Motoman NX100 Controller
ArcWorld® III-1000 System Manual
MSR-500 SIGMA III Positioner
SSA2000 Manipulator

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Chapter 1

Introduction

1.1 About This Document

This System Manual provides coverage of the Motoman ArcWorld® III-1000 Robotic Welding System and is organized as follows –

CHAPTER 1 - INTRODUCTION
This chapter provides a brief ArcWorld® III-1000 system overview, a list of reference documents, and Motoman Customer Support contact information.

CHAPTER 2 - SAFETY
This chapter provides information regarding the safe use and operation of the ArcWorld® III-1000 system.

CHAPTER 3 - EQUIPMENT DESCRIPTION
This chapter provides a detailed description of ArcWorld® III-1000 major components.

CHAPTER 4 - INSTALLATION
This chapter provides positioning, setup, and installation instructions for the ArcWorld® III-1000 system.

CHAPTER 5 - OPERATION
This chapter provides basic operating procedures for the ArcWorld® III-1000 system.

CHAPTER 6 - MAINTENANCE
This chapter lists suggested periodic / preventive maintenance procedures and schedules for ArcWorld® III-1000 system components.

APPENDIX A - ANCHORING
This appendix gives foundation and anchoring suggestions for ArcWorld® III-1000 system components.
1.2 System Overview

The Motoman ArcWorld® III-1000 Robotic Welding System is a pre-engineered, fully integrated robotic work cell that is designed and constructed for large part fabrication at medium to high volumes. The ArcWorld® III-1000 Robotic Welding System features an MSR-500 Sigma III positioner; one Motoman SSA2000 manipulator (robot); one NX100 controller; an integrated welding package; and one Operator Station. Safety features include load station(s) interlocked with dual-channel safeguards, an interlocked access door on each side of the work cell, safety fencing, and a safety light curtain system.

Figure 1 illustrates system layout and component locations for the ArcWorld® III-1000 Robotic Welding System.

Figure 1  Layout and Component Location — ArcWorld III-1000 Robotic Work Cell

1.2.1 System Layout

The SSA2000 robot and the MSR-500 Sigma-III positioner are mounted to a positioner/robot base (see Figure 11). The ArcWorld® III-1000 work cell is fully enclosed by safety fencing and a safety-interlocked access door on each side of the work cell. Light curtains provide a safety zone to prevent the positioner from cycling while personnel or objects are located within the zone protected by the light curtain system. All operator controls, including those on the NX100 controller and weld power source, are accessible from outside the work cell enclosure.
1.2.2 **Major Components**

The ArcWorld® III-1000 system includes the following major components –

- SSA2000 Manipulator (robot)
- NX100 Controller (with Programming Pendant)
- MSR-500 Sigma-III Rotary Positioner
- Operator Station
- Welding Equipment –
  - Welding power source
  - Welding torch (water-cooled or air-cooled)
  - Welding wire feeder
  - Welding interface
  - Welding torch mount
- Safety Equipment –
  - Safety fencing with arc curtains
  - Safety light curtain system
  - Interlocked work cell access doors
  - Positioner arc screen

1.2.3 **Optional Equipment**

The following optional equipment is available for use with the ArcWorld® III-1000 system –

- Torch tender
- Wire cutter
- Com-Arc III seam tracking unit
- Water-cooled torch assembly (with water cooler/circulator)
- Touch Sense-Starting Point detection unit

1.3 **Reference Documentation**

For additional information, refer to the following documentation –

- Motoman *SSA2000 Manipulator Manual* (P/N 153599-1)
- 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 *MSR-Series Positioner Manual* (P/N 152988-1)
- *Vendor Manuals / Instruction Sheets* for ArcWorld® III-1000 system components not manufactured by Motoman, but supplied with your system.
1.4 Customer Support Information

If you need assistance with any aspect of your ArcWorld® III-1000 system, please contact Motoman Customer Support at the following 24-hour telephone number –

937. 847. 3200

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

techsupport@motoman.com

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

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

Please have the following information ready before you call –

- SYSTEM ArcWorld® III-1000
- POSITIONER MSR-500 Sigma-III
- ROBOT SSA2000
- CONTROLLER NX100
- SOFTWARE VERSION Access this information on the Programming Pendant LCD display screen by accessing MAIN MENU ➔ SYSTEM INFO ➔ VERSION
- ROBOT SERIAL NUMBER Located on robot data plate
- ROBOT SALES NUMBER Located on NX100 controller data plate
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 (ANSI/RIA R15.06-1999). You can obtain this document from the Robotic Industries Association (RIA) at the following address:

RoboticIndustriesAssociation
900VictorsWay
P.O.Box3724
AnnArbor,Michigan48106
TEL:(734)994-6088
FAX:(734)994-3338
www.roboticsonline.com

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

We recommend approved Motoman training courses for all personnel involved with the operation, programming, or repair of the robot system. This training is designed to familiarize personnel with the safe and correct operation of the robot 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 Important Advisory Information

Throughout this manual you will find advisory paragraphs (denoted by graphic symbols and bold typeface). All of these (except “NOTE”) direct the reader’s attention to information and procedures that are essential to the safety of personnel or protection of equipment.

The type of information contained in the various advisories is described below. These are listed here in descending order of importance to the safety of personnel and protection of equipment.

**DANGER!**
Information appearing under the DANGER caption concerns the protection of personnel from an 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 under the WARNING caption 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 under the CAUTION caption 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 caption provides additional information that can be 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).
Chapter 3

Equipment Description

3.1 Robot Description

The Motoman six-axis SSA2000 robot is specifically designed for arc welding applications. The robot payload is 3 kg and it features a reach of 1390 mm and a repeatability accuracy of ±0.08 mm. The SSA2000 robot incorporates a patented “through-the-arm” 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 that improves circumferential welding on cylindrical work pieces. The T-axis can rotate the torch ±360 degrees without cable interference.

The robot can be mounted on the floor, wall, or ceiling with minor modifications. Rotation of the S-axis is restricted by hardstops for use in this system.

For additional information on the Motoman SSA2000 robot, please refer to the SSA2000 Manipulator Manual that is included with your ArcWorld® III-1000 documentation package (refer to Section 1.3).

3.2 NX100 Controller

The NX100 robotic controller (see Figure 3) 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® III-1000 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 additional information on the Motoman NX100 controller, please refer to the NX100 Controller Manual that is included with your ArcWorld® III-1000 documentation package (refer to Section 1.3).
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 in. color touch screen display (640 x 480 VGA) and provides a CompactFlash card slot for data back-ups. The system uses the INFORM III 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 control cabinet to be mounted remotely. By using the pendant, the operator can teach robot motion, and perform programming, editing, maintenance, and diagnostic functions. For additional information, refer to the NX100 Controller Manual that is included in the ArcWorld® III-1000 documentation package (refer to Section 1.3)
Figure 3 Programming Pendant

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

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 Programming 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 at the left rear of the Programming Pendant. It is a safety feature that controls servo power while the system is in TEACH mode. When pressed in (first “CLICK”), servo power is enabled. Should the operator release the ENABLE switch or grasp it too tightly, servo power is immediately removed, thus 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 on a stand-alone pedestal. 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 Home position. If the CYCLE START button is pressed while the robot is outside Home position, the CYCLE START command does not execute and the positioner does not sweep until the robot returns to Home position.

The CYCLE LATCHED lamp illuminates when the CYCLE START button is pressed during operation. When the lamp is illuminated, the positioner will sweep and the robot will begin to weld immediately after the current weld cycle is complete. It is not necessary to wait for the robot to finish welding and return to Home position before pressing the CYCLE START button to sweep the positioner. Pressing the CYCLE START button while the robot is still in motion latches the CYCLE START command into the controller. If a person enters the safety zone created by the light curtains, the CYCLE START command will unlatch and the positioner will not sweep.

**Emergency Stop (E-Stop)**

Pressing an E-Stop button removes servo power and stops all system operation. Brakes are applied to the robot and all positioner motion is stopped.

**Robot Hold**

Pressing ROBOT HOLD stops robot operation and interrupts the job until the operator presses the START button to resume operation. Operation resumes at the point in the program where the ROBOT HOLD state was initiated. Refer to the operator’s manual for more information.

**Alarm**

The ALARM lamp lights red when the controller encounters an alarm condition.
**Positioner Auto/Manual**
The POSITIONER AUTO/MANUAL selector switch is used to select AUTOMATIC or MANUAL mode for the positioner. 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 Home position.

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

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

**Operator Station Enable/Disable**
The OPERATOR STATION ENABLE/DISABLE selector switch allows the operator to transfer system control from the Operator Station to the Programming Pendant, and visa versa. When the Operator Station is disabled, the Programming Pendant controls system operation. When the Operator Station is enabled, control of the system is transferred to the Operator Station.

**Reset**
Pressing the RESET button clears a minor alarm or error condition.

**Servo On**
The SERVO-ON push button turns servo power ON when the robot is in PLAY mode and the Operator Station is enabled.

### 3.4 MSR-500 Sigma III Positioner

The MSR-500 Sigma III positioner uses a reciprocating motion to sweep each side of the circular turntable from the operator’s loading zone, into the robot’s work zone, and back to the operator again. An arc screen divides the positioner into two semicircular work areas labelled Side A and Side B. This screen acts as a shield to protect the operator from the arc radiation and sparks produced by the welding operation. Do not operate this equipment unless the arc screen is in place.

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

When the positioner’s Side A is in the robot’s welding zone, Side B is facing the operator and ready to be loaded or unloaded with parts, and vice versa. For detailed positioner information, specifications, and an Illustrated Parts Lists, please refer to the MSR-Series Positioner Manual, that is included in the ArcWorld® III-1000 documentation package (refer to Section 1.3).

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

Motoman offers several different power sources for use with the ArcWorld® III-1000 system, depending on the customer’s specific application. For additional information, refer to the Weld Power Source vendor manual that is included with the ArcWorld® III-1000 documentation package (refer to Section 1.3).

3.5.2 **Wire Feeder**

The wire feeder mounts on the robot arm. This 4-roll wire feeder provides reliable wire feeding at rates up to 750 in. 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.

3.5.3 **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.

3.6 **Safety Features**

The ArcWorld® III-1000 system includes a total safety environment. When all standard safety precautions are observed, the safety equipment helps to ensure safe operation of the robotic work cell. The ANSI/RIA R15.06-1999 Robot Safety Standard stipulates that the user is responsible for safeguarding.

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

Two types of arc screen are part of the ArcWorld® III-1000 system –

1. The positioner arc screen. This steel screen protects the operator by blocking ultraviolet radiation, sparks, and other welding by-products that result from the welding operation.

2. Safety fence covering. The orange-colored sheeting that covers the safety fence composes the second arc screen. This material reduces the amount of ultraviolet radiation that escapes the ArcWorld® III-1000 work cell during welding operations.

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 Stop (E-Stop)

In addition to the safety features described above, the ArcWorld® III-1000 system has strategically placed E-Stop push buttons. These are operator-actuated devices that will immediately stop all system operation when activated. Brakes are applied to the robot and all servo power is removed from the system.

The following is a list of E-Stop push button locations –

- The NX100 controller access door
- The Programming Pendant
- The Operator Station

Refer to Section 5.3.2 for E-Stop recovery procedures.
3.6.5 **ENABLE Switch**

The ENABLE switch is a safety feature which controls servo power while the system is in TEACH mode (see Figure 4). 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 *NX100 Controller Manual* that is included with the ArcWorld® III-1000 documentation package (refer to Section 1.3).

3.6.6 **Robot Braking System**

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 Section 5.3.4 for brake release procedures.

3.6.7 **Interlocked Work Cell Access Doors**

A safety interlock on each of the ArcWorld® III-1000 work cell access doors prevents entry into the work cell during PLAY mode. Opening either work cell door while the ArcWorld® III-1000 system is in PLAY mode, immediately triggers an E-Stop condition. Brakes are applied to the robot, all servo power is disabled, and all positioner motion is stopped. To continue operation of the ArcWorld® III-1000 system, the operator must reset these safety interlocks. Refer to Section 3.6.4 for E-Stop reset procedures. Refer to Section 3.6.6 for Robot Braking System release procedures.
CAUTION!
The ArcWorld® III-1000 system should be installed by qualified personnel who are familiar with the installation and set-up of a robotic system.

CAUTION!
Installation of the ArcWorld® III-1000 system is not a task for the novice. The ArcWorld® III-1000 system is not fragile, but it is a highly sophisticated robotic system. Handle components with care. Rough handling can damage system electronic components.

The ArcWorld® III-1000 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.

4.1 Materials Required

All hardware necessary for installing the ArcWorld® III-1000 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
- Two earth ground cables with two earth ground stakes
- Weld wire
- Clean, dry air supply (for torch tender or wire cutter options) -
  - Flow Rate 0.04 m³/minute (15 cfm)
  - Pressure 620 kPa, gage (90 psi, gage)
- Stepladder
- Forklift and/or overhead crane
- Appropriate hand tools
4.1.2 List of Tools

- Safety glasses
- Face shields
- Gloves
- Level
- Ratchet with 3/4-in. 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-in. 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 6).

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

   ![Figure 6 Area Needed for Installation](image)

2. Gather all customer-supplied items and required tools listed in Section 4.1.
4.3 Installing the Robot/Positioner Base

The robot/positioner base and Operator Station are shipped on shipping skid. To install the robot/positioner base, proceed as follows:

1. Unbolt the robot/positioner base from shipping skid using a 3/4 in. socket wrench (see Figure 7).

![Figure 7 Unbolting the Robot/Positioner Base]

**WARNING!**
The robot/positioner base weighs 2200 kg. Be sure that your crane is capable of handling this weight or damage to the equipment or injury to personnel can result.

2. Using an overhead crane, remove base from shipping skid.
3. Place robot/positioner base in position.

**Note:** Make sure there is adequate room on all sides of the robot/positioner base for the Operator Station, the light curtains, and the auxiliary equipment common base.

4. Carefully remove protective plastic wrapping from robot, torch, and positioner.
5. Inspect robot, torch, and positioner for shipping damage.

**Note:** Notify your shipping contractor if you notice any shipping damage.

6. Remove Operator Station from skid and set safely aside.
4.3.1 Removing the Shipping Bracket

**CAUTION!**
Failure to remove shipping brackets from robot before operating the ArcWorld® III-1000 may result in damage to the robot drive mechanisms.

A yellow bracket (see Figure 8) 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 8 Location of Shipping Brackets](image)

4.4 Installing the Safety Light Curtains

4.4.1 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. Use the three bolt holes (see Figure 9) located on the fence posts to mount the light curtain/fence assemblies onto the fencing. The wiring connections are tucked underneath the positioner base. Pull those wires out and match them with the connectors from the light curtains.
4.4.2 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.

4.4.3 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.

4.5 Installing the Common Equipment Base

The common equipment base contains the NX100 controller and the welding power source with disconnect. It may also include the optional water circulator and/or the Com-Arc III. The common equipment base is shipped on a separate shipping skid. The accessories box is secured to the top of the welding power source. To install the common equipment base, proceed as follows:

1. Unbolt the common equipment base from shipping skid by removing the four shipping bolts using a 3/4-in. deep well socket (see Figure 10).

**WARNING!**
The common equipment base can weigh as much as 600 kg. 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. Using a forklift, lift base and remove from shipping skid.

3. Place common equipment base approximately 0.6 m behind ArcWorld® III-1000 cell (see Figure 10).
4. Carefully remove protective plastic wrapping and cardboard from the common equipment base.
5. Remove accessories boxes from welding power source and set safely aside.
6. Inspect common equipment base components for shipping damage.

*Note: Notify your shipping contractor if you notice any shipping damage.*

![Diagram of Common Equipment Base]

**Figure 10** Location of the Common Equipment Base

### 4.6 Installing the Operator Station

To install the Operator Station, proceed as follows:

1. Unload Operator Station.
2. Carefully remove protective plastic wrapping from Operator Station.
3. Inspect Operator Station for shipping damage.

*Note: Notify your shipping contractor if you notice any shipping damage.*

4. Place Operator Station outside fence to front of positioner.
5. Insert 1/4-in. concrete drill bit through center of lag holes in Operator Station and drill holes for lag bolts.
6. Vacuum concrete dust from holes.
7. Lag Operator Station to floor.
4.7 Leveling and Securing the Equipment

After everything is in position, level the equipment and secure it to the floor. To level and secure the equipment, proceed as follows:

1. Level robot/positioner base by adjusting leveling bolts (see Figure 11).
2. Insert a 1/2-in. concrete drill bit through center of leveling bolts and drill holes for lag bolts.
3. Vacuum concrete dust from holes.
4. Lag robot/positioner base to floor.
5. Level common equipment base by adjusting leveling bolts.
6. Insert a 1/2-in. concrete drill bit through center of leveling bolts and drill holes for lag bolts.
7. Vacuum concrete dust from holes.
8. Lag common equipment base to floor.
9. Level common equipment base by adjusting leveling bolts.
10. Insert a 1/2-in. concrete drill bit through center of leveling bolts and drill holes for lag bolts.
11. Lag common equipment base to floor.

![LEVELING BOLT]

Figure 11 Location of Leveling Bolts

4.8 Connecting the Cables

Ensure components are level and securely in place, unwrap cables from 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.

4.8.1 Connecting the Earth Ground

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

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 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.

### 4.8.2 Connecting the Robot Cables

Two cables, 1BC and 2BC, connect the robot to the controller. The 1BC cable provides position feedback from the robot to the controller. 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 12). Connect other ends of 1BC and 2BC cables to the 1BC and 2BC connections on side of controller.

![Figure 12 Connecting Robot to NX100 Controller](image-url)
4.9 Connecting the Power

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

After all of the system components have been properly installed, connect the power to the ArcWorld® III-1000 as follows:

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

*Note: The ArcWorld® III-1000 is configured for 3-phase 460/480V AC, unless the customer requested a different configuration. If a different configuration is required for your plant, you must make the necessary modifications to the transformer. For more information, refer to the electrical diagrams that are included with the ArcWorld® III-1000 documentation package (refer to Section 1.3)*

<table>
<thead>
<tr>
<th>Table 1</th>
<th>Incoming Power Specifications (Decal)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lug Data</td>
<td>60/75°C wire</td>
</tr>
<tr>
<td>Catalog No.</td>
<td>TCAL14</td>
</tr>
<tr>
<td>Wire Size</td>
<td>#14-7 Copper, #12-8 Aluminum</td>
</tr>
<tr>
<td>Torque</td>
<td>#14-7, 4.0 N•m</td>
</tr>
</tbody>
</table>

4.10 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 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.
CAUTION!
The ArcWorld system should be operated by personnel who have received operator training from Motoman and who are familiar with the operation of this Motoman robot model.

Your ArcWorld® III-1000 is now ready for power-up. Turn the main power ON, and continue the safety/operation check.

8. Check all system E-Stops (programming pendant, operator station, controller door).
9. Check system Hold buttons.
10. Check Gate Interlock.

4.11 Installation of Tooling and Fixtures

Your ArcWorld® III-1000 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.
Chapter 5

Operation

The ArcWorld® III-1000 is a fully integrated robotic arc welding cell. The SSA 2000 robot welds on one side of the MSR-500 Sigma III positioner while the operator loads the opposite side with parts. Upon completion of the weld process, the robot returns to a pre-defined HOME (safe) position. The operator then initiates a sweep (rotation) of the positioner, thus enabling the robot to start the weld process on the next part.

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 Motoman Customer Support (see Section 1.4).

5.1.1 Sweeping the MSR-500 Sigma III Positioner

Note: In order to sweep the positioner, the robot must be in the HOME (safe) 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.
Procedure -

1. Place robot in HOME (safe) position (see Section 5.2.2).
2. Set the Operator Station POSITIONER switch to MANUAL mode and start Master Control job (see Section 5.2.3). Normally, robot will not move out of HOME (safe) 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 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 (safe) 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 the System

Procedure -

1. Set MAIN POWER switch on NX100 controller to ON.
2. Turn ON welding power source disconnect.
3. Set INPUT POWER switch on welding power source to ON; power source pilot light turns on.
4. Open regulator valve on welding gas supply.
5. Make sure the enclosure door is closed and the safety plug is connected.
6. Make sure E-Stop buttons on Programming Pendant, controller door, and Operator Station are released.
7. Select TEACH mode on Programming Pendant.
8. Place robot in Home (safe) position.
5.2.2  Move the Robot to HOME (Safe) Position

Procedure -

1. Select TEACH mode on the Programming Pendant.
2. Select MAIN MENU on Programming Pendant touch 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 (safe) position.

5.2.3  Starting the Master Job

Procedure -

1. With the system powered up and in Teach Mode, call up the Master Job.
2. Select MAIN MENU on Programming Pendant touch screen.
5. Select PLAY mode on Programming Pendant and press the PLAY ENABLE button on the controller door. Job playback operation is enabled.
6. Press SERVO ON button on the Programming Pendant.

The ArcWorld® III-1000 cell is now ready for operation.

5.2.4  Perform Operation Cycle

Procedure -

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 parts fixture with additional parts to be welded.
5. After the parts to be welded are attached to the parts fixture, press the CYCLE START button on Operator Station (the CYCLE LATCHED indicator illuminates). After the robot completes the welding process it returns to the Home (safe) position, and the positioner rotates to return the welded parts to the operator side of the positioner to be unloaded. Concurrently, the previously loaded parts to be welded are moved into the robot work area to be welded.

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**

Procedure -

1. Ensure robot is in HOME (safe) 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® III-1000 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 NX100 controller door.
- Opening the ArcWorld® III-1000 work cell access door when the robot is not in TEACH mode.
- Stepping into light curtain when positioner is sweeping.
- Actuating shock sensor on torch mount.

To restart the ArcWorld® III-1000 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).

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® III-1000 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.
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® III-1000 cell is now ready to continue operation.

5.3.4 Brake Release

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

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:

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 BRAKE RELEASE option.
4. Select the control group (R1, S1).
5. Hold down the minus key for the axis to be released (S-, U-) and simultaneously engage the ENABLE switch.
6. The brake for the selected axis will release.
Chapter 6
Maintenance

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

Maintenance of the ArcWorld® III-1000 system and components must be performed by authorized personnel who are familiar with the ArcWorld® III-1000 system. Be sure to read and understand the documentation for a particular component before doing actual repair maintenance or preventive maintenance on that component. Be sure that you understand the maintenance procedures, have the proper tools at hand, and comply with safety precautions given in Chapter 2.

Maintenance intervals given in Table 2 are recommendations, only. Adjust the frequency and level of repair maintenance and preventive maintenance to suit your specific equipment schedules and shop environment.

For periodic maintenance procedures and schedules for the individual components of your ArcWorld® III-1000 system, refer to the documentation package that is included with your system (refer to Section 1.3).

Table 2  Periodic Maintenance

<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

Anchoring

The customer shall determine all anchoring and foundation requirements, and supply the appropriate anchoring hardware and foundation for a particular system installation. Table A.1 gives anchoring and foundation suggestions.

Table A.1  Suggested Anchor, Floor Plate, and Foundation Specifications

<table>
<thead>
<tr>
<th>SYSTEM EQUIPMENT</th>
<th>MINIMUM HILTI® ANCHOR ROD DIA / TYPE</th>
<th>MINIMUM FLOOR PLATE</th>
<th>MINIMUM FOUNDATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>ROBOTS</td>
<td>1/2&quot; HVA Chemical Anchor (Note 3) (Note 5) (Note 6)</td>
<td>380 mm (15 in.) Length 380 mm (15 in.) Width 19 mm (0.7 in.) Thick</td>
<td>381 mm (15.0 in.) Length 381 mm (15.0 in.) Width 76 mm (3.0 in.) Thick 4000 psi Reinforced Concrete</td>
</tr>
<tr>
<td>ROBOTS</td>
<td>5/8&quot; HVA Chemical Anchor (Note 3) (Note 5) (Note 6)</td>
<td>600 mm (24 in.) Length 600 mm (24 in.) Width 38.1 mm (1.5 in.) Thick</td>
<td>762 mm (30.0 in.) Length 762 mm (30.0 in.) Width 178 mm (7.0 in.) Thick 4000 psi Reinforced Concrete</td>
</tr>
<tr>
<td>ROBOTS</td>
<td>5/8&quot; HVA Chemical Anchor (Note 3) (Note 5) (Note 6)</td>
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</tr>
<tr>
<td>ROBOTS</td>
<td>7/8&quot; HVA Chemical Anchor (Note 3) (Note 5) (Note 6)</td>
<td>900 mm (35.4 in.) Length 900 mm (35.4 in.) Width 50.8 mm (2.0 in.) Thick</td>
<td>1524 mm (60.0 in.) Length 1524 mm (60.0 in.) Width 229 mm (9.0 in.) Thick 4000 psi Reinforced Concrete</td>
</tr>
<tr>
<td>ROBOTS</td>
<td>7/8&quot; HVA Chemical Anchor (Note 3) (Note 5) (Note 6)</td>
<td>900 mm (35.4 in.) Length 900 mm (35.4 in.) Width 50.8 mm (2.0 in.) Thick</td>
<td>1524 mm (60.0 in.) Length 1524 mm (60.0 in.) Width 229 mm (9.0 in.) Thick 4000 psi Reinforced Concrete</td>
</tr>
<tr>
<td>ROBOTS</td>
<td>7/8&quot; HVA Chemical Anchor (Note 3) (Note 5) (Note 6)</td>
<td>1200 mm (47.2 in.) Length 1200 mm (47.2 in.) Width 50.8 mm (2.0 in.) Thick</td>
<td>1828 mm (72.0 in.) Length 1828 mm (72.0 in.) Width 229 mm (9.0 in.) Thick 4000 psi Reinforced Concrete</td>
</tr>
</tbody>
</table>
### Table A.1  Suggested Anchor, Floor Plate, and Foundation Specifications (Continued)

<table>
<thead>
<tr>
<th>SYSTEM EQUIPMENT</th>
<th>MINIMUM HILTI® ANCHOR ROD DIA / TYPE</th>
<th>MINIMUM FLOOR PLATE</th>
<th>MINIMUM FOUNDATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>ROBOTS</td>
<td>7/8&quot; HVA Chemical Anchor (Note 3) (Note 5) (Note 6)</td>
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<tr>
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</tr>
<tr>
<td>ROBOTS</td>
<td>7/8&quot; HVA Chemical Anchor (Note 3) (Note 5) (Note 6)</td>
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<td>1828 mm (72.0 in.) Length 1828 mm (72.0 in.) Width 229 mm (9.0 in.) Thick 4000 psi Reinforced Concrete</td>
</tr>
<tr>
<td>ROBOTS</td>
<td>7/8&quot; HVA Chemical Anchor (Note 3) (Note 5) (Note 6)</td>
<td>1500 mm (59.1 in.) Length 1500 mm (59.1 in.) Width 50.8 mm (2.0 in.) Thick</td>
<td>1828 mm (72.0 in.) Length 1828 mm (72.0 in.) Width 229 mm (9.0 in.) Thick 4000 psi Reinforced Concrete</td>
</tr>
<tr>
<td>POSITONER</td>
<td>5/8&quot; HVA Chemical Anchor (Note 3) (Note 6)</td>
<td>Not Applicable</td>
<td>Refer to Applicable Positioner Manual</td>
</tr>
<tr>
<td>POSITONER</td>
<td>7/8&quot; HVA Chemical Anchor (Note 3) (Note 6)</td>
<td>Not Applicable</td>
<td>Refer to Applicable Positioner Manual</td>
</tr>
</tbody>
</table>
Table A.1  Suggested Anchor, Floor Plate, and Foundation Specifications (Continued)

<table>
<thead>
<tr>
<th>SYSTEM EQUIPMENT</th>
<th>MINIMUM HILTI® ANCHOR ROD DIA / TYPE</th>
<th>MINIMUM FLOOR PLATE</th>
<th>MINIMUM FOUNDATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>PERIPHERAL EQUIPMENT</td>
<td>1/2” Kwik Bolt II Expansion Anchor (Note 4) (Note 6)</td>
<td>Not Applicable</td>
<td>3” min 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” Kwik Bolt II Expansion Anchor (Note 4) (Note 6)</td>
<td>Not Applicable</td>
<td>3” min thickness or 1.3 Embedment Depth (whichever is larger), 4000 psi Reinforced Concrete</td>
</tr>
</tbody>
</table>

Notes –

(1) Minimum robot lagging requirements are based on Maximum Repulsion Forces and Hilti® Anchor Design Program (v3.3b).
(2) SP and EPL series robots require base plates and/or risers to be level to ± 2°. 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) Cast-in anchors are specified in some robot manuals. The Hilti® HVA Chemical Anchors listed in this table can be substituted for the cast-in anchors.
(6) Refer to Hilti® Product Technical Guide for suggestions on the correct size and type of drill bit to use with each anchor type.

Contact Information –

1-800-879-8000 (USA)  [http://us.hilti.com](http://us.hilti.com)
1-800-363-4458 (CAN)  [http://ca.hilti.com](http://ca.hilti.com)
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