



# A Safety Guide to Industrial Robotics Hazards

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## With the rapid growth of technology, industrial robotics is becoming increasingly popular in the market.

These robots are being utilized to automate industrial processes, which is resulting in a significant increase in productivity. Moreover, they are capable of performing various tasks in different industrial settings, which has further boosted their demand. As a result, the robotics industry has seen a positive surge in recent years.

**According to the World Robotics 2021** Reports by the International Federation of Robotics (IFR), global robot installations have significantly increased, even during the pandemic. Currently, there are over 3 million industrial robots operating worldwide, and this number is expected to continue to grow.

By 2027, it is predicted that the industrial robotics market will reach



**USD 30.8 million**

Despite their numerous benefits, industrial robots present their own set of challenges, especially when it comes to safety issues. These machines are powerful and intelligent, but they can also lead to serious accidents, making it crucial to address the risks, hazards, and safety standards associated with them. By prioritizing safety and adhering to industry standards, we can ensure that the benefits of industrial robotics are realized while minimizing potential hazards and risks.

This whitepaper offers an in-depth exploration of the fundamentals of industrial robotics and aims to provide a comprehensive safety guide for addressing hazards and mitigating risks associated with these machines.

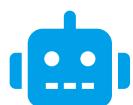
# What are Industrial Robots?

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Industrial robots are versatile machines that have revolutionized the industrial sector. These robots are programmable and can execute various tasks in different industrial settings, such as manufacturing, logistics, agriculture, and healthcare. They can perform various operations that are hazardous or require precision, such as welding, painting, and assembly.

As the industrial sector requires repetitive and time-consuming tasks, industrial robots offer a cost-effective and efficient solution. Moreover, industrial robots can work in extreme temperatures, high-pressure environments, and hazardous areas where human workers cannot operate safely.

The increasing demand for industrial robots has led to technological advancements, resulting in collaborative robots (cobots) that can work alongside human workers. These cobots are designed to share the workspace with humans and can be programmed to assist workers in various tasks, improving safety and productivity.



Industrial robots have also become more accessible to small and medium-sized enterprises (SMEs) as the cost of industrial robots has decreased, and the installation process has become more straightforward. As a result, SMEs can now adopt automation and enhance their productivity and efficiency.

# The Exponential Rise in the Use of Industrial Robotics

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As industrial robots are equipped with sophisticated sensors and better control technologies, they are used for a wide range of applications across different industries. The two main reasons industries have started using robots at a large scale are efficiency and safety.



Robots are capable of carrying out tedious and hazardous operations with **consistent efficiency 24/7**.

These intelligent automated machineries can replace manual processes that otherwise put human lives at risk. Besides, they can also execute tasks in coordination with humans, simplifying industrial operations and maximizing throughput at reduced time and risks.

The COVID-19 pandemic is another major factor that triggered the extensive adoption of industrial robots in the last few years. Since factory operations were largely affected due to the imposed movement restrictions, the industrial sector suffered extensive losses. The virus outbreak universally highlighted the demand for automation and backups.



# Do Industrial Robots Improve Workplace Safety?

Industrial robots are designed to undertake human tasks and perform them more efficiently. They have faster processing speed and can handle complex tasks without any errors. These robots have actuators and servo motors that generate tremendous forces for heavy lift operations. They also have vision systems and sensors to help them operate precisely, quickly, and accurately.

Here's how industrial robots improve safety at the industrial workplace setup:



## Minimize hazard exposure

Human workers operate in difficult conditions in factories. There can be extreme atmospheric conditions like high temperature and pressure or freezing conditions depending upon the operational requirements. However, humans do not have the ability to cope with extreme weather conditions. Besides, as industrial operations expose them to toxic chemicals and fumes, these can adversely affect the workers' health.

Robots, on the contrary, can work in adverse conditions 24/7. Moreover, they can operate in extreme environments with high precision. Thus, workers' health risks can be eliminated if industries automate risky processes through robots.



## Reducing the risk of injuries

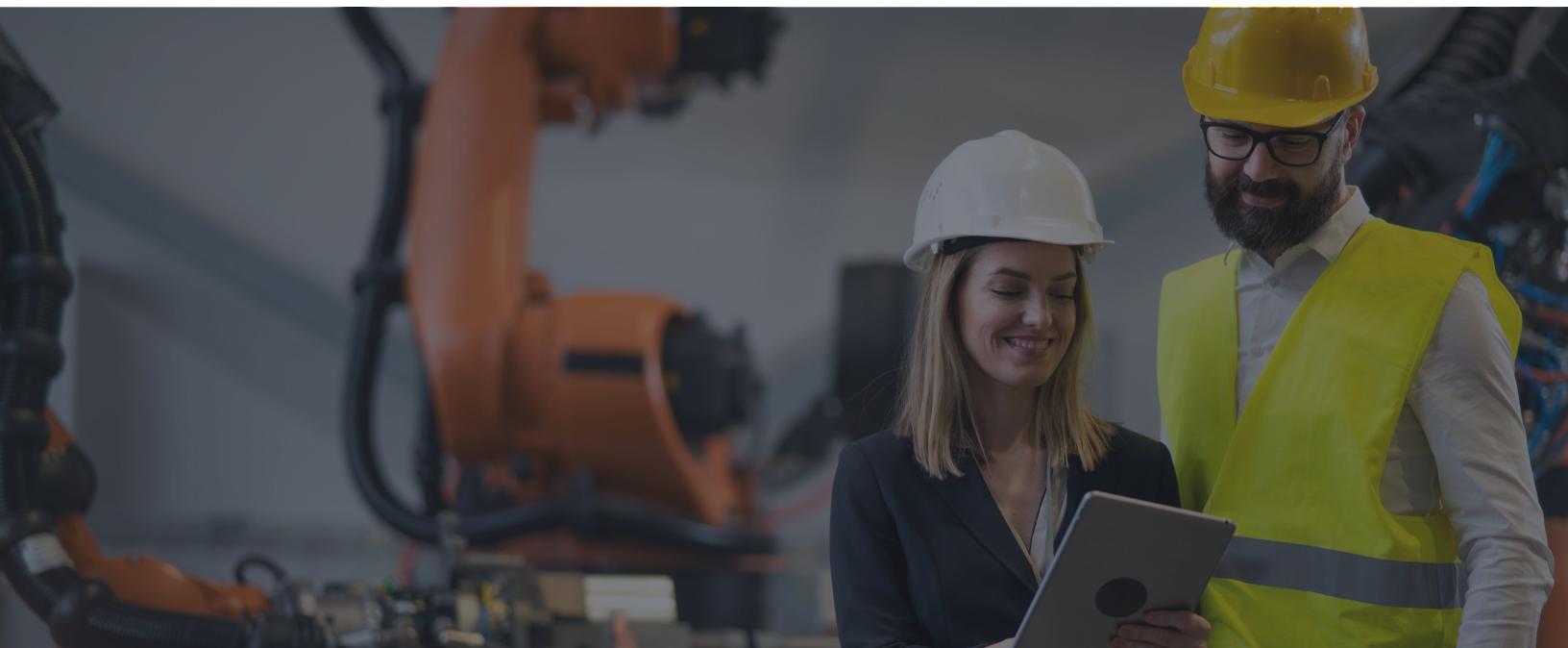
Industrial work processes include several routine tasks performed repetitively. Workers often require lifting weights and are under constant muscle stress. These strenuous activities can cause sprains, back pains, and other muscle damage. Besides, even a minor accident, like a collision, can lead to severe injuries.

Industrial robots can perform these repetitive tasks without any failure. They have well-designed control mechanisms that help them operate efficiently and carry out strenuous jobs efficiently, limiting the risk of injuries to human workers.



## Operational safety

Industrial robots can help increase awareness of workplace safety. The embedded sensors in these robots can trigger safety alarms in case of any potential accidents. Thus, they can foster a better safety culture and ensure minimal risks of accidents in a factory environment.



# Are Industrial Robots Completely Safe?

Robots are automatic machines that require little to no human intervention to operate. While there are several technical disciplines that govern industrial robotics, there are still chances of mishaps. **Therefore, they cannot be considered completely safe as:**

- Robots have high-speed movements, and it is almost impossible to follow these movement sequences. As different equipment operates in the industries at a time, there are chances of overlapping their radius of actions.
- Energy beams like lasers or water jets carry a high reserve of energy, and any asynchronism can cause uncontrolled release.
- Robots are programmed machinery. They are sensitive to external errors like electromagnetic compatibility. Moreover, there are chances of software corruption or malfunction, which can lead to unforeseen circumstances.
- Mishaps can also result from human errors that can cause issues in the robot's defined operation.

As per [reports](#) more than half of the robot accidents in Japan resulted from electronic circuit faults. Also, about 20% of issues were due to human faults. Therefore, even if we can govern human behavior, system faults cannot be reduced down to zero.

Since the 1980s, several notable fatal accidents related to robots have occurred. Typically, accidents do not occur during normal mode operations. The common reasons for accidents resulting from robots include any malfunctioning or breakdown, power failure, control defects, or similar incidents.

# Safety Principles for Industrial Robots

Since industrial robots have complex mechanisms involved, it is also necessary to follow robotics safety standards to establish a safe working environment for humans. No matter how efficient and productive industrial robots are, there are underlying safety concerns. This is why industrial standard bodies have developed several safety standards and guidelines that industrial businesses must follow to ensure safe working environments.

**The three primary versions of robot safety standards are from OSHA, ISO, and ANSI.**

## OSHA

OSHA, or the Occupational Safety and Health Administration, outlines the standard regulations for hazard-free and safe workplace conditions. These standards are updated regularly based on the latest safety guidelines. As per OSHA, each stage of robot development needs risk assessment to outline the worker and system safety requirements. Besides, when implementing industrial robots, it is also essential to use safeguarding devices. These devices ensure that there are fixed barriers to restrict the work area.

OSHA also highlights that awareness devices should be used in the industrial robotics system. These can generate warning signals in the form of flashlights or alarms to alert the workers in case of crossing the safe proximity levels or any other impending hazards.

Additionally, OSHA also emphasizes routine inspections and regular maintenance of industrial robots. Any wear and tear or mechanical malfunctions should be detected beforehand. Another important aspect that OSHA outlines is the proper training of those involved in dealing with industrial robots. The workers interacting with these intelligent machines must be fully aware of the safety standards and features.

**OSHA standards** related to robotics include 1910 Subpart J, which highlights the general environmental controls. The 1910 Subpart O further outlines the machine and machinery guarding. It contains standard definitions of different machine parts and operations. The 1910 Subpart S highlights the electrical work practices, protection, equipment, training, and other aspects.

## ANSI

The American National Standards Institute defines safety standards for robotics systems. It also outlines the guidelines for manufacturing facilities to integrate industrial robots into their operations. These standards are developed along with RIA or the Robotics Industries Association.

The most extensive ANSI standard is [ANSI/RIA R15.06-1999](#). It elaborates on the guidelines about the manufacturer requirements, installation, protection, and safeguarding practices related to the operation of robots. It also specifies the importance of personnel safety and risk assessment. This version has been updated to [ANSI/RIA R15.06-2012](#).

ANSI/RIA R15.06-2012 has adopted ISO safety regulations. These international guidelines set the global compliance standard for the use of industrial robots. Adhering to these standards assures that the latest safety protocols are followed.

## ISO

The [International Organization for Standardization](#) has prepared the international robotics standards that define the safety criteria for robot operations. ISO 10218:2011 highlights the requirements for robots and robot work cells. There are two parts: ISO 10218-1:2011 and ISO 10218-2:2011.

[ISO 10218-1:2011](#) defines the requirements for the inherent safe design of industrial robots, protection measures, and other associated information. It also discusses the basic hazards related to robotic systems and how these risks can be adequately reduced or eliminated.

[ISO 10218-2:2011](#) is about the safe integration of industrial robot systems. It also describes the design, manufacturing, component devices, and other operational aspects of the system. The standard highlights the requirements that industrial businesses must follow when implementing an integrated manufacturing system.

# Common Industrial Robot Hazards

**Major industrial robot systems hazards include:**



## Environmental hazards

If the operating conditions affect the robot's operation in any way, there might be a risk of hazards. Any power failure, lightning discharge, issues in equipment orientation, or potentially hazardous radiation are beyond control. However, these anomalies can affect the robot's performance and result in abnormal behavior. As a result, workplace safety will be at risk.



## Operational hazards

Any unpredicted or imprecise movement, the unexpected change in the program, component malfunctions, breakdowns, or any maloperation can cause serious hazards like collision, crushing, and other serious injuries.



## Installation hazards

Poor installation of industrial robots and improper testing measures pose significant risks to the working environment. Also, as workers are first exposed to these systems, they are at increased risk.



## Control hazards

Software malfunctions, radio or electromagnetic interference, or any such controlling errors can affect the functional safety performance of the system, resulting in accidents. These hazards can also result from any faults in the control system, electrical sub-controls, hydraulic faults, and similar issues.



## Human errors

Industrial robots need supervision at some levels and cannot be left alone to perform the tasks all by themselves. Any unpredicted movement or action, incorrect activation of a sub-component, or overlooked critical safety functions can lead to hazards. Sometimes, workers put themselves in a risky position when they make any mistake in the robotics system's operation, maintenance, or troubleshooting.



## Power system failures

Any disruption in the power system can affect the functioning of industrial robots. Moreover, disruption in the electric signals can also lead to operational failures or malfunctioning of the system at some level. These issues can affect workplace safety and also result in hazardous situations.



# Notable Industrial Robotics Accidents

There are several instances related to industrial robot accidents.

In Alabama, a 20-year-old worker was killed due to the abrupt restarting of a robot in an auto parts supplier facility. The assembly line stopped due to some fault. About four workers went in to check the fault in the robot station when the machine crushed the young woman. OSHA investigated this case, cited some serious violations, and imposed **a 2.5 million USD fine** on the company.



In another case in Ohio, an auto parts manufacturer faced a **fine of USD 3.42 million**. A 58-year-old worker suffered from an elbow fracture and serious injuries while removing scrap on a robotic press line. Another 22-year-old worker suffered a similar fate while coming in contact with operating machine parts. OSHA found multiple violations upon investigation even after the company assured to improve safety conditions. Thus, a fine was imposed.

The **Washington Fatality Assessment and Control Evaluation (WA FACE) program** investigates hazards and performs an in-depth analysis of workplace fatalities. It reported an unfortunate incident involving a driverless forklift that killed a 45-year-old worker in Washington. On hearing an alarm sound from a Laser Guided Vehicle (LGV), he removed a piece of plastic and was outside the sensor path. As the LGV resumed operation, he was crushed by the elevated forks and was pronounced dead after being rushed to a local hospital.

# Safety Considerations for Industrial Robots

As per OSHA, it is essential to implement an efficient safeguarding strategy to protect workplaces involving industrial robots. Following are some of the essential steps industrial businesses must take to ensure a safe workplace environment when integrating robots.



## Safety standards review

At the manufacturer level, it is essential to comply with applicable safety regulations and standards when designing robot applications. These guidelines and specifications help create a safe working environment. The sum total of interlinked devices constitutes a robot. Therefore, the entire system must meet safety requirements.

Although these standards differ with countries, there are common standards accepted universally, like ISO, ANSI, and OSHA. These governing bodies set international guidelines and also update the standards based on the latest developments. So, manufacturers should stick to certified standards and mention their compliance to ensure that the systems they designed are safe.

When buying industrial robots, companies must also review the safety standards of the systems. They must question the robot manufacturer about the specifications and cross-check that the robots can be safely integrated into their workspace.



## Risk assessments

Risk assessment and comprehensive hazard analysis must be performed when integrating robotic systems. There must be ideal participation from employers and workers since they will deal with the system. These assessments can help detect any likelihood of risks and develop protective measures for risk reduction and safety control.

### Here are some considerations that can help in effective risk assessment:

- For risk assessment, choosing an expert in robot applications and process operations is important. Also, employees must be included as they deal directly with industrial robots.
- Documentation is an important aspect of risk assessment as the specific guidelines associated with the task can be referred to in the future. The potential risks must be enlisted for each task, and the team can then decide on the risk recursion techniques.
- After finalizing the appropriate risk reduction techniques, these principles must be implemented effectively. Also, all employees must be made aware of the risks and how to handle them.
- There must be periodical reviews as, with time, the requirements might change. Besides, as the safety guidelines and standards are updated regularly, the risk assessment must include those. Therefore, frequent monitoring and inspections can ensure correct safety functions.
- It is also crucial to periodically validate the training manuals, electrical and mechanical drawings, control system safety function settings, sensors, and other safeguarding devices. These can help drive continuous improvements.



## Risk reduction

Risk reduction measures should be decided based on specific robot applications. They should align with the standards hierarchy of controls. External risk control measures will include laser scanners, guards and barriers, and light curtains. Training professionals can handle internal risk reduction measures like built-in safety functions and software settings.

There are non-collaborative robots that operate separately and do not need workers' support. These applications can be physically isolated during their operations. Safeguarding devices like fences and barriers, safety vision systems, and scanners can serve the purpose. Providing adequate clearance when designing the application layout is also a good practice. Training the workers dealing with these applications and ensuring they know the Standard Operating Procedures (SOPs) is also necessary.

As collaborative robot applications need the involvement of workers, they need specific risk reduction measures based on different tasks. Mostly, they have safety functions integrated into their systems that can control the speed, force, momentum, and positions.



## Adequate safeguarding

Safeguarding devices can help prevent hazards related to restricted space. There are presence-sensing devices, fixed and interlocked barrier guards, and limiting devices that can safeguard workers from accidents. Awareness devices like chain or rope barriers, alarm signals, flashlights, and horns should also be implemented as per the risk level.

PPE or Personal Protection Equipment like safety glasses, protective footwear, arc glare shields, and hand protection should be used by workers when operating with the robot applications.

Besides, regular inspection and maintenance programs should minimize any malfunctioning or breakdown within the system.

# Smart Solutions for Safe Industrial Robots

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The development of smarter and more advanced industrial robots has brought a whole new level of efficiency and productivity to industries across the globe. However, as these machines become more advanced, it is critical to ensure that they are also safe to operate alongside human workers.

There is a growing need for modular or collaborative robotic systems that can work in tandem with human workers, which has led to the development of various safety features and protocols. The incorporation of smart solutions that utilize sensors, cameras, and other technologies can help mitigate potential hazards and ensure the overall safety of the system.

At [Hokuyo](#), we recognize the importance of safety in the robotics industry and offer a range of industrial sensor products designed to address safety concerns related to industrial robots. Our products include safety laser scanners, crane collision avoidance solutions, LiDAR/obstacle detection sensors, laser distance sensors, and more. By utilizing our high-quality sensor products for robotics and automation applications, you can build a safer and more efficient workplace.

[Contact us](#) to learn more about our sensor products and how they can help you ensure the safety of your industrial robotics applications.



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