

Simple  friendly

 **Kawasaki**

**Kawasaki Robot
KF121**

**Installation and
Connection Manual**

(E Controller)

Robot

Kawasaki Heavy Industries, Ltd.

90202-1003DEA

PREFACE

This manual explains the installation and connection procedures for Kawasaki Painting Robot KF121.

Read and understand the contents of this manual and the safety manuals thoroughly, and strictly observe all safety rules before proceeding with any operation.

This manual describes only the installation and connection of KF121 series robot arm. For installation and connection of the controller and cables, see the separate manual “Installation and Connection Manual” for the controller for explosion-proof robot.

Kawasaki will not take any responsibility for any accidents and/or damages caused by operations that are based on only a limited reading of this manual.

This manual is applicable to the following robot model.

KF121


-
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.

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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.

 **WARNING**

- 1. The accuracy and effectiveness of the diagrams, procedures, and detail explanations given in this manual cannot be confirmed with absolute certainty. Accordingly, it is necessary to give one's fullest attention when using this manual to perform any work.**
- 2. Safety related contents described in this manual apply to each individual work and not to all robot work. In order to perform every work in safety, read and fully understand the safety manual, all pertinent laws, regulations and related materials as well as all the safety explanations described in each chapter, and prepare safety measures suitable for actual work.**

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1.0 PRECAUTIONS

1.1 PRECAUTIONS DURING TRANSPORTATION AND STORAGE

When transporting the Kawasaki Robot to its installation site, strictly observe the following cautions.



WARNING

1. When the robot arm is to be transported by using a crane or forklift, never support the robot arm manually.
2. During transportation, never climb on the robot or stay out from under the lifted robot arm.



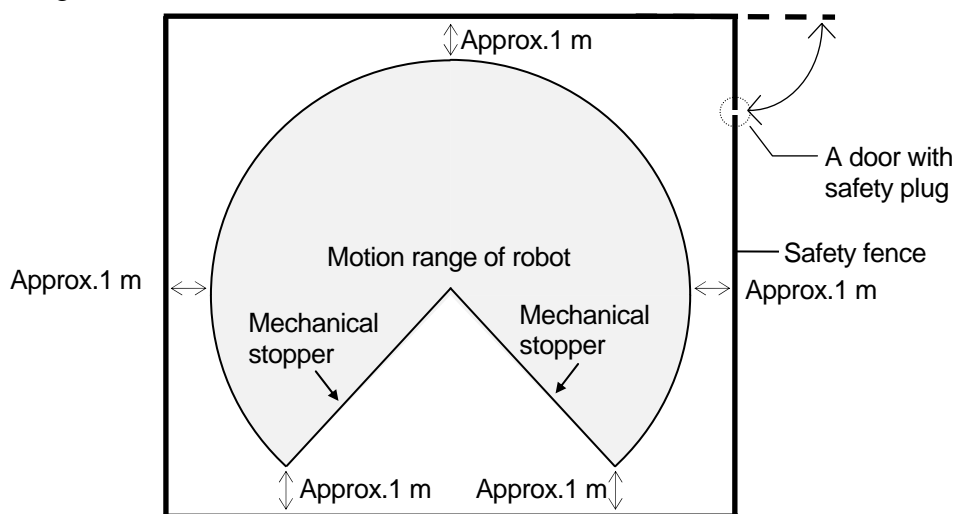
CAUTION

1. Since the robot arm is composed of precision parts, be careful not to apply excessive shocks or vibrations during transportation.
2. Prior to installation, remove all obstacles so the installation is carried out smoothly and safely. Clear a passage to the installation area for transportation of the robot arm using a crane or forklift.
3. During transportation and storage,
 - (1) keep the ambient temperature within the range of minus 10 - 60°C,
 - (2) keep the relative humidity within the range of 35 - 85% RH without dew condensation,
 - (3) keep free from excessively strong vibration.

1.2 INSTALLATION ENVIRONMENT OF THE ROBOT ARM

KF121 robot arm must be installed in a place that satisfies all the following environmental conditions:

1. When robot is installed on the floor, the levelness must be within 5 °.
2. Be sure that the installation floor/pedestal has sufficient rigidity.
3. Secure a flatness to prevent undue force applied to the installation section. (If sufficient flatness is unobtainable, insert liners and adjust the flatness within 0.3.)
4. Keep the ambient temperature during operation within the range of 0 - 40 °C.
(Deviation or overload error may occur due to high viscosity of grease/oil when starting operation at low temperatures. In this case, perform warm-up operation at low speed before regular operation.)
5. Keep the relative humidity during operation within the range of 35-85 %RH without dew condensation.
6. The robot installing place should be free from dust, dirt, smoke, water, and other foreign matters.
7. The robot installing place should be free from excessively strong vibration.
8. The robot installing place should be free from electric noise interference.
9. The robot installing place should be sufficiently larger than the motion range of robot arm. Install safety fence so the maximum movement of fully equipped robot arm (with tools) does not cause interference.
 - (1) Provide an entrance door with a safety plug for the safety fence.
 - (2) Follow national and local standards regarding safety fence construction/function.
(e.g. EN953, EN294, EN811, EN1088, ISO13852, ISO13854, ISO/NP14120)



[NOTE]

Protect sealed joints, etc. on the robot arm axes with vinyl sheets, etc. to prevent paint mist/foreign materials from entering.

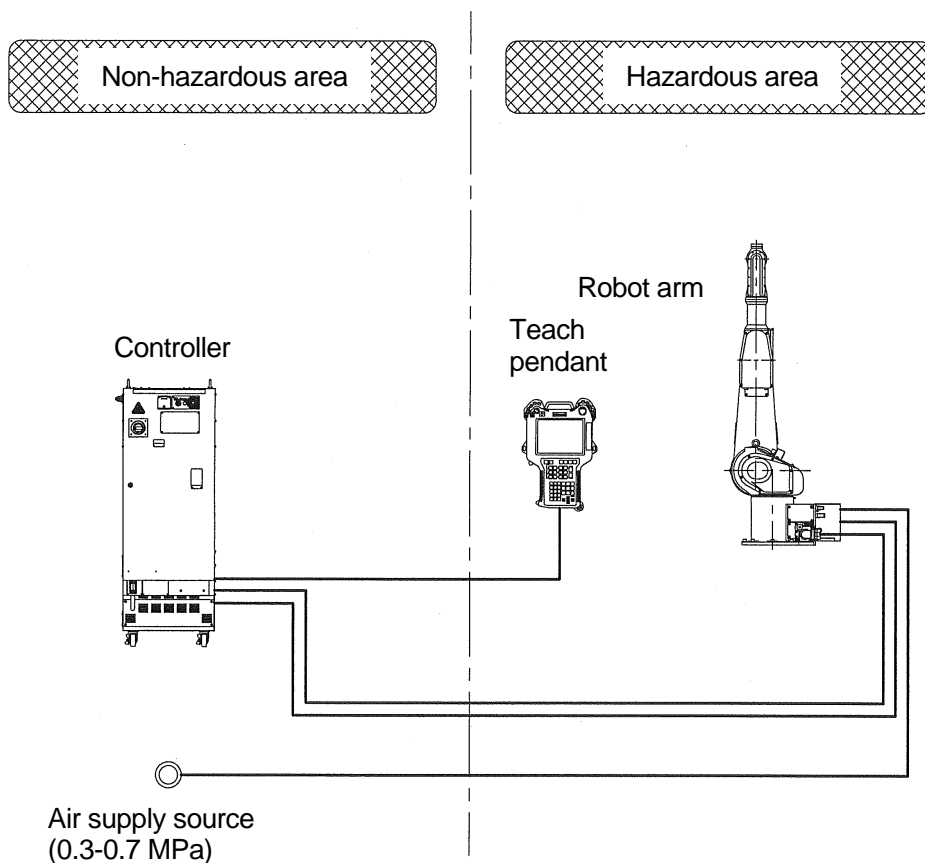
1.3 CAUTIONARY INSTRUCTIONS FOR EXPLOSION-PROOF

KF121 is an explosion-proof type robot protected by pressurized and intrinsically safe structures. Strictly observe the following instructions for safe operation.



DANGER

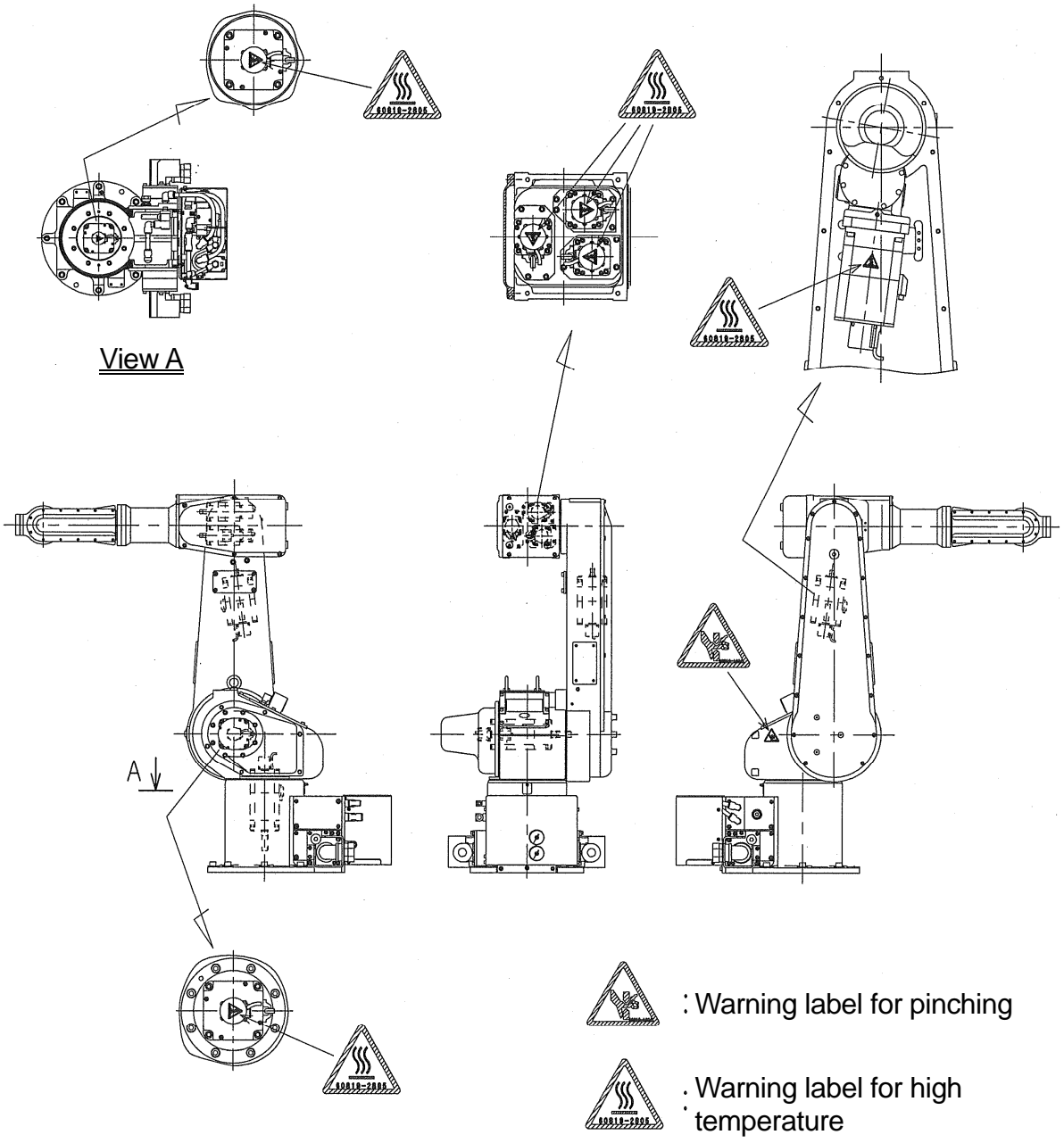
- This painting robot has pressurized enclosures for explosion-proof specifications. Before loosening the bolts from the pressurized enclosure, always follow instructions from the person in charge.**
 - Do not loosen tightening bolts of pressurized enclosures without instructions from the person in charge.**
 - Do not open the cover of a pressurized enclosure while electricity is supplied to robot.**
- Install controller in a non-hazardous area where there is no possibility of explosion. Before accessing the robot for maintenance, inspection, or for inspection and adjustments of painting equipment, always turn OFF the external power for shutting off power supply to the robot controller, close the air supply valve and confirm there is no residual pressure in any air supply lines.**



1.4 WARNING LABELS

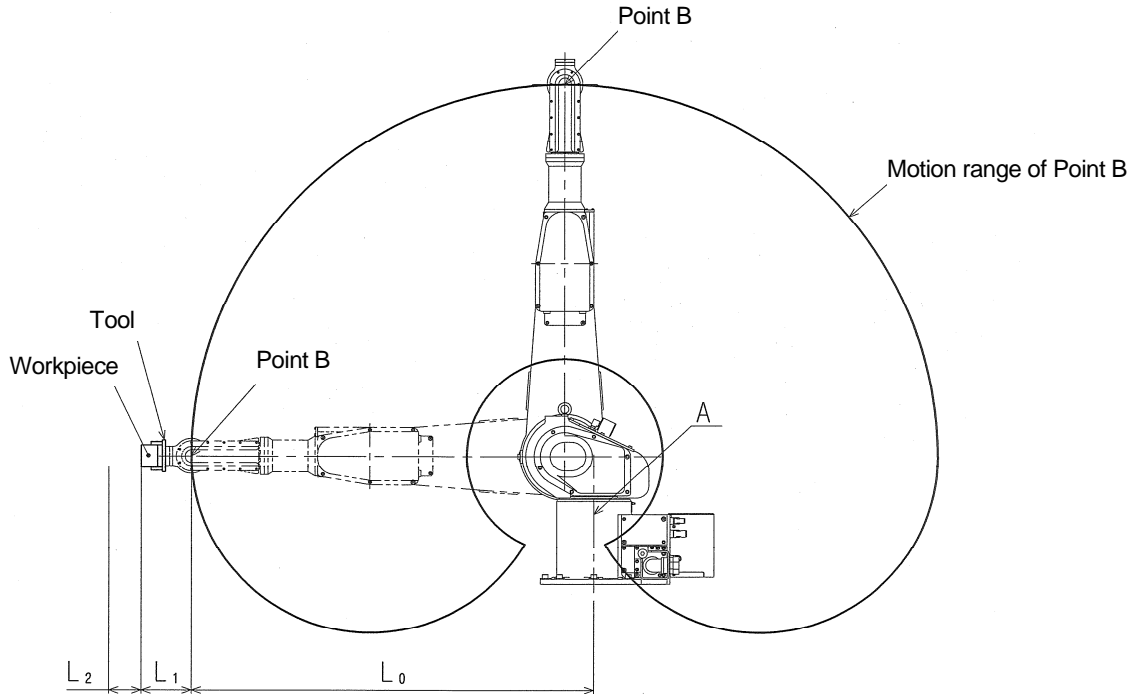
⚠ WARNING

During operations, pay attention to the warning labels indicated in the figures below.

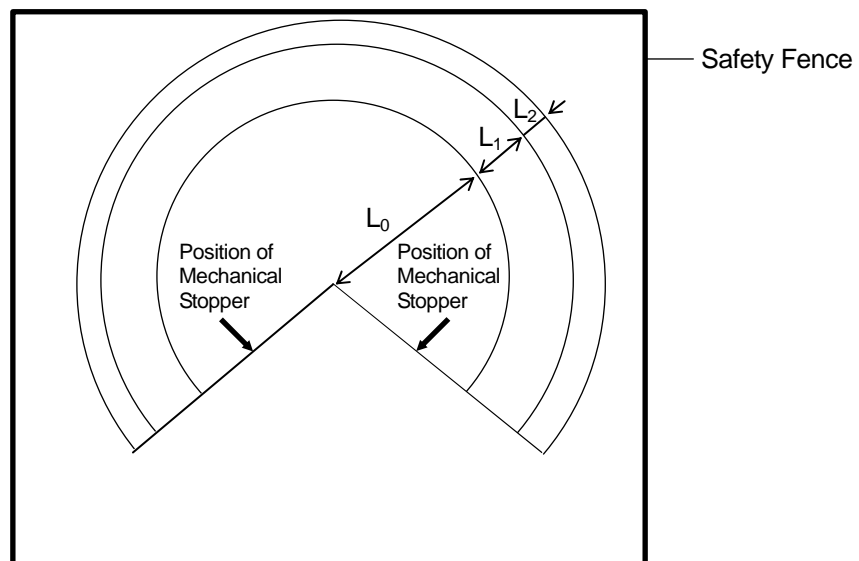


2.0 MOTION RANGE & SPECIFICATIONS OF ROBOT

DETERMINATION OF SAFETY FENCE INSTALLATION LOCATION

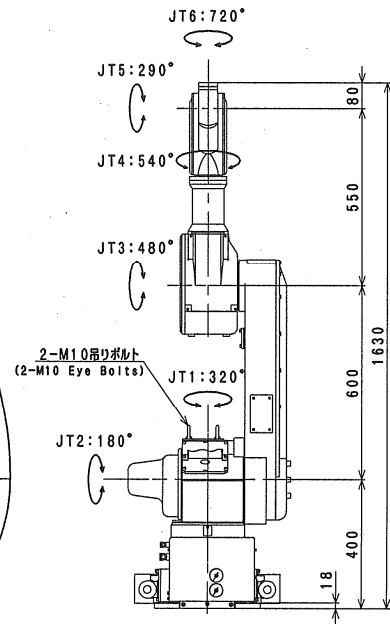
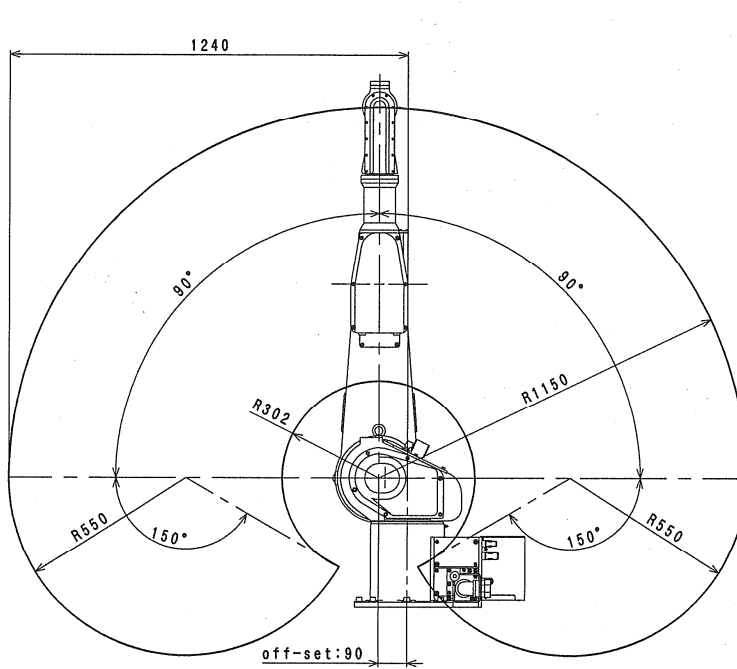


The motion range of robot arm is represented by Point B in the figure above. Accordingly, the dimensions of safety fence should be determined as follows: Calculate sum of L_0 , L_1 and L_2 for minimum dimension. That is: distance from the center of arm (Point A shown in the figure above) to Point B ($=L_0$) + distance from the center of wrist to the edge of tool/workpiece ($=L_1$) + allowance ($=L_2$). For the value of L_0 , see Motion Range & Specifications of Robot on the following pages.

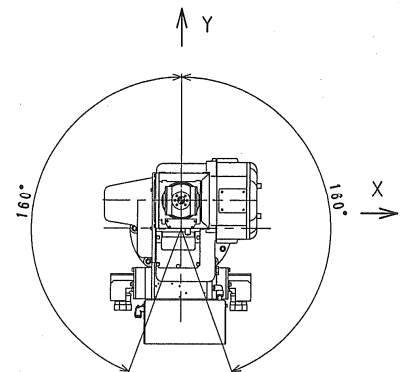


KF121

Floor mounted spec.



Type	Articulated robot		
Degree of freedom	6		
Motion range & speed	JT	Motion range	Max. speed
	1	320 °	220 °/s
	2	180 °	120 °/s
	3	480 °	240 °/s
	4	540 °	430 °/s
	5	290 °	430 °/s
6	720 °	720 °/s	
Load capacity	5 kg		
Wrist load capacity	JT	Torque	Moment of inertia
	4	7.8 N·m	0.17 kg·m ²
	5	7.8 N·m	0.17 kg·m ²
6	2.9 N·m	0.06 kg·m ²	
Repeatability	±0.2 mm		
Mass	Approx. 140 kg		
Acoustic noise	74 dB (A)*		

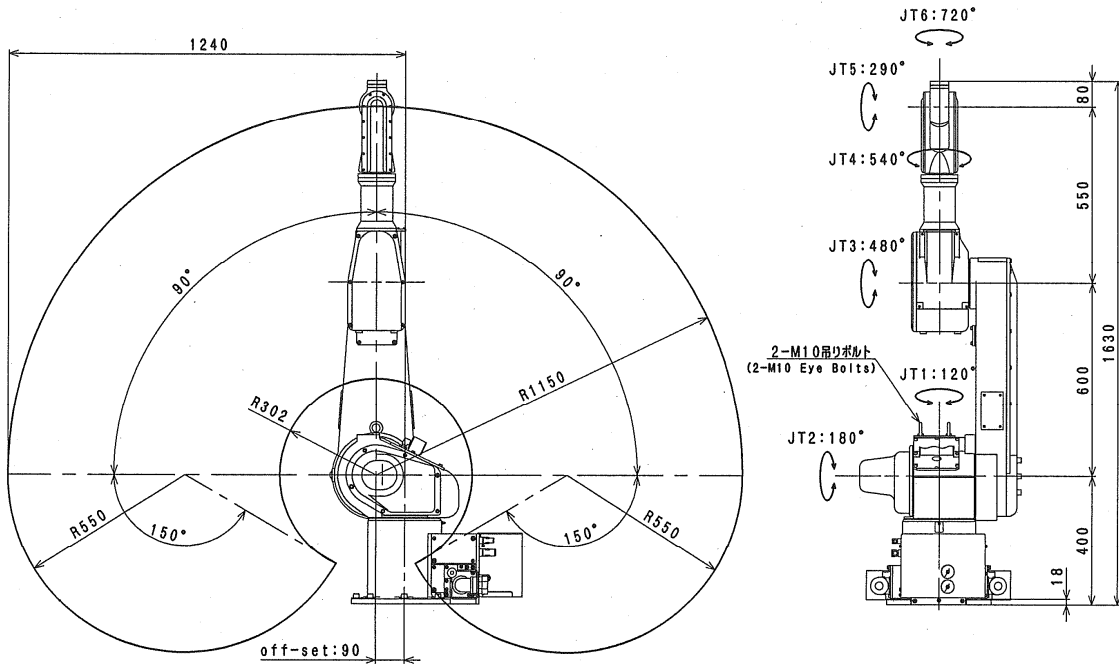


NOTE* measured condition:

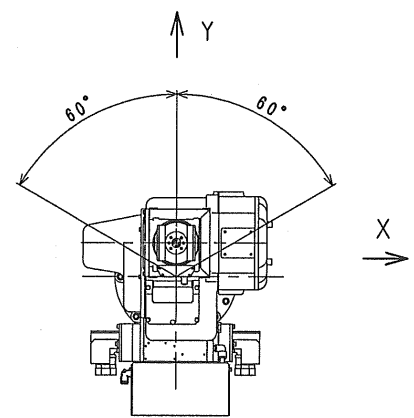
- 1000 mm away from the end of robot motion range (Noise level changes depending on conditions.)

KF121

Wall mounted spec.



Type	Articulated robot		
Degree of freedom	6		
Motion range & speed	JT	Motion range	Max. speed
	1	120 °	120 °/s
	2	180 °	120 °/s
	3	480 °	240 °/s
	4	540 °	430 °/s
	5	290 °	430 °/s
6	720 °	720 °/s	
Load capacity	5 kg		
Wrist load capacity	JT	Torque	Moment of inertia
	4	7.8 N·m	0.17 kg·m ²
	5	7.8 N·m	0.17 kg·m ²
6	2.9 N·m	0.06 kg·m ²	
Repeatability	±0.2 mm		
Mass	Approx. 140 kg		
Acoustic noise	74 dB (A)*		

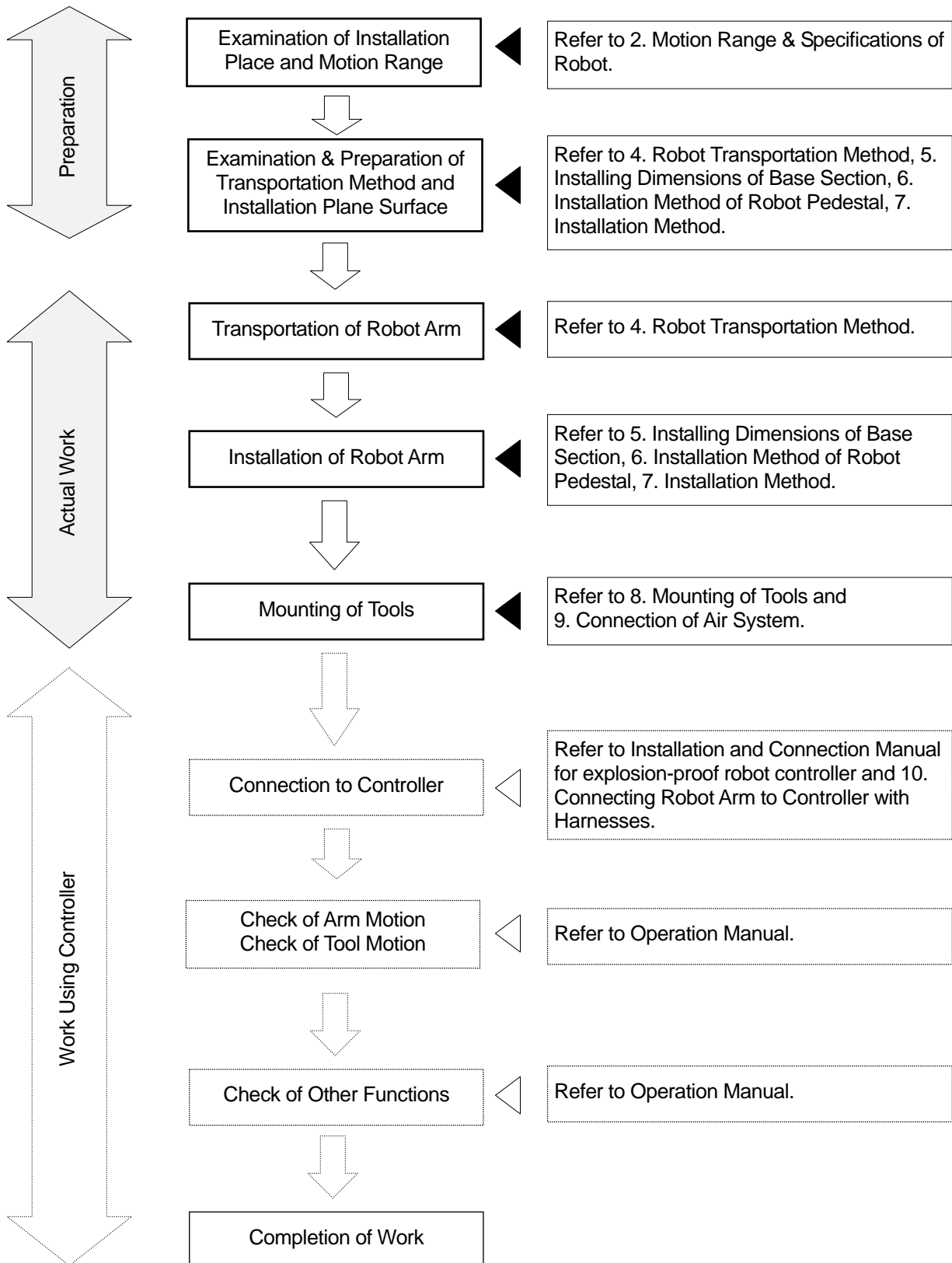


NOTE* measured condition:

- 1000 mm away from the end of robot motion range (Noise level changes depending on conditions.)

3.0 WORK FLOW AT ARM INSTALLATION AND CONNECTION

This flowchart describes only the robot arm section. For the controller, refer to separate Installation and Connection Manual for Explosion-proof robot controller.



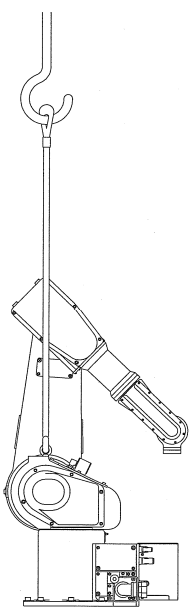
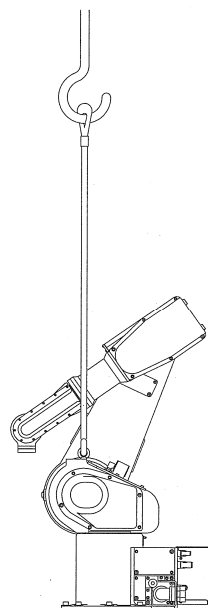
4.0 ROBOT TRANSPORTATION METHOD

4.1 WIRE SLING

Hoist up the robot by fastening wires to two eyebolts (M10), holding the upper arm (arm 2) as shown in the figure below. (Hoist up the robot with the pedestal/ base plate in the same way.)

⚠ WARNING

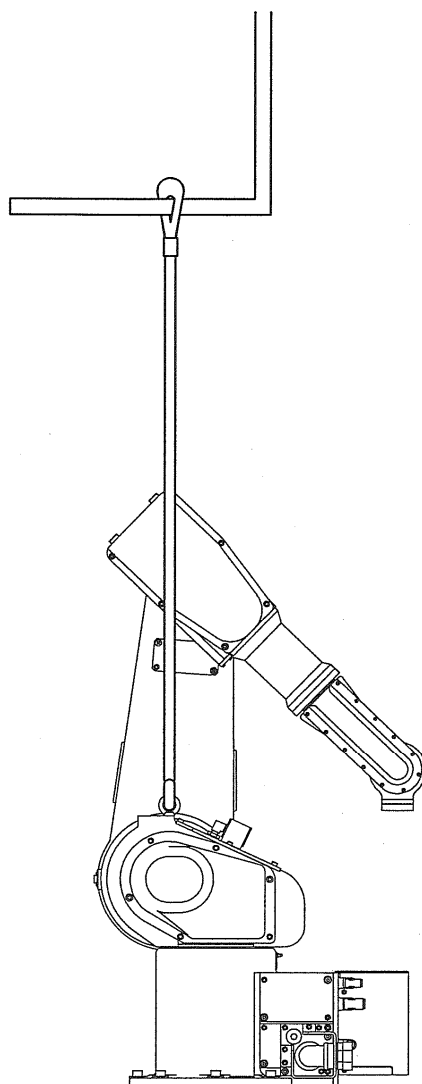
When hoisting up robot, be careful because robot may lean forward/backward/left/right depending on the robot posture. Be sure to hoist up the robot in the specified hoisting postures below, otherwise it may swing excessively or the wire may interfere with other objects, resulting in damage. In places where wire touches the arm, protect arm with board, etc.

Model		KF121	
Hoisted posture*			
Hoisting posture	JT1	0 °	0 °
	JT2	-4 °	-25 °
	JT3	130 °	-150 °
	JT4	0 °	0 °
	JT5	46 °	-55 °
	JT6	0 °	0 °

NOTE* Consult Kawasaki on the hoisting postures for the wall mounted robot arm.

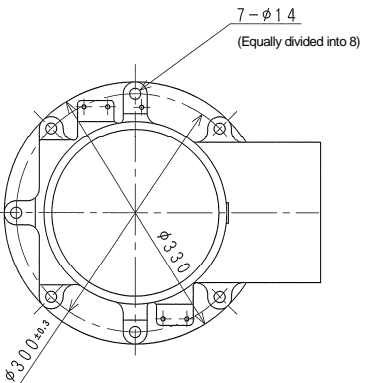
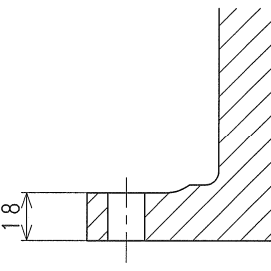
4.2 FORKLIFT

There is no jig for the forklift. Transport the robot arm using wires by a forklift in the same way as you transport the robot by wire sling. Be careful when transporting the robot by a forklift because the robot may fall when the wire slips due to oscillation, etc.



5.0 INSTALLING DIMENSIONS OF BASE SECTION

When installing the base section, fix it with high-tension bolts through the bolt holes on the base section using the plane washer.

Model	KF121
Installing dimensions of base section	
Cross-section of installation bolt hole	
Bolt holes	7-φ14
High tension bolts	7-M12 Material: SCM435 Strength: 10.9 or more
Tightening torque	98 N·m
Levelness	Within ±5°

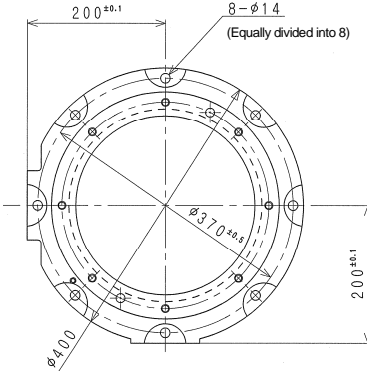
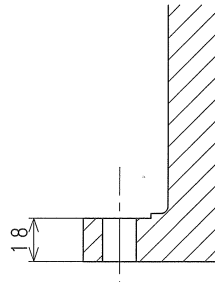


CAUTION

Be sure to install the arm on a surface with flatness of 0.3 mm or less, otherwise robot arm may suffer damage.

6.0 INSTALLATION METHOD OF ROBOT PEDESTAL

When installing a robot on the pedestal, fix the pedestal with high tension bolts through the bolt holes.

Model	KF121
Installing dimensions of base section	
Cross-section of installation bolt hole	
Bolt holes	8-φ14
High tension bolts	8-M12 Material: SCM435, Strength: 10.9 or more
Tightening torque	98 N·m
Levelness	Within ±5°

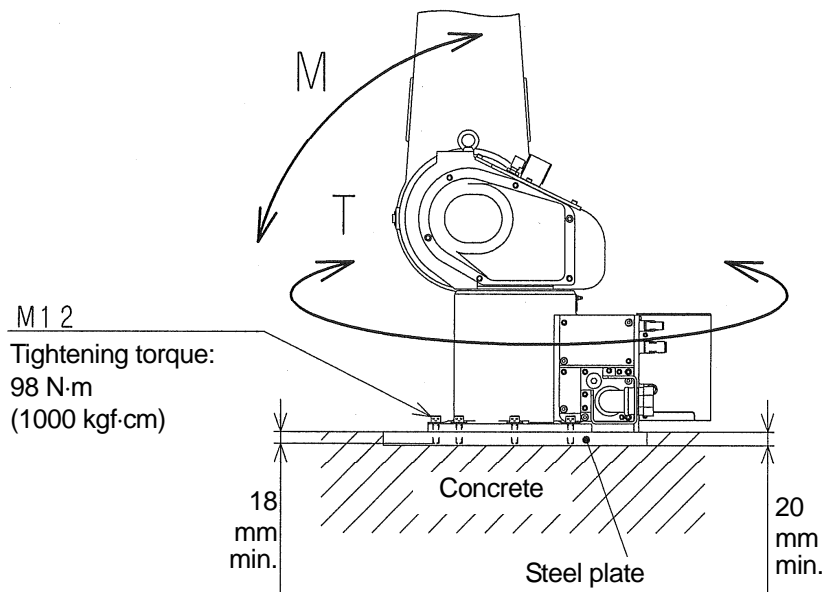
⚠ CAUTION

Be sure to install the pedestal on a surface with flatness of 0.3 mm or less, otherwise robot arm may suffer damage.

7.0 INSTALLATION METHOD

1. When installing the base section of the robot arm directly on the floor*

Embed a steel plate (20 mm min. thick) in the concrete floor and fix the base section on it as shown in the figure below or fix the base section directly on the concrete floor with anchors. Fix the steel plate firmly enough to endure the reaction forces produced by the robot.

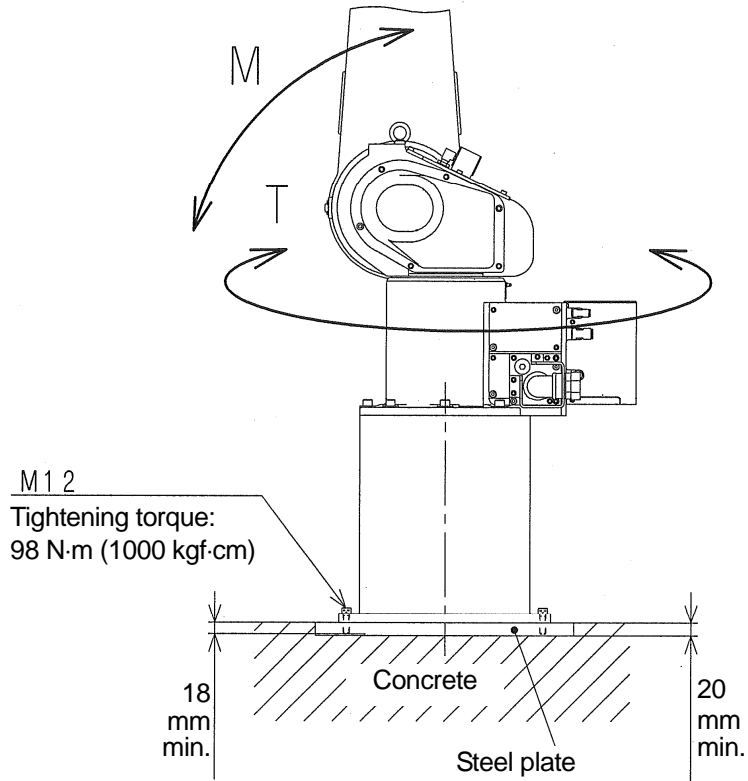


Model	KF121
M (Inversion moment)	2617 N·m
T (Rotating torque)	1706 N·m

NOTE* Consult Kawasaki on the installation method for the wall mounted robot arm.

2. When installing the robot pedestal on the floor*

In this case, the installation procedure is practically the same as that in installing the base section of the robot arm directly on the floor.



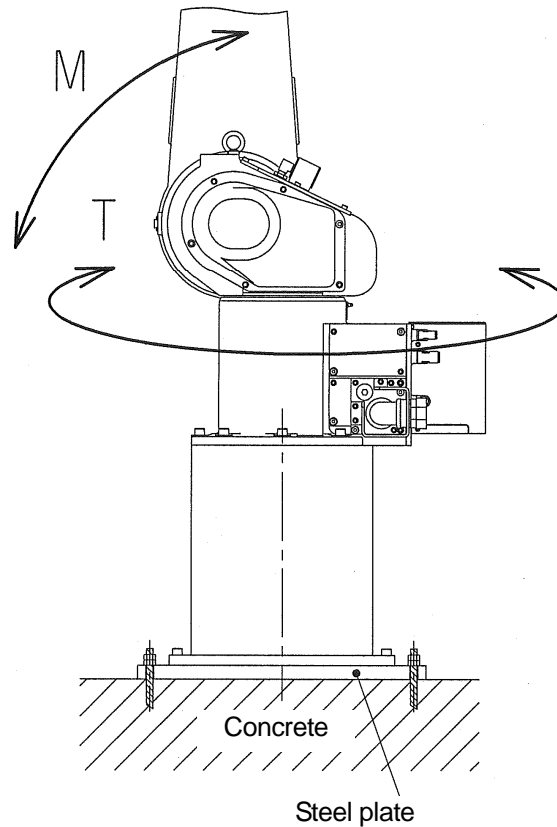
Model	KF121
Pedestal installation bolt	8-M12
Tightening torque	98 N·m
L1	18 mm or more
L2	20 mm or more

The reaction force received from the robot is the same as that in installing the base section of the arm directly on the floor.

NOTE* Consult Kawasaki on the installation method for the wall mounted robot arm.

3. When installing the base section of the robot arm with the robot base plate*

Fix the base plate on concrete floor or steel floor using four of $\phi 20$ or $\phi 22$ bolt holes (PCD800) on the base plate and install the arm. The reaction force received from the robot is the same as that in installing the base section of the robot arm directly on the floor.



Model	KF121
ϕD	$\phi 20$ mm
L	20 mm

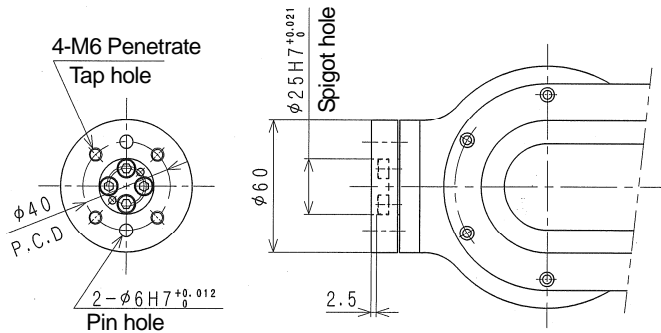
NOTE* Consult Kawasaki on the installation method for the wall mounted robot arm.

8.0 MOUNTING OF TOOLS

⚠ WARNING

Prior to mounting tools on the robot, turn OFF the controller power switch and the external power switch. Display signs indicating clearly “Installation and connection in progress”, and lockout/tagout the external power switch.

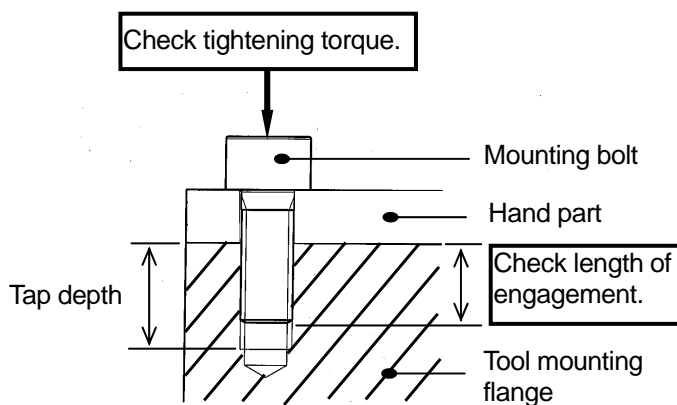
8.1 DIMENSIONS OF WRIST END (FLANGE)



In the robot arm end section, a flange is provided on which tools are mounted. Screw the mounting bolts into the tap holes on the circumference of φ102 on the flange, referring to the left figure. Moreover, position the tool by utilizing the pin hole and the spigot hole.

8.2 SPECIFICATION OF MOUNTING BOLTS

Select mounting bolts with proper length depending on the tap depth of tool mounting flange to secure the specified engagement length. Use high tension mounting bolts and tighten them to the torque specified in the table below.



Model	KF121
Tap hole	4-M6
P.C.D	φ40
Pin	2-φ6H7 Depth 6
Spigot hole	φ25H7 Depth 2.5
Tap depth	12 mm
Length of engagement	6-12 mm
High tension bolt	SCM435, 10.9 min
Tightening torque	11.76 N·m

⚠ CAUTION

If the engagement length has exceeded the specified value, the mounting bolt interferes with fixed section, and the flange will not move.

8.3 CALCULATING THE LOAD ON WRIST AXIS

1. The maximum load capacity of the robot is specified per robot model.
2. Strictly observe the limiting conditions for load mass and load torque and load moment of inertia around each wrist axis (JT4, JT5, JT6) as shown below.

! WARNING

Exceeding the specified load capacity may cause deterioration in motion performance and shorten the life of robot. The specified load capacity includes the mass of all attachments such as spray gun, gun bracket, piping/wiring, etc. If total mass exceeds the capacity specification, consult Kawasaki before starting operations.

The load torque and the moment of inertia can be calculated by the following formula.

Calculating formula

M (kg)

L_6 : Length from JT6 axis rotation center to load center of gravity.

$L_{4,5}$: Moment of inertia around center of gravity.

Load mass (including tool) : $M \leq M_{max.}(kg)$

Load torque : $T=9.8 \cdot M \cdot L(N \cdot m)$

Load moment of inertia : $I=M \cdot L^2(kg \cdot m^2)$

M, W : Load mass (Example)

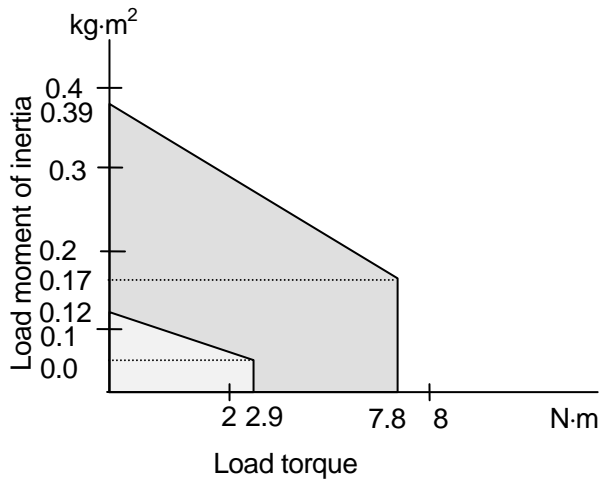
KF121 ... $M_{max.}$: 5 kg



($W_{max.}$: 5 kgf)

L : Length from center of rotation axis to load center of gravity. (Unit: m) (See the left figure.)

If calculation of load is made by dividing the load into several parts, such as tool and load, use the total calculation values of each part as load torque and moment of inertia.

Adhere to the following limiting conditions for the load torque and the load moment of inertia around each wrist axis.



-  Acceptable range for JT4,5
-  Acceptable range for JT6

9.0 CONNECTION OF AIR SYSTEM

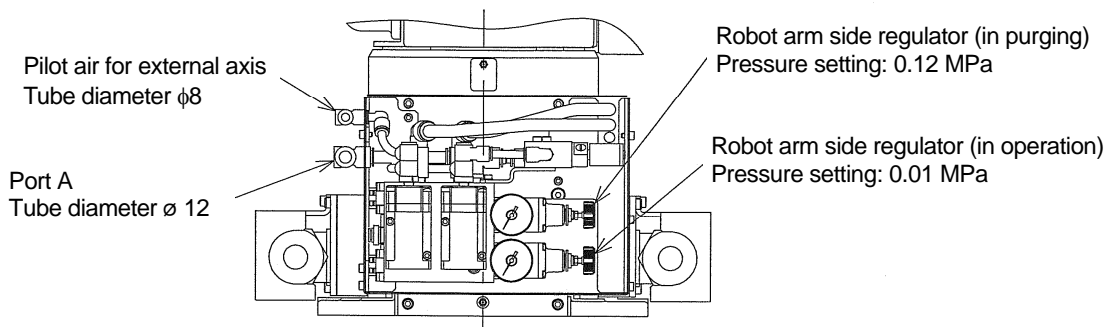
9.1 EXPLOSION-PROOF SPECIFICATIONS

KF121 is an explosion-proof specified robot protected by pressurized and intrinsically safe structures that comply with national laws and safety standards.

9.2 AIR SUPPLY TO ROBOT ARM

9.2.1 FOR JAPAN EXPLOSION-PROOF SPECIFICATION

Air connecting port is provided in base section of robot arm as shown in the figure below.



Supply the air from the port A (tube diameter $\phi 12$) in the rear of the robot arm as show in the figure above.

CAUTION

Do not change regulator setting on side of robot arm as it is adjusted at factory shipment.

CAUTION

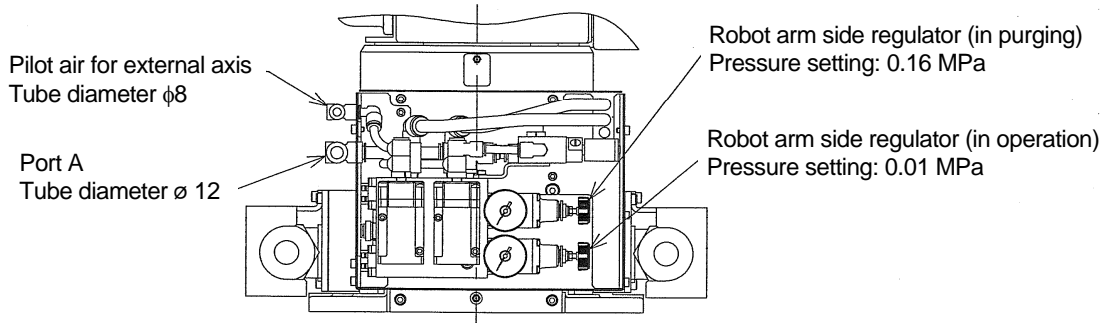
Use clean air that meets specifications below.

- 1. Solid material ... 0.01 μm or less**
- 2. Oil content..... Mist separation: 99.9999 % or more**
- 3. Humidity Dew point: -17 °C or less at atmospheric pressure.**
- 4. Input pressure .. 0.3 - 0.7 MPa (4.1 - 7.1 kgf/cm^2)**
- 5. Input quantity .. 300 L/min. (nor) (Only at purging)**

When purging completes, the air operated valve set on exhaust side closes.
After that, air consumption is minimized to only a little air leakage from various sealed sections.

9.2.2 FOR CHINA EXPLOSION-PROOF SPECIFICATION

Air connecting port is provided in base section of robot arm as shown in the figure below.



Supply the air from the port A (tube diameter $\phi 12$) in the rear of the robot arm as show in the figure above.

⚠ CAUTION

Do not change regulator setting on side of robot arm as it is adjusted at factory shipment.

⚠ CAUTION

Use clean air that meets specifications below.

- 1. Solid material.... 0.01 μm or less**
- 2. Oil content..... Mist separation: 99.9999 % or more**
- 3. Humidity Dew point: -17 °C or less at atmospheric pressure.**
- 4. Input pressure... 0.3-0.7 MPa (4.1 - 7.1 kgf/cm^2)**
- 5. Input quantity... 300 L/min. (nor) (Only at purging)**

When purging completes, the air operated valve set on exhaust side closes. After that, air consumption is minimized to only a little air leakage from various sealed sections.

10.0 CONNECTING ROBOT ARM TO CONTROLLER WITH HARNESSSES

10.1 CAUTIONARY INSTRUCTIONS FOR CONNECTING HARNESSSES

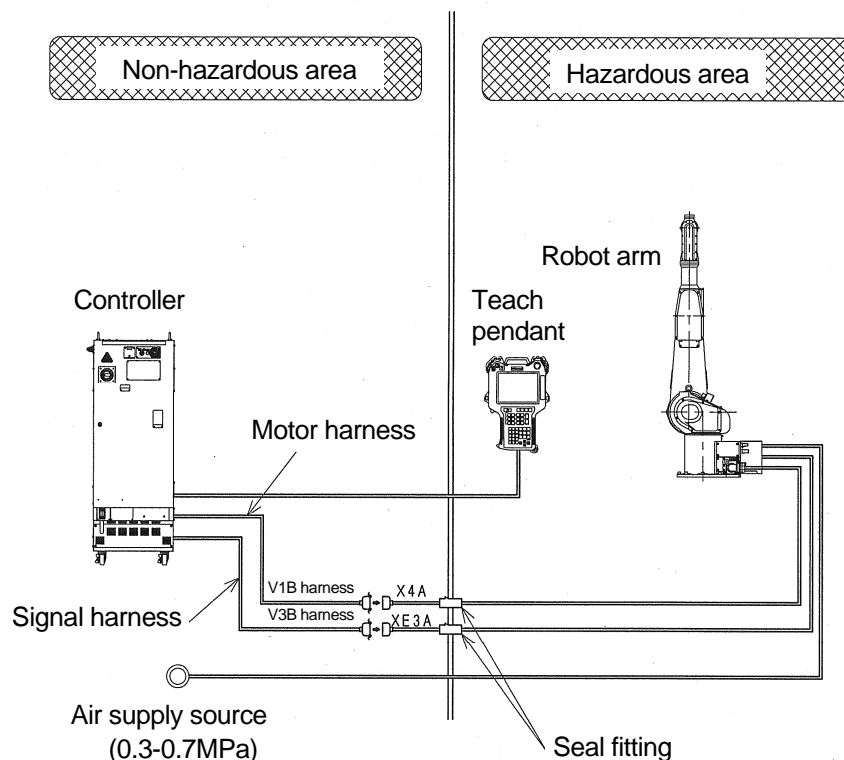
Strictly observe the following instructions when connecting separate harnesses.



CAUTION

1. Follow the national and local standards for installing harnesses.
2. Be sure to use the correct harness cable and check that connector fittings match between the harness side and controller side before attempting connection. Using an incorrect harness, or forcing or misconnecting the harness may damage connectors or cause a break in the electrical system.
3. Use conduits, ducts, etc. to prevent people or equipment (forklift, etc.) from stepping on or riding over the signal and motor harness lines. An unprotected harness may become damaged causing breaks in the electrical system.
4. Do not bundle or run the robot motor and signal harnesses together. Signal harness is specified for use in intrinsically safe circuit and must be separated or wired independently from other harness lines using a duct. Also, keep away signal harness line a minimum of 1 m from any high voltage/current lines. Noise generated from high voltage/current lines will cause malfunctions.
5. Make the separate harnesses as short as possible.

For Japan and China explosion-proof specifications



Kawasaki Robot KF121
Installation and Connection Manual

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