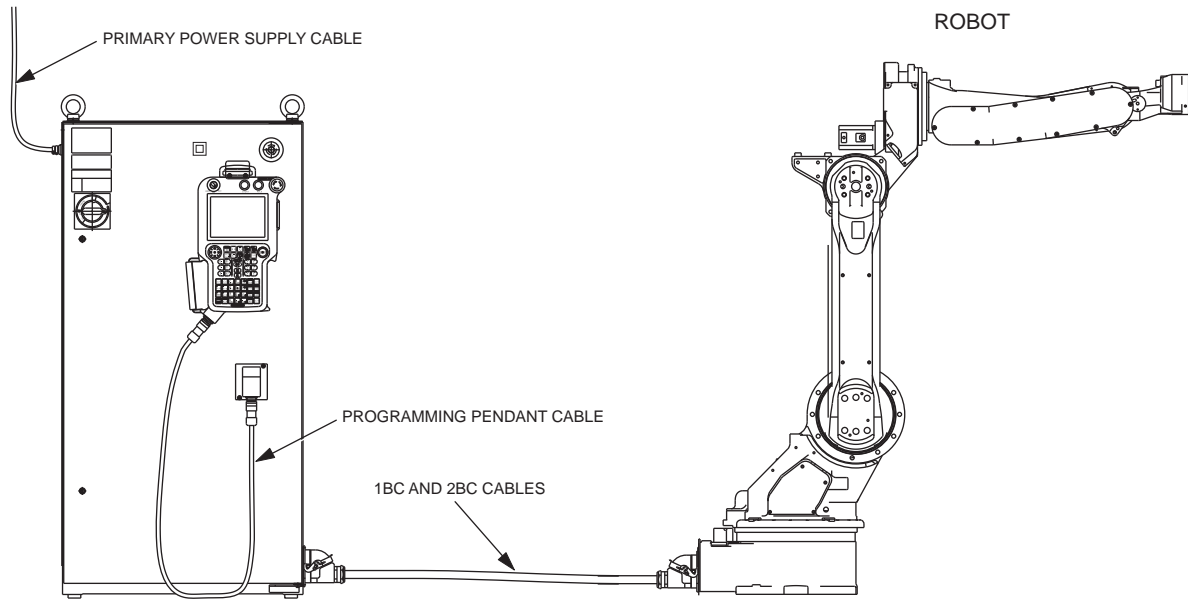


Figure 9 Connecting Robot to Controller

4.5 Connecting the Power

After all of the system components have been properly installed, connect the power to the Process World as follows:



DANGER!

POWER SHOULD BE CONNECTED ONLY BY A QUALIFIED ELECTRICIAN. ELECTRICAL AND GROUNDING CONNECTIONS MUST COMPLY WITH APPLICABLE PORTIONS OF THE NATIONAL ELECTRICAL CODE AND/OR LOCAL ELECTRICAL CODES.

1. Install 3-phase power wiring to the fused disconnect located inside left wall of NX100 controller cabinet. Table 5 shows size and type of wire needed.
2. Tighten screws to the torque indicated in Table 2.
3. Install an M5 lug on incoming ground wire.
4. Terminate ground wire to frame ground stud with hardware provided.



Note: The Process World is configured for 3-phase 460/480V AC, unless other voltage was requested. If other voltage is required for your plant, you must make the necessary modifications to the transformer. For more information, refer to the electrical diagrams that came with your system.

Table 2 Incoming Power Specifications (Decal)

Lug Data	60/75° C wire
Catalog No.	TCAL14
Wire Size	#14-7 Copper #12-8 Aluminum
Torque	#14-7, 4.0 N•m (35 lb-in.)

4.6 Conducting a Safety/Operation Check

Before installing the tooling and fixtures for your application, take a few minutes to perform a safety/operation check. To conduct a safety/operation check:

1. Check that the yellow shipping bracket has been removed from the robot.
2. Be sure there is a clearance of at least 2.5 cm (1 in.) on either side of the positioner.
3. Be sure the safety barrier tracks are aligned correctly.
4. Check that the cell door is closed and latched.
5. Check that all cable connections are tight.
6. Be sure the welding power source is set correctly (see the welding power source vendor's manual).
7. Verify that incoming line power matches the input power specified on the sticker on the front of the controller.

Your Process World is now ready for power-up. The Process World system should be operated only by personnel who have received operator training from Motoman and who are familiar with the operation of this Motoman robot model. Turn the main power ON, and continue the safety/operation check.

8. Check all system E-STOPS (pendant, op-station, breakaways, controller door).
9. Check system Hold buttons.
10. Check Gate Interlock.

4.7 Installation of Tooling and Fixtures

Your Process World system is now ready for the installation of tooling and fixtures for your application. Installation of tooling and fixtures should be performed by personnel who are familiar with the operation of this system. Tooling and fixtures are supplied by the customer. After tooling is installed, test the positioner for proper operation.

NOTES

Chapter 5

Operation

The Process World is a fully integrated robotic processing work cell. The robot performs predetermined processing tasks while the operator prepares the next part to be processed. Once the robot is finished with its process, it returns to the Home position. The operator removes the finished part and places the next part to be processed.

5.1 Programming

The operation of this system is programming dependent. The following operating instructions are based on one possible configuration of this system. Your system configuration and job structure may differ slightly from that presented here; however, basic operation will be the same. For additional programming instructions, refer to the controller and operator manuals that came with your system.

Any changes made to your system configuration and/or job structure will alter the operation of this cell. Motoman recommends you do not modify the original jobs and system configuration that came with your system. If modifications need to be made, they should be made to copies of these jobs and not to the originals. Modifications should only be performed by personnel who have received operator training from Motoman, and who are familiar with the operation of this Motoman system. If you have questions concerning the configuration of your system please contact the 24 hour Service Hotline, at (937) 847-3200 (see Section 1.4).

5.1.1 Sweeping the Positioner



Note: In order to sweep the positioner, the robot must be in the Home position.

MANUAL mode allows you to raise or lower the barrier door without activating the robot. Parts can be loaded onto the fixture to achieve the most efficient configuration and then swept into the process position before teaching the robot a series of moves. To sweep the positioner into the robot's processing position, proceed as follows:

1. Place robot in Home position (see Section 5.2.2).
2. Set the op-station POSITIONER switch to MANUAL mode and start Master Control job (see Section 5.2.3). Normally robot will not move out of Home position when POSITIONER switch is in MANUAL. (This depends on job structure.)



Note: Cycle Start latching is not operative in Manual mode.

3. Press the CYCLE START button on operator station. Barrier door raises each time CYCLE START button is pressed.

5.2 Daily Operation

The procedures below represent the typical operating sequence from power up to shutdown. Your basic operating procedures may vary depending on your situation.

- Perform Start-up Procedures (see Section 5.2.1).
- Move robot to Home position (see Section 5.2.2).
- Select master job (see Section 5.2.3).
- Perform Operation Cycle (see Section 5.2.4)
- Perform Shutdown Procedures (see Section 5.2.5)

5.2.1 Start-Up

To start up cell from a Power-Off condition, proceed as follows:

1. Set MAIN POWER switch on controller to ON.
2. Make sure the enclosure doors are closed and the safety plug is connected.
3. Make sure E-STOP buttons on programming pendant, controller door, and operator station are released.
4. Select TEACH mode on programming pendant.
5. Place robot in Home position.

5.2.2 Robot Home Position

To move the robot to the Home position:

1. Select TEACH mode on the programming pendant.
2. Select MAIN MENU on programming pendant touch screen.
3. Select JOB on programming pendant touch screen.
4. Select SELECT JOB on programming pendant touch screen. A job list appears on the screen.
5. Using cursor keys, move cursor to R1 SAFE job and press SELECT. The job appears on display screen.
6. Turn servo power ON by pressing SERVO ON and holding in the ENABLE switch.
7. Use the FWD button on programming pendant to jog robot to Home position.

5.2.3 Starting the Master Job

With the system powered up and in TEACH mode, call up the Master job:

1. Select MAIN MENU on programming pendant touch screen.
2. Select JOB on programming pendant touch screen.
3. Select CTRL MASTER on programming pendant touch screen. Press SELECT twice to activate the Master job.
4. Select PLAY mode on programming pendant and press the PLAY ENABLE button on the controller door. Job playback operation is enabled.
5. Press SERVO ON button on the programming pendant.
6. Press START button on programming pendant. The Master job cycles, waiting for a Cycle Start input from operator station.

The Process World cell is now ready for operation.

5.2.4 Perform Operation Cycle

The following is the typical sequence of operation for the Process World cell after start-up:

1. Load fixture on the positioner table with parts to be processed.
2. Press the CYCLE START button on operator station. The barrier door raises, the CYCLE LATCH light cones on and the robot begins processing parts.
3. When robot is finished, it returns to Home position and positioner sweeps, returning the processed parts to the load/unload position.
4. Unload processed parts from the fixture.



Note: Before sweeping at first power up, make sure the correct job has been loaded.

5.2.5 Shutdown

Use the following procedure to shut down the Process World cell after operation is complete:

1. Make sure robot is in Home position.
2. Turn off system servo power by pressing E-STOP button on operator station or programming pendant.
3. Select TEACH mode on the programming pendant.
4. Set controller Main Power switch to OFF position.

The Process World cell is now shut down.

5.3 System Recovery

When a system error or alarm occurs, you must clear the error or alarm to return the system to normal operation. The paragraphs below describe the different types of alarms and errors you may encounter and how to remedy them when you do.

5.3.1 Alarms and Errors

Alarms and errors will cause the program to stop. There are three levels of alarms and errors: Error Messages, Minor Alarms, and Major Alarms. For more detailed information about alarm recovery, refer to operator's manual that came with your system.

5.3.1.1 Error Messages

These are simple errors such as pressing the START button when the robot is not in PLAY mode, or enabling the programming pendant when servo power is off. Clear these errors by pressing the CANCEL button on the programming pendant.

5.3.1.2 Minor Alarms

Minor alarms are usually programming errors. Minor alarms might occur if a circle has been programmed with fewer than three circular points, etc. Clear these errors by pressing the CANCEL button on the programming pendant.

5.3.1.3 Major Alarms

Major alarms are hardware failures. Major alarms might occur because of a servo tracking error or an abnormal speed. To clear these alarms, you must turn off the controller and then turn it on again.

5.3.2 E-STOP Recovery

An E-STOP can occur under any of the following conditions:

- Pressing E-STOP button on the operator station, programming pendant, or controller door.
- Opening the cell door on robot enclosure when robot is not in TEACH mode.
- Defeating the safety barrier.

To restart the Process World cell after an E-STOP condition occurs, follow the procedures below:

1. To clear E-STOP condition, perform any of the following actions that apply:
 - Release E-STOP button on operator station, programming pendant, or controller door.
 - Close cell door
 - Make sure the safety barrier is in the full "up" position.



CAUTION!

If an emergency stop condition occurs while the positioner is sweeping, the positioner will continue the sweep when system is restarted.

2. Press SERVO ON button on operator station or programming pendant.
3. Ensure operator station is enabled.
4. Press START button on the operator station.

The Process World cell is now ready to continue operation.

5.3.3 Brake Release

The robot brakes are designed to protect the robot and other system components from damage in event of a system or robot failure and loss of drive power. If a system or robot failure occurs, it will be necessary to release the brakes on the robot to move it. To release the brakes, proceed as follows:



WARNING!

Releasing brakes could cause personal injury or machine damage. Always support the axis to be released BEFORE you release it.

1. On the programming pendant, select TEACH mode and turn servo power OFF.
2. Select ROBOT on the programming pendant touch screen.
3. Select the BRAKE RELEASE option.
4. Select the control group (R1, S1).
5. Hold down the minus key for the axis to be released (S-, U-) and simultaneously engage the ENABLE switch.
6. The brake for the selected axis will release.

Chapter 6

Maintenance

Table 3 provides periodic maintenance items and intervals for the Process World cell. Keep in mind that the maintenance intervals serve as guidelines only. You should adjust the frequency of maintenance to suit your specific work conditions.

For periodic maintenance procedures and schedules for the individual components of your Process World, including the positioner and barrier refer to the additional manuals that come with your system.

Table 3 Periodic Maintenance

Frequency	Component	Procedure
Monthly or as needed	Process World	Clean entire cell of dirt, grease and debris

H=Hours of operation

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