

# ArcWorld<sup>®</sup> II-100 SYSTEM MANUAL

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Upon receipt of the product and prior to initial operation, read these instructions thoroughly and retain for future reference.

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## MOTOMAN INSTRUCTIONS

MOTOMAN XXXXXX INSTRUCTIONS  
DX100 INSTRUCTIONS  
DX100 OPERATOR'S MANUAL  
DX100 MAINTENANCE MANUAL


The DX100 operator's manual above corresponds to specific usage.  
Be sure to use the appropriate manual.

Part Number: 156584-1CD  
Revision: 1



YASKAWA

MANUAL NO.

156584-1CD 



## MANDATORY

- This system manual provides an overview of the Motoman ArcWorld® II-100 system. It gives general information about the system, a description of its major components, and the procedures for installation, system operation, and preventive and repair maintenance. Be sure to read and understand this manual thoroughly before installing and operating the ArcWorld® II-100 system.
- General items related to safety are listed in Section 2 of the *DX100 Controller Manual*. To ensure correct and safe operation, carefully read the *DX100 Controller Manual* before reading this manual.



## CAUTION

- Some drawings in this manual are shown with the protective covers or shields removed for clarity. Be sure that all covers and shields are replaced before operating this product.
- The drawings and photos in this manual are representative examples, and differences may exist between them and the delivered product.
- YASKAWA may modify this model without notice when necessary due to product improvements, modifications, or changes in specifications.
- If such a modification is made, the manual number will also be revised.
- If your copy of the manual is damaged or lost, contact a YASKAWA representative to order a new copy. The representatives are listed on the back cover. Be sure to tell the representative the manual number listed on the front cover.
- YASKAWA is not responsible for incidents arising from unauthorized modification of its products. Unauthorized modification voids your product's warranty.

## Notes for Safe Operation

Read this manual carefully before installation, operation, maintenance, or inspection of the Motoman ArcWorld® II-100 system.

In this manual, the Notes for Safe Operation are classified as "WARNING," "CAUTION," "MANDATORY," or "PROHIBITED."



### WARNING

Indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury to personnel.



### CAUTION

Indicates a potentially hazardous situation which, if not avoided, could result in minor or moderate injury to personnel and damage to equipment. It may also be used to alert against unsafe practices.



### MANDATORY

Always be sure to follow explicitly the items listed under this heading.



### PROHIBITED

Must never be performed

Even items described as "CAUTION" may result in a serious accident in some situations. At any rate, be sure to follow these important items.



To ensure safe and efficient operation at all times, be sure to follow all instructions, even if not designated as "CAUTION" and "WARNING."



## WARNING

- Before operating the manipulator, check that servo power is turned OFF by pressing the EMERGENCY STOP buttons on the operator station or Programming Pendant (refer to *Figure 1*). When servo power is turned OFF, the SERVO ON LED on the Programming Pendant is turned OFF.

Injury or damage to machinery may result if the Emergency Stop circuit cannot stop the manipulator during an emergency. The manipulator should not be used if the EMERGENCY STOP buttons do not function.

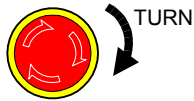
*Figure 1: EMERGENCY STOP Button*



- Release the EMERGENCY STOP button (refer to *Figure 2*). Once this button is released, clear the cell of all items which could interfere with the operation of the manipulator. Then turn servo power ON.

Injury may result from unintentional or unexpected manipulator motion.

*Figure 2 : Release of EMERGENCY STOP Button*



- Observe the following precautions when performing teaching operations within the P-point maximum envelope of the manipulator:
  - View the manipulator from the front whenever possible.
  - Always follow the predetermined operating procedure.
  - Ensure that you have a safe place to retreat to in case of emergency.

Improper or unintended manipulator operation may result in injury.

- Confirm that no person is present in the P-point maximum envelope of the manipulator and that you are in a safe location before:
  - Turning on the power for the DX100 controller.
  - Moving the manipulator with the Programming Pendant.
  - Running the system in the check mode.
  - Performing automatic operations.

Injury may result if anyone enters the P-point maximum envelope of the manipulator during operation. Always press an EMERGENCY STOP button immediately if there is a problem. The EMERGENCY STOP buttons are located on the operator station and on the Programming Pendant.



## CAUTION

- Perform the following inspection procedures prior to conducting manipulator teaching. If problems are found, repair them immediately and be sure that all other necessary processing has been performed.
  - Check for problems in manipulator movement.
  - Check for damage to insulation and sheathing of external wires.
- Always return the Programming Pendant to the hook on the cabinet of the DX100 controller after use.

The Programming Pendant can be damaged if it is left in the manipulator's work area, on the floor, or near fixtures.

- Read and understand the Explanation of Warning Labels in the *DX100 Controller Manual* before operating the ArcWorld® II-100 system.

## Definition of Terms Used Often in This Manual

The MOTOMAN manipulator is the YASKAWA industrial robot product.

The manipulator usually consists of the controller, the Programming Pendant, and supply cables.

In this manual, the equipment is designated as follows:

Equipment	Manual Designation
DX100 controller	DX100
DX100 Programming Pendant	Programming Pendant
Cable between the manipulator and the controller	Manipulator cable

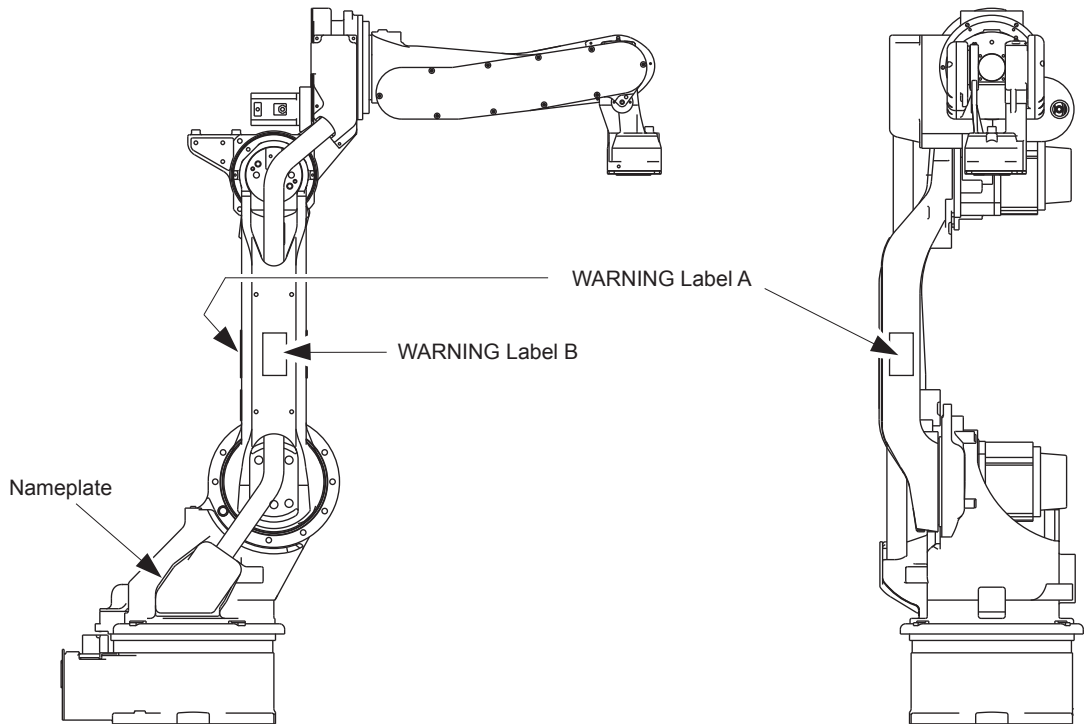
## Explanation of Warning Labels

The following warning labels are attached to the manipulator (refer to *Figure 3*).


Always follow the warnings on the labels.

Also, an identification label with important information is placed on the body of the manipulator. Prior to operating the manipulator, confirm the contents.

*Figure 3: Warning Labels Location*



Nameplate:

<b>MOTOMAN</b>	
TYPE □□□□□	
PAYLOAD □□ kg	MASS □□□ kg
ORDER NO. □□□□□□	DATE □□
SERIAL NO. □□□□□□	
 YASKAWA ELECTRIC CORPORATION JAPAN	

WARNING Label A:



WARNING Label B:



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ArcWorld® II-100	1	Introduction
	1.1	About This Document

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# 1 Introduction

## 1.1 About This Document

This system manual is delivered with the ArcWorld® II-100 system to provide a “first look” and overview of the complete Motoman ArcWorld® II-100 system. You should read and understand this system manual before moving on to the more detailed documentation that is included with your ArcWorld® II-100 system. Although basic in content, the system manual is intended for personnel who have received operator training from Motoman and who are familiar with the operation of this particular Motoman system. For more detailed information on any specific component or peripheral of the ArcWorld® II-100 system, please review the full documentation package that is included with your ArcWorld® II-100 system (refer to Section 1.3).

This system manual contains the following sections:

### *Section 1 – Introduction*

This section provides general information about the ArcWorld® II-100 system and its components, a list of reference documents, and Motoman Customer Support contact information.

### *Section 2 – Equipment Description*

This section provides a detailed description of the major components of the ArcWorld® II-100 system.

### *Section 3 – Installation*

This section provides instructions for the setup and installation of the ArcWorld® II-100 system.

### *Section 4 – Operation*

This section provides instructions for basic operation of the ArcWorld® II-100 system. This section also provides procedures for start-up, loading, normal operation, fault recovery, and shutdown.

### *Section 5 – Maintenance*

This section lists periodic and preventive maintenance suggestions for ArcWorld® II-100 system components.

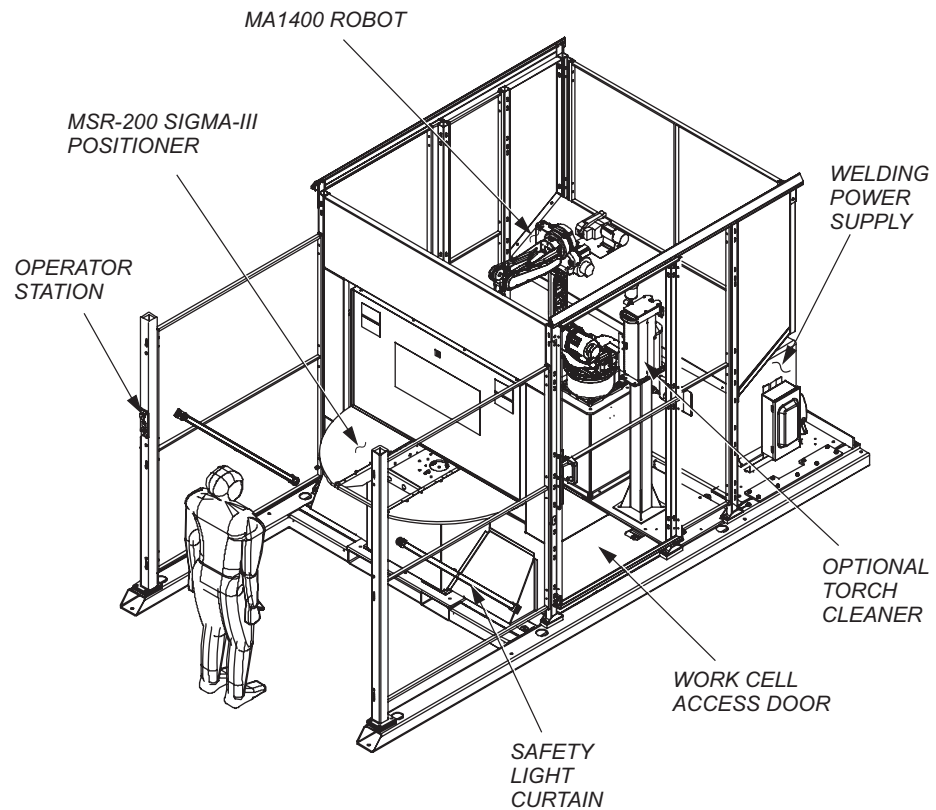
### *Section 6 – Anchoring*

This section gives foundation and anchoring suggestions for components of the ArcWorld® II-100 system.

## 1.2 System Overview

Motoman’s classic ArcWorld® II-100 robotic solutions are high-performance, pre-engineered robotic work cells that are ideal for large part fabrication at medium to high volumes. Fully integrated ArcWorld® II-100 work cells feature a high-speed, servo-driven, rotary positioner; one high-performance MA1400 manipulator (robot); one DX100 controller; an integrated welding package; one Operator Station; and a total safety environment. Safety features include load stations interlocked with dual-channel safeguards, an interlocked access door on each side of the work cell, safety fencing, and a safety light curtain system. *Figure 1-1* illustrates the system layout and component locations for the ArcWorld® II-100 work cell.

Figure 1-1: Layout — ArcWorld® II-100 with Optional Equipment Base



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

### 1.2.1 System Layout

The MA1400 manipulator, an MSR200 180° rotary positioner, and heavy-gauge, welded wire safety fencing are all mounted directly to the floor. An optional common steel base is available for ease of installation and assurance of proper alignment between the robot and rotary positioner. The welded wire safety fencing completely surrounds the ArcWorld® II-100 work cell.

The DX100 controller and welding power source are located outside and to the rear of the work cell. All operator controls, including those on the Programming Pendant, DX100 controller, welding power supplies, and Operator Station, are accessible from outside the ArcWorld® II-100 work cell.

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ArcWorld® II-100	1	Introduction
	1.3	Reference Documentation

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### 1.2.2 Major Components

The ArcWorld® II-100 system includes the following major components:

- MA1400 manipulator (robot)
- DX100 controller (with Programming Pendant)
- MSR-200 Sigma III rotary positioner
- Operator Station
- Welding Equipment:
  - Welding power source
  - Welding torch (water-cooled or air-cooled)
  - Welding wire feeder
  - Welding interface
  - Welding torch mount
- Safety Equipment:
  - Safety fencing with arc curtains
  - Safety light curtain system
  - Interlocked work-cell access doors
  - Positioner arc screen

### 1.2.3 Optional Equipment

The following optional equipment is available for use with the ArcWorld® II-100 system:

- Equipment Base - Provides fork lift access for ease of moving and setup of cell assembly.
- Controller & power source equipment base
- Torch tender
- Wire cutter
- ComArc III™ seam tracking unit
- Water-cooled torch assembly (with water cooler/circulator)
- Touch Sense™ starting point detection unit

## 1.3 Reference Documentation

For additional information, refer to the following documentation:

- Motoman *MA1400 Manipulator Manual* (P/N 155557-1CD)
- Motoman *Brake Release Manual* (P/N 156239-1CD)
- Motoman *DX100 Controller Manual* (P/N 155494-1CD)
- Motoman *Maintenance Manual for DX100* (P/N 155492-1CD)
- Motoman *Operator's Manual for Arc Welding* (P/N 155490-1CD)
- Motoman *DX100 Concurrent I/O Manual* (P/N 155491-1CD)
- Motoman *MSR-Series Positioner Manual* (P/N 152988-1CD)
- Motoman *INFORM User's Manual* (P/N 155493-1CD)

1	Introduction
1.4	Customer Support Information

- Vendor manuals and instruction sheets for ArcWorld® II-100 system components not manufactured by Motoman but supplied with your system

## 1.4 Customer Support Information

If you need assistance with any aspect of your ArcWorld® II-100 system, please contact Motoman Customer Support at the following 24-hour telephone number:

**(937) 847-3200**

For **routine** technical inquiries, you can contact Motoman Customer Support at the following e-mail address:

[techsupport@motoman.com](mailto:techsupport@motoman.com)

When using e-mail to contact Motoman Customer Support, please provide a detailed description of your issue, along with complete contact information. Please allow approximately 24 to 36 hours for a response to your inquiry.



Please use e-mail for **routine** inquiries only. If you have an urgent or emergency need for service, replacement parts, or information, please contact Motoman Customer Support at the telephone number shown above.

Please have the following information ready before you call:

- |                            |  |
|----------------------------|--|
| • System                   | ArcWorld® II-100   |
| • Positioner               | MSR-200 Sigma III  |
| • Robot                    | MA1400   |
| • Controller               | DX100  |
| • Software Version         | Access this information on the Programming Pendant's LCD display screen by selecting {MAIN MENU} - {SYSTEM INFO} - {VERSION} |
| • Robot Serial Number      | Located on the robot's data plate  |
| • Robot Sales Order Number | Located on the DX100 controller's data plate   |

	2	Equipment Description
ArcWorld® II-100	2.1	Robot Description

## 2 Equipment Description

### 2.1 Robot Description

The ArcWorld® II-100 system uses the Motoman MA1400 six-axis robot(s). The MA1400 robot is specifically designed for arc-welding applications. The robot has a payload capability of 3 kg and features a horizontal reach of 1434 mm. The MA1400 robot also features a relative positioning accuracy of  $\pm 0.08$  mm. The MA1400 robot has an internal cabling design that provides high flexibility and streamlines the robot profile, thus allowing access into confined spaces. The robot's B-axis (Pitch/Yaw) features an expanded range of motion that improves circumferential welding on cylindrical work pieces. The T-axis (Twist) can rotate the welding torch  $\pm 200$  degrees without cable interference.

For additional information on the Motoman MA1400 robot, please refer to the *MA1400 Manipulator Manual* that is included with your ArcWorld® II-100 system (refer to *Section 1.3*).

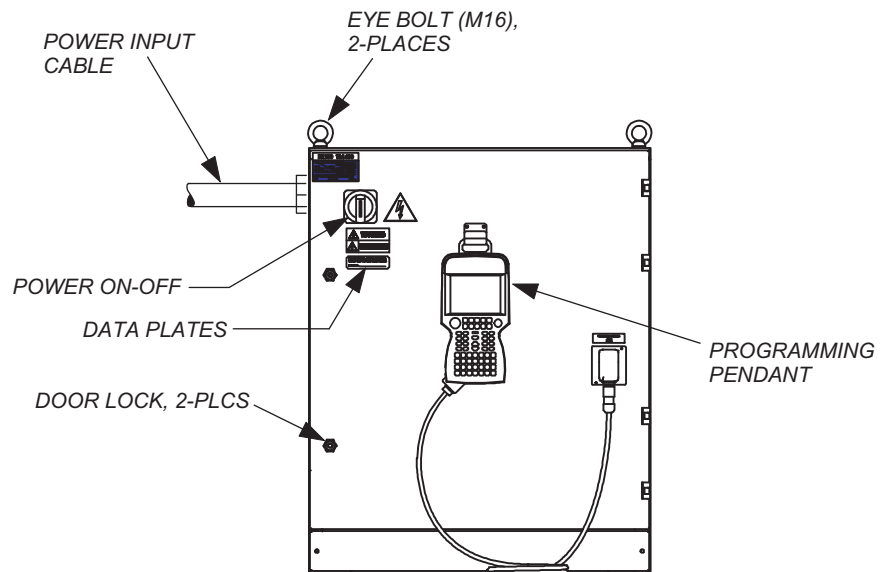
### 2.2 DX100 Controller

The DX100 robotic controller (see *Figure 2-1*) includes a Windows® CE Programming Pendant with a color touch screen, high-speed processing, built-in Ethernet, and a robust PC architecture. The DX100 easily handles multiple tasks and can control up to eight robots (up to 72 axes, including robots and external axes) and input/output (I/O) devices. Advanced Robot Motion (ARM) control provides high-performance path accuracy and vibration control.

The DX100 coordinates the operation of the ArcWorld® II-100 system. It controls manipulator movement and welding power supply, processes input and output signals, and provides the signals to operate the welding system.

For additional information on the Motoman DX100 controller, please refer to the *DX100 Controller Manual* that is included with your ArcWorld® II-100 documentation package (see *Section 1.3*).

*Figure 2-1: DX100 Controller*

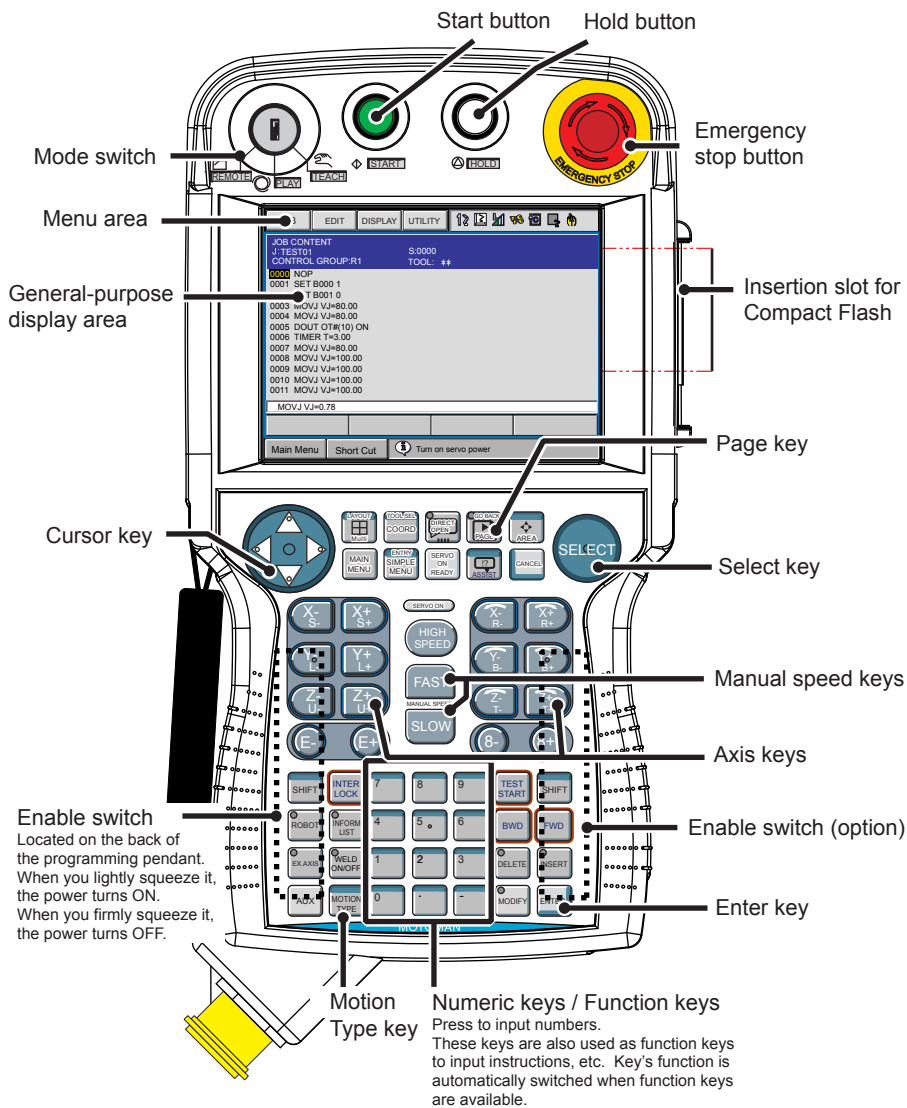


2.2.1 Programming Pendant

The Programming Pendant (see *Figure 2-2*) 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 5.7-inch color touch-screen display (640 x 480 VGA) and provides a CompactFlash card slot and USB port for data backups. The system uses the INFORM robot programming language and a menu-driven interface to simplify operator interaction with the robot.

Most operator controls are located on the Programming Pendant, allowing the controller cabinet to be mounted remotely. By using the pendant, the operator can teach the robot motion and perform programming, editing, maintenance, and diagnostic functions. For detailed information on the pendant's programming keys, programming functions, and display functions, refer to the *Operator's Manual for Arc Welding* that came with your system (see *Section 1.3*).

Figure 2-2: Programming Pendant

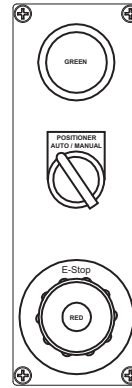


**NOTE** The Programming Pendant's LCD display goes dark after a few minutes of inactivity. Press any key to restore the screen.

## 2.3 Operator Station

The standard Operator Station includes a NEMA 12 rated enclosure and is mounted on the ArcWorld system fence post. The standard Operator Station includes the Positioner Auto/Manual, Cycle Start, and E-Stop buttons.

Figure 2-3: Operator Station



### 2.3.1 Start

Pressing the green Start button starts the current, active job. The Operator Station must be enabled and servo power must be ON for the Start button to function.

### 2.3.2 Positioner Auto/Manual

The Positioner Auto/Manual switch is used to select automatic or manual mode for the rotary positioner. When the switch is set to the Auto position, the robots weld the parts immediately after the positioner sweeps. When the switch is set to the Manual position, the robots do not immediately start to weld after the positioner sweeps and remain in Home position.



The Positioner Auto/Manual signal depends upon the structure of the Control Master job.

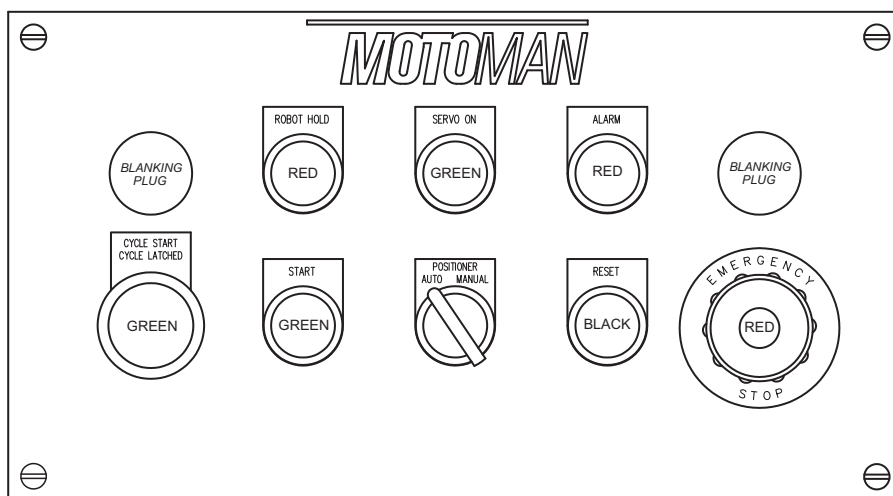
### 2.3.3 Emergency Stop (E-STOP)

Pressing the red Emergency Stop (E-STOP) button on the Operator Station removes servo power and stops all system operation. Brakes are applied to the robots, and all positioner motion is stopped.

The optional Pedestal Operator Station (see *Figure 2-4*) includes a NEMA enclosure on a stand-alone pedestal. See for the location of the Operator Station pedestal in relation to other components of the ArcWorld® II-100 system.



Figure 2-4: Optional Pedestal Operator Station



The following paragraphs describe the optional Operator Station controls:

### 2.3.4 Cycle Start/Cycle Latched

The operation of the Cycle Start/Cycle Latched button depends upon the structure of the Control Master job.

The green Cycle Start/Cycle Latched button, located on the Operator Station, initiates a positioner sweep cycle if the robots are in Home position. If the Cycle Start/Cycle Latched button is pressed while the robots are outside Home position, the Cycle Start command does not execute and the positioner does not sweep until the robots return to Home position.

The green Cycle Latched lamp illuminates when the Cycle Start/Cycle Latched button is pressed during operation. When the lamp is illuminated, the positioner will sweep and the robots will begin to weld immediately after the current weld cycle is complete and the robots have returned to Home position. It is not necessary to wait for the robots to finish welding and return to Home position before pressing the Cycle Start/Cycle Latched button to sweep the positioner. Pressing the Cycle Start/Cycle Latched button while the robots are still in motion latches the Cycle Start command into the controller. If a person or object enters the safety zone created by the safety light curtain system, the Cycle Start command will unlatch and the positioner will not sweep.

### 2.3.5 Robot Hold

Pressing the red Robot Hold button stops robot operation and interrupts the job until the operator presses the green Start button to resume operation. Operation resumes at the point in the program where the Robot Hold state was initiated.

### 2.3.6 Alarm

A red Alarm lamp illuminates to indicate that a DX100 controller has encountered an alarm condition.

### 2.3.7 Reset

The black Reset button is used to clear a minor alarm or error condition.

ArcWorld® II-100	2	Equipment Description
	2.4	MSR-200 Sigma III Positioner

### 2.3.8 Servo On

The green Servo On push button turns servo power ON when the robot is in Play mode and the Operator Station is enabled.

## 2.4 MSR-200 Sigma III Positioner

The MSR-200 Sigma III 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. An arc screen divides the positioner into two semicircular work areas, labeled Side A and Side B. This screen acts as a shield to protect the operator from the arc radiation and sparks produced by the welding operation. Do not operate this equipment unless the arc screen is in place.



### WARNING

Do not operate the positioner unless the arc screen is in place. Operation without the arc screen can cause eye damage to the operator, as well as to other personnel in the vicinity of the welding arc.

When the positioner's Side A is in the robot's welding zone, Side B is facing the operator and ready to be loaded or unloaded with parts, and vice versa. For detailed positioner information, specifications, and an illustrated parts list, please refer to the *MSR-Series Positioner Manual for MSR 200, 500, 1000 Sigma III* that is included in the ArcWorld® II-100 documentation package (see *Section 1.3*).



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

## 2.5 Welding Equipment

In its standard configuration, the ArcWorld system includes a welding power source, wire feeder, torch, and torch mount. Optional equipment — including water circulators, ComArc™ units, and torch tenders — may also be included with your system.

### 2.5.1 Power Sources

Motoman offers several different power sources for use with the ArcWorld® II-100 system, depending on the customer's specific application. For additional information, refer to the welding power source vendor manual that is included with the ArcWorld® II-100 documentation package (see *Section 1.3*).

### 2.5.2 Wire Feeder

The wire feeder mounts on the robot's arm. This 4-roll wire feeder provides reliable wire feeding at rates up to 750 inches per minute (ipm). An integral gas valve provides fast gas response time. Interchangeable feed rolls are used to accommodate different types and sizes of wire.

### 2.5.3 GMAW Torch

The ArcWorld® II-100 system uses either an air-cooled or optional water-cooled robotic/automatic GMAW torch. These are heavy-duty torches, designed for quick replacement and a minimum of robot reprogramming.

The GMAW torch is installed in a torch mount at the end of the robot's wrist. The torch mount provides multi-dimensional impact (collision) detection to protect the robot, torch, fixture, positioner, and work piece from damage in the event of a collision. Any torch impact (collision) triggers an Emergency Stop condition (refer to *Section 4.3.2*). For applications that use the optional water-cooled torch, the ArcWorld® II-100 system includes a water circulator kit.

## 2.6 Safety Features

The ArcWorld® II-100 system includes a total safety environment. When all standard safety precautions are observed, the safety equipment helps to ensure safe operation of the robotic work cell. The ANSI/RIA R15.06-1999 Robot Safety Standard stipulates that the user is responsible for safeguarding.



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.

### 2.6.1 Arc Screens



## WARNING

Never look directly at the welding arc without protective eye wear. The welding arc can cause permanent eye damage if viewed without protective shielding or eye wear.

Two types of arc screens are part of the ArcWorld® II-100 system:

- The positioner arc screen: This steel screen protects the operator by blocking ultraviolet radiation, sparks, and other welding by-products that result from the welding operation.
- Safety fence covering: The orange-colored sheeting that covers the safety fence composes the second arc screen. This material reduces the amount of ultraviolet radiation that escapes the ArcWorld® II-100 work cell during welding operations.

### 2.6.2 Fencing

The safety fencing provided with the ArcWorld® II-100 system encloses the entire robotic cell. It forms a physical barrier preventing entry into the cell during automatic operation.

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ArcWorld® II-100	2	Equipment Description
	2.6	Safety Features

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### 2.6.3 Safety Light Curtains

The safety light curtains help prevent serious injury to anyone entering the positioner area during the sweeping process. In PLAY or TEACH mode, if the positioner is sweeping and the operator steps into the safety zone, servo power is removed from the system, and all system motion stops. When the safety zone is clear, servo power can be reapplied and the operation resumed by pressing SERVO ON and START.

### 2.6.4 EMERGENCY STOP (E-STOP)

In addition to the safety features described above, the ArcWorld® II-100 system has strategically placed EMERGENCY STOP (E-STOP) push buttons. These are operator-actuated devices that immediately stop all system operation when activated. Brakes are applied to the robot, and all servo power is removed from the system.

The following is a list of E-STOP push button locations:

- The Programming Pendant
- The Operator Station

Refer to *Section 4.3.2* for E-STOP recovery procedures.

### 2.6.5 ENABLE Switch

The ENABLE switch is a three-position switch located on the left rear of the Programming Pendant (see *Figure 2-2*). It is a safety feature that controls servo power while the system is in TEACH mode. When pressed in (first “Click”), it allows the operator to turn servo power ON. Should the operator release the ENABLE switch or grasp it too tightly, servo power is immediately removed, thus preventing further robot movement. For detailed information about the operation of the ENABLE switch, refer to the *DX100 Controller Manual* and the *Operator’s Manual for Arc Welding* that came with your system (see *Section 1.3*).

### 2.6.6 Robot Braking System

The robot brakes are designed to protect the robot and other system components from damage in the event of, for example, a system or robot failure or a loss of drive power. The brake release allows the operator to release the brake of a specific robot axis when drive power has been removed from the system. The Programming Pendant is used to access the brake release function. Refer to the *Brake Release Manual* that came with your system (see *Section 1.3*).

### 2.6.7 Interlocked Work-cell Access Doors

A safety interlock on each of the ArcWorld® II-100 robotic work-cell access doors prevents entry into the work cell during PLAY mode. Opening either work-cell door while the ArcWorld® II-100 system is in PLAY mode immediately triggers an E-STOP condition. Brakes are applied to the robot, all servo power is removed, and all positioner motion stops. To continue operation of the ArcWorld® II-100 system, the operator must reset these safety interlocks. Refer to *Section 4.3.2* for E-STOP reset procedures.

## 3 Installation



### CAUTION

- The ArcWorld® II-100 system should be installed by qualified personnel who are familiar with the installation and setup of a robotic system.
- Be sure to handle all system components with care. The ArcWorld® II-100 system is not extremely fragile; however, it is a sophisticated robotic system that can be damaged by rough handling.

Two to three qualified technicians can install the ArcWorld® II-100 system in a reasonable amount of time. Always comply with all the safety instructions and precautions given throughout this manual during the installation process.

The instructions given in this section are general guidelines for installing the ArcWorld® II-100 system. Refer to your system drawings and relevant component manuals for specific installation information (see *Section 1.3*).

### 3.1 Materials Required

All system components and **most** hardware items required for installation of the ArcWorld® II-100 system are included with your shipment. The customer must supply some items, such as recommended hand tools (refer to *Section 3.1.2*) and special anchor bolts (refer to *Section 6*).

#### 3.1.1 Customer-supplied Items

- Four eye bolts
- Shielding gas for the welding torches
- Local electrical service
- Earth ground wires for the robot, DX100 controller, and peripheral equipment
- Earth ground rods and/or buried copper sheeting (quantity and placement depth as required to achieve a specified resistance-to-ground reading of 100 ohms or less)
- Chemical (optional) to increase the conductivity of soil in the vicinity of the earth ground system
- Welding wire
- Clean, dry air supply (for torch tender or wire cutter options):
  - Flow Rate: 0.425 m<sup>3</sup>/minute (15 cfm)
  - Pressure: 620 kPa (gage) [90 psi (gage)]
- Forklift(s) and/or overhead crane
- Special anchor bolts and drill bits (*Section 6* of this manual gives anchoring suggestions for your ArcWorld® II-100 robotic work cell).

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ArcWorld® II-100	3	Installation
	3.2	Site Preparation

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### 3.1.2 Recommended Hand Tools and Equipment

- 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
- Air-impact gun with 3/4-inch socket
- Open-end wrench set
- Two socket-heads (Allen®)
- Wrench sets (standard and metric)

## 3.2 Site Preparation

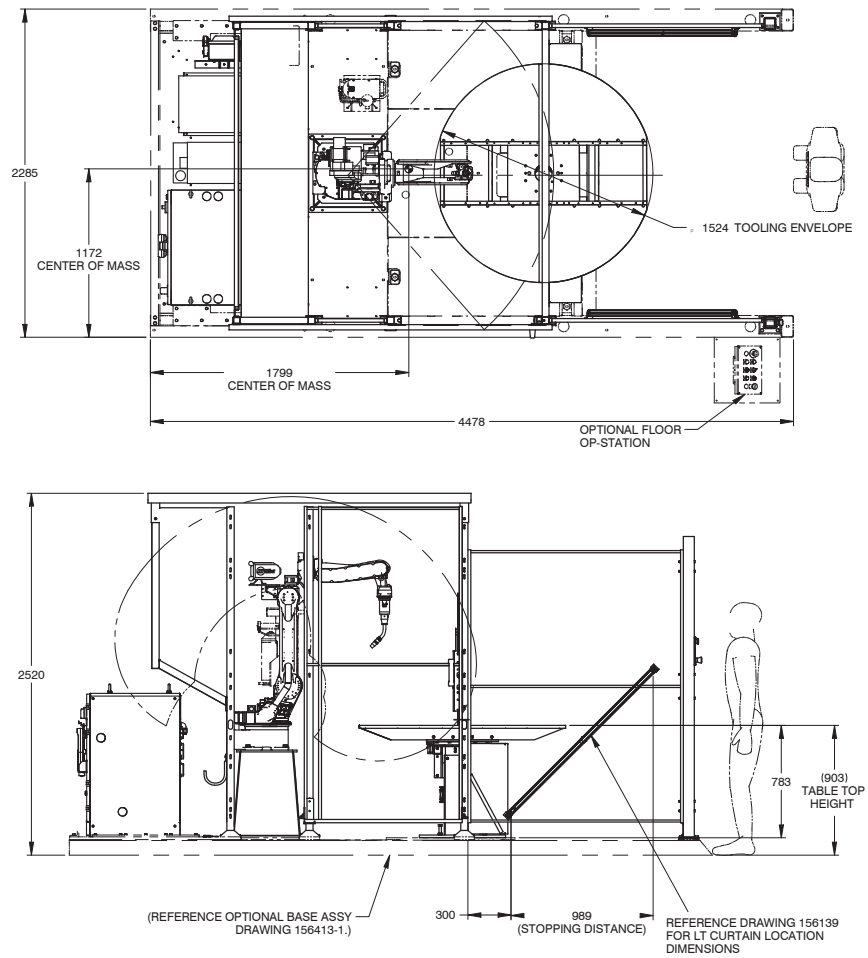
To prepare your site, proceed as follows:

1. Clear the floor space needed for placement of the ArcWorld® II-100 robotic work cell (see *Figure 3-1*).



Allow an additional 1.2 to 1.5 m clear space on all sides of the ArcWorld® II-100 work cell. This extra space makes for easier access and installation.

Figure 3-1: Plan View ArcWorld® II-100 Robotic Work Cell



2. Gather all the customer-supplied items and recommended tools (refer to *Section 3.1*).

### 3.3 Installing the Positioner



## WARNING

The MSR-200 Sigma III positioner weighs 450 kg. Be sure that your crane or forklift is capable of handling this much weight. Overloading the lifting device can result in equipment damage and injury to personnel.

The following are general guidelines for transporting and installing the MSR-200 Sigma III positioner. For more detailed information, refer to your system drawings and to the positioner manual (see *Section 1.3*).

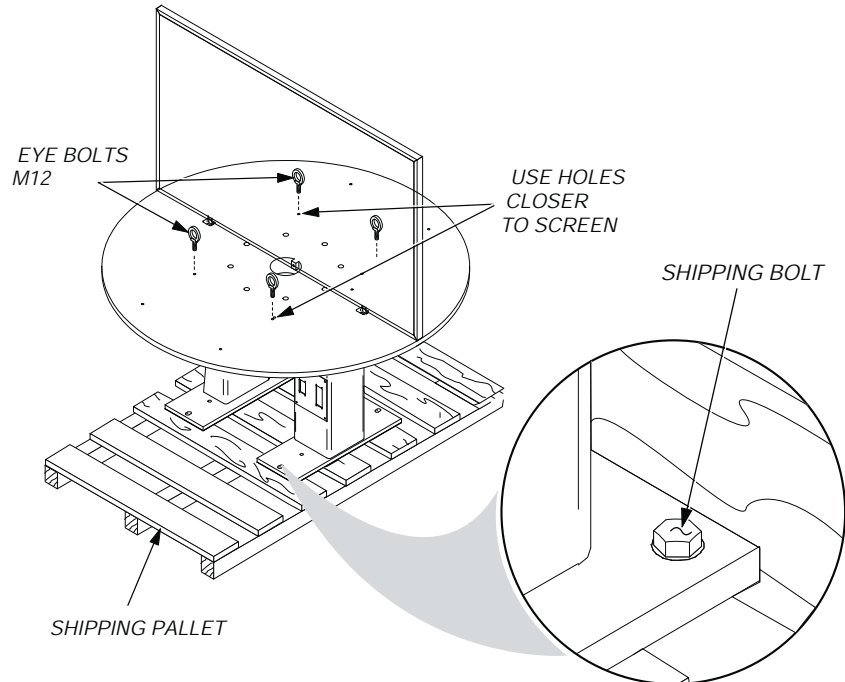
1. Carefully remove the protective plastic wrapping from the positioner.
2. Inspect the positioner for shipping damage.



If damage is found, notify the shipper immediately.

3. Unbolt the positioner from its shipping skid using a 3/4-inch socket wrench (see *Figure 3-2*).
4. Insert two eye bolts (four total) on each side of the arc screen. Use the four M12 holes closest to the arc screen (see *Figure 3-2*).

*Figure 3-2: Unpacking the Positioner*



5. Attach chains from the lifting device to the eye bolts and remove the positioner from the wooden shipping pallet.
6. Place the positioner in position according to the system drawings.
7. Remove the chains and eye bolts.
8. Refer to *Section 6* of this manual for anchoring suggestions for the positioner.

### 3.4 Installing the Robot/Riser Base



## WARNING

The robot/riser weighs 450 kg. Be sure that your crane or forklift is capable of handling this much weight. Overloading the lifting device can result in equipment damage and injury to personnel.

The following are general guidelines for transporting and installing the robot/riser. For more detailed information, refer to your system drawings and to the manipulator manual (see *Section 1.3*).

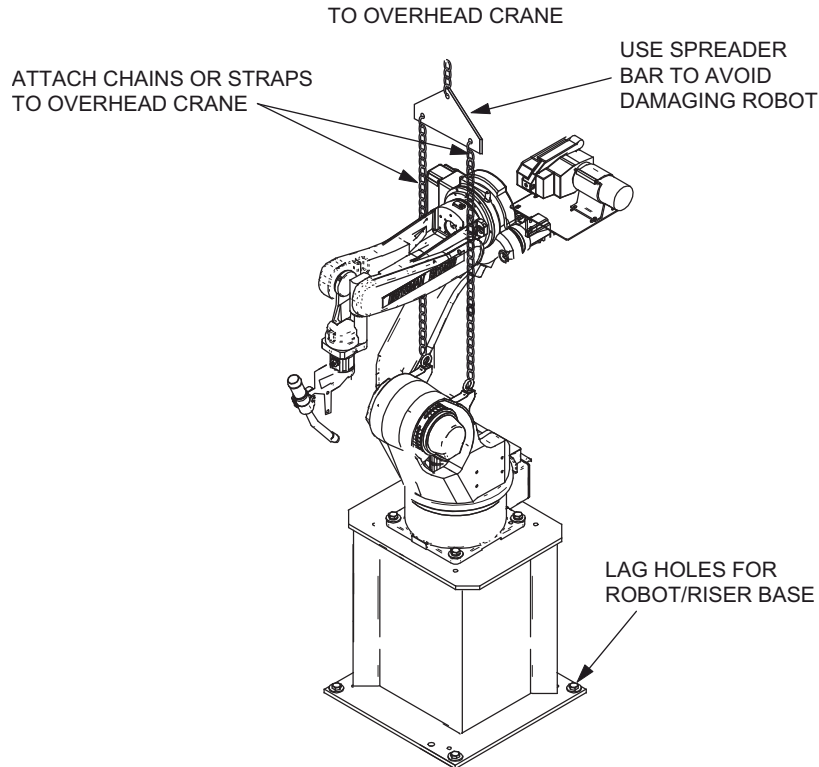


### 3 Installation

#### 3.5 Installing the Safety Fence

1. Unbolt the robot/riser base from its shipping skid using a 3/4-inch socket wrench.
2. Using an overhead crane, remove the robot/riser from the shipping skid (see *Figure 3-3*).

*Figure 3-3: Robot Riser*



3. Place the robot/riser in position according to the system drawings.
4. Carefully remove the protective plastic wrapping from the robot and torch.
5. Inspect the robot, torch, and riser for shipping damage.



If damage is found, notify the shipper immediately.

6. Refer to *Section 6* of this manual for anchoring suggestions for the robot/riser base.

### 3.5 Installing the Safety Fence

The safety fence is shipped in a separate crate, along with all the necessary hardware and specific assembly instructions. To install the safety fencing, proceed as follows:

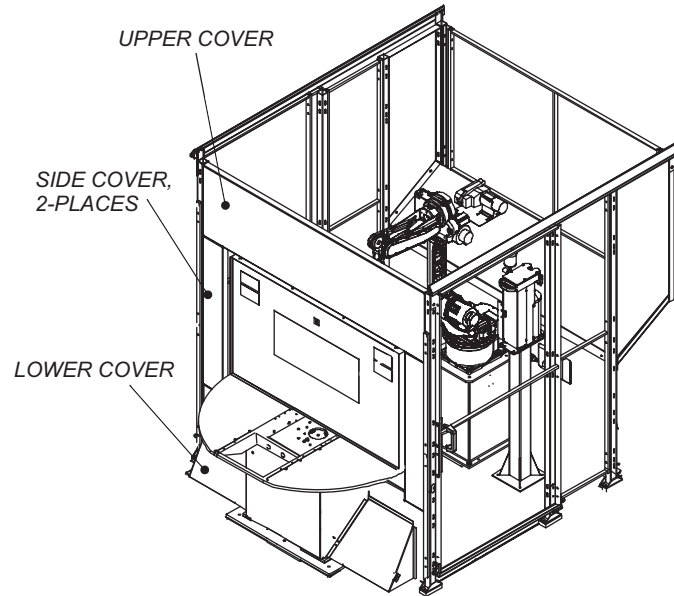
1. Unpack all safety fence components from the shipping crate.
2. Inspect all safety fence components for shipping damage.



If damage is found, notify the shipper immediately.

3. Refer to your system prints and fencing vendor instructions for specific installation instructions.

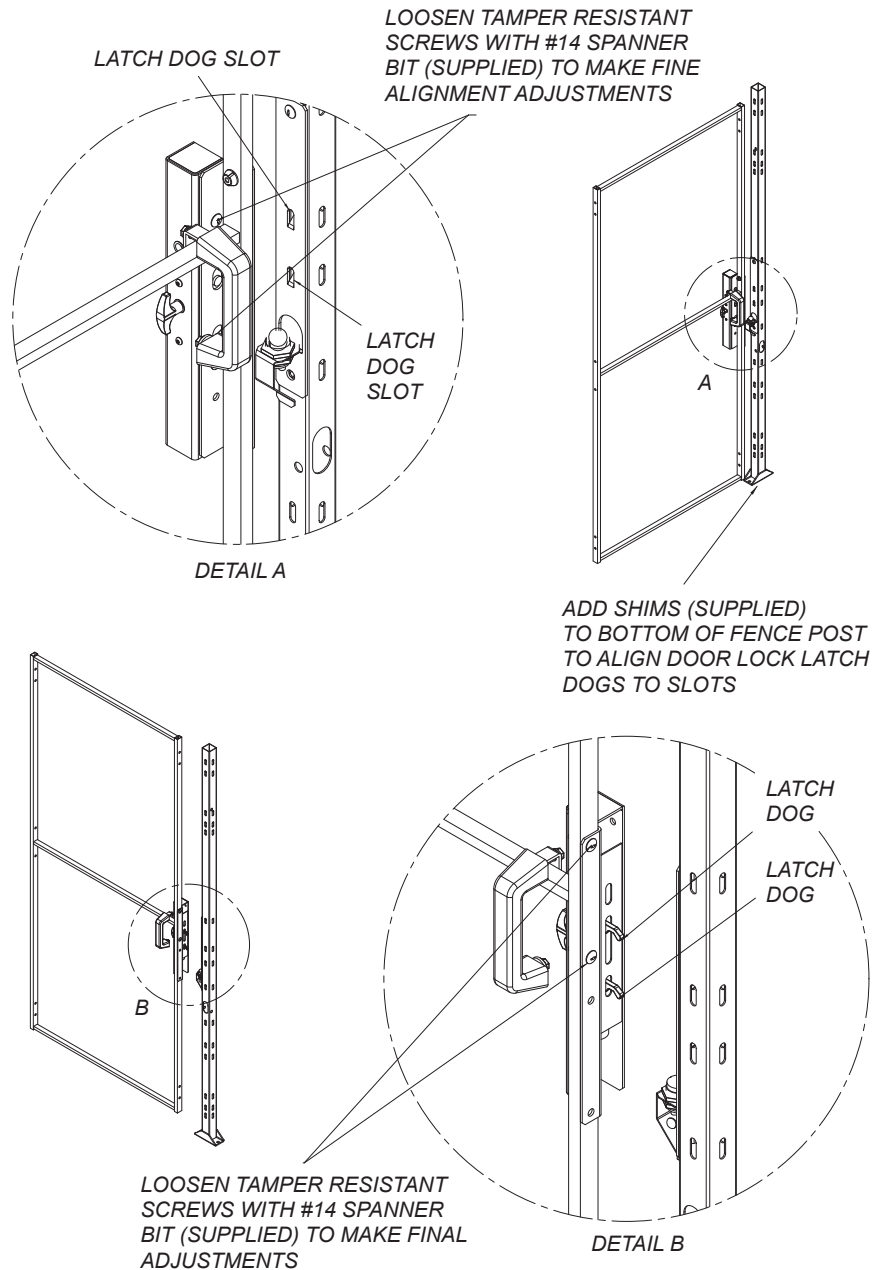
*Fig. 3-4: Fence Covers*



### 3.5.1 Door Latch Alignment

Adjust the location of the door latch as necessary to provide smooth operation of the door assembly. A #14 spanner bit is provided to loosen and adjust the location of the latch assembly. Metal shims are also provided and can be placed beneath the fence posts to make gross adjustments. See *Figure 3-5*.

*Figure 3-5: Door Latch Alignment*



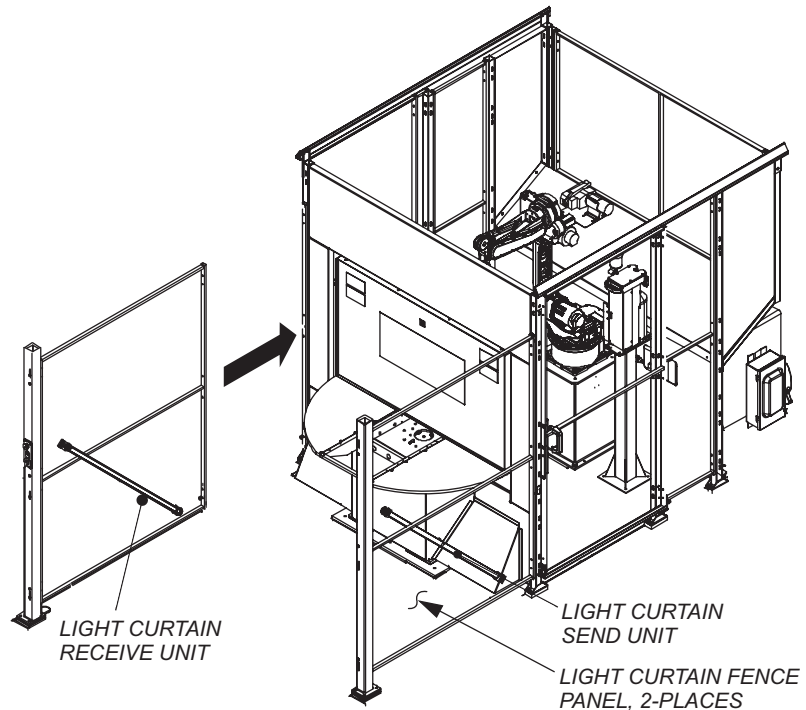
## 3.6 Installing the Safety Light Curtains

### 3.6.1 Installation

The light curtain components — the Send unit, Receive unit, and associated fence panels — are pre assembled at the factory and secured inside the ArcWorld® II-100 robotic work cell for shipping.

Remove both fence panels from their shipping positions and install them in accordance with *Figure 3-6* and the vendor documentation (included with the safety fence package). The light curtain Send and Receive units are oriented correctly when the status light cluster of each unit is located near the base of the positioner.

*Figure 3-6: Safety Light Curtain Installation*



### 3.6.2 Light Curtain Alignment

The Send unit and Receive unit must be aligned properly. Refer to the light curtain manufacturer's literature that accompanies the robot cell for exact alignment procedures.

### 3.6.3 Lagging the Fencing

Once the light curtains have been properly attached to the fencing, anchor the fence posts to the concrete floor (refer to *Section 6*). Verify that the light curtain units are properly aligned.

### 3.7 Installing the Common Base (Option)

When the ArcWorld® II-100 system is ordered with the optional common base, the entire system is shipped pre-installed, together on one wooden shipping platform. To install the ArcWorld® II-100 system with optional common base, refer to your system drawings and proceed as follows:

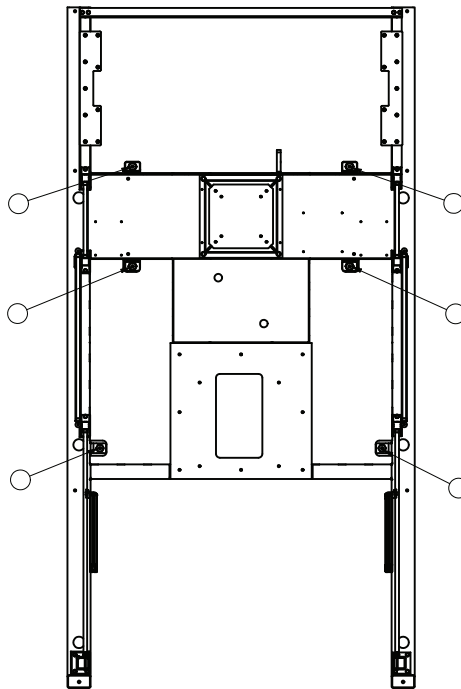


## CAUTION

Handle system components carefully. Some components can be damaged if dropped or otherwise handled roughly.

1. Unbolt the system from the platform. The bolts that secure the common base to the wooden platform go down through the hollow leveling screws and are threaded into the wooden platform (see *Figure 3-7*). It may be necessary to hold the leveling screws in place with a suitable open-end wrench while removing the shipping bolts.

*Figure 3-7: Stabilizing and Lag Points (Robot/Positioner Common Base)*



## WARNING

As shipped, the robot/positioner common base (with equipment) weighs approximately 3550 kg (7810 lbs). Use a forklift that is rated for this amount of weight load.

2. Using a forklift, lift the system from the wooden platform. Discard or recycle the wooden shipping skid.
3. Place the system in position (see *Figure 3-1*).



Make sure that there is adequate room on all sides of the system for maintenance and operation (see *Figure 3-1*).

4. Carefully remove the protective plastic wrapping from the robot(s), torches, and rotary positioner.
5. Inspect system components for shipping damage.



If you notice any equipment damage, notify your shipping contractor as soon as possible.

6. Use an M36 socket to loosen or tighten each leveling bolt to level the common base (see *Figure 3-7*).



## CAUTION

Be absolutely certain of the correct location for the system before securing the base with anchor (lag) bolts.

7. Secure the common base to the floor. Use a suitable concrete drill bit and special anchor (lag) bolts (refer to *Section 6* for the correct drill bit and anchor bolt). Be sure to remove all concrete dust from the drilled hole before driving each anchor bolt.

### 3.8 Connecting the Cables

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

#### 3.8.1 Connecting the Earth Ground

The robot and DX100 controller must each be connected to an earth ground. A ground stake should be driven a minimum of 2.43 m 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

Do not use the ArcWorld® II-100 robotic work cell without a good low-resistance earth ground. Use of the work cell without the correct earth ground can result in injury or death to personnel.



If the robot and DX100 controller are within 4.57 m of each other, a common earth ground may be used. Otherwise, separate earth grounds must be used.

1. Connect one end of the robot earth ground cable to the lug marked EARTH GROUND on the bottom back of robot.
2. Connect the other end of the robot earth ground cable to the earth ground stake.
3. Connect one end of the second earth ground cable to the common ground bus bar inside the controller.
4. Connect the other end of the second earth ground cable to the earth ground stake.

### 3.8.2 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, while the 2BC cable provides power to the robot's servo motors. To connect the robot cables, proceed as follows:



The right side of the DX100 controller is on your right when you face the access door (front) of the controller.

1. Unpack the Programming Pendant and plug its connector into the receptacle located on the access door on the front of the controller.
2. Unpack the two large black manipulator cables and route one to the controller and the other to the back of the robot.
3. Carefully engaging connectors, connect one end of each cable (labeled 1BC and 2BC) to the 1BC and 2BC connections on the back of the robot. Connect the other ends of the 1BC and 2BC cables to the 1BC and 2BC connections on the back of the controller.

## 3.9 Connecting the Power



### WARNING

A qualified, licensed electrician must make all power connections. Power and ground connections must comply with the National Electrical Code and/or local electrical codes.

After all the system components have been properly installed, refer to *Table 3-1* and connect the primary power to the ArcWorld® II-100 system as follows:

1. Install three-phase power wiring to the fused disconnect (located near the inside left wall of the DX100 controller's cabinet). *Table 3-1* shows the size and type of wire needed.
2. Tighten screws to the torque indicated in *Table 3-1*.

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3. Install an M5 lug on the incoming ground wire.
4. Terminate the ground wire to the frame ground stud with the hardware provided.



The ArcWorld® II-100 is configured for three-phase 460/480V AC, unless the customer requested a different configuration. If a different configuration is required for your plant, you must make the necessary modifications to the transformer. For more information, refer to the electrical diagrams that are included with the ArcWorld® II-100 documentation package (see *Section 1.3*).

*Table 3-1: Incoming Power Specifications (Decal)*

Lug Data	60/75° C wire
Catalog Number	TCAL14
Wire Size	#14-7 Copper #12-8 Aluminum
Torque	#14-7, 4.0 N•m (35 lb.-in.)

### 3.10 Conducting a Safety/Operation Check

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

1. Be sure that there is a clearance of at least 2.5 cm on either side of the MSR-200 Sigma III positioner.
2. Be sure that the safety light curtains are aligned correctly.
3. Check that the work-cell access door is closed and latched.
4. Check that all cable connections are tight.
5. Ensure that the welding power source is set correctly. Refer to the welding power source manual that is included in the ArcWorld® II-100 documentation package (see *Section 1.3*).
6. Verify that incoming line power matches the input power specified on the sticker on the front of the DX100 controller.

Your ArcWorld® II-100 is now ready for power-up. The 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, as follows:

7. Check for correct operation of the E-STOP push buttons at the following locations:
  - Programming Pendant
  - Operator Station
8. Check for correct operation of the system HOLD button on the Programming Pendant. Refer to the *Operator's Manual for Arc Welding* for more information on the pendant's HOLD button *Section 1.3*).
9. Check for correct operation of the work-cell access door interlock.



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ArcWorld® II-100	3	Installation
	3.11	Installation of Tooling and Fixtures

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### **3.11 Installation of Tooling and Fixtures**

Your ArcWorld® II-100 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. Refer to the positioner manual that came with your system for information on how to test that the positioner is operating properly (see *Section 1.3*).

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ArcWorld® II-100	4	Operation
	4.1	Programming

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## 4 Operation

The ArcWorld® II-100 is a fully integrated robotic arc-welding cell. The MA1400 robot welds on one side of the MSR-200 Sigma III positioner, while the operator loads the opposite side with parts. Upon completion of the welding process, the robot returns to a pre-defined HOME (safe) position. The operator then initiates a sweep (rotation) of the positioner, enabling the robot to start the welding process on the next part.

### 4.1 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 (see *Section 1.3*).

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 Motoman Customer Support (refer to *Section 1.4*).

#### 4.1.1 Sweeping the MSR-200 Sigma III Positioner



In order to sweep the positioner, the robot must be in HOME (safe) position.

Setting the Operator Station's POSITIONER AUTO/MANUAL switch to MANUAL mode allows you to sweep the positioner without activating the robot. Parts can be loaded onto the fixture to achieve the most efficient configuration and then swept into the welding zone, before teaching the robot a series of moves.

To sweep Side A or Side B of the positioner into the robot's welding zone, proceed as follows:

1. Place the robot in HOME (safe) position (refer to *Section 4.2.2*).
2. Set the POSITIONER AUTO/MANUAL switch to MANUAL mode and start the Control Master job (refer to *Section 4.2.3*). Normally, the robot will not move out of HOME (safe) position when the POSITIONER AUTO/MANUAL switch is set to MANUAL. (This depends on job structure.)



Cycle Start latching is not operative in MANUAL mode.

3. Press the CYCLE START/CYCLE LATCHED button on the Operator Station. (The positioner sweeps each time this button is pressed.)

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## 4.2 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 the start-up procedure (refer to *Section 4.2.1*).
- Move the robot to HOME (safe) position (refer to *Section 4.2.2*).
- Start the Control Master job (refer to *Section 4.2.3*).
- Perform the operation cycle (refer to *Section 4.2.4*).
- Perform system shutdown (refer to *Section 4.2.5*).

### 4.2.1 Start-up Procedure

To start up the work cell from a power-off condition, proceed as follows:

1. Set the main power switch on the DX100 controller to ON.
2. Set the input power switch on the welding power source to ON; the power source pilot light illuminates.
3. Open the regulator valve for the welding gas supply.
4. Make sure that the work-cell access doors are closed and the safety plug connected.
5. Make sure that the E-STOP buttons on the Programming Pendant, controller door, and Operator Station are released.
6. Select TEACH mode on the Programming Pendant.
7. Place the robot in HOME (safe) position (refer to *Section 4.2.2*).

### 4.2.2 Move the Robot to HOME Position

To move the robot to HOME position:

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

### 4.2.3 Start the Control Master Job

The procedure to call up the Control Master job is as follows:

1. Ensure that the ArcWorld® II-100 system is powered up.
2. Ensure that the ArcWorld® II-100 system is in TEACH mode.
3. Select MAIN MENU on the Programming Pendant's touch screen.
4. Select JOB on the Programming Pendant's touch screen.
5. Select CTRL MASTER on the Programming Pendant's touch screen.

ArcWorld® II-100	4	Operation
	4.2	Daily Operation

6. Press SELECT twice to activate the Control Master job.
7. Select PLAY mode on the Programming Pendant, then press the PLAY MODE ENABLE button on the DX100 controller's door. Job playback operation is now enabled.
8. Press the SERVO ON button on the Programming Pendant.
9. Press the START button on the Programming Pendant. The Control Master job cycles, waiting for a Cycle Start input from the Operator Station.

The ArcWorld® II-100 cell is now ready for operation.

#### 4.2.4 Perform the Operation Cycle

The following is the typical sequence of operation for the ArcWorld® II-100 work cell after start-up:

1. Load the **operator** side of the MSR-200 Sigma III positioner table with parts to be welded.
2. Step out of the area protected by the light curtain system.
3. Press the Operator Station's CYCLE START/CYCLE LATCHED push button. The positioner sweeps, moving previously loaded parts into the robot's work area. The robot then begins welding these parts.
4. While the robot is welding, load the parts fixture on the operator side with additional parts to be welded.
5. After the parts to be welded are attached to the parts fixture, press the CYCLE START/CYCLE LATCHED button on the Operator Station (the Cycle Latched indicator illuminates). After the robot completes the welding process, it returns to HOME (safe) position and the positioner rotates to return the welded parts to the operator side of the positioner for unloading. Concurrently, the previously loaded parts to be welded are moved into the robot's work area for welding.
6. Unload the welded parts from the fixture.



Before sweeping the positioner at first power-up, make sure that the correct job is loaded.

#### 4.2.5 Perform System Shutdown

Use the following procedure to shut down the ArcWorld® II-100 work cell after the welding operation is complete:

1. Ensure that the robot is in HOME (safe) position.
2. Turn off system servo power by pressing the EMERGENCY STOP (E-STOP) push button on the Operator Station or Programming Pendant.
3. Select TEACH mode on the Programming Pendant.
4. Set the DX100 controller's main power switch to the OFF position.
5. Set the main power switch on the welding power source to the OFF position.
6. Close the regulator valve for the welding gas supply.

The ArcWorld® II-100 robotic work cell is now shut down.

## 4.3 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 might encounter and how to remedy them when you do.

### 4.3.1 Alarms and Errors

There are three levels of alarms and errors that will stop the program:

- Error messages
- Minor alarms
- Major alarms

For more detailed information on alarm and error recovery, refer to the operator's manual that came with your system (see *Section 1.3*).

#### 4.3.1.1 Error Messages

Error messages are caused by 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.

#### 4.3.1.2 Minor Alarms

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

#### 4.3.1.3 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.

### 4.3.2 Emergency Stop (E-STOP) Recovery

An Emergency Stop (E-STOP) can occur under any of the following conditions:

- Pressing an EMERGENCY STOP (E-STOP) push button on the Operator Station, Programming Pendant, or DX100 controller's door.
- Opening the ArcWorld® II-100 work-cell access door when the robot is **not** in TEACH mode.
- Stepping into the area protected by the light curtain system while the positioner is sweeping.
- A collision (crash) that actuates the torch-mounted shock sensor (refer to *Section 2.5.3*).

The following is the procedure for restarting the ArcWorld® II-100 cell after an E-STOP condition occurs:

1. Clear an E-STOP condition by performing any of the following actions that apply:
  - Release the affected E-STOP push button.
  - Close the ArcWorld® II-100 work-cell access door.

- Step out of the zone protected by the light curtain system.
- Clear the shock sensor condition (refer to *Section 4.3.3*).



## CAUTION

If an E-STOP condition occurs while the positioner is sweeping, the positioner will continue the sweep when the ArcWorld® II-100 system is restarted.

2. Press the SERVO ON button on the Programming Pendant.
3. Ensure that the Operator Station is enabled.
4. Press the START button on the Programming Pendant.

The ArcWorld® II-100 cell is now ready to continue operation.

### 4.3.3 Shock Sensor Override

The ArcWorld welding package includes a Motoman gun mount that incorporates a shock sensor assembly. The shock sensor assembly protects the welding torch from damage in the event of a collision (crash) involving the torch and a component or part within the work cell. A slight deflection of the torch activates a SHOCK SENSOR signal that triggers an E-STOP condition. To clear the E-STOP condition, you must override the shock sensor, then move the robot clear of the impact.

To override the shock sensor, proceed as follows:

1. Select MAIN MENU on the Programming Pendant's touch screen.
2. Select ROBOT on the Programming Pendant's touch screen.
3. Select OVERRUN-S.SENSOR on the Programming Pendant's touch screen.
4. Select RELEASE to release the shock sensor.
5. Turn servo power ON by first depressing and holding the Programming Pendant's ENABLE switch, then pressing the SERVO ON READY push button.
6. Move the robot clear of the collision (impact) location.

The ArcWorld® II-100 cell is now ready to continue operation.

### 4.3.4 Brake Release



## WARNING

Always support the robot axis to be released **before** releasing the brake for that axis. Releasing the brake system without proper support could cause injury to personnel and/or equipment damage.

The robot brakes are designed to protect the robot and other system components from damage in the event of, for example, a system or robot failure, a loss of drive power, or any other occurrence that activates the brakes. It is then necessary to release the brakes on the robot in order to move it. To release the brakes, proceed as follows:

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4 Operation  
4.3 System Recovery

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1. On the Programming Pendant, select TEACH mode and turn servo power OFF.
2. Select ROBOT on the Programming Pendant's 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. The brake for the selected axis releases.

## 5 Maintenance



### CAUTION

If your system uses water-cooled torches, use only Motoman-specified antifreeze. Typical automotive antifreeze contains additives that can clog the small cooling ports in the welding torch assembly and damage sealing gaskets in the water circulator pumps.

Maintenance of the ArcWorld® II-100 system and components must be performed by authorized personnel who are familiar with the ArcWorld® II-100 system. Be sure to read and understand the documentation for a particular component before doing actual repair maintenance or preventive maintenance on that component. Be sure that you understand the maintenance procedures, have the proper tools at hand, and comply with all the safety instructions and precautions given throughout this manual.

Maintenance intervals given in *Table 5-1* are recommendations only. Adjust the frequency and level of repair maintenance and preventive maintenance to suit your specific equipment schedules and shop environment.

For periodic maintenance procedures and schedules for the individual components of your ArcWorld® II-100 system, refer to the documentation package that is included with your system (see *Section 1.3*).

*Table 5-1: Periodic and Preventive Maintenance*

FREQUENCY	COMPONENT	PROCEDURE
Daily (or on condition)	Water Circulators (water-cooled torch application only)	Add a mixture of Motoman antifreeze (P/N 131224-1) and distilled water, as required. Mix antifreeze and distilled water in the proportions shown on the antifreeze container.
	All safeguard items — work-cell door interlocks, E-STOP push buttons, safety light curtains, arc curtains, etc.	Check the physical condition of the safeguard item and ensure that it is working correctly.
Monthly (or on condition)	ArcWorld® II-100 Work Cell	Remove accumulated dirt, grease, and debris from inside and outside the work cell.



## 6 Anchoring

The purchaser must determine all anchoring and foundation requirements and supply the appropriate anchoring hardware for a particular installation. Always use chemical anchors for equipment with dynamic loads. Use appropriate sized anchors, relative to the clearance holes, to anchor equipment to the floor. *Table 6-1* provides sample anchor and foundation requirements for peripheral equipment. Refer to equipment manuals included with your system documentation package (Section 1.3) for anchoring requirements.

 <b>WARNING</b>
<p>Do not mount robots directly to the floor without the indicated floor plate. Failure to follow floor-plate requirements can result in equipment damage or injury to personnel.</p>

*Table 6-1: Minimum Recommended Equipment Anchor Requirements*

EQUIPMENT	MINIMUM HILTI® ANCHOR ROD DIAMETER/TYPE	MINIMUM FLOOR-PLATE REQUIREMENTS	MINIMUM FOUNDATION REQUIREMENTS
<b>ROBOTS</b>	Refer to the manipulator manual included with your system documentation package (Section 1.3) for anchoring requirements. Always use chemical anchors for equipment with dynamic loads. Use appropriate sized anchors, relative to the clearance holes, to anchor equipment to the floor.		
<b>POSITIONER</b>	Refer to the positioner manual included with your system documentation package (Section 1.3) for anchoring requirements. Always use chemical anchors for equipment with dynamic loads. Use appropriate sized anchors, relative to the clearance holes, to anchor equipment to the floor.		
<b>PERIPHERAL EQUIPMENT</b>	1/2-inch Kwik Bolt II Style Anchor (Note 1)	Not Applicable	3-inch minimum thickness or 1.3 embedment depth (whichever is larger) 4000 psi Reinforced Concrete
<b>WORK-CELL FENCE POSTS</b>	3/8-inch Kwik Bolt II Style Anchor (Note 1)	Not Applicable	3-inch minimum thickness or 1.3 embedment depth (whichever is larger) 4000 psi Reinforced Concrete
<b>OPERATOR STATION PEDESTAL</b>	1/4-inch Kwik Bolt II Style Anchor (Note 1)	Not Applicable	3-inch minimum thickness or 1.3 embedment depth (whichever is larger) 4000 psi Reinforced Concrete
<p>NOTES:</p> <p>(1) Reference source: <i>Hilti® Product Technical Guide</i> (Section 4.3.3) for hardware specifications or equivalent.</p> <p>Refer to <a href="http://us.hilti.com">http://us.hilti.com</a> or <a href="http://ca.hilti.com">http://ca.hilti.com</a> for further information.</p>			

# ArcWorld® II-100 SYSTEM MANUAL

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## HEAD OFFICE

2-1 Kurosaki-Shiroishi, Yahatanishi-ku, Kitakyusyu-shi, 806-0004, Japan  
Phone +81-93-645-7745 Fax +81-93-645-7746

## MOTOMAN INC. HEADQUARTERS

805 Liberty Lane, West Carrollton, OH 45449, U.S.A.  
Phone +1-937-847-6200 Fax +1-937-847-6277

## MOTOMAN ROBOTICS EUROPE AB

Franska Vagen 10, Box 4004, SE-390 04 Kalmar, Sweden  
Phone +46-480-417800 Fax +46-480-417999

## MOTOMAN ROBOTEC GmbH

Kammerfeld strasse 1, 85391 Allershausen, Germany  
Phone +49-8166-90-100 Fax +49-8166-90-103

## YASKAWA ELECTRIC KOREA CORPORATION

1F, Samyang Bldg. 89-1, Shinchun-dong, Donk-Ku, Daegu, Korea  
Phone +82-53-382-7844 Fax +82-53-382-7845

## YASKAWA ELECTRIC (SINGAPORE) PTE. LTD.

151 Lorong Chuan, #04-01, New Tech Park, Singapore 556741  
Phone +65-6282-3003 Fax +65-6289-3003

## YASKAWA ELECTRIC (MALAYSIA) SDN. BHD.

Unit 47-1 and 2, Jalan PJU 5/9, Dataran Sunway, Kota Damansara, 47810, Petaling Jaya Selangor, Malaysia  
Phone +60-3614-08919 Fax +60-3614-08929

## YASKAWA ELECTRIC (THAILAND) CO., LTD.

252/246, 4th Floor, Muang Thai-Phatra office Tower II Rechadapisek Road, Huaykwang Bangkok 10320, Thailand  
Phone +66-2-693-2200 Fax +66-2-693-4200

## SHOUGANG MOTOMAN ROBOT CO., LTD.

No.7, Yongchang-North Road, Beijing Economic and Technological and Development Area, Beijing 100076, China  
Phone +86-10-6788-0541 Fax +86-10-6788-0542

## MOTOMAN MOTHERSON ROBOTICS LTD.

910, DLF Galleria, DLF City Phase IV, Gurgaon - 122002 Haryana, India  
Phone +91-124-414-8514 Fax +91-124-414-8016



YASKAWA ELECTRIC CORPORATION

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