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Chapter 1

Introduction

1.1 About This Document

This System Manual provides an overview of the complete Motoman® Modular FabWorld® DRC system. For detailed information on any specific system component listed in this document, please refer to the documentation package that is included with your Modular FabWorld® DRC system (refer to Section 1.3).

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

This System Manual contains the following chapters –

CHAPTER 1 – INTRODUCTION
This chapter introduces the Modular FabWorld® DRC System Manual, provides an overview of the Modular FabWorld® DRC system, lists reference documents that are included with the documentation package, and provides Motoman® Customer Support contact information.

CHAPTER 2 – SAFETY
This chapter provides general information regarding the safe installation, maintenance, and operation of the Modular FabWorld® DRC system.

CHAPTER 3 – DESCRIPTION OF EQUIPMENT
This chapter describes the major components of the Modular FabWorld® DRC system.

CHAPTER 4 – INSTALLATION
This chapter provides installation instructions for Modular FabWorld® DRC system components.

CHAPTER 5 – OPERATION
This chapter provides an overview of Modular FabWorld® DRC system operation — start-up, loading, normal operations, fault recovery, and system shutdown.

CHAPTER 6 – MAINTENANCE
This chapter provides a listing of preventive maintenance suggestions for certain components of the Modular FabWorld® DRC system.

APPENDIX A – ANCHORING
Appendix A gives foundation and anchoring suggestions for Modular FabWorld® DRC system components that require anchoring.
1.2 System Overview

The Modular FabWorld® DRC system provides a complete arc welding solution in a modular, configurable package.

When placing an order with Motoman® for the Modular FabWorld® DRC system, the customer chooses a “core” work cell assembly and two configurable Station Kits. The Station Kits are attached to the “core” work cell during installation at the customer’s site (see Figure 1).

Core system components include two Motoman® EA1900N robots, one NX100–DRC controller assembly (refer to Section 3.2), two welding power sources, a wireway assembly that protects the various component cable runs, and a safety fence assembly.

Station Kit components include one of three available MHT-series positioner (refer to Section 3.4), associated safety fence panels, one Light Curtain System, Arc Curtains, and one Operator Station.

The Modular FabWorld® DRC system features a total safety environment that meets or exceeds requirements of the ANSI/RIA R15.06 Robot Safety standard, and is designed to safeguard both personnel and equipment (refer to Section 3.6).

Figure 1 Overview and Component Location — Modular FabWorld® DRC System

NOTE: Station Kit 1 and Station Kit 2 are shown in this illustration for reference, only. Actual Station Kit layout and specifications are given in the drawing and schematic package supplied with your Modular FabWorld® DRC system documentation package (refer to Section 1.3).
1.2.1 System Layout

Most major components of the Modular FabWorld® DRC system are anchored individually to the floor, as this system does not use a Common Equipment Base or platform inside the work cell. The only Common Equipment Base used with the Modular FabWorld® DRC system is located outside the work cell. That base provides a mounting point for the NX100–DRC controller assembly, both welding power sources, and two power disconnect boxes for the welding power sources (see Figure 1 and Figure 2). Heavy-gauge, wire mesh safety fencing is provided for installation at the customer’s location. All system controls, including those on the Programming Pendant, NX100–DRC controller assembly, welding power sources, and Operator Stations are safely accessible from outside the Modular FabWorld® DRC work cell.

1.2.2 Major Components

The Modular FabWorld® DRC system includes the following major components –

- Two Motoman® EA1900N manipulators (robots)
- One NX100–DRC controller assembly
- One MHT-450, MHT-1500, or MHT-3000 positioner for each Station Kit
- One NX100–DRC Programming Pendant
- One Operator Station for each of the two Station Kits
- Welding equipment for each robot –
  - Welding power supply
  - Welding torch (air-cooled – standard; water-cooled – optional)
  - Wire feeder assembly
  - Applicable welding interface
  - Torch mount
  - Cable support assemblies
- Safety equipment –
  - Heavy-gauge, wire-mesh safety fencing
  - Heavy-gauge (14 mil) polymer arc curtains
  - Interlocked Light Curtain System
  - Interlocked work cell entry door

1.2.3 Optional Welding Equipment

The following optional welding equipment is available for use with the Modular FabWorld® DRC system –

- Torch cleaner
- Wire cutter
- Water-cooled torch (w/ coolant circulator)
- Bulk wire dereeler, 454 kg (1000 lbs)
- ComArc™ (seam tracking)
- TouchSense™ (starting point detection)
- ToolSight® (auto verification of correct torch alignment)
1.3 Reference Documentation

For additional information on individual Modular FabWorld® DRC components, refer to the following documentation that is included with your Modular FabWorld® DRC system –

- Motoman® EA1900N Manipulator Manual (149894-1)
- Motoman® NX100 Controller Manual (149201-1)
- Motoman® NX100 Maintenance Manual (150133-1)
- Motoman® NX100 Operator’s Manual for Arc Welding (149235-1)
- Motoman® MH-series Positioner Manual w/ MotoMount and Drive Assys (146703-1)
- Motoman® NX100 Independent/Coordinated Control Function Manual (149648-1)
- Motoman® INFORM User’s Manual (150078-1)
- Vendor manuals for system components not manufactured by Motoman®
- Modular FabWorld® DRC system schematics, drawings, and wiring diagrams package

1.4 Customer Support Information

If you need technical assistance with your Modular FabWorld® DRC system, please contact the Motoman® Customer Support Group at the following 24-hour telephone number –

1–937–847–3200

Please have the following information ready before you place your telephone call –

- SYSTEM . . . . . . . . . . Modular FabWorld® DRC
- ROBOTS . . . . . . . . . . EA1900N
- CONTROLLER . . . . . . . NX100–DRC
- POSITIONER . . . . . MHT-400, MHT-1500, or MHT-3000 positioner for each of the two Station Kits (choice of positioner type is a customer option)
- PRIMARY APPLICATION . . . . Arc welding
- SOFTWARE VERSION . . Access this information on the Programming Pendant display screen by selecting MAIN MENU ➔ SYSTEM INFO ➔ VERSION
- ROBOT SERIAL NO. . . . Located on robot data plate
- ROBOT SALES ORDER NO . . . Located on data plate of NX100–DRC controller (R1)
- WARRANTY ID CODE. . . . Located on back of the Programming Pendant
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.

Here is RIA contact information –

Robotic Industries Association
900 Victors Way
P.O. Box 3724
Ann Arbor, Michigan 48106
TEL 734.994.6088
FAX 734.994.3338
www.roboticsonline.com

Ultimately, 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 chapter 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.

- 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 Modular FabWorld® DRC system uses two Motoman® EA1900N six-axis robots that are designed for arc welding applications. Each EA1900N robot has a payload capacity of 3 kg (6.6 lbs.), features a horizontal reach of 1904 mm (75.0 inches), and achieves a relative positioning accuracy of ±0.08 mm (±0.003 inch). The EA1900N features an internal cabling design that provides high flexibility and streamlines the robot profile, thus allowing access into confined spaces. Each robot’s B-axis (Pitch/Yaw) features an expanded range of motion that improves circumferential welding on cylindrical work pieces. The T-axis (Twist) can rotate the welding torch ±360° without cable interference.

For additional information on the Motoman® EA1900N robot, please refer to the *EA1900N Manipulator Manual* that is included with your Modular FabWorld® DRC system documentation package (refer to Section 1.3).

3.2 NX100 – DRC Controller

The Modular FabWorld® DRC system features an NX100–DRC controller assembly that consists of one NX100 controller mated to an expansion cabinet (see Figure 2). This combination provides the same functionality of two full-size controllers, while reducing the overall width by 250 mm (9.8 in) when compared to two, full-size NX100 controllers. This configuration also reduces the cost to the customer by eliminating certain redundant components and circuit assemblies.

Through specific internal cable interconnections, the NX100–DRC is configured as controller R1 and controller R2 (see Figure 2). This configuration allows the two EA1900N robots to operate as a dual system that takes advantage of all the unique functions available in a dual system configuration. With the Modular FabWorld® DRC system, the full-size NX100 controller cabinet is designated R1, while the smaller, expansion cabinet is designated R2.

In addition to controlling the movement of the two robots, the NX100–DRC also controls the two welding power sources, positioners, and provides the signals necessary to operate the two welding systems.
The NX100–DRC controller features a proprietary, embedded real-time operating system (RTOS) and is programmed with the Motoman® INFORM programming language.

![Diagram](image.png)

Figure 2 Components — Common Equipment Base

### 3.2.1 Programming Pendant

The Programming Pendant provides the Human/Machine Interface (HMI) for programmer/operator interaction with the Modular FabWorld® DRC system (see Figure 3). The pendant features the Windows® CE.Net operating system and displays information on a 6½-inch, color LCD, touch-screen display. The pendant also incorporates a CompactFlash® card slot for program backups. The Programming Pendant provides icon-driven system programming. It also features a menu-driven interface to simplify operator interaction with the robots. Most operator controls are located on the Programming Pendant. This allows remote installation of the NX100-DRC controller. By using the Programming Pendant, the operator can teach robot motion; perform programming, editing, maintenance, and diagnostic functions; and enable/disable Operator Station control of the Modular FabWorld® DRC system. The Programming Pendant is “hardened” in order to survive the typical industrial environment.

For detailed information on the pendant programming keys, programming functions, and display functions, please refer to the *NX100 Operator’s Manual for Arc Welding* that is included with your Modular FabWorld® DRC system documentation package (refer to Section 1.3).
Figure 3 NX100–DRC Programming Pendant

Note: The Programming Pendant LCD touch screen display features a “screen saver” that causes the screen to go dark after a few minutes of inactivity. Press any key to restore the screen.

Note: Operator Station “enable” or “disable” is accomplished with the Programming Pendant MODE SELECT SWITCH. To transfer control of the Modular FabWorld® DRC system to an Operator Station, set the Programming Pendant MODE SELECT SWITCH to REMOTE.
3.3 Operator Station

One Operator Station is included with each Station Kit (see Figure 1 for location of the Operator Stations in relation to other Modular FabWorld® DRC system components).

An Operator Station includes a NEMA-approved enclosure and mounting brackets for attachment of the Operator Station assembly to the Station Kit safety fence.

Operator Station controls are shown in Figure 4.

![Operator Station Controls](image)

Figure 4 Operator Station Controls

The following paragraphs describe the operator station controls –

3.3.1 Operator Station Function – CYCLE START / CYCLE LATCHED

**WARNING!**
The operation of the CYCLE START / CYCLE LATCHED push button depends on the structure of the Master Job. Any alteration of the Master Job could result in injury to personnel or damage to equipment.

Pushing the green CYCLE START / CYCLE LATCHED push button initiates a positioner sweep cycle if the robot is in the HOME (Safe) position. If the CYCLE START / CYCLE LATCHED push button is pressed while the robot is still welding, or otherwise not in the HOME (Safe) position, the CYCLE START command is “latched” into (stored in) the NX100-DRC controller circuitry. When the robot returns to the HOME (Safe) position, the “latched” CYCLE START command is executed and the positioner sweeps. Circuitry in the NX100-DRC controller prevents the positioner from continuously cycling, should the operator depress and hold the CYCLE START / CYCLE LATCHED push button.
3.3.2 Operator Station Function – START

The green START button is connected to the robot external start input. Pressing the START button starts the current, active job. The Programming Pendant MODE SELECT SWITCH must be set to REMOTE, and servo power must be ON for the START button to function.

3.3.3 Operator Station Function – SERVO ON

The green SERVO ON push button turns servo power ON if the Programming Pendant MODE SELECT SWITCH is set to REMOTE.

3.3.4 Operator Station Function – REV HOME FWD (Joystick Control)

The “joystick” controls orbital axis (tooling axis) load positions. Moving the joystick to the FWD position indexes the positioner headstock orbital axis toward the robots in 30° intervals. Moving the joystick to the REV position indexes the positioner headstock orbital axis away from the robots in 30° intervals. Moving the joystick forward to the HOME position resets the positioner headstock orbital axis to zero degrees.

3.3.5 Operator Station Function – ALARM

A red ALARM lamp illuminates to indicate that the NX100-DRC controller has encountered an alarm condition or servo power has been disabled. The ALARM lamp is connected to the robot SERVO ON and ALARM OCCURRENCE outputs.

3.3.6 Operator Station Function – RESET

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

3.3.7 Operator Station Function – ROBOT HOLD

Pressing the red ROBOT HOLD button stops robot operation and interrupts the job until the operator presses the green START button to resume operation. Operation resumes at the point in the program where the ROBOT HOLD state was initiated.

3.3.8 Operator Station Function – THUMBWHEEL SWITCH

Each Operator Station includes an integrated, 2-digit thumb wheel switch (see Figure 4). This thumb wheel switch allows the operator to select different robot jobs to facilitate part change over.
3.3.9 Operator Station Function – EMERGENCY STOP (E-Stop)

Pressing the EMERGENCY STOP push button stops all Modular FabWorld® DRC system operation by initiating an emergency stop (E-Stop) condition. Refer to Section 3.6.4 for a discussion of the E-Stop function, and procedures for recovering the Modular FabWorld® DRC system from an emergency stop (E-Stop) condition.

3.4 MHT-Series Positioners

The MHT-series positioners include the following –

- MotoMan® MHT 450
- MotoMan® MHT 1500
- MotoMan® MHT 3000.

These positioner systems include a headstock drive assembly, tailstock column, and the MotoMount® tool mounting system. Parts fixturing is mounted between the headstock and tailstock face plates providing a highly versatile work area.

MotoMount® and Motoman® MHT-series positioner details are given in the *MH-series Positioner Manual with MotoMount and Drive Assemblies*. This manual is included in the Modular FabWorld® DRC system documentation package (refer to Section 1.3).

The MHT-series positioners are capable of synchronized motion between various components depending on the job configuration. Synchronized components move at the same time during welding operations. The robots can be synchronized with the MHT-series positioners. The MHT-series positioners are also capable of true coordinated motion, where linear, circular, or spline motion can be coordinated between the robots and the positioner. Coordinated motion allows the robots to weld while the positioner rotates the parts.

For additional information on coordinated motion, refer to the *NX100 Independent / Coordinated Control Function Manual* included with the Modular FabWorld® DRC system documentation package (refer to Section 1.3).

*Note: The customer shall supply all tooling and fixtures for the positioner.*

*Note: Tooling and fixtures located in a high-humidity environment should be protected by application of a corrosion / rust preventive compound that conforms to ASTM F-945. Motoman recommends *LPS 3® Heavy-Duty Rust Inhibitor* for this application. Complete product details and ordering information are available at the following WWW site –

[www.lpslabs.com](http://www.lpslabs.com)
3.5 **Welding Equipment**

In its standard configuration, the Modular FabWorld® DRC system includes a welding power source, wire feeder, torch, and torch mount for each of the two EA1900 robots. Optional equipment may also be included with your Modular FabWorld® DRC system (refer to Section 1.2.3).

3.5.1 **Welding Power Sources**

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

3.5.2 **Wire Feeder**

A welding wire feeder is mounted on the upper arm (U-Axis) of each robot. The wire feeder is the “4-roll” type and provides reliable wire feeding at rates up to 750 inches per minute (ipm). An electronically controlled gas valve provides fast welding gas response time. Interchangeable feed rolls are used to accommodate different wire gauges and wire types. For additional information on how the wire feeder is mounted to the robot upper arm, including allowable load and installation position, refer to the wire feeder documentation that is included with your Modular FabWorld® DRC system documentation package (refer to Section 1.3).

3.5.3 **GMAW Torch**

The Modular FabWorld® DRC system uses either an air-cooled or a water-cooled robotic / automatic GMAW torch for each robot. 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 flange. For applications that use the optional water-cooled torch, the Modular FabWorld® DRC system includes a water circulator kit for each robot. For additional information on the torches that are supplied with your system, refer to the vendor documentation that is included with your Modular FabWorld® DRC system documentation package (refer to Section 1.3).

3.6 **Safety Features**

The Modular FabWorld® DRC system features Motoman’s *Total Safety Environment*. The system incorporates a practical level of safeguarding to satisfy most plant conditions. If the customer complies with all standard safety precautions, the safety equipment helps to ensure safe operation of the robot work cell.

*Note: Modular FabWorld® DRC safety features are independent of program logic. All safeguards are “hard wired” and provide protection that is independent of any software program. System safeguards do not depend upon a programmer correctly inputting an instruction in the operating program.*
Note: Modular FabWorld® DRC system safeguards are interfaced with normally closed (NC) “fail-to-safe” switch contacts. These components will stop work cell operation if they are disconnected or damaged.

Note: Users are responsible for determining that the safeguards provided with the Modular FabWorld® DRC system are adequate for their plant conditions. Users must also ensure that all safeguards are maintained in working order.

3.6.1 Welding Arc Protection

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

\[ \text{WARNING!} \]

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

Heavy-gauge (14 mil) arc curtains cover all the safety fencing of the Modular FabWorld® DRC system. In addition, two arc curtains run transversely across the core work cell to block ultraviolet radiation from robot 1 and robot 2 welding arcs (see Figure 1).

3.6.2 Fence Assembly

The safety fence assembly provided with the Modular FabWorld® DRC system encloses the work cell. It forms a physical barrier that prevents personnel or objects from entering the work cell while the robots are performing welding operations.

3.6.3 Light Curtain System

The main function of the Light Curtain System is to protect an operator from positioner movement. The Light Curtain System consists of a SEND unit, RECEIVE unit, and associated wiring (see Figure 1). The Light Curtain System establishes an infrared light path between the SEND and RECEIVE units to define a protected zone in front of the positioner. The positioner will not initiate a sweep if an operator (or an object) is in a location that interrupts (breaks) the established light path. Interruption of the established light path during a positioner sweep immediately triggers an E-Stop condition (refer to Section 3.6.4).

For additional information on the Light Curtain System, refer to the vendor documentation that is included with your Modular FabWorld® DRC system documentation package (refer to Section 1.3).
3.6.4 Emergency Stop (E-Stop)

E-Stop is a primary safety feature of the Modular FabWorld® DRC system. A work cell access door interlock, a safety light curtain system, robot welding torch impact (collision) detection circuitry (refer to Section 3.5.3), and E-Stop push buttons can all trigger an E-Stop condition. An E-Stop condition immediately de-energizes the control system and activates the robot braking system (refer to Section 3.6.6). The E-Stop push buttons are used for an intentional shutdown of the Modular FabWorld® DRC system, and are installed at the following locations –

- Programming Pendant
- NX100-DRC controller (R1)
- Operator Station(s)

To resume operation after an E-Stop system shutdown, the operator must clear and reset the action that caused the E-Stop condition (refer to Section 5.3.2).

3.6.5 ENABLE Switch

The ENABLE switch is part of the Programming Pendant, and provides a safety feature that controls servo power while the system is in TEACH mode (see Figure 5). When pressed in, this switch allows the operator to enable servo power. However, should the operator release the switch or grasp it too tightly, servo power is immediately disabled, thus preventing further robot movement. For detailed information about the operation of the ENABLE switch, refer to the NX100 Operator’s Manual for Arc Welding that is included with the Modular FabWorld® DRC system documentation package (refer to Section 1.3).

![Figure 5 Programming Pendant ENABLE Switch](image)

3.6.6 Emergency Braking System

Each EA1900N robot incorporates a braking system that protects personnel from injury and prevents equipment damage if servo power is disabled. Upon loss of servo power, the brake system activates to hold all robot axes in place. The braking system incorporates a feature that allows the operator to release the brake of a specific robot axis, even if drive power is disabled. Brake release is accomplished with the Programming Pendant (refer Section 5.3.4).

3.6.7 Interlocked Work Cell Door

The work cell access door features a safety interlock (see Figure 1). Any attempt to open the access door while the robots are in PLAY mode triggers an E-Stop condition (refer to Section 3.6.4).
NOTES
Chapter 4
Installation

CAUTION!
The Modular FabWorld® DRC system should be installed by qualified personnel who are familiar with the installation and set-up of a robotic system.

Note: All anchoring hardware for the Modular FabWorld® DRC system must be supplied by the customer. Please refer to Appendix A of this document for suggested anchoring hardware and foundation specifications.

Two or three qualified technicians can install the Modular FabWorld® DRC system in a reasonable amount of time. Always comply with established safety procedures throughout the installation process (refer to Chapter 2).

Because this system features various combinations of Station Kits and MHT-series positioners, specific installation details are beyond the scope of this manual.

During installation of your Modular FabWorld® DRC system, use this chapter of the manual in combination with the Modular FabWorld® DRC system schematics, drawings, and wiring diagrams that are included in the documentation package for your system (refer to Section 1.3).

4.1 Required Materials

All system components and most of the hardware items required for installation of the Modular FabWorld® DRC system are included with your shipment. There are, however, some required items that the customer must supply, such as typical installation and maintenance tools (refer to Section 4.1.2) and special anchor bolts (refer to Appendix A).

4.1.1 Customer-Supplied Items

- Shielding gas supply cylinder(s) and pressure regulator(s)
- Local electrical service
- Earth ground wires for the robots and the NX100-DRC controller
- Earth ground rods and/or buried copper sheeting (quantity and placement depth as required to achieve specified resistance-to-ground reading of 100 ohms or less)
- Chemical (optional) to increase conductivity of soil in the vicinity of the earth ground system
- Welding wire
- Clean, dry air supply (for torch tender or wire cutter options) –
  - Flow Rate 0.425 m$^3$/min (15 cfm)
  - Pressure 620 kPa (gage) [90 psi (gage)]
- Forklift(s) and/or overhead crane
- Special anchor bolts and drill bits (refer to Appendix A for suggested anchoring hardware)

4.1.2 Recommended List of Hand Tools and Equipment

- Safety glasses
- Face shield
- Gloves (heavy-duty leather recommended)
- Level (short and long)
- Adjustable wrench (large and small)
- Air impact wrench / hammer drill with concrete drill bits (refer to Appendix A)
- Phillips and flat-blade screwdrivers
- Hammers (“dead-blow”, standard, and non-marring)
- Ratchet handle and breaker bar (3/8-inch and 1/2-inch drive)
- Socket set, 3/8-inch and 1/2-inch drive (SAE and Metric)
- Open-end wrench set (SAE and Metric)
- Wrench set, Allen® (SAE and metric)

4.2 Site Preparation

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

Procedure –

1. Clear floor and overhead space needed for the Modular FabWorld® DRC system (refer to the system diagrams and schematics included with your Modular FabWorld® DRC system documentation package). Allow an additional 1.2 – 1.5 m (4 – 5 ft) on all sides of the work cell to provide the clearances needed for installation
2. Gather all customer-supplied items and required tools (refer to Section 4.1).
4.3 Removal of System Components from Shipping Skids

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

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

1. Unbolt each component from its shipping skid using a ¾-inch socket (see Figure 6).
2. Use forklift(s) or overhead crane to lift each component away from its shipping skid.
3. Discard or recycle all shipping materials including the shipping skids.

![Figure 6 Typical Shipping Bolt Removal](image)

4.4 Installation — EA1900N Robots

Mount the EA1900N robots on a base plate or foundation rigid enough to support the robots and withstand repulsion forces (refer to Appendix A for mounting suggestions).

Refer to Appendix A for recommended foundation material and thickness.

The foundation must be smooth and level.

**WARNING!**

Make sure that your lifting device is capable of safely handling the weight of each robot. Each EA1900N robot weighs approximately 250 kg (551 lbs).

**CAUTION!**

Always use the robot shipping bracket and a suitable hoisting sling to lift and move the EA1900N robots (refer to Section 4.5). Other lifting arrangements could damage the robot.
Procedure –

1. Move the EA1900N robots to their correct mounting locations as shown in your Modular FabWorld® DRC system drawings and schematics package.

2. After the robots are correctly positioned, remove the shipping bracket from each robot (refer to Section 4.5).

3. Carefully remove protective shipping materials from robots and torches.

4. Inspect each robot for shipping damage.

Note: If you notice any equipment damage, notify your shipping contractor as soon as possible.

5. Anchor each robot securely in place (refer to Appendix A for anchoring suggestions).

4.5 Installation — Robot Shipping / Hoisting Bracket Removal

CAUTION!
Be sure to remove the shipping / hoisting bracket from each robot prior to power-up or operation. Operation of a robot, without first removing the bracket, can damage the robot drive components.

A shipping / hoisting bracket is installed on each EA1900N robot at the factory to prevent undesired movement during shipping and provide suitable lifting points (see Figure 7). The bracket is painted bright yellow for easy location and identification. The bracket secures the lower arm of the robot to the S-axis housing. In addition, the bracket provides the correct attachment points for a hoisting sling for lifting and moving the robot. Upon bracket removal, be sure to keep both brackets and attaching hardware in a safe location, should they be needed in the future.

Figure 7 Robot Shipping / Hoisting Bracket
4.6 Installation – MHT-series Positioner Modules

Using the drawings and schematics package included with your Modular FabWorld® DRC Station Kit documentation package, place each MHT-series positioner module. Refer to the Motoman® MH-series Positioner Manual w/ MotoMount and Drive Assemblies for detailed installation instructions (refer to Section 1.3).

4.7 Installation – Common Equipment Base

The Common Equipment Base serves as a mounting platform for the NX100-DRC controller, both welding power sources, electrical disconnect box for each welding power source, and water circulators (optional equipment). Refer to Figure 1 for the location of the Common Equipment Base in relation to other Modular FabWorld® DRC system components. Refer to Figure 2 for details of component locations on the Common Equipment Base.

Procedure –

1. If not previously accomplished, remove the four shipping bolts that secure the Common Equipment Base to the wooden shipping blocks (refer to Section 4.3).
2. Carefully remove plastic shipping wrap and protective cardboard from the Common Equipment Base and its installed components.
3. Inspect the Common Equipment Base and installed components for shipping damage.

Note: If you discover any equipment damage, notify your shipping contractor as soon as possible.

WARNING!
Make sure that your lifting device is capable of safely handling the weight of the Common Equipment Base and installed components. The Common Equipment Base and installed components weigh approximately 1600 kg (3520 lbs).

4. Using a forklift, lift the controller base and remove the wooden shipping blocks.
5. Using the dimensions given in your Modular FabWorld® DRC system drawings and schematics package, place the Common Equipment Base in the correct position outside the safety fencing.
6. Anchor the base securely in place (refer to Appendix A for anchoring suggestions).

4.8 Installation – Safety Fencing

The fencing that makes up the welding cell’s protective walls is shipped on its own skid with all hardware needed for the installation.

WARNING!
Wear protective gloves and eye protection while cutting steel shipping bands. Ensure that all personnel are clear of the cutting area prior to cutting the bands. The steel shipping bands have sharp edges and are highly tensioned. When cut, a tensioned shipping band can cause injury to personnel in the cutting area.
Procedure –

1. Cut the steel bands that secure the safety fencing package.
2. Temporarily layout fence components on the floor around the EA1900N robots to form the core work cell. Refer to the Modular FabWorld® DRC system drawings and schematics package (refer to Section 1.3).

**WARNING!**
Enlist the help of a qualified assistant for the following procedures. At least two people are required in order to complete these procedures safely.

3. Connect and tighten fence posts to panels according to the fence instructions included with your Modular FabWorld® DRC system documentation package (refer to Section 1.3).
4. Have an assistant hold the fencing in place while you attach each additional panel.
5. Measure to ensure cell walls are square. Adjust as necessary.
6. Anchor the fence posts to the floor (refer to Appendix A for anchoring suggestions).

### 4.8.1 Work Cell Access Door

1. Steady the rear wall and install top door rail across door opening, with the clamps provided.
2. Raise cell door and slide it into position on door rail.
3. Close door and install remaining door rail clamp.
4. Install stop bolt and tighten clamp.
5. Connect the gate interlock cable between the NX100-DRC controller and gate interlock.

### 4.8.2 Arc Curtains

The arc curtains are packaged in an accessories box that is shipped with the Modular FabWorld® DRC system.

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

Procedure –

1. Unfold each arc curtain and install one arc curtain on the inside of each work cell safety fence panel, using supplied plastic cable ties and the eyelets in each arc curtain (see Figure 8).

*Note: The arc curtains are precut to match the work cell fence panels. Each arc curtain bag contains documentation that includes the arc curtain dimensions. If necessary, these dimensions can be used to match the arc curtain to the correct work cell fence panel.*
2. Make sure there are no gaps between the arc curtains.

3. Install the work cell door arc curtain on the inside of the door panel, using the supplied plastic cable ties and the eyelets in the arc curtain (see Figure 8).

*Figure 8* Arc Curtain Installation on Typical Safety Fence or Access Door Panel

NOTE – Arc curtain is installed on the fence panel side that faces the INTERIOR of the robotic work cell
4. Install the two center arc curtains laterally across the core work cell near the EA1900N robots (see Figure 1 and Figure 9).

![Figure 9 Center Arc Curtain Installation](image)

### 4.9 Installation – Light Curtain System

*Note: Light Curtain System components — send unit, receive unit, and associated fence panels — are assembled at the factory. These components are part of each Station Kit.*

**Procedure** –

1. Move fences into position according to system drawings. The light curtains are oriented properly with the status lights located at the bottom.
2. The wiring connections are located on the controller. Unpack the light curtain cables and connect them to the matching connectors on the light curtains.
3. The send unit and receive unit must be aligned before use. Refer to the Light Curtain System vendor’s manual for alignment procedures (refer to Section 1.3).
4. After the light curtains are aligned, anchor the fence posts to the floor (refer to Appendix A for anchoring suggestions).
5. Check the alignment of the send unit and receive unit again after the fence posts have been anchored. Readjust as necessary.

### 4.10 Installation – Operator Stations

**Procedure** –

1. Locate the Operator Stations and remove all protective shipping materials.
2. Inspect each Operator Station for shipping damage.

*Note: If you discover any equipment damage, notify your shipping contractor as soon as possible.*
3. Mount one Operator Station to the fence panel of each Station Kit. Refer to system drawings and schematics that are included with your Modular FabWorld® DRC system documentation package (refer to Section 1.3).

4.11 Cable / Wiring Connections

After the Modular FabWorld® DRC system components and peripherals are anchored in their correct locations, locate the interconnect cables for the system components and route them according to the system drawings / schematics included in your Modular FabWorld® DRC system documentation package (refer to Section 1.3). All cables and connectors are labelled to ensure correct connection to the mating connectors on the applicable system component.

4.11.1 Earth Ground

**WARNING!**

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

The EA1900N robots and NX100-DRC controller must be connected to a low-resistance earth ground. If a ground stake is used, it should be driven at least 2.43 m (8 ft) into the soil. The soil surrounding the driven ground stake should be treated with a chemical that increases the soil conductivity in the vicinity of the driven ground stake. This is often referred to as a “low-resistance earth ground” and may require more than a single driven ground rod, depending on soil conditions. Often, multiple ground rods (bonded together) or even a bonded network of buried copper sheeting (plus conduction-enhancing chemicals) may be required, depending on local soil condition. In any event, the “low-resistance earth ground” must indicate a resistance of **100 ohms or less** (when measured directly between grounded equipment and the earth ground system). Specialized measuring equipment is usually required to get an accurate “resistance-to-ground” reading. Consult a specialist in this field, if required.

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

Connect both robots and NX100-DRC controller to the earth ground as follows –

1. Connect one end of an earth ground wire to the lug marked EARTH GROUND on the connector panel of robot (R1). Connect the other end of the earth ground wire to the low-resistance earth ground. See Figure 1 for location of robot (R1).

2. Connect one end of an earth ground wire to the lug marked EARTH GROUND on the connector panel of robot (R2). Connect the other end of the earth ground wire to the low-resistance earth ground. See Figure 1 for location of robot (R2).
3. Connect one end of an earth ground wire to the COMMON GROUND BUS BAR located inside NX100-DRC R1 controller (see Fig 0000). Connect the other end of the earth ground wire to the low-resistance earth ground.

4. Connect one end of an earth ground wire to the COMMON GROUND BUS BAR located inside NX100-DRC R2 expansion cabinet (see Fig 0000). Connect the other end of the earth ground wire to the low-resistance earth ground.

4.11.2 Connection to Local Electrical Service

DANGER!

Local electrical service connection to the Modular FabWorld® DRC system must be performed by a qualified, licensed electrician. Electrical and grounding connections must comply with the National Electrical Code (NEC), as well as all local electrical codes.

Note: The Modular FabWorld® DRC system is configured for 3-phase 460/480V AC primary power. For additional information, refer to the electrical drawings and schematics that are included with your system documentation package (refer to Section 1.3).

After all of the system components have been properly installed and interconnected, connect local electrical service to the NX100-DRC controller and welding power sources (refer to Section 4.11.2.1 and Section 4.11.2.2).

4.11.2.1 NX100-DRC Controller

For detailed electrical service interconnect procedures for the NX100-DRC controller, refer to the NX100 Controller Manual and Modular FabWorld® DRC system drawings / schematics that are included with your system documentation package (refer to Section 1.3).

4.11.2.2 Welding Power Sources

Refer to the welding power source documentation and Modular FabWorld® DRC system drawings / schematics for electrical service connection procedures and diagrams for the welding power sources (refer to Section 1.3).

4.12 Safety / Operation Check

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

1. Ensure that the shipping bracket is removed from each robot (refer to Section 4.5).

2. Ensure correct alignment and operation of the safety light curtain system (refer to safety light curtain documentation that is included with your Modular FabWorld® DRC system).

3. Check the security and integrity of all cable connections.

4. Ensure that the work cell access door is closed and that the door interlock is engaged.

5. Verify the correct settings for the welding power sources (refer to the welding power source documentation that is included with your Modular FabWorld® DRC system).
6. Verify that local electrical service complies with the power requirements for your Modular FabWorld® DRC system.

7. Verify that local electrical service is correctly wired into the NX100-DRC controller and the welding power sources (refer to Section 4.11).

**CAUTION!**
The Modular FabWorld® DRC system is now ready for power-up. Qualified, trained personnel, who are familiar with this system, should perform the power-up sequence.

8. Set the POWER ON-OFF switch on the NX100-DRC R1 controller to ON (see Figure 2).

9. Set the service disconnect boxes for the welding power sources to ON (see Figure 2).

10. Set POWER ON-OFF switch on welding power source (R2) to ON.

11. Set POWER ON-OFF switch on welding power source (R1) to ON.

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

12. Check for correct operation of all E-Stop push buttons (refer to Section 3.7.4).

13. Check for correct operation of the system HOLD button on the Programming Pendant and Operator Station.

14. Check for correct action of the work cell access door safety interlock.

15. Remove power from the Modular FabWorld® DRC system after completion of the safety / operation check.

### 4.13 Installation of Tooling and Fixtures

Your Modular FabWorld® DRC system is now ready for installation of tooling and fixtures for your particular application. Personnel who are familiar with the operation of the Modular FabWorld® DRC system should do the installation. After tooling installation, test the positioner for correct operation.

*Note: All tooling and fixtures shall be supplied by the customer.*

*Note: Tooling and fixtures located in a high-humidity environment should be protected by application of a corrosion / rust preventive compound that conforms to ASTM F-945. Motoman recommends **LPS 3® Heavy-Duty Rust Inhibitor** for this application. Complete product details and ordering information are available at the following WWW site – [www.lpslabs.com](http://www.lpslabs.com)*
Chapter 5

Operation

This chapter provides a brief overview of the operating procedures and precautions for your Modular FabWorld® DRC system. For more detailed operating information, refer to specific component manuals that are part of the Modular FabWorld® DRC system documentation package (refer to Section 1.3).

The Modular FabWorld® DRC system is a fully integrated robotic GMAW welding cell. The Master Job setup, and the sub-routines programmed within it, determine how the Modular FabWorld® DRC system performs welding operations and other tasks. One EA1900N robot welds parts in work station 1 (active station), while the operator loads or unloads parts on the opposite end of the work cell at work station 2 (inactive station). When the robot in work station 1 completes the welding process, it returns to the HOME position. The operator is then able to enter the safety zone of work station 1 and safely process the welded parts, while the other EA1900N robot welds parts in work station 2 at the opposite end of the work cell. This alternating process repeats as many times as necessary.

The Modular FabWorld® DRC features two Station Kits that can contain any combination of the following positioner assemblies –

- MHT-450
- MHT 1500
- MHT 3000

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 procedures and information, refer to the NX100-DRC controller documentation that is included with your Modular FabWorld® DRC system documentation package (refer to Section 1.3).

Any changes made to your system configuration and/or job structure will alter the operation of the system. Motoman recommends that you DO NOT modify the original jobs and system.
configuration of your Modular FabWorld® DRC system. If you determine a need to modify the
original jobs and system configuration, make any modifications to a copy of the original. Keep
the original as a backup. Do not modify the original. Modifications must be performed by
trained and experienced personnel, who are familiar with the operation of the Modular
FabWorld® DRC system. If you have questions concerning the configuration of your Modular
FabWorld® DRC system, please contact Motoman 24 hour Customer Support (refer to
Section 1.4).

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

Note: Refer to your system's Independent/Coordinated Motion Manual for information on coordinated
motion, selecting synchronization, group axes, and tooling calibration (refer to Section 1.3).

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 (refer to Section 5.2.1).
- Move robots to Home position (refer to Section 5.2.2).
- Select Master job (refer to Section 5.2.3).
- Perform operation cycle (refer to Section 5.2.4)
- Perform shutdown procedures (refer to Section 5.2.5)

5.2.1 Start-Up

Procedure –

1. If installed, switch the NX100-DRC controller electrical service disconnect box to ON.

   Note: Electrical service disconnect box for the NX100-DRC controller shall be supplied (if desired) by
   the customer. It is not part of the Modular FabWorld® DRC system shipment.

2. Set POWER ON-OFF switch on NX100 controller (R1) to ON (see Figure 2).

3. Switch both welding power source electrical service disconnect boxes to ON (see Figure
   2).

4. Set POWER ON-OFF switch on each welding power source to ON (ON-OFF
   indicator lamp on each welding power source will illuminate).

5. Open regulator valve on welding gas supply cylinder.

6. Make sure that the work cell access door is closed and door safety interlock is engaged.
7. Make sure all E-Stop buttons are released. E-Stop buttons are installed at the following
   locations –
   • Programming Pendant
   • NX100-DRC controller (R1)
   • Operator Stations

8. Select TEACH mode on the Programming Pendant.

9. Place robots in Home position (refer to Section 5.2.2).

5.2.2 Robot Home Position

To move the robots to the Home position –

1. Select TEACH mode on the Programming Pendant.
2. Select MAIN MENU on Programming Pendant touch screen.
4. Select SELECT JOB on Programming Pendant touch screen (a job list appears on the
   screen).
5. Use the navigation cursor key to move the cursor to R1 SAFE job and press SELECT
   (the job appears on the display screen).
6. Turn servo power ON by pressing SERVO ON and holding in the ENABLE switch.
7. Use the FWD button on Programming Pendant to jog robot (R1) to Home position.
8. Use the navigation cursor key to move the cursor to R2 SAFE job and press SELECT
   (the job appears on the display screen).
9. Turn servo power ON by pressing SERVO ON and holding in the ENABLE switch.
10. Use the FWD button on Programming Pendant to jog robot (R2) to Home position.

5.2.3 Master Job

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

1. Select JOB on Programming Pendant touch screen.
2. Select CTRL MASTER on Programming Pendant touch screen. Press SELECT twice to
   activate the Master job.
3. Select PLAY mode on Programming Pendant and press the PLAY ENABLE button on
   the NX100-DRC controller (R1) door (job playback operation is enabled). See Figure 2
   for location of the PLAY ENABLE button on the controller.
4. Press SERVO ON button on the Programming Pendant.
5. Press START button on Programming Pendant (the Master job cycles, waiting for a
   CYCLE START input from Operator Station).
6. Transfer control to the Operator Station by selecting REMOTE on the Programming
   Pendant MODE SELECT SWITCH.

The Modular FabWorld® DRC work cell is now ready for operation.
5.2.4 Operation Cycle

The following is the typical sequence of operation for the Modular FabWorld® DRC cell after start-up –

1. Load fixture in station 1.
2. Step out of safety light curtain.
3. Press the CYCLE START button on the operator station. The CYCLE LATCHED light comes on and the robots begin welding parts.
4. While the robots are welding, load station 2.
5. When parts are loaded, press the CYCLE START button on operator station; CYCLE LATCHED light comes on. When the robots are finished welding at station 1, they return to Home position allowing the operator to process parts at station 1.
6. Unload welded parts from the station 1.

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

5.2.5 Shutdown

Use the following procedure to perform a normal shut down of the Modular FabWorld® DRC system –

1. Make sure the robots are in Home position.
2. Turn off system servo power by pressing the E-Stop button on Operator Station or Programming Pendant.
3. Select TEACH mode on the Programming Pendant.
4. Set NX100-DRC controller (R1) POWER ON-OFF switch to OFF position.
5. Set both welding power source POWER ON-OFF switches to OFF position.
7. Switch NX100-DRC controller disconnect box (if installed) to OFF.
8. Switch welding power source disconnect boxes to OFF (see Figure 2).

The Modular FabWorld® DRC system 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 clear them.
5.3.1 Alarms and Errors

Alarms and errors will stop the program. There are three levels –

- Error Messages
- Minor Alarms
- Major Alarms

For more detailed information on alarm and error recovery, refer to the *NX100 Controller Manual* and the *NX100 Maintenance Manual* that are included with your Modular FabWorld® DRC system documentation package (refer to Section 1.3).

5.3.1.1 Error Messages

Error messages are usually the result of simple, easily-cleared operation errors. An example could include:

- Pressing the START button when the robots are not in PLAY mode

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

5.3.1.2 Minor Alarms

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

5.3.1.3 Major Alarms

Major alarms usually involve hardware failures. Examples could include –

- An overload condition
- An abnormal speed

Clear alarms of this type by cycling the NX100-DRC (R1) controller in accordance with the following steps –

1. Rotate the NX100-DRC (R1) POWER ON-OFF switch to OFF.
2. Allow the NX100-DRC (R1) POWER ON-OFF switch to remain in the OFF position for approximately 10 seconds.
3. Rotate the NX100-DRC (R1) POWER ON-OFF switch to ON.

5.3.2 E-Stop Recovery

An E-Stop (emergency stop) will occur under any of the following conditions –

- An E-Stop switch is pushed in (activated)
- The work cell access door is opened while the robots are not in TEACH mode
- The safety light curtain system is triggered
- A collision triggers a shock sensor output
After an E-Stop condition, restart the Modular FabWorld® DRC system as follows –

1. Clear the E-Stop condition by performing any of the following that apply –
   - Release the activated E-Stop push button(s)
   - Close work cell access door
   - Clear the area protected by the light curtain system
   - Clear shock sensor condition (refer to Section 5.3.3).

CAUTION!
If an E-Stop condition occurs while the positioner is sweeping, the positioner will continue
the sweep when the Modular FabWorld® DRC system is restarted.

2. Press the SERVO ON button on the Programming Pendant.
3. Select REMOTE mode on the Programming Pendant MODE SELECT SWITCH to transfer control of the system to the Operator Station.
4. Press the green START button on the Operator Station.

The Modular FabWorld® DRC system is now ready to continue operation.

5.3.3 Shock Sensor Recovery

Each EA1900N robot includes a Motoman gun mount. This mount protects the torch from damage during a crash (collision). A slight deflection of the torch activates a SHOCK SENSOR signal that triggers an E-Stop condition. To clear the E-Stop condition, you must override the shock sensor and move the affected robot clear of the impact. To override the shock sensor, proceed as follows –

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

The Modular FabWorld® DRC system is now ready to continue operation.

5.3.4 Brake Release

The robot braking system is designed to protect the robots and other system components from damage in the event of a system / robot failure or loss of drive power. If a system or robot failure occurs, you must release the brakes on the affected robot in order to move it.

Procedure –
WARNING!
Always support the robot axis to be released BEFORE you release it. Without adequate robot axis support, brake release could cause personal injury or machine damage.

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. Use the CURSOR key to select desired robot axis for release.
5. While pressing in on the pendant ENABLE switch, hold down the INTERLOCK key plus the SELECT key.
6. The brake for the selected axis releases.
NOTES
Chapter 6

Maintenance

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

Maintenance intervals given in this chapter 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 Modular FabWorld® DRC system, refer to the documentation that is included with your system documentation package (refer to Section 1.3).

**CAUTION!**

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

Table 1 Periodic Maintenance

<table>
<thead>
<tr>
<th>FREQUENCY</th>
<th>COMPONENT</th>
<th>PROCEDURE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Daily (or on condition)</td>
<td>Water Circulators (water-cooled torch application, only)</td>
<td>Add a mixture of Motoman antifreeze (P/N 131224-1) and distilled water, as required. Mix antifreeze and distilled water in proportions shown on the antifreeze container.</td>
</tr>
<tr>
<td></td>
<td>All safeguard items – work cell door interlocks, E-Stop push buttons, safety light curtains, arc curtains, etc.</td>
<td>Check physical condition of safeguard item and ensure that the safeguard item is working correctly</td>
</tr>
<tr>
<td>1 Month (or on condition)</td>
<td>Modular FabWorld® DRC work cell</td>
<td>Remove accumulated dirt, grease, and debris from inside and outside the work cell.</td>
</tr>
<tr>
<td>6 Months (or on condition)</td>
<td>Anchoring Hardware</td>
<td>Check integrity and torque of anchoring hardware.</td>
</tr>
</tbody>
</table>
Appendix A

Anchoring

The customer must 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 HP3JC, HP3, HP3C, HP3CL, HP3XF, HP5, HP5C</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 UP6, UP20 UP20-6, EA1400, EA1900</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 HP6, HP6S, HP6R, HP20, HP20-6, EA1400N, EA1900N, DX1350N</td>
<td>5/8&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 UP20M, UP50 SP80 (Note 2)</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>
<tr>
<td>ROBOTS HP50, HP50-20, HP50-35, EPL80 (Note 2)</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>
<tr>
<td>ROBOTS UP120,UP130 UP165,SP100 SP160,SP250 SP400 (Note 2)</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

<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” HVA Chemical Anchor</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>(Note 3) (Note 5) (Note 6)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ROBOTS</td>
<td>7/8” HVA Chemical Anchor</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>HP200, ES200N, HP200T, HP200RN,</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EPL300 (Note 2)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ROBOTS</td>
<td>7/8” HVA Chemical Anchor</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>UP350, UP500, SK300X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ROBOTS</td>
<td>7/8” HVA Chemical Anchor</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>HP350, HP350-200, HP500, HP600,</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EPL450, EPL500 (Note 2)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>POSITIONER</td>
<td>7/8” HVA Chemical Anchor</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>Rotary Turntable Type</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Note 3) (Note 6)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>POSITIONER</td>
<td>7/8” HVA Chemical Anchor</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>“Ferris wheel” type with headstock</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>and tailstock (HS/TS)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PERIPHERAL EQUIPMENT</td>
<td>1/2” Kwik Bolt II Expansion Anchor</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>POSTS</td>
<td>(Note 4) (Note 6)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>WORK CELL FENCE POSTS</td>
<td>3/8” Kwik Bolt II Expansion Anchor</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></td>
<td>(Note 4) (Note 6)</td>
<td></td>
<td></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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