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

MOTOMAN INSTRUCTIONS
MA1440 MANIPULATOR INSTRUCTIONS
MSR355 AND MSR655 POSITIONER MANUAL
ARC WELDING OPERATORS MANUAL
DX200 INSTRUCTIONS
DX200 OPERATOR’S MANUAL
DX200 MAINTENANCE MANUAL

The DX200 operator’s manual above corresponds to specific usage. Be sure to use the appropriate manual.
MANDATORY

- This system manual provides an overview of the Motoman ArcWorld® 1000 and 1200 Series 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® 1000 and 1200 Series system.

- General items related to safety are listed in Section 1 of the DX200 Controller Manual. To ensure correct and safe operation, carefully read the DX200 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 revision 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.
We suggest that you obtain and review a copy of the ANSI/RIA National Safety Standard for Industrial Robots and Robot Systems (ANSI/RIA R15.06-2012). You can obtain this document from the Robotic Industries Association (RIA) at the following address:

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

Ultimately, well-trained personnel are the best safeguard against accidents and damage that can result from improper operation of the equipment. The customer is responsible for providing adequately trained personnel to operate, program, and maintain the equipment. NEVER ALLOW UNTRAINED PERSONNEL TO OPERATE, PROGRAM, OR REPAIR THE EQUIPMENT!

We recommend approved Yaskawa training courses for all personnel involved with the operation, programming, or repair of the equipment.

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications.
Notes for Safe Operation

Read this manual carefully before installation, operation, maintenance, or inspection of the Motoman ArcWorld® 1000 and 1200 Series system.

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

---

**DANGER**

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

**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.

---

NOTE

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

---

**DANGER**

- Maintenance and inspection must be performed by specified personnel.

Failure to observe this caution may result in electric shock or injury.
- For disassembly or repair, contact your YASKAWA representative.
- Do not remove the motor, and do not release the brake.

Failure to observe these safety precautions may result in death or serious injury from unexpected turning of the manipulator's arm.
This Robot Cell has Collaborative Motion functionality:

Collaboration is a special type of operation between a person and robot sharing a common workspace. The following are the guidelines for collaborative operation.

1. Used for pre-determined tasks.
2. Possible when all protective measures are active.
3. For robots with features specifically designed for collaborative operation.

The integrator shall include in the information for use the safeguards and mode selection required for collaborative operation.

---

<table>
<thead>
<tr>
<th>CAUTION</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CAUTION</strong></td>
</tr>
</tbody>
</table>

- 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 DX200 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 DX200 Controller Manual before operating the ArcWorld® 1000 and 1200 Series system.
WARNING

Before operating the manipulator, check that servo power is turned OFF pressing the emergency stop buttons on the front door of the DX200 and the programming pendant.

When the 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.

Fig. : Emergency Stop Button

Once the emergency stop button is released, clear the cell of all items which could interfere with the operation of the manipulator. Then turn the servo power ON.

Injury may result from unintentional or unexpected manipulator motion.

Fig. : Release of Emergency Stop

Observe the following precautions when performing teaching operations within the P-point maximum envelope of the manipulator:

– Be sure to use a lockout device to the safeguarding when going inside. Also, display the sign that the operation is being performed inside the safeguarding and make sure no one closes the safeguarding.

– View the manipulator from the front whenever possible.

– Always follow the predetermined operating procedure.

– Keep in mind the emergency response measures against the manipulator’s unexpected motion toward you.

– Ensure that you have a safe place to retreat 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 DX200.

– 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 right of front door of the DX200 and the programming pendant.
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:

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Manual Designation</th>
</tr>
</thead>
<tbody>
<tr>
<td>DX200 controller</td>
<td>DX200</td>
</tr>
<tr>
<td>DX200 Programming Pendant</td>
<td>Programming Pendant</td>
</tr>
<tr>
<td>Cable between the manipulator and the controller</td>
<td>Manipulator cable</td>
</tr>
</tbody>
</table>

Description of the Operation Procedure

In the explanation of the operation procedure, the expression “Select • • •” means that the cursor is moved to the object item and the SELECT key is pressed, or that the item is directly selected by touching the screen.

Registered Trademark

In this manual, names of companies, corporations, or products are trademarks, registered trademarks, or bland names for each company or corporation. The indications of (R) and TM are omitted.
Explanation of Warning Labels

The following warning labels are attached to the manipulator (refer to "Fig. : Warning Labels Location").

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.

**Fig. : Warning Labels Location**

![Diagram of Warning Labels Location]

**WARNING Label A:**
- **WARNING:** Moving parts may cause injury

**WARNING Label B:**
- **WARNING:** Do not enter robot work area.

**NAMEPLATE**

- **YASKAWA**
- **MODEL:**
- **MOTOR/ARM:**
- **TYPE:**
- **PAYLOAD:** kg
- **MASS:** kg
- **ORDER NO.:**
- **DATE:**
- **SERIAL NO.:**

YASKAWA ELECTRIC CORPORATION
2-1 Kunokakihoro, Takarazuka-shi, Hyogo
Kakogawa-ku 661-0004 Japan
MADE IN JAPAN NJ3878
Safeguarding Tips

All operators, programmers, maintenance personnel, supervisors, and anyone working near the system 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 equipment, the operator's manuals, the system equipment, and options and accessories should be permitted to operate this equipment.

• Improper connections can damage the equipment. All connections must be made within the standard voltage and current ratings of the equipment.

• The system must be placed in Emergency Stop (E-Stop) mode whenever it is not in use.

• In accordance with ANSI/RIA R15.06-2012, 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).

Mechanical Safety Devices

The safe operation of this equipment 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 R15.06-2012 safety standards, and other local codes that may pertain to the installation and use of this 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 barriers
• Door interlocks
• Emergency stop palm buttons located on operator station

Check all safety equipment frequently for proper operation. Repair or replace any non-functioning safety equipment immediately.
Programming, Operation, and Maintenance Safety

All operators, programmers, maintenance personnel, supervisors, and anyone working near the system 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 equipment should be permitted to program, or maintain the system. All personnel involved with the operation of the equipment must understand potential dangers of operation.

- Inspect the equipment 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.
- Check the E-Stop button on the operator station for proper operation before programming. The equipment 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 the controller unit can cause severe personal injury or death, as well as damage to the robot! Do not make any modifications to the controller unit. Making any changes without the written permission from YASKAWA will void the warranty.
- Some operations require a standard passwords and some require special passwords.
- The equipment allows modifications of the software for maximum performance. Care must be taken when making these modifications. All modifications made to the software will change the way the equipment operates and can cause severe personal injury or death, as well as damage parts of the system. Double check all modifications under every mode of operation to ensure that the changes have not created hazards or dangerous situations.
- 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 equipment. All connections must be made within the standard voltage and current ratings of the equipment.
Maintenance Safety

Turn the power OFF and disconnect and lockout/tagout all electrical circuits before making any modifications or connections.

Perform only the maintenance described in this manual. Maintenance other than specified in this manual should be performed only by YASKAWA-trained, qualified personnel.

Summary of Warning Information

This manual is provided to help users establish safe conditions for operating the equipment. Specific considerations and precautions are also described in the manual, but appear in the form of Dangers, Warnings, Cautions, and Notes.

It is important that users operate the equipment in accordance with this instruction manual and any additional information which may be provided by YASKAWA. Address any questions regarding the safe and proper operation of the equipment to YASKAWA Customer Support.
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1 Introduction

1.1 About This Document

This system manual is delivered with both the ArcWorld 1000 and ArcWorld 1200 systems to provide a “first look” and overview of the complete Motoman ArcWorld 1000 series system. You should read and understand this system manual before moving on to the more detailed documentation that is included with your ArcWorld 1000 series 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 1000 series system, please review the full documentation package that is included with your ArcWorld 1000 series system (refer to section 1.3).

This system manual contains the following sections:

Chapter 1 “Introduction”

This chapter provides general information about the ArcWorld 1000 Series System and its components, a list of reference documents, and customer service contact information.

Chapter 2 “Equipment Description”

This chapter provides a description of the major components of the ArcWorld 1000 Series System.

Chapter 3 “Installation”

This chapter provides installation procedures for the ArcWorld 1000 Series System.

Chapter 4 “Operation”

This chapter provides an overview of ArcWorld 1000 Series System operation, including start-up, loading, normal operations, fault recovery, and system shutdown.

Chapter 5 “Maintenance”

This chapter provides a listing of preventive maintenance requirements for certain components of the ArcWorld 1000 Series System.

Chapter 6 “Anchor Requirements”

This chapter gives recommended anchoring hardware specifications and foundation requirements for all the equipment that is part of the ArcWorld 1000 Series System.

Appendix A

Appendix A provides a checksheet on what is included with the documentation.
1.2 System Overview

The ArcWorld 1000 Series System provides a complete arc-welding solution in a standardized configuration. There are two available tables that can be selected for the AW1000/1200 cell assemblies. The tables available are the MSR355 or MSR655. The payloads are 355, or 655 per side of the table. The ArcWorld 1000 system is designed around a single Motoman MA1440 robot, a DX200 controller, and welding power source. The ArcWorld 1200 system is designed around two Motoman MA1440 robots, a DX200 DRC controller, and welding power sources.

The ArcWorld 1000 Series family uses the servo driven rotary positioner. The rotary positioner allows an operator to prepare and set up parts on one side of the positioner while the robots weld on the other side.

The ArcWorld 1000 Series System features a total safety environment that meets or exceeds the requirements of the ANSI/RIA R15.06-2012 standard and is designed to safeguard both personnel and equipment. Heavy-gauge, wire-mesh safety fencing prevents unintended entry of personnel into the work cell while it is in operation. Arc curtains cover the wire-mesh fencing to attenuate the amount of arc radiation that escapes the work cell during the welding operations. Dual-interlocked access doors on each side of the work cell provide convenient access to equipment while providing a safety interlock to disable all equipment should these doors be opened while the robots are active.

A dual-channel safety light curtain system provides a “sensing field” in front of the rotary positioner through use of an infrared light beam. Rotary positioner motion is prevented whenever an operator is in a position to disrupt the sensing field of the light curtain system. In addition, maximum robot travel is physically limited by an S-axis “hard stop” at the base of each robot. Fig. 1-1 illustrates the layout and component locations for the ArcWorld 1000 Series System.

Safeguards for the system complement the system operation while protecting the various people that will program, operate, and/or provide maintenance to the system. Possible pinch points and other hazards from the risk assessment process determined needed safeguards and interlocks. While the system design safeguards the support staff, it does not protect against misuse of the system. Misuse of the system includes, but is not limited to climbing over/under barriers, climbing over/under interlocked doors, or disabling/bypassing of system interlocks.

During the install and commissioning process the end user must ensure tooling, ancillary equipment, etc. have not introduced additional hazards into the design. This evaluation ensures that the system will provide a safe and reliable operation. The Risk Assessment document should be reviewed for installation of the system and prior to operation. Any changes and additions to the system require full review of the Risk Assessment document.
1.2.1 System Layout

The MA1440 manipulator(s) (robots), an MSR positioner, and heavy-gauge, wire-mesh safety fencing all share a common steel base for ease of installation and assurance of proper alignment between the robot(s) and rotary positioner. The wire-mesh safety fencing completely surrounds the ArcWorld 1000 Series System work cell. The DX200 controller shares a common platform with the welding power source(s).

These equipment platforms are located outside and to the rear of the work cell. This arrangement allows most of the component wiring interconnects to be pre-wired at the factory, thus reducing the amount of point-to-point wiring required of the customer. All operator controls, including those on the Programming Pendant, DX200 controllers, welding power supplies, and Operator Station pedestal, are accessible from outside the ArcWorld 1000 Series System work cell.
1.2 System Overview

1.2.2 Major Components

The ArcWorld 1000 Series System includes the following major components:

- Motoman MA1440 manipulator(s) (robots)
- DX200 controller (AW1200-DRC configuration)
- One MSR series rotary positioner
- One Programming Pendant (located on the DX200 controller)
- Operator Station pedestal
- Welding equipment (for each robot):
  - Welding power supply
  - Welding torch (water-cooled or air-cooled)
  - Wire feeder
  - Applicable welding interface
  - Torch mount
- Safety equipment:
  - Heavy gauge, wire-mesh safety fencing
  - Arc curtains (covering the safety fencing)
  - Dual-channel, interlocked safety light curtain system
  - Dual-channel, interlocked work-cell entry doors
  - Steel arc screen on the MSR rotary positioner

1.2.3 Optional Equipment

The following optional equipment is available for use with the ArcWorld 1000 Series System:

- Torch cleaner
- Wire cutter
- Water circulator
- Touch Sense™ (starting point detection unit)
- ComArc™ (seam tracking)
1.2.4 Theory of Operation and Safe Guarding

The DX200 “ArcWorld 1000” series of cells are designed to accommodate a single or dual MA1440 robot(s). The cells are available in two configurations:

- AW-1000 - Single MA1440 robot with MSR series positioner (MSR355 or MSR655.)
- AW-1200 - Two MA1440 robots with MSR series positioner (MSR-355 or MSR655.)

The cells are designed for arc welding applications where the robot controller(s) and welding power source(s) are located behind the cell. In the AW-1200 cell, the R2 robot utilizes a full-size MA1440 robot cabinet in a DRC (dual robot control) configuration. This DRC configuration provides a single programming pendant for both robots. Two sliding doors with safety interlocks allow access from either side. The MA1440(s) sit(s) on a 610 mm riser(s). Mounting provisions are in the base for an in-cell torch cleaning station.

The standard servo driven MSR positioners provides either a 60 inch (1500 mm) or 72 inch (1829 mm) H-Frame tabletop. The table comes programmed reciprocate between two positions (Side A/Side B). Based on the selected table, options for additional load positions, rotary brushes, slip-rings and hard-stops are available and therefore not included in the standard cell.

The R1 controller includes a functional safety unit (FSU) for monitoring the rotary table and light curtain to ensure the table does not move when safety gate is open or light curtain is blocked in TEACH mode. An AW1200 cell does not include a FSU for the R2 controller.

NOTE

The FSU will allow table motion at a reduced speed even if the safety gates are open or light curtains are blocked in TEACH mode.

Additional FSU functionality can be added by the integrator or end-user by implementing safety and zone monitoring.

The three button post mounted operator station is located on the front right fence post. This operator station provides a [CYCLE START CYCLE LATCHED] push button, [POSITIONER AUTO/MANUAL] selector switch and an [EMERGENCY STOP] button.

A L-shaped light curtains provide personnel detection on the front of the cell. This light curtain detects when someone approaches the rotary table and ensures that the table does not move while someone interrupts the light curtain. If an interruption occurs to the light curtain while the table is moving causes the system to shut-down with a FSU alarm.
1 Introduction
1.2 System Overview

Fig. 1-2(a): AW1000 Cell

Fig. 1-3: AW1200 Cell
1.2.4.1 System Teaching:

Programming of the system is intended to take place from within the cell. In order to program the robot, the controller must be in TEACH Mode selected at the selector switch on the front of the programming pendant. This TEACH Mode selection will limit all robot speeds to 250 mm/min. While in TEACH Mode, the two gates may be in the open position allowing the programmer to be in the cell. In order for the robot servo motors to be turned on, the enabling device on the programming pendant must be maintained. Once servo power is on, the operator is able to manipulate and program the part as desired. While in TEACH Mode the MSR table can be rotated from side A to B or B to A via the programming pendant's external axis keys or by selecting the “Sweep” job and test starting thru the job logic. If the operator or another person enters interrupts the light curtain signal while in TEACH mode, the “Standstill Monitor” function prevents the table from moving.

1.2.4.2 System Operation:

Once path and logic programming is complete, the system can begin operation once the following conditions are met:

1. Programming pendant must be in PLAY Mode.
2. Safety gates are closed
3. Servo power is applied using the programming pendant.
4. Pressing the [Start] button on the programming pendant to begin the execution of the “INFORM” job. Once applying servo power and job execution begins, then normal cell production can begin.

Normal cell production beings with the rotary table is at either “Side A” or “Side B” as reported by the FSU’s “position monitor” function (specific outputs). Anytime the light curtain on the front of the cell is clear, the rotary table is free to move as directed by the “INFORM” job. Once an operator approaches the cell and interrupts the light curtain clear signal, the rotary table will enter a “standstill monitoring” state where the table cannot move until the light curtain signal is clear. Once the operator steps out of the light curtain ending the "standstill monitoring" and presses the [CYCLE START CYCLE LATCHED] button on the operator station. The [CYCLE START CYCLE LATCHED] button press will latch (if the robot is actively processing a part on the other side of the table) or will initiate table movement from the executing "INFORM" job to sweep the table 180 degree to allow the operator to unload the processed part while presenting the robot with the unprocessed part. Once the table has swept into position the operator can interrupt the light curtain signal ("Standstill Monitoring" enables again when interrupting the light curtain) to begin the removal of the processed part and begin loading a new part into the fixture. If there are no faults or issues during the production of a part the robot returns to a safe position. Once in the safe position and loading a part and pressing the [CYCLE START CYCLE LATCHED] button the "INFORM" JOB will sweep the table from side to side so the operator can unload the finished part. The process begins again once loading a new part.
1.2.4.3 Key Safety Devices

- DX200 controller with MA1440(s), FSU (R1 only), MSR rotary table:
  - Dual channel programming pendant E-Stop
  - Dual channel programming pendant enabling device
  - PLAY/TEACH mode switch
  - Functional Safety Unit (FSU)
- Safety Gate Interlocks (qty 2):
  - Dual channel dry contact outputs
- L-Shaped light curtain:
  - 30mm object sensitivity
  - 42 ms response time
  - Dual channel output
- Pilz PNOZ-S4 Safety Relay:
  - Monitors outputs from light curtains & generates dry-contact connections for use in the external E-Stop logic
- Three button operator station:
  - Dual channel “Cycle Start” button
  - Dual channel “E-Stop”
  - Single channel “Auto/Manual” switch
- Functional Safety Unit (FSU):
  - Responsible for monitoring the MSR rotary table to ensure no external motion occurs (via “Standstill monitor” function while the light curtain signal is interrupted.)

1.2.4.4 Safety Logic Implementation (all cells):

1. In PLAY Mode and TEACH Mode, FSU-based “Standstill monitoring” will ensure that MSR positioner is not able to move anytime the light curtain signal is interrupted.
2. In “PLAY Mode” the DX200 monitors with the “Safety Gates” closed to ensure someone does not access the work cell while in “PLAY Mode”.
3. The FSU is not for preventing robot collision with either the safety fence or the MSR positioner at any time.
1.2.4.5 Functional Safety Setup

The following FSU files are utilized as a standard:

*Fig. 1-4(a): S1 "Axis Range Limit" Being Set for Side A/B*

*Fig. 1-4(b): Axis Range Limits for Side A:*
1 Introduction
1.2 System Overview

Fig. 1-4(c): Axis Range Limits for Side B

Fig. 1-4(d): Functional Safety Signal Allocation
1 Introduction

1.2 System Overview

Fig. 1-4(e): Safety Logic Circuit (1)

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<th>INPUT</th>
<th>LOGIC</th>
<th>OUTPUT</th>
<th>TIMER</th>
<th>COMMENT</th>
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</thead>
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| 01    | 0     | 0      | 0      | Light Curtain |}
| 02    | 0     | 0      | 0      | Dr. Side A At Rbt |}
| 03    | 0     | 0      | 0      | Dr. Side B At Rbt |}
| 04    | 0     | 0      | 0      | Dr. Side A Or B Rbt |}
| 05    | 0     | 0      | 0      | Dr. Side A Or B Dr |}
| 06    | 0     | 0      | 0      | Dr. Side A Or B Dr |}
| 07    | 0     | 0      | 0      | Dr. Side A Or B Dr |}
| 08    | 0     | 0      | 0      | Dr. Side A Or B Dr |}
| 09    | 0     | 0      | 0      | Dr. Side A Or B Dr |}
| 10    | 0     | 0      | 0      | Dr. Side A Or B Dr |}
| 11    | 0     | 0      | 0      | Dr. Side A Or B Dr |}
| 12    | 0     | 0      | 0      | Dr. Side A Or B Dr |}
| 13    | 0     | 0      | 0      | Dr. Side A Or B Dr |}
| 14    | 0     | 0      | 0      | Dr. Side A Or B Dr |}
| 15    | 0     | 0      | 0      | Dr. Side A Or B Dr |}
| 16    | 0     | 0      | 0      | Dr. Side A Or B Dr |}
| 17    | 0     | 0      | 0      | Dr. Side A Or B Dr |}

Fig. 1-4(f): Safety Logic Circuit (2)

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<th>TIMER</th>
<th>COMMENT</th>
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</thead>
</table>
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| 02    | 0     | 0      | 0      | Dr. Side A At Rbt |}
| 03    | 0     | 0      | 0      | Dr. Side B At Rbt |}
| 04    | 0     | 0      | 0      | Dr. Side A Or B Rbt |}
| 05    | 0     | 0      | 0      | Dr. Side A Or B Dr |}
| 06    | 0     | 0      | 0      | Dr. Side A Or B Dr |}
| 07    | 0     | 0      | 0      | Dr. Side A Or B Dr |}
| 08    | 0     | 0      | 0      | Dr. Side A Or B Dr |}
| 09    | 0     | 0      | 0      | Dr. Side A Or B Dr |}
| 10    | 0     | 0      | 0      | Dr. Side A Or B Dr |}
| 11    | 0     | 0      | 0      | Dr. Side A Or B Dr |}
| 12    | 0     | 0      | 0      | Dr. Side A Or B Dr |}
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| 15    | 0     | 0      | 0      | Dr. Side A Or B Dr |}
| 16    | 0     | 0      | 0      | Dr. Side A Or B Dr |}
| 17    | 0     | 0      | 0      | Dr. Side A Or B Dr |}
Fig. 1-4(g): S1 Standstill Monitor

Fig. 1-4(h): S1 Standstill Monitor Details
1.3 Reference Documentation

For additional information on individual components of the ArcWorld 1000 Series System, refer to the following documentation that is included with your delivered system:

- Motoman MA1440 Manipulator Manual (P/N 165830-1CD)
- Motoman DX200 Controller Manual (P/N 165292-1CD)
- Motoman Maintenance Manual for DX200 (P/N 165293-1CD)
- Motoman Operator’s Manual for Arc Welding (P/N 166346-1CD)
- Motoman DX200 Concurrent I/O Manual (P/N 165294-1CD)
- Motoman MSR-355 and MSR-655 Positioner Manual (P/N 169856-1CD)
- Motoman DX200 Independent/Coordinated Control Function Manual
- Motoman INFORM User’s Manual (P/N 165301-1CD)
- Vendor manuals for system components not manufactured by Motoman
# 1.4 Reference Table

The table below provides location(s) for various operations.

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1.5 Customer Support Information

If you need technical assistance with any aspect of your ArcWorld® 1000 and 1200 Series System, please contact YASKAWA Customer Support at the following 24-hour support telephone number:

(937) 847-3200

Please have the following information ready before you call:

- **System**: ArcWorld® 1000 and 1200 Series
- **Robot**: MA1440
- **Positioner**: MSR355 or MSR655
- **Primary Application**: Welding
- **Controller**: DX200 (AW1200-DRC)
- **Software Version**: Access this information on the Programming Pendant display screen by selecting \{MAIN MENU\} - \{SYSTEM INFO\} - \{VERSION\}
- **Robot Serial Number**: Located on a data plate on the rear of each robot arm
- **Robot Sales Order Number**: Located on a data plate on the front door of the DX200 controller
2 Equipment Description

2.1 Robot Description

The ArcWorld® 1000 and 1200 Series system uses the Motoman MA1440 six-axis robot(s). The MA1440 (ALL) robot is specifically designed for arc-welding applications. The robot has a payload capability of 6 kg and features a horizontal reach of 1440 mm. The MA1440 robot also features a relative positioning accuracy of ±0.08mm. The MA1440 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 ± 200 degrees without cable interference.

For additional information on the Motoman MA1440 robot, please refer to the MA1440 Manipulator Manual that is included with your ArcWorld® 1000 and 1200 Series system (refer to section 1.3).

2.2 DX200 Controller

The ArcWorld® 1000 and 1200 Series system features a DX200 controller (see Fig. 2-5). The DX200 controls the movement of a single or multiple robots. It also controls the welding power source(s) and MSR rotary positioner and provides the signals necessary to operate the welding system.

The DX200 controller features a real-time operating system (RTOS) and is programmed with the Motoman INFORM programming language.

For more detailed information on the DX200 controller, refer to the DX200 Controller Manual that is included with your ArcWorld® 1000 and 1200 Series system (see section 1.3).
ArcWorld® 1000 and 1200 Series

2 Equipment Description
2.2 DX200 Controller

Fig. 2-5: DX200 Controller

- POWER INPUT CABLE (Located in back)
- DOOR LOCK
- POWER ON/OFF EYE BOLT M12
- PROGRAMMING PENDANT
2.3 Programming Pendant

The Programming Pendant (see Fig. 2-6) provides the primary means of programmer/operator interaction with the ArcWorld® 1000 and 1200 Series system. The pendant features the Windows® CE operating system and displays information on a 6½-inch, color LCD, touch-screen display (640 X 480 VGA). The pendant also incorporates a Compact Flash card and USB port for program backups.

The pendant provides icon-driven system programming. It also features a menu-driven interface to simplify operator interaction with the robots. Most operator controls are located on the Programming Pendant. This allows the DX200 controller cabinet to be mounted remotely. By using the pendant, the operator can teach the robots motion; perform programming, editing, maintenance, and diagnostic functions; and transfer control of the ArcWorld® 1000 and 1200 Series system to or from the Operator Station. For detailed information on the pendant programming keys, programming functions, and display functions, please refer to the DX200 Operator’s Manual for Arc Welding that is included with your ArcWorld® 1000 and 1200 Series system (see section 1.3).

*Fig. 2-6: DX200 Programming Pendant*
2.4 Operator Station

The standard Operator Station includes a NEMA enclosure and is mounted on the ArcWorld system fence post. The standard Operator Station includes the [CYCLE START CYCLE LATCHED] push button, [POSITIONER AUTO/MANUAL] selector switch and an [EMERGENCY STOP] button.

Fig. 2-7: Operator Station

The optional Pedestal Operator Station (see Fig. 2-8) 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® 1000 and 1200 Series system.

Fig. 2-8: Optional Pedestal Operator Station
2.4 Operator Station

The following paragraphs describe the Operator Station controls:

2.4.1 [CYCLE START CYCLE LATCHED] Push Button

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 START 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.

2.4.2 [EMERGENCY STOP] Button

Pressing the red [EMERGENCY 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.

2.4.3 [ROBOT HOLD] Button

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.

2.4.4 ALARM Lamp

A red ALARM lamp illuminates to indicate that a DX200 controller has encountered an alarm condition.

2.4.5 [POSITIONER AUTO/MANUAL] Selector Switch

The [POSITIONER AUTO/MANUAL] selector switch is used to select automatic or manual mode for the MSR 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.

NOTE: The Positioner Auto/Manual signal depends upon the structure of the Control Master job.
2.4.6 [START] Button
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.

2.4.7 [RESET] Button
The black [RESET] button is used to clear a minor alarm or error condition.

2.4.8 [SERVO ON] Button
The green [SERVO ON] push button turns servo power ON when the robot is in PLAY mode and the Operator Station is enabled.

2.5 MSR Family Positioner

The MSR Family positioner is part of the ArcWorld® 1000 and 1200 Series system. It is mounted on the same common equipment base as the MA1440 robot(s) and the wire-mesh safety fencing. The MSR family is a high-speed rotary positioner that features controlled rotary motion and a 355kg (783lb) or 655kg (1444lb) payload capacity per side. The standard configuration utilizes a brushless servo drive motor plus gear reducer, a 1524 mm (60-inch) circular table top, and a housing. A steel arc screen divides the table top, providing two semicircular work areas (Side A and Side B). The steel arc screen creates a barrier that safeguards the operator from arc radiation and sparks produced during the welding operation. The MSR family uses a rotary motion to sweep each side of the circular turntable 180° from the operator’s loading zone, into the robots’ work zone and back to the operator again. The positioner can accept optional external axis control for coordinated motion between the positioner and the robots. See Fig. 1-1 for a general view of the MSR positioner.

**WARNING**

Do not operate the MSR family positioner unless the arc screen is in place. Operation of the positioner without the arc screen in place can result in burns or serious eye damage for the operator.

For detailed positioner information, including illustrated parts lists, load capabilities, and dimensions, refer to the **MSR355 and MSR655 Positioner Manual** that is included with your ArcWorld® 1000 and 1200 Series system (see section 1.3).

- All tooling and fixtures for the MSR family rotary positioner are supplied by the customer.
- In high humidity areas, use surface protection to prevent corrosion of the tooling plates.
2.6 Welding Equipment

In its standard configuration, the ArcWorld® 1000 and 1200 Series system includes a welding power source, wire feeder, torch, and torch mount for each MA1440 robot. Optional equipment — water-cooled torch, water circulators, ComArc™ seam tracking units, and torch tenders — may also be included with your ArcWorld® 1000 and 1200 Series system.

2.6.1 Welding Power Sources

Motoman offers various brands and types of welding power sources. The actual brand and type of welding power source supplied with the ArcWorld® 1000 and 1200 Series system depends on the customer’s specific application and preference. For specific information on the welding power sources supplied with your ArcWorld® 1000 and 1200 Series system, refer to the welding power source vendor manual that is included with your system (see section 1.3).

2.6.2 Wire Feeder

A welding wire feeder is mounted on the upper arm (U-Axis) of each MA1440 robot. The wire feeder is the “4-roll” type and provides reliable wire feeding at rates up to 750 inches per minute (ipm). An integral gas valve provides fast shielding gas response time. Interchangeable feed rolls are used to accommodate different wire gauges and wire types. For additional information on how the wire feeder is mounted to the robot’s upper arm, including allowable load and installation position, refer to the MA1440 Manipulator Manual that is included with your ArcWorld® 1000 and 1200 Series system (see section 1.3).

2.6.3 GMAW Torch

The ArcWorld® 1000 and 1200 Series system uses either an air-cooled or water-cooled robotic/automatic GMAW torch for each robot. 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 flange. 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 4.4.2 “E-STOP Recovery”).

For applications that use the optional water-cooled torch, the ArcWorld® 1000 and 1200 Series system includes a water circulator kit for each robot. For additional information on the torches that are supplied with your system, refer to the documentation that is included with your ArcWorld® 1000 and 1200 Series system (see section 1.3).
2.7 Safety Features

The ArcWorld® 1000 and 1200 Series system includes a total safety environment. If you comply with all standard safety precautions, the safety equipment helps to ensure safe operation of the robot work cell.

### 2.7.1 Welding Arc Protection

Two forms of welding arc protection are part of the ArcWorld® 1000 and 1200 Series system:

- a steel arc screen on the MSR family rotary positioners.
- arc curtains that are attached to the steel-mesh safety fencing

The steel arc screen on the MSR family rotary positioner protects the operator from arc radiation and sparks that result from the welding operation (see Fig. 1-1).

![WARNING]

Although safety fence arc curtains block dangerous arc radiation, never look directly at the arc without protective eye wear.

Arc curtains cover the steel-mesh safety fencing that surrounds the entire work cell. The curtains provide protection from arc flash and reduce the amount of ultraviolet radiation that escapes from the work cell during welding operations.

### 2.7.2 Safety Fencing

The heavy-gauge, steel-mesh safety fencing that is provided with the ArcWorld® 1000 and 1200 Series system attaches to the common base and encloses the entire work cell. It forms a physical barrier that prevents personnel from entering the work cell during automatic operation.

### 2.7.3 Safety Light Curtains

The safety light curtain system consist of two units (a Send unit and a Receive unit) that emit and receive infrared light pulses to create an invisible protective field. The infrared light pulses, coded by the Send unit, are sent to the Receive unit, which evaluates them. If an object or person penetrates the protective field created by the infrared light, outputs of the safety light curtain system change state to stop all machine motion. The safety light curtain system incorporates a dual-channel safety feature. The dual-channel feature provides redundant operation to ensure a continuous field of coverage for the area protected by the light curtain units.

With the ArcWorld® 1000 and 1200 Series system, the safety light curtains are set up to protect personnel who might unintentionally enter the MSR rotary positioner area during the positioner sweeping process. In Play mode, if the positioner is sweeping and the operator steps into the safety zone (defined by the light curtain Send and Receive units), servo...
power is removed from the ArcWorld® 1000 and 1200 Series system, and all MSR positioner motion stops. Servo power can be reapplied and the operation resumed (after the operator is clear of the protected area) by pressing SERVO ON and START on the Operator Station panel. Refer to section 3.5 for the alignment of the safety light curtains in the ArcWorld® 1000 and 1200 Series system.

2.7.4 Emergency Stops (E-STOPS)

In addition to the safety features described above, the ArcWorld® 1000 and 1200 Series system incorporates large, red Emergency Stop (E-STOP) push buttons that are placed in accessible locations. When any E-STOP push button is activated (pushed in), the E-STOP circuitry immediately stops all system operation and robot movement.

E-STOP push buttons are found in the following locations:

- The door of the DX200 controller
- The Programming Pendant
- The Operator Station

2.7.5 Programming Pendant’s Enable Switch

The Enable switch is a three-position switch located on the left rear of the Programming Pendant (see Fig. 2-6). It is a safety feature that controls servo power while the system is in TEACH mode. When pressed in, this switch allows the operator to turn servo power ON. Should the operator release the switch or grasp it too tightly, however, servo power is immediately removed, thus preventing further robot movement. For detailed information about the operation of the Enable switch, refer to the Operator’s Manual included with your ArcWorld® 1000 and 1200 Series system (see section 1.3).

2.7.6 Emergency Braking System

The MA1440 manipulator incorporates a series of brakes that are designed to protect the robot and other system components from damage in the event of a software or hardware robot control failure. Upon activation, the brake system stops all robot motion. The brake system incorporates a 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 section 4.4.4 “Brake Release” for brake release procedures.

2.7.7 Interlocked Work-cell Doors

A dual-redundant safety interlock is installed on each work-cell access door. If either one of the work-cell doors is opened while the robots are in PLAY mode, the robot emergency braking system activates, all servo power is removed from the system, and all positioner motion stops.
3 Installation

3.1 Required Materials

The ArcWorld® 1000 and 1200 Series system can be installed in a short amount of time by two to three qualified technicians. Always comply with the established safety instructions and precautions given throughout this manual throughout the installation process.

The instructions given in this section are general guidelines for installing the ArcWorld® 1000 and 1200 Series system. Refer to your system drawings and relevant system component manuals for specific installation information (see section 1.3).

3.1 Required Materials

All system components and most hardware required for installation of the ArcWorld® 1000 and 1200 Series system are included with your shipment. There are, however, some required items that the customer must supply (hand tools, special anchor bolts, etc.). These are not included with your shipment.

3.1.1 Customer-supplied Items

- Shielding gas for the welding torches
- Local electrical service
- Earth ground wires for the MA1440 robots, DX200 controllers, and peripheral equipment
- Ground rods and/or buried copper sheeting (quantity 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 ground system
- Welding wire
- Clean, dry air supply (15 scfm @ 90 psig) for torch tender or wire cutter options
- Stepladder
- Forklift and/or overhead crane

CAUTION

- The ArcWorld® 1000 and 1200 Series system should be installed by qualified personnel who are familiar with the installation and setup of a robotic system.
- The ArcWorld® 1000 and 1200 Series system is not extremely fragile. It is, however, a sophisticated robotic system that can be damaged by rough handling. Be sure to handle all system components with care.
3.1 Required Materials

3.1.2 Recommended List of Hand Tools and Equipment

- Safety glasses
- Face shield
- Gloves (protective, leather)
- Levels (short and long)
- Ratchet handle (with 3/4-inch hex socket)
- Adjustable wrench
- Hammer drill with appropriate concrete bits
- Phillips and flat-blade screwdrivers
- Hammers (dead-blow and steel)
- Hammer (non-marring)
- Socket sets (SAE and Metric)
- Air-impact gun (with 3/4-inch hex socket)
- Open-end wrench sets (SAE and Metric)
- Socket head wrench sets (Allen®, Bondhaus®, etc.)

Special anchor bolts (lag bolts) are supplied by the customer. Refer to chapter 6 for a listing of special bolts that are required for anchoring the common equipment bases and other components of the ArcWorld® 1000 and 1200 Series system.
3.2 Site Preparation

**WARNING**

Be sure to allow for sufficient room for maintenance on the robots, DX200 controllers, and other peripheral equipment. Failure to observe this precaution could result in injury to personnel during system maintenance.

To prepare your site, proceed as follows:

1. Clear the floor space needed for the ArcWorld® 1000 and 1200 Series system (see Fig. 3-1(a) or Fig. 3-1(b)). Allow an additional 1.2 to 1.5m (4 to 5ft) on all sides of the work cell to facilitate installation.

2. Gather all customer-supplied items and required tools (refer to section 3.1).

*Fig. 3-1(a): Installation Dimensions for the ArcWorld 1000 System*
3 Installation
3.2 Site Preparation

Fig. 3-1(b): Installation Dimensions for the ArcWorld 1200 System
3.3 Installing and Leveling the Common Base

The common base is shipped on a wooden platform. To install the 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 common base 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 Fig. 3-2). It may be necessary to hold the leveling screws in place with a suitable open-end wrench while removing the shipping bolts.

*Figure 3-2: Stabilizing and Lag Points (Robot/Positioner Common Equipment Base)*

**WARNING**

As shipped, the robot/positioner common base (with equipment) weighs approximately 2200 kg (4409 lbs). Use a forklift that is rated for this amount of weight load.

2. Using a forklift, lift the common base from the wooden platform. Discard or recycle the wooden shipping skid.

3. Place the common base in position (see Fig. 3-1(a)).
3 Installation
3.3 Installing and Leveling the Common Base

4. Carefully remove the protective plastic wrapping from the robot(s), torches, and rotary positioner.

5. Inspect the robots, torches, and rotary positioner for shipping damage.

6. Use a M36 socket to loosen or tighten each leveling bolt so they are not touching the ground. Tighten the leveling bolts to make contact to the floor. The ArcWorld cell assembly does not require to be level. Adjust the leveling screws to eliminate instability. The leveling bolts have a 17 mm diameter though hole for lagging the cell assembly to the floor. Lagging is not required for this ArcWorld cell assembly, but is recommended. The minimum anchor size is 1/4” diameter with a 2” embed depth. An oversized plate/washer will have to be used with this anchor size. A 1/2” anchors with a 2” embed depth is the recommend anchor size for the oversize washer. Chemical anchor type is recommend, but not required for this application due to the cell assembly is inherently stable. (see Fig. 3-2).

7. Secure the common base to the floor. Use a suitable concrete drill bit and special anchor (lag) bolts. If selecting the recommended 1/2” chemical anchor in step 6 then insert the correct drill size specified by the anchor manufacture through the center of the leveling bolt on the cell assembly and drill into the foundation to accept an anchor bolt. Be sure to remove all concrete dust from the drilled hole before driving each anchor bolt.

CAUTION

Be absolutely certain of the correct location for the common base before securing the base with anchor (lag) bolts.
3.4 Installing the Operator Station Pedestal (Option)

To install the Operator Station pedestal, proceed as follows:

1. Locate the Operator Station pedestal.
2. Carefully remove the protective plastic wrapping from the Operator Station pedestal.
3. Inspect the Operator Station pedestal for shipping damage.
4. Place the Operator Station pedestal outside the light curtain fence panels (see Fig. 3-1(a) for the recommended location).
5. Secure the Operator Station pedestal to the floor. Use a suitable concrete drill bit and special anchor (lag) bolts (refer to chapter 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.

3.5 Light Curtain Alignment

The light curtain Send unit and Receive unit must be accurately positioned, relative to each other, to ensure correct operation. Complete alignment procedures are included in the light curtain documentation that is included with your ArcWorld® 1000 and 1200 Series system (refer to section 1.3).

3.6 Cable Connections

After the ArcWorld® 1000 and 1200 Series components and peripherals are secured in their correct locations, unwrap the cables from around the equipment and route them according to the cable diagrams included in the documentation supplied with your ArcWorld® 1000 and 1200 Series system. All cables and connectors are labeled for ease of installation.

A small gap exists between the bottom of the work-cell safety fence and the robot/positioner common base. This gap provides a passage for cables that run between components outside the work cell and those inside the work cell.
3.6 Cable Connections

3.6.1 Connection to Earth Ground

**WARNING**

Do not use the ArcWorld® 1000 and 1200 Series system unless specified components are connected to a low-resistance earth ground. Do not connect the earth ground wire with the wires for the electric power source, welder, etc. The low-resistance earth ground must be a “dedicated” ground that is a direct connection between the component and the earth ground point. Operator injury or death, as well as equipment damage, can result from an inadequate or defective earth ground system.

Each robot and DX200 controller must be connected to an earth ground. If a ground stake is used, it should be driven at least 2.43m (8 ft) into the soil. The soil surrounding the driven ground stake should be treated with a chemical that increases the soil conductivity in the vicinity of the driven ground stake. This is often referred to as a “low-resistance earth ground” and may require quite a bit more than a single driven ground rod, depending on soil conditions. Multiple ground stakes (bonded together) or even a bonded network of buried copper sheeting (plus conduction-enhancing chemicals) may be required, depending on local soil condition. In any event, the “low-resistance earth ground” must indicate a resistance of **100 ohms or less** (when measured directly between grounded equipment and the earth ground system). Be advised that specialized measuring equipment is usually required to get an accurate “resistance-to-ground” reading. Consult a specialist in this field, if required.

**NOTE**

The customer must supply all wires associated with the earth ground. The customer is responsible for establishing and maintaining an adequate earth ground (must maintain a resistance of 100 ohms or less).

Connect both robots and DX200 controller to the earth ground as follows:

1. Connect one end of an earth ground wire to the lug marked Earth Ground on the connector panel of MA1440 robot. Connect the other end of the earth ground wire to the low-resistance earth ground.

2. Connect one end of an earth ground wire to the Common Ground Bus Bar located inside DX200 controller. Connect the other end of the earth ground wire to the low-resistance earth ground.
3.6 Cable Connections

3.6.2 Connection to Local Electrical Service

**WARNING**

Connection of the ArcWorld® 1000 and 1200 Series system to local electrical service must be done by a qualified, licensed electrician. Electrical and grounding connections must comply with the National Electrical Code (NEC), as well as local electrical codes.

After all the system components have been properly installed and interconnected, connect local electrical service to the fused electrical service disconnect boxes. The boxes are located on the DX200 controller common base (see Fig. 1-1 and Fig. 2-5).

**NOTE**

The ArcWorld® 1000 and 1200 Series is configured for three-phase 460/480V\textsubscript{AC} primary power. For additional information, please refer to the electrical drawings and schematics that are included with your ArcWorld® 1000 and 1200 Series system.
3.7 Safety/Operation Check

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

1. Ensure correct alignment and operation of the safety light curtain Send and Receive units.
2. Ensure that both work-cell access doors are closed and latched and door interlocks engaged.
3. Check the torque and security of all cable connections.
4. Ensure the correct setting of the welding power sources (refer to the welding power source documentation that is included with your ArcWorld® 1000 and 1200 Series system).
5. Verify that local electrical service is correctly wired into the fused disconnect boxes on the DX200 controller common base (refer to section 3.6.2 “Connection to Local Electrical Service”).
6. Verify that the local electrical service line voltage and phase comply with the voltage and phase requirements for your ArcWorld® 1000 and 1200 Series system.

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<th>CAUTION</th>
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<td>The ArcWorld® 1000 and 1200 Series system is now ready for power-up. Ensure that qualified, trained operators who are familiar with the ArcWorld® 1000 and 1200 Series system perform this power-up sequence.</td>
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7. Switch ON the electrical service disconnect box located on the DX200 controller common base (see Fig. 2-5).
8. Set the power ON-OFF switch on DX200 controller to ON (see Fig. 2-5).
9. Switch ON the electrical service disconnect boxes located on the controller common base (see Fig. 2-5).

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<td>Before operating the robots, check each E-STOP push button to verify that servo power can be disabled by activation of the E-STOP. Injury to personnel or equipment damage can result from an E-STOP circuit defect. The E-STOP push buttons must be able to positively stop robot and positioner movement during an emergency situation.</td>
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11. Check for correct operation of the system HOLD buttons on the Programming Pendant and Operation Station [ROBOT HOLD]. Refer to the Operator's Manual for Arc Welding for more information on the pendant’s HOLD button (see section 1.3). Refer to section 2.4 for more information on the Operator Station's [ROBOT HOLD] button.
12. Ensure correct action of the safety interlocks on both work-cell access doors.
3.8 Installation of Tooling and Fixtures

Your ArcWorld® 1000 and 1200 Series system is now ready for the installation of tooling and fixtures for your particular application. Personnel who are familiar with the operation of the ArcWorld® 1000 and 1200 Series system should do the installation. After the installation, test the MSR positioner for correct operation.

NOTE: All tooling and fixtures for the MSR rotary positioner are supplied by the customer.
4 Operation

The ArcWorld® 1000 and 1200 Series system is a fully integrated robotic GMAW welding cell. Motoman EA1400N robot(s) weld on one side of the MSR rotary positioner while the operator loads the opposite side with a part to be welded. Once the robot(s) are finished, they return to HOME (Safe) position. The operator then enables the positioner sweep, allowing the robot(s) to start welding on the next part. This section provides operation instructions for the ArcWorld® 1000 and 1200 Series system.

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 procedures and information, refer to the DX200 controller and operator documentation that is included with your ArcWorld® 1000 and 1200 Series system (refer to section 1.3). Any changes made to your system configuration and/or job structure will alter the operation of the system. Motoman recommends that you DO NOT modify the original jobs and system configuration of your ArcWorld® 1000 and 1200 Series system.

If you determine a need to modify the original jobs and system configuration, make any modifications to a copy of the original. Keep the original as a backup. Do not modify the original.

Modifications must be performed by trained and experienced personnel who are familiar with the operation of the ArcWorld® 1000 and 1200 Series system. If you have questions concerning the configuration of your ArcWorld® 1000 and 1200 Series system, please contact YASKAWA 24-hour Customer Support (refer to section 1.5).

4.2 Sweeping the Positioner

MANUAL mode allows you to sweep the MSR positioner without activating the robot(s). Parts can be loaded onto the fixture to achieve the most efficient configuration and then swept into the welding zone before teaching the robot(s) 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(s) in HOME position (refer to section 4.3.2 “Robot HOME Position”).
2. Make sure that the Operator Station is enabled (Programming Pendant’s Mode Select Switch set to REMOTE).
3. (Optional Pedestal Operator Station) Set the Operator Station’s [POSITIONER AUTO/MANUAL] switch to MANUAL mode and start the Control Master job (see section 4.3.3 “Control Master Job”). Normally, the robot(s) will not move out of HOME position when the POSITIONER switch is set to MANUAL. (This depends on the job structure.)

Control of the positioner uses collaborative motion between the robot and the positioner external axis. Collaborative motion is active when jogging the tooling axis, loading, or unloading parts.

Cycle Start latching is not operative in Manual mode.

4. Press the [CYCLE START/CYCLE LATCHED] button on the Operator Station (the MSR positioner sweeps each time this button is pressed).

4.3 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 4.3.1).
- Move the robots to HOME position (refer to section 4.3.2).
- Select the Control Master job (refer to section 4.3.3).
- Perform the operation cycle (refer to section 4.3.4).
- Perform the shutdown procedure (refer to section 4.3.5).

4.3.1 Start-up Procedure

To start up the ArcWorld® 1000 and 1200 Series work cell from a power-off condition, proceed as follows:

1. Switch the DX200 controller’s electrical service disconnect box to ON (see Fig. 1-1).
2. Set the power ON-OFF switch on DX200 controller to ON (see Fig. 2-5).
3. Switch both welding power source electrical service disconnect boxes to ON.
4. Set the Power ON-OFF switch on each welding power source to ON (the ON-OFF indicator lamp on each welding power source will illuminate).
5. Open the regulator valve for the welding gas supply.
6. Make sure that both work-cell doors are closed and operating properly and the door safety interlocks are engaged.
4 Operation

4.3 Daily Operation

7. Make sure that all E-STOP buttons are released. E-STOP buttons are installed at the following locations:
   - Programming Pendant
   - Door of DX200 controller
   - Operator Station pedestal

8. Select TEACH mode on the Programming Pendant.

9. Place the robot(s) in HOME position (refer to section 4.3.2).

4.3.2 Robot HOME Position

To move the robot(s) to HOME position:

1. Select TEACH mode on the Programming Pendant.


4. Select SELECT JOB on the Programming Pendant touch screen (a job list appears on the screen).

5. Use the navigation cursor key to move the cursor to SAFE job and press SELECT (the job appears on the display screen).

6. Turn servo power on by pressing SERVO ON and holding in the ENABLE switch.

7. Use the [FWD] button on the Programming Pendant to move robot(s) to HOME position.

4.3.3 Control Master Job

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

1. Select JOB on the Programming Pendant touch screen.

2. Select CTRL MASTER on the Programming Pendant touch screen.

3. Press SELECT twice to activate the Control Master job.

4. Select PLAY mode on the Programming Pendant and press the PLAY MODE ENABLE button on the door of DX200 controller (job playback operation is enabled).

5. Press the SERVO ON button on the Programming Pendant.

6. Press the [START] button on the Programming Pendant (the Control Master job cycles, waiting for a Cycle Start input from the Operator Station).

7. Transfer control to the Operator Station by selecting REMOTE on the Programming Pendant’s Mode Select Switch.

The ArcWorld® 1000 and 1200 Series work cell is now ready for operation.
4.3 Daily Operation

4.3.4 Operation Cycle

The following is the typical sequence of operation for the ArcWorld® 1000 and 1200 Series work cell after start-up:

1. The operator loads the fixture (on the operator side of the positioner) with parts to be welded.

2. The operator steps out of the safety zone created by the safety light curtain system and moves to the front of the Operator Station.

3. The operator presses the green [CYCLE START/CYCLE LATCHED] button on the Operator Station. The MSR positioner sweeps 180°, placing parts to be welded into the robot work area. The robot(s) then begin to weld the parts (Optional Pedestal Operator Station’s [POSITIONER AUTO/MANUAL] switch must be set to AUTO).

4. While the robot(s) are welding, the operator loads the operator side of the positioner with the next group of parts to be welded.

5. The operator again moves to the Operator Station pedestal and presses the green [CYCLE START/CYCLE LATCHED] button. When the robot(s) are finished welding, they return to HOME position. The MSR positioner then sweeps 180° to return completed, welded parts to the operator position while moving the next group of parts into the robot work area.

6. The operator moves back to the operator side of the MSR positioner and unloads the completed, welded parts.

4.3.5 Shutdown Procedure

Use the following procedure to perform a normal shutdown of the ArcWorld® 1000 and 1200 Series system:

1. Make sure that the robot(s) are in HOME position.

2. Turn off system servo power by pressing the [EMERGENCY STOP] button on the Operator Station pedestal or Programming Pendant.

3. Select TEACH mode on the Programming Pendant.

4. Set the DX200 controller’s power ON-OFF switch to the OFF position.

5. Set welding power source power ON-OFF switches to the OFF position.

6. Close the regulator valve for the welding gas supply.

7. Switch all electrical service disconnect boxes to OFF.

The ArcWorld® 1000 and 1200 Series system is now shut down.
4.4 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 clear them.

4.4.1 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 DX200 controller and MA1440 robot documentation that is included with your ArcWorld® 1000 and 1200 Series system (refer to section 1.3).

4.4.1.1 Error Messages

Error messages are usually the result of simple, easily cleared operation errors. One example of this type of error is pressing the [START] button when the robots are not in PLAY mode.

Clear errors of this type by pressing the [CANCEL] button on the Programming Pendant.

4.4.1.2 Minor Alarms

Minor alarms usually involve programming errors. Clear alarms of this type by pressing the [CANCEL] button on the Programming Pendant.

4.4.1.3 Major Alarms

Major alarms usually involve hardware failures. Examples of this type of error include an overload condition and abnormal speed.

Clear alarms of this type by cycling the DX200 controller (switch the Power ON-OFF switch on each controller to OFF, then back to ON).

4.4.2 E-STOP Recovery

An E-STOP (emergency stop) will occur under any of the following conditions:

- An E-STOP button is pushed in (activated).
- A work-cell access door is opened while the robots are not in TEACH mode.
- The safety light curtain system is triggered while the MSR positioner is sweeping.
- A collision triggers a shock sensor output.
To restart the ArcWorld® 1000 and 1200 Series system after an E-STOP condition occurs, follow the procedures below.

1. To clear the E-STOP condition, perform any of the following actions that apply:
   - Release the activated E-STOP push button.
   - Close the work-cell access door(s).
   - Clear the area (in front of the MSR positioner) that is protected by the safety light curtain system.
   - Clear the shock sensor condition (refer to section 4.4.3).

2. Press the SERVO ON button on the Operator Station or Programming Pendant.

3. Ensure that the Programming Pendant is in REMOTE mode (Programming Pendant’s Mode Select Switch set to REMOTE).

4. Press the green [START] button on the Operator Station.

The ArcWorld® 1000 and 1200 Series system is now ready to continue operation.

### 4.4.3 Shock Sensor Recovery

The MA1440 robot includes a Motoman gun mount. This mount is designed to protect the torch from damage in case of a crash. 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 and move the affected robot clear of the impact. To override the shock sensor, proceed as follows:

1. Select {MAIN MENU} on the Programming Pendant touch screen.
2. Select {ROBOT} on the Programming Pendant touch screen.
3. Select {OVERRUN-S.SENSOR} on the Programming Pendant touch screen.
4. Select {RELEASE} to release the shock sensor.
5. Turn servo power ON (press in on the pendant’s ENABLE switch while pressing SERVO ON READY).
6. Move the affected robot clear of the impact position.

The ArcWorld® 1000 and 1200 Series system is now ready to continue operation.
4.4 System Recovery

4.4.4 Brake Release

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:

1. On the Programming Pendant, select TEACH mode.
2. Select {ROBOT} on the Programming Pendant touch screen.
3. Select the {BRAKE RELEASE} option.
4. Select the control group (R1, R2, S1).
5. While pressing in on the pendant’s {ENABLE} switch, hold down the minus key for the axis to be released (S-, L-, U-, etc.). The brake for the selected axis releases.

**WARNING**

Always support the robot axis to be released before you release it. Without adequate robot axis support, brake release could cause personal injury or machine damage.
Maintenance of the ArcWorld® 1000 and 1200 Series system and components must be performed by authorized personnel who are familiar with the ArcWorld® 1000 and 1200 Series system. Perform the procedures given in this section only as needed (on condition). Be sure to read and understand the documentation for a particular component before doing 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.

Be advised that the 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® 1000 and 1200 Series system, refer to the documentation that is included with your ArcWorld® 1000 and 1200 Series system (refer to section 1.3).

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**CAUTION**

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

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**Table 5-1: Periodic Maintenance**

<table>
<thead>
<tr>
<th>FREQUENCY</th>
<th>COMPONENT</th>
<th>PROCEDURE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Daily (or on condition)</td>
<td>Water Circulator (water-cooled torch application only)</td>
<td>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.</td>
</tr>
<tr>
<td></td>
<td>All safeguard items – work-cell door interlocks, E-STOP push buttons, safety light curtains, arc curtains, etc.</td>
<td>Check the physical condition of the safeguard item and ensure that the safeguard item is working correctly.</td>
</tr>
<tr>
<td>Monthly (or on condition)</td>
<td>ArcWorld® 1000 and 1200 Series Work Cell</td>
<td>Remove accumulated dirt, grease, and debris from inside and outside the work cell.</td>
</tr>
</tbody>
</table>
6 Anchor Requirements

The purchaser must determine all anchoring and foundation requirements and supply the appropriate anchoring hardware for a particular installation. Before installing the ArcWorld, refer to Table 6-1 “Minimum Recommended Equipment Anchor Requirements” to determine special anchor and foundation requirements. (If no anchor requirement stated in installation section of the manual use the table below for anchor requirements.)

**CAUTION**

- Do not mount robots directly to the floor without the indicated floor plate.

Failure to follow floor-plate requirements can result in injury to equipment damage.

**NOTE**

The robots must be in the HOME position before you can sweep the positioner.

<table>
<thead>
<tr>
<th>EQUIPMENT</th>
<th>MINIMUM HILTI® ANCHOR ROD DIAMETER/TYPE</th>
<th>MINIMUM FLOOR-PLATE REQUIREMENTS</th>
<th>MINIMUM FOUNDATION REQUIREMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>ROBOTS</td>
<td>Refer to the robot manual included with your system documentation package (section 1.3 “Theory of Operation and Safe Guarding”) 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.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>POSITIONER</td>
<td>Refer to the Positioner manual included with your system documentation package (section 1.3 “Theory of Operation and Safe Guarding”) 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.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>COMPLETE CELL BASE (NOTE 2)</td>
<td>3/8-inch Chemical Anchor</td>
<td>Not Applicable</td>
<td>3.5-inch minimum thickness 4000 psi Reinforced Concrete</td>
</tr>
<tr>
<td></td>
<td>1/2-inch Chemical Anchor</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>5/8-inch Chemical Anchor</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PERIPHERAL EQUIPMENT</td>
<td>1/2-inch Kwik Bolt II Style Anchor (NOTE 1)</td>
<td>Not Applicable</td>
<td>3-inch minimum thickness or 1.3 embedment depth (whichever is larger) 4000 psi Reinforced Concrete</td>
</tr>
</tbody>
</table>
### ArcWorld® 1000 and 1200 Series

#### Anchor Requirements

Table 6-1: Minimum Recommended Equipment Anchor Requirements

<table>
<thead>
<tr>
<th>EQUIPMENT</th>
<th>MINIMUM HILTI® ANCHOR ROD DIAMETER/TYPEx</th>
<th>MINIMUM FLOOR-PLATE REQUIREMENTS</th>
<th>MINIMUM FOUNDATION REQUIREMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>WORK-CELL FENCE POSTS</td>
<td>3/8-inch Kwik Bolt II Style Anchor (NOTE 1)</td>
<td>Not Applicable</td>
<td>3-inch minimum thickness or 1.3 embedment depth (whichever is larger) 4000 psi Reinforced Concrete</td>
</tr>
<tr>
<td>OPERATOR STATION PEDESTAL</td>
<td>1/4-inch Kwik Bolt II Style Anchor (NOTE 1)</td>
<td>Not Applicable</td>
<td>3-inch minimum thickness or 1.3 embedment depth (whichever is larger) 4000 psi Reinforced Concrete</td>
</tr>
</tbody>
</table>

**NOTES:**

1. Reference source: Hilti® Product Technical Guide (section 4.3.3) for hardware specifications or equivalent. Refer to [http://us.hilti.com](http://us.hilti.com) or [http://ca.hilti.com](http://ca.hilti.com) for further information.

2. The number anchors required varies per ArcWorld. Use appropriate sized anchors, relative to the clearance holes, to anchor equipment to the floor.
Appendix A Checklist

Since our customer is very important to us we include a checklist to use before start-ups and after maintenance for your convenience and safety.

<table>
<thead>
<tr>
<th>BEFORE APPLYING POWER</th>
<th>Time/Date</th>
<th>Checked By</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>(Refer to System Drawings)</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Check Mounting <em>(Refer to Installation Section in all Mnls)</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Check Power <em>(Refer to Connections, Controller Mnls)</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Check Ground <em>(Refer to Grounding in all Mnls)</em></td>
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</tr>
<tr>
<td>Check Water <em>(Refer to Operation and Vendor Mnls)</em></td>
<td></td>
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</tr>
<tr>
<td>Check Air <em>(Refer to Manipulator and Vendor Mnls)</em></td>
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<tr>
<td>Check Gas <em>(Refer to Operation and Vendor Mnls)</em></td>
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<tr>
<td>Check Interlocks <em>(Refer to Work Cells in all Mnls)</em></td>
<td></td>
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</tr>
<tr>
<td>Check Limiting Devices <em>(Refer to Limits in all Mnls)</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Check Environment <em>(Refer to Installation in Controller Mnls)</em></td>
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<tr>
<td>Check Version <em>(Refer to Confirmation of Software Version)</em></td>
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</tbody>
</table>

Other Items to Check Before Applying Power *(Vendor or Integrator Supplied)*

|                                                               |           |            |
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|                                                               |           |            |
## AFTER APPLYING POWER

<table>
<thead>
<tr>
<th>Task</th>
<th>Time/Date</th>
<th>Checked By</th>
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</thead>
<tbody>
<tr>
<td><strong>Check Control Switches</strong></td>
<td></td>
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</tr>
<tr>
<td><em>(Refer to Operator Station, Controller MnI)</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Check Axis Move and are Restricted</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>(Refer to Basic Specifications, Manipulator MnI)</em></td>
<td></td>
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<tr>
<td><strong>Check Emergency Stop(s)</strong></td>
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<tr>
<td><em>(Refer to E-Stop in all MnIs)</em></td>
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<tr>
<td><strong>Check External Power Disconnect</strong></td>
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</tr>
<tr>
<td><em>(Refer to Turning OFF The Power Supply)</em></td>
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<tr>
<td><strong>Check Teach Mode</strong></td>
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<tr>
<td><em>(Refer to Teach Mode, Controller MnI)</em></td>
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<tr>
<td><strong>Check Playback Mode</strong></td>
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<tr>
<td><em>(Refer to Play Mode, Controller MnI)</em></td>
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<tr>
<td><strong>Check Environment</strong></td>
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<tr>
<td><em>(Refer to Location in Manipulator MnI)</em></td>
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<tr>
<td><strong>Check Safeguards</strong></td>
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<td><em>(Refer to Safeguards in all MnIs)</em></td>
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<tr>
<td><strong>Check Manual Mode</strong></td>
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<tr>
<td><em>(Refer to Manual Mode in Operations MnI)</em></td>
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<tr>
<td><strong>Check Automatic Mode</strong></td>
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<tr>
<td><em>(Refer to Automatic Mode in Operations MnI)</em></td>
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<td></td>
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<tr>
<td><strong>Other Items to Check After Applying Power</strong></td>
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</tr>
<tr>
<td><em>(Vendor or Integrator Supplied)</em></td>
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**Vendor or Integrator Supplied**

**Time/Date Checked By**

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<table>
<thead>
<tr>
<th>DOCUMENTATION INCLUDED</th>
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<tbody>
<tr>
<td>System Drawings</td>
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<tr>
<td>Modifications Made to Original Protective Equipment</td>
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<tr>
<td>End Effector Load Analysis</td>
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<tr>
<td>Instructions on Synchronized Motion (More than one piece of equipment)</td>
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<tr>
<td>Programmed Limits</td>
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<tr>
<td>Collaborative Operation Declaration (Robot is suitable for integration that includes)</td>
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<tr>
<td>Compliance Documents (ANSI, ISO, RIA, etc.)</td>
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<td>Risk Assessment</td>
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<tr>
<td>Other Documents to Include (Vendor or Integrator Supplied)</td>
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<tr>
<td>(Vendor Manuals, Supplier Certifications, Compliance)</td>
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### MARKINGS INCLUDED ON EQUIPMENT

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<td>Machinery Designation and Type</td>
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<tr>
<td>Year Built</td>
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<tr>
<td>Explosive Proof</td>
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<tr>
<td><strong>Order Number (Serial Number)</strong></td>
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### Other Markings on Equipment

(Vendor Machine Designation, Type, Serial No, Version, etc.)

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<th>Other Markings on Equipment</th>
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### OTHER ITEMS

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