



ROBOT SAFETY IN INDUSTRIAL ENVIRONMENTS

The Importance of HAZLOC and ORDLOC
Certifications

ABSTRACT

This whitepaper explores the critical importance of safety in the deployment of robots across industrial environments, highlighting why proper certification is essential to protect human life, ensure regulatory compliance, and maintain operational integrity.

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Why Robot Safety Matters

The deployment of robots in industrial environments has grown exponentially in recent years. From autonomous drones inspecting infrastructure to legged robots navigating complex terrain, these machines are transforming how industries operate. However, as robots increasingly work alongside human personnel, safety becomes a paramount concern. Industrial settings, especially those involving hazardous materials or confined spaces, pose unique risks that demand rigorous safety protocols.

Robots are no longer isolated systems operating behind barriers. They now integrate into workflows, sharing spaces with technicians, engineers, and operators. This proximity introduces potential hazards such as electrical faults, mechanical failures, and even ignition risks in explosive atmospheres. Ensuring that robots are designed and certified to operate safely in these environments is not just a technical requirement — it's a moral and legal obligation.

Safety certification plays a critical role in protecting both human life and operational continuity. A single failure in a hazardous location can lead to catastrophic consequences, including fires, explosions, or toxic exposure. Certified robots help mitigate these risks by adhering to established safety standards and undergoing rigorous testing. As robotics continues to evolve, the importance of safety will only grow, making certification a foundational element of responsible innovation.

Understanding HAZLOC and ORDLOC Environments

Industrial environments vary widely in terms of risk, and understanding these differences is essential for deploying robots safely. **Hazardous Locations**, or *HAZLOC*, refer to areas where flammable gases, vapours, dusts, or fibres may be present in sufficient quantities to ignite under certain conditions. These include offshore oil platforms, chemical processing plants, grain silos, and other high-risk facilities. Robots operating in these environments must be engineered to prevent any possibility of ignition or failure that could lead to disaster.

In contrast, **Ordinary Locations**, or *ORDLOC*, are environments that do not typically contain explosive or flammable materials. These include warehouses, logistics centers,

hospitals, and office buildings. While the risks in ORDLOC settings are lower, they are not negligible. Electrical faults, overheating, and mechanical malfunctions can still pose threats to safety and productivity. Robots in these environments must meet standards that ensure they operate reliably and do not pose a risk to personnel or infrastructure.

The distinction between HAZLOC and ORDLOC is more than semantic. It determines the level of certification required and the design considerations that must be considered. Robots must be evaluated based on the specific risks of their operating environment, and certification ensures that they are equipped to handle those risks appropriately. This environmental awareness is the first step toward building a safe and compliant robotic system.

How Certification Helps Reduce Risk

Certification is a cornerstone of industrial safety, particularly in the realm of robotics. In hazardous environments, **the consequences of equipment failure can be severe, ranging from explosions to toxic leaks**. Certification ensures that robots are designed and tested to prevent such failures, providing an additional layer of protection that extends beyond basic engineering. *It is a formal acknowledgment that a robot meets the safety standards* required for its intended environment.

Certified robots are built to eliminate ignition sources, contain electrical faults, and withstand harsh conditions. This is achieved through design features such as explosion-proof enclosures, intrinsically safe circuits, and purging systems that prevent the accumulation of flammable gases. These features are not optional; they are mandated by regulatory bodies and insurance providers to ensure workplace safety.

Beyond technical compliance, certification also plays a vital role in legal and operational assurance. **It reduces liability for manufacturers and operators, facilitates insurance coverage, and builds trust with stakeholders**. Clients, regulators, and employees are more likely to embrace robotic systems that have been certified by recognized authorities.

In essence, *certification transforms safety from a reactive measure into a proactive strategy*, enabling organizations to deploy robotics confidently and responsibly.

The Regulatory Landscape in North America

In North America, robot safety in industrial environments is governed by a robust framework of standards and enforcement bodies. These organizations collaborate to ensure that robotic systems are designed, tested, and deployed in a manner that protects both human life and infrastructure. At the core of this framework are the **National Electrical Code (NEC)**, published as **NFPA 70**, and the **Canadian Electrical Code (CSA C22.1)**. These codes outline the requirements for electrical installations in hazardous locations, including specifications for wiring, enclosures, and the classification of equipment.

Enforcement of these standards falls under the jurisdiction of the **Occupational Safety and Health Administration (OSHA)** in the United States and **various Authorities Having Jurisdiction (AHJs)** across Canada. These entities ensure that workplaces comply with safety regulations and that certified equipment is used in accordance with its intended purpose. Non-compliance can result in fines, shutdowns, or legal liability, making adherence to these standards a critical aspect of operational planning.

Certification itself is carried out by Nationally Recognized Testing Laboratories (NRTLs), such as **Underwriters Laboratories (UL)** and the **Canadian Standards Association (CSA)**. These organizations test and certify robotic systems to ensure they meet the safety requirements outlined in the NEC and CSA codes. Their certification marks are widely recognized and trusted across industries, serving as a visible assurance of safety and reliability. Together, these regulatory bodies form a comprehensive system that supports the safe integration of robotics into hazardous and ordinary industrial environments.

Making Sense of Classification Systems

Hazardous environments are classified using two primary systems: *the Class/Division system* and the *Zone system*. Each provides a framework for identifying the types of hazards present and the likelihood of their occurrence, which in turn informs us of the design and certification requirements for robotic equipment.

The **Class/Division** system is predominantly used in North America. It categorizes environments based on the nature of hazardous material. Class I for gases and vapours, Class II for dust, and Class III for fibres. Each class is further divided into Division 1 and

Division 2. Division 1 indicates that hazardous materials are present under normal operating conditions, while Division 2 suggests that such materials are only present under abnormal or infrequent conditions. This system helps engineers determine the level of protection required for electrical and mechanical components.

The **Zone system**, more commonly used internationally, offers a more granular classification. It defines hazardous areas based on the frequency and duration of explosive atmosphere presence. For gas environments, Zone 0 indicates a continuous presence, Zone 1 indicates frequent presence, and Zone 2 indicates occasional presence. For dust environments, Zones 20, 21, and 22 follow a similar pattern. This system is often preferred in complex installations where detailed risk assessments are necessary.

Understanding these classification systems is crucial for selecting the most suitable certification path. Robots must be designed to meet the specific requirements of the environment in which they will operate. Misclassification can lead to inadequate safety measures, increasing the risk of accidents and regulatory violations.

What Certification Looks Like in Practice

The certification of robots for industrial use is a meticulous process that involves design, testing, documentation, and ongoing compliance. It begins with engineering the robot to meet the safety requirements of its intended environment. In hazardous locations, this often means incorporating features such as explosion-proof housing, intrinsically safe circuits, and purging systems that prevent the accumulation of flammable gases or dust. These design elements are critical to ensuring that the robot does not become a source of ignition or mechanical failure.

Once the design is complete, the robot must undergo testing by a *Nationally Recognized Testing Laboratory (NRTL)*, such as UL or CSA. These organizations evaluate the robot's components, construction, and performance under simulated conditions that replicate the hazards of the target environment. The testing process is rigorous and may include thermal analysis, electrical fault simulation, and mechanical stress testing. Only after passing these evaluations can the robot receive certification.

Certification is not a one-time event; it *includes detailed documentation, labelling, and traceability*. Certified robots must carry visible marks indicating their compliance, and manufacturers must maintain records that demonstrate adherence to safety standards.

This documentation is essential for audits, inspections, and insurance purposes. It also assures end-users that the robot has been thoroughly vetted for safety. In practice, certification transforms a robot from a promising innovation into a trusted tool for industrial operations.

Global Certifications and Real-World Examples

When it comes to deploying robots in hazardous environments, global certifications like **ATEX** (used in Europe) and **IECEX** (used internationally) are essential. These standards ensure that equipment can operate safely in areas where explosive gases, vapours, or dusts may be present. While North America typically relies on the Class/Division system defined by the NEC and CSA, ATEX and IECEx use a Zone-based classification—Zone 0, 1, and 2 for gases, and Zone 20, 21, and 22 for dusts.

Several industrial robots have already achieved ATEX and IECEx certification, proving their readiness for deployment in high-risk environments. For example, the ExR-2 robot from **ExRobotics** is designed for predictive maintenance and inspection in ATEX/IECEx Zone 1 environments. It can carry up to 30 kg of equipment and navigate complex terrains using LiDAR, GPS, and AI-based obstacle avoidance.

In addition to explosion protection ratings, robots often carry **Ingress Protection (IP) ratings**, which define their resistance to dust and water. For instance, an IP67 rating means the robot is dust-tight and can withstand immersion in water up to 1 meter deep. These ratings complement Class/Division or Zone certifications by ensuring the robot's enclosure can withstand environmental stressors such as rain, humidity, or chemical exposure.

Together, ATEX/IECEx certifications and IP ratings provide a comprehensive safety profile. While ATEX and IECEx focus on preventing ignition in explosive atmospheres, IP ratings ensure the robot's physical durability. When combined with Class/Division ratings in North America, these standards create a globally harmonized framework for deploying robots safely across various industries, including oil and gas, food processing, and mining.

Safety Considerations in Ordinary Locations

Even in environments that are not classified as hazardous, safety remains a critical consideration. *Ordinary Locations, or ORDLOC, include spaces such as warehouses, hospitals, office buildings, and logistics centers.* While these areas may not contain explosive gases or combustible dusts, they still present risks that must be managed through proper design and certification of robotic systems.

Robots operating in ORDLOC settings must be engineered to prevent electrical faults, overheating, and mechanical failures. These issues, although less dramatic than explosions, can still result in fires, equipment damage, or personnel injury. Certification ensures that robots meet the necessary safety standards for these environments, assuring that they will operate reliably and safely over time.

Examples of robots in ORDLOC environments include *autonomous mobile robots (AMRs) in warehouses, delivery robots in hospitals, and service robots in office buildings.* **These machines often interact closely with people, making safety features such as collision avoidance, emergency stops, and thermal protection essential.** Certification ensures that these features function as intended and that the robot can be relied upon in everyday operations.

By adhering to *ORDLOC certification standards, manufacturers and operators demonstrate a commitment to safety and reliability.* This not only protects people and property but also enhances the reputation of robotics as a dependable solution for modern industrial and commercial challenges.

Looking Ahead with UL 6260 and New Standards

As robotics technology continues to evolve, so must the standards that govern its safe use. **UL 6260** is one such emerging standard that addresses the unique challenges posed by new types of robotic platforms. This standard is designed to cover a wide range of robotic systems, including drones, tracked robots, legged robots, and subsea remotely operated vehicles (ROVs). These platforms often operate in hazardous or remote environments, where traditional safety standards may not fully apply.

UL 6260 provides a comprehensive framework for evaluating the safety of these advanced robotic systems. *It considers factors such as mobility, environmental exposure, and*

operational autonomy. By establishing clear guidelines for design, testing, and certification, UL 6260 helps ensure that these innovative robots can be deployed safely and effectively.

This standard is significant because industries are increasingly relying on robotics for tasks that are *dangerous, repetitive, or difficult for humans to perform*. Whether inspecting offshore oil rigs, navigating disaster zones, or exploring underwater infrastructure, **robots certified under UL 6260 offer a higher level of assurance**. They are built to withstand harsh conditions while minimizing risks to people and property.

By supporting innovation without compromising safety, UL 6260 represents a significant step forward in the responsible development of robotics. It enables manufacturers to bring cutting-edge technologies to market while maintaining the trust and confidence of regulators, operators, and the public.

Why Certified Robots Are Better Than Hot Work Permits

In many industrial settings, tasks that involve heat, sparks, or open flames require a **hot work permit**. *These permits are temporary authorizations that allow personnel to perform potentially hazardous operations under strict supervision*. While effective, hot work permits are inherently procedural and rely heavily on human oversight. They are not a substitute for engineered safety.

Certified robots offer a compelling alternative. Unlike hot work permits, which are limited in scope and duration, certified robots are designed for continuous safe operation in hazardous environments. They are designed with features that eliminate ignition sources and are tested to withstand the specific risks associated with their operating conditions. This makes them inherently safer and more reliable than temporary procedural controls.

By deploying certified robots, organizations can reduce their reliance on hot work permits and the associated administrative burden. This not only streamlines operations but also minimizes the potential for human error. Certified robots can perform tasks consistently and safely without requiring constant monitoring or intervention.

The shift from procedural to engineered safety represents a fundamental improvement in risk management. It enables companies to maintain high safety standards while enhancing efficiency and *minimizing downtime*. In environments where safety is

paramount, certified robots offer a robust and scalable solution that surpasses the limitations of traditional hot work permits.

Keeping People Safe Around Robots

As robots become more integrated into industrial operations, ensuring the safety of human workers who interact with them is a top priority. Certified robots are equipped with a range of features designed to protect people from harm. These include collision avoidance systems, emergency stop mechanisms, and physical shielding that prevent accidental contact with moving parts.

In confined or high-risk environments, such as offshore platforms or chemical plants, these safety features are especially critical. Robots must be able to detect the presence of humans and respond appropriately to avoid injury. Certification ensures that these systems are not only present but also effective under real-world conditions.

Human-robot interaction is a growing area of focus in safety engineering. As robots undertake more complex tasks and operate in closer proximity to people, the potential for accidents increases. Certification provides a structured approach to mitigating these risks. It verifies that the robot has been designed and tested to operate safely in human-centric environments.

*By investing in certified robotic systems, companies demonstrate their commitment to worker safety. This not only helps **prevent accidents but also fosters a culture of trust and collaboration between humans and machines.** In the long run, safe human-robot interaction is essential for the successful integration of robotics into the industrial workforce.*

Conclusion

The importance of HAZLOC and ORDLOC certifications cannot be overstated. These certifications provide the foundation for safe and compliant robotic operations in a wide range of environments. Whether dealing with explosive gases or simply ensuring reliable performance in a warehouse, certification ensures that robots meet the necessary safety standards.

Standards like UL 6260 are paving the way for the future of robotics. They address the unique challenges posed by emerging technologies and provide a framework for their safe deployment. By adhering to these standards, manufacturers can innovate with confidence, knowing that their products will be accepted and trusted by both regulators and end-users alike.

Certified robots offer numerous benefits. They reduce the risk of accidents, enhance operational efficiency, and build trust with stakeholders. Most importantly, they protect the people who work alongside them. In an era where automation is becoming increasingly prevalent, ensuring the safety of robotic systems is not just a technical requirement; it is a moral and strategic imperative.

As industries continue to embrace robotics, the role of certification will only grow in importance. It is the key to unlocking the full potential of automation while maintaining the highest standards of safety and reliability.