YASKAWA

ArcWorld® 6000 SERIES
SYSTEM MANUAL

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

Have the following information available when contacting the YASKAWA Representative:
- System
- Primary Application
- Software Version *(Located on Programming Pendant by selecting: {Main Menu} - {System Info} - {Version})*
- Warranty ID *(Located on Robot Controller)*
- Robot Serial Number *(Located on Manipulator data plate)*
- Robot Sales Order Number *(Located on Robot controller data plate)*

The Americas YASKAWA Representative

- 24-hour Telephone Number: **(937) 847-3200**
  Use for urgent or emergency needs for technical support, service and/or replacement parts
- Routine Technical Inquiries: *techsupport@motoman.com*
  Allow up to 36 hours for response

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YASKAWA America, Inc.
Motoman Robotics Division
100 Automation Way
Miamisburg, OH 45342
Phone: 937-847-6200

www.motoman.com

Safety

For Your Safety

Robots generally have requirements which are different from other manufacturing equipment, such as larger working areas, high-speed operation, rapid arm movements, etc., which can pose safety hazards.

Read and understand the instruction manuals and related documents, and observe all precautions in order to avoid the risk of injury to personnel and damage to equipment.

Carelessness contributes to serious accidents in the work area.

It is the user's responsibility to ensure that all local, state, and national codes, regulations, rules, or laws relating to safety and safe operating conditions are met and followed.

DANGER

- Teaching, operations, and maintenance of the Robot must conform to:
  - Industrial Safety and Health Law
  - Order for Enforcement of the Industrial Safety and Health Law
  - Industrial Safety and Health Regulations
  - Technical Standards for Electrical Facilities

  Other related laws and regulations are:
  - Occupational Safety and Health Act in USA
  - Factory Act (Gewerbeordnung) in Germany
  - Health and Safety at Work, etc. Act in UK
  - EC Machinery Directive 2006/42/EC
- Prepare:
  - SAFETY WORK REGULATIONS
    based on concrete policies for safety management complying with related laws and regulations.
- Observe:
  - JIS B 8433-1: 2015 "Robots for industrial environments-Safety requirements" (ISO 10218-1: 2011) for safe operation of the robot. (JIS B 8433 is for Japan only)
- Reinforce:
  - SAFETY MANAGEMENT SYSTEM
    by designating authorized operators and safety managers for the Robot, as well as giving continuing safety education and training.
- Teaching, operation, and maintenance of the Robot are specified as "Hazardous Operations" in the Industrial Safety and Health Act (for Japan only).
  Personnel engaged in these operations must receive special training offered by YASKAWA.

DANGER

- Personnel engaged in operation, maintenance, or management of the Robot must receive required training before using the Robot.

For more information on training, contact your local YASKAWA representative.

- Make sure to have and follow all manuals, read them thoroughly and understand the contents of them.

Confirm that you have all required manuals. If any of the manuals are missing, contact your local YASKAWA representative.

- Read and understand these instructions throughly before installing, operating, or maintaining the Robot.

Any matter not described in this manual must be regarded as “prohibited” or “improper”.

We suggest that you obtain and review a copy of the ANSI/RIA National Safety Standard for Industrial Robots and Robot Systems (ANSI/RIA R15.06-2012). You can obtain this document from the Robotic Industries Association (RIA) at the following address:

Robotic Industries Association
900 Victors Way
P.O. Box 3724
Ann Arbor, Michigan 48106
TEL: (734) 994-6088
FAX: (734) 994-3338
www.roboticsonline.com

Ultimately, well-trained personnel are the best safeguard against accidents and damage that can result from improper operation of the equipment. The customer is responsible for providing adequately trained personnel to operate, program, and maintain the equipment.

We recommend approved YASKAWA training courses for all personnel involved with the operation, programming, or repair of the equipment.

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications.

WARNING

- Safe operation of this equipment is the users 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 R15.06-2012 safety standards, and other local codes that may pertain to the installation and use of this equipment.

Not following all national codes, safety standards and local codes can result in death or serious injury

- 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 barriers
    - Door interlocks
    - Emergency Stop button

Not providing additional safety measures as required can result in death or serious injury.

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

If safety equipment does not operate properly death or serious injury can result.

CAUTION

- Only trained personnel familiar with the operation, manuals, electrical design, and interconnections of this equipment should program, or maintain the system.

Any personnel involved with the operation of the equipment must understand potential dangers of operation.

NOTICE

- The drawings and photos in this manual are examples. Differences may exist between them and the delivered product.
- YASKAWA may modify this model without notice due to product improvements, modifications, or changes in specifications. If such modification is made, the manual number will also be revised.
- Some operations require standard passwords and while others require special passwords.
- If a manual is damaged or lost, contact your local YASKAWA representative to order a new copy. Make sure to tell your local YASKAWA representative the Manual Number listed on the front cover.

Notes for Safe Operation

Read this manual carefully before installing, operating, maintaining, or inspecting the system.

In this instruction, Safe Operations are classified as “DANGER”, “WARNING”, “CAUTION” or “NOTICE”.

	Indicates an imminently hazardous situation which, if not avoided, **WILL result in death or serious injury**.
	Indicates a potentially hazardous situation which, if not avoided, **MAY result in death or serious injury**.
	Indicates a hazardous situation, which if not avoided, **MAY result in minor to moderate injury**.
	Indicate a situation which if not avoided **may result in equipment damage.**
	Indicates **practices not related to personal injury**.

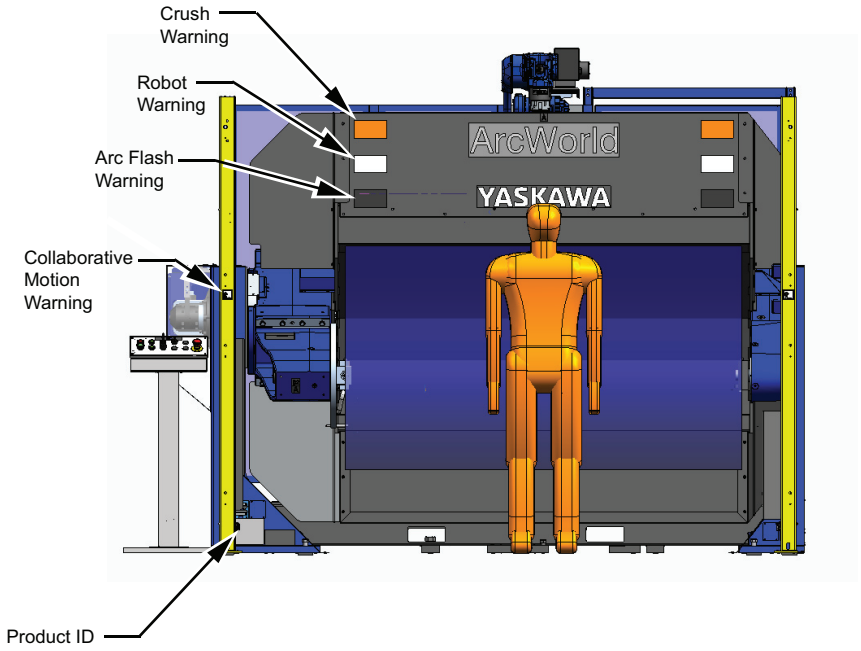
NOTICE

To ensure safe and efficient operation at all times, be sure to follow all instructions, even if not designated as “DANGER”, “WARNING” or “CAUTION”.

ArcWorld Explanation of Warning Labels

The following labels are attached to the ArcWorld. Always follow these warning labels.

Fig. : ArcWorld Label Locations



■ Crush Warning

Description

Keep clear of moving parts when performing a teaching operation within the Robot's operating range. Failure to observe this instruction may result in personal injury.

■ Robot Warning

Description

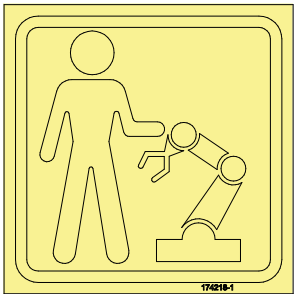
Keep clear of moving parts when performing a teaching operation within the Robot's operating range. Failure to observe this instruction may result in personal injury.

■ Arc Flash Warning

Description

Do not open covers without appropriate personnel protection equipment. Failure to observe this instruction may result in injury.

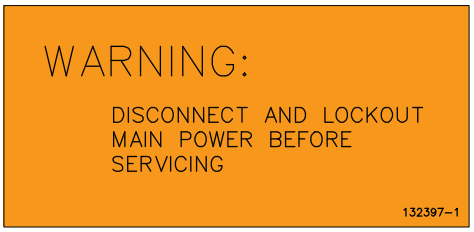
■ Collaborative Motion Label



Description

Collaboration is a special type of operation between a person and Robot sharing a common workspace. The following are the guidelines for collaborative operation.

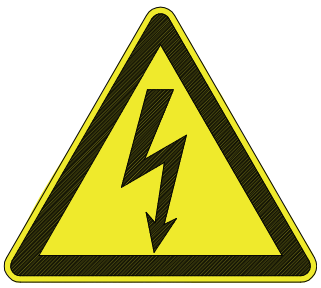
■ Lockout and Tagout Warning Label



Description

Use a device to ensure that the ArcWorld remain inoperable while repairs or adjustments are being made.

■ High Voltage Label (Not Shown in *Fig. : "ArcWorld Label Locations"*)



Description

This label lets know of hazardous voltage and there is a danger of getting an electrical shock.

Product Identification Label

Description

This label gives the Model and Serial Number of the ArcWorld. See *Fig. : "ArcWorld Label Locations"* for a reference of the location.

Maintenance Safety

WARNING

- Turn the power OFF, disconnect and lockout/tagout all electrical circuits before making any modifications or connections.

Perform only the maintenance described in this manual. Maintenance other than specified in this manual should be performed only by YASKAWA-trained, qualified personnel.

Installation and Wiring Safety

Review the Manipulator and Robot Controller Instructions for details on installation and wiring.

In planning installation, adapt an easy to observe arrangement to ensure safety. Take safety into consideration when planning the installation. Observe the following when installing the Robot:

DANGER

- Maintenance and inspection must be performed by specified personnel.

Failure to observe this caution may result in electric shock or injury.

- For disassembly or repair, contact your local YASKAWA representative.
- Do not remove the motor, and do not release the brake.

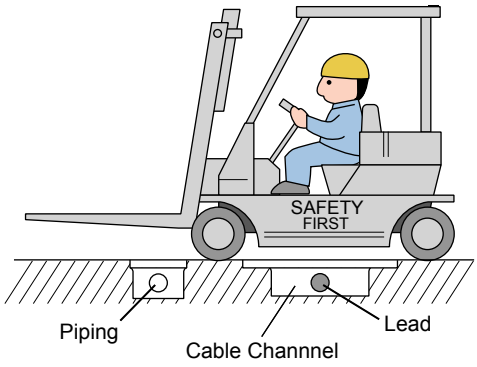
Failure to observe these safety precautions may result in death or serious injury from unexpected motion of the Robot's arm.

- Any person who programs, teaches, operates, maintains or repairs the included system MUST be trained and demonstrates competence to safely perform assigned tasks.

Failure to observe these safety precautions may result in death or serious injury from unexpected movements.

WARNING

- Run the piping, wiring, and cables for the Robot Controller, Manipulator, Positioner control panel, peripheral devices, etc. in a pit so that they are not stepped on by personnel or run over by a forklift.



Failure to observe this Warning may cause personnel to trip over exposed piping, wiring, or a cables, which may result in personal injury. Additionally it may also cause damage to piping, wiring, or cables, and unexpected movement of the Robot, which may result in personal injury and/or equipment damage.

CAUTION

- Make sure all covers and shields are installed correctly before operating.
  - Some drawings in this manual may have protective covers or shields removed to show details.

Not having all covers and shields installed correctly can result in injury.

- When installing the Robot system, avoid interference with buildings, structures, utilities, other machines.

Not avoiding these items may create trapping or pinch points.

- Do not make unauthorized modifications.

Unauthorized modifications can result in injury or equipment damage and will void the warranty.

- Inspect:
  - For problems with movement
  - Damages to external wires

Repair any problems immediately and perform all necessary procedures. If problems are not repaired or procedures are not fixed unexpected results can occur causing injury.

NOTICE

- If supplying a supplementary audible means for Robot operation, it shall exceed the ambient noise at the end-use of the application.
- Any changes or additions to the applicable information as provided by the manufacturer is to be provided by the party that makes the change or addition to the Robot system

Ensure Safety

DANGER

- When the power supplies of the Robot are turned ON at start-up, be sure to confirm the following:
  - Safety protection devices such as the E-Stop circuit, door interlocks, etc. operate normally.
  - Each axis operates normally in TEACH mode.
  - Robot operates normally at the speed limit or less in the TEACH mode.(Speed limit: 250 mm/s at the TCP or the flange)
  - The teaching function and the playback function operate normally.
- The Robot may stop movements while waiting for a condition to be satisfied during operation.

Once meeting the condition, the Robot starts movement causing a danger that will cause death or severe injury.

- Make sure to clearly indicate when the Robot is in operation:
  - Use a pilot lamp and/or an audible alert or
  - The Robot stops operation if the operator comes close.
- Install a safety fence around the Robot to prevent any accidental contact with the Robot when power is applied.
  - Display a warning sign stating “Off-Limits During Operation” at the entrance of the safety fence.
  - The gate of the safety fence must be equipped with a safety interlock to turn the servo power OFF when the gate opens.
  - Make sure interlocks operate properly before use.
- For areas not enclosed by safety fences, use a photoelectric sensor, a safety light curtain, etc. to make sure that the Robot stops its operation if the operator enters its operating range.

Failure to observe this Danger notice will result in death or serious injury due to contact with the Robot.

All personnel working with the Robot (safety administration, installation, operation, and maintenance personnel) must always be prepared and “Safety First” minded, to ensure the safety of all personnel.

WARNING

- In the vicinity of the area where the Robot is installed, avoid any dangerous actions, such as entering the Robot's operating range without due care.

Failure to observe this instruction may cause contact with the Robot or peripheral equipment, which may result in death or serious injury.

- Strictly observe the safety precautions and signs in the factory, such as “Flammable”, “High Voltage”, “Danger”, “Off-limits to Unauthorized Personnel”.

Failure to observe this instruction may result in death or serious injury do to fire, electric shock, caused by contact with the Robot or other equipment.

- Strictly observe the following precautions about clothing:
  - Always wear approved work clothes (no loose-fitting clothes).
  - To prevent mis-operation, do not wear gloves when operating the Robot.
  - Do not allow underwear, shirts, or neckties hang out from the work clothes.
  - Do not wear accessories, such as earrings, rings, or necklaces.
  - Always wear protective safety equipment, such as hard hats, safety shoes (with slip-proof soles), face shields, safety glasses, and gloves as necessary.

Failure to observe this instruction may result in death or serious injury.

- The following must be understood and strictly observed by all personnel as rules:
  - Unauthorized personnel other than the operator must not approach the area where the Robot is installed.

Failure to observe this instruction may cause contact with the Manipulator, Robot Controller, control panel, workpiece, or Positioner, etc., may result in death or serious injury.

WARNING

- Turn OFF servo power before operating.
  - Press the Emergency Stop button to turn off SERVO POWER. When servo power is OFF, the SERVO ON LED on the Programming Pendant is OFF.

If the Emergency Stop button(s) do not work correctly, death or serious injury may result. Do not use if the Emergency Stop button does not perform correctly.

Fig. : Emergency Stop Button

- Clear the cell of all items which could interfere with the operation before releasing the Emergency Stop button.

Death or serious injury may result from unintentional or unexpected motion.

Fig. : Release of Emergency Stop Button

- Make sure no person is in the operating range and the operator is in a safe location before:
  - Turning ON power to the Robot Controller
  - Moving the Robot with the Programming Pendant
  - Running the system in the TEACH mode
  - Performing automatic operations

Death or serious injury may result if a person enters the operating range during operation. Immediately press an Emergency Stop button whenever there is a problem.

CAUTION

- All operators, programmers, maintenance personnel, supervisors, and anyone working near the system must be 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:
  - Place system in E-Stop mode whenever it is not in use.
  - Use lockout/tagout procedures during equipment maintenance in accordance with ANSI/RIA R15.06-2012, section 4.2.5, Sources of Energy. Refer also to Section 1910.147 (29CFR, Part 1910), Occupational Safety and Health Standards for General Industry (OSHA).
  - Only trained personnel familiar with the operation of this equipment, the operator's manuals, the system equipment, and options and accessories can operate equipment.

Improper operation can result in personal injury and/or damage to the equipment.

- If the light in the operator's working space is not bright enough, provide the space with appropriate lighting.

CAUTION

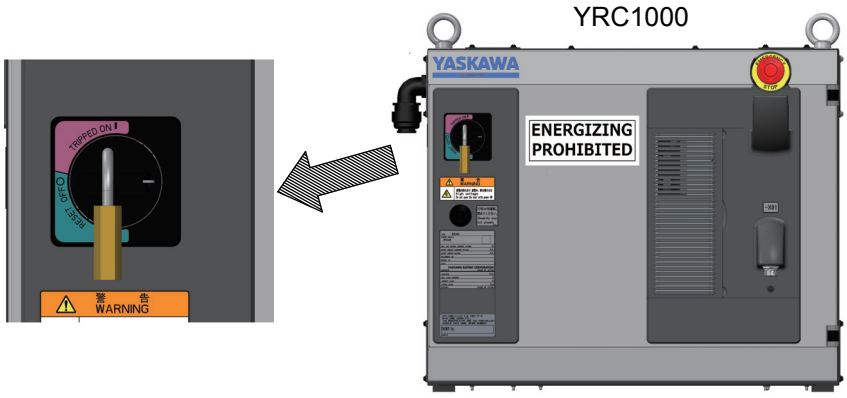
- Store industrial tools, etc. in a safe location outside the Robot's operating range.

If an industrial tool, etc. is left unattended on the Robot, on a fixture, or on the floor, etc., the Robot may come in contact with the industrial tool left unattended, which may result in damage to the Robot and/or the fixture.

Operation Safety

DANGER

- Personnel engaged in teaching or inspection, etc. of the Robot must receive special training required by applicable laws and regulations.
- While performing inspection and maintenance, wiring, or attaching a tool to the Robot, etc., make sure to turn OFF the power supply of the Robot Controller and the tool, and keep the switch of the power supply locked so that unauthorized personnel cannot turn ON the power supply.
  In addition, display a warning sign stating “Energizing Prohibited”.



  Turning ON the power supply without due care during inspection and maintenance, etc., may cause electric shock or unexpected movement of the Robot, which may result in personal injury.

- Use the Robot only within the specifications described in the manuals for the Robot.

Failure to observe this instruction may result in personal injury and/or equipment damage.

- Observe the following precautions when performing a teaching operation within the Robot's operating range:
  - Be sure to perform lockout by putting a lockout device on the safety fence when going into the area enclosed by the safety fence. In addition, the operator of the teaching operation must display the sign that the operation is being performed so that no other person closes the safety fence.
  - View the Robot from the front whenever possible.
  - Always follow the predetermined operating procedure.
  - Always keep in mind emergency response measures against the Robot’s unexpected movement toward a person.
  - Ensure a safe place to retreat in case of emergency.

Failure to observe this instruction may cause improper or unintended movement of the Robot, which may result in personal injury.

DANGER

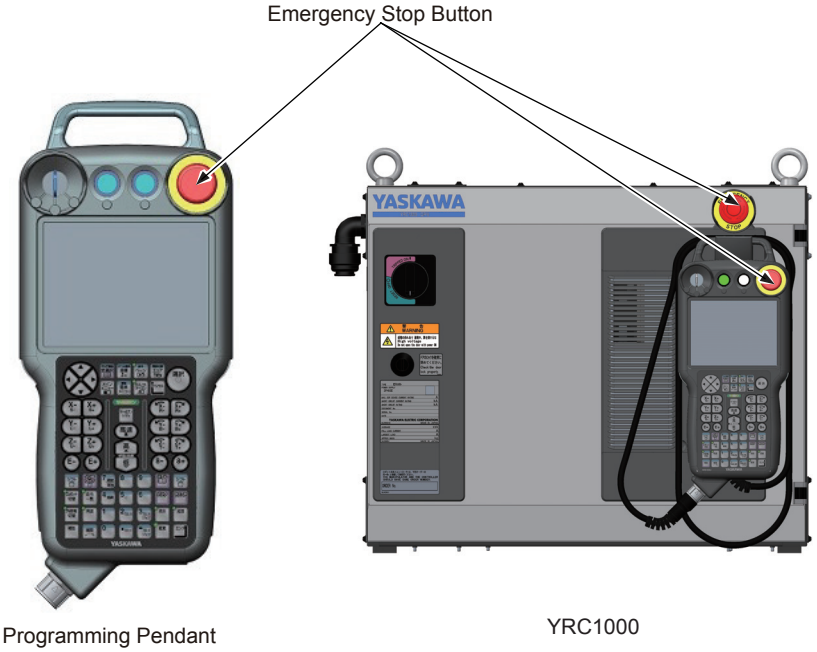
- Before operating the Robot, make sure the servo power is turned OFF by performing the following operations. When the servo power is turned OFF, the SERVO ON LED on the Programming Pendant is turned OFF.
  - Press the Emergency Stop buttons on the front door of the Robot Controller, on the Programming Pendant, on the external control device, etc.
  - Disconnect the safety plug of the safety fence. (when in the PLAY mode or REMOTE mode)

If operation of the Robot cannot be stopped in an emergency, personal injury and/or equipment damage may result.

- Make sure that all safety protection devices are activated before starting a job in the PLAY mode.
- Confirm that no person is present in the Robot's operating range and that the operator is in a safe location before:
  - Turning ON the Robot Controller
  - Moving the Robot by using the Programming Pendant
  - Running the system in the TEACH mode
  - Performing automatic operations

Personal injury may result if a person enters the Robot's operating range during operation

- Immediately press an Emergency Stop button whenever there is a problem.



WARNING

- Read “Safety” of the Robot Controller instructions before operating.

Not reading and understanding chapter 1 of the Robot Controller instruction can result in death or serious injury.

- Read and understand all Warning Labels before operating.

Not reading and understanding all Warning Labels can result in death or serious injury.

- Confirm that no person is present in the P-point maximum envelope of the Robot before:
  - Turning on the power for the Robot Controller.
  - Moving the Robot with the Programming Pendant.
  - Running the system in the TEACH mode.
  - Performing automatic operations.

Injury may result if anyone enters the working envelope of the Robot during operation. Always press an Emergency Stop button immediately if there are problems.

- Observe the following when performing teaching operation within the operating range:
  - Lockout by putting a lockout device on the safety fence when going into the area enclosed by the safety fence.
  - Display a sign that operations are being performed so no other person closes the safety fence.
  - View from the front whenever possible.
  - Always follow the predetermined operating procedure.
  - Always keep in mind emergency response measures against unexpected movement toward a person.
  - Ensure a safe place to retreat in case of emergency.

Failure to observe this precautions may cause improper or unintended movement, which may result in personal injury.

- Maintenance and inspection must be performed by specified personnel.

Failure to observe this Warning may result in electric shock or injury.

- Contact your local YASKAWA representative for disassembly or repairs.

Not contacting your local YASKAWA representative can result in electrical shock or injury.

CAUTION

Robot Cells have Collaborative Motion functionality:

Collaboration is a special type of operation between a person and Robot sharing a common workspace. The following are the guidelines for collaborative operation.

1. Used for pre-determined tasks.
2. Possible when all protective measures are active.
3. For Robots with features specifically designed for collaborative operation.

The integrator shall include in the information for use the safeguards and mode selection required for collaborative operation.

CAUTION

- Do not operate the Robot when a [COOLING FAN2 ERROR] appears on the Programming Pendant.

If operation continues with a warning message, equipment damage can occur.

- During high speed continuous operation Robot temperature may rise quickly depending on ambient temperature and operation pattern.

If a warning message displays stop operations or equipment damage may occur.

- Monitor warning messages on the Programming Pendant.

Not monitoring warning messages may cause equipment damage.

- Refer to the Robot Controller Concurrent I/O manual for details on the signal output.

Not referring to Robot Controller Concurrent I/O manual can result in equipment damage.

Maintenance Safety

WARNING

- Make sure equipment has no potentially hazardous conditions.
  - area is clean and free of water, oil, debris, etc.
  - all safeguards are in place.
  - all safety equipment work correctly. Repair or replace any non-functioning safety equipment immediately.
  - Check the EMEREGENCY STOP button(s) for proper operation before programming. The equipment must be in E-Stop mode when not in use.

If a hazardous condition is present death or serious injury may occur.

- Use care when modifying software.
  - The equipment allows modifications to the software for maximum performance.

All modifications made to the software will change the way the equipment operates and may cause death or serious injury, as well as damage parts of the system.

- Make sure all modifications did not make create a hazardous or dangerous condition in all modes.

All modifications made to the software will change the way the equipment operates and may cause death or serious injury, as well as damage parts of the system.

- Disconnect and lockout/tagout all sources of energy before making modifications or connections.

Not disconnecting and doing lockout/tagout of all sources of energy can result in death or serious injury.

- Read and understand all maintenance procedures before completing procedures.

Not reading and understanding maintenance procedure may result in death or serious injury.

CAUTION

- Do not modify the Robot Controller.

Making modifications without written permission from YASKAWA will void the warranty.

- 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.

- Use proper replacement parts only.

Not using proper replacement parts can cause damage to equipment.

- All connections must be made within the standard voltage and current ratings of the equipment.

Improper connections can damage the equipment.

Notes for Moving and Transferring the Robot

DANGER

- When relocating, transferring, or selling the Robot, make sure that the Robot is always accompanied by its manuals so that all users have access to necessary manuals.

See the Bill of Material for a list of the manuals.

If any of them are missing, contact your local YASKAWA representative. The telephone numbers of our offices are listed on the back cover of this manual.

- If a warning label on the Robot is dirty and unreadable, clean the label to make it clearly readable. If a warning label has come off, put the label back in place. Note that some local laws and regulations may prohibit equipment operation if safety labels are not in place.

Contact your local YASKAWA representative if requiring new warning labels.

- After the Robot is relocated, inspection by your local YASKAWA representative is recommended.

If installation or wiring of a device is incorrect, personal injury and/or equipment damage may result.

Definition of Terms Used Often in This Manual

The MOTOMAN is the YASKAWA industrial Robot product.

The MOTOMAN Robot usually consists of a Manipulator, Robot Controller, Programming Pendant, and supply cables.

In this manual, the equipment is designated as follows unless the instructions is for a specific piece of equipment:

Equipment	Manual Designation
ArcWorld 6000-755, ArcWorld 6200-755, ArcWorld 6300-755, ArcWorld 6000-1255RH, ArcWorld 6200-1255RH, ArcWorld 6300-1255RH, ArcWorld 6000-1255SL, ArcWorld 6200-1255SL, or ArcWorld 6300-1255SL,	ArcWorld
YRC1000 Controller	Robot Controller
YRC1000 Programming Pendant	Programming Pendant
AR1440 or AR2010 Manipulator	Robot
Cable between the Manipulator and the Robot Controller	Robot cable
RM2-755, RM2-1255RH, or RM2-1255SL	Positioner

Descriptions of the Programming Pendant keys, buttons, and displays are shown as follows:

Equipment		Manual Designation
Programming Pendant	Character Keys /Symbol Keys	The keys which have characters or symbols printed on them are denoted with [ ]. e.g. [ENTER]
	Axis Keys /Numeric Keys	[Axis Key] and [Numeric Key] are generic names for the keys for axis operation and number input.
	Keys pressed simultaneously	When two keys are to be pressed simultaneously, the keys are shown with a “+” sign between them, e.g. [SHIFT]+[COORD].
	Mode Switch	Mode Switch can select three kinds of modes that are denoted as follows: REMOTE, PLAY or TEACH. (The switch names are denoted as symbols)
	Button	The three buttons on the upper side of the Programming Pendant are denoted as follows: START, HOLD, or Emergency Stop. (The button names are denoted as symbols)
	Displays	The menu displayed in the Programming Pendant is denoted with { }. e.g. {JOB}

Registered Trademark

In this manual, names of companies, corporations, or products are trademarks, registered trademarks, or bland names for each company or corporation. The indications of ® and ™ are omitted.

Robot Disposal

WARNING

- Take precautionary measures to prevent the Robot from overturning, such as anchoring it firmly, etc., even when temporarily storing it before disposal.

Failure to observe this instruction may cause overturning of the Robot, which may result in personal injury.

CAUTION

- Do not modify the Robot.

Failure to observe this instruction can cause fire, mechanical failure, or malfunction, which may result in personal injury and/or equipment damage.

NOTICE

- When disposing of or recycling the Robot, follow the applicable national/local laws and regulations.
- This symbol is applicable in some locations.

The wheelie bin symbol on this product, manual or its packaging indicates that at the end of life the product should enter the recycling system. It must be disposed at an appropriate collection point for electrical and electronic equipment (EEE) and should not be put in the normal waste stream.

Table of Contents

1 Introduction

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

1.1 About This Document

This system manual is delivered with ArcWorld systems to provide a “first look” and overview of the complete Motoman ArcWorld system. Read and understand this manual before moving on to more detailed documentation that is included with the ArcWorld. Although basic in content, the system manual is intended for personnel who have received operator training from YASKAWA and are familiar with the operation of this particular Motoman system. For more detailed information on any specific component or peripheral of the ArcWorld, review the full documentation package that is included (refer to *section 1.5 “Reference Documentation” on page 1-23*).

NOTICE

This manual documents a standard Motoman system. If the system is custom or modified, use this manual in conjunction with the drawings, schematics, and part listings (Bill of Material) for the specific system.

The drawings, schematics, and parts listing are included in the documentation package supplied with the Motoman system.

1.2 System Overview

The ArcWorld provides a complete arc-welding solution in a standardized configuration (see *Fig. 1.3 "System Layout"*). The ArcWorld 6000 Series systems are designed around a Robot and a welding power source.

*Table 1-1(a): ArcWorld 6*00-755 General Specifications*

	ArcWorld 6000-755 2 Meter Span	**ArcWorld 6000-755 3 Meter Span**	**ArcWorld 6200-755 2 Meter Span**	**ArcWorld 6200-755 3 Meter Span**	**ArcWorld 6300-755 3 Meter Span**
Robot Controller	⟵ YRC1000 ⟶				
Manipulator	⟵ AR1440 OR AR2010 ⟶				
Robot Quantity	1	1	2	2	3
Work Stations	⟵ Two ⟶				
Work Area/Envelope	⟵ 1300mm Tool Diameter (Max) ⟶				
Door Opening	⟵ 972.2mm ⟶				
Positioner	⟵ RM2-755 ⟶				
Positioner Motion (Main Axis)	⟵ 180 degrees ⟶				
Each Tooling Axis	⟵ ±360 degrees ⟶				
Payload Capacity Per Side	⟵ 755kg ⟶				
Fencing	⟵ Heavy Gauge Wire Mesh ⟶				
Riser Height	⟵ 915mm ⟶				
Access Door	⟵ Dual Channel Safety Interlock ⟶				
Light Curtain	⟵ Guarding Load Side / Operator ⟶				
Approximate Weight of ArcWorld Cell Assembly	4248.736kg	4646.873kg	4623.853kg	5022.202kg	5397.425kg
Approximate Weight of Robot Controller Base Assembly	247.636kg	247.636kg	335.32kg	335.32kg	419.36kg
Approximate Weight of Complete Assembly	8497.472kg	9293.746kg	9247.706kg	10044.404kg	10794.850kg
Dimensions of ArcWorld Cell Assembly	6040 x 3213 x 2300mm	6040 x 4220 x 2300mm	6040 x 3213 x 2300mm	6040 x 4220 x 2300mm	6040 x 4220 x 2300mm
Dimensions of Robot Controller Assembly	1194 x 772 x 1670mm	1792 x 772 x 1670mm	1194 x 772 x 1670mm	1792 x 772 x 1670mm	2390 x 772 x 1670mm
Input Voltages	⟵ 480VAC Without Transformer ⟶				
External Axis Speed in TEACH Mode	⟵ 250mm/sec ⟶				

*Table 1-1(b): ArcWorld 6*00-1255*RH *General Specifications*

	ArcWorld 6000-1255RH 2 Meter Span	**ArcWorld 6000-1255RH 3 Meter Span**	**ArcWorld 6200-1255RH 2 Meter Span**	**ArcWorld 6200-1255RH 3 Meter Span**	**ArcWorld 6300-1255RH 3 Meter Span**
Robot Controller	⟵ YRC1000 ⟶				
Manipulator	⟵ AR1440 OR AR2010 ⟶				
Robot Quantity	1	1	2	2	3
Work Stations	⟵ Two ⟶				
Work Area/Envelope	⟵ 1300mm Tool Diameter (Max) ⟶				
Door Opening	⟵ 972.2mm ⟶				
Positioner	⟵ RM2-1255RH ⟶				
Positioner Motion (Main Axis)	⟵ 180 degrees ⟶				
Each Tooling Axis	⟵ ±360 degrees ⟶				
Payload Capacity Per Side	⟵ 1255kg ⟶				
Fencing	⟵ Heavy Gauge Wire Mesh ⟶				
Riser Height	⟵ 915mm ⟶				
Access Door	⟵ Dual Channel Safety Interlock ⟶				
Light Curtain	⟵ Guarding Load Side / Operator ⟶				
Approximate Weight of ArcWorld Cell Assembly	2079.767kg	4073.278kg	3973.406kg	4460.662kg	4862.382kg
Approximate Weight of Robot Controller Base Assembly	220.662kg	220.662kg	311.662kg	311.662kg	446.622kg
Approximate Weight of Complete Assembly	4597.003kg	5172.010kg	4994.401kg	5559.392kg	5963.301kg
Dimensions of ArcWorld Cell Assembly	6040 x 3278 x 2300mm	6040 x 4280 x 2300mm	6040 x 3278 x 2300mm	6040 x 4280 x 2300mm	6040 x 4280 x 2300mm
Dimensions of Robot Controller Assembly	1189 x 840 x 1819mm	1189 x 840 x 1819mm	1789 x 840 x 1819mm	1789 x 840 x 1819mm	2387 x 840 x 1819mm
Input Voltages	⟵ 480VAC Without Transformer ⟶				
External Axis Speed in TEACH Mode	⟵ 250mm/sec ⟶				

*Table 1-1(c): ArcWorld 6*00-1255*SL *General Specifications*

	ArcWorld 6000-1255SL 2 Meter Span	**ArcWorld 6000-1255SL 3 Meter Span**	**ArcWorld 6200-1255SL 2 Meter Span**	**ArcWorld 6200-1255SL 3 Meter Span**	**ArcWorld 6300-1255SL 3 Meter Span**
Robot Controller	← YRC1000 →				
Manipulator	← AR1440 OR AR2010 →				
Robot Quantity	1	1	2	2	3
Work Stations	← Two →				
Work Area/Envelope	← 1300mm Tool Diameter (Max) →				
Door Opening	← 972.2mm →				
Positioner	← RM2-1255SL →				
Positioner Motion (Main Axis)	← 180 degrees →				
Each Tooling Axis	← ±360 degrees →				
Payload Capacity Per Side	← 1255kg →				
Fencing	← Heavy Gauge Wire Mesh →				
Riser Height	← 915mm →				
Access Door	← Dual Channel Safety Interlock →				
Light Curtain	← Guarding Load Side / Operator →				
Approximate Weight of ArcWorld Cell Assembly	2079.767kg	4073.278kg	3973.406kg	4460.662kg	4862.382kg
Approximate Weight of Robot Controller Base Assembly	220.662kg	220.662kg	311.662kg	311.662kg	446.622kg
Approximate Weight of Complete Assembly	4597.003kg	5172.010kg	4994.401kg	5559.392kg	5963.301kg
Dimensions of ArcWorld Cell Assembly	6040 x 3278 x 2300mm	6040 x 4280 x 2300mm	6040 x 3278 x 2300mm	6040 x 4280 x 2300mm	6040 x 4280 x 2300mm
Dimensions of Robot Controller Assembly	1189 x 840 x 1819mm	1189 x 840 x 1819mm	1789 x 840 x 1819mm	1789 x 840 x 1819mm	2387 x 840 x 1819mm
Input Voltages	← 480VAC Without Transformer →				
External Axis Speed in TEACH Mode	← 250mm/sec →				

The ArcWorld features a total safety environment that meets or exceeds the requirements of the ANSI/RIA R15.06-2012 Robot Safety standard and is designed to safeguard both personnel and equipment. Heavy-gauge, wire-mesh safety fencing prevents unintended entry of personnel into the work cell while it is in operation. Arc curtains cover the wire-mesh fencing to decrease the amount of arc radiation that escapes the work cell during welding operations. A dual-channel interlocked access door at the back of the work cell provides convenient access to equipment while providing a safety interlock to disable all equipment should the access door be opened while the Robot is active (in PLAY mode). A safety light curtain system provides a “sensing field” in front of the Positioner to protect the operator. Positioner movement is prevented whenever an operator has disrupted the sensing field of the light curtain system. Reset the light curtain to resume system operation.

Safeguards for the system complement the system's operation while protecting people that program, operate, and/or provide maintenance to the system. Possible pinch points and other hazards from the risk assessment process determined needed safeguards and interlocks. While the system design safeguards the support staff, it does not protect against misuse of the system. Misuse of the system includes, but is not limited to climbing over/under barriers, climbing over/under interlocked doors, or disabling/bypassing of system interlocks.

During the install and commissioning process the end user must ensure tooling, and other equipment, do not cause additional hazards into the design. This evaluation ensures that the system will provide a safe and reliable operation. The Risk Assessment document should be reviewed for installation of the system and prior to operation. Any changes and additions to the system require a full review of the Risk Assessment document.

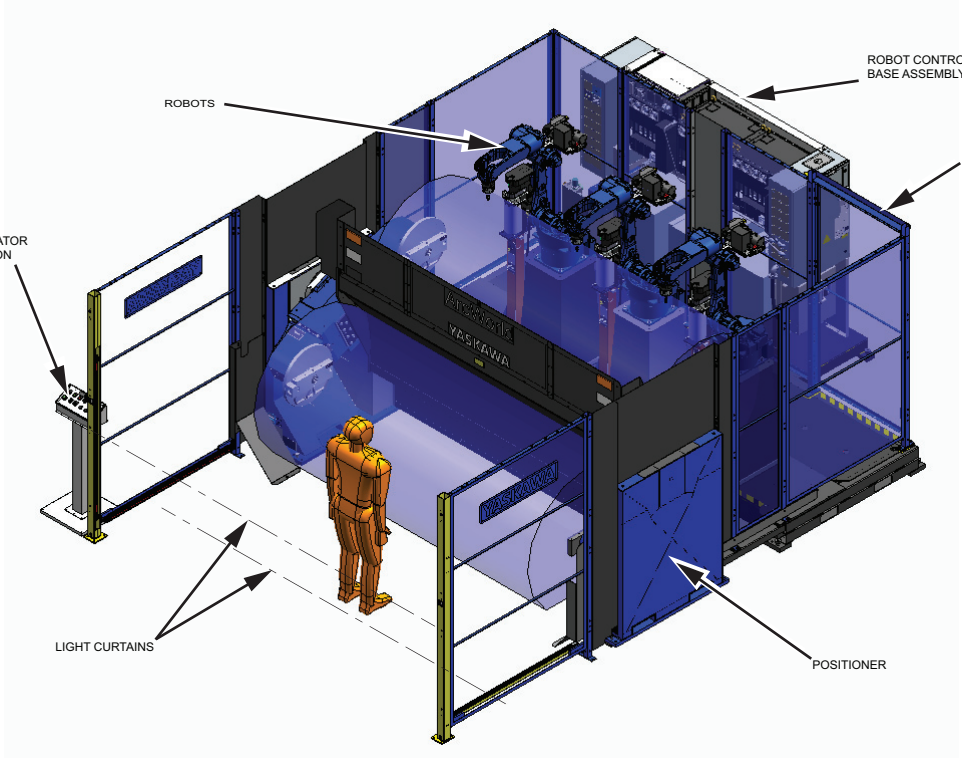
1.3 System Layout

The ArcWorld consists of two main assemblies. These three main assemblies are the Positioner Assembly, Robot Common Base Assembly, and the Robot Controller Base Assembly.

NOTICE

Fig. 1-1 is an example of an ArcWorld 6000 configuration. ArcWorld 6000s use the same basic format for the various cell models. The cell models use different Positioner models, Manipulator models, fixture span, and quantity.

Figure 1-1: System Layout



1.3.1 Positioner Assembly

The Positioner assembly allows parts to be loaded onto the fixture to achieve the most efficient configuration and then swept into the welding zone.

1.3.1.1 Positioner Assembly Major Components

- Positioner
- Safety Equipment
  - Steel Arc Screen
  - Heavy-gauge, Welded Wire Safety Fencing
  - Light Curtain System

1.3.2 Robot Cell Assembly

The Robot(s), share a common steel base for ease of installation and assurance of proper alignment between the Robot(s). The welded wire safety fencing completely surrounds the ArcWorld work cell. The Robot Controller shares a common equipment platform with the welding power source(s).

The common equipment platform is located outside and to the rear of the work cell. This arrangement allows most of the component wiring interconnects to be pre-wired at the factory, thus reducing the amount of point-to-point wiring required by the customer. All operator controls, including those on the Programming Pendant, Robot Controller, welding power supplies, and Operator Station pedestal, are accessible from outside the ArcWorld work cell.

1.3.2.1 Robot Cell Major Components

The Robot Cell Assembly includes the following major components:

- – Robot
- – One Operator Station
- – Welding Equipment (for each Robot)
  - • Welding Power Supply
  - • Welding Torch (air cooled)
  - • Wire Feeder
  - • Applicable Welding Interface
  - • Torch Mount
- – Safety Equipment
  - • Arc Curtains (cover the safety fencing)
  - • Interlocked Work-cell Access Door

1.3.3 Robot Controller Base Assembly

1.3.3.1 The Robot Controller Base Assembly Major Components

- – Top Hat and Interface
  - • FSU Relay Board
  - • Power Distribution Terminals
  - • Eight port Ethernet Switch
  - • Machine Safety Board
  - • External Axis Connection(s)
  - • Master Fuse Module
- – Control Enclosure Assembly
- – Robot Controller

• Programming Pendant (located on Robot Controller)

NOTICE

- DR2C and TR3C Robot Controller configurations include two or three Programming Pendants.
- The ArcWorld configuration allows connection of only one Programming Pendant at a time.
- Operations of the ArcWorld only requires one Programming Pendant.

– Accessories/Air Panel
  • Pneumatic Filter/Regulator
  • Air Manifold
  • Valve Assemblies
– Weld Accessories
– 110V GFCI Receptacle (Optional)
– Welding Power Supply
– Transformer (Optional)

1.3.4 Optional Equipment

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

- **Slip Ring Kit: Air & I/O**
  This slip ring features 12 channel of discrete connections for customer use in a variety of scenarios. Each conductor can carry up to 10 amps of current.

- **Slip Ring Kit: EtherNet, I/O & Air**
  This slip ring features both an EtherNet connection and six channels of discrete connections for customer use in a variety of scenarios. The EtherNet connection can be used for EtherNet/IP or other communication networks as appropriate - the cabling is shielded twisted pair when possible. Each discrete conductor can carry up to 10 amps of current.

- **Torch Cleaner**
  This stand-alone device uses a pneumatic motor with a reamer to clean the torch nozzle.

- **Wire Cutter**
  Automatically cuts welding wire to a desired length. A programmed path brings the welding wire into the cutter jaw. Using a Robot output signal, the pneumatic device will shear off the wire, leaving a clean edge at the programmed stick-out length. A specific length of wire is used for touch sensing on the Robot system.

- **Water-cooled Torch (with water circulation)**
  Reduces temperatures and prevents the system from overheating.

- **TouchSense**
  The Touch Sensing function enables the Robot to find the welding joint.

- **ComArc**
  Seam tracking functions by weaving the welding wire in the joint and sensing the current at each stroke of the weaving motion. If the detected current at each stroke is not the same, the Robot will correct its path in a direction required to make the current the same.

- **Digital Gas Flow Gauge**
  Provides a readout and diagnostic for the shield gas delivery to confirm if flow is present. This sends a digital signal to the Robot Controller to trigger an alarm when detecting a low flow.

- **Beacon Light**
  Visual indicator of cell status and audible alert if alarm occurs. Colors indicate status conditions. Stack lights are in front of the cell for operator and plant personnel. Fence or post mounting is available for most cells and typically is located near the operator stations.

- **Tip Change Request with No Box**
  This is a standalone “Operator Station” with the buttons and indicators to complement the tip change process. This is available for compact cells where the Robot(s) can move towards an operator door, station door, or barrier door to allow the operator to access the torch to do the tip change operation.

- **Enabling Switch for Second Cell Occupant**
  Enabling switch with holster allows additional personnel to enter the workcell when removing switch from holster.

- **Wire Spool Mount**
  A bracket and cover to support cabling and mounting of a 30lb spool to the Robot. Also provided is conduit between the spool and wire-feeder.

- **Wire Delivery Kit for Bulk Wire**
  This kit includes brackets and conduit to attach to a customer provided bulk spool.

- **No Wire Sensor**
  Provides feedback from each wire conduit/delivery system when there is no wire present.

- **Exhaust Hoods**
  Ideal solution for capturing fumes before they can spread throughout a facility, and ensuring regulatory compliance.

  YASKAWA has worked with RoboVent to provide pre-engineered customized hoods that match each ArcWorld. Specific ventilation requirements require discussions with RoboVent.

1.4 Theory of Operation and Safe Guarding

1.4.1 System Overview and Variations:

The ArcWorld series of cells are designed to accommodate single, dual, or triple Robots. The cells are available in three configurations:

– ArcWorld 6000

– ArcWorld 6200

– ArcWorld 6300

The cell is designed for arc welding applications where the Robot(s), Controller(s) and welding power source(s) are located behind the cell. In the ArcWorld 6200 and ArcWorld 6300 cells, the R2 and R3 Robots use full-size Robot Controller cabinets. The DR2C and TR3C configurations are such that if the Robot needed to be redeployed, the Robot and Robot Controllers can be separated to be used in individual Robot applications.

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

Other items included with the cell are: A swing door with safety interlock which allows access from the rear of the work cell. The Robots sit(s) on a 915mm riser(s). Mounting provisions are provided in the base for in-cell torch cleaning station(s). The pedestal mount operator station is on front of the cell and is able to be relocated as desired based on cabling restrictions. The operator station includes the following;

- [ALARM / RESET] indicator/button
- [CYCLE START CYCLE LATCHED] button/indicator
- [SERVO ON] button
- [START] button
- [POSITIONER AUTO/ MANUAL] selector switch
- [LIGHT CURTAIN RESET] button/indicator
- [ROBOT HOLD] button
- Emergency Stop button
- [REV/HOME/FWD] Three position joystick (jogs the operator side tooling)

A L-shape light curtain provides personnel detection for the front of the cell. This light curtain will detect when someone approaches the Positioner and ensures the Positioner does not move while the light curtain is broken.

Any light curtain violation requires the operator to check that the cell is clear of any interferences and all operators are now clear of the protected area before acknowledging the cell is now clear to resume operation. Pressing the [LIGHT CURTAIN RESET] button is the operator’s acknowledgment that this observation has occurred.

During a light curtain violation the “LIGHT CURTAIN RESET” light will flash on the operator station until pressing the [LIGHT CURTAIN RESET].

When the operator completes work in the operator side station they will exit the station, and MAKE SURE all other operators and equipment are clear of the station, Positioner, customer supplied tooling/fixture, and then press the [LIGHT CURTAIN RESET] button to resume monitoring of the station by the light curtain. When the light curtain is clear the reset indicator stops flashing. Servos should have remained on through this process.

The Robot Controller's "Safety Logic Circuit" and R1's Functional Safety Unit (FSU) are responsible for monitoring safety critical devices and controlling Positioner motion (described in detail in later sections). Each Robot includes its own FSU to monitor its position as well as motion and position status of the Positioner. The "Safety Logic Circuit" monitors safety critical external devices such as the light curtains and FSU generated signals like the trunnion position (At side A/B) then generates signals to enable and disable other FSU functions such as "Standstill Monitoring" and "Speed Limiting" to ensure operator safety.

Fig. 1-2(a): ArcWorld 6000-755 Cell

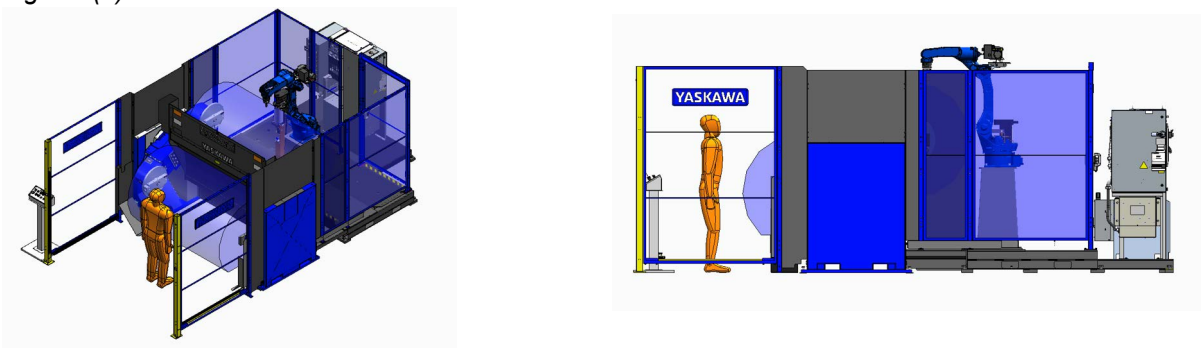


Fig. 1-2(b): ArcWorld 6200-755 Cell

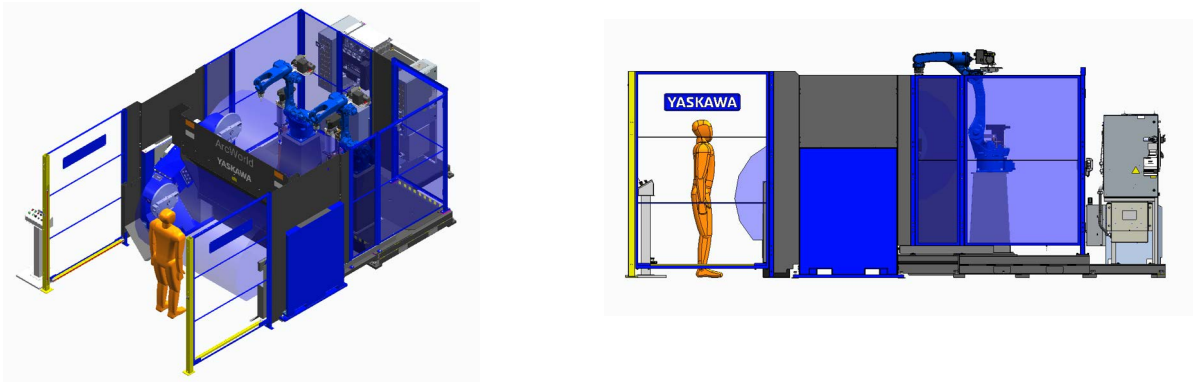
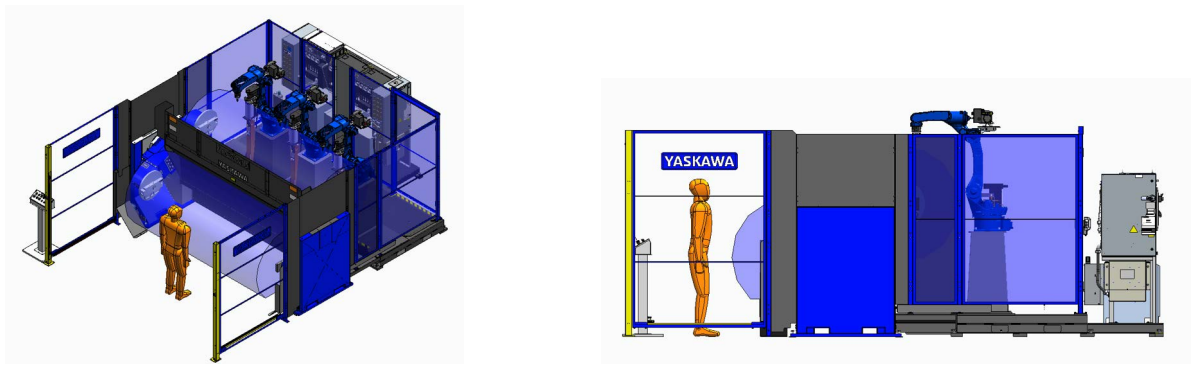


Fig. 1-2(c): ArcWorld 6300-755 Cell



1.4.2 Cell Related Safety Functions & Components:

Ensuring safety is paramount to YASKAWA and the proper operation of the ArcWorld cells. The following sections outline the various safety related functions and their operational interactions for proper operation. Functional Safety files are loaded and verified prior to shipment from YASKAWA and are continually checked to ensure they are active when expected through concurrent IO (CIO). The concurrent I/O is programmed to generate a “SYS CRITICAL FSU FUNCT DISABLED” alarm if any of the following safety functions are disabled while in PLAY mode. A message on the bottom will indicate the problem, this guides the operator in regards to which files are required to be active to make the system operational in PLAY mode. Specific details on each message and the resolution can be found in *Chapter 6 “Alarms and Messages”*.

1.4.2.1 Trunnion Axis Position via “Axis Range Limit” Function:

NOTICE

This cell does not use the trunnion axis limit switches to determine “At Side A” or “At Side B”. Instead, the FSU's “Axis Range Limit” function provides the status inputs to the “Safety Logic Circuit.”

The following two “Axis Range Limit” files are used to report the trunnion axis position instead of mechanical limit switches. The two files are set as “Valid” which indicates that they are active at all times and their “Alarm” setting is set to “Off” to allow them to report actual status without interrupting cell operation. These two files will enable the specified “Output Signal” (FS-OUT01 or FS-OUT02) whenever the trunnion axis is within the 1 degree location specified.

NOTICE

File#1 “Trunnion A Side At Rbt(s)” may not read the (-179.5) to (-180.5) degrees as shown in *Fig. 1-3(b)* and *Fig. 1-3(c)*. The values for this file could vary by as much as (± 3) degrees if the welded hardstop location varied on the particular Positioner. YASKAWA will ensure proper setup prior to shipping the system just be aware that the angular values in file#1 could vary based on the particular Positioner.

Fig. 1-3(a): "Axis Range Limit" Files Used

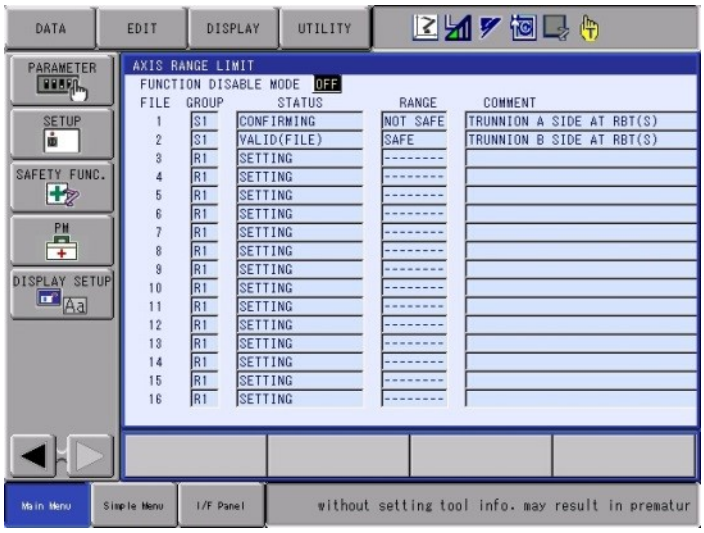


Fig. 1-3(b): File #1: "Trunnion A Side At Robot(s)"

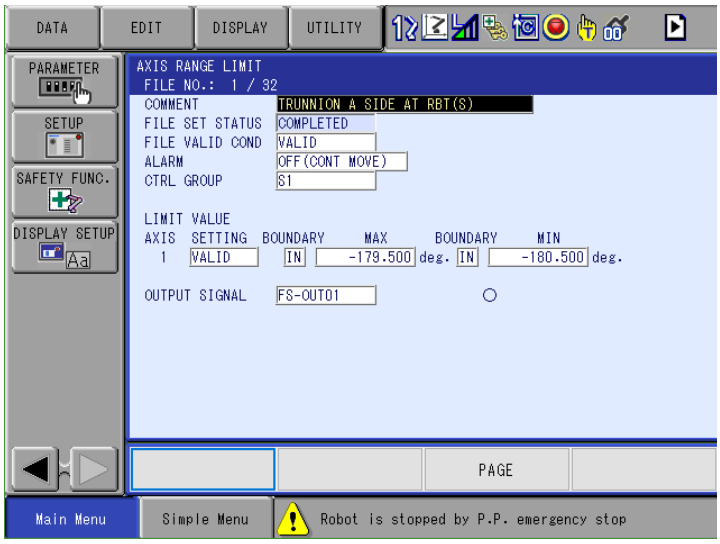
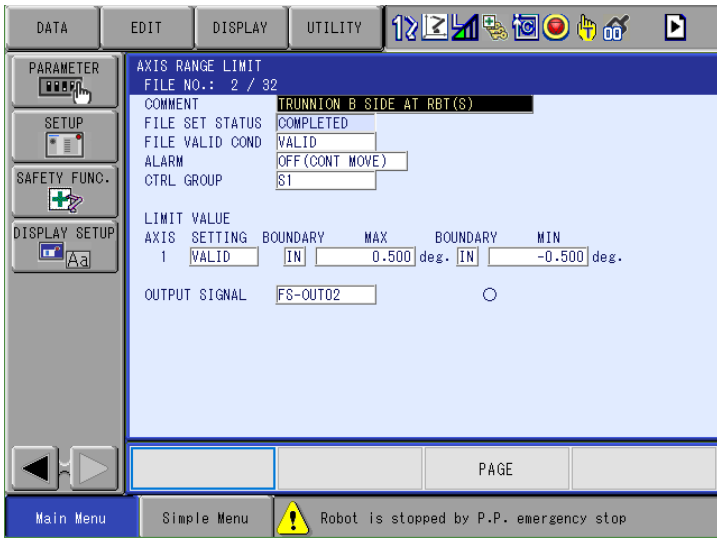


Fig. 1-3(c): File #2: "Trunnion B Side At Robot(s)"



1.4.2.2 Safety Logic Circuit:

The “Safety Logic Circuit” acts as an internal safety PLC, monitoring the status of inputs and generating controlling outputs. The inputs could be external switches or sensors connected to the either the Safety Board or the Functional Safety Board. In the case of the ArcWorld cell the Light Curtains are connected the Functional Safety Board’s FSBIN1 input. The Safety Logic Circuit then monitors the light curtain status along with the trunnion axis position (at side A or B) to determine what axes need to have the Speed Limited at 30% speed, when to stop to the Positioner and also controls the status of fixture A and B tooling power.

Light curtain reset logic is included in the safety logic circuit. This logic monitors the status of the light curtain device itself then generates a “clear” signal based on rising pulse and inputs from the operator station.

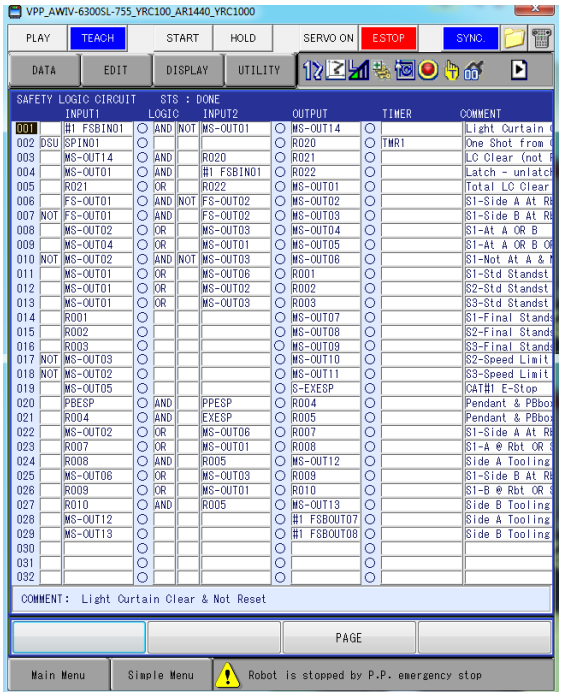
In the Robot Controller the Safety Logic Circuit is expanded. A system section is added. The EDM feedback signals for the tooling relays is monitored in this section. This section can only be changed with the YASKAWA mode password.

Results of the “Safety Logic Circuit” can be utilized in Concurrent IO (CIO) if the signals are mapped/routed through a MS-OUT signal. In the case of this ArcWorld Series of cells, the majority of logic is routed to MS-OUT signals and subsequently mapped to Universal Inputs to the status can be checked within INFORM jobs or mapped to PLCS on external industrial networks if needed.

NOTICE

Detailed operation of the “Safety Logic Circuit” can be found in the “Robot Controller Instructions.” See *section 1.5 “Reference Documentation”* concerning instructions.

Fig. 1-4(a): Safety Logic Circuit - Standard Version



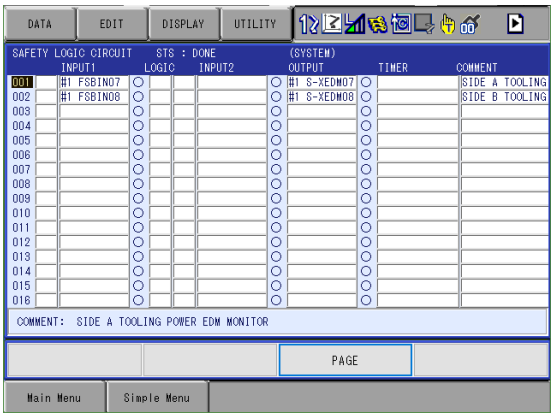
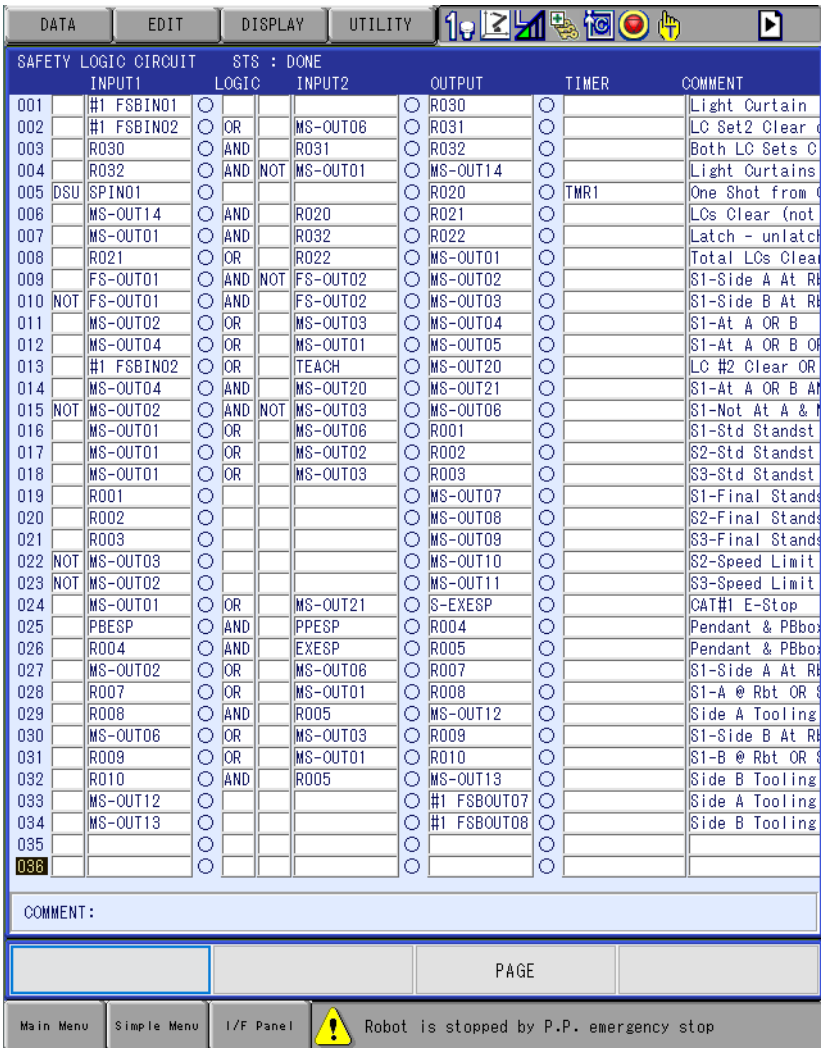


Fig. 1-4(b): Safety Logic Circuit - Additional Light Curtain Version



1.4.2.3 FSU Functions Controlled by “Safety Logic Circuit”:

The results of the “Safety Logic Circuit” enable and disable various FSU functions. The MS-OUT signals generated within the “Safety Logic Circuit” can be used as “Input Signals” to activate various functional safety functions. Below several safety functions are shown and described:

Fig. 1-5(a): “Speed Limit (Stop Monitor)” Files Used:

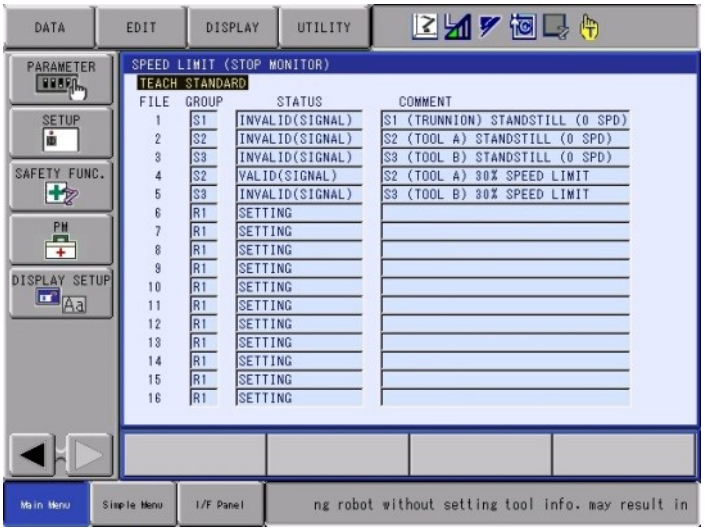
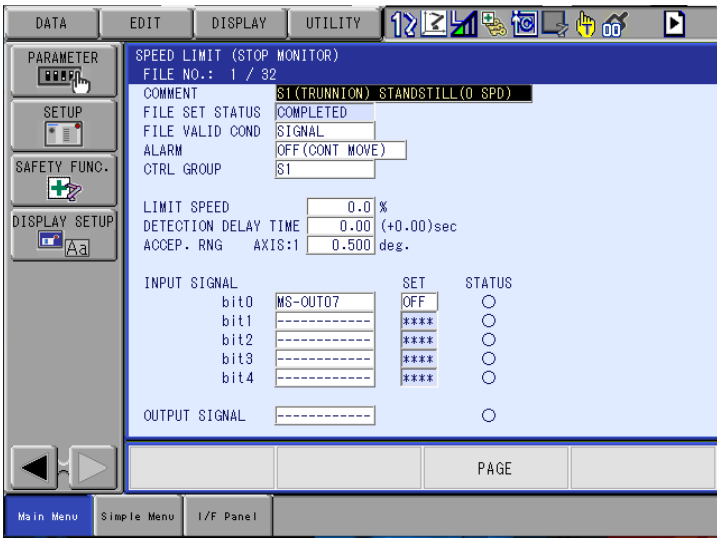
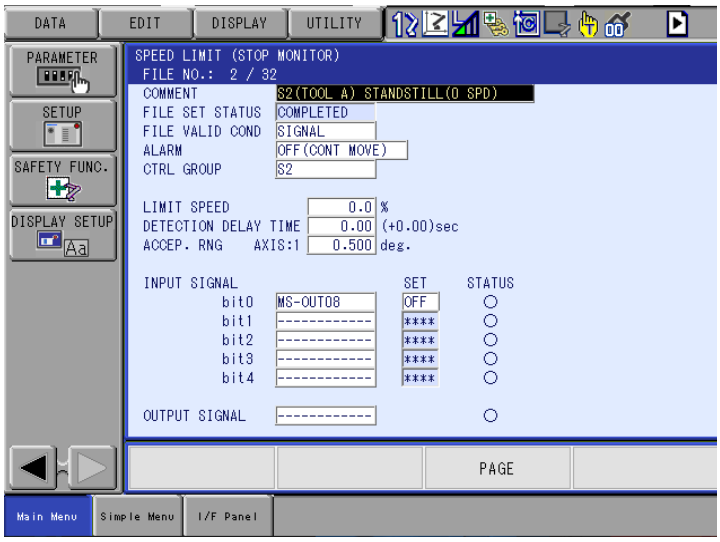


Fig. 1-5(b): File#1: “S1 (Trunnion) Standstill (0% Speed Limit)”



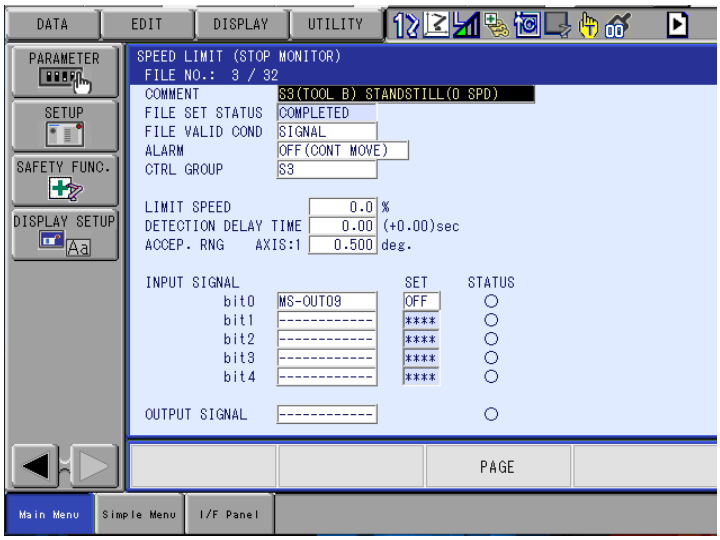
Axis	S1
Function	Prohibit trunnion axis motion
Triggering Input	MS-OUT07
Triggering Logic	Light curtain is broken and the trunnion axis located at “Side A” or “Side B”.

Fig. 1-5(c): File#2: "S2 (Tool A) Standstill (0% Speed Limit)"



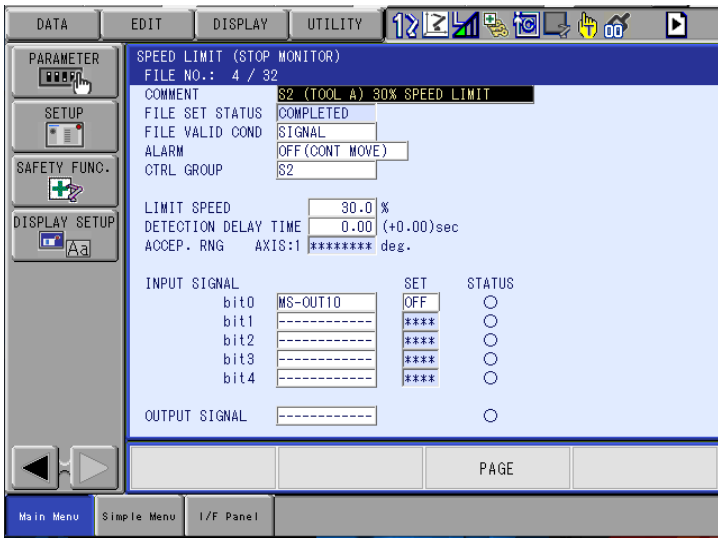
Axis	S2
Function	Prohibit S2 (Tool A) motion
Triggering Input	MS-OUT08
Triggering Logic	Light curtain is broken and S2 (Tool A) is at the Operator

Fig. 1-5(d): File#3: "S3 (Tool B) Standstill (0% Speed Limit)"



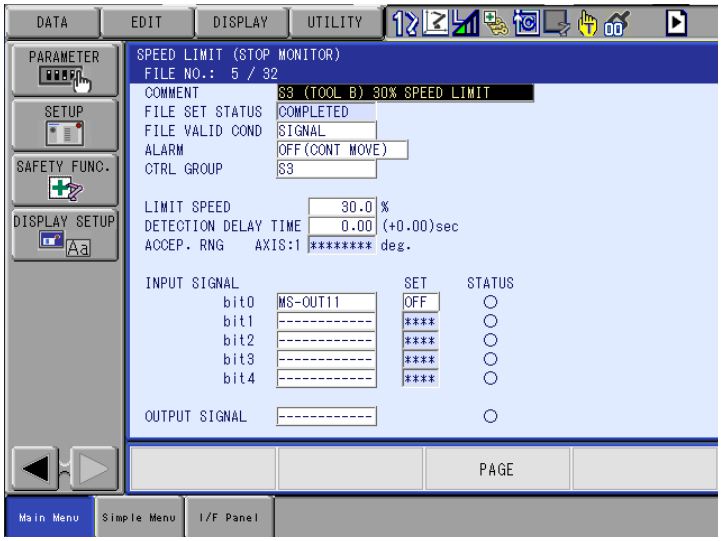
Axis	S3
Function	Prohibit S3 (Tool B) motion
Triggering Input	MS-OUT09
Triggering Logic	Light curtain is broken and S3 (Tool B) is at the Operator

Fig. 1-5(e): File#4: "S2 (Tool A) 30% Speed Limit)"



Axis	S2
Function	Limit S2 (Tool A) Speed < 30%
Triggering Input	MS-OUT10
Triggering Logic	S3 (Tool B) is at Robot/S2 (Tool A) is at the operator

Fig. 1-5(f): File#5: "S3 (Tool B) 30% Speed Limit)"



Axis	S3
Function	Limit S3 (Tool A) Speed < 30%
Triggering Input	MS-OUT11
Triggering Logic	S2 (Tool A) is at Robot/S3 (Tool b) is at the operator

1.4.2.4 Robot Range Limit Files

Each Robot in a cell configuration includes the FSU function Robot Range Limit. This prevents the Robots from colliding with the cell and the Positioner's main arc screen. If the cell layout changes or including options like a tip change box there is a requirement for modifications. These files are active in TEACH or PLAY mode.

NOTICE

The settings below show the values for the ArcWorld 6300-755 cell (three Robots with a three meter span with the RM2-755 Positioner). The values will be different for other configurations.

Fig. 1-6(a): Robot Range Limit Screen

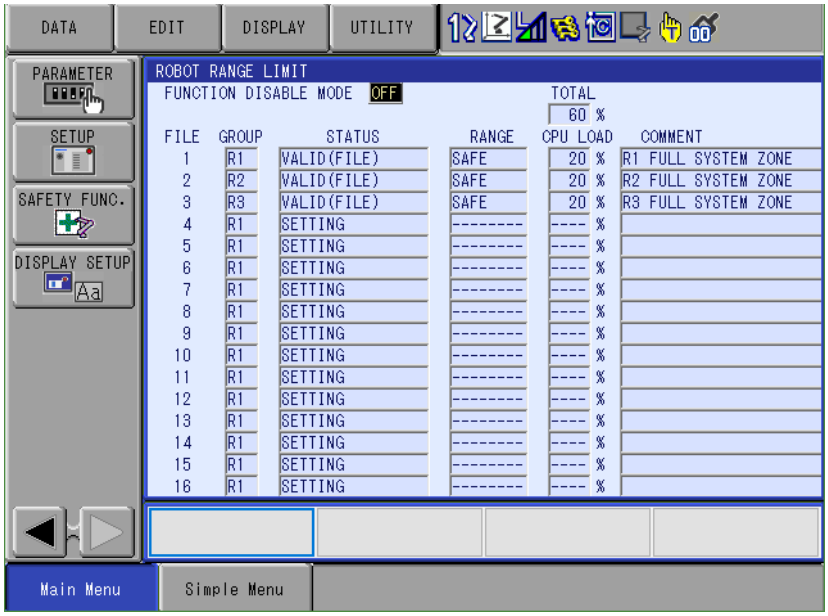
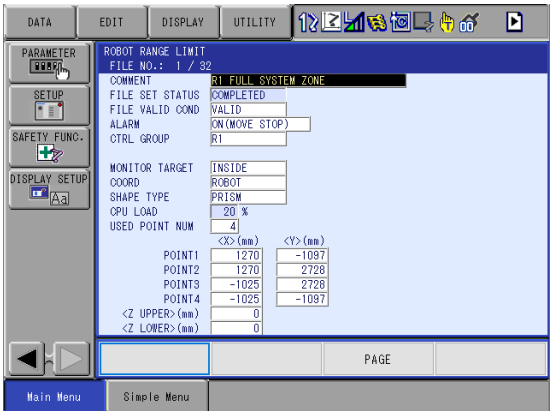


Fig. 1-6(b): R1 Full System Zone



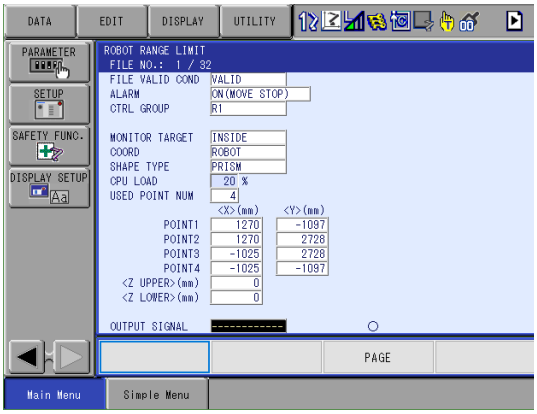
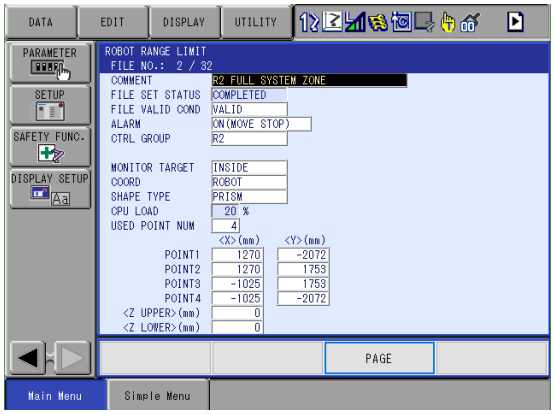


Fig. 1-6(c): R2 Full System Zone



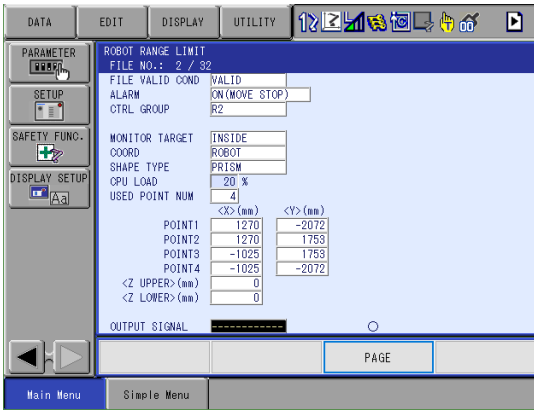
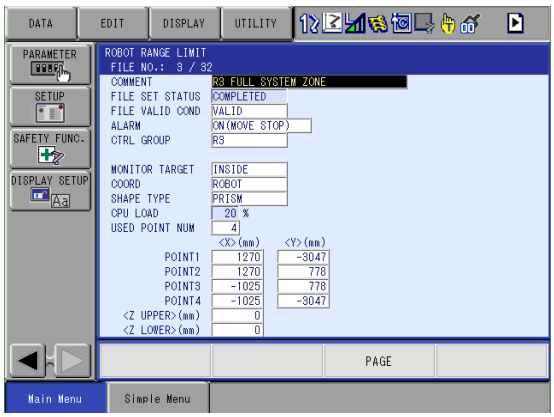
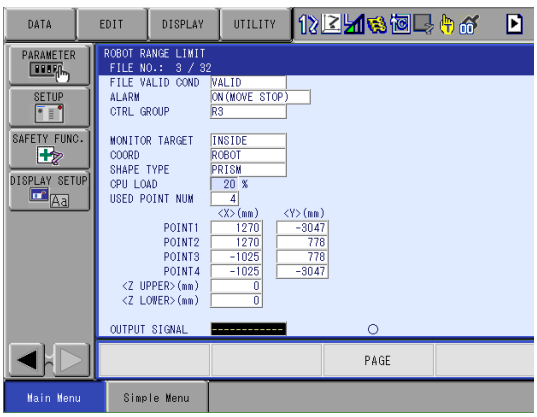


Fig. 1-6(d): R3 Full System Zone





1.4.2.5 Tooling Power Outputs Controlled by “Safety Logic Circuit”

It is common for the ArcWorld cells to have automated tooling. Control logic is included which allows tooling power to be switched On and Off based on the “Safety Logic Circuit”. The “Safety Logic Circuit” controls FSU outputs FSBOUT#7 and FSBOUT#8 which drive force-guided relays on a relay breakout card located in the top-hat enclosure.

– FSBOUT#7

- *Function:* Enable power to S2 (Tool A) tooling
- *Triggering Input:* MS-OUT12
- *Triggering Logic:* Power is applied anytime other than when S2 is at the operator and the light curtain is broken or any of the Emergency Stop buttons in the cell have been pressed.

– FSBOUT#8

- *Function:* Enable power to S3 (Tool B) tooling
- *Triggering Input:* MS-OUT13
- *Triggering Logic:* Power is applied anytime other than when S3 is at the operator and the light curtain is broken or any of the Emergency Stop buttons in the cell have been pressed.

1.4.2.6 External E-Stop & Safety Gate:

Other safety critical inputs such as “External E-Stop” and “Safety Gate” are wired directly into the Safety card. Their status is then available to “Safety Logic Circuit” where these signals can be utilized in conjunction with other logic when required.

1.4.2.7 System Teaching:

All ArcWorlds are intended to be programmed from within the cell. In order to program the Robot, it needs to be in TEACH mode from the selector switch on the front of the Programming Pendant. This TEACH mode selection will limit all Robot speeds to 250mm/sec While in TEACH mode, the operator gate can be opened allowing the programmer within the cell. In order for the Robot's servo motors to be turned on, the enabling switch on the Programming Pendant needs to be maintained. Once servo power is on, the operator is able to manipulate and program the operation sequences as desired. While in TEACH mode”, the individual Robots and the Positioner trunnion axis (S1) and tooling axes (S2 & S3) can be manipulated from the programming pendant. The system will have preconfigured “Sweep” jobs that will allow rotating of “Side A” and “Side B” tooling toward the Robot(s). Selecting these jobs and pressing “Interlock” + “Test Start” will execute the job and rotate the tooling toward the Robot(s). While in TEACH mode, if the operator or another person breaks the light curtain, the “Speed Limit” functions will activate (if the trunnion axis is located at Side A or B). While teaching, the operator-side tooling axis will be limited to 30% speed just as it will be limited in PLAY mode.

1.4.2.8 System Operation:

Once path and logic programming has been completed, the system can be placed into operation once the following conditions have been met:

1. Programming Pendant must be in PLAY Mode
2. The safety gate must be closed
3. The “Master” job must be selected
4. The job “Cycle” need to be set to {AUTO}
5. Servo power has to be applied from the Programming Pendant
6. The [Start] button on the Programming Pendant needs to be pressed to begin execution of the “Master” job.

Normal cell production beings with the assumption that the trunnion axis is at either “Side A” or “Side B” as reported by the “Range Limit” file #1 or #2. Anytime the light curtain on the front of the cell is clear, the Positioner is free to move as directed by the INFORM job but the operator-side tooling axis is speed limited to 30% speed. Once the operator approaches the cell to load a part and breaks the light curtain, the operator-side tooling axis (S2 or S3) and the trunnion axis (S1) will start a speed limit file in the FSU, ensuring no motion of the trunnion or operator-side tool can occur with the light curtain broken. Once the part loads, the operator steps out of the light curtain ending the speed limit restriction and the operator-side tooling axis reverts to the 30% speed limit. Once loading the new part, the operator presses the [Cycle Start] button on the operator station allowing the INFORM job to sweep the Positioner when the Robot side part completes.

If the Robot(s) are still processing the part when pressing the [Cycle Start] button, the [Cycle Start] button will light, indicating the Positioner will automatically sweep once the Robot(s) complete their process.

Once the Positioner sweeps, the operator can unload the processed part and reload a new part to process while the Robot processes the other side.

Loading the next part and pressing the [Cycle Start] button will continue the process if there are no faults or issues during the production of the part.

The 3-position joystick on the operator station allows manual movement of the operator-side tooling. The joystick allows jogging forward and reverse to desired position within ±90 degrees of the final sweep position.

The light curtain must remain clear while jogging the axis to the position desired. Once in position enter light curtain to load parts (axis speed limiting enabled when entering the curtain).

Once the light curtain is clear, use the joystick to jog the Positioner to another posture, if desired or if the joystick is in the “Home” position momentarily, the Positioner will re-home itself to the pre-sweep position. If pressing the [Cycle Start] button before re-homing the axis, an automatic re-homing will occur to minimize cycle time.

1.5 Reference Documentation

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

- *YRC1000 READ FIRST!! Safety Requirements (179526-1CD)*
- *AR1440 Manipulator Manual (HW1484060)*
- *AR1440 Manipulator Maintenance Manual (HW1484062)*
- *AR2010 Manipulator Manual (HW1484892)*
- *AR2010 Manipulator Maintenance Manual (HW1484894)*
- *Brake Release Manual (HW1483370)*
- *YRC1000 Controller Instructions (RE-CTO-A221)*
- *YRC1000 General Operator's Manual (RE-CSO-A051)*
- *YRC1000 Maintenance Manual (RE-CHO-A114)*
- *YRC1000 Alarm Codes Manual (RE-CER-A600)*
- *Operator's Manual for Arc Welding (RE-CSO-A052)*
- *Concurrent I/O Manual (RE-CKI-A467)*
- *RM2-755RDR/1255RH Positioner Manual (183523-1CD)*
- *RM2-755/1255SL Positioner Manual (166008-1CD)*
- *YRC1000 Independent/Coordinated Control Function Manual (HW1484042)*
- *INFORM User's Manual (RE-CKI-A466)*
- *Functional Safety Board Operation Manual (HW1481991)*
- Vendor manuals for system components not manufactured by YASKAWA

1.5.1 Location of Operations in Reference Documentation

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

Table 1-2: Reference Table

Description	Manual/Chapter	Handling	Installation & Commissioning	Start-up	System Information	Use of System	Maintenance	Decommissioning	Emergency Situations	Robot Specific Information
Environmental Information	Manipulator & Controller Chap 3, Positioner Chap 2	✓	✓	✓		✓	✓			
Dimensions	ArcWorld Chap 3	✓			✓		✓			
Mass Value(s)	ArcWorld Chap 3	✓			✓		✓			✓
Center of Gravity, Lifting	Positioner & Manipulator Chap 2	✓					✓	✓		✓
Anchoring	Positioner Chap 2 ArcWorld Chap 3	✓	✓	✓			✓			
Vibration Dampening	Positioner Chap 2 Manipulator Chap 3		✓		✓		✓			
Assembly & Mounting Condition	Positioner Chap 2 Manipulator Chap 3		✓				✓	✓		
Space Needed for Maintenance	ArcWorld Chap 3		✓		✓	✓	✓			
Connecting Power	ArcWorld Chap 3		✓	✓	✓		✓	✓	✓	
Waste Removal	Controller Chap 1		✓				✓	✓		
Protective Measures by Users	Throughout Manuals		✓		✓		✓			
Initial Checks	ArcWorld Chap 3 & 4		✓	✓		✓	✓			
Description of system, fittings, and protective devices	ArcWorld Chap 3		✓	✓	✓	✓	✓			✓
Range of Applications	ArcWorld Chap 1				✓		✓			✓
Safety Function Perform Correctly	ArcWorld Chap 3 & 4		✓	✓		✓	✓			
Controller Functions, Operator Panels, Programming Pendant and Enabling Devices	ArcWorld Chap 2 & 3		✓		✓	✓	✓			
Drawings and Diagrams	Throughout Manuals and Included Outside Manuals	✓	✓		✓		✓			
Hazards and Measuring Methods	Throughout Manuals	✓	✓	✓	✓		✓	✓	✓	
Technical Documents concerning Electrical Equipment	Included Outside Manuals		✓	✓	✓		✓			
Documents of Complying with Mandatory Requirements	Included Outside Manuals				✓					✓
Modifications Made to Protective Equipment	Drawings				✓		✓			
Load Analysis	Documents Included				✓					✓
Energy Loss, Human Interventions	ArcWorld Chap 2 & 4				✓		✓		✓	

Description	Manual/Chapter	Handling	Installation & Commissioning	Start-up	System Information	Use of System	Maintenance	Decommissioning	Emergency Situations	Robot Specific Information
Maintenance and Intended Life	ArcWorld Chap 5				✓		✓			
Interface Requirements	ArcWorld Chap 3				✓		✓			
Dynamic Limiting Zones	ArcWorld Chap 2 & 4				✓		✓			✓
Risks that Can Not be Eliminated	Throughout Manuals	✓	✓	✓	✓	✓	✓	✓	✓	✓
Risks with Certain Applications	Throughout Manuals					✓				✓
Foreseeable Misuse	Throughout Manuals					✓				
Material Flow	Manipulator Chap 4 Positioner Chap 5					✓	✓			
Intended Use	ArcWorld Chap 2					✓				
Residual Risk for Various Tasks	Throughout Manuals					✓	✓			
Span of Control	ArcWorld Chap 2					✓	✓		✓	✓
Description of Manual Controls	ArcWorld Chap 2					✓				
Settings and Adjustments	ArcWorld Chap 4					✓	✓			✓
Modes and Means for Stopping	ArcWorld Chap 2 & 4					✓	✓		✓	
Fault ID, Repair, and Restarting	ArcWorld Chap 4					✓	✓			
Personal Protective Equipment	Throughout Manuals	✓	✓	✓	✓	✓	✓	✓	✓	✓
Test and Examination After Changing Components	ArcWorld Chap 3 & 4					✓	✓			
Instructions for Disconnecting Pendants	Controller Chap 4					✓	✓			
Instructions for Fault and Emergency Recovery	ArcWorld Chap 4					✓	✓			
Training Requirements	ArcWorld Chap 1					✓	✓			✓
Drawings and Diagrams allowing Maintenance Carry Out Task	Throughout Manuals						✓			
Information to Replace Safety Devices	ArcWorld Chap 3						✓			✓
Contact Information	ArcWorld Chap 1						✓			
Safe Working Practices for Manual Suspension of Safeguards	Controller Chap 14						✓			
Dismantling	Manipulator Chap 3 Positioner Chap 2						✓	✓		
Emergency Situations	ArcWorld Chap 4						✓		✓	
Raising and Lowering Speed Using Pendant	Controller Chap 8						✓			✓
Information on Limiting Device	ArcWorld Chap 2 & 3						✓			✓
Information on Operating and Enabling Devices	ArcWorld Chap 3					✓	✓			✓

Description	Manual/Chapter	Handling	Installation & Commissioning	Start-up	System Information	Use of System	Maintenance	Decommissioning	Emergency Situations	Robot Specific Information
Stopping Time and Distance	Drawings; Positioner Chap 4									✓
Specifications for Fluids	Manipulator Chap 9 Positioner Chap 6						✓			✓
Limits for Range of Motion	ArcWorld Chap 2									✓
Relevant Standards	Included Outside Manuals									✓
Instruction on Synchronized Motion	ArcWorld Chap 2									✓
Programmed Limits	Controller Chap 11									✓
Robot Suitable for Integrations	Documents Included									✓

1.6 Customer Support Information

The following information is for a YASKAWA representative in America, for other locations refer to the back cover.

(937) 847-3200

For **routine** technical inquiries, you can also contact your local YASKAWA representative at the following e-mail address:

techsupport@motoman.com

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

Please have the following information ready before calling your local YASKAWA representative:

NOTICE

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 your local YASKAWA representative at the telephone number shown above or on the back cover.

- System

  ArcWorld 6000-755, -1255RH, or -1255SL
  ArcWorld 6200-755, -1255RH, or -1255SL
  ArcWorld 6300-755, -1255RH, or -1255SL

- Manipulators

  AR1440 or AR2010

- Positioner

  RM2-755, RM2-1255RH, or RM2-1255SL

- Primary Application Arc Welding
- Controller YRC1000
- Software Version

  Access this information on the Programming Pendant's LCD display screen by selecting {MAIN MENU} - {SYSTEM INFO} - {VERSION}

- Robot Serial Number

  Located on the Manipulator data plate

- Robot Sales Order Number

  Located on the YRC1000 controller data plate

- Warranty ID:

  Located on Controller

1.7 Quick Start Guide

WARNING

- Anyone working with the ArcWorlds is responsible for reading and understanding all included documents.

  This Quick Start Guide is just a basic outline of the setup of the ArcWorld.

Not reading and understanding all included documents can cause death or serious injury.

PHASE 1 **PREPARATION (PRE-ARRIVAL)**	**PRELIMINARY RISK ASSESSMENT** □ *ArcWorld Manual Sec 2.6, 3.1* □ *ISO 10218-2:2011* □ *ANSI/RIA 15.06-2012*	**DETERMINE LOCATION FOR INSTALL** □ *Controller Inst. Sec 3.2 & 3.3* □ *ArcWorld Manual Chapter 3*	**PREPARATION FOR POWER CONNECTION** □ *Controller Inst. Sec 4.1 & 4.2* □ *ArcWorld Manual Chap 2 & 3*	**MOUNTING SPECIFICATIONS** □ *Controller Inst. Sec 3.4 to 3.5* □ *ArcWorld Manual Sec 3.2 to 3.3* □ *Contact YASKAWA for Mounting*	**TOOLING SPECIFICATIONS** □ *Application Specific* □ *Manipulator Inst. Sec 6*	**COMPRESSED AIR SUPPLY (IF USED)** □ *Sales Order* □ *ArcWorld Manual Sec 3.1.1*	**TRAINING** □ *Contact YASKAWA Academy:* • *Phone: 937-847-3307* • *Email: training@motoman.com*	**PHASE 1 Complete** ☐
PHASE 2 **RECEIVE ARCWORLD CELL**	**RECEIVE & INSPECT CRATES FOR DAMAGE** □ *Controller Inst. Sec 3.1* □ *ArcWorld Manual Chap 3.3*	**OPEN CRATE** □ *ArcWorld Manual Sec 3.3*	**INVENTORY & INSPECT EQUIPMENT** □ *Sales Order* □ *Controller Inst. Sec 2.1* □ *ArcWorld Manual Sec 1.1*	**VERIFY ORDER RECEIVED** □ *Sales Order* □ *Controller Inst. Sec 2.2* □ *ArcWorld Sec 1.2*	**READ & UNDERSTAND ALL SAFETY & INCLUDED DOCUMENTATION** □ *Controller READ FIRST* □ *Controller Notes for Safe Oper.* □ *Controller Inst. (All Safety Sections)*	**PREPARE FOR HANDLING & TRANSPORTATION OF EQUIPMENT TO WORKSPACE** □ *Controller Inst. Chap 3* □ *ArcWorld Manual Inst. Chap 2*		**PHASE 2 Complete** ☐
PHASE 3 **INSTALL ARCWORLD CELL**	**TAG OUT POWER** □ *Company Procedures* □ *Government Regulations* □ *Controller Inst. Chap 4*	**TRANSPORT CELL TO WORKSPACE** □ *Controller Inst. Sec 3.1* □ *ArcWorld Manual Sec 3.3*	**INSTALLING THE SYSTEM COMPONENTS** □ *Controller Inst. Sec 3.4 & 3.5* □ *ArcWorld Manual Sec 3.4 to 3.9*	**CONNECT PRIMARY POWER & GROUND** □ *Company Procedures* □ *Government Regulations* □ *Controller Inst. Chap 4*	**CONNECT PROGRAMMING PENDANT TO CONTROLLER** □ *Controller Inst. Sec 4.3.3*	**ATTACH ROBOT & POSITIONER CABLES (IF EQUIPPED)** □ *Manipulator Inst. Sec 4.2* □ *Positioner Manual Sec 4.2.5*	**ATTACH AIR LINES (IF USED)** □ *Manipulator Inst. Sec 7.1*	**PHASE 3 Complete** ☐
PHASE 4 **SYSTEM VERIFICATION**	**VERIFY POWER INSTALLATION FOR CONTROLLERS** □ *Controller Instr. Chap 4* □ *Manipulator Inst. Sec 4.1, 4.2, & 7.1*	**PRESS E-STOP, CLOSE CONTROLLER DOOR, & CLEAR WORKSPACE AREA** □ *Controller Inst. Sec 5.3.1* □ *Controller Inst. Sec 4.3*	**TAG IN POWER SUPPLY** □ *Company Procedures* □ *Government Regulations*	**TURN ON MAIN POWER SUPPLY & CONTROLLER** □ *Controller Read First Alarm* □ *Controller Inst. Sec 5.1* □ *If Alarms are present, see 178644-1CD "Alarm Codes"*	**TEST SERVOS & E-STOPS** □ *Controller Inst. Sec 5.2*	**VERIFY POSITIONER RANGE OF MOTION** □ *Positioner Manual* □ *Positioner Drawings* □ *Tooling Documentation*		**PHASE 4 Complete** ☐
PHASE 5 **INSTALL AND VERIFY ARC WELDING TOOLS**	**MECHANICAL INSTALLATION OF TOOL** □ *May be provided with the system - Customer Specific* □ *Manipulator Inst. Sec 6*	**ELECTRICAL INSTALLATION OF TOOL** □ *Controller Inst. Sec 4.3.4* □ *Manipulator Inst. Sec. 7*	**ENTER TOOL SETTINGS ON PROGRAMMING PENDANT** □ *May be set if tooling was provided with the system* □ *Manipulator Inst. Sec 6* □ *Controller Inst. Sec 8.3* □ *Tool Settings Guide*	**VERIFY TOOL TCP OPERATION** □ *Documentation Pending* □ *Controller Instr. Sec 8.3.2*	**VERIFY RANGE OF MOTION (IF EQUIPPED WITH POSITIONER)** □ *General Information - Positioner Manual*	**CONFIRM RISK ASSESSMENT** □ *ArcWorld Manual Sec 2.6, 3, 3.1* □ *ISO 10218-2:2011* □ *ANSI/RIA 15.06-2012*		**PHASE 5 Complete** ☐

PHASE 6 TEST OPERATION OF THE CELL	STEP THROUGH PROVIDED MASTER JOB	CREATE NEW JOB & TEACH POINTS	TEST & CHECK STEPS	PLAYBACK JOB	STOP JOB	RUN MASTER JOB
	□ *Controller Operator's Manual Sec 1.1.1* □ *Controller General Operator's Manual Chap 3*	□ *Controller Operator's Manual Sec 1.1.1* □ *Controller General Operator's Manual Chap 3*	□ *Controller Operator's Manual Sec 1.1.1.3* □ *Controller General Operator's Manual Sec 3.3*	□ *Controller Operator's Manual Sec 1.1.2* □ *Controller General Operator's Manual Chap 4*	□ *Controller General Operator's Manual Sec 4.3*	□ *ArcWorld Manual Sec 1.4, 2.3, & 4.2.*

PHASE 6 Complete

☐

2 Equipment Description

2.1 Robot Description

The ArcWorld system includes a Robot. This Robot is specifically designed for arc-welding applications. Refer to the manipulator manual concerning specifications (see *section 1.5 “Reference Documentation” on page 1-23*.)

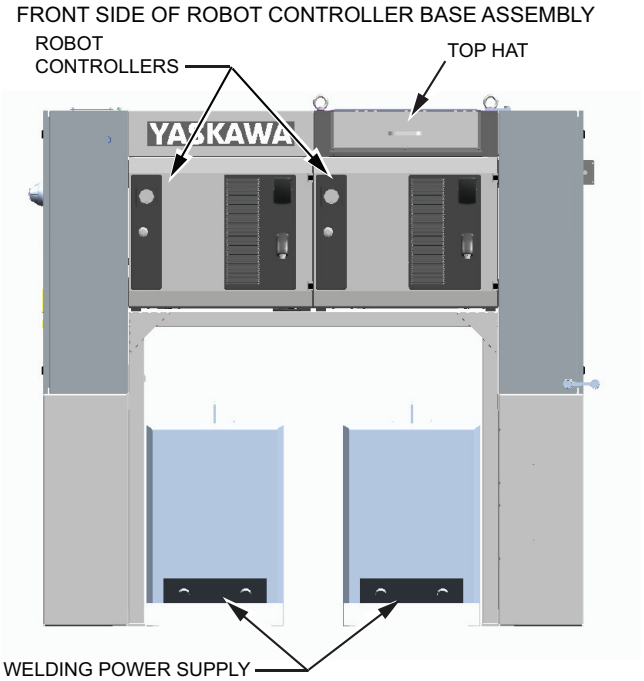
2.2 Robot Controller

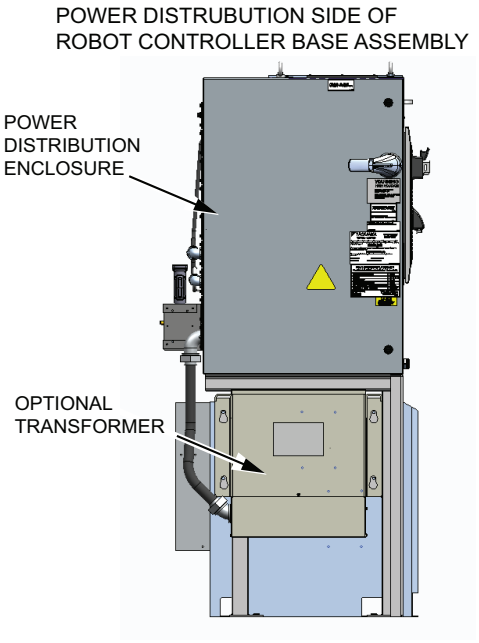
The ArcWorld also includes a controller. The controller handles multiple tasks and can control Robots input/output (I/O) devices.

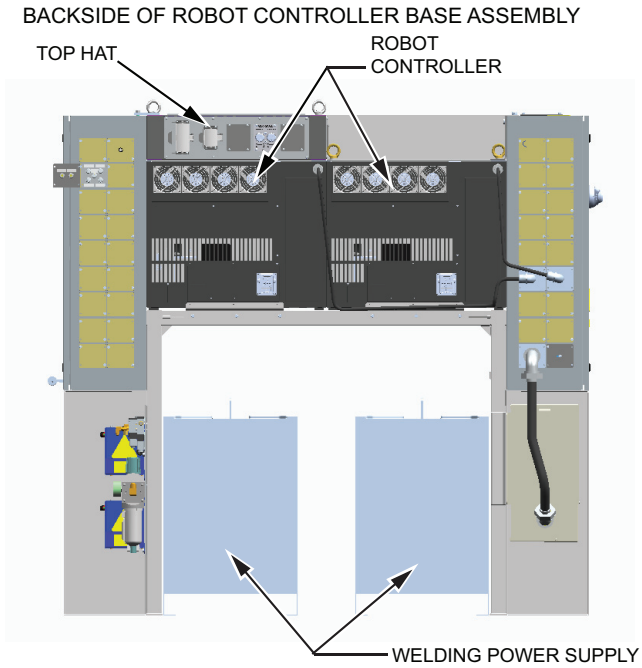
The controller coordinates operations of the ArcWorld. It controls Robot movement, welding power supply, processes input and output signals, and provides signals to operate the welding system.

For detailed information on the Controller, refer to the *Controller Manual* that is included with the ArcWorld documentation package (see *section 1.5 “Reference Documentation” on page 1-23*.)

Fig. 2-1(a): Two Robot Controllers







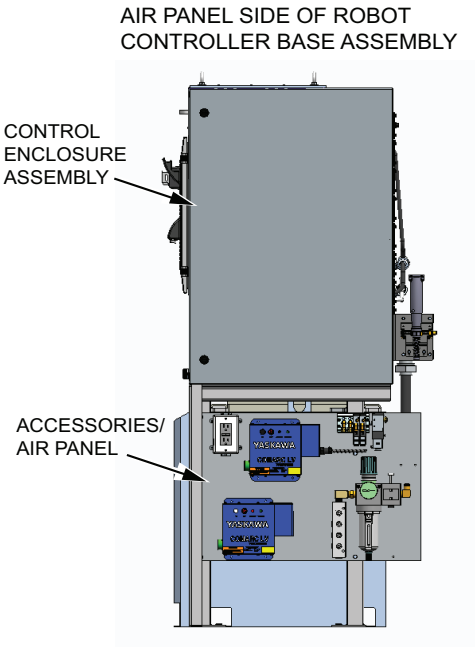
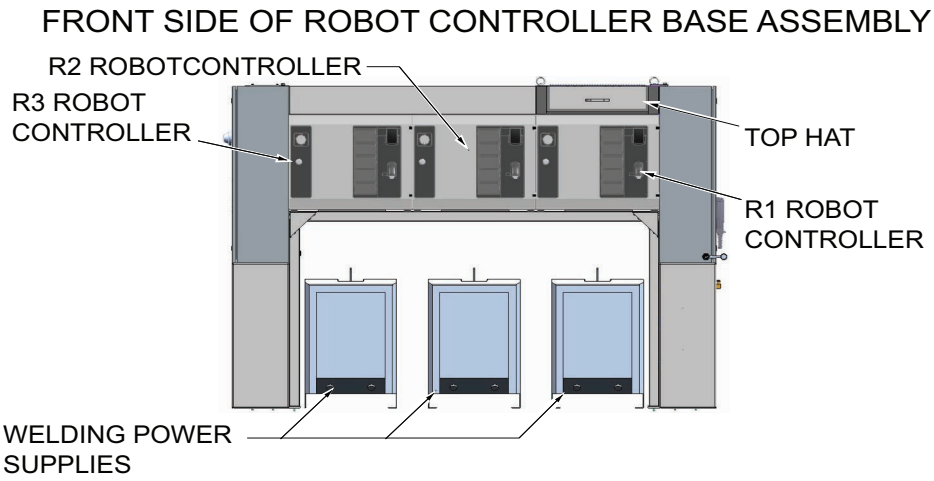
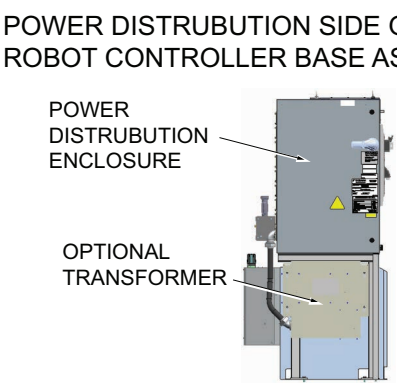
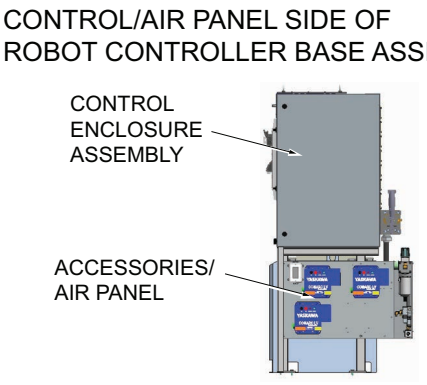
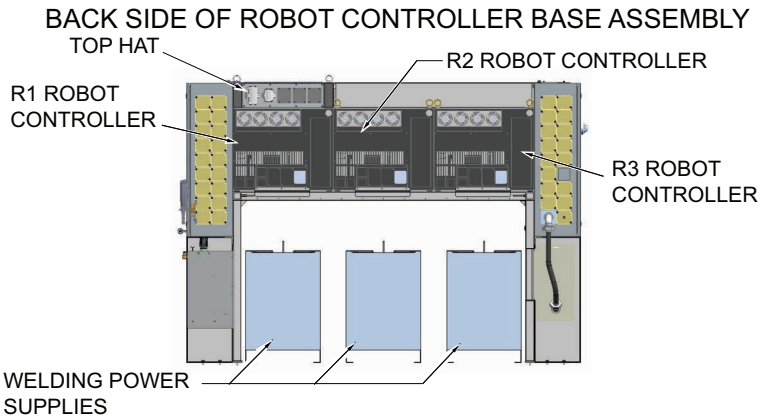


Fig. 2-1(b): Three Robot Controllers









2.2.1 Programming Pendant

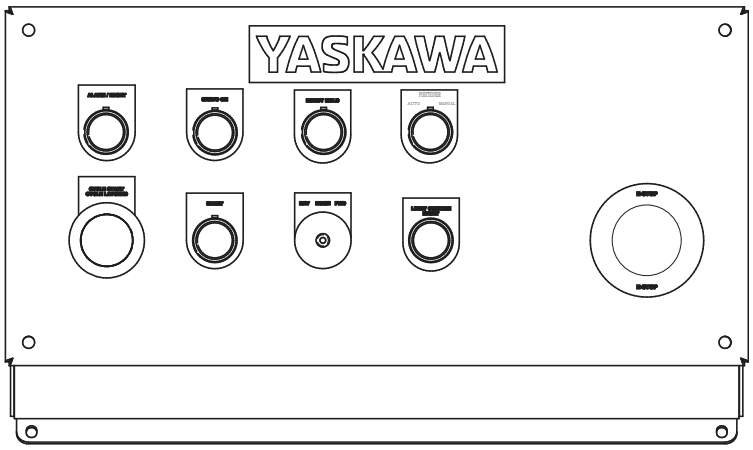
The Programming Pendant provides the primary means for programmer/ operator interaction with the ArcWorld.

The Programming Pendant provides icon-driven system programming. It 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 Robot Controller. By using the Programming Pendant, the operator can teach the Robots motion; perform programming, editing, maintenance, and diagnostic functions; and enable or disable Operator Station control of the ArcWorld. For detailed information on the pendant's programming keys, programming functions, and display functions, refer to the *Operator's Manual for Arc Welding* that is included with the ArcWorld documentation package (see *section 1.5 "Reference Documentation" on page 1-23*).

2.3 Operator Station

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

Figure 2-2: Operator Station



2.3.1 Operator Station — ALARM/RESET

The [ALARM/RESET] indicator/button lights red indicating the Robot Controller has encountered a minor alarm or error condition. To clear the minor alarm or error condition press the [ALARM/RESET] button.

2.3.2 Operator Station — SERVO ON

The green [SERVO ON] push button turns servo power on if the Programming Pendant's Mode Select Switch is set to REMOTE.

2.3.3 Operator Station — ROBOT HOLD

Pressing the red [ROBOT HOLD] button stops the 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 HOLD state was initiated.

2.3.4 Operator Station — POSITIONER AUTO/MANUAL

The POSITIONER AUTO/MANUAL switch is used to select automatic or manual mode for the Positioner. When the switch is set to the AUTO position, the Robots weld the parts immediately after the Positioner sweeps. When the switch is set to the MANUAL position, the Robots do not immediately start to weld after the Positioner sweeps. The Robots remain in HOME position.

NOTICE

The POSITIONER AUTO/MANUAL switch signal depends on the structure of the Master job.

2.3.5 Operator Station — CYCLE START CYCLE LATCHED

WARNING

- The operation of the [CYCLE START CYCLE LATCHED] button is dependent 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] button initiates a Positioner sweep cycle if the Robots are in HOME (Safe) position. If the [CYCLE START CYCLE LATCHED] push button is pressed while the Robots are welding, or otherwise not in HOME (Safe) position, the Cycle Start command is “latched” into (stored in) the Robot Controller circuitry. When the Robots return to HOME (Safe) position, the “latched” Cycle Start command is executed and the Positioner sweeps. Circuitry in the Robot Controller prevents the Positioner from continuously cycling should the operator depress and hold the [CYCLE START CYCLE LATCHED] push button.

2.3.6 Operator Station — START

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

2.3.7 Operator Station — REV/HOME/FWD

The Positioner has the ability to position each tooling axis (orbital axis) ±360° for better part-loading and unloading ergonomics. This rotation of the orbital axis (also known as jogging) is accomplished with the JOYSTICK CONTROL located on the Operator Station (see *Fig. 2-2*).

2.3.8 Operator Station — LIGHT CURTAIN RESET / SYSTEM RESET

This button/indicator flashes after the light curtains on this side have been violated. The flashing indicates a manual reset is required and is done by pressing the button momentarily.

NOTICE

In later revisions of this operator station, the LIGHT CURTAIN RESET was renamed SYSTEM RESET. The functionality of the button matches all other text in this document, which continues to refer to this button as LIGHT CURTAIN RESET.

2.3.9 Operator Station — Emergency Stop

Pressing the Operator Station’s Emergency Stop push button initiates an E-Stop condition. Refer to *section 2.6.4* for details of the E-Stop function and the steps for recovering the ArcWorld from an E-Stop condition.

2.3.10 Operator Station — THUMBWHEEL SWITCH *(Option)*

Several operator stations are offered for use with this robotic system. Some of the operator stations include thumbwheel switches. When included the thumbwheel switch can be used to select a specific robot job to run, often this is correlated to a particular series of parts or fixtures at the customer's installation to allow quick selection and change over parts without use of the Programming Pendant. The value from the thumbwheel switch is stored into an integer variable so it can be referenced by a supplied job logic. This could also be echoed to a PLC or HMI for other purposes.

- When using a one switch thumbwheel the value is stored in integer variable I091 and controls the job on both side A and B.
- When using a two switch thumbwheel, each thumbwheel controls either side A or side B. Only one thumbwheel can read and update an integer variable at a time, both do not occur simultaneously. The robot software reads each value in the following ways:
  - If side A of the Positioner is at the robot, then thumbwheel A reads and updates integer variable I091.
  - If side B of the Positioner is at the robot, then thumbwheel B reads and updates integer variable I092.
  - If the Positioner is sweeping side A to the robot, then thumbwheel A reads and updates integer variable I091 as the Positioner starts to sweep.
  - If the Positioner is sweeping side B to the robot, then thumbwheel B reads and updates integer variable I092 as the Positioner starts to sweep.

2.4 Positioner

The Positioner is a high-speed, three-axis, AC servo-controlled “Ferris-wheel” type Positioner. The Positioner provides 755kg capacity per side and three servo axes for high speed positioning. Fixture length is 2 or 3 meters.

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

NOTICE

- The customer supplies all tooling and fixtures for the Positioner.
- YASKAWA recommends applying a corrosion/rust preventive compound to the tooling and fixtures that are located in a high-humidity environment.

The ArcWorld is capable of synchronized motion between various components depending on the job configuration. Synchronized Robots move at the same time during operation. R1, R2, and R3 can be synchronized with the Positioner, and each Robot can be synchronized with the other two. All three Robots can work simultaneously on a rotating work piece. For additional information on this type of independent control and coordinated motion, refer to the Robot Controller *Independent/ Coordinated Control Function Manual* that is included with the documentation package (see *section 1.5 “Reference Documentation” on page 1-23*).

For additional Positioner information, including specifications, an illustrated parts list, load capabilities, and dimensions, refer to the *Positioner Manual* included with the documentation package (see *section 1.5 “Reference Documentation” on page 1-23*).

2.5 Welding Equipment

In it's standard configuration, the ArcWorld includes a welding power source, wire feeder, torch, and torch mount for each of the Robots. Optional equipment may also be included with the ArcWorld (refer to *section 1.3.4 "System Layout" on page 1-8*).

2.5.1 Welding Power Sources

YASKAWA offers various brands and types of welding power sources. The welding power sources supplied with the ArcWorld depends on the customer's specific application and preference. For specific information on the welding power sources supplied with your ArcWorld, refer to the welding power source manual that is included in the documentation package (see *section 1.5 "Reference Documentation" on page 1-23*).

2.5.2 Wire Feeder

A welding wire feeder is mounted on the upper arm (U-Axis) of each Robot. The wire feeder is the "4-roll" type and provides reliable wire feeding at rates up to 750 inches per minute (ipm). An electronically controlled gas valve provides fast welding gas response time. Interchangeable feed rolls are used to accommodate different wire gauges and wire types. For additional information on how the wire feeder is mounted to the Robot's upper arm, including allowable load and installation position, refer to the wire feeder documentation that is included with the ArcWorld documentation package (see *section 1.5 "Reference Documentation" on page 1-23*).

2.5.3 GMAW Torch

The ArcWorld uses either an air-cooled or water-cooled Robotic/automatic GMAW torch for each Robot. These are heavy-duty torches designed for quick replacement and minimum of Robot reprogramming. The GMAW torch is installed in a torch mount at the end of the Robot's wrist flange. The torch mount provides multi-dimensional impact (collision) detection to protect the Robot, torch, fixture, Positioner, and work piece from damage in the event of a collision. Any torch impact (collision) triggers an Emergency Stop condition (refer to *section 4.4.2 "E-Stop Recovery" on page 4-7* and *section 4.4.3 "Shock Sensor Recovery" on page 4-8*).

For applications that use the optional water-cooled torch, the ArcWorld system includes a water circulator kit for each Robot. For additional information on the torches that are supplied, refer to the vendor documentation that is included with the documentation package (see *section 1.5 "Reference Documentation" on page 1-23*).

2.6 Safety Features

The ArcWorld includes a total safety environment. If complying with all the safety instructions and precautions given throughout this manual, the safety equipment helps to ensure safe operation of the Robot work cell.

NOTICE

Users are responsible for determining that the safeguards provided with the ArcWorld are adequate for their plant conditions. Users must also ensure that all safeguards are maintained in working order.

2.6.1 Welding Arc Protection

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

Two forms of welding arc protection are part of the ArcWorld:

- a steel arc screen on the Positioner
- arc curtains (attached to the steel-mesh safety fencing)

The steel arc screen on the Positioner is always positioned between the welding arc and the operator. This protects the operator from the ultraviolet light radiation and sparks that result from the welding operation (see *Fig. 1.3 “System Layout” on page 1-6*).

WARNING

- Never look directly at the welding arc without protective eye wear.

Although safety fence arc curtains block the radiation of ultraviolet light can cause blindness.

The arc curtains filter (or “block”) most of the ultraviolet light radiation that would otherwise escape the work cell. Just as the arc screen on the Positioner protects the operator from intense ultraviolet light, the arc curtains protect other personnel who are near the work cell.

2.6.2 Safety Fencing (Standard)

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

2.6.2.1 Safety Fencing Based on Tooling Diameter

WARNING

- Never look directly at the welding arc without protective eye wear.

Although safety fence arc curtains block the radiation of ultraviolet light can cause blindness.

The cell is available with two fence configurations. One fence configuration is based on the full tooling diameter of the tooling (1300mm) and a second is based on a smaller or limited diameter tooling. A diagram which shows both is shown in *Fig. 3-3(b "Plan View Side View - ArcWorld 6300-755" on page 3-4*. When using the limited diameter tooling the fence span can be reduced due to the reduced stopping time of the Positioner.

- When using an RM2-755 Positioner, if the diameter of the tool is equal to or greater than 640mm, then the larger diameter fence solution must be used.
- When using RM2-1255RH or RM2-1255SL Positioner, if the diameter of the tool is equal to or greater than 710mm, then the larger diameter fence solution must be used.

2.6.2.2 Safety Fencing (Option)

CAUTION

- Always consider the light curtain coverage with tooling. Especially when tooling is smaller than;
  - 640mm when using a RM2-755
  - 710mm when using a RM2-1255RH or RM2-1255SL

YASKAWA recommends construction of tooling be equal to or greater than the smallest tooling fixture available or personnel injury can occur.

The cell can also be configured with solid panel fencing as an upgrade. This will block more of the ultraviolet light radiation that could escape from the work environment and also forms a physical barrier that prevents personnel from entering the work cell during automatic operation.

2.6.3 Safety Light Curtains

Infrared safety light curtains protect the operator from Positioner movement. The Positioner will not sweep if the light path (between the light curtain's Send unit and Receive unit) is obstructed. Should any person or object enter this zone during a Positioner sweep from A to B (or B to A), an E-Stop condition is triggered (refer to *section 2.6.4*).

During non-sweep operation, the light curtains are monitored to control the speed of the tooling axis at the operator side. When the light curtain indicates an obstruction the tooling axis at the operator will be speed limited to "zero speed" and held until the curtains are cleared and reset.

For additional information on the safety light curtain system, refer to the vendor documentation that is included with the ArcWorld documentation package (see *section 1.5 "Reference Documentation" on page 1-23*).

2.6.3.1 Additional Safety Light Curtains (Option)

One additional set of light curtains can be installed under the Positioner. These are mounted to the floor and monitor for conditions when operators use the system incorrectly. This prevents an operator from crouching down and going under the Positioner into the active Robot zone.

In PLAY mode, when the main axis is stationary, these light curtains are used to detect intrusions. When violated an E-Stop will occur.

These light curtains are muted during a Positioner sweep so that the tooling diameters are not impacted or cause an unintentional E-Stop.

2.6.4 E-Stop

E-Stop is a primary safety feature of the ArcWorld. A work-cell access door interlock, the safety light curtain system, Robot welding torch impact (collision) detection circuitry (refer to *section 2.5.3*), and Emergency Stop push buttons can all trigger an E-Stop condition. An E-Stop condition immediately
de-energizes the control system and activates the Robot emergency braking system (refer to *section 2.6.6*). The Emergency Stop push buttons are used for an intentional shutdown of the ArcWorld and are installed at the following locations:

- Programming Pendant
- Operator Station

To resume operation after an E-Stop system shutdown, the operator must clear and reset the action that caused the E-Stop condition (refer to *section 4.4.2 "E-Stop Recovery" on page 4-7*).

2.6.5 Programming Pendant's ENABLE Switch

The ENABLE switch is part of the Programming Pendant and provides a safety feature that controls servo power while the system is in TEACH mode (see *Fig. 2.3 "Operator Station" on page 2-5*). When pressed in, this switch allows the operator to enable servo power. Should the operator release the switch or grasp it too tightly, servo power is immediately disabled, thus preventing Robot movement. For detailed information about the operation of the ENABLE switch, refer to the Robot Controller *Operator's Manual for Arc Welding* that is included with the documentation package (see *section 1.5 "Reference Documentation" on page 1-23*).

2.6.6 Emergency Braking System

Each Robot incorporates a braking system that protects personnel from injury and prevents equipment damage if servo power is removed. Upon loss of servo power, the brake system activates to hold all Robot axes in place. The brake system incorporates a feature that allows the operator to release the brake of a specific Robot axis, even if drive power is disabled. Brake release is accomplished with the Programming Pendant. Refer to the Robot Controller *Manual Brake Release* manual included with the documentation package (see *section 1.5 “Reference Documentation” on page 1-23*).

2.6.7 Interlocked Work-cell Access Door

The work-cell access door features a safety interlock (see *Fig. 1.3 “System Layout” on page 1-6*). Any attempt to open the access door while the Robots are in PLAY mode triggers an E-Stop condition (refer to *section 2.6.4*).

3 Installation

CAUTION

- ArcWorld is to be installed by a qualified personnel who are familiar with the installation and setup of the Robot.

Not having the ArcWorld installed by qualified personnel may cause personal injury and equipment damage.

Two to three qualified technicians can install the ArcWorld in a reasonable amount of time. Always comply with all the safety instructions and precautions given throughout this manual during the installation process.

The instructions given in this section are general guidelines for installing the ArcWorld. Refer to the system drawings and relevant system component manuals for specific installation information (see *section 1.5 “Reference Documentation” on page 1-23*).

3.1 Required Materials

All system components and most hardware items required for installation of the ArcWorld are included with the shipment. There are, however, some required items that the customer must supply, such as typical installation and maintenance tools (refer to *section 3.1.2*).

3.1.1 Customer-supplied Items

– Shielding gas for the welding torches

– Local electrical service

– Earth ground wires for the Manipulators, the Robot Controller, and peripheral equipment

– Earth ground rods and/or buried copper sheeting (quantity and placement depth as required to achieve specified resistance-to-ground reading of 100 ohms or less)

– Chemical (optional) to increase the conductivity of soil in the vicinity of the earth ground system

– Welding wire

– Clean, dry air supply (for torch tender or wire cutter options):

  • Flow Rate: 0.425m^3/min. (15cfm)

  • Pressure: 620kPa (gauge) [90psi (gauge)]

– Forklift(s) and/or overhead crane

– Special anchor bolts and drill bits

3.1.2 Recommended List of Hand Tools and Equipment

– Safety glasses
– Face shield
– Gloves (heavy-duty leather recommended)
– Levels (short and long)
– Ratchet handle (with 3/4-inch hex socket)
– Adjustable wrench
– Hammer drill with appropriate concrete bits
– Phillips and flat-blade screwdrivers
– Hammers (dead-blow and steel)
– Hammer (non-marring)
– Socket sets (SAE and metric)
– Air-impact gun (with 3/4-inch hex socket)
– Open-end wrench sets (SAE and metric)
– Allen wrench sets (SAE and metric)

3.2 Site Preparation

CAUTION

- Provide room for access to the work-cell door, Operator Station, and system components that are exterior to the work cell.

Failure to observe this precaution could result in injury to personnel during system operation and maintenance.

To prepare your site, proceed as follows:

1. Clear the floor and overhead space needed for the ArcWorld system (see *Fig. 3-3(a)* and *Fig. 3-3(b)*). Allow an additional 1.2m to 1.5m on all sides of the work cell to provide the clearances needed for installation. Refer to the schematics that are included with the system documentation package.
2. Gather all the customer-supplied items and required tools (refer to *section 3.1*).

Fig. 3-3(a): Plan View Overhead View - ArcWorld 6300-755

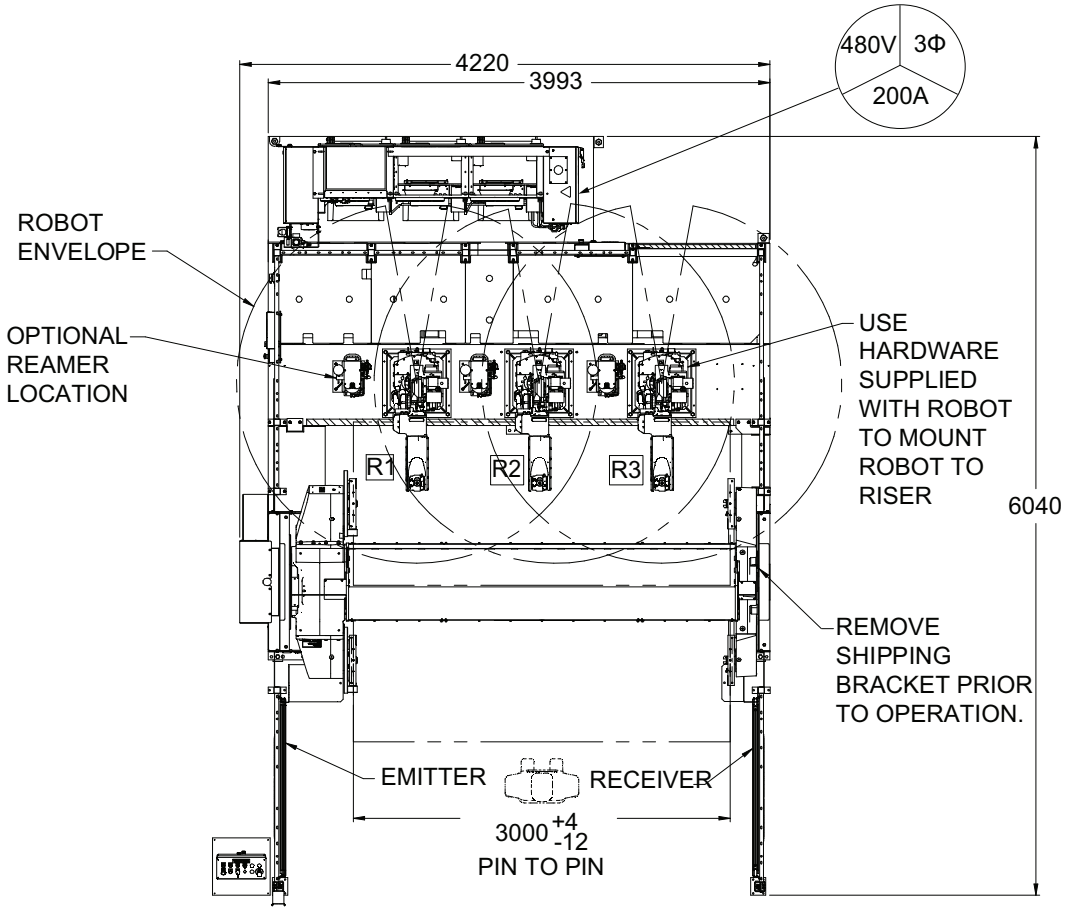
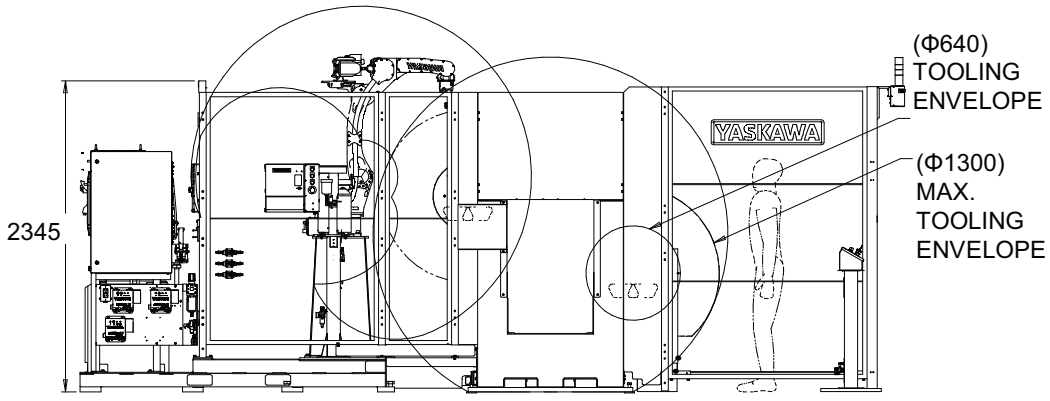
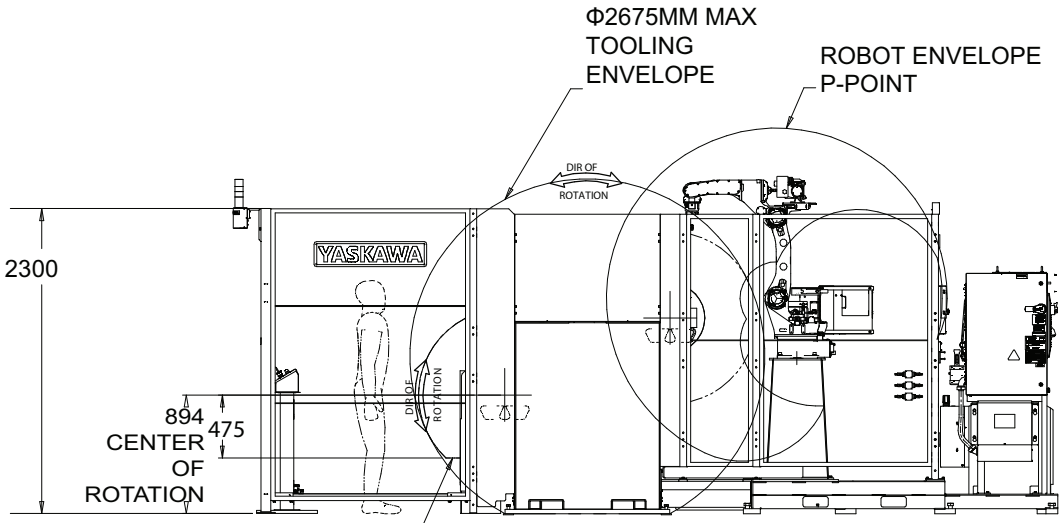


Fig. 3-3(b): Plan View Side View - ArcWorld 6300-755



RIGHT SIDE VIEW ROTATED 90°



TOOLING AT MAXIMUM DIAMETER IS REQUIRED TO HAVE AN “D” SHAPE SWEEP ENVELOPE TO CLEAR THE FLOOR WHEN INDEXING

LEFT HAND SIDE VIEW ROTATED 270°

3.3 Removal of System Components from Shipping Skids

CAUTION

- Make sure lifting device is rated to handle the system components on the shipping skid.
  - Refer to *Table 1-1(a) "ArcWorld 6*00-755 General Specifications" on page 1-2* and *Table 1-1(b) "ArcWorld 6*00-1255RH General Specifications" on page 1-3* for weights.

Not making sure the lifting device is rated to handle the system component weights may cause personnel injury or equipment damage.

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

NOTICE

Notify your shipping contractor as soon as possible if you notice any equipment damage.

CAUTION

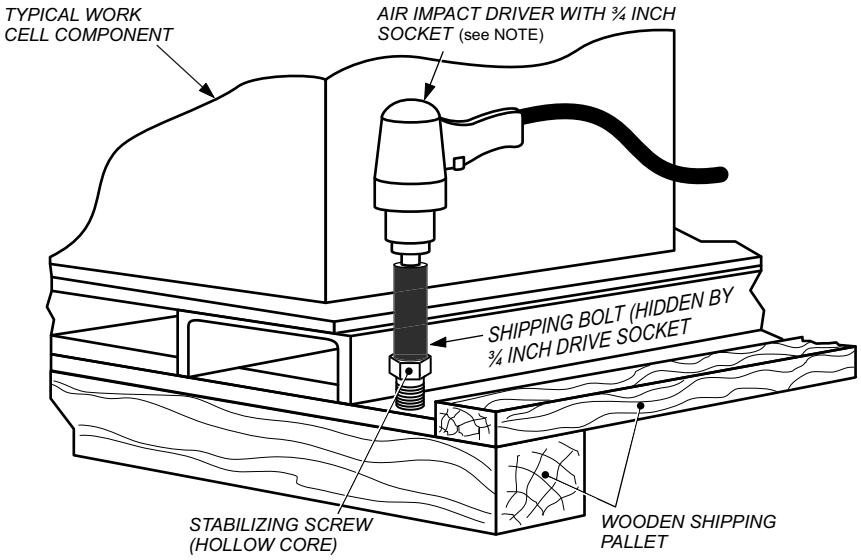
- Do **not** remove the Positioner shipping bracket assembly until the Positioner is securely anchored to the foundation.
  - The shipping bracket assembly retains the headstock and tailstock in correct alignment during shipping and installation.

Removing the shipping bracket assembly before anchoring to foundation may cause personal injury or equipment damage.

1. Unbolt each component from its shipping skid using a 3/4-inch socket (see *Fig. 3-4*).

Figure 3-4: Typical Stabilizing Screw and Removal of A Shipping Lag Bolt

NOTE – An air-powered tool is not required for removal of the shipping bolts, as these fasteners can be removed with ordinary hand tools. However, the air-powered tool does make quick work of the task.



2. Use a forklift(s) or overhead crane to lift each component away from its shipping skid.

NOTICE

Two forklifts are required to lift or move the Positioner. Forklift pockets are provided on each end of the Positioner for this purpose.

⚠ CAUTION

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

Removing the shipping bracket assembly before anchoring to foundation may cause personal injury or equipment damage.

3. Remove and discard or recycle all shipping materials, including the shipping skids. Do **not** remove the Positioner shipping bracket assembly.

3.4 Installation — Positioner

Refer to Chapter 2 of the Positioner manual for detailed installation instructions for your specific Positioner.

CAUTION

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

Removing the shipping bracket assembly before anchoring to foundation may cause personal injury or equipment damage.

Mount the Positioner on a foundation rigid and strong enough to support the Positioner and withstand dynamic repulsion forces. If the foundation surface is not level and even, grind the swell to flatten the surface.

CAUTION

- Make sure lifting device is rated to handle the Positioner weight.
  - Refer to *Table 1-1(a) "ArcWorld 6*00-755 General Specifications" on page 1-2* and *Table 1-1(c) "ArcWorld 6*00-1255SL General Specifications" on page 1-4* for weights.

Not making sure the lifting device is rated to handle the system component weights may cause personnel injury or equipment damage.

3.5 Installation — Robot Common Base Assembly

CAUTION

- Make sure lifting device is rated to handle the system components on the shipping skid.
  - Refer to *Table 1-1(a) "ArcWorld 6*00-755 General Specifications" on page 1-2* and *Table 1-1(b) "ArcWorld 6*00-1255RH General Specifications" on page 1-3* for weights.

Not making sure the lifting device is rated to handle the system component weights may cause personnel injury or equipment damage.

1. Loosen and remove lag bolts securing the Robot Common Base Assembly and associated panels to the wooden shipping skid.
2. Carefully remove all protective packaging materials and discard or recycle.
3. Carefully inspect all equipment for shipping damage.

NOTICE

Notify your shipping contractor as soon as possible if you notice any equipment damage.

4. Using a forklift, lift the Robot Common Base Assembly away from the wooden shipping skid (forklift pockets are located at each end of the Robot Common Base Assembly).
5. Fasten the two spanners to the Robot Common Base Assembly with the supplied hardware.
6. Carefully place the Robot Common Base Assembly in a position that will allow the spanners to be joined to the Positioner base with supplied hardware (see *Fig. 3-5*).

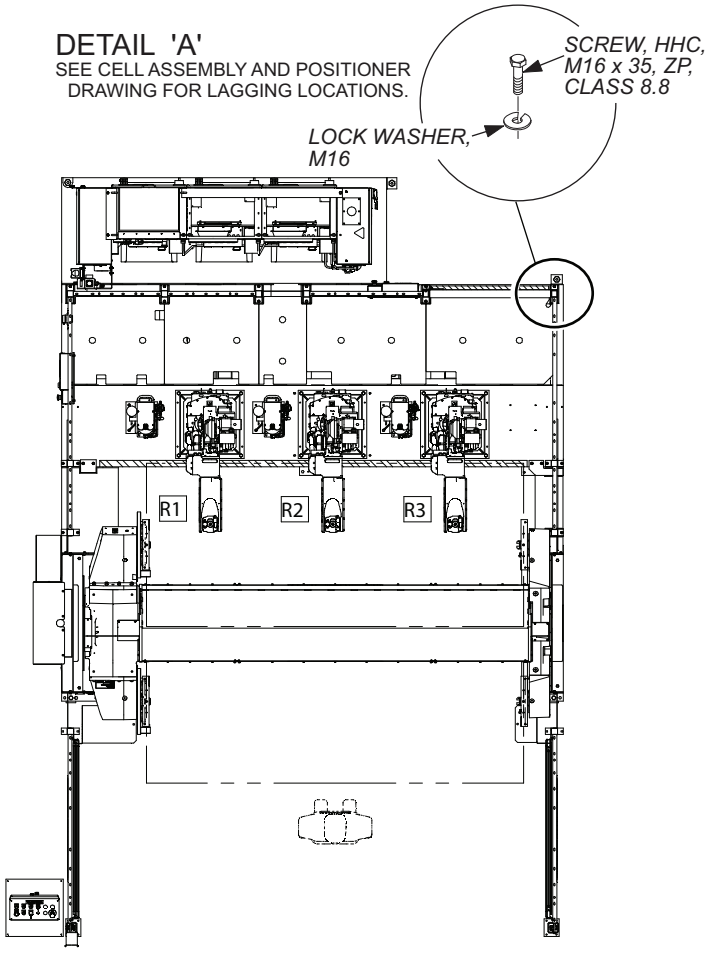
CAUTION

- Make certain the Robot Common Base Assembly is positioned correctly before leveling and anchoring the unit.

Not making sure the Robot Common Base Assembly is positioned correctly may cause damage to equipment.

7. Fasten the spanners to the Positioner base with the supplied hardware (see *Fig. 3-5*).

Figure 3-5: Robot Common Base Installation



CAUTION

- Wear eye protection and sturdy work gloves when cutting steel strapping bands.
- Make sure that all other personnel are clear of the area before cutting bands.

The steel strapping bands are under tension, and can cause injury to personnel when cutting.

8. Cut the steel strapping bands that secure the floor cover plate and remove it from the Robot Common Base Assembly. The cover plate will be replaced after control and power cables are routed beneath the Robot Common Base Assembly.

CAUTION

- Wear eye protection during the anchoring process.

Failure to observe this precaution could result in eye injury.

9. Adjust the leveling screws as required to level and stabilize the ArcWorld Assembly (see *Fig. 3-5*).
10. Insert a drill bit through the center of a leveling bolt on the Robot Common Base Assembly and drill a hole into the foundation to accept an anchor bolt.

NOTICE

See cell assembly drawing package lagging detail for the location of all required lag locations.

11. Repeat drilling process for each leveling bolt associated with the Robot Common Base assembly (see *Fig. 3-5*).
12. Use compressed air to remove all concrete dust from each drilled hole.
13. At each drilled location, install and secure a suitable anchor bolt.

3.6 Installation — Safety Fence Assembly

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

CAUTION

- Wear eye protection and protective gloves when cutting metal bands.

Metal bands are under tension and may cause injury to anyone near the bands when cut.

See *Fig. 1.3 "System Layout" on page 1-6* and *Fig. 3-3(a) "Plan View Overhead View - ArcWorld 6300-755" on page 3-3* for the general arrangement and positioning of the safety fence assembly. Refer to the safety fence manufacturer instructions for details of safety fence placement, erection, and anchoring. The safety fence instructions are included in the ArcWorld documentation package (refer to *section 1.5 "Reference Documentation" on page 1-23*).

3.7 Installation — Arc Curtains

The arc curtains are packaged in an accessories box that is shipped with the ArcWorld.

CAUTION

- Make sure Work-cell Safety Fence is anchored before installing arc curtain.

Unanchored fence panels can fall and injure personnel or damage equipment.

Install the arc curtains as follows:

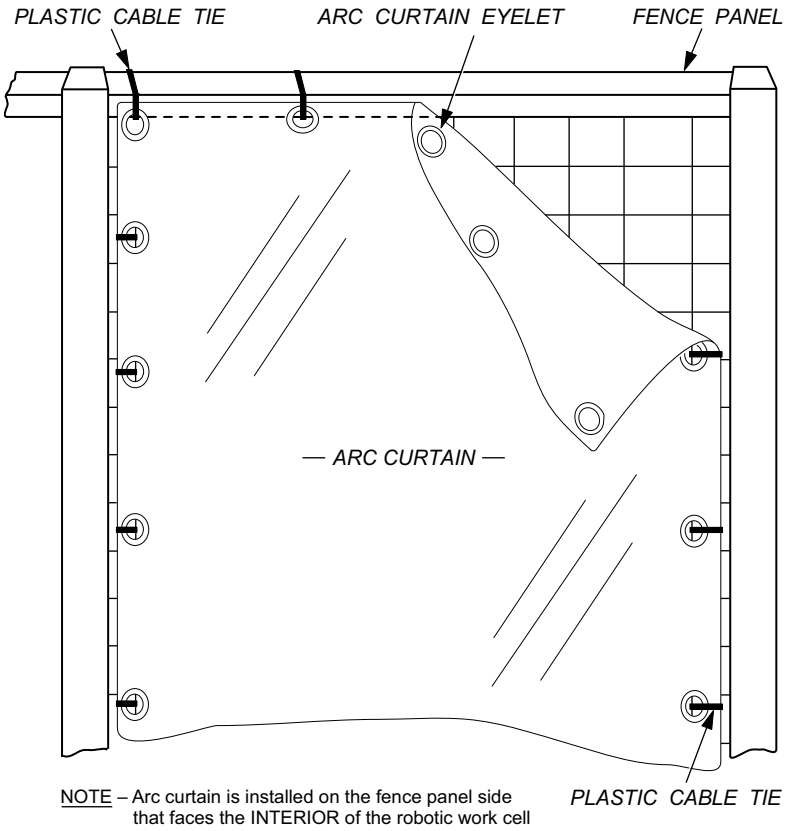
1. Unfold each arc curtain and install one on the **inside** of each work-cell safety fence panel using the supplied plastic cable ties and the eyelets in each arc curtain (see *Fig. 3-6 “Arc Curtain Installation on Typical Safety Fence Panel” on page 3-13*).

NOTICE

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 that there are no gaps between the arc curtains.
3. Install the work-cell door arc curtain on the **inside** of the door panel using the supplied plastic cable ties and the eyelets in the arc curtain (see *Fig. 3-6 “Arc Curtain Installation on Typical Safety Fence Panel” on page 3-13*).

Figure 3-6: Arc Curtain Installation on Typical Safety Fence Panel



3.8 Installation — Safety Light Curtain System

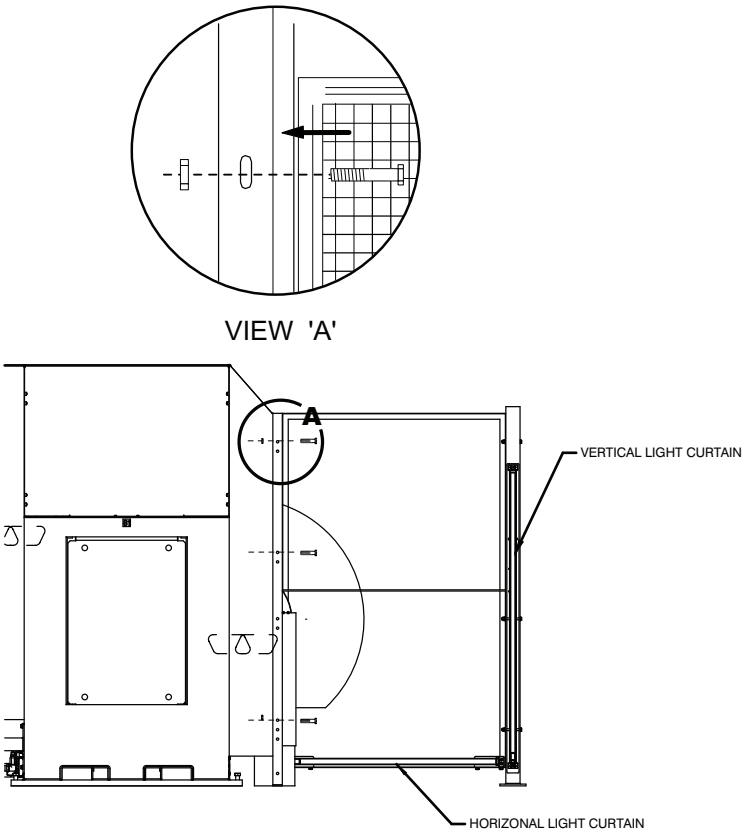
NOTICE

Safety light curtain components (Send unit, Receive unit) are mounted to safety fence panels at the factory and then secured for shipment to the customer

The steps for installing the safety light curtain system is as follows:

1. Unpack both safety light curtain fence panels from their shipping position and move them into position.
   – The light curtain units are oriented properly when their status lights are located near the base of the Positioner.
2. Use the three bolt holes located on the Positioner housing to mount the light curtain fence panels (see *Fig. 3-7*).
3. Unpack the light curtain cables and connect them to the matching connectors on the light curtain Send and Receive units.
4. Align the Send unit with the Receive unit.
   – Refer to the light curtain manufacturer's literature that is included in the ArcWorld documentation package (see *Fig. 1.5 "Reference Documentation" on page 1-23*).
5. After the light curtain units are installed and aligned, anchor the light curtain fence panel posts to the foundation (refer to *Motoman Lagging Supplement* for suggested anchor drills and bolts).
6. Check the alignment of the light curtain Send and Receive units after the fence posts are anchored to the foundation.
   – If required readjust alignment of the light curtain Send unit and Receive unit.

Figure 3-7: Safety Light Curtain Installation



3.9 Installation — Operator Station

The following steps installs the Operator Station:

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

NOTICE

Notify your shipping contractor as soon as possible if you notice any equipment damage.

4. Place the Operator Station outside the fence in front of the Positioner (see *Fig. 1.3 “System Layout” on page 1-6* and *Fig. 3-3(a) “Plan View Overhead View - ArcWorld 6300-755” on page 3-3*).

CAUTION

Make certain the Operator Station is positioned correctly before securing with anchors.

Not positioning the Operator Station correctly can cause equipment damage.

5. Anchor the Operator Station to the foundation.

3.10 Cable Connections

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

NOTICE

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

3.10.1 Connection to Earth Ground

WARNING

- Make sure ArcWorld 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 Manipulator and Robot Controller must be connected to a low-resistance earth ground. If a ground stake is used, it should be driven at least 2.43m into the soil. The soil surrounding the driven ground stake should be treated with a chemical that increases the soil conductivity in the vicinity of the driven ground stake. This is often referred to as a “low-resistance earth ground” and may require more than a single driven ground rod, depending on soil conditions.

Multiple ground rods (bonded together) or even a bonded network of buried copper sheeting (plus conduction-enhancing chemicals) may be required, depending on local soil conditions. The “low-resistance earth ground” must indicate a resistance of **100 ohms or less** (when measured directly between grounded equipment and the earth ground system). Be advised that specialized measuring equipment is usually required to get an accurate “resistance-to-ground” reading. Consult a specialist in this field, if required.

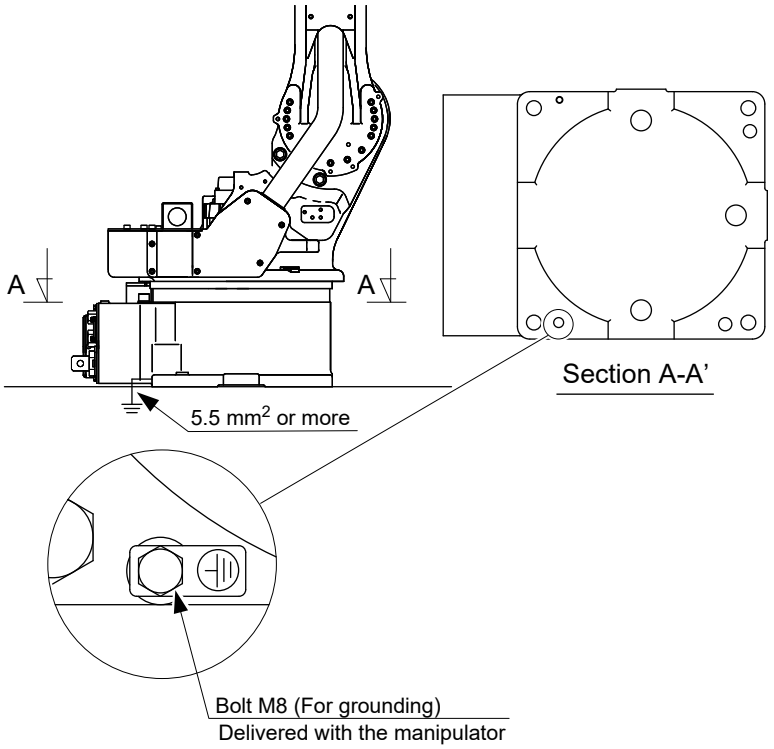
NOTICE

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 the Manipulators and Robot Controller assembly to the earth ground as follows:

1. Connect one end of an earth ground wire to the lug marked EARTH GROUND on the connector panel of Manipulator R1. Connect the other end of the earth ground wire to the low-resistance earth ground. See *Fig. 1.3 "System Layout" on page 1-6* for the location of Manipulator R1.
2. Repeat *step 1* for Manipulators R2 and R3.
3. Connect one end of an earth ground wire to the COMMON GROUND BUS BAR located inside Robot Controller R1 (see *Fig. 2-1(a) "Two Robot Controllers" on page 2-2*). Connect the other end of the earth ground wire to the low-resistance earth ground.
4. Repeat *step 3* for Robot Controller cabinets R2 and R3 as required.

Fig. 3-8: Grounding Method



3.10.2 Connection to Local Electrical Service

WARNING

- A qualified, licensed electrician must perform local electrical service connections to the ArcWorld.
  - Electrical and grounding connections must comply with the National Electrical Code (NEC), as well as all local electrical codes.

Not having a qualified, license electrician make connection to ArcWorld may result in electrical shock.

NOTICE

The ArcWorld is configured for three-phase 460/480V AC primary power. For additional information, refer to the electrical drawings and schematics that are included with the documentation package (see *section 1.5 “Reference Documentation” on page 1-23*

After installing system components properly, connect local electrical service to the Robot Controller and welding power sources (refer to *section 3.10.2.1* and *section 3.10.2.2*).

3.10.2.1 Robot Controller

For detailed electrical service interconnect procedures for the Robot Controller, refer to the *Robot Controller Manual* and ArcWorld system drawings and schematics that are included with the documentation package (see *section 1.5 “Reference Documentation” on page 1-23*).

3.10.2.2 Process Equipment

Install process equipment as instructed in the manufacturer's documentation (supplied if purchased through YASKAWA). Take particular care to insure there are no restrictions or kinks in hoses or conduits. Electrical cables must be laid flat and not coiled.

3.11 Safety/Operation Check

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

1. Ensure the correct alignment and operation of the safety light curtain system (refer to the safety light curtain documentation that is included with the ArcWorld).
2. Check the security and integrity of all cable connections.
3. Ensure that the work-cell sliding access door is closed and the door interlock is engaged.
4. Verify the correct settings for the welding power sources (refer to the welding power source documentation that is included with the ArcWorld).
5. Verify that local electrical service complies with the power requirements for the ArcWorld.
6. Verify that local electrical service is correctly wired into the Robot Controller assembly and the welding power sources (refer to *Fig. 3-8*).

CAUTION

- Use qualified, trained personnel who are familiar with the ArcWorld to perform the power-up sequence.

Not using someone who is qualified, trained and familiar with the ArcWorld can result in personal injury and equipment damage.

7. Set the power ON-OFF switch on the Robot Controller to ON [see *Fig. 2-1(a "Two Robot Controllers" on page 2-2*).]

NOTICE

An electrical service disconnect box for the Robot Controller shall be supplied (if desired) by the customer. It is not part of the ArcWorld shipment.

8. Set the service disconnect boxes for the welding power sources to ON [see *Fig. 2-1(a "Two Robot Controllers" on page 2-2*).]
9. Set the power ON-OFF switch on the welding power sources to ON.

WARNING

- Before operating the Robots, verify that each Emergency Stop button(s) disables servo power when activated (pushed in).
  - Each Emergency Stop button must immediately stop Robot and Positioner movement when activated (pushed in).

If the Emergency Stop button(s) do not work correctly can cause severe injury or death.

10. Check for correct operation of all Emergency Stop buttons (refer to *section 2.6.4 “E-Stop” on page 2-12*).
11. Check for correct operation of the system HOLD buttons on the Programming Pendant and Operator Station (Robot HOLD).

- Refer to the *Operator’s Manual for Arc Welding* for more information on the pendant’s HOLD button (see *section 1.5 “Reference Documentation” on page 1-23*). Refer to *section “Operator Station — Emergency Stop” on page 2-6* and the Manipulator manual for more information on the Operator Station’s Robot HOLD button (see *section 1.5 “Reference Documentation” on page 1-23*).

12. Check for correct operation of the work-cell access door safety interlock.
13. Remove power from the ArcWorld after completion of the safety/ operation check.

3.12 Installation of Tooling and Fixtures

Your ArcWorld is now ready for installation of the tooling and fixtures for your particular application. Personnel who are familiar with the operation of the ArcWorld should do the installation. After tooling installation, test the Positioner for correct operation. Refer to the Positioner manual for information on how to test that the Positioner is operating correctly (see *section 1.5 “Reference Documentation”*).

NOTICE

- The customer supplies all tooling and fixtures for the Positioner.
- YASKAWA recommends applying a corrosion/rust preventive compound to the tooling and fixtures that are located in a high-humidity environment.

4 Operation

This section provides a brief overview of the operating procedures and precautions for your ArcWorld. For more detailed operating information, refer to the specific component manuals that are part of the ArcWorld documentation package (see *section 1.5 “Reference Documentation” on page 1-23*).

The ArcWorld system is a fully integrated Robotic GMAW welding cell. Robot weld parts on one side of the Positioner, while the operator loads the opposite side with parts to be welded. When the Robots complete the welding process, they return to HOME (Safe) position. The operator can then initiate another Positioner sweep cycle from the Operator Station. This moves the previously loaded parts into the Robot work area, where the Robots then move from HOME (Safe) position to complete another welding cycle.

NOTICE

The customer supplies all tooling and fixtures for the Positioner.

4.1 Programming

The operation of this system is programming dependent. The following operating instructions are based on one possible configuration of this system. Your system configuration and job structure may differ slightly from that presented here; however, basic operation will be the same. For additional programming procedures and information, refer to the Robot Controller documentation that is included with your documentation package (see *section 1.5 “Reference Documentation” on page 1-23*).

Any changes made to your system configuration and/or job structure will alter the operation of the system. Motoman recommends that you **do not** modify the original jobs and system configuration of your ArcWorld. **If you determine a need to modify the original jobs and system configuration, make any modifications to a copy of the original. Keep the original as a backup. Do not modify the original.** Modifications must be performed by trained and experienced personnel who are familiar with the operation of the ArcWorld. If you have questions concerning the configuration of your system, please contact your local YASKAWA representative.

4.2 Sweeping the Positioner

NOTICE

Before sweeping the Positioner the Robot must be in the HOME position.

Selecting MANUAL mode on the Operator Station's [POSITIONER AUTO/MANUAL] switch allows the operator to sweep the Positioner without activating the Robots. Parts can be loaded onto the fixture to achieve the most efficient configuration and then swept into the welding zone, before teaching the Robots a series of moves. To sweep Side A or Side B of the Positioner into the Robot's welding zone, proceed as follows:

1. Place the Robots in HOME position (refer to *section 4.3.2*).
2. Make sure that the Operator Station is enabled (Programming Pendant's Mode Select Switch set to REMOTE).
3. Set the Operator Station's [POSITIONER AUTO/MANUAL] switch to MANUAL and start the Control Master job (refer to *section 4.3.3*).
   - Normally, the Robots will not move out of HOME position when the [POSITIONER AUTO/MANUAL] switch is set to MANUAL (this depends on job structure).

NOTICE

Cycle Start latching is not operative in MANUAL mode.

4. Press the [CYCLE START/CYCLE LATCHED] button on the Operator Station (the Positioner sweeps each time this button is pressed).

4.3 Daily Operation

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

- Perform the start-up procedure (refer to *section 4.3.1*).
- Move the Robots to HOME position (refer to *section 4.3.2*).
- Select the Control Master job (refer to *section 4.3.3*).
- Perform the operation cycle (refer to *section 4.3.4*).
- Perform the shutdown procedure (refer to *section 4.3.5*).

4.3.1 Start-up Procedure

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

1. If installed, switch the Robot Controller electrical service disconnect box to ON.

NOTICE
An electrical service disconnect box for the Robot Controller shall be supplied (if desired) by the customer. It is not part of the ArcWorld.

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

4.3.2 Robot HOME Position

To move the Robots to HOME position:

1. Select TEACH mode on the Programming Pendant.
2. Select {MAIN MENU} on the Programming Pendant's touch screen.
3. Select {JOB} on the Programming Pendant's touch screen.
4. Select {SELECT JOB} on the Programming Pendant's touch screen (a job list appears on the screen).
5. Use the navigation cursor key to move the cursor to SAFE job and then press [SELECT] (the job appears on the display screen).
6. Turn servo power ON by pressing [SERVO ON] and holding in the ENABLE switch.
7. Use the [FWD] button on the Programming Pendant to jog Robot R1 to HOME position.
8. Repeat Steps *5* through *7* for Robots R2 and R3 as required.

4.3.3 Master Job

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

1. Select {JOB} on the Programming Pendant's touch screen.
2. Select {CTRL MASTER} on the Programming Pendant's touch screen.
3. Press [SELECT] twice to activate the Master job.
4. Select PLAY mode on the Programming Pendant (job playback operation is enabled).
5. Press the [SERVO ON] button on the Programming Pendant.
6. Press the [START] button on the Programming Pendant (the Control Master job cycles, waiting for a Cycle Start input from the Operator Station).
7. Transfer control to the Operator Station by selecting REMOTE on the Programming Pendant's Mode Select Switch.

The ArcWorld work cell is now ready for operation.

4.3.4 Operation Cycle

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

1. The operator loads the fixture on the operator side of the Positioner with parts to be welded.
2. The operator steps out of the safety zone created by the safety light curtain system and moves to the Operator Station.
3. The operator observes the cell and confirms that no obstructions or unintentional users have entered the cell. Once confirmed, press the blue [LIGHT CURTAIN RESET] button on the Operator Station.
4. The operator presses the green [CYCLE START/CYCLE LATCHED] button on the Operator Station.
5. The Positioner sweeps, placing parts to be welded into the Robot work area. The Robots then begin to weld the parts (if the Operator Station's [POSITIONER AUTO/MANUAL] switch is set to AUTO).
6. While the Robots are welding, the operator loads the operator side of the Positioner with the next group of parts to be welded.

7. The operator again moves to the Operator Station and presses the green [CYCLE START/CYCLE LATCHED] button (the Cycle Latched light illuminates). When the Robots are finished welding, they return to HOME position. The Positioner then sweeps again to return the completed, welded parts to the operator position, while moving the next group of parts into the Robot work area.
8. The operator moves back to the operator side of the Positioner and unloads the completed, welded parts.

4.3.5 Shutdown Procedure

Use the following procedure to perform a normal shutdown of the ArcWorld:

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

NOTICE

An electrical service disconnect box for the Robot Controller shall be supplied (if desired) by the customer. It is not part of the ArcWorld.

8. Switch all welding power source disconnect boxes to OFF (see *Fig. 2-1(a) "Two Robot Controllers" on page 2-2*).

The ArcWorld 6000 Series system is now shut down.

4.4 System Recovery

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

4.4.1 Alarms and Errors

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

– Error messages

– Minor alarms

– Major alarms

For more detailed information on alarm and error recovery, refer to the maintenance and Robot Controller documentation that is included with your ArcWorld (refer to *section 1.5 “Reference Documentation” on page 1-23*).

4.4.1.1 Error Messages

Error messages are usually the result of simple, easily cleared operation errors. One example of this type of error is pressing the [START] button when the Robots are not in PLAY mode.

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

4.4.1.2 Minor Alarms

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

4.4.1.3 Major Alarms

Major alarms usually involve hardware failures. Examples of this type of error include an overload condition and abnormal speed.

Clear alarms of this type by cycling the Robot Controller in accordance with the following steps:

1. Rotate the Robot Controller’s power ON-OFF switch to OFF.
2. Allow the Robot Controller’s power ON-OFF switch to remain in the OFF position for approximately 10 seconds.
3. Rotate the Robot Controller’s power ON-OFF switch to ON.

4.4.2 E-Stop Recovery

An E-Stop condition will occur under any of the following conditions:

- An Emergency Stop button is pressed in (activated).
- The work-cell access door is opened while the Robot's are not in TEACH mode.
- The safety light curtain system is triggered while the Positioner is sweeping.
- A welding torch collision triggers a shock sensor output (refer to *section 4.4.3*).

After an E-Stop condition occurs, restart the ArcWorld as follows:

1. To clear the E-Stop condition, perform any of the following actions that apply:
   - Release the activated Emergency Stop push button
   - Close the work-cell access door
   - Clear the area in front of the Positioner that is protected by the safety light curtain system and press the [LIGHT CURTAIN RESET] button.
   - Clear the shock sensor condition (refer to *section 4.4.3*).

CAUTION

- Make sure to stand clear of the Positioner when restarting after an E-Stop condition.
  - If the Positioner is sweeping when an E-Stop condition occurs the Positioner will continue the sweep when the ArcWorld restarts.

Not following this Caution can cause injury when the ArcWorld restarts after an E-Stop condition.

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

The ArcWorld is now ready to continue operation.

4.4.3 Shock Sensor Recovery

Each Robot includes a Motoman gun mount. This mount is designed to protect the torch from damage in case of a crash (collision). A slight deflection of the torch activates a SHOCK SENSOR signal that triggers an E-Stop condition. To clear the E-Stop condition, you must override the shock sensor and move the affected Robot clear of the impact. To override the shock sensor, proceed as follows:

1. Select {MAIN MENU} on the Programming Pendant's touch screen.
2. Select {Robot} on the Programming Pendant's touch screen.
3. Select {OVERRUN-S.SENSOR} on the Programming Pendant's touch screen.
4. Select {RELEASE} to release the shock sensor.
5. Turn servo power ON (press in on the Programming Pendant's ENABLE switch while pressing [SERVO ON READY]).
6. Move the affected Robot clear of the impact position.

The ArcWorld is now ready to continue operation.

5 Maintenance

Maintenance must be performed by authorized personnel who are familiar with the ArcWorld. Be sure to read and understand the documentation for a particular component before doing repair maintenance or preventive maintenance on that component. Be sure that you understand the maintenance procedures, have the proper tools at hand, and comply with all the safety instructions and precautions given throughout this manual.

The maintenance intervals given in *Table 5-1* 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, refer to the documentation that is included in the documentation package (refer to *section 1.5 “Reference Documentation” on page 1-23*).

CAUTION

- Use only YASKAWA specified antifreeze if using water-cooled torches.

Typical automotive antifreeze contains additives that can clog the small cooling ports in the torches and damage sealing gaskets in the water circulator pumps.

Table 5-1: Periodic Maintenance

FREQUENCY	COMPONENT	PROCEDURE
Daily (or on condition)	Water Circulators (water-cooled torch application only)	Add a mixture of YASKAWA antifreeze (P/N 131224-1) and distilled water, as required. Mix antifreeze and distilled water in proportions shown on the antifreeze container.
	All safeguard items – work-cell door interlocks, Emergency Stop buttons, safety light curtains, arc curtains, etc.	Check the physical condition of the safeguard item and ensure that it is working correctly.
	Gas and Water Hoses	Inspect hoses for damage and replace as required
One Month (or on condition)	ArcWorld Work Cell	Remove accumulated dirt, grease, and debris from inside and outside the work cell.
Six Months (or on condition)	Spanner Plates	Check the integrity and torque of the hardware that secures the spanner plates to the Robot equipment base and Positioner (see *Fig. 3-5 “Robot Common Base Installation” on page 3-9*).

6 Alarms and Messages

This section contains information on alarms and ladders that are generated by the Robot Controller ladder. Cause and resolution of each alarm are presented to help with troubleshooting. For additional help contact your local YASKAWA representative.

6.1 Alarms Based on Robot and Positioner Position

Table 6-1: Robot Position Alarms

Alarm Text	Alarm Cause	Suggested Resolutions
ROBOT(S) MUST BE HOME FOR SWEEP	Any Robot is forward of home “wall” cube # (58 - 60). While the Positioner is not at side A or B and while in automatic operation.	Switch to TEACH mode then either: • Move all Robots to home or away from the Positioner. • Move the Positioner back to side A or B.

6.2 Alarms Based on Functional Safety Unit Conditions

Table 6-2: Functional Safety Unit Alarms

Alarm Text	Alarm Cause	Suggested Resolutions
SYS CRITICAL FSU FUNCT DISABLED	This alarm occurs when any Safety file has been changed from the standard configuration. This alarm prevents the cell from running until the safe configuration is restored.	When this alarm occurs a corresponding USER MESSAGE should also occur. Follow the USER ALARM text in the next section for resolution and settings to investigate.

6.3 Cell Messages

Table 6-3: Cell Messages

Message Text	Message Cause	Suggested Resolutions
ANY ROBOT RANGE FILE DISABLED	After “SYS CRITICAL FSU” type alarm occurs, this message will follow, which helps point towards the specific feature to examine.	Check the menu: SAFETY FUNC. > ROBOT RANGE LIMIT and verify that all Files 1 through 3 are setup per *section 1.4.2 “Cell Related Safety Functions & Components:” on page 1-12*. There is one file for each Robot in the system.
AXIS RANGE LIMIT #1 OR #2 DISABLED	After “SYS CRITICAL FSU” type alarm occurs, this message will follow, which helps point towards the specific feature to examine.	Check the menu: SAFETY FUNC. > AXIS RANGE LIMIT and verify that Files 1 and 2 are setup per *section 1.4.2 “Cell Related Safety Functions & Components:” on page 1-12*
ANY SPEED MONITOR FILE DISABLED	After “SYS CRITICAL FSU” type alarm occurs, this message will follow, which helps point towards the specific feature to examine.	Check the menu: SAFETY FUNC. > AXIS SPEED MONITOR and verify that Files 1 through 5 are setup per *section 1.4.2 “Cell Related Safety Functions & Components:” on page 1-12*

7 Spare Parts

Maintenance of the ArcWorld cell and its associated components should be performed only by authorized personnel who are familiar with the design, construction, and operation of the system. When exchanging failed parts be sure to understand the procedure, risks, have the proper tools, and observe all applicable safety precautions.

WARNING

- Ensure that servo power is OFF and observe standard lockout/ tagout practices before performing the following procedures.

Severe Injury or death may result if servo power is not removed.

When a part malfunctions, it is helpful to have replacement parts in stock for quick replacement. YASKAWA recommends the parts in the following sections be kept on hand.

7.1 Robot Spare Parts

Reference the supplied Manipulator manual for spare part recommendations.

7.2 Positioner Spare Parts

Reference the Positioner manual for spare part recommendations relative to the Positioner.

7.3 ArcWorld Interface Spare Parts

Each ArcWorld is supplied with a power distribution enclosure and top hat interface that is attached to the Controller base assembly. Recommended spare parts include:

Table 7-4: Recommended Spare Parts for the Electrical Interface

System	Component	YASKAWA Part Number	Recommended Quantity
24VDC Fuses			
Protection for Robot Controller's 24VDC circuit	1 Amp Fuse 24VDC	703093-3	2
Protection ahead of Ethernet Switch	1.6 Amp Fuse 24VDC	703039-8	2
Protection ahead of 24VDC distribution block	2 Amp Fuse 24VDC	703039-1	2
Fuse Module main fuse	10 Amp Fuse 24VDC	149593-1	2
24VDC Fuses (Radial Lead Type)			
Expansion Safety Relay Board (Inputs)	0.315 Amp Fuse 24VDC (Radial Lead Type)	174237-2	6
Safety I/O Interface Board (Inside RM2 Positioner)	1.6 Amp Fuse 24VDC (Radial Lead Type)	174237-4	4
Expansion Safety Relay Board (Outputs)	2.5 Amp Fuse 24VDC (Radial Lead Type)	174237-1	2
Master PWR/NET Module (Top Hat of Robot Controller)	6.3 Amp Fuse 24VDC (Radial Lead Type)	174237-3	2
600VAC Fuses			
Protection ahead of Robot Controller Input Power (Single Robot Cell)	15 Amp Fuse 600VAC	180653-4	3
Protection ahead of Robot Controller Input Power (Dual Robot Cell)	20 Amp Fuse 600VAC	180653-3	3
Protection ahead of Robot Controller Input Power (Triple Robot Cell)	30 Amp Fuse 600VAC	180653-1	3
Primary fuses for the whole system disconnect.	200 Amp Fuse 600VAC	703070-11	3
Miscellaneous			
Water Circulation (If equipped)	Coolant/Antifreeze (if equipped with Water Circulation)	131224-1	1
External Lubrication System	Mobil CM-P No. 2	180144-1 (14 oz Tube) 180144-2 (120lb keg)	See Positioner Manual for details

Appendix A

A.1 Checklist

Since our customer is very important to us we include a checklist to use before start-ups and after maintenance for your convenience and safety.

	Time/Date	Checked By
BEFORE APPLYING POWER *(Refer to System Drawings)*		
Check Mounting *(Refer to Installation Section in all Manuals)*		
Check Power *(Refer to Connections, Robot Controller Manual)*		
Check Ground *(Refer to Grounding in all Manuals)*		
Check Water *(Refer to Operation and Vendor Manuals)*		
Check Air *(Refer to Manipulator and Vendor Manuals)*		
Check Gas *(Refer Operation and Vendor Manuals)*		
Check Interlocks *(Refer to Work Cells in all Manuals)*		
Check Limiting Devices *(Refer to Limits in all Manuals)*		
Check Environment *(Refer to Installation in Robot Controller Manual)*		
Check Version *(Refer to Confirmation of Software Version)*		
Other Items to Check Before Applying Power *(Vendor or Integrator Supplied)*		

	Time/Date	Checked By
AFTER APPLYING POWER		
Check Control Switches (*Refer to Operator Station, Robot Controller Manual*)		
Check Axis Move and are Restricted *(Refer to Basic Specifications, Manipulator Manual)*		
Check Emergency Stop(s) *(Refer to E-Stop in all Manuals)*		
Check External Power Disconnect *(Refer to Turning OFF The Power Supply)*		
Check TEACH Mode (*Refer to TEACH Mode, Robot Controller Manual)*		
Check Playback Mode *(Refer to PLAY Mode, Robot Controller Manual)*		
Check Environment *(Refer to Location in Manipulator Manual)*		
Check Safeguards *(Refer to Safeguards in all Manuals)*		
Check Manual Mode *(Refer to Manual Mode in Operations Manual)*		
Check Automatic Mode *(Refer to Automatic Mode in Operations Manual)*		
Other Items to Check After Applying Power *(Vendor or Integrator Supplied)*		

	Time/Date	Checked By
DOCUMENTATION INCLUDED		
System Drawings		
Modifications Made to Original Protective Equipment		
End Effector Load Analysis		
Instructions on Synchronized Motion *(More than one piece of equipment)*		
Programmed Limits		
Collaborative Operation Declaration *(Robot is suitable for integration that includes requirements met and types of operation)*		
Compliance Documents *(ANSI, ISO, RIA, etc.)*		
Risk Assessment		
Other Documents to Include *(Vendor or Integrator Supplied)* *(Vendor Manuals, Supplier Certifications, Compliance*		

	Time/Date	Checked By
MARKINGS INCLUDED ON EQUIPMENT		
Business Name, Address, Info		
Machinery Designation and Type		
Year Built		
Explosive Proof		
Order Number *(Serial Number)*		
Other Markings on Equipment (Vendor Machine Designation, Type, Serial No, Version, etc.)		
OTHER ITEMS		

ArcWorld® 6000
SYSTEM MANUAL

For inquiries or after-sales service on this product, contact your local YASKAWA representative as shown below.

YASKAWA ELECTRIC CORPORATION
2-1 Kurosakishiroishi, Yahatanishi-ku, Kitakyushu, 806-0004, Japan
Phone: +81-93-645-7703 Fax: +81-93-645-7802
http://www.yaskawa.co.jp

YASKAWA AMERICA, INC. (MOTOMAN ROBOTICS DIVISION)
100 Automation Way, Miamisburg, OH 45342, U.S.A.
Phone: +1-937-847-6200 Fax: +1-937-847-6277
http://www.motoman.com

YASKAWA EUROPE GmbH (ROBOTICS DIVISION)
Yaskawastrasse 1, 85391, Allershausen, Germany
Phone: +49-8166-90-100 Fax: +49-8166-90-103
http://www.yaskawa.eu.com

YASKAWA NORDIC AB
Verkstadsgatan 2, Box 504, SE-385 25 Torsas, Sweden
Phone: +46-480-417-800 Fax: +46-486-414-10
http://www.yaskawa.se

YASKAWA ELECTRIC (CHINA) CO., LTD.
22F, One Corporate Avenue, No.222 Hubin Road, Huangpu District, Shanghai 200021, China
Phone: +86-21-5385-2200 Fax: +86-21-5385-3299
http://www.yaskawa.com.cn

YASKAWA SHOUGANG ROBOT CO., LTD.
No.7 Yongchang North Road, Beijing E&T Development Area, Beijing 100076, China
Phone: +86-10-6788-2858 Fax: +86-10-6788-2878
http://www.ysr-motoman.cn

YASKAWA ELECTRIC KOREA CORPORATION
35F, Three IFC, 10 Gukjegeumyung-ro, Yeongdeungpo-gu, Seoul, 07326, Korea
Phone: +82-2-784-7844 Fax: +82-2-784-8495
http://www.yaskawa.co.kr

YASKAWA ELECTRIC TAIWAN CORPORATION
12F, No.207, Sec. 3, Beishin Rd., Shindian District, New Taipei City 23143, Taiwan
Phone: +886-2-8913-1333 Fax: +886-2-8913-1513
http://www.yaskawa.com.tw

YASKAWA ASIA PACIFIC PTE. LTD.
30A Kallang Place, #06-01, 339213, Singapore
Phone: +65-6282-3003 Fax: +65-6289-3003
http://www.yaskawa.com.sg

YASKAWA ELECTRIC (THAILAND) CO., LTD.
59, 1st-5th Floor, Flourish Building, Soi Ratchadapisek 18, Ratchadapisek Road, Huaykwang, Bangkok 10310, Thailand
Phone: +66-2-017-0099 Fax: +66-2-017-0199
http://www.yaskawa.co.th

PT. YASKAWA ELECTRIC INDONESIA
Secure Building-Gedung B Lantai Dasar & Lantai 1 Jl. Raya Protokol Halim Perdanakusuma, Jakarta 13610, Indonesia
Phone: +62-21-2982-6470 Fax: +62-21-2982-6471
http://www.yaskawa.co.id

YASKAWA INDIA PRIVATE LIMITED (ROBOTICS DIVISION)
#426, Udyog Vihar Phase-IV, Gurgaon, Haryana 122016, India
Phone: +91-124-475-8500 Fax: +91-124-475-8542
http://www.yaskawaindia.in

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