ArcWorld® IV-6000SL Series with PLC SAFETY LOGIC
SYSTEM MANUAL
FOR DX200 CONTROLLER

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

MOTOMAN INSTRUCTIONS
MOTOMAN XXXXXXX INSTRUCTIONS
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.

Part Number: 169587-1CD
Revision: 4
MANDATORY

• This system manual provides an overview of the Motoman ArcWorld® IV-6000SL 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® IV-6000SL Series system.

• General items related to safety are listed in Section 2 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 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.
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® IV-6000SL Series 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.

**NOTE**
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 Fig. 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 Fig. 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 DX200 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 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® IV-6000SL Series 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:

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Explanation of Warning Labels

The following warning labels are attached to the manipulator (refer to Fig. 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

![Diagram of warning labels on a manipulator]

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

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

**Nameplate:**

- MOTOMAN
- TYPE
- PAYLOAD kg
- ORDER NO.
- SERIAL NO.
- MASS kg
- DATE
- YASKAWA ELECTRIC CORPORATION JAPAN
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1 Introduction

1.1 About This Document

This system manual is delivered with the ArcWorld IV-6000SL, ArcWorld IV-6200SL, and ArcWorld IV-6300 systems to provide a “first look” and overview of the complete Motoman ArcWorld® IV-6000SL Series system. You should read and understand this system manual before moving on to the more detailed documentation that is included with your ArcWorld® IV-6000SL 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® IV-6000SL Series system, please review the full documentation package that is included with your ArcWorld® IV-6000SL Series system (refer to section 1.3 “Reference Documentation” on page 1-12).

This manual documents a standard Motoman system. If your system is custom or modified, please use this manual in conjunction with the drawings, schematics, and parts listing (Bill of Material) for your specific system. The drawings, schematics, and parts listing are included in the documentation package supplied with your Motoman system.

This system manual contains the following sections:

chapter 1 “Introduction”
This section provides general information about the ArcWorld® IV-6000SL Series system, a list of reference documents, and customer support contact information.

chapter 2 “Equipment Description”
This section provides a description of the major components of the ArcWorld® IV-6000SL Series system.

chapter 3 “Installation”
This section provides installation procedures for the ArcWorld® IV-6000SL Series system.

chapter 4 “Operation”
This section provides an overview of ArcWorld® IV-6000SL Series system operation, including start-up, loading, normal operations, fault recovery, and system shutdown.

chapter 5 “Maintenance”
This section provides preventive maintenance requirements for certain components of the ArcWorld® IV-6000SL Series system.

chapter 6 “Anchoring”
This section gives recommended anchoring hardware specifications and foundation requirements for all the equipment that is part of the ArcWorld® IV-6000SL Series system.
1.2 System Overview

The ArcWorld® IV-6000SL Series system provides a complete arc-welding solution in a standardized configuration (see Fig. 1-1 “System Layout”). The ArcWorld® IV-6000SL Series systems are designed around the Motoman MA1440 or MA2010 robots, a DX200 controller assembly, welding power sources, and an RM2-SL series positioner (RM2-755, or RM-1255SL). Refer to Fig. 2.2 “DX200 Controller” on page 2-1 for a description of features and advantages of the DX200 controller configuration. Refer to section 2.4 “RM2-SL Series Positioner” on page 2-5 for a description of the RM2-SL Series positioners.

The ArcWorld® IV-6000SL Series system features a total safety environment that meets or exceeds the requirements of the ANSI/RIA R15.06 Robot Safety 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 welded wire fencing to attenuate the amount of arc radiation that escapes the work cell during welding operations. A dual channel interlocked access door at the rear of the work cell provides convenient access to equipment while providing a safety interlock to disable all equipment should the access door be opened while the robots are active. A safety light curtain system provides a “sensing field” in front of the positioner to protect the operator. Positioner movement is prevented whenever an operator is in a position that disrupts 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.

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.
Figure 1-1: System Layout

- WORK CELL ACCESS DOOR
- DX200 CONTROLLER
- WELDING POWER SUPPLIES
- OPTIONAL WATER CHILLERS
- OPERATOR STATION
- MA1440 ROBOT
- RM2-755SL/1255SL POSITIONER
- LIGHT CURTAIN
1.2.1 System Layout

The MA-Series manipulator(s) (robots), an RM2-SL positioner, and heavy-gauge, welded wire safety fencing all share a common steel base for ease of installation and assurance of proper alignment between the robot(s) and positioner. The welded wire safety fencing completely surrounds the ArcWorld® IV-6000SL Series work cell. The DX200 controller shares a common equipment platform with the welding power source(s).

The common equipment platform is 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 by the customer. All operator controls, including those on the Programming Pendant, DX200 controller, welding power supplies, and Operator Station pedestal, are accessible from outside the ArcWorld® IV-6000SL Series work cell.

1.2.2 Major Components

The ArcWorld® IV-6000SL Series system includes the following major components:

- Motoman MA1440 or MA2010 manipulators (robots)
- One DX200 controller assembly
- One RM2-SL series positioner:
  - RM2-755SL
  - RM2-1255SL
- One Programming Pendant (located on DX200 controller)
- One Operator Station
- Welding equipment (for each robot):
  - Welding power supply
  - Welding torch (air-cooled)
  - Wire feeder
  - Applicable welding interface
  - Torch mount
- Safety equipment:
  - Heavy-gauge, welded wire safety fencing
  - Arc curtains (cover the safety fencing)
  - Light curtain system
  - Interlocked work-cell access door
  - Steel arc screen on the positioner
1.2.3 Optional Equipment

The following optional equipment is available for use with the RM2-SL Series system:

- Torch cleaner
- Wire cutter
- Water-cooled torch (with water circulator)
- TouchSense™ (starting point detection)
- ComArc™ (seam tracking)

1.2.4 Theory of Operation and Safe Guarding

The DX200 “ArcWorld IV 6000” series of cells accommodate a single, dual, or triple MA1440/MA2010 robot(s). The cells are available in two configurations:

- AWIV-6000 (various robot and RM2 positioner combinations exist)
- AWIV-6200 (various robot and RM2 positioner combinations exist)
- AWIV-6300 (various robot and RM2 positioner combinations exist)

The cell is for arc welding applications where the robot controller(s) and welding power source(s) are located behind the cell. In the AWIV-6200 and 6300 cells, the R2 and R3 robots utilize full-size MA1440/MA2010 robot cabinets in a DR2C configuration. This DR2C configuration provides a single programming pendant for programming all robots but still allows the robots to be redeployed later as individual standalone robots. A sliding door with safety interlock allows access from the rear of the work cell. The MA1440/MA2010(s) sit(s) on a 915 mm raiser(s). Mounting provisions are in the base for an in-cell torch cleaning station.

The three-axis RM2 positioners provide high-speed and compact part positioning in a variety of spans and capacities. No matter the positioner selection, they all operate the same. The positioner's main axis (S1) allows for 180 degree motion. This “trunnion” axis is intended to be driven into welded hard-stops on both sides of the main casting. Driving the trunnion axis into the hard-stops provides a fixed location where the servo motors can maintain position while parts are loaded and unloaded from the operator side fixturing. The two tooling axes (S2 & S3) can rotate more than 720 degrees and allow the robot(s) to coordinate motion while processing the part. Options for slip-rings and additional weld current carrying brushes are optional and therefore not included in the standard cell.

A safety PLC and R1’s Functional Safety Unit (FSU) (FSU is not provided on R2/R3 in the case of AWIV-6200/6300 cells) are responsible for monitoring safety critical devices and controlling positioner motion. The safety PLC monitors input devices such as E-Stops (Pendant and External Op-Station), the safety gate, the positioner’s “Side A/B” location, and light curtain status.

Logic in the safety PLC then controls the following outputs based on the status of the input devices:
S1 Standstill monitoring Outputs - These safety PLC outputs are inputs to the FSU (Speed Limit File #1) where they are used to prevent trunnion axis motion while the light curtain is broken and the trunnion axis is located at “Side A” or “Side B”. These outputs are “On” when the light curtain is clear and they turn “Off” when the light curtain is broken (enabling the standstill monitor function).

S2 Standstill monitoring Outputs - These safety PLC outputs are inputs to the FSU (Speed Limit File #2) where they prevent “Tooling Side A” axis motion while the light curtain is broken and the trunnion axis is located at “Side B”. These outputs are “On” when the light curtain is clear and they turn “Off” when the light curtain is broken (enabling the standstill monitor function).

S3 Standstill monitoring Outputs - These safety PLC outputs are inputs to the FSU (Speed Limit File #3) where they prevent “Tooling Side B” axis motion while the light curtain is broken and the trunnion axis is located at “Side A”. These outputs are “On” when the light curtain is clear and they turn “Off” when the light curtain is broken (enabling the standstill monitor function).

Side A tooling power Outputs - These safety PLC outputs are dry-contact outputs made available on the safety PLC to end-users or integrators for controlling power to tooling based on E-stop status and S2 being at the operator and the light curtain being broken.

Side B tooling power Outputs - These safety PLC outputs are dry-contact outputs made available on the safety PLC to end-users or integrators for controlling power to tooling based on E-stop status and S3 at the operator and the light curtain being broken.

External E-Stop Outputs - These safety PLC outputs “AND” together the op-station, programming pendant, and the RM2’s “At Side A/B” switches while the light curtain is broken to generate a Cat#1 External E-Stop.

Safety Gate - These safety PLC outputs connect to the DX200’s Machine Safety input for “Safety Gate” preventing the robot from operating in “Play” mode without the safety gate being closed.

The integrator or end-user may implement additional safety and zone monitoring though the standard system does not include this additional FSU functionality.

A pedestal mounted operator station is located in the front of the cell and can be located as desired (cabling restriction exists). The operator station provides a [Cycle Start] push button, [Auto/Manual] selector switch, an “E-Stop” button, a “Servo On” button, a “Start” button, an “Alarm Reset” button, and a three position joystick to job the operator side tooling. The operator station also provides indication of “Servo On”, “Alarm” status, and a “Cycle Latched” indication.

An L-shaped light curtain provides detection personnel detection on the front of the cell. This light curtain will detect when someone approaches the rotary table and ensures that the RM2 positioner does not move while someone is in the light curtain.
1.2.4.1 System Teaching

Program all systems from within the cell. In order to program the robot, the controller needs to be in “Teach Mode” from the selector switch on the front of the pendant. This “Teach Mode” selection will limit all robot speeds to 250 mm/min while in this mode. The gate can be open while in “Teach Mode,” allowing the programmer within the cell. In order for the robot's servo motors to be turned on, the “deadman” switch on the programming pendant needs to be maintained. Once servo power is on, the operator is able to manipulate and program the part as desired. While in “Teach
Mode” the individual robot(s) and the RM2’s trunnion axis (S1) and tooling axes (S2 & S3) can be manipulated with the programming pendant. The system will have pre-configured “Sweep” jobs that will allow rotating of “Side A” and “Side B” tooling into robot. Selecting these jobs and pressing [“Interlock” + “Test Start”] will execute the job and rotate the tooling into the robot. If the operator or another person enters the light curtain while teaching the cell, the external E-Stop logic explained earlier will E-Stop or place the operator-side tooling axis into “Standstill” while there is a violation in the safeguarded space.

1.2.4.2 System Operation:

Once completing the path and logic programming, you can place the system into operation after meeting the following conditions:

1. Placing programming pendant in “Play” mode
2. Closing the gate
3) Applying servo power to the programming pendant
4) The [Start] button on the pendant needs to be pressed to begin execution of the INFORM job. Once applying the servo power and job execution begins, then normal cell production can begin.

Normal cell production begins with the assumption that the trunnion axis is at either “Side A” or “Side B” as reported by the trunnion axis limit switches. Anytime the light curtain on the front of the cell is clear, the positioner is free to move as directed by the INFORM job. Once an operator approaches the cell to load a part and breaks the light curtain, the operator-side tooling axis (S2 or S3) and the trunnion axis (S1) will enter “Standstill monitoring.” Once the part has been loaded, the operator steps out of the light curtain, the “Light Curtain Clear” ends and the “Standstill” monitoring allows the INFORM job to sweep the positioner when the robot side part is complete. The operator can press the [Cycle-Start] button on the operator station which will either latch (if the robot is actively processing a part on the other side of the positioner) or will initiate sweeping of the positioner allowing the operator to unload the processed part while presenting the robot with the unprocessed part. Once the positioner has swept into position, the operator is able to enter the light curtain (enabling S1 and operator-side tooling standstill monitoring) to begin the removal of the processed part and begin installation of a new part into the fixture. Assuming there are no faults or issues during the production of the part, once completed, the robot will return to a safe position, and assuming the next part has been loaded and the [Cycle Start] button pressed/latched, the INFORM job will sweep the positioner from side-to-side so the operator can unload the processed part. Once a new part has been loaded, the process begins again.
1.2.4.3 Key Safety Devices:

- **DX200 controller with MA1440(s)/MA2010(s):**
  - Dual channel pendant E-Stop
  - Dual channel pendant “deadman” switch
  - Play/Teach mode switch
  - Dual channel “Safety Gate” input
  - Dual channel “External E-Stop” input

- **Safety Gate Interlock (qty 1):**
  - Dual channel dry contact outputs

- **Cascaded L-Shaped light curtain:**
  - 30 mm object sensitivity
  - 29 ms response time
  - Dual channel output

- **Pilz Safety PLC:**
  - Monitored PLC inputs:
    - Pendant E-Stop
    - Op-Station E-Stop
    - Safety Gate
    - Light Curtain
    - Tunnion axis “Side A” switch
    - Tunnion axis “Side B” switch
  - PLC Generated outputs:
    - External E-stop
    - Safety Gate
    - S1 Standstill
    - S2 Standstill
    - S3 Standstill
    - Side A tooling power
    - Side B tooling power

- **Pedestal operator station:**
  - Dual channel “E-Stop”
  - Single channel “Auto/Manual” switch
  - Single channel “Cycle Start”
  - Single channel “Hold”
  - Single channel “External Servo On”
  - Single channel “Alarm Reset”
  - 3-position joystick with “Forward”, “Reverse”, and “Home” positions
  - “Servo On” indicator
  - “Alarm/Error” indicator
  - “Cycle Latched” indicator

- **Function Safety Unit (FSU):**
  - The FSU is responsible for monitoring the safety PLC outputs connected to FSBIN#1-3. Logic within the safety PLC will disable (open the contacts) connected to FSBIN#1 (trunnion axis), FSBIN#2 (tooling A axis), and FSBIN#3 (tooling B axis). When disabled, the specified axis will go into standstill monitoring preventing axis motion while the light curtain is broken.
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1.2.4.4 Functional Safety Setup

The following FSU files are utilized as standard in the AWIV-6*00 cells:

**Fig. 1-3(a): “Speed Limit”/“Standstill” files used**

![Speed Limit Monitor](image1)

**Fig. 1-3(b): “Speed Limit” file #1: S1 Standstill**

![Speed Limit Monitor](image2)
1. Introduction

1.2 System Overview

Fig. 1-3(c): “Speed Limit” file#2: S2 Standstill

Fig. 1-3(d): “Speed Limit” file#3: S3 Standstill
1.3 Reference Documentation

For additional information on individual components of the ArcWorld® IV-6000SL Series system, refer to the following documentation that is included with your system:

- Motoman MA1440 Manipulator Manual (P/N 165830-1CD)
- Motoman MA2010 Manipulator Manual (P/N 169627-1CD)
- 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 RM2 Positioner Manual (P/N 166006-1CD)
- Motoman Manual Brake Release Manual (P/N 165310-1CD)
- Motoman DX200 Independent/Coordinated Control Function Manual (P/N 165836-1CD)
- Motoman INFORM Language User’s Manual (P/N 165301-1CD)
- Vendor manuals for system components not manufactured by Motoman

1.3.1 Location of Operations in Reference Documentation

The table below provides the location(s) for various operations within the included reference manuals.

Table 1-1: Reference Table

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1.4 Customer Support Information

If you need assistance with any aspect of your ArcWorld® IV-6000SL Series system, please contact Motoman Customer Support at the following 24-hour telephone number:

(937) 847-3200

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

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, you must contact Motoman Customer Support at the telephone number shown above.

Please have the following information ready before you call:

• System ArcWorld® IV-6000SL Series
• Robots MA1440 or MA2010
• Positioner RM2-755SL RM2-1255SL
• Primary Application Arc Welding
• Controller DX200
• 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 data plate
• Robot Sales Order Number Located on the DX200 controller R1 data plate
2  Equipment Description

2.1  Robot Description

The ArcWorld® IV-6000SL Series system uses the Motoman MA-Series six-axis robot(s). The MA-Series robots are specifically designed for arc-welding applications. The MA1440 robot has a payload capability of 6 kg and features a horizontal reach of 1440 mm. The MA1440 robot features a relative positioning accuracy of ±0.08 mm. The MA2010 robot has a payload capability of 6 kg and features a horizontal reach of 2010 mm. The MA2010 robot also features a relative positioning accuracy of ±0.08 mm.

The MA-Series robots feature an internal cabling design that provides high flexibility and streamlines the robot profile, 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.

The robot's S-axis rotation is physically limited by a hard stops located in the base of each robot. For more information, refer to the MA1440 or MA2010 Manipulator Manual that came with your ArcWorld® IV-6000SL Series system documentation package (see section 1.3 “Reference Documentation” on page 1-12).

2.2  DX200 Controller

The ArcWorld® IV-6000SL Series system features one to three full size controller assemblies for the DX200 controller. Additional expansion cabinets are mated to the master cabinet for each additional robot (see Fig. 2-1 “DX200-TRC Controller” on page 2-2). The DRC and TRC configurations provide the same functionality of two or three full-size controllers, without the space requirement and weight of additional, full-size DX200 controllers. This configuration also reduces the cost by eliminating redundant components and circuitry.

Through specific cable interconnections (internal to the DX200), the DX200 and each expansion cabinet is configured as controller R1, R2, and R3 (see Fig. 2-1 “DX200-TRC Controller” on page 2-2). This configuration allows the three robots to operate as a multi-robot system that takes advantage of all the unique functions available only in a multi-robot system configuration. With the ArcWorld IV-6300SL system, the full-size DX200 controller cabinet is designated R1, while the two expansion cabinets are designated R2 and R3. The DX200 controller assembly is mounted on a Common Equipment Base, which is positioned outside the ArcWorld® IV-6000SL Series work cell (see Fig. 1-1 “System Layout” on page 1-3 and Fig. 2-1 “DX200-TRC Controller” on page 2-2).

In addition to controlling the movement of the three robots, the DX200 controls the welding power sources, the positioner, and provides the signals necessary to operate the welding systems.

The DX200 features an embedded real-time operating system (RTOS) and is programmed with the Motoman INFORM programming language. For more information on the DX200 controller, refer to the DX200 Controller manual that came with your ArcWorld® IV-6000SL Series system documentation package (see section 1.3 “Reference Documentation” on page 1-12).
2.2.1 Programming Pendant

The Programming Pendant (see Fig. 2-2 “DX200 Programming Pendant” on page 2-3) provides the primary means of programmer/operator interaction with the ArcWorld® IV-6000SL Series system. The pendant features the Windows® CE operating system and displays information on a 5.7-inch, color LCD, touch-screen display (640 X 480 VGA). The pendant also incorporates a CompactFlash® card slot for program backups.

The Programming 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 remote installation of the DX200 controller. By using the Programming Pendant, the operator can teach the robots motion; perform programming, editing, maintenance, and diagnostic functions; and enable or disable Operator Station control of the ArcWorld® IV-6000SL Series system. For detailed information on the pendant’s programming keys, programming functions, and display functions, please refer to the DX200 Operator’s Manual for Arc Welding that is included with your ArcWorld® IV-6000SL Series system documentation package (see section 1.3 “Reference Documentation” on page 1-12).
2.2 DX200 Controller

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

NOTE

• Operator Station Enable or Disable is accomplished with the Programming Pendant’s Mode Select Switch. To transfer control of the ArcWorld® IV-6000SL Series system to the Operator Station, set the Mode Select Switch to REMOTE.
2.3 Operator Station

The Operator Station (see Fig. 2-3 “Operator Station”) includes a NEMA enclosure on a stand-alone pedestal. The following paragraphs describe the controls on the Operator Station.

Figure 2-3: Operator Station

2.3.1 Operator Station — CYCLE START/CYCLE LATCHED

WARNING

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

Pushing the green CYCLE START/CYCLE LATCHED button initiates a positioner sweep cycle if the robots are in HOME (Safe) position. If the CYCLE START/CYCLE LATCHED push button is pressed while the robots are welding, or otherwise not in HOME (Safe) position, the Cycle Start command is “latched” into (stored in) the DX200 controller circuitry. When the robots return to HOME (Safe) position, the “latched” Cycle Start command is executed and the positioner sweeps. Circuitry in the DX200 controller prevents the positioner from continuously cycling should the operator depress and hold the CYCLE START/CYCLE LATCHED push button.

2.3.2 Operator Station — Emergency Stop (E-STOP)

Pressing the Operator Station’s Emergency Stop (E-STOP) push button initiates an Emergency Stop (E-STOP). Refer to section 2.6.4 “Emergency Stop (E-STOP)” on page 2-8 for a discussion of the E-STOP function and the procedures for recovering the ArcWorld® IV-6000SL Series system from the Emergency stop (E-STOP) condition.

2.3.3 Operator Station — 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.
2.3.4 Operator Station — ALARM
A red ALARM lamp illuminates to indicate that the DX200 controller has encountered an alarm condition.

2.3.5 Operator Station — POSITIONER AUTO/MANUAL
The POSITIONER AUTO/MANUAL switch is used to select automatic or manual mode for the 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. The robots remain in HOME position.

2.3.6 Operator Station — START
Pressing the green START button starts the current, active job. The Programming Pendant’s Mode Select Switch must be set to REMOTE and servo power must be ON for the START button to function.

2.3.7 Operator Station — RESET
The black RESET button is used to clear a minor alarm or error condition.

2.3.8 Operator Station — SERVO ON
The green SERVO ON push button turns servo power on if the Programming Pendant’s Mode Select Switch is set to REMOTE.

2.3.9 Operator Station — JOYSTICK CONTROL (Option)
The RM2-SL Series positioners have the ability to position each tooling axis (orbital axis) ±360° for better part-loading and unloading ergonomics. This rotation of the orbital axis (also known as “jogging”) is accomplished with the JOYSTICK CONTROL located on the Operator Station (see Fig. 2-3 “Operator Station” on page 2-4).

2.4 RM2-SL Series Positioner
The RM2-SL Series positioners are high-speed, three-axis, AC servo-controlled “Ferris-wheel” type positioners. The RM2-755SL positioner provides 755-kg capacity per side and three servo axes for high speed positioning. The RM2-1255SL positioner has a 1255-kg capacity per side and also includes three servo axes for high-speed positioning. Fixture length is 2 or 3 meters.

One external axis is used to rotate the trunnion (swing arm) axis, while the two additional servo motors are used to rotate the two orbital (parts fixture) axes independently of the trunnion (swing arm) axis. The positioner uses a reciprocating motion that sweeps each side of the “Ferris-wheel” type positioner, from the operator’s loading zone into the robot work zone and back to the operator again. A metal arc screen divides the positioner into two work areas: Side A and Side B. When Side A is in the robot’s welding zone, Side B is facing the operator and ready to be loaded or unloaded.
2.5  Welding Equipment

In its standard configuration, the ArcWorld® IV-6000SL Series system includes a welding power source, wire feeder, torch, and torch mount for each of the robots. Optional equipment may also be included with your ArcWorld® IV-6000SL Series system (refer to section 1.2.3 “Optional Equipment” on page 1-5).

2.5.1  Welding Power Sources

Motoman offers various brands and types of welding power sources. The welding power sources supplied with the ArcWorld® IV-6000SL Series system depends on the customer’s specific application and preference. For specific information on the welding power sources supplied with your ArcWorld® IV-6000SL Series system, refer to the welding power source manual that is included with the system documentation package (see section 1.3 “Reference Documentation” on page 1-12).

2.5.2  Wire Feeder

A welding wire feeder is mounted on the upper arm (U-Axis) of each robot. The wire feeder is the “4-roll” type and provides reliable wire feeding at rates up to 750 inches per minute (ipm). An electronically controlled gas valve provides fast welding 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 wire feeder documentation that is included with the ArcWorld® IV-6000SL Series system documentation package (see section 1.3 “Reference Documentation” on page 1-12).
2.5.3 GMAW Torch

The ArcWorld® IV-6000SL 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 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” on page 4-6 and section 4.4.3 “Shock Sensor Recovery” on page 4-7).

For applications that use the optional water-cooled torch, the ArcWorld® IV-6000SL 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 vendor documentation that is included with the ArcWorld® IV-6000SL Series system documentation package (see section 1.3 “Reference Documentation” on page 1-12).

2.6 Safety Features

The ArcWorld® IV-6000SL Series system includes a total safety environment. If you comply with all the safety instructions and precautions given throughout this manual, the safety equipment helps to ensure safe operation of the robot work cell.

Users are responsible for determining that the safeguards provided with the ArcWorld® IV-6000SL Series system are adequate for their plant conditions. Users must also ensure that all safeguards are maintained in working order.

2.6.1 Welding Arc Protection

One by-product of the welding arc is an intense level of ultraviolet light. The ultraviolet light radiates outwardly (equal strength in all directions) from the weld point whenever an arc is established. If not attenuated, the radiated ultraviolet light can present a health risk to personnel near the welding arc.

Two forms of welding arc protection are part of the ArcWorld® IV-6000SL Series system:

• a steel arc screen on the positioner

• arc curtains (attached to the steel-mesh safety fencing)

The steel arc screen on the positioner is always positioned between the welding arc and the operator. This protects the operator from the ultraviolet light radiation and sparks that result from the welding operation (see Fig. 1-1 “System Layout” on page 1-3).
The arc curtains filter (or “block”) most of the ultraviolet light radiation that would otherwise escape the work cell. Just as the arc screen on the positioner protects the operator from intense ultraviolet light, the arc curtains protect other personnel who are near the work cell.

### 2.6.2 Safety Fencing

The heavy-gauge, welded wire safety fencing that is provided with the ArcWorld® IV-6000SL Series system encloses the entire work cell. It forms a physical barrier that prevents personnel from entering the work cell during automatic operation.

### 2.6.3 Safety Light Curtains

Infrared safety light curtains protect the operator from positioner movement. The positioner will not sweep if the light path (between the light curtain’s Send unit and Receive unit) is obstructed. Should any person or object enter this zone during a positioner sweep from A to B (or B to A), an E-STOP condition is triggered (refer to section 2.6.4 “Emergency Stop (E-STOP)” on page 2-8).

For additional information on the safety light curtain system, refer to the vendor documentation that is included with the ArcWorld® IV-6000SL Series system documentation package (see section 1.3 “Reference Documentation” on page 1-12).

### 2.6.4 Emergency Stop (E-STOP)

Emergency Stop (E-STOP) is a primary safety feature of the ArcWorld® IV-6000SL Series system. A work-cell access door interlock, the safety light curtain system, robot welding torch impact (collision) detection circuitry (refer to section 2.5.3 “GMAW Torch” on page 2-7), and E-STOP push buttons can all trigger an E-STOP condition. An E-STOP condition immediately de-energizes the control system and activates the robot emergency braking system (refer to section 2.6.6 “Emergency Braking System” on page 2-9). The E-STOP push buttons are used for an intentional shutdown of the ArcWorld® IV-6000SL Series system and are installed at the following locations:

- Programming Pendant
- Operator Station

To resume operation after an E-STOP system shutdown, the operator must clear and reset the action that caused the E-STOP condition (refer to section 4.4.2 “E-STOP Recovery” on page 4-6).

**WARNING**

Although safety fence arc curtains block the radiation of ultraviolet light, never look directly at the welding arc without protective eye wear.
2.6.5 Programming Pendant’s ENABLE Switch

The ENABLE switch is part of the Programming Pendant and provides a safety feature that controls servo power while the system is in TEACH mode (see Fig. 2-2 “DX200 Programming Pendant” on page 2-3). When pressed in, this switch allows the operator to enable servo power. Should the operator release the switch or grasp it too tightly, however, servo power is immediately disabled, thus preventing further robot movement. For detailed information about the operation of the ENABLE switch, refer to the DX200 Operator’s Manual for Arc Welding that is included with the ArcWorld® IV-6000SL Series system documentation package (see section 1.3 “Reference Documentation” on page 1-12).

2.6.6 Emergency Braking System

Each robot incorporates a braking system that protects personnel from injury and prevents equipment damage if servo power is removed. Upon loss of servo power, the brake system activates to hold all robot axes in place. The brake system incorporates a feature that allows the operator to release the brake of a specific robot axis, even if drive power is disabled. Brake release is accomplished with the Programming Pendant. Refer to the DX200 Manual Brake Release manual included with the ArcWorld® IV-6000SL Series system documentation package (see section 1.3 “Reference Documentation” on page 1-12).

2.6.7 Interlocked Work-cell Access Door

The work-cell access door features a safety interlock (see Fig. 1-1 “System Layout” on page 1-3). Any attempt to open the access door while the robots are in PLAY mode triggers an E-STOP condition (refer to section 2.6.4 “Emergency Stop (E-STOP)” on page 2-8).
3  Installation

3.1 Required Materials

Two to three qualified technicians can install the ArcWorld® IV-6000SL Series 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® IV-6000SL Series system. Refer to your system drawings and relevant system component manuals for specific installation information (see section 1.3 “Reference Documentation” on page 1-12).

3.1 Required Materials

All system components and most hardware items required for installation of the ArcWorld® IV-6000SL Series system are included with your shipment. There are, however, some required items that the customer must supply, such as typical installation and maintenance tools (refer to section 3.1.2 “Recommended List of Hand Tools and Equipment” on page 3-2) and special anchor bolts (refer to chapter 6 “Anchoring”).

3.1.1 Customer-supplied Items

• Shielding gas for the welding torches
• Local electrical service
• Earth ground wires for the robots, the DX200 controller, and peripheral equipment
• Earth ground rods and/or buried copper sheeting (quantity and placement depth as required to achieve 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 m³/min. (15 cfm)
  • Pressure: 620 kPa (gage) [90 psi (gage)]
• Forklift(s) and/or overhead crane
• Special anchor bolts and drill bits (refer to chapter 6 “Anchoring” for suggested anchoring hardware)

CAUTION

• The ArcWorld® IV-6000SL Series system should be installed by qualified personnel who are familiar with the installation and setup of a robotic system.
3 Installation
3.1 Required Materials

3.1.2 Recommended List of Hand Tools and Equipment

- Safety glasses
- Face shield
- Gloves (heavy-duty leather recommended)
- 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)
- Allen® wrench sets (SAE and metric)
3.2 Site Preparation

**WARNING**

Be sure to provide sufficient room for access to the work-cell door, Operator Station, and system components that are exterior to the work cell. Failure to observe this precaution could result in injury to personnel during system operation and maintenance.

To prepare your site, proceed as follows:

1. Clear the floor and overhead space needed for the ArcWorld® IV-6000SL Series system (see Fig. 3-4(a) and Fig. 3-4(b)). Allow an additional 1.2m to 1.5m on all sides of the work cell to provide the clearances needed for installation. Refer to the schematics that are included with your system documentation package.

2. Gather all the customer-supplied items and required tools (refer to section 3.1 “Required Materials” on page 3-1).

*Fig. 3-4(a): Plan View Overhead View - ArcWorld IV*
3.3 Removal of System Components from Shipping Skids

**WARNING**

- The positioner weighs approximately 2550 kg. Be sure that your lifting device is rated to safely handle this load.
- The main robot/controller common equipment base (with equipment) weighs approximately 2770 kg (AWIV6200) and 3220 kg (AWIV-6300). Be sure that your lifting device is rated to safely handle this load.

System components are attached to shipping skids at the factory prior to shipment to the customer. The customer is responsible for removing the components from the skids and inspecting the components for shipping damage.

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

**CAUTION**

Do not remove the positioner shipping bracket assembly until the positioner is securely anchored to the foundation. The shipping bracket assembly retains the headstock and tailstock in correct alignment during shipping and installation.

1. Unbolt each component from its shipping skid using a 3/4-inch socket (see Fig. 3-5 “Typical Stabilizing Screw and Removal of A Shipping Lag Bolt” on page 3-6).
2. Use a forklift(s) or overhead crane to lift each component away from its shipping skid.

**NOTE**
Two forklifts are required to lift or move the positioner. Forklift "pockets" are provided on each end of the positioner for this purpose.
3. Remove and discard or recycle all shipping materials, including the shipping skids. Do **not** remove the positioner shipping bracket assembly.
3.4 Installation — MRM2-M3XSL Series Positioner

Refer to Chapter 2 of the RM2-SL Positioner Manual for detailed installation instructions for your specific RM2-SL positioner.

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**CAUTION**

Do **not** remove the positioner shipping bracket assembly until the positioner is securely anchored to the foundation. The shipping bracket assembly retains the headstock and tailstock in correct alignment during shipping and installation.

Mount the positioner on a foundation rigid and strong enough to support the positioner and withstand dynamic repulsion forces. If the foundation surface is not level and even, grind the swell to flatten the surface. Refer to chapter 6 “Anchoring” for a suggested minimum foundation thickness and strength.

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**WARNING**

The positioner weighs approximately 2550 kg. Be sure that your lifting device is rated to safely handle this load.
3. Installation
3.5 Installation — Robot Common Base

### WARNING

- The main robot/controller common equipment base (with equipment) weighs approximately 2770 kg (AWIV6200) and 3220 kg (AWIV-6300). Be sure that your lifting device is rated to safely handle this load.

1. Loosen and remove lag bolts securing the robot common base and associated panels to the wooden shipping skid.
2. Carefully remove all protective packaging materials and discard or recycle.
3. Carefully inspect the robot(s), robot equipment base, and associated panels for shipping damage.

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

4. Using a forklift, lift the robot common base away from the wooden shipping skid (forklift pockets are located at each end of the base).
5. Fasten the two spanners to the robot common base with the supplied hardware.
6. Carefully place the robot common base in a position that will allow the spanners to be joined to the positioner base with supplied hardware (see Fig. 3-6 “Robot Common Base Installation” on page 3-9).
7. Fasten the spanners to the positioner base with the supplied hardware (see Fig. 3-6 “Robot Common Base Installation” on page 3-9).

### CAUTION
Make certain the joined robot common base/positioner are positioned correctly before leveling and anchoring the unit.
Figure 3-6: Robot Common Base Installation

**WARNING**

Wear protective eye wear and sturdy work gloves when you cut steel strapping bands. Make sure that all other personnel are clear of the area before you cut the bands. The steel strapping bands are under tension, and can cause injury to personnel when cut.
8. Cut the steel strapping bands that secure the floor cover plate and remove it from the Robot Common Base. The cover plate will be replaced after control and power cables are routed beneath the Robot Common Base and the Programming Platform.

9. Adjust the leveling screws as required to level and stabilize the Robot Common Base/Programming Platform (see Fig. 3-6 “Robot Common Base Installation” on page 3-9).

10. Insert a drill bit through the center of a leveling bolt on the Robot Common Base/Programming Platform and drill a hole into the foundation to accept an anchor bolt (refer to chapter 6 “Anchoring” for foundation and anchoring suggestions).

11. Repeat drilling process for each leveling bolt associated with the robot equipment base/positioner base assembly (see Fig. 3-6 “Robot Common Base Installation” on page 3-9).

12. Use compressed air to remove all concrete dust from each drilled hole.

13. At each drilled location, install and secure a suitable anchor bolt (refer to chapter 6 “Anchoring” for foundation and anchoring suggestions).
3.6 Installation — Safety Fence Assembly

The fencing that surrounds the positioner and completes the welding cell’s protective walls is shipped on its own skid with all the hardware needed for installation.

CAUTION

Be careful when cutting the metal bands and wear protective gloves. The metal bands are under tension and may cause injury to anyone near the bands when cut.

See Fig. 1-1 “System Layout” on page 1-3 and Fig. 3-4(a) "Plan View Overhead View - ArcWorld IV" on page 3-3 for the general arrangement and positioning of the safety fence assembly. Refer to the safety fence manufacturer instructions for details of safety fence placement, erection, and anchoring. The safety fence instructions are included in the ArcWorld® IV-6000SL Series system documentation package (refer to section 1.3 “Reference Documentation” on page 1-12).
3.7 Installation — Arc Curtains

The arc curtains are packaged in an accessories box that is shipped with the ArcWorld® IV-6000SL Series system.

**WARNING**

Ensure that the work-cell safety fence is anchored in place before installing the arc curtains. Unanchored fence panels can fall and injure personnel or damage equipment.

Install the arc curtains as follows:

1. Unfold each arc curtain and install one on the **inside** of each work-cell safety fence panel using the supplied plastic cable ties and the eyelets in each arc curtain (see Fig. 3-7 “Arc Curtain Installation on Typical Safety Fence Panel” on page 3-13).

2. Make sure that there are no gaps between the arc curtains.

3. Install the work-cell door arc curtain on the **inside** of the door panel using the supplied plastic cable ties and the eyelets in the arc curtain (see Fig. 3-7 “Arc Curtain Installation on Typical Safety Fence Panel” on page 3-13).
3.7 Installation — Arc Curtains

**Figure 3-7: Arc Curtain Installation on Typical Safety Fence Panel**

NOTE – Arc curtain is installed on the fence panel side that faces the INTERIOR of the robotic work cell.

PLASTIC CABLE TIE  ARC CURTAIN EYELET  FENCE PANEL

ARC CURTAIN
The procedure for installing the safety light curtain system is as follows:

1. Unpack both safety light curtain fence panels from their shipping position and move them into position. The light curtain units are oriented properly when their status lights are located near the base of the positioner.

2. Use the three bolt holes located on the positioner housing to mount the light curtain fence panels (see Fig. 3-8 “Safety Light Curtain Installation”).

3. Unpack the light curtain cables and connect them to the matching connectors on the light curtain Send and Receive units.

4. Align the Send unit with the Receive unit. Refer to the light curtain manufacturer’s literature that is included in the ArcWorld® IV-6000SL Series system documentation package (see Fig. 1.3 “Reference Documentation” on page 1-12).

5. After the light curtain units are installed and aligned, anchor the light curtain fence panel posts to the foundation (refer to chapter 6 “Anchoring” for suggested anchor drills and bolts).

6. Check the alignment of the light curtain Send and Receive units after the fence posts are anchored to the foundation. If indicated, readjust alignment of the light curtain Send unit and Receive unit.

Figure 3-8: Safety Light Curtain Installation
3.9 Installation — Operator Station

The procedure for installing the Operator Station is as follows:

1. Unload the Operator Station.
2. Remove the protective plastic wrapping from the Operator Station.
3. Inspect the Operator Station for shipping damage.

![NOTE]
Notify your shipping contractor if you notice any shipping damage.

4. Place the Operator Station outside the fence in front of the positioner (see Fig. 1-1 “System Layout” on page 1-3 and Fig. 3-4(a “Plan View Overhead View - ArcWorld IV” on page 3-3).

![CAUTION]
Be absolutely certain of the correct location for the Operator Station before securing it with anchor (lag) bolts.

5. Anchor the Operator Station to the foundation (refer to chapter 6 “Anchoring” for suggested drill bits and anchor bolts).
3.10 Cable Connections

After the ArcWorld® IV-6000SL Series system components and peripherals are anchored in their correct locations, locate the interconnect cables for the system components and route them according to the system drawings and schematics included in the ArcWorld® IV-6000SL Series system documentation package. All cables and connectors are labeled to ensure correct connection to the mating connectors on the applicable system component.

A small gap exists between the bottom of the work-cell safety fence and the floor. This gap provides a passage for cables that run between the components outside the work cell and those inside the work cell.

3.10.1 Connection to Earth Ground

WARNING

Do not use the ArcWorld® IV-6000SL 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 a 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.

The robots and DX200 controller must be connected to a low-resistance earth ground. If a ground stake is used, it should be driven at least 2.43m 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 more than a single driven ground rod, depending on soil conditions.

Multiple ground rods (bonded together) or even a bonded network of buried copper sheeting (plus conduction-enhancing chemicals) may be required, depending on local soil conditions. 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.

The customer shall supply all wires associated with the earth ground. The customer is responsible for establishing the correct gauge of all wires associated with the earth ground and maintaining an adequate earth ground (measured resistance of 100 ohms or less).
3.10 Cable Connections

Connect the robots and controller assembly 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 robot R1. Connect the other end of the earth ground wire to the low-resistance earth ground. See Fig. 1-1 “System Layout” on page 1-3 for the location of robot R1.

2. Repeat Step 1 for robots R2 and R3.

3. Connect one end of an earth ground wire to the COMMON GROUND BUS BAR located inside DX200 controller R1 (see Fig. 2-1 “DX200-TRC Controller” on page 2-2). Connect the other end of the earth ground wire to the low-resistance earth ground.

4. Repeat Step 3 for DX200 expansion cabinets R2 and R3 as required.

3.10.2 Connecting the Robot Cables

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

**CAUTION**

Use care when attaching the cable connectors to the mating connectors on the robot(s) and controller(s). Do not use excessive force. Make sure that the cable connectors are correctly aligned with the mating connectors. The connectors are of the “multi-pin” type and are easily damaged if forced into position.
3 Installation
3.10 Cable Connections

1. Unpack the Programming Pendant and plug its connector into the receptacle on the front door 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. Connect one end of each cable (labeled 1BC and 2BC) to the 1BC and 2BC connections on the back of the robot (see Fig. 3-10 “Manipulator Cables”). Connect the other ends of the 1BC and 2BC cables to the 1BC and 2BC connections on the side of the controller.

Fig. 3-10: Manipulator Cables
3 Installation
3.10 Cable Connections

Fig. 3-11(a): Manipulator Cable Connectors (Manipulator Side)

Fig. 3-11(b): Manipulator Cable Connection to the DX200
3.10.3 Connection to Local Electrical Service

**WARNING**

Local electrical service connection to the ArcWorld® IV-6000SL Series system must be performed by a qualified, licensed electrician. Electrical and grounding connections must comply with the National Electrical Code (NEC), as well as all local electrical codes.

**NOTE**

The ArcWorld® IV-6000SL Series system is configured for three-phase 460/480V AC primary power. For additional information, refer to the electrical drawings and schematics that are included with your system documentation package (see section 1.3 “Reference Documentation” on page 1-12).

After all the system components have been properly installed and interconnected, connect local electrical service to the DX200 controller and welding power sources (refer to section 3.10.3.1 “DX200 Controller” on page 3-20 and section 3.10.3.2 “Welding Power Sources” on page 3-20).

3.10.3.1 DX200 Controller

For detailed electrical service interconnect procedures for the DX200 controller, refer to the DX200 Controller Manual and ArcWorld® IV-6000SL Series system drawings and schematics that are included with your system documentation package (see section 1.3 “Reference Documentation” on page 1-12).

3.10.3.2 Welding Power Sources

Refer to the welding power source documentation and ArcWorld® IV-6000SL Series system drawings and schematics for electrical service connection procedures and diagrams for the welding power sources.
3.11 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 the correct alignment and operation of the safety light curtain system (refer to the safety light curtain documentation that is included with the ArcWorld® IV-6000SL Series system).
2. Check the security and integrity of all cable connections.
3. Ensure that the work-cell sliding access door is closed and the door interlock is engaged.
4. Verify the correct settings for the welding power sources (refer to the welding power source documentation that is included with your ArcWorld® IV-6000SL Series system).
5. Verify that local electrical service complies with the power requirements for your ArcWorld® IV-6000SL Series system.
6. Verify that local electrical service is correctly wired into the DX200DX200 controller assembly and the welding power sources (refer to Fig. 3-9 “Grounding Method” on page 3-17).
7. Set the power ON-OFF switch on the DX200 controller to ON (see Fig. 2-1 “DX200-TRC Controller” on page 2-2).
8. Set the service disconnect boxes for the welding power sources to ON (see Fig. 2-1 “DX200-TRC Controller” on page 2-2).
9. Set the power ON-OFF switch on the welding power sources to ON.

**CAUTION**

The ArcWorld® IV-6000SL Series system is now ready for power-up. Qualified, trained personnel who are familiar with this system should perform the power-up sequence.

**NOTE**

An electrical service disconnect box for the DX200 controller shall be supplied (if desired) by the customer. It is not part of the ArcWorld® IV-6000SL Series system shipment.

**WARNING**

Before operating the robots, verify that each E-STOP push button disables servo power when activated (pushed in). Each E-STOP push button must immediately stop robot and positioner movement when activated (pushed in).

10. Check for correct operation of all E-STOP push buttons (refer to section 2.6.4 “Emergency Stop (E-STOP)” on page 2-8).
3 Installation

3.12 Installation of Tooling and Fixtures

11. Check for correct operation of the system HOLD buttons on the Programming Pendant and Operator 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 “Reference Documentation” on page 1-12). Refer to section 2.3.3 “Operator Station — ROBOT HOLD” on page 2-4 and the manipulator manual for more information on the Operator Station’s ROBOT HOLD button (see section 1.3 “Reference Documentation” on page 1-12).

12. Check for correct operation of the work-cell access door safety interlock.

13. Remove power from the ArcWorld® IV-6000SL Series system after completion of the safety/operation check.

3.12 Installation of Tooling and Fixtures

Your ArcWorld® IV-6000SL Series system is now ready for installation of tooling and fixtures for your particular application. Personnel who are familiar with the operation of the ArcWorld® IV-6000SL Series system should do the installation. After tooling installation, test the positioner for correct operation. Refer to the positioner manual for information on how to test that the positioner is operating correctly (see section 1.3 “Reference Documentation”).

- All tooling and fixtures for the positioner shall be supplied by the customer.

- Motoman recommends application of a corrosion/rust preventive compound to tooling and fixtures located in a high-humidity environment.
This section provides a brief overview of the operating procedures and precautions for your ArcWorld® IV-6000SL Series system. For more detailed operating information, refer to the specific component manuals that are part of the ArcWorld® IV-6000SL Series system documentation package (see section 1.3 “Reference Documentation” on page 1-12).

The ArcWorld® IV-6000SL Series system is a fully integrated robotic GMAW welding cell. Motoman MA-Series robots weld parts on one side of the positioner, while the operator loads the opposite side with parts to be welded. When the robots complete the welding process, they return to HOME (Safe) position. The operator can then initiate another positioner sweep cycle from the Operator Station. This moves the previously loaded parts into the robot work area, where the robots then move from HOME (Safe) position to complete another welding cycle.

The customer shall supply all tooling fixtures for the positioner.

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 documentation that is included with your ArcWorld® IV-6000SL Series system documentation package (see section 1.3 “Reference Documentation” on page 1-12).

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® IV-6000SL 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® IV-6000SL Series system. If you have questions concerning the configuration of your system, please contact Motoman’s 24-hour Customer Support (refer to section 1.4 “Customer Support Information” on page 1-15).
4.2 Sweeping the Positioner

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

Selecting MANUAL mode on the Operator Station’s POSITIONER AUTO/MANUAL switch allows the operator to sweep the positioner without activating the robots. Parts can be loaded onto the fixture to achieve the most efficient configuration and then swept into the welding zone, before teaching the robots 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 robots in HOME position (refer to section 4.3.2 “Robot HOME Position” on page 4-4).
2. Make sure that the Operator Station is enabled (Programming Pendant’s Mode Select Switch set to REMOTE).
3. Set the Operator Station’s POSITIONER AUTO/MANUAL switch to MANUAL and start the Control Master job (refer to section 4.3.3 “Master Job” on page 4-4). Normally, the robots will not move out of HOME position when the POSITIONER AUTO/MANUAL switch is set to MANUAL (this depends on job structure).

**NOTE** Cycle Start latching is not operative in MANUAL mode.

4. Press the CYCLE START/CYCLE LATCHED button on the Operator Station (the 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 “Start-up Procedure”).
• Move the robots to HOME position (refer to section 4.3.2 “Robot HOME Position” on page 4-4).
• Select the Control Master job (refer to section 4.3.3 “Master Job” on page 4-4).
• Perform the operation cycle (refer to section 4.3.4 “Operation Cycle” on page 4-4).
• Perform the shutdown procedure (refer to section 4.3.5 “Shutdown Procedure” on page 4-5).

4.3.1 Start-up Procedure

To start up the ArcWorld® IV-6000SL Series work cell from a power-off condition, proceed as follows:

1. If installed, switch the DX200 controller electrical service disconnect box to ON.

   An electrical service disconnect box for the DX200 controller shall be supplied (if desired) by the customer. It is not part of the ArcWorld® IV-6000SL Series system shipment.

2. Set the power ON-OFF switch on the DX200 controller to ON (see Fig. 2-1 “DX200-TRC Controller” on page 2-2).
3. Switch all welding power source electrical service disconnect boxes to ON (see Fig. 2-1 “DX200-TRC Controller” on page 2-2).
4. Set the power ON-OFF switch on each welding power source to ON (the ON-OFF indicator lamp on each welding power source illuminates).
5. Open the regulator valve for the welding gas supply.
6. Make sure that the work-cell access door is closed and operating properly and the door safety interlock is engaged.
7. Make sure all E-STOP buttons are released. E-STOP buttons are installed at the following locations:
   • Programming Pendant
   • Operator Station
8. Select TEACH mode on the Programming Pendant.
9. Place the robots in HOME position (refer to section 4.3.2 “Robot HOME Position” on page 4-4).
4.3.2 Robot HOME Position

To move the robots to HOME position:

1. Select TEACH mode on the Programming Pendant.
2. Select MAIN MENU 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. Use the navigation cursor key to move the cursor to SAFE job and then 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 jog robot R1 to HOME position.
8. Repeat Steps 5 through 7 for robots R2 and R3 as required.

4.3.3 Master Job

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

1. Select JOB on the Programming Pendant’s touch screen.
2. Select CTRL MASTER on the Programming Pendant’s touch screen.
3. Press SELECT twice to activate the Master job.
4. Select PLAY mode on the Programming Pendant (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® IV-6000SL Series work cell is now ready for operation.

4.3.4 Operation Cycle

The following is the typical sequence of operation for the ArcWorld® IV-6000SL 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 Operator Station.
3. The operator presses the green CYCLE START/CYCLE LATCHED button on the Operator Station.
4. The positioner sweeps, placing parts to be welded into the robot work area. The robots then begin to weld the parts (if the Operator Station’s POSITIONER AUTO/MANUAL switch is set to AUTO).
5. While the robots are welding, the operator loads the operator side of the positioner with the next group of parts to be welded.
6. The operator again moves to the Operator Station and presses the green CYCLE START/CYCLE LATCHED button (the Cycle Latched light illuminates). When the robots are finished welding, they return to HOME position. The positioner then sweeps again to return the completed, welded parts to the operator position, while moving the next group of parts into the robot work area.

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

### 4.3.5 Shutdown Procedure

Use the following procedure to perform a normal shutdown of the ArcWorld® IV-6000SL Series system:

1. Make sure all robots are in HOME position.
2. Turn off the system servo power by pressing the E-STOP button on the Operator Station or Programming Pendant.
3. Select TEACH mode on the Programming Pendant.
4. Set the DX200 controller power ON-OFF switch to the OFF position.
5. Set both welding power source power ON-OFF switches to the OFF position.
6. Close the regulator valve for the welding gas supply.
7. Switch the DX200 controller disconnect box (if installed) to OFF.

8. Switch all welding power source disconnect boxes to OFF (see Fig. 2-1 “DX200-TRC Controller” on page 2-2).

The ArcWorld® IV-6000SL 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 remedy them when you do.

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 maintenance and DX200 controller documentation that is included with your ArcWorld® IV-6000SL Series system (refer to section 1.3 “Reference Documentation” on page 1-12).

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 in accordance with the following steps:

1. Rotate the DX200 controller’s power ON-OFF switch to OFF.
2. Allow the controller’s power ON-OFF switch to remain in the OFF position for approximately 10 seconds.
3. Rotate the controller’s power ON-OFF switch 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).
- The work-cell access door is opened while the robots are not in TEACH mode.
- The safety light curtain system is triggered while the positioner is sweeping.
- A welding torch collision triggers a shock sensor output (refer to section 4.4.3 “Shock Sensor Recovery” on page 4-7).
4. Operation
4.4 System Recovery

After an E-STOP condition occurs, restart the ArcWorld® IV-6000SL Series system as follows:

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
   - Clear the area in front of the positioner that is protected by the safety light curtain system
   - Clear the shock sensor condition (refer to section 4.4.3 “Shock Sensor Recovery” on page 4-7).

2. Press the SERVO ON button on the Programming Pendant.
3. Select REMOTE mode on the Programming Pendant’s Mode Select Switch to transfer control of the system to the Operator Station.
4. Press the green START button on the Operator Station.

The ArcWorld® IV-6000SL Series system is now ready to continue operation.

4.4.3 Shock Sensor Recovery

Each robot includes a Motoman gun mount. This mount is designed to protect the torch from damage in case of a crash (collision). 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's touch screen.
2. Select ROBOT on the Programming Pendant’s 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® IV-6000SL Series system is now ready to continue operation.
5 Maintenance

Maintenance must be performed by authorized personnel who are familiar with the ArcWorld® IV-6000SL Series system. 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.

The maintenance intervals given in Table 5-1 “Periodic Maintenance” 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® IV-6000SL Series system, refer to the documentation that is included with your system documentation package (refer to section 1.3 “Reference Documentation” on page 1-12).

**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 torches and damage sealing gaskets in the water circulator pumps.

<table>
<thead>
<tr>
<th>FREQUENCY</th>
<th>COMPONENT</th>
<th>PROCEDURE</th>
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<tbody>
<tr>
<td>Daily (or on condition)</td>
<td>Water Circulators (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 proportions shown on the antifreeze container. Check the physical condition of the safeguard item and ensure that it is working correctly.</td>
</tr>
<tr>
<td>One Month (or on condition)</td>
<td>ArcWorld® IV-6000SL Series Work Cell</td>
<td>Remove accumulated dirt, grease, and debris from inside and outside the work cell.</td>
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<tr>
<td>Six Months (or on condition)</td>
<td>Spanner Plates</td>
<td>Check the integrity and torque of the hardware that secures the spanner plates to the robot equipment base and positioner (see Fig. 3-6 “Robot Common Base Installation” on page 3-9).</td>
</tr>
</tbody>
</table>
6 Anchoring

The purchaser must determine all anchoring and foundation requirements and supply the appropriate anchoring hardware for a particular installation. Before installing the ArcWorld® IV-6000SL Series, refer to Table 6-1 "Minimum Recommended Equipment Anchor Requirements" to determine special anchor and foundation requirements.

**WARNING**

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.

<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 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.</td>
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<tr>
<td>POSITIONER</td>
<td>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.</td>
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<tr>
<td>PERIPHERAL EQUIPMENT</td>
<td>1/2-inch Kwik Bolt II Style Anchor &lt;Emphasis&gt;(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>WORK-CELL FENCE POSTS</td>
<td>3/8-inch Kwik Bolt II Style Anchor &lt;Emphasis&gt;(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>
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<tr>
<td>OPERATOR STATION PEDESTAI</td>
<td>1/4-inch Kwik Bolt II Style Anchor &lt;Emphasis&gt;(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>
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</tbody>
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**NOTES:**
1. Reference source: Hilti® Product Technical Guide (section 4.3.3) for hardware specifications or equivalent.

Refer to http://us.hilti.com or http://ca.hilti.com for further information.
6 Anchoring
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.

### BEFORE APPLYING POWER
*(Refer to System Drawings)*

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<tr>
<th>Check Mounting</th>
<th>Time/Date</th>
<th>Checked By</th>
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<tbody>
<tr>
<td><em>(Refer to Installation Section in all Manuals)</em></td>
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| Check Power             |           |            |
| *(Refer to Connections, Controller Manual)* |           |            |

| Check Ground            |           |            |
| *(Refer to Grounding in all Manuals)* |           |            |

| Check Water             |           |            |
| *(Refer to Operation and Vendor Manuals)* |           |            |

| Check Air               |           |            |
| *(Refer to Manipulator and Vendor Manuals)* |           |            |

| Check Gas               |           |            |
| *(Refer to Operation and Vendor Manuals)* |           |            |

| Check Interlocks        |           |            |
| *(Refer to Work Cells in all Manuals)* |           |            |

| Check Limiting Devices  |           |            |
| *(Refer to Limits in all Manuals)* |           |            |

| Check Environment       |           |            |
| *(Refer to Installation in Controller Manual)* |           |            |

| Check Version           |           |            |
| *(Refer to Confirmation of Software Version)* |           |            |

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

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### checklist

<table>
<thead>
<tr>
<th>Task</th>
<th>Time/Date</th>
<th>Checked By</th>
</tr>
</thead>
<tbody>
<tr>
<td>After Applying Power</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Check Control Switches</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>(Refer to Operator Station, Controller Manual)</em></td>
<td></td>
<td></td>
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<tr>
<td>Check Axis Move and are Restricted</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>(Refer to Basic Specifications, Manipulator Manual)</em></td>
<td></td>
<td></td>
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<tr>
<td>Check Emergency Stop(s)</td>
<td></td>
<td></td>
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<tr>
<td><em>(Refer to E-Stop in all Manuals)</em></td>
<td></td>
<td></td>
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<tr>
<td>Check External Power Disconnect</td>
<td></td>
<td></td>
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<tr>
<td><em>(Refer to Turning OFF The Power Supply)</em></td>
<td></td>
<td></td>
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<tr>
<td>Check Teach Mode</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>(Refer to Teach Mode, Controller Manual)</em></td>
<td></td>
<td></td>
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<tr>
<td>Check Playback Mode</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>(Refer to Play Mode, Controller Manual)</em></td>
<td></td>
<td></td>
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<tr>
<td>Check Environment</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>(Refer to Location in Manipulator Manual)</em></td>
<td></td>
<td></td>
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<tr>
<td>Check Safeguards</td>
<td></td>
<td></td>
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<tr>
<td><em>(Refer to Safeguards in all Manuals)</em></td>
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<tr>
<td>Check Manual Mode</td>
<td></td>
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<tr>
<td><em>(Refer to Manual Mode in Operations Manual)</em></td>
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<tr>
<td>Check Automatic Mode</td>
<td></td>
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<tr>
<td><em>(Refer to Automatic Mode in Operations Manual)</em></td>
<td></td>
<td></td>
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<tr>
<td>Other Items to Check After Applying Power <em>(Vendor or Integrator Supplied)</em></td>
<td></td>
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<tr>
<td>DOCUMENTATION INCLUDED</td>
<td>Time/Date</td>
<td>Checked By</td>
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<tr>
<td>----------------------------------------------------------------------------------------</td>
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<tr>
<td>System Drawings</td>
<td></td>
<td></td>
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<tr>
<td>Modifications Made to Original Protective Equipment</td>
<td></td>
<td></td>
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<tr>
<td>End Effector Load Analysis</td>
<td></td>
<td></td>
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<tr>
<td>Instructions on Synchronized Motion (More than one piece of equipment)</td>
<td></td>
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<tr>
<td>Programmed Limits</td>
<td></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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<tr>
<td>Risk Assessment</td>
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<tr>
<td>Other Documents to Include (Vendor or Integrator Supplied) (Vendor Manuals, Supplier</td>
<td></td>
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<tr>
<td>Certifications, Compliance</td>
<td></td>
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<tr>
<td>MARKINGS INCLUDED ON EQUIPMENT</td>
<td>Time/Date</td>
<td>Checked By</td>
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<tr>
<td>Business Name, Address, Info</td>
<td></td>
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</tr>
<tr>
<td>Machinery Designation and Type</td>
<td></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>Order Number (Serial Number)</td>
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</tbody>
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| Other Markings on Equipment   |           |            |
| (Vendor Machine Designation, Type, Serial No, Version, etc.) |           |            |

| OTHER ITEMS                   |           |            |
|                               |           |            |
|                               |           |            |
|                               |           |            |
|                               |           |            |
|                               |           |            |
|                               |           |            |
|                               |           |            |