Motoman NX100 Controller

ArcWorld 6000
System Manual

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Chapter 1

Introduction

The ArcWorld 6000 system is part of the ArcWorld family of standardized arc welding solutions. It is a fully integrated welding system, and is supported from wire to weld by Motoman, Inc.

1.1 About This Document

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

SECTION 1 - INTRODUCTION
This section provides general information about the ArcWorld 6000 and its components, a list of reference documents, and customer service information.

SECTION 2 - SAFETY
This section provides information regarding the safe use and operation of the ArcWorld 6000 system.

SECTION 3 - DESCRIPTION OF EQUIPMENT
This section provides a detailed description of the major components of the ArcWorld 6000 system. This section also includes a table of component specifications.

SECTION 4 - INSTALLATION
This section provides instructions for set up and installation of the ArcWorld 6000 system.

SECTION 5 - OPERATION
This section provides instructions for basic operation of the ArcWorld 6000 system. This section also provides procedures for start-up, loading, normal operation, fault recovery, and shutdown. Sample robot programs are also included in this section.

SECTION 6 - MAINTENANCE
This section contains a table listing periodic maintenance requirements for the components of the ArcWorld 6000 cell.
1.2 System Overview

Motoman’s classic ArcWorld 6000 robotic solutions are high-performance, pre-engineered workcells that are ideal for large part fabrication at medium to high volumes. Fully integrated ArcWorld 6000 series workcells feature a dual-station, 180-degree reciprocating positioner with rotating headstock, one high-performance EA-series Motoman robot, an NX100 controller, integrated welding package, operator interface, and total safety environment. Safety features include an interlocked access door, safety fencing, and light curtains.

Figure 1 illustrates the system layout of the ArcWorld 6000 cell.

![System Layout Diagram]

Figure 1 System Layout

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

The robot manipulator and positioner are mounted to a common programming platform. The NX100 controller and welding power source share a common base and are located at the side of the cell. The robotic cell is fully enclosed by safety fencing and an interlocking door. Light curtains provide a safety zone to prevent the positioner from cycling while anyone is standing within the zone. All operator controls, including those on the NX100 controller and welding power supply, are accessible from outside the robotic enclosure.

1.2.2 Major Components

The ArcWorld 6000 includes the following major components:

- A Motoman EA1400N or EA1900N manipulator and NX100 controller
- MRM2-250STX positioner
- Operator station
- Welding equipment, including the following:
  - Welding power source
  - Motoman torch (water-cooled or air-cooled)
  - Wire feeder
  - Applicable welding interface
  - Torch mount
- Safety equipment, including the following:
  - Safety fencing with arc curtains
  - Interlocked light curtains
  - Interlocked cell door
  - Positioner arc screen

1.2.3 Optional Equipment

The following optional equipment is available for use with the ArcWorld 6000:

- Torch tender
- Wire cutter
- Com-Arc III seam tracking unit
- Water circulator
- Touch Sense-Starting Point detection unit
1.3 Reference to Other Documentation

For additional information refer to the following:

- Motoman EA1400N Manipulator Manual (P/N 149209-1)
- Motoman EA1900N Manipulator Manual (P/N 149894-1)
- Motoman NX100 Controller Manual (P/N 149201-1)
- Motoman Operator's Manual for Arc Welding (P/N 149235-1)
- Motoman Concurrent I/O Parameter Manual (P/N 149230-1)
- Motoman MRM2-250 Positioner Manual (PN 137174-1)
- Vendor manuals for system components not manufactured by Motoman

1.4 Customer Service Information

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

- Robot Type (EA1400N, EA1900N)
- Application Type (arc welding)
- System Type (ArcWorld 6000)
- Software Version (access using MAIN MENU, SYSTEM INFO, VERSION on programming pendant)
- Robot Serial Number (located on back side of robot arm)
- Robot Sales Order Number (located on front door of NX100 controller)
Chapter 2

Safety

2.1 Introduction

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

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

**Robotic Industries Association**

900 Victors Way

P.O. Box 3724

Ann Arbor, Michigan 48106

TEL: (734) 994-6088

FAX: (734) 994-3338

INTERNET: www.roboticsonline.com

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

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

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

2.2 Standard Conventions

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

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

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

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

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

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

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

2.4 Mechanical Safety Devices

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

- Safety fences and barriers
- Light curtains and/or safety mats
- Door interlocks
- Emergency stop palm buttons located on operator station, robot controller, and programming pendant

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

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

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

2.6 **Programming, Operation, and Maintenance Safety**

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

- Inspect the robot and work envelope to be sure no potentially hazardous conditions exist. Be sure the area is clean and free of water, oil, debris, etc.
- Be sure that all safeguards are in place. Check all safety equipment for proper operation. Repair or replace any non-functioning safety equipment immediately.
- Do not enter the robot cell while it is in automatic operation. Be sure that only the person holding the programming pendant enters the workcell.
- Check the E-STOP button on the programming pendant for proper operation before programming. The robot must be placed in Emergency Stop (E-STOP) mode whenever it is not in use.
- Back up all programs and jobs onto suitable media before program changes are made. To avoid loss of information, programs, or jobs, a backup must always be made before any service procedures are done and before any changes are made to options, accessories, or equipment.
• Any modifications to PART 1, System Section, of the robot controller concurrent I/O program can cause severe personal injury or death, as well as damage to the robot! Do not make any modifications to PART 1, System Section. Making any changes without the written permission of Motoman will VOID YOUR WARRANTY!

• Some operations require standard passwords and some require special passwords. Special passwords are for Motoman use only. YOUR WARRANTY WILL BE VOID if you use these special passwords.

• The robot controller allows modifications of PART 2, User Section, of the concurrent I/O program and modifications to controller parameters for maximum robot performance. Great care must be taken when making these modifications. All modifications made to the controller will change the way the robot operates and can cause severe personal injury or death, as well as damage the robot and other parts of the system. Double-check all modifications under every mode of robot operation to ensure that you have not created hazards or dangerous situations.

• Check and test any new or modified program at low speed for at least one full cycle.

• This equipment has multiple sources of electrical supply. Electrical interconnections are made between the controller and other equipment. Disconnect and lockout/tagout all electrical circuits before making any modifications or connections.

• Do not perform any maintenance procedures before reading and understanding the proper procedures in the appropriate manual.

• Use proper replacement parts.

• Improper connections can damage the robot. All connections must be made within the standard voltage and current ratings of the robot I/O (Inputs and Outputs).
NOTES
Chapter 3

Equipment Description

3.1 Robot Description

The Motoman six-axis EA1400N and EA1900N “Expert Arc” robots are specifically designed for arc welding applications. The EA1400N has a payload of 3 kg (6.6 lbs.) and features a horizontal reach of 1388-mm (54.6 inch) and a relative positioning accuracy of ±0.08 mm (±0.003 inch). The EA1900N has a payload of 3 kg (6.6 lbs.) and features a horizontal reach of 1904-mm (74.96 inch) and a relative positioning accuracy of ±0.08 mm (±0.003 inch). The EA-series robots have a patented internal cabling design that provides high flexibility and streamlines the robot profile, allowing access into confined spaces. The robot's B-axis features an expanded range of motion which improves circumferential welding on cylindrical work pieces. The T-axis can rotate the torch ±360 degrees without cable interference.

The robots can be mounted on the floor, wall, or ceiling with minor modifications. The S-axis has been restricted by hardstops for use in this system. For more information, refer to the manipulator manual that came with your system.

3.2 NX100 Controller

The NX100 robotic controller, shown in Figure 2, features a Windows® CE programming pendant with color touch screen, high-speed processing, built-in Ethernet, and a robust PC architecture. The NX100 easily handles multiple tasks and can control up to four robots (up to 36 axes, including robots and external axes), and I/O devices. Advanced Robot Motion (ARM) control provides high-performance path accuracy and vibration control.

The NX100 coordinates the operation of the ArcWorld 6000 system. It controls manipulator movement and welding power supply, processes input and output signals, and provides the signals to operate the welding system. It maintains variable data and performs numeric processing to convert to and from different coordinate systems. In addition, the controller provides main logic functions, servo control, program and constant data memory, and power distribution. For more information, refer to the controller manual that came with your system.
3.2.1 Programming Pendant

The programming pendant (see Figure 3) is the primary user interface for the system and features a cross-shaped navigation cursor that reduces teaching time by 30 percent. The pendant has a 6.5-inch full color touch screen display (640 x 480 VGA) and provides a convenient Compact Flash slot for easy memory back-ups. The system uses the INFORM III robot language and a menu-driven interface to simplify operator interaction with the robot.

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

Note: The programming pendant display goes into screen saver mode after a few minutes of inactivity. Press any key to restore screen.
**Figure 3** Programming Pendant

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

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

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

**Emergency Stop (E-STOP)**
Pressing the E-STOP button puts the controller in Emergency Stop and stops all system operation.
Keypad
The user keypad on the programming pendant serves as an input device. The keys are grouped into
different functional sections to simplify operator use.

Status Area
The Status Area shows system status via the following symbols:

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

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

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

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

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

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

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

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

Figure 4 Enable Switch
3.3 Operator Station

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

![Operator Station Diagram]

**Figure 5 Operator Station**

**Cycle Start/Cycle Latched**

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

The green CYCLE START/CYCLE LATCHED button, located on the operator station, initiates a positioner sweep cycle if the robot is in the Safe or Home position (Cube 24). If the CYCLE START/CYCLE LATCHED button is pressed while the robot is outside Cube 24, the CYCLE START command is latched into the controller. Once the robot returns to Cube 24 and Output #1 is on, the CYCLE START command is executed and the positioner sweeps. A pulse instruction prevents the operator from holding the button down and continuously cycling the positioner.

**Emergency Stop (E-STOP)**

Pressing an E-STOP button or interrupting a door interlock stops all system operation. The operator station E-STOP, the robot E-STOP, and the sliding door interlocks are connected to a safety PLC and the Emergency Stop circuit. Brakes are applied to the robot and all servo power is removed from the system. The system E-STOP lights come on and all positioner motion is stopped.

**Robot Hold**

The ROBOT HOLD button is a normally closed, momentarily actuated switch. Pressing ROBOT HOLD stops the operation of the manipulator until another START signal is sent. The indicator light stays ON only while the ROBOT HOLD button is pressed. Operation resumes at the point in the program where the ROBOT HOLD state was initiated. Refer to the manipulator manual for more information.

**Alarm**

The ALARM lamp is connected to the robot SERVO ON and ALARM OCCURRENCE outputs. The ALARM lamp lights red when the robot encounters an alarm condition or when servo power is cut.
**Positioner Auto/Manual**
The POSITIONER AUTO/MANUAL selector switch is used to select AUTOMATIC or MANUAL mode for the positioner. The selector switch is connected to robot Input #2. When the selector switch is in the AUTOMATIC position, the robot processes the part after the positioner sweeps. In MANUAL mode, the robot does not process the part after the positioner sweeps, but remains in the Safe position.

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

**Start**
The START button is connected to the robot external start input. The robot will start the current active job when START is pressed. The operator station must be enabled and servo power ON for the START button to work.

**Reset**
The RESET button is connected to the robot alarm reset input. A minor alarm or error condition is cleared when this button is pressed. The positioner only needs to be reset after initial power-up and after an emergency stop while in Play mode.

*Note: Resetting the positioner may cause some positioner motion. You must be careful when you reset the positioner with the robot close to tooling. If an Emergency Stop occurs during programming, be sure to reset the positioner before resuming programming.*

**Servo On**
The SERVO-ON pushbutton turns servo power ON. In TEACH mode, the SERVO ON pushbutton operates only when the ENABLE switch on the programming pendant is held in.
3.4 MRM2-Series Positioners

The ArcWorld 6000 cell uses the MRM2-250STX positioner. The MRM2-250STX is AC-servomotor controlled by the NX100 to provide coordinated motion. Standard distance between headstock and tailstock faceplates on the MRM2-250STX is 2600 mm.

Refer to Table 1 for specifications for the MRM2-250STX positioner. The patented servomotor is used to sweep the positioner workstations into and out of the robot envelope, and also to rotate the weld side of the positioner during welding.

A fixture frame is typically mounted between headstock and tailstock faceplates. Fixtures are either mounted on or integrated into these frames for positioning and clamping of production parts. Pneumatic signals and electrical signals can be run to the fixtures if required. Depending on part(s) size(s)/weights(s) you can mount single, multiple, or a combination of parts to the frame.

The ArcWorld 6000 system is capable of synchronized motion between various components depending on the job configuration. Synchronized components move at the same time during operation. The robot (R1) can be synchronized with the positioner. The ArcWorld 6000 system is also capable of true coordinated motion, where linear, circular, or spline motion can be coordinated between R1 and the positioner. Coordinated motion allows the robot to weld while the positioner rotates the parts. For additional information on coordinated motion, refer to the Independent/Coordinated Motion Manual (P/N 149648-1).

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

Table 1 MRM2-250STX Positioner Specifications

<table>
<thead>
<tr>
<th>Conditions</th>
<th>Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Payload</td>
<td>250 kg (1102 lbs) combined part/fixture weight per side</td>
</tr>
<tr>
<td></td>
<td>500 kg (2204 lbs) total</td>
</tr>
<tr>
<td>Index Time</td>
<td>4 seconds</td>
</tr>
<tr>
<td>Load height</td>
<td>975 mm (38 inches)</td>
</tr>
<tr>
<td>Programming Height</td>
<td>1171 mm (46 inches)</td>
</tr>
<tr>
<td>Maximum Fixture Diameter</td>
<td>1170 mm (46 inches)</td>
</tr>
<tr>
<td>Standard Fixture Length</td>
<td>2600 mm (102 inches)</td>
</tr>
<tr>
<td>Tooling Axis Weld Ground Capacity</td>
<td>700 amperes at 100% duty cycle</td>
</tr>
</tbody>
</table>
3.4.1  **Welding Ground System**

The welding ground system consists of a spring-loaded copper brush that contacts the large gear inside the positioner gear housing. The ground cable to the welding power source is connected to the ground stud located on the right side of the positioner base as you face the back of the ArcWorld 6000 cell.

*Note: The connection ground cable between to the insulated ground bar must be tight. If the connection is loose, arcing can occur and cause the insulator to melt.*

3.4.2  **Locking Pins**

The MRM2-series positioners are equipped with fixture locking pins that prevent the headstock/tailstock faceplates from turning when the servo motor retracts. The fixture locking pins are spring loaded, so when the servo motor withdraws, the pins engage. Each headstock faceplate on the MRM2-series positioners has two locking pins.

3.4.3  **Arc Shield**

**WARNING!**

*Do not operate this equipment unless the arc screen is in place or eye damage can occur!*

The MRM2-series positioners are equipped with a sheet metal screen that runs the length of the positioner table and visually separates the loading zone from the welding zone. This screen acts as a shield to protect the operator from the arc radiation and sparks produced by the welding operation. Do not operate this equipment unless the arc screen is in place.

3.5  **Welding Equipment**

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

3.5.1  **Wire Feeder**

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

3.5.2  **GMAW Torch**

The ArcWorld system uses either an air-cooled or a water-cooled robotic/automatic GMAW torch. These are heavy-duty torches designed for quick replacement and minimum robot reprogramming. The GMAW torch is installed at the end of the robot wrist. For applications that use the water-cooled torch, the ArcWorld system includes a water circulator kit.
3.5.3 Power Sources

Motoman offers several different power sources for use with the ArcWorld 6000 system, depending on the system’s application. Figure 6 shows some of the more common power sources used. However, the power source your system uses may be different. For more specific information, refer to the vendor manual that came with your system.

Figure 6 Available Power Sources
3.6 Safety Features

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

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

3.6.1 Arc Screens

WARNING!
Although the arc curtain blocks dangerous arc radiation, never look directly at the arc without protective eye wear!

Two arc screens are used on the ArcWorld system. The first is an arc screen on the positioner. This screen blocks arc radiation and spark from the welding operation.

The material used to cover the safety fencing of the entire robotic cell acts as the second arc screen. This material reduces the amount of ultra-violet radiation that escapes from the robotic cell.

3.6.2 Fencing

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

3.6.3 Safety Light Curtains

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

3.6.4 Emergency Stops (E-STOPS)

In addition to the safety features described above, the ArcWorld 6000 has strategically placed E-STOPS. These are operator-actuated devices that, when activated, immediately stop all system operation. Brakes are applied to the robot and all servo power is removed from the system. The following is a list of E-STOP locations:

- The controller door
- The programming pendant
- The operator station
3.6.5 **ENABLE Switch**

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

3.6.6 **Brake Release**

The robot brakes are designed to protect the robot and other system components from damage in event of a system or robot failure. The brake release is a safety feature that allows the operator to release the brake of a specific robot axis when drive power has been removed from the system. Use the programming pendant to access the brake release function. Refer to paragraph 5.3.4 for brake release procedures.

3.6.7 **Interlocked Cell Door**

A safety interlock on the cell entrance door prevents entry into the cell during PLAY mode. If the cell door is opened when the robot is in PLAY mode, brakes are applied to the robot, all servo power is removed from the system, and all positioner motion is stopped.
Chapter 4
Installation

The ArcWorld 6000 system can be installed easily in just a short amount of time. Follow established safety procedures at all times throughout the installation process. Failure to use safe work practices can result in damage to the equipment and injury to the workers.

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

4.1 Materials Required

All hardware necessary for installing the ArcWorld 6000 is included with the system. This section identifies customer-supplied items and tools required to complete installation.

4.1.1 Customer-Supplied Items

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

4.1.2 List of Tools

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

To prepare your site, proceed as follows:

1. Clear floor space needed for unit (see Figure 7).

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

\[\text{Figure 7 Area Needed for Installation}\]

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

4.3 Installing the Positioner

WARNING!
The positioner weighs 2000 kg (4400 lbs), make sure the lifting device used to move these objects are capable of safely handling this much weight.

1. Unbolt positioner from the shipping skid using a 3/4-inch socket.
2. Using two forklifts, one on each end, place positioner in position according to system drawings.
3. Use supplied hardware to fasten positioner to robot base and both programming platforms.
4. Carefully remove any protective plastic wrapping and inspect positioner for shipping damage.

   Note: If damage is found, notify shipper immediately.

5. Anchor positioner securely in place (refer to Appendix A for anchor requirements).
4.4 Installing the Robot Base

**WARNING!**
The robot base weighs 1380 kg (3042 lbs). 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.

1. Carefully remove protective plastic wrapping from robot base.
2. Inspect robot base for shipping damage.

---

**Note:** If damage is found, notify shipper immediately.

3. Unbolt the base from shipping skid using 3/4 inch socket wrench.
4. Using a forklift, remove the robot base from the wooden shipping skid.
5. Place robot common base in position according to system drawings.

---

**Figure 8** Robot Common Base

6. Anchor robot base securely in place (refer to Appendix A for anchor requirements).
7. Install programming platforms on either side of robot base using supplied hardware.
4.4.1 Removing the Robot Shipping Bracket

CAUTION!
Failure to remove shipping brackets from robot before operating the ArcWorld 6000 may result in damage to the robot drive mechanisms.

A yellow bracket (see Figure 9) prevents the robot from moving during shipping. The bracket secures the lower arm assembly to the S-axis housing. After the robot is in place, remove the shipping bracket.

![Figure 9 Location of Shipping Brackets](image)
4.5 Installing the Fencing

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

1. Unpack fencing components from shipping crate.
2. Inspect fencing components for shipping damage.

\[\text{Note: If damage is found, notify shipper immediately.}\]

3. Verify that the following components are present:
   - Two 1500 mm panels
   - Two 1500 mm panels modified with light curtains
   - Two 1000 mm panels
   - Two 1000 mm removable panels
   - Two 600 mm panels
   - Two 500 mm panels
   - Four 400 mm panels
   - One 1000 mm door panel
   - Seventeen fence posts
   - One modified fence post with door latch

4. Install the right side fence panels to fence posts using hardware provided.
5. Install the left side fence panels to fence posts using hardware provided.

Figure 10  Right Side Fence Installation
6. Anchor fencing securely in place (refer to Appendix A for anchor requirements).

4.6 Installing the Arc Curtains

⚠️ DANGER!
Do not install the arc curtains until 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. Unfold arc curtains and install one curtain on inside of each cell wall section.
4.7 Installing the Safety Light Curtains

4.7.1 Installation

The light curtain components – the sender, receiver, and safety fence – come pre-assembled and fastened inside the cell for shipping.

Unfasten both fences from their shipping position and install. The light curtains are oriented properly with the status lights located near the base of the positioner. Light Curtain Alignment

The sender and receiver must be aligned properly. Refer to the light curtain manufacture’s literature that accompanies the robot cell for exact alignment procedures.

4.7.2 Lagging the Fencing

Once the light curtains have been properly installed onto the fencing, anchor the fence posts to the concrete floor. Check the alignment of the light curtains and adjust as necessary.

4.8 Installing the Controller and Power Source

The controller base contains the two controllers and main service disconnect. The base is shipped on wood blocks. To install the controller base, proceed as follows:

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

**WARNING!**
The controller base weighs 1600 kg (3520 lbs). 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 plastic wrapping and cardboard from controller base.
3. Inspect base components for any shipping damage.

*Note: If damage is found, notify shipper immediately.*

4. Using a forklift, lift the controller base and remove both wood blocks.
5. Using the system drawings, place the controller base next to the robot common base closest to the positioner headstock.
4.9 Connecting the Cables

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

4.9.1 Connecting the Earth Ground

Each robot and NX100 controller must each be connected to an earth ground. A ground stake may be driven a minimum of 2.43 m (8 ft) into the earth, and the earth must be treated with chemicals in order to reduce resistance to the ground stake. Deeper ground stakes may be required depending on area soil conditions. A maximum of 100 ohms ground resistance is recommended. To ground the robots and controller, proceed as follows:

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

**Note:** If the robot and the NX100 controller are within 4.57 m (15 ft) of each other, a common earth ground may be used. Otherwise, separate earth grounds must be used.

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

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

Note: The right side of the NX100 controller is on your right as you are facing the front of it.

1. Unpack programming pendant and plug connector into receptacle on front door of controller.
2. Unpack two large black manipulator cables and route to controller and back of robot.
3. Carefully engaging connectors, connect one end of each cable (labeled 1BC and 2BC) to 1BC and 2BC connections on back of robot (see Figure 13). Connect other ends of 1BC and 2BC cables to the 1BC and 2BC connections on side of controller.

![Figure 13 Connecting Robot to NX100 Controller]

4.10 Connecting the Power

After all of the system components have been properly installed, connect the power to the ArcWorld 6000 as follows:

**DANGER!**

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

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

Note: The ArcWorld 6000 is configured for 3-phase 460/480V AC, unless other voltage was requested. If other voltage is required for your plant, you must make the necessary modifications to the transformer. For more information, refer to the electrical diagrams that came with your system.

### Table 2  Incoming Power Specifications (Decal)

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

### 4.11 Conducting a Safety/Operation Check

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

1. Check that the yellow shipping bracket has been removed from the robot (see Section 4.3.1).
2. Be sure there is a clearance of at least 2.5 cm (1 in.) on either side of the positioner.
3. Be sure the safety light curtains are aligned correctly.
4. Check that the cell door is closed and latched.
5. Check that all cable connections are tight.
6. Be sure the welding power source is set correctly (see the welding power source vendor's manual).
7. Verify that incoming line power matches the input power specified on the sticker on the front of the NX100 controller.

Your ArcWorld 6000 is now ready for power-up. The ArcWorld system should be operated only by personnel who have received operator training from Motoman and who are familiar with the operation of this Motoman robot model. Turn the main power ON, and continue the safety/operation check.

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

### 4.12 Installation of Tooling and Fixtures

Your ArcWorld 6000 system is now ready for the installation of tooling and fixtures for your application. Installation of tooling and fixtures should be performed by personnel who are familiar with the operation of this system. Tooling and fixtures are supplied by the customer. After tooling is installed, test the positioner for proper operation.
Notes
Chapter 5
Operation

The ArcWorld 6000 is a fully integrated robotic arc welding cell. The Master job setup, and the
sub-jobs programmed within it, determine how the robot performs the welding operation or other
tasks. The robot welds parts on one side of the 180-degree reciprocating positioner, while the operator
loads or unloads parts on the opposite side. Once the robot is finished with the welding process, it
returns to the Home position. The operator then sweeps the positioner 180 degrees placing the
unwelded parts into the robot work area and the finished parts into the operator area for unloading.

The MRM2-250 STX positioner uses a 180-degree reciprocating motion that sweeps the parts tooling
and fixtures from the operator's loading zone, into the robot's work zone, and back. The positioner
arc shield visually divides the positioner into two separate halves, labeled Side A and Side B. As the
positioner reciprocates, Side A moves under the primary axis and Side B moves over the primary axis.
When Side A is in the robot's welding zone, Side B is facing the operator, ready to be loaded or
unloaded, and vice versa. Additionally, the headstock/tailstock on both Sides A and B rotate, which
provides two welding surfaces per side. Loading fixtures and pneumatic or electric lines can be
attached to the headstock and tailstock on both sides.

5.1 Programming

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

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

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

MANUAL mode allows you to sweep the positioner without activating the robot. Parts can be loaded onto the fixture to achieve the most efficient configuration and then swept into the welding zone, before teaching the robot a series of moves. To sweep Side A or Side B of the positioner into the robot’s welding zone, proceed as follows:

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

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

3. Press the CYCLE START button on operator station. Positioner sweeps each time the CYCLE START button is pressed.

5.2 Daily Operation

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

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

5.2.1 Start-Up

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

1. Set MAIN POWER switch on NX100 controller to ON.
2. Set INPUT POWER switch on welding power source to ON; power source pilot light turns on.
3. Open regulator valve on welding gas supply.
4. Make sure the enclosure doors are closed and the safety plug is connected.
5. Make sure E-STOP buttons on programming pendant, controller door, and operator station are released.
6. Select TEACH mode on programming pendant.
7. Place robot in Home position.
5.2.2  **Robot Home Position**

To move the robot to the Home position:

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

5.2.3  **Starting the Master Job**

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

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

The ArcWorld 6000 cell is now ready for operation.
5.2.4 **Perform Operation Cycle**

The following is the typical sequence of operation for the ArcWorld 6000 cell after start-up:

1. Load fixture on operator side of positioner table with parts to be welded.
2. Step out of safety light curtain.
3. Press the CYCLE START button on operator station. The positioner sweeps, placing unwelded parts in robot work area. The robot then begins welding parts.
4. While robot is welding, load operator side.
5. When parts are loaded, press the CYCLE START button on operator station; CYCLE LATCHED light comes on. When robot is finished welding, it returns to Home position and the positioner sweeps, returning welded parts outside cell and placing newly loaded, unwelded parts in robot work area.
6. Unload welded parts from the fixture.

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

5.2.5 **Shutdown**

Use the following procedure to shut down the ArcWorld 6000 cell after operation is complete:

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

The ArcWorld 6000 cell is now shut down.
5.3 System Recovery

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

5.3.1 Alarms and Errors

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

5.3.1.1 Error Messages

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

5.3.1.2 Minor Alarms

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

5.3.1.3 Major Alarms

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

5.3.2 E-STOP Recovery

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

- Pressing E-STOP button on the operator station, programming pendant, or controller door.
- Opening the cell door on robot enclosure when robot is not in TEACH mode.
- Stepping into light curtain when positioner is sweeping.
- Actuating shock sensor on torch mount.

To restart the ArcWorld 6000 cell after an E-STOP condition occurs, follow the procedure below.

1. To clear E-STOP condition, perform any of the following actions that apply:
   - Release E-STOP button on operator station, programming pendant, or controller door.
   - Close cell door.
   - Step out of safety curtain.
   - Clear Shock Sensor condition (refer to Section 5.3.3).
CAUTION!

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

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

The ArcWorld 6000 cell is now ready to continue operation.

5.3.3 Shock Sensor Recovery

The ArcWorld 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 clear of the impact. To override the shock sensor, proceed as follows:

1. Select MAIN MENU on programming pendant touch screen.
2. Select ROBOT on programming pendant touch screen.
3. Select OVERRUN-SENSOR on programming pendant touch screen.
4. Select RELEASE to release shock sensor.
5. Turn servo power ON by holding ENABLE switch on the programming pendant and pressing SERVO ON READY.
6. Move the robot clear of impact position.

The ArcWorld 6000 cell is now ready to continue operation.

5.3.4 Brake Release

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

WARNING!

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

1. On the programming pendant, select TEACH mode and turn servo power OFF.
2. Select ROBOT on the programming pendant touch screen.
3. Select the MANUAL BRAKE RELEASE option.
4. A Warning dialog appears. 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.
7. The brake for the selected axis releases.
Chapter 6
Maintenance

Table 3 provides periodic maintenance items and intervals for the ArcWorld 6000 cell. Keep in mind that the maintenance intervals serve as guidelines only. You should adjust the frequency of maintenance to suit your specific work conditions.

For periodic maintenance procedures and schedules for individual components of your ArcWorld 6000 cell, including the positioner, refer to the additional manuals that came with your system.

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

<table>
<thead>
<tr>
<th>Frequency</th>
<th>Component</th>
<th>Procedure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Daily</td>
<td>Water Circulator</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>(Water-cooled Torch Application only)</td>
<td></td>
</tr>
<tr>
<td>Monthly or as needed</td>
<td>ArcWorld Cell</td>
<td>Clean entire cell of dirt, grease and debris.</td>
</tr>
</tbody>
</table>

H=Hours of operation
Appendix A

Anchor Requirements

It is the purchaser's responsibility to determine and supply all anchoring and foundation requirements for their installation. Before installing your ArcWorld 6000 cell, refer to Table 16 to determine the anchor and foundation requirements for all the equipment used in your cell.

⚠️ WARNING!
Do not mount robots directly to the floor without the indicated floor plate. Failure to follow floor plate requirements can result in severe damage or personal injury.

Table 4 Minimum Recommended Equipment Anchor Requirements

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Minimum &quot;Hilti&quot; Anchor Rod Diameter and Type</th>
<th>Minimum Floor Plate Requirements</th>
<th>Minimum Foundation Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Robots: UP6, UP20, UP20-6, E1A400, E1A900</td>
<td>(4) 5/8&quot; HVA Chemical Style anchor (See Note 3)</td>
<td>600 x 600 x 38.1</td>
<td>30&quot; x 30&quot; x 7&quot; thick, 4000 psi Reinforced Concrete</td>
</tr>
<tr>
<td>Robots: UP20M, UP50, SP80 (See Note 2)</td>
<td>(4) 7/8&quot; HVA Chemical Style anchor (See Note 3)</td>
<td>900 x 900 x 50.8</td>
<td>60&quot; x 60&quot; x 9&quot; thick, 4000 psi Reinforced Concrete</td>
</tr>
<tr>
<td>Robots: UP120, UP130, UP165, SP100, SP160, SP250, SP400 (See Note 2)</td>
<td>(4) 7/8&quot; HVA Chemical Style anchor (See Note 3)</td>
<td>1200 x 1200 x 50.8</td>
<td>72&quot; x 72&quot; x 9&quot; thick, 4000 psi Reinforced Concrete</td>
</tr>
<tr>
<td>Robots: UP200</td>
<td>(8) 7/8&quot; HVA Chemical Style anchor (See Note 3)</td>
<td>1200 x 1200 x 50.8</td>
<td>72&quot; x 72&quot; x 9&quot; thick, 4000 psi Reinforced Concrete</td>
</tr>
<tr>
<td>Robots: UP350, UP500, SK300X</td>
<td>(8) 7/8&quot; HVA Chemical Style anchor (See Note 3)</td>
<td>1500 x 1500 x 50.8</td>
<td>72&quot; x 72&quot; x 9&quot; thick, 4000 psi Reinforced Concrete</td>
</tr>
<tr>
<td>Rotary Turntable Positioners:</td>
<td>5/8&quot; HVA Chemical Style anchor (See Note 3)</td>
<td>Not Applicable</td>
<td></td>
</tr>
</tbody>
</table>
Table 4  Minimum Recommended Equipment Anchor Requirements

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Minimum &quot;Hilti&quot; Anchor Rod Diameter and Type</th>
<th>Minimum Floor Plate Requirements</th>
<th>Minimum Foundation Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trunion Style Positioners:</td>
<td>7/8&quot; HVA Chemical Style anchor (See Note 3)</td>
<td>Not Applicable</td>
<td></td>
</tr>
<tr>
<td>Peripheral Equipment:</td>
<td>1/2&quot; Kwik Bolt II Style anchor (See Note 4)</td>
<td>Not Applicable</td>
<td>3&quot; min Thick or 1.3 Embedment Depth (whichever is larger), 4000 psi Reinforced Concrete</td>
</tr>
<tr>
<td>Cell Fence Posts:</td>
<td>3/8&quot; Kwik Bolt II Style anchor (See Note 4)</td>
<td>Not Applicable</td>
<td>3&quot; min Thick or 1.3 Embedment Depth (whichever is larger), 4000 psi Reinforced Concrete</td>
</tr>
</tbody>
</table>

Note: (1) Minimum Robot Lagging Requirements are based on Maximum Repulsion Forces and Hilti Anchor Design Program V3.3b. (2) SP series robots require base plates and/or risers to be level within 2 degrees. Grout if necessary. (3) Reference source: Hilti Product Technical Guide Section 4.2.1 for hardware specifications or equivalent. (4) Reference source: Hilti Product Technical Guide Section 4.3.3 for hardware specifications or equivalent. (5) Robot manual requirements calling for cast-in anchors may be substituted with the recommendations listed. See also us.hilti.com or ca.hilti.com for further information.
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