

Simple  friendly

 **Kawasaki**

Kawasaki Robot

Safety Manual

Robot

Kawasaki Heavy Industries, Ltd.

PREFACE

This manual describes precautions and rules for safety when using the Kawasaki Robot. Read and fully understand this manual and other related manuals including Operation Manual, Installation and Connection Manual, Inspection and Maintenance Manual, etc., and prepare the safety measures required for each procedure before initiating use of the robot.

The contents of this manual apply to all types and models of robots produced by Kawasaki.

-
1. This manual does not constitute a guarantee of the systems in which the robot is utilized. Accordingly, Kawasaki is not responsible for any accidents, damages, and/or problems relating to industrial property rights as a result of using the system.
 2. It is recommended that all personnel assigned for activation of operation, teaching, maintenance or inspection of the robot attend the necessary education/training course(s) prepared by Kawasaki, before assuming their responsibilities.
 3. Kawasaki reserves the right to change, revise, or update this manual without prior notice.
 4. This manual may not, in whole or in part, be reprinted or copied without the prior written consent of Kawasaki.
 5. Store this manual with care and keep it available for use at any time. If the robot is reinstalled or moved to a different site or sold off to a different user, attach this manual to the robot without fail. In the event the manual is lost or damaged severely, contact Kawasaki.

All rights reserved. Copyright © 2006 by Kawasaki Heavy Industries Ltd.

SYMBOLS

The items that require special attention in this manual are designated with the following symbols.

Ensure proper and safe operation of the robot and prevent physical injury or property damage by complying with the safety matters given in the boxes with these symbols.

 **DANGER**

Failure to comply with indicated matters can result in imminent injury or death.

 **WARNING**

Failure to comply with indicated matters may possibly lead to injury or death.

 **CAUTION**

Failure to comply with indicated matters may lead to physical injury and/or mechanical damage.

[NOTE]

Denotes precautions regarding robot specification, handling, teaching, operation and maintenance.

CONTENTS

1.0 Safety	1
2.0 Five Principles of the Safety, Kawasaki Robot	2
3.0 General Safety Precautions	3
4.0 Safety at Each Work Process	7
4.1 Safety at Installation and Connection	7
4.2 Safety before Activation of Robot	9
4.3 Safety at Robot Activation	10
4.4 Safety during Teaching	12
4.5 Safety during Automatic Operation	14
4.6 Safety during Troubleshooting	15
4.7 Safety during Inspection and Maintenance	17
5.0 Safety Features of the Kawasaki Robot	21

1.0 SAFETY

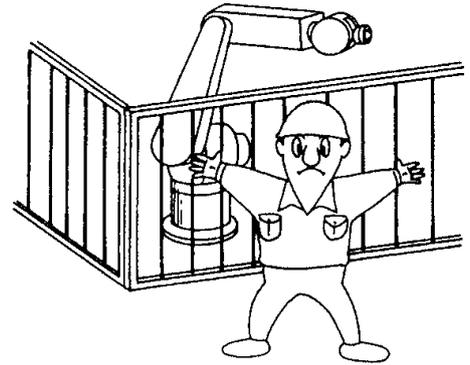
As stated in national and local laws and legislation, safety provision is the most essential concern when using industrial systems that include robots.

In the event of physical injury or property damage as a result of robot use, the plant that utilizes the robot will be held liable. Accordingly, it is important to fully understand all statutes and standards regarding health and safety in addition to this manual and its related texts, and to comply with their contents.

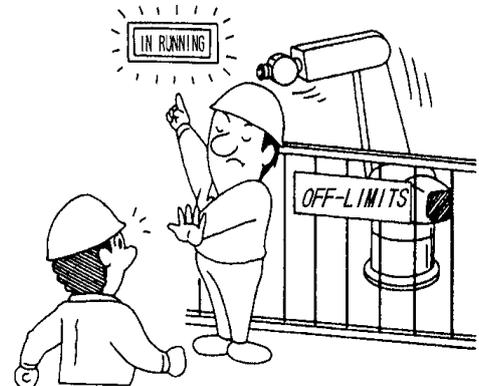
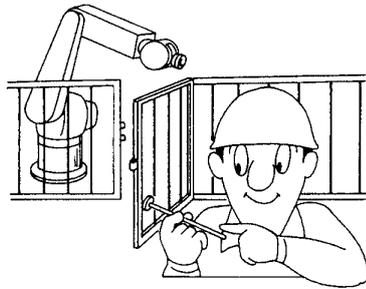
For safety, at least follow this manual and all the other manuals issued by Kawasaki separately but all safety related information presented here is intended for use as general precautions and does not apply to each particular system in which the robot is utilized. Therefore, when using the robot, provide the safety measures necessary for that system and working environment and strictly observe these safety measures.

2.0 FIVE PRINCIPLES OF THE SAFETY, KAWASAKI ROBOT

1. Install the robot within a safety fence without fail, so as to ensure that nobody may have access to the robot during operation.

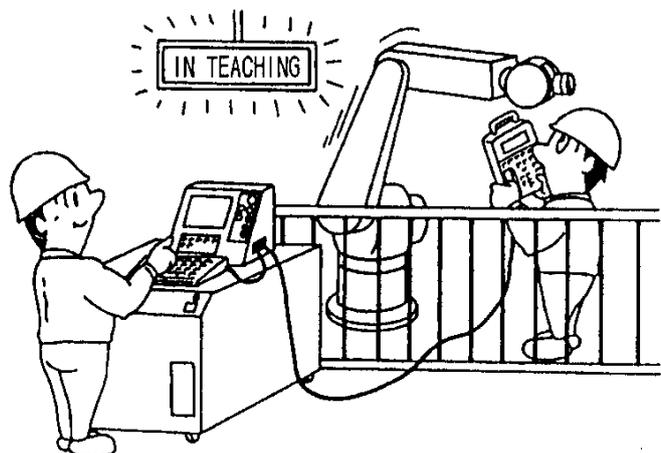


2. Install a safety fence with door that uses a safety plug at its locking mechanism. The door must not open unless the plug is pulled out, and removal of the plug must cause the robot to stop automatically and safety.



3. While the robot is operating or waiting, never enter within the motion range.
4. When working within a safety fence for robot teaching/check, the operator must enter with the safety plug to prevent personnel from accidentally operate the robot. Also, in front of the controller assign a supervisor who can monitor operations and be ready to press **EMERGENCY STOP** switch at any time. Supervisor must be personnel who have completed the special education and training course.

5. Display the operation mode clearly, such as: automatic mode, teaching, and emergency stop, etc. so the current condition of the robot can be seen by everybody.



3.0 GENERAL SAFETY PRECAUTIONS



DANGER

The manual focuses exclusively on safety matters for the main body of the robot and is not intended to describe safety for the whole system or any individual system in which it is used. Accordingly, read and understand fully all pertinent laws, regulations, user manuals and related materials and prepare the safety measures suitable for each system and working environment before initiating use of the robot.

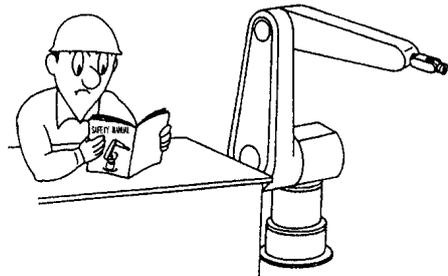
The following are general precautions relating to safe use of the robot.

1. Conduct teaching and maintenance in compliance with all national/international laws, local legislation and industrial codes and standards*.

NOTE* 1. JIS B8433 Manipulating Industrial Robots-Safety
2. ISO 10218 Manipulating Industrial Robots-Safety

2. It is recommended that all personnel assigned to install, operate, teach, inspect, maintain, and troubleshoot the robot attend the Kawasaki prepared education/training course(s) that would be pertinent to each employee's specific job. Please contact the Kawasaki office listed on the rear cover for information on education/training course(s).

3. Before installing, operating, teaching, inspecting, maintaining, and troubleshooting the robot, customers are expected to fully understand this Safety Manual and other related manuals/documents, and to comply with safety precautions so as to prevent incidents from occurring during operation.

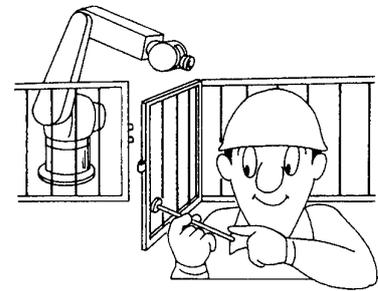


Also, predetermine responses beforehand in the event incident does occur in robot or system.

4. Plant operating personnel should prepare and comply with safety regulations based on established guidelines for ensuring work safety.
5. Plant operating personnel should appoint a full-time operator and safety supervisor who are responsible for creating a safety regulation system that administers all safety related issues, including safety education.
6. In order to prevent accidents from occurring with the robot, the supervisor should provide the

following protection measures according to the conditions at each robot's installation. Furthermore, personnel must comply with these measures at all times.

- (1) Always place the robot within the safeguarding devices (guard, fence, equipment, etc. provided for preventing hazards) so that the robot arm is put off limits. Also, install an emergency stop device in an easily accessible area within reach of the operator.
- (2) Safety guarding zone (area surrounded by the safety fence) should be built so as to prevent the robot from jumping over or extending beyond the fence in the event of breakdown and/or error.
- (3) Minimize the number of doors on the safeguarding devices (preferably only one). The door should be equipped with a safety plug which must be removed manually in order to open/close the door. Then, set motor power to be turned OFF if plug is removed during automatic operation. Confirm that safety devices such as **EMERGENCY STOP** switch and safety plug function normally before entering the safeguarding devices. Then, the operator must set **TEACH LOCK** switch on the teach pendant to ON to prevent personnel from accidentally switching to automatic mode. Also, the operator must keep the plug on him/herself.
- (4) Display the robot state clearly, such as: automatic mode, teaching, and emergency stop, etc. on the safeguarding devices so the current condition of the robot can be seen by everybody.
- (5) Prepare safety procedures in accordance with the configuration of the actual line and peripheral equipment.
- (6) The administrator should provide relevant training to all personnel assigned to operate, teach, inspect, maintain, and repair the system. Also, personnel should be given the necessary education to gain proficiency in their work procedures including all measures for ensuring safety.
- (7) Limit the robot operating personnel to only those who have taken and completed the training course(s) authorized by Kawasaki.



7. Always confirm that conditions are safe prior to initializing or restarting the robot, and remove any obstacles within its motion range. Also, never attempt a dangerous action such as stopping the robot during operation with tools or your body. If it is necessary to stop motion instantly, press **EMERGENCY STOP** switch.
8. Do not operate the robot over its specified capacities (load, speed, motion range, environment, etc.).
9. Clarify the motion range of robot or peripheral equipment by marking the danger area with paint on the floor. In addition, circumferentially make sufficient space (safety area) where the operator can take shelter during operation, in an abnormality or in an emergency, and install the safeguarding devices. Also, know both the danger and safety areas well.
10. The robot can move in a wide area with variety of motion patterns. Take precautions to prevent the hand from throwing the work held in its grasp and to prevent the robot arm from impacting or crushing the peripheral equipment. Also, personnel must ensure there are no places where personnel can be squeezed between fixed and moving sides of equipment.
11. The safety fence must be strong enough to endure the forces applied during operation in and outside the fence. Its position must be fixed, unmovable and installed so as to prevent personnel from breaching or removing the fence without the use of tools. Also, it must be free from sharp edges, projections and be arranged without potentially dangerous parts.
12. Verify the position and function of **EMERGENCY STOP** switches. Never perform conversions on work cell or system which render the safety related devices, be they mechanical or electrical, useless by jumper out, etc.
13. Properly install all safety devices to prevent danger, and perform the periodic maintenance as scheduled.
14. For safety, design and install the interlock for electro-mechanical interfacing between system devices to be failsafe – a standard used in device construction that ensures: 1) personnel are protected from harm if any one part of the device malfunctions, and 2) that the system automatically assumes a safe state after an error.
15. Do not plug/unplug the electrical connections of the printed boards, connectors, etc. when power to the robot is ON.
16. The Teach Pendant is a precision instrument, protect it from shock and avoid dropping it.

17. If robot arm is labeled with a warning sign, comply with its stated safety instructions and protect the label against damage and soiling. In the event the label becomes illegible, consult Kawasaki.

Never step on robot arm or controller. The following accidents may happen and cause not only part deformation/property damage but physical injury.

1. Personnel lose their footing,
2. Axis brakes release and arm moves suddenly,
3. If controller casters are unlocked, controller moves, falls, etc.

18. Avoid wearing loose fit clothing, ties, scarves, watches, and jewelry. Additionally, wear the specified protective gear, safety eyeglasses, helmet, and safety shoes required for each working environment and condition.

19. If any personnel observe unsafe working conditions, report them immediately to the supervisor or plant safety coordinator so that corrective actions can be taken.

4.0 SAFETY AT EACH WORK PROCESS

Robot work processes are divided into the following seven categories, and the safety considerations to be taken for each category is explained below.

1. Safety at Installation and Connection
2. Safety Before Activation of Robot
3. Safety at Robot Activation
4. Safety during Teaching
5. Safety during Automatic Operation
6. Safety during Troubleshooting
7. Safety during Inspection and Maintenance

4.1 SAFETY AT INSTALLATION AND CONNECTION

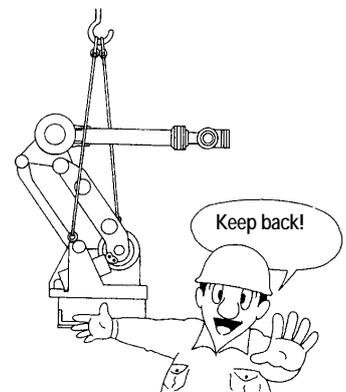
For all operations at installation and connection, strictly comply with the following considerations, while referencing the national/international safety codes and standards* below.

NOTE* 1. JIS B8433 Manipulating Industrial Robots-Safety 9.2
2. ISO 10218 Manipulating Industrial Robots-Safety 9.2

1. Read and understand fully all manuals, specifications and related documents provided by Kawasaki before operation. In addition, understand thoroughly all procedures for operation, teaching and maintenance. Also, make sure that all the necessary measures for safety are installed and fully functioning.
2. When lifting the robot for transport, avoid going over the specified height.

DANGER

1. Only personnel qualified in forklift or crane operation must be permitted to move/transport the robot arm, controller, traverse axis, etc.
2. Never go near or under a hoisted robot components, controller, traverse axis, etc. during transport.
3. Never get on the robot arm, controller, traverse axis, etc., touch or support them manually during transport.



3. Hook the wire on the eyebolts as instructed in the Installation and Connection Manual, a separate volume, and confirm there are no loose eyebolts before starting operation.
4. When hoisting the controller via wire, remove the teach pendant and teach pendant holder so that cables, etc. do not get caught on other devices.
5. Before transporting robot, remove unnecessary objects and clear the path up to the installation site.
6. Controller may tilt if carried by forklift truck. To prevent the controller from tilting, use a belt to fix the controller securely to the forklift truck.
7. Protect robot from shock during transport as it consists of precision components.
8. Do not connect primary power cable to controller while the main power switch to the installation site is ON. Failure to do so is extremely dangerous and may cause electric shock. Confirm that main power supply is shut OFF before connecting primary power cable. Also, display signs indicating clearly shutoff, inspection/maintenance, repair in progress, and fix the main power switch with a lock (lockout) or place a tag (tagout) to prevent personnel from accidentally turning ON the power.
9. Be sure to attach the cover for the primary power cable connecting terminals when wiring work is completed. Failing to cover the terminals properly is extremely dangerous as accidental contact with terminals may cause electric shock.
10. Place the motor/signal harnesses to be connected with the robot inside ducts, etc. to prevent them from being damaged. In addition, provide adequate safety measures not to trip over them.

**WARNING**

Do not connect the primary power cable until controller and robot are completely connected. Failure to do so is dangerous and may result in accidents or electric shock.

4.2 SAFETY BEFORE ACTIVATION OF ROBOT

For all operations before activation of robot, strictly comply with the following considerations, while referencing the national/international safety codes and standards* below.

NOTE* 1. JIS B8433 Manipulating Industrial Robots-Safety 9.2
2. ISO 10218 Manipulating Industrial Robots-Safety 9.2

1. Read and understand fully all manuals, specifications and related documents provided by Kawasaki before operation. In addition, understand thoroughly all procedures for operation, teaching and maintenance. Also, make sure that all the necessary measures for safety are installed and fully functioning.
2. Confirm that the robot controller, operation panel and all other control devices are installed outside the safeguarding devices where entire robot motion range can be monitored.
3. Make sure that no operator, packing material, jig, or obstacles of any kind are within the arm's motion range.
4. Eliminate any areas between moving and fixed devices where a person can be trapped.
5. When connecting the primary power, comply with the specified conditions for power voltage, hertz, cable size and so on.
6. Ensure a proper earthing of the controller and/or peripheral equipment. Earth lines connected to controller and other equipment must not be wired in common. Also, if external devices cause noise due to the placement of electromagnetic switches, etc. near the controller, install noise-killers or similar devices at the appropriate places.
7. Before turning the motor power ON, ensure that installation is performed according to Installation and Connection Manual, a separate volume.
8. In addition to the operator who is manipulating the robot, operation of robot must be monitored by an observer who has completed the education and training course given by Kawasaki.
9. For all utilities (water, air and gas, etc.), a system for monitoring of the rated values must be established so that errors can be detected in the event supply of the utility becomes abnormal.

10. If a great deal of garbage, metal particles, fine particles, etc. are expected to be generated during operations, then the robot, controller, peripheral equipment, etc. must be protected with appropriate covers, etc.

**CAUTION**

For safety during installation and connection, comprehend and comply with the contents of Installation and Connection Manual, a separate volume.

4.3 SAFETY AT ROBOT ACTIVATION

To activate the robot, the control power is turned ON first, followed by motor power. For this operation, strictly comply with the following considerations while referencing the national/international safety codes and standards* below.

- NOTE***
1. JIS B8433 Manipulating Industrial Robots-Safety 9.3
 2. ISO 10218 Manipulating Industrial Robots-Safety 9.3

**DANGER**

Before activation of robot, confirm that all EMERGENCY STOP switches function normally.

1. Read and understand fully all manuals, specifications and related documents provided by Kawasaki before operation. In addition, understand thoroughly all procedures for operation, teaching and maintenance. Also, make sure that all the necessary measures for safety are installed and fully functioning.
2. Check all of switches, displays, signal names and functions necessary for robot operation.
3. Never enter the safety fence unless its robot power cutoff circuit is functioning. Also, before activating robot, confirm that all safeguarding devices function normally.
4. If robot is activated in a system where several operators work, determine a starting signal that all operators and related personnel know and recognize as the robot activation signal.
5. Before turning the motor power ON or starting teach or automatic operation, make sure no person or obstacle remains inside the safeguarding devices or around the robot.

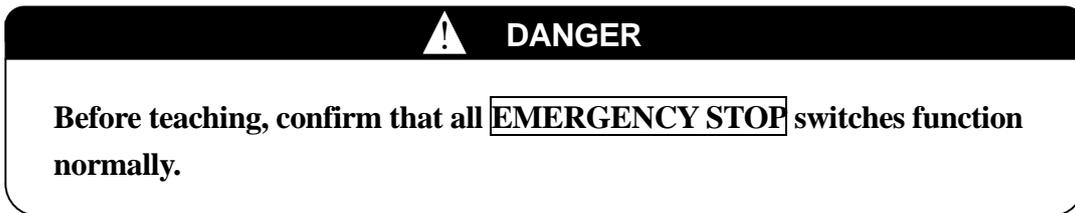
6. When turning ON motor power, keep your hand on the **EMERGENCY STOP** switch so that motor power can be cut OFF immediately if a faulty condition occurs, at start-up robot operations and when recovering from a faulty condition.

7. Before activation of robot, reconfirm that the following conditions are satisfied.
 - (1) Before turning the motor power ON
 - 1) Be sure that the installation state of robot is adequate and stable.
 - 2) Be sure that connection to the controller is adequate and specifications (power voltage, frequency, etc.) are satisfied.
 - 3) Be sure that the connection with utilities (water, air and gas, etc.) is adequate and conforms to the specification.
 - 4) Be sure that connections to peripheral equipment are correct.
 - 5) Be sure to install the mechanical stoppers and/or limit switches to restrict the motion range in addition to the software motion limits.
 - 6) Be sure to check the related parts and replace faulty mechanical stoppers if necessary when the robot is stopped by mechanical stopper.
 - 7) Be sure that the safety measures are adopted; safeguarding devices such as safety fence or warning device, etc. and interlock are installed.
 - 8) Be sure that the safeguarding devices and interlock function normally.
 - 9) Be sure that environmental conditions (temperature, humidity, light, noise, dust, etc.) are satisfied/do not exceed system and robot specifications.
 - (2) After turning the motor power ON
 - 1) Be sure that the hold/run and teach/repeat mode selectors function normally.
 - 2) Be sure that the robot axes move normally within the restricted range and speed.
 - 3) Be sure that the emergency stop circuit and safety devices on controller, teach pendant, peripheral systems, etc. function normally during robot operation in teach/repeat modes.
 - 4) Be sure that limit switches (Option) function normally during robot operation in teach mode.
 - 5) Be sure the safety circuit functions normally and the robot stops when safety plug is removed during robot operation in repeat mode.
 - 6) Be sure the robot stops when **TRIGGER** enable-switch is either released or fully depressed during robot operation in teach mode.
 - 7) Be sure warning sign labels are not damaged/soiled, and that all safety devices including warning lamps and safeguarding devices function normally.
 - 8) Be sure that the external power source including control power, air, etc. can be cut OFF.
 - 9) Be sure that the teaching and repeat functions are normal.
 - 10) Be sure that the robot axes move properly and can perform the work.
 - 11) Be sure that the robot can operate properly in automatic mode and can perform the planned operation at the specified speed and load.

4.4 SAFETY DURING TEACHING

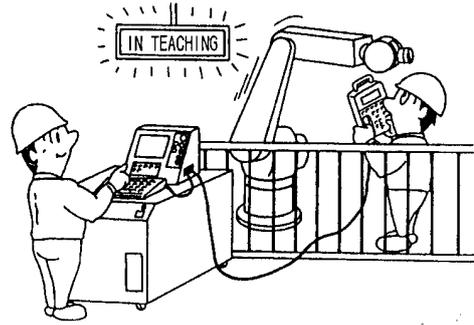
Kawasaki recommends conducting teaching outside the safety fence. However, if teaching must be done inside the fence, then strictly comply with the following considerations, while referencing the national/international safety codes and standards* below.

- NOTE***
1. JIS B8433 Manipulating Industrial Robots-Safety 8.3, 8.5
 2. ISO 10218 Manipulating Industrial Robots-Safety 8.3, 8.5



1. Read and understand fully all manuals, specifications and related documents provided by Kawasaki before operation. In addition, understand thoroughly all procedures for operation, teaching and maintenance. Also, make sure that all the necessary measures for safety are installed and fully functioning.
2. Before activation of robot, be sure to confirm that all the safeguarding devices function normally.
3. Teach with two persons, a teacher and an observer. The observer must also be assigned the role of “Work supervisor”, and perform teaching after mutually confirming signal for “work starting” etc.
4. When entering the safety fence, the operator must set TEACH LOCK switch on the teach pendant to ON to prevent incidents caused by switching to automatic mode. If the robot makes any abnormal motion, immediately press the EMERGENCY STOP switch and evacuate on a planned path of retreat.

5. Outside the safety fence where entire robot motion can be monitored, install the **E-STOP** switch for the supervisor. The supervisor should have easy access to the **E-STOP** switch in case robot motion needs to be terminated when erroneous movement is made. Also, if restarting the robot after an emergency stop, conduct manual operation or reset operation outside the fence. Moreover, the teacher and supervisor (as shown above) must be personnel who have completed the special education and training course.



6. Display a sign indicating teaching in progress to prevent personnel from accidentally operating any robot system devices by controller, operation panel, teach pendant, etc.
7. After completing the teaching, before confirming the taught data and motion, move all people away from the safeguarding area, and then perform the confirmation outside the safeguarding area after making sure no person or obstacle remains inside the safeguarding devices or around the robot. Also, at this time, operate the robot at or less than the safety operation speed (250 mm/s) until it is confirmed normal.
8. If restarting the robot after an emergency stop, conduct manual operation or reset operation outside the safety fence. Confirm conditions are safe before restarting, and make sure no person or obstacle remains inside the safeguarding devices or around the robot.
9. During teaching, be sure to confirm the motion range of the robot, and never approach the robot carelessly or go under the robot arm. Especially when the work is grasped, never approach it or go under it because it may suddenly fall by mistaken operation.
10. For safety, the maximum speed for the robot in teach or check mode is limited to 250 mm/s (safety operation speed). However, set the check speed as low as possible just after starting teaching, when personnel are verifying the teaching data in check mode, after error occurs, etc.
11. During teaching, both teacher and supervisor must always watch out for abnormal motion and possible hit/pinch points in and around the robot. Also, ensure a safe passage for the operator in the event immediate evacuation is required.
12. After the motions have been taught to the robot, set the software limits slightly outside the “work area” that is defined by the taught motions. See Operation Manual for details on setting software limits.

4.5 SAFETY DURING AUTOMATIC OPERATION

Because taught programs are played back at high speed, strictly comply with the following considerations, while referencing the national/international safety codes and standards* below.

- NOTE***
1. JIS B8433 Manipulating Industrial Robots-Safety 8.2
 2. ISO 10218 Manipulating Industrial Robots-Safety 8.2

⚠ DANGER

Before automatic operation, confirm that all EMERGENCY STOP switches function normally.

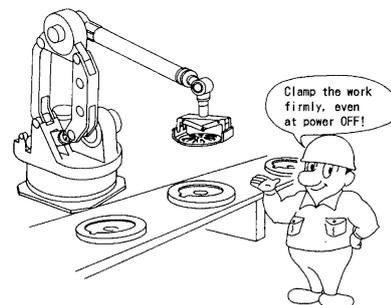
1. Read and understand fully all manuals, specifications and related documents provided by Kawasaki before operation. In addition, understand thoroughly all procedures for operation, teaching and maintenance. Also, make sure that all the necessary measures for safety are installed and fully functioning.

2. Never enter or let any part of your body inside the safety fence during automatic operation. Also, make sure no person or obstacle remains inside the safety fence prior to running the robot.



3. When the robot is waiting for a timer or external signal input during automatic operation, it may appear stopped. However, do not approach the robot because it will immediately restart motion to the next step once the timer has elapsed or the external signal is input.

4. It is extremely dangerous if the work is grasped insufficiently during automatic operation because it may be thrown by the robot's motion. Be sure that the work is grasped firmly. When work is handled by mechanisms such as pneumatic hands, electromagnet, etc., employ a failsafe system to prevent the work from being ejected if the mechanism's drive is cut OFF. If there is even the smallest possibility that the work may fly outward at times of error, install a protective barrier such as net.



5. Post signs on the safeguarding devices indicating automatic operation is in progress and entry to the work cell is off limits. Also, ensure a safe passage for the operator in the event immediate evacuation is required.

6. If an error causes the robot to stop during automatic operation, check the displayed error message, follow the appropriate recovery procedures, and restart the robot.
7. Be sure to confirm that safe working conditions are satisfied before restarting the robot after recovery procedures, and make sure no person, jig, peripheral system, obstacle, etc. remains inside the safeguarding devices or around the robot.

4.6 SAFETY DURING TROUBLESHOOTING

To work on troubleshooting, strictly comply with the following considerations, while referencing the national/international safety codes and standards* below, and report all details to Kawasaki, including robot model, controller model, machine number, any options, etc. when trouble occurs.

- NOTE***
1. JIS B8433 Manipulating Industrial Robots-Safety 8.6
 2. ISO 10218 Manipulating Industrial Robots-Safety 8.6



DANGER

Before troubleshooting work, confirm that all EMERGENCY STOP switches function normally.

1. Read and understand fully all manuals, specifications and related documents provided by Kawasaki before operation. In addition, understand thoroughly all procedures for operation, teaching and maintenance. Also, make sure that all the necessary measures for safety are installed and fully functioning.
2. Before entering the safety fence, make sure all necessary safety measures are prepared and functioning well.
3. Before entering the safety fence, shut OFF control power up to the main power switch. Display signs indicating clearly shutoff, troubleshooting in progress, and fix the main power switch with a lock (lockout) or place a tag (tagout) to prevent personnel from accidentally turning ON the power.
4. Troubleshooting duties are limited to personnel who have completed special training/education for the installed robot or for an equivalent model.

5. Before troubleshooting work, ensure enough space around the robot so there is no interference with peripheral systems. Set the peripheral systems in a fixed status so they will not make any sudden motion.
6. Disable automatic operation functions when entering the safety fence. If the robot makes any abnormal motion, press **EMERGENCY STOP** switch immediately, and evacuate on a planned path of retreat.
7. In addition to the **EMERGENCY STOP** switch held by the operator, install another **E-STOP** switch for the supervisor outside the safety fence, in a place where the robot's entire motion range can be monitored. If the robot moves abnormally during observation of troubleshooting, the **E-STOP** switch should be accessible and easy for the supervisor to press. After an E-Stop, reset and restart robot operations from outside the fence. Moreover, the operator and supervisor must be personnel who have completed the special education and training course.
8. During operation, both operator and supervisor must always watch out for abnormal motion and possible hit/pinch points in and around the robot.
9. Use only Kawasaki approved parts during replacement.
10. Support the robot arm firmly with a suitable lifting device before removing any servo motor from its axis. Removing the motor will disable the braking mechanism for that axis, and without proper support, the arm will fall. Use caution as the same danger exists when pressing any axis brake release switch on the control panel.
11. When replacing printed boards, turn OFF control power without fail. To replace power block, MC unit or AVR, shut OFF control power and wait at least seven minutes. Then, confirm that output voltage from the DC power source is 0V before starting replacement work, removing connectors, etc. Also, be careful not to touch any parts that may be hot. (Refer to Troubleshooting Manual, a separate volume, for more details.)
12. When air or water is supplied, shut OFF the supply source and purge any remaining pressure from the lines before proceeding with troubleshooting.
13. Because the type of printed boards or power block, etc. differs per model, use lighting of 300 lux (preferably 500 lux) or more to avoid mistakes when reading the type or replacing defective parts.

4.7 SAFETY DURING INSPECTION AND MAINTENANCE

In order to prevent system trouble, clean, inspect and maintain the robot or replace parts in strict compliance with the following considerations, while referencing the national/international safety codes and standards* below.

- NOTE***
1. JIS B8433 Manipulating Industrial Robots-Safety 8.7
 2. ISO 10218 Manipulating Industrial Robots-Safety 8.7



1. Read and understand fully all manuals, specifications and related documents provided by Kawasaki before operation. In addition, understand thoroughly all procedures for operation, teaching and maintenance. Also, make sure that all the necessary measures for safety are installed and fully functioning.
2. Before inspection and maintenance work, remove unnecessary objects and clear the path up to the installation site.
3. Inspection and maintenance duties are limited to personnel who have completed special training/education for the installed robot or for an equivalent model.
4. Before inspection and maintenance work, ensure enough space around the robot so there is no interference with peripheral systems. Set the peripheral systems in a fixed status so they will not make any sudden motion.
5. Before entering the safety fence, shut OFF control power for the entire line or for the robot on which work is to be performed, also cut OFF power up to the main power switch. Display signs indicating clearly shutoff, inspection/maintenance, repair in progress, and fix the main power switch with a lock (lockout) or place a tag (tagout) to prevent personnel from accidentally turning ON the power. If the entire line cannot be stopped, install temporary safety fences between the subject robot and any adjacent robots in close proximity.

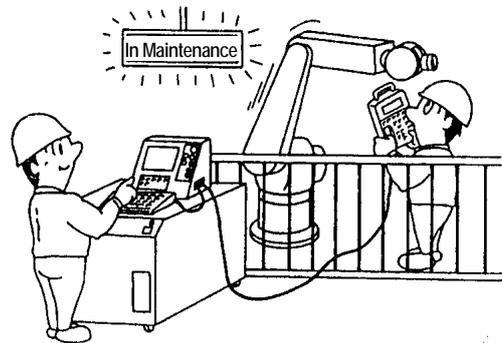


6. When performing the inspection and maintenance of interlock circuit, without fail shut OFF all power sources connected with the interlock circuit to ensure safety. During this work, never enter the safety fence.

⚠ DANGER

After completing the inspection and maintenance, be sure to confirm that the safeguarding devices (safety fence, safety plug, **EMERGENCY STOP switch, etc.), peripheral equipment or safety devices such as interlock circuit function normally.**

7. In addition to the **EMERGENCY STOP** switch held by the operator, install another **E-STOP** switch for the supervisor outside the safety fence, in a place where the robot's entire motion range can be monitored. If the robot moves abnormally during observation of maintenance/inspection, the **E-STOP** switch should be accessible and easy for the supervisor to press. After an E-Stop, reset and restart robot operations from outside the fence. Moreover, the operator and supervisor must be personnel who have completed the special education and training course.
8. When entering the safety fence, the operator must set **TEACH LOCK** switch on the teach pendant to ON to prevent incidents caused by switching to automatic mode. If the robot makes any abnormal motion, immediately press the **EMERGENCY STOP** switch and evacuate on a planned path of retreat.
9. During inspection/maintenance, both operator and supervisor must always watch out for abnormal motion and possible hit/pinch points in and around the robot. Also, ensure a safe passage for the operator in the event immediate evacuation is required.
10. If removal of the safety fence cannot be avoided during inspection/maintenance, provide adequate safety measures:
- (1) Stop the robot or peripheral equipment in the proper way.
 - (2) Lockout/tagout the power source/switches that must not be operated to prevent personnel from switching to ON/automatic mode.
 - (3) After the completion of inspection/maintenance, replace the safety fence and confirm that the safety measures function as before.



11. Use only Kawasaki approved parts during replacement.
Also, in inspection/maintenance, move the robot in teach mode and at the lowest possible speed without fail. At this time, refer to 4.4 Safety during Teaching together.
12. Many semiconductors are used in the printed boards.
Because they are sensitive to electricity, there is the threat of electrostatic discharge damage if touched directly by hand.
When holding the printed boards, be sure to hold the edges of it without touching any semiconductor parts. If board parts must be felt, discharge one's body in advance and confirm without fail that one's person is electrically neutral.
13. When placing printed boards in the controller etc., there is the threat of electrostatic discharge damage to the semiconductors. Be sure to place the board on antistatic mat or sheet, or put it into the antistatic bag.
14. When replacing printed boards or parts such as motor, turn OFF control power without fail. Avoid removing the printed boards with the control power ON, or turning it ON with no-printed boards installed. To replace power block, MC unit or AVR, shut OFF control power and wait at least seven minutes. Then, confirm that output voltage from the DC power source is 0V before starting replacement work, removing connectors, etc. Also, if the robot was operating just a moment before, heat sink or regenerative resistance may be hot. Thus, be careful not to touch any parts that may be hot. (Refer to Troubleshooting Manual, a separate volume, for more details.)
15. Support the robot arm firmly with a suitable lifting device before removing any servo motor from its axis. Removing the motor will disable the braking mechanism for that axis, and without proper support, the arm will fall. Use caution as the same danger exists when pressing any axis brake release switch on the control panel.
16. If robot must maintain the same pose before and after the work, record the robot pose data before replacing the parts.
17. At the start of the replacement process, when removing printed boards or cables, check and record their position, connector No., installed condition, set data, etc. so that arrangements may be fully restored. The connector with lock mechanism must be surely locked after inserting. Also, never touch connector pins.



18. When the utilities (water, air and gas, etc.) are supplied, shut OFF the supply source and purge any remaining pressure from the lines before proceeding with inspection/maintenance.
19. Because the type of printed boards or power block, etc. differs per model, use lighting of 300 lux (preferably 500 lux) or more to avoid mistakes when reading the type or replacing defective parts.
20. After inspection/maintenance, confirm that all safeguarding devices function normally.
21. After inspection/maintenance, another qualified personnel, other than the operator, must check. If there is no abnormality, operate the robot again.
22. For daily check/periodic inspections, be sure to comply with the inspection period specified in Inspection and Maintenance Manual, a separate volume. In particular, the inspection must be performed without fail.
23. Do not convert the robot without the consent of Kawasaki. If converted without prior approval, Kawasaki cannot assume any responsibility.
24. In the robot arm and controller, various batteries are used for backup of data. If used mistakenly these batteries may malfunction as well as ignite, overheat, explode, corrode, leak, etc., thus strictly comply with the following considerations.

**WARNING**

1. Use only Kawasaki specified batteries.
2. Never re-charge, dismantle, convert and heat the batteries.
3. Never dump the batteries into water or fire.
4. Batteries with damaged surface may short out internally, and thus must never be used.
5. Never short out the plus and minus of the batteries with metallic material such as wire.

**CAUTION**

Never dump old, depleted batteries with garbage that is disposed in incinerator, land-fill, dumping-ground, etc. When dumping the batteries, insulate with tape so as not to contact other metal and comply with local regulations and rules for battery disposal.

5.0 SAFETY FEATURES OF THE KAWASAKI ROBOT

Kawasaki Robots are equipped with the features below to safeguard personnel during operations. Use these features in addition to devising safety measures that are appropriate for each individual system.

1. All the Emergency Stop circuits are composed of hardwire logics
2. Teach pendant and controller are installed with mushroom-shaped push lock **EMERGENCY STOP** buttons, and **TRIGGER** enable-switch is installed on the teach pendant. **E-STOP** buttons can also be installed externally, set these buttons in accessible and easy to see locations.
3. Speed and deviation of the robot are monitored by the control panel, and if either value exceeds the threshold, an error is detected, and the robot stops.
4. For safety, the maximum speed for the robot in teach or check mode is limited to 250 mm/s (safety operation speed).
5. Motion range of the robot is set to the maximum range at shipping unless specified. However, it is adjustable as needed by setting the software or the mechanical stopper limits. For details, refer to Installation and Connection Manual =Arm=, a separate volume.
6. All the robot axes are equipped with DC24V electromagnetic brakes. Even if the control power is turned OFF, these brakes are applied on all axes.



WARNING

Controlling the motion range by software limits alone is insufficient as means of preventing accidents and injuries. Make sure to install mechanical stoppers and safety fences.



CAUTION

1. **If the mechanical motion range is to be changed, set software motion range smaller than the mechanical motion range.**
2. **Confirm the robot does not collide with the mechanical stoppers after changing software motion limit values.**

Kawasaki Robot
SAFETY MANUAL

April 1993 : 1st Edition
February 2006 : 5th Edition

Published by KAWASAKI HEAVY INDUSTRIES, LTD.

90801-1001DEE

All rights reserved. Copyright © 2006 by KAWASAKI HEAVY INDUSTRIES, LTD.