FabWorld® II-Series
SYSTEM MANUAL

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

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

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

Part Number: 156719-1CD
Revision: 1
MANDATORY

- This system manual provides an overview of the Motoman FabWorld® II-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 FabWorld® II-Series system.

- General items related to safety are listed in Section 2 of the DX100 Controller Manual. To ensure correct and safe operation, carefully read the DX100 Controller Manual before reading this manual.

CAUTION

- Some drawings in this manual are shown with the protective covers or shields removed for clarity. Be sure that all covers and shields are replaced before operating this product.

- The drawings and photos in this manual are representative examples, and differences may exist between them and the delivered product.

- YASKAWA may modify this model without notice when necessary due to product improvements, modifications, or changes in specifications.

- If such a modification is made, the manual number will also be revised.

- If your copy of the manual is damaged or lost, contact a YASKAWA representative to order a new copy. The representatives are listed on the back cover. Be sure to tell the representative the manual number listed on the front cover.

- YASKAWA is not responsible for incidents arising from unauthorized modification of its products. Unauthorized modification voids your product's warranty.
Notes for Safe Operation

Read this manual carefully before installation, operation, maintenance, or inspection of the Motoman FabWorld® II-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 Figure 1). When servo power is turned OFF, the SERVO ON LED on the Programming Pendant is turned OFF.

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

Figure 1: EMERGENCY STOP Button

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

Injury may result from unintentional or unexpected manipulator motion.

Figure 2: Release of EMERGENCY STOP Button

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

Improper or unintended manipulator operation may result in injury.

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

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

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**CAUTION**

- Perform the following inspection procedures prior to conducting manipulator teaching. If problems are found, repair them immediately and be sure that all other necessary processing has been performed.
  - Check for problems in manipulator movement.
  - Check for damage to insulation and sheathing of external wires.
- Always return the Programming Pendant to the hook on the cabinet of the DX100 controller after use. The Programming Pendant can be damaged if it is left in the manipulator’s work area, on the floor, or near fixtures.
- Read and understand the Explanation of Warning Labels in the DX100 Controller Manual before operating the FabWorld® II-Series system.
Explanation of Warning Labels

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

Always follow the warnings on the labels.

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

Figure 3: Warning Labels Location
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1 Introduction

1.1 About This Document

This system manual is delivered with the FabWorld® II-Series system to provide a “first look” and overview of the complete Motoman FabWorld® II-Series system. You should read and understand this system manual before moving on to the more detailed documentation that is included with your FabWorld® II-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 FabWorld® II-Series system, please review the full documentation package that is included with your FabWorld® II-Series system (refer to Section 1.3).

This system manual contains the following sections:

Section 1 – Introduction

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

Section 2 – Equipment Description

This section provides a detailed description of the major components of the FabWorld® II-Series system.

Section 3 – Installation

This section provides instructions for set up and installation of the FabWorld® II-Series system.

Section 4 – Operation

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

Section 5 – Maintenance

This section lists periodic and preventive maintenance suggestions for FabWorld® II-Series system components.

Section 6 – Anchoring

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

1.2 System Overview

The FabWorld® II-Series work cell provides a complete arc-welding solution with multiple robot and station kit configurations. The system is designed around single or dual Motoman arc-welding robots and DX100 controllers and includes a complete welding package. Two MHT-series positioners comprise the work stations and allow the robot(s) to weld in synchronous motion with each positioner. The cell can also be purchased with a stationary weld table instead of the headstock/tailstock combination.
The cell also includes a full complement of safety features designed to protect both personnel and equipment. Dual robot systems feature single point of control of all axes from one Programming Pendant, as required by ANSI/RIA 15.06-1999. Figure 1-1 illustrates a typical system layout for the FabWorld® II-Series work cell (dual robot feature shown).

Figure 1-1: System Layout — FabWorld® II-Series System

1.2.1 System Layout

The FabWorld® II-Series system provides multiple configuration options for different application requirements. Several robot options are available for different applications and weld lengths. Single-robot MA1400 or MA1900 cells are available, as well as dual configurations. The robot manipulator(s) are mounted on a common base, providing ease of installation.

Welding tack tables or headstock/tailstock positioners make up the two work stations. Several optional MHTH-series positioners are available in either 500- or 1600-kg capacities. Each positioner is equipped with Motoman’s patented MotoMount flexible fixture system. Robot controllers and welding power sources share common bases outside the welding cell. The robotic cell is enclosed by safety fencing with an interlocking door. S-axis zone rings and light curtains provide reliable safeguarding. All operator controls, including those on the controller and welding power supplies, are accessible from outside the safety fencing.

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

1.2.2 Major Components

The FabWorld® II-Series system is made up of the following major components:

- One or two Motoman MA-series manipulators and DX100 controllers
- MHT-series positioner
- Welding Tack Table
- Operator Stations
- Welding equipment, including the following:
  - Welding power source
  - Welding torch (water-cooled or air-cooled)
  - Wire feeder
  - Applicable welding interface
  - Torch mount
- Safety equipment, including the following:
  - Safety fencing with arc curtains
  - Interlocked safety light curtains
  - Interlocked cell door

1.2.3 Optional Equipment

The following optional welding equipment is available for use with the FabWorld® II-Series system:

- Torch cleaner
- Wire cutter
- Water-cooled torch (with coolant circulator)
- Bulk wire dereeler, 454 kg
- ComArc™ (seam tracking)
- TouchSense™ (starting point detection)
- ToolSight® (auto verification of correct torch alignment)

1.3 Reference Documentation

For additional information refer to the following:

- Motoman MA1400 Manipulator Manual (P/N 155557-1CD)
- Motoman MA1900 Manipulator Manual (P/N 156226-1CD)
- Motoman Independent/Coordinated Control (P/N 156431-1CD)
- Motoman INFORM User’s Manual (P/N 155493-1CD)
- Motoman Brake Release Manual (P/N 156239-1CD)
- Motoman DX100 Controller Manual (P/N 155494-1CD)
- Motoman Maintenance Manual for DX100 (P/N 155492-1CD)
- Motoman Operator’s Manual for Arc Welding (P/N 155490-1CD)
- Motoman DX100 Concurrent I/O Manual (P/N 155491-1CD)
1.4 Customer Support Information

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

(937) 847-3200

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

techsupport@motoman.com

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.

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

Please have the following information ready before you call:

- System Type: FabWorld® II-Series
- Robot Type: MA1400 or MA1900
- Application Type: Welding
- 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 back side of the robot’s arm
- Robot Sales Order Number: Located on the DX100 controller’s data plate
2 Equipment Description

2.1 Robot Description

The FabWorld® II-Series system uses the Motoman MA-Series six-axis robot(s). The MA-Series robots are specifically designed for arc-welding applications. The MA1400 robot has a payload capability of 3 kg and features a horizontal reach of 1434 mm. The MA1400 robot features a relative positioning accuracy of ±0.08 mm. The MA1900 robot has a payload capability of 3 kg and features a horizontal reach of 1,904 mm. The MA1900 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, 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.

The robot’s S-axis rotation is physically limited by hard stops located in the base of each robot. For more information, refer to the MA1400 or MA1900 Manipulator Manual that came with your FabWorld® II-Series system documentation package (see Section 1.3).

2.2 DX100 Controller

The FabWorld® II-Series system features a DX100 controller assembly. Additional expansion cabinets are mated to the master cabinet for each additional robot (see Figure 2-1). The DRC configuration provides the same functionality of two full-size controllers, without the space requirement and weight of additional, full-size DX100 controllers. This configuration also reduces the cost to the operator by eliminating redundant components and circuitry.

Through specific cable interconnections (internal to the DX100), the DX100 and expansion cabinet are configured as controller R1, and R2 (see Figure 2-1). This configuration allows the robots to operate as a multi-robot system that takes advantage of all the unique functions available only in a multi-robot system configuration. The full-size DX100 controller cabinet is designated R1, while the expansion cabinet is designated R2. The DX100 controller assembly is mounted on a Common Equipment Base, which is positioned outside the FabWorld® II-Series work cell (see Figure 1-1 and Figure 2-1).

In addition to controlling the movement of the robots, the DX100 controls the welding power sources and the positioner and provides the signals necessary to operate the welding systems.

The DX100 features an embedded real-time operating system (RTOS) and is programmed with the Motoman INFORM programming language. For more information on the DX100 controller, refer to DX100 Controller manual that came with your FabWorld® II-Series system documentation package (see Section 1.3).
2.2.1 Programming Pendant

The Programming Pendant (see Figure 2-2) is the primary user interface for the system and features a cross-shaped navigation cursor that reduces teaching time by 30 percent. The pendant has a 5.7-inch color touch-screen display (640 x 480 VGA) and provides a CompactFlash card slot and USB port for data backups. The system uses the INFORM robot programming language and a menu-driven interface to simplify operator interaction with the robot.

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

The Operator Station (see Figure 2-3) includes a NEMA enclosure and fence-mounting brackets. The following paragraphs describe the controls on the Operator Station.
2.3.1 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.

2.3.2 SERVO ON
Pressing the SERVO ON button turns servo power on if the Programming Pendant’s Mode Select Switch is set to REMOTE.

2.3.3 ALARM
A red ALARM lamp illuminates to indicate that the DX100 controller has encountered an alarm condition.

2.3.4 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 DX100 controller circuitry. When the robots return to HOME (Safe) position, the “latched” Cycle Start command is executed and the positioner sweeps. Circuitry in the DX100 controller prevents the positioner from continuously cycling should the operator depress and hold the CYCLE START/CYCLE LATCHED push button.
2.3.5 REV/HOME/FWD (Joystick)

The joystick controls positioner rotation and user-defined load positions. Moving the joystick to the right (FWD) indexes the positioner headstock in a clockwise direction at 30-degree intervals. Moving the joystick to the left (REV) indexes the positioner headstock in a counterclockwise direction at 30-degree intervals. Moving the joystick forward (HOME) moves the positioner headstock to zero degrees (HOME position).

2.3.6 RESET

The RESET button is connected to the robot's alarm reset input. Pressing this button clears a minor alarm or error condition.

2.3.7 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.

2.3.8 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 for a discussion of the E-STOP function and the procedures for recovering the FabWorld® II-Series system from the Emergency stop (E-STOP) condition.

2.4 MHT-Series Positioners

The MHT-series positioners include the MHT-500 and MHT-1600 positioners. These positioners have a headstock drive assembly, a tailstock column, and the MotoMount™ tool-mounting system. Part fixturing is mounted between the headstock and tailstock face plates. Refer to the positioner manual for technical details on the MotoMount system and the MHT-500 and MHT-1600 positioners (see Section 1.3).

• The customer shall supply all tooling and fixtures for the positioner.
• Motoman recommends application of a corrosion/rust preventive compound to tooling and fixtures located in a high-humidity environment.

The FabWorld® II-Series system is capable of true coordinated motion, where linear, circular, or spline motion can be coordinated between the robot(s) and positioner. Coordinated motion allows the robot(s) to weld while the positioner rotates the parts. For additional information on coordinated motion, refer to the Independent/Coordinated Control Manual that is included with your system documentation package (see Section 1.3).
2.5 Welding Equipment

In its standard configuration, the FabWorld® II-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 FabWorld® II-Series system (refer to Section 1.2.3).

2.5.1 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 FabWorld® II-Series system documentation package (see Section 1.3).

2.5.2 GMAW Torch

The FabWorld® II-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 4.3.2). For applications that use the optional water-cooled torch, the FabWorld® II-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 FabWorld® II-Series system documentation package (see Section 1.3).

2.5.3 Power Sources

Motoman offers various brands and types of welding power sources. The welding power sources supplied with the FabWorld® II-Series system depends on the customer’s specific application and preference. For specific information on the welding power sources supplied with your FabWorld® II-Series system, refer to the welding power source manual that is included with the system documentation package (see Section 1.3).

2.6 Safety Features

WARNING

The ANSI/RIA R15.06-1999 Robot Safety Standard stipulates that the user is responsible for safeguarding. Users are responsible for determining whether the provided safeguards are adequate for plant conditions and must ensure that safeguards are maintained in working order.
The FabWorld® II-Series system includes a total safety environment. When all standard safety precautions are taken, the safety equipment helps to ensure safe operation of the robotic cell.

### 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.

**WARNING**

Although safety fence arc curtains block the radiation of ultraviolet light, never look directly at the welding arc without protective eye wear.

The arc curtains (attached to the steel-mesh safety fencing) filter (or "block") most of the ultraviolet light radiation that would otherwise escape the work cell. The arc curtains protect the operator from the ultraviolet light radiation and sparks that result from the welding operation (see Figure 1-1).

### 2.6.2 Safety Fencing

The heavy-gauge, welded wire safety fencing that is provided with the FabWorld® II-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

The safety light curtains work in conjunction with the robot zone rings to help prevent serious injury to anyone entering a station safety zone while the robot is working in that area. In PLAY mode, if the robot is at Station 1 and the operator steps into the Station 1 safety zone, servo power is removed from the system and all positioner motion stops. Servo power can be reapplied and operation resumed by pressing SERVO ON and START.

### 2.6.4 Emergency Stops (E-STOPs)

Emergency Stop (E-STOP) is a primary safety feature of the FabWorld® II-Series system. A work-cell access door interlock, the safety light curtain system, robot welding torch impact (collision) detection circuitry (refer to Section 2.5.2), 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). The E-STOP push buttons are used for an intentional shutdown of the FabWorld® II-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 4.3.2).
2.6.5 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 Figure 2-2). 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 DX100 Operator’s Manual for Arc Welding that is included with the FabWorld® II-Series system documentation package (see Section 1.3).

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 DX100 Manual Brake Release manual included with the FabWorld® II-Series system documentation package (see Section 1.3).

2.6.7 Interlocked Cell Door

A safety interlock on the cell entrance door prevents entry into the cell during PLAY mode. If the safety interlock is bypassed or otherwise defeated, brakes are applied to the robot, servo power is removed from the system, and all positioner motion is stopped.
3 Installation

The FabWorld® II-Series system can be installed easily in just a short time. Comply with all the safety instructions and precautions given in this section during the installation process. Failure to use safe work practices can result in damage to the equipment and injury to the workers.

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

### 3.1 Materials Required

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

#### 3.1.1 Customer-supplied Items

- Gas for welding torches
- Incoming power
- Two earth ground cables with two earth ground stakes
- Weld wire
- Incoming air supply: 0.04 cm at 620.5 kPa (1.5 scfm at 90 psi) for torch tender or wire cutter options
- Stepladder
- Forklift and/or overhead crane

#### 3.1.2 List of Tools

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

**CAUTION**

Installation of the FabWorld® II-Series system is not a task for the novice. The FabWorld system is not fragile, but it is a highly sophisticated robotic system. Handle components with care. Rough handling can damage the system’s electronic components.
3.2 Site Preparation

To prepare your site, proceed as follows:

1. Clear the floor space needed for the unit (refer to your specific system prints).

   **NOTE** To make installation easier, allow an additional 1.2 to 1.5 m on all sides of the cell.

2. Gather all the customer-supplied items and required tools listed in Section 3.1.

3.3 Installing the Robot/Positioner Common Base

The robot/positioner common base is shipped on a wooden shipping skid. To install the common base, refer to Figure 3-1 and proceed as follows:

   **CAUTION** Handle the FabWorld® II-Series system components carefully to avoid damage.

1. Unbolt the robot/positioner common base from the shipping skid using a 3/4-inch socket.

   **WARNING** The robot/positioner common base can weigh up to 3870 kg with two robots and two positioners. Be sure that your crane or forklift is capable of handling this much weight, or damage to the equipment or injury to personnel can result.

2. Move the common base in position according to the system drawings.
3. Carefully remove the protective plastic wrapping from the equipment.
4. Inspect the equipment for shipping damage.

   **NOTE** Notify your shipping contractor if you notice any shipping damage.

5. Anchor the common base securely in place (refer to Section 6 for anchor requirements).

*Figure 3-1: Robot/Positioner Common Base*
3.3.1 Shipping Bolts and Brackets

The robots are provided with two shipping bolts and a shipping bracket. (See fig. 3-2 ?Shipping Bolts and Brackets?.)

Fig. 3-2: Shipping Bolts and Brackets

- The shipping bolts and bracket are painted yellow.
- The shipping bracket is to be fixed with the hexagon socket head cap screws M10 (2 screws).

Before turning ON the power, check to be sure that the shipping bolts and brackets are removed. The shipping bolts and brackets then must be stored for future use, in the event that the manipulator must be moved again.
3.4 Installing the Controller/Welder Base

The FabWorld® II-Series system uses a separate controller/welder base mounted on the outside of the system fencing. This base contains the robot controller, welder, service disconnect, and optional water circulator. To install the base, proceed as follows:

1. Unbolt the base by removing the four shipping bolts using a 3/4-inch socket.

![WARNING]

The controller base can weigh up to 730 kg. Be sure that your lifting device is capable of handling this much weight, or damage to the equipment or injury to personnel can result.

2. Carefully remove the plastic wrapping and cardboard from the base.

3. Inspect the base components for any shipping damage.

![NOTE]

Notify your shipping contractor if you notice any shipping damage.

4. Use a forklift to lift the base and remove the wooden blocks.

5. Refer to your system drawings (supplied with the robot cell) to place the base in position.

6. Anchor the base securely in place (refer to Section 6 for anchor requirements).

3.5 Connecting the Cables

After the components are level and securely in place, unwrap the cables and connect them according to the cable diagram included in the system drawing package. All cables are labeled to match the labels at the connection points. Using cable trays, route the cables between the system components.

![CAUTION]

Route the wires in the cable trays to avoid wire breakage and unnecessary interruption of cell operations.

3.5.1 Connecting the Earth Ground

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

**WARNING**

Do not use the equipment if proper earth grounds cannot be provided. Equipment that is not grounded correctly can result in serious injury or death to personnel.

**NOTE**

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

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

*Fig. 3-3: Grounding Method*

3.5.2 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:

![Diagram showing cable connections and grounding method.](image-url)
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 Figure 3-4). Connect the other ends of the 1BC and 2BC cables to the 1BC and 2BC connections on the side of the controller.

**Fig. 3-4: Manipulator Cables**

**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.
3.6 Installing the Safety Fencing

The fencing that makes up 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.

To install the safety fencing, proceed as follows:

1. Cut the metal bands securing the metal fencing and remove all items from the skid.
2. Place the fence components on the floor around the positioner according to the system drawings (see Figure 3-6).

Figure 3-6: Safety Fence Components and Orientation

![Safety Fence Components and Orientation](image)

**WARNING**

At least two people are required for safe accomplishment of the remaining fence installation steps.

3. Connect and tighten the fence posts to the panels according to the fence instructions.

4. Have an assistant hold the fencing in place while you attach each panel.

5. Measure to ensure that the cell walls are square (adjust as necessary).

6. Anchor the fence posts to the floor (refer to Section 6 for anchor requirements).
3.6.1 Door Latch Alignment

Adjust the location of the door latch as necessary to provide smooth operation of the door assembly. A #14 spanner bit is provided to loosen and adjust the location of the latch assembly. Metal shims are also provided and can be placed beneath the fence posts to make gross adjustments. See Figure 3-7.

Figure 3-7: Door Latch Alignment
3.6.2 Installing the Arc Curtains

WARNING

Do not install the arc curtains until after the cell walls have been secured. Unsecured cell walls can fall and injure personnel and damage equipment.

The arc curtains are shipped in an accessories box. To install the arc curtains, proceed as follows:

1. Unfold the arc curtains and install one curtain on the inside of each cell wall section, using the supplied wire ties and eyelets in the curtain or Velcro, depending on your design.

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

3. Install the door panel’s arc curtain on the inside of the door panel using the supplied wire ties and eyelets in the curtain or Velcro, depending on your design.

NOTE

The arc curtains are pre-cut to match the cell fencing. Each arc curtain bag contains documentation that includes the arc curtain’s dimensions. If necessary, these dimensions can be used to match the arc curtain to the correct cell fencing.

3.7 Installing the Safety Light Curtains

There are two types of light curtains used on the FabWorld® II-Series system: floor-mounted and safety-fence mounted. One light curtain pair consists of a Sender and Receiver (and associated cabling). All required light curtain pairs for the robot cell are typically shipped attached to the robot controller. To install the light curtains, proceed as follows:

1. Unpack the safety light curtain components.

2. Carefully remove the protective plastic wrapping.

NOTE

Cable connections are typically left attached during shipping. If not, unpack the safety light curtain cables and connect them to the matching connectors on the light curtains and controller.

3. The safety light curtain Sender and Receiver panels must be aligned properly. For exact alignment procedures, refer to the light curtain documentation that is supplied with the robot cell.

4. Identify the light curtains that are to be floor-mounted. Align the floor-mounted light curtains for proper operation, then anchor them to the floor (refer to Section 6 of this manual for anchor requirements). See Figure 1-1 and Figure 3-6 for the approximate attachment locations for the floor-mounted light curtains.
3 Installation

3.8 Installing the Operator Stations

5. Identify the light curtains that will be mounted to the safety fencing. Align these light curtains for proper operation, then attach them to the safety fencing. See Figure 1-1 and Figure 3-6 for the approximate attachment locations for the safety fence-mounted light curtains.

6. Check the alignment of the light curtains again after the fence posts have been anchored. If necessary, readjust the alignment and fastening of the safety light curtains to ensure proper operation.

3.8 Installing the Operator Stations

The Operator Stations are shipped attached to the fencing. To install the Operator Stations, proceed as follows:

1. Carefully remove the protective plastic wrapping from the Operator Stations.
2. Inspect the Operator Stations for shipping damage.
3. Unpack the Operator Stations’ cables and route them to the controller.
4. Carefully engaging the connectors, connect each cable according to the cable diagram included in the system drawing package.

3.9 Connecting the Power

After all the system components have been properly installed, connect the power to the FabWorld® II-Series system as follows:

**WARNING**

Power must be connected by a qualified electrician only. Electrical and grounding connections must comply with applicable portions of the National Electrical Code and/or local electrical codes.

1. Install three-phase power wiring to the main service disconnect located on the controller base (and welder base for dual systems). Table 3-1 shows the size and type of wire needed.
2. Make sure that the service disconnect switch is set to the OFF position.
3. Route the incoming power cable into the disconnect box. Knock-out holes are provided.
4. Using a cord grip, secure the incoming power cable to the service disconnect housing.
5. Strip the three incoming power wires and secure them to the power disconnect connections inside. Use a philips screwdriver to tighten the connections.

**NOTE** Notify your shipping contractor if you notice any shipping damage.
6. Strip the ground wire and secure it to the ground lug inside the service disconnect box. A ring-tongue terminal will be needed. Nut and lock-washer are provided.

7. Turn the service disconnect switch to the ON position.

8. Using a volt/ohm meter, verify the incoming voltage and amperage values. Refer to the label on the service disconnect box and system prints for the correct voltage.

The FabWorld® II-Series system is configured for three-phase 460/480V AC, unless other voltage was requested. If other voltage is required for your plant, you must make the necessary modifications to the transformer. For more information, refer to the manipulator manual that came with your system (see Section 1.3).

**Note**

<table>
<thead>
<tr>
<th>Table 3-1: Incoming Power Specifications (Decal)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lug Data</td>
</tr>
<tr>
<td>60/75°C wire</td>
</tr>
<tr>
<td>Catalog Number</td>
</tr>
<tr>
<td>TCAL14</td>
</tr>
<tr>
<td>Wire Size</td>
</tr>
<tr>
<td>#14-7 Copper</td>
</tr>
<tr>
<td>#12-8 Aluminum</td>
</tr>
<tr>
<td>Torque</td>
</tr>
<tr>
<td>#14-7, 4.0 N•m (35 lb-in.)</td>
</tr>
</tbody>
</table>

3.10 Conducting A Safety/Operation Check

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

1. Verify that all yellow shipping brackets have been removed from each robot (refer to Section 3.3.1).

2. Be sure the safety light curtains are aligned correctly.

3. Check that the cell door is closed and latched.

4. Check that all cable connections are tight.

5. Be sure that the welding power source is set correctly (see the welding power source vendor's manual).

6. Verify that the incoming line power matches the input power specified on the front of the controller.

Your FabWorld® II-Series system is now ready for power-up. The FabWorld system should be operated only by personnel who have received operator training from Motoman and who are familiar with the operation of this Motoman robotic system. Turn the main power on and continue the safety/operation check.

7. Check for correct operation of all system E-STOPS (Programming Pendant, Operator Station, and controller door).

8. 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). Refer to Section 2.3.7 for more information on the Operator Station's ROBOT HOLD button (see Section 1.3).
3.11 Installation of Tooling and Fixtures

Your FabWorld® II-Series system is now ready for the installation of tooling and fixtures for your application. The installation of tooling and fixtures should be performed by personnel who are familiar with the operation of this system. Tooling and fixtures are supplied by the customer. After tooling is installed, test the positioner for proper operation (refer to the positioner manual for instructions on testing for proper operation; see Section 1.3).
The FabWorld® II-Series system is a fully integrated robotic arc-welding cell. The Control Master job setup, and the sub-jobs programmed within it, determine how the system performs welding operation and other tasks. The robot(s) welds parts on the active station while the operator loads or unloads parts on the opposite side. Once the robot(s) is finished with the welding process, it returns to HOME position. The operator is then able to enter the safety zone and safely process the parts while the robot(s) works at the opposite station.

The FabWorld® II-Series system offers two work stations containing any combination of the following station kits: MHT-500 (500-kg capacity), MHT-1600 (1600-kg capacity) positioners, and/or weld tack tables.

**NOTE**

All tooling and fixtures are supplied by the customer.

### 4.1 Programming

The operation of this system is programming dependent. The following operating instructions are based on one possible configuration of this system. Your system configuration and job structure may differ slightly from that presented here; however, basic operation will be the same. For additional programming instructions, refer to the *DX100 Controller Manual* that is supplied with your system (see Section 1.3).

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

A major advantage of the FabWorld® II-Series system is its high degree of flexibility. The operator can fine-tune the movement of both the robots and positioners according to parts configuration. The robots can be programmed to weld parts with the headstock stationary, or the robots and headstock can move simultaneously. The robots can be programmed to weld different seams on the same part and to move from part to part to continue welding.

With the DX100 Programming Pendant, you can develop a series of jobs for the robots. You can program the robots independently, the station axis independently, or the robots and station axis together. You must select the axis combination when first teaching the job (see Section 4.1.1). Motoman recommends programming the robots and station axis together to reduce the risk of interference.
4.1.1 Programming Specific Jobs

For more detailed information on programming user jobs, refer to the Operator's Manual for Arc Welding.

You can program three types of moves, as follows:

- Rotation of headstock during air-cut moves
- Robot motion with headstock stationary
- Rotation of headstock during welding

The job you create may consist of a combination of the above. The first two types of moves assume a robot-plus-station group axis specification. The last type of move is called station synchronous and should be programmed with a station-plus-robot group axis specification with the station as the Master control device.

Refer to the Independent/Coordinated Control Function Manual for information on coordinated motion, selecting synchronization, group axes, and tooling calibration (see Section 1.3).
4.2 Daily Operation

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

- Perform the start-up procedure (see Section 4.2.1).
- Move the robot(s) to HOME position (see Section 4.2.2).
- Select the Control Master job (see Section 4.2.4).
- Perform the operation cycle (see Section 4.2.5).
- Perform the shutdown procedures (see Section 4.2.6).

4.2.1 Start-up Procedure

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

1. Make sure that the enclosure door is closed and securely latched.
2. Turn on the main service disconnect switch.
3. Set the main power switch on R1 controller to ON.
4. Set the input power switch on the welding power sources to ON.
5. Turn on the welding gas supply.
6. Make sure that the Emergency Stop (E-STOP) buttons on the Programming Pendant and Operator Station are released.
7. Select TEACH mode on the Programming Pendant; the indicator light turns on.
8. Place the robot(s) in HOME position (refer to Section 4.2.2).

4.2.2 Robot HOME Position

To place the robot(s) in HOME position, proceed as follows:

1. Select TEACH mode on the Programming Pendant.
2. Press the MAIN MENU on the Programming Pendant.
3. Select the JOB icon on the pendant using the cursor keys and then press SELECT.
4. Move the cursor on the pendant to SELECT JOB and press SELECT key.
5. Using the pendant’s cursor keys, move the cursor to SAFE job and press SELECT.
6. Turn servo power on by pressing the SERVO ON button on the Programming Pendant and holding in the ENABLE switch.
7. Using the INTERLOCK and FWD buttons on the Programming Pendant, move the robot(s) to HOME position.
4.2.3 Safety Circuit Check

Test each of the following safety circuit items daily for proper operation. If any of these items do not work as instructed, contact the Motoman Customer Support staff at (937) 847-3200 before operating the cell.

4.2.3.1 Gate Interlock

Open gate interlock while robot is in PLAY mode with servo power ON. Verify that servo power goes off.

4.2.3.2 Emergency Stop (E-STOP) Buttons

Press each Emergency Stop (E-STOP) button with the robot in PLAY mode and the servo power on. After each button is pressed, verify that servo power goes off and the Programming Pendant reads “Robot is Stopped.”

4.2.4 Start the Control Master Job

With the system powered up and in TEACH mode, perform the following steps to start the Control Master job:

1. Select the MAIN MENU key on the Programming Pendant’s touch screen.
2. Select JOB on the Programming Pendant’s touch screen.
4. Press SELECT twice to activate the Control Master job.
5. Select PLAY mode on the Programming Pendant and press the PLAY MODE ENABLE button on the controller door. Job playback operation is enabled.
6. Press the SERVO ON button on the Programming Pendant.
7. Press the START button on the Programming Pendant. The Control Master job cycles, waiting for a Cycle Start input from the Operator Station.

The FabWorld® II-Series cell is now ready for operation.

4.2.5 Perform the Operation Cycle

The following is the typical sequence of operation for the FabWorld® II-Series cell after start-up:

1. Load the fixture in Station 1 with parts to be welded.
2. Step out of the safety light curtain.
3. Press the CYCLE START/CYCLE LATCHED button on the Operator Station. The Cycle Latched light comes on, and the robot(s) begins welding parts.
4. While the robot(s) are welding, the operator may load Station 2 with more parts to be welded.
5. After the parts are loaded, press the CYCLE START/CYCLE LATCHED button on Operator Station 2; the Cycle Latched light comes on. When the robot is finished welding at Station 1, it returns to HOME position (or, if Cycle Latched is active at Station 2, the robot begins welding at Station 2), thus allowing the operator to process the parts at Station 1.
6. Unload the welded parts from Station 1.
4.2.6 **Shutdown Procedure**

To shut down the FabWorld® II-Series cell after operation is complete, perform the following steps:

1. Make sure that the robot(s) are in HOME position.
2. Turn off system servo power by pressing the Emergency Stop (E-STOP) button on the Operator Station or Programming Pendant.
3. Select TEACH mode on the Programming Pendant.
4. Set the main service disconnect switch to the OFF position.
5. Close the welding gas supply.

The FabWorld® II-Series cell is now shut down.

4.3 **System Recovery**

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

4.3.1 **Alarms and Errors**

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

- Error messages
- Minor alarms
- Major alarms

For more detailed information on alarm and error recovery, refer to the maintenance and DX100 controller documentation that is included with your FabWorld® II-Series system (see Section 1.3).

4.3.1.1 **Error Messages**

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

4.3.1.2 **Minor Alarms**

Minor alarms are usually programming errors, such as programming a circle with fewer than three circular points. Clear these type of errors by pressing the RESET (F5) soft key on the Programming Pendant.

4.3.1.3 **Major Alarms**

Major alarms are hardware failures. Major alarms might occur because of a servo tracking error or an abnormal speed and are usually associated with crashes. To clear this type of alarm, you must turn off the controller and then turn it on again.
4.3.2 Emergency Stop (E-STOP) Recovery

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

- Pressing the EMERGENCY STOP (E-STOP) button on the Operator Station, Programming Pendant, or controller door.
- Opening the cell door on the robot enclosure when the robot(s) are not in TEACH mode.
- Stepping into the safety light curtain when the positioner is sweeping.
- Actuating the shock sensor on the torch mount.

To restart the FabWorld® II-Series cell after an E-STOP condition occurs, proceed as follows:

1. To clear an E-STOP condition, perform any of the following actions that apply:
   - Release the E-STOP button on the Operator Station or Programming Pendant.
   - Close the cell door.
   - Step out of the safety light curtain.
   - Clear the shock sensor condition (refer to Section 4.3.3).

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

3. Ensure that the robot(s) is in REMOTE mode.

4. Press the START button on the Operator Station.

The FabWorld® II-Series cell is now ready to continue operation.

4.3.3 Shock Sensor Recovery

The FabWorld® II-Series welding package 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 message, which triggers an E-STOP condition. To clear the E-STOP condition, you must override the shock sensor and move the robot(s) clear of the impact. To override the shock sensor, proceed as follows:

1. Press MAIN MENU on the Programming Pendant.

CAUTION

If an Emergency Stop condition occurs while the positioner is sweeping, the positioner will continue the sweep when system is started again.

CAUTION

Always remember to reactivate the Shock Sensor before continuing system operation. The robot can be crashed if the Shock Sensor Override Switch is left in the “Override” position.
2. Select the ROBOT icon using the cursor keys and press the SELECT key.

3. Move the cursor to OVERRUN-S.SENSOR and press the SELECT key.

4. Select RELEASE to release the shock sensor.

5. Turn servo power ON by holding in the ENABLE switch on the Programming Pendant and pressing SERVO ON.

6. Move the robot(s) clear of the impact position.

The FabWorld® II-Series cell is now ready to continue operation.

### 4.3.4 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:

![WARNING]

**WARNING**

Releasing brakes can cause personal injury or machine damage. Make sure that the axis to be released is properly supported before proceeding.

1. On the Programming Pendant, select TEACH mode and turn servo power OFF.

2. Select ROBOT on the Programming Pendant's touch screen.

3. Select the MANUAL BRAKE RELEASE option. A Warning dialog box appears.

4. Select YES in the Warning dialog box.

5. Select the axis to be released using the cursor key.

6. Engage the ENABLE switch and press the INTERLOCK and SELECT keys. The brake for the selected axis releases.
Table 5-1 provides periodic maintenance items and intervals for the FabWorld® II-Series cell. The maintenance intervals listed here are intended as guidelines only. You should adjust the frequency of maintenance to suit your specific work conditions.

For periodic maintenance procedures and schedules for the individual components of your FabWorld® II-Series system, including the MH-series positioners, refer to the manuals that are included with your system (see Section 1.3).

<table>
<thead>
<tr>
<th>Frequency</th>
<th>Component</th>
<th>Procedure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Daily</td>
<td>Water Circulator (water-cooled torch application only)</td>
<td>Check the fluid in the water circulator. Add fluid as required. Use only distilled water and approved antifreeze (Motoman P/N 131224-1).</td>
</tr>
<tr>
<td></td>
<td>Safety Circuits and Interlocks</td>
<td>Validate functionality.</td>
</tr>
<tr>
<td>Monthly (or on condition)</td>
<td>FabWorld® II-Series Cell</td>
<td>Clean the entire cell of dirt, grease, and debris.</td>
</tr>
</tbody>
</table>

**CAUTION**

Use only the antifreeze provided by Motoman. Automotive antifreezes contain stop-leak additives that clog small torch water-cooling ports and damage gaskets in the water circulator pump.
6 Anchoring

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

<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>
<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>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>
<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>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>
<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 or http://ca.hilti.com for further information.