SAFETY PRECAUTIONS

Be sure to observe all of the following safety precautions.

Strict observance of these warning and caution indications are a MUST for preventing accidents, which could result in bodily injury and substantial property damage. Make sure you fully understand all definitions of these terms and related symbols given below, before you proceed to the text itself.

⚠ **WARNING**	Alerts you to those conditions, which could result in serious bodily injury or death if the instructions are not followed correctly.
⚠ **CAUTION**	Alerts you to those conditions, which could result in minor bodily injury or substantial property damage if the instructions are not followed correctly.

Terminology and Definitions

Maximum space: Refers to the volume of space encompassing the maximum designed movements of all robot parts including the end-effector, workpiece and attachments. (Quoted from the RIA* Committee Draft.)

Restricted space: Refers to the portion of the maximum space to which a robot is restricted by limiting devices (i.e., mechanical stops). The maximum distance that the robot, end-effector, and workpiece can travel after the limiting device is actuated defines the boundaries of the restricted space of the robot. (Quoted from the RIA Committee Draft.)

Motion space: Refers to the portion of the restricted space to which a robot is restricted by software motion limits. The maximum distance that the robot, end-effector, and workpiece can travel after the software motion limits are set defines the boundaries of the motion space of the robot. (The "motion space" is DENSO WAVE-proprietary terminology.)

Operating space: Refers to the portion of the restricted space (or motion space in Denso robot) that is actually used by the robot while performing its task program. (Quoted from the RIA Committee Draft.)

Task program: Refers to a set of instructions for motion and auxiliary functions that define the specific intended task of the robot system. (Quoted from the RIA Committee Draft.)

(*RIA: Robotic Industries Association)

1. Introduction

This section provides safety precautions to be observed during installation, teaching, inspection, adjustment, and maintenance of the robot.

2. Installation Precautions

2.1 Insuring the proper installation environment

2.1.1 For standard type

The standard type has not been designed to withstand explosions, dust-proof, nor is it splash-proof. Therefore, it should not be installed in any environment where:

(1) there are flammable gases or liquids,

(2) there are any shavings from metal processing or other conductive material flying about,

(3) there are any acidic, alkaline or other corrosive gases,

(4) there is cutting or grinding oil mist,

(5) it may likely be submerged in fluid,

(6) there is sulfuric cutting or grinding oil mist, or

(7) there are any large-sized inverters, high output/high frequency transmitters, large contactors, welders, or other sources of electrical noise.

2.1.2 For dust-proof, splash-proof type

The dust-proof, splash-proof type is an IP54-equivalent structure, but it has not been designed to withstand explosions. (The HM/HS-E-W and the wrist of the VM-D-W/VS-E-W are an IP65-equivalent dust-proof and splash-proof structure.)

Note that the robot controller is not a dust- or splash-proof structure. Therefore, when using the robot controller in an environment exposed to mist, put it in an optional protective box.

The dust-proof, splash-proof type should not be installed in any environment where:

(1) there are any flammable gases or liquids,

(2) there are any acidic, alkaline or other corrosive gases,

(3) there are any large-sized inverters, high output/high frequency transmitters, large contactors, welders, or other sources of electrical noise,

(4) it may likely be submerged in fluid,

(5) there are any grinding or machining chips or shavings,

(6) any machining oil not specified in this manual is in use, or

Note: Yushiron Oil No. 4C (non-soluble) is specified.

(7) there is sulfuric cutting or grinding oil mist.

2.2 Service space

The robot and peripheral equipment should be installed so that sufficient service space is maintained for safe teaching, maintenance, and inspection.

2.3 Control devices outside the robot's restricted space

The robot controller, teach pendant, and operating panel should be installed outside the robot's restricted space and in a place where you can observe all of the robot’s movements when operating the robot controller, teach pendant, or operating panel.

2.4 Positioning of gauges

Pressure gauges, oil pressure gauges and other gauges should be installed in an easy-to-check location.

2.5 Protection of electrical wiring and hydraulic/pneumatic piping

If there is any possibility of the electrical wiring or hydraulic/pneumatic piping being damaged, protect them with a cover or similar item.

2.6 Positioning of emergency stop switches

Emergency stop switches should be provided in a position where they can be reached easily should it be necessary to stop the robot immediately.

(1) The emergency stop switches should be red.

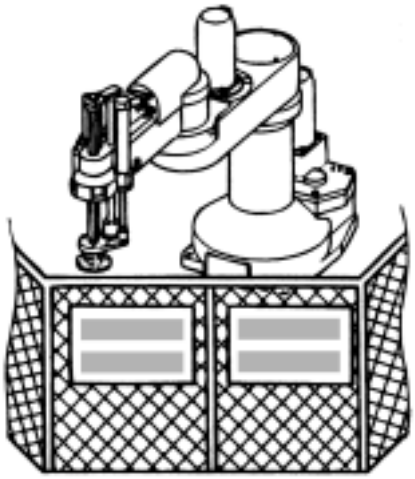
(2) Emergency stop switches should be designed so that they will not be released after pressed, automatically or mistakenly by any other person.

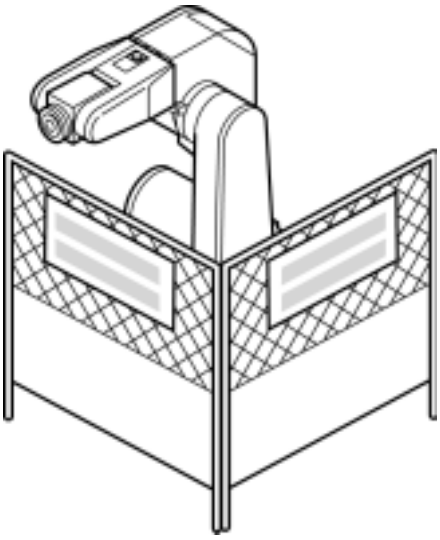
(3) Emergency stop switches should be separate from the power switch.

2.7 Positioning of operating status indicators

Operating status indicators should be positioned in such a way where workers can easily see whether the robot is on temporary halt or on an emergency or abnormal stop.

2.8 Setting-up the safety fence or enclosure





A safety fence or enclosure should be set up so that no one can easily enter the robot's restricted space. If it is impossible, utilize other protectors as described in Section 2.9.

(1) The fence or enclosure should be constructed so that it cannot be easily moved or removed.

(2) The fence or enclosure should be constructed so that it cannot be easily damaged or deformed through external force.

(3) Establish the exit/entrance to the fence or enclosure. Construct the fence or enclosure so that no one can easily get past it by climbing over the fence or enclosure.

(4) The fence or enclosure should be constructed to ensure that it is not possible for hands or any other parts of the body to get through it.

(5) Take any one of the following protections for the entrance/exit of the fence or enclosure:

1) Place a door, rope or chain across the entrance/exit of the fence or enclosure, and fit it with an interlock that ensures the emergency stop device operates automatically if it is opened or removed.

2) Post a warning notice at the entrance/exit of the fence or enclosure stating "In operation--Entry forbidden" or "Work in progress--Do not operate" and ensure that workers follow these instructions at all times.

When making a test run, before setting up the fence or enclosure, place an overseer in a position outside the robot’s restricted space and one in which he/she can see all of the robot’s movements. The overseer should prevent workers from entering the robot's restricted space and be devoted solely to that task.

2.9 Positioning of rope or chain

If it is not possible to set up the safety fence or enclosure described in Section 2.8, hang a rope or chain around the perimeter of the robot’s restricted space to ensure that no one can enter the restricted space.

(1) Ensure the support posts cannot be moved easily.

(2) Ensure that the rope or chain’s color or material can easily be discerned from the surrounds.

(3) Post a warning notice in a position where it is easy to see stating "In operation--Entry forbidden" or "Work in progress --Do not operate" and ensure that workers follow these instructions at all times.

(4) Set the exit/entrance, and follow the instructions given in Section 2.8, (3) through (5).

2.10 Setting the robot's motion space

The area required for the robot to work is called the robot's operating space.

If the robot's motion space is greater than the operating space, it is recommended that you set a smaller motion space to prevent the robot from interfering or disrupting other equipment.

Refer to the "INSTALLATION & MAINTENANCE GUIDE."

2.11 No robot modification allowed

Never modify the robot unit, robot controller, teach pendant or other devices.

2.12 Cleaning of tools

If your robot uses welding guns, paint spray nozzles, or other end-effectors requiring cleaning, it is recommended that the cleaning process be carried out automatically.

2.13 Lighting

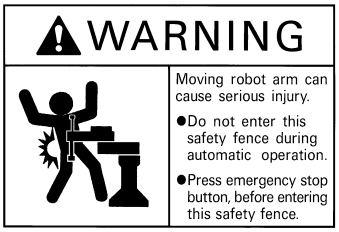
Sufficient illumination should be assured for safe robot operation.

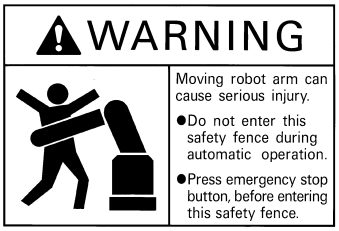
2.14 Protection from objects thrown by the end-effector

If there is any risk of workers being injured in the event that the object being held by the end-effector is dropped or thrown by the end-effector, consider the size, weight, temperature and chemical nature of the object and take appropriate safeguards to ensure safety.

2.15 Affixing the warning label

Place the warning label packaged with the robot on the exit/entrance of the safety fence or in a position where it is easy to see.

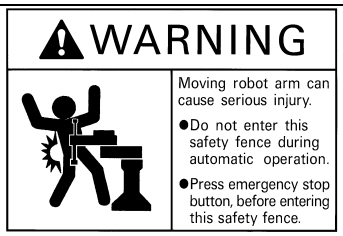


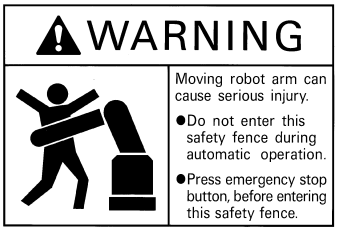


3. Precautions while robot is running

⚠ Warning

Touching the robot while it is in operation can lead to serious injury. Please ensure the following conditions are maintained and that the cautions listed from Section 3.1 onwards are followed when any work is being performed.





1) Do not enter the robot's restricted space when the robot is in operation or when the motor power is on.
2) As a precaution against malfunction, ensure that an emergency stop device is activated to cut the power to the robot motor upon entry into the robot's restricted space.
3) When it is necessary to enter the robot's restricted space to perform teaching or maintenance work while the robot is running, ensure that the steps described in Section 3.3 "Ensuring safety of workers performing jobs within the robot's restricted space" are taken.

3.1 Creation of working regulations and assuring worker adherence

When entering the robot’s restricted space to perform teaching or maintenance inspections, set "working regulations" for the following items and ensure workers adhere to them.

(1) Operating procedures required to run the robot.

(2) Robot speed when performing teaching.

(3) Signaling methods to be used when more than one worker is to perform work.

(4) Steps that must be taken by the worker in the event of a malfunction, according to the contents of the malfunction.

(5) The necessary steps for checking release and safety of the malfunction status, in order to restart the robot after robot movement has been stopped due to activation of the emergency stop device

(6) Apart from the above, any steps below necessary to prevent danger from unexpected robot movement or malfunction of the robot.

1) Display of the control panel (See Section 3.2 on the following page)
2) Assuring the safety of workers performing jobs within the robot's restricted space (See Section 3.3 on the following page)

3) Maintaining worker position and stance

   Position and stance that enables the worker to confirm normal robot operation and to take immediate refuge if a malfunction occurs.

4) Implementation of measures for noise prevention

5) Signaling methods for workers of related equipment

6) Types of malfunctions and how to distinguish them

Please ensure "working regulations" are appropriate to the robot type, the place of installation and to the content of the work.

Be sure to consult the opinions of related workers, engineers at the equipment manufacturer and that of a labor safety consultant when creating these "working regulations".

3.2 Display of operation panel

To prevent anyone other than the worker from accessing the start switch or the changeover switch by accident during operation, display something to indicate it is in operation on the operating panel or teach pendant. Take any other steps as appropriate, such as locking the cover.

3.3 Ensuring safety of workers performing jobs within the robot's restricted space

When performing jobs within the robot's restricted space, take any of the following steps to ensure that robot operation can be stopped immediately upon a malfunction.

(1) Ensure an overseer is placed in a position outside the robot's restricted space and one in which he/she can see all robot movements, and that he/she is devoted solely to that task.

   ① An emergency stop device should be activated immediately upon a malfunction.

   ② Do not permit anyone other than the worker engaged for that job to enter the robot's restricted space.

(2) Ensure a worker within the robot's restricted space carries the portable emergency stop switch so he/she can press it (the robot stop button on the teach pendant) immediately if it should be necessary to do so.

3.4 Inspections before commencing work such as teaching

Before starting work such as teaching, inspect the following items, carry out any repairs immediately upon detection of a malfunction and perform any other necessary measures.

(1) Check for any damage to the sheath or cover of the external wiring or to the external devices.

(2) Check that the robot is functioning normally or not (any unusual noise or vibration during operation).

(3) Check the functioning of the emergency stop device.

(4) Check there is no leakage of air or oil from any pipes.

(5) Check there are no obstructive objects in or near the robot's restricted space.

3.5 Release of residual air pressure

Before disassembling or replacing pneumatic parts, first release any residual air pressure in the drive cylinder.

3.6 Precautions for test runs

Whenever possible, have the worker stay outside of the robot's restricted space when performing test runs.

3.7 Precautions for automatic operation

(1) At start-up

Before the robot is to be started up, first check the following items as well as setting the signals to be used and perform signaling practice with all related workers.

1) Check that there is no one inside the robot's restricted space.

2) Check that the teach pendant and tools are in their designated places.

3) Check that no lamps indicating a malfunction on the robot or related equipment are lit.

(2) Check that the display lamp indicating automatic operation is lit during automatic operation.

(3) Steps to be taken when a malfunction occurs

Should a malfunction occur with the robot or related equipment and it is necessary to enter the robot's restricted space to perform emergency maintenance, stop the robot's operation by activating the emergency stop device. Take any necessary steps such as placing a display on the starter switch to indicate work is in progress to prevent anyone from accessing the robot.

3.8 Precautions in repairs

(1) Do not perform repairs outside of the designated range.

(2) Under no circumstances should the interlock mechanism be removed.

(3) When opening the robot controller's cover for battery replacement or any other reasons, always turn the robot controller power off and disconnect the power cable.

(4) Use only spare tools specified in this manual.

4. Daily and periodical inspections

(1) Be sure to perform daily and periodical inspections. Before starting jobs, always check that there is no problem with the robot and related equipment. If any problems are found, take any necessary measures to correct them.

(2) When carrying out periodical inspections or any repairs, maintain records and keep them for at least 3 years.

5. Management of floppy disks

(1) Carefully handle and store the "Initial settings" floppy disks packaged with the robot, which store special data exclusively prepared for your robot.

(2) After finishing teaching or making any changes, always save the programs and data onto floppy disks.

Making back-ups will help you recover if data stored in the robot controller is lost due to the expired life of the back-up battery.

(3) Write the names of each of the floppy disks used for storing task programs to prevent incorrect disks from loading into the robot controller.

(4) Store the floppy disks where they will not be exposed to dust, humidity and magnetic field, which could corrupt the disks or data stored on them.