

Guide to service robot safety compliance

Overview of the robot certification process



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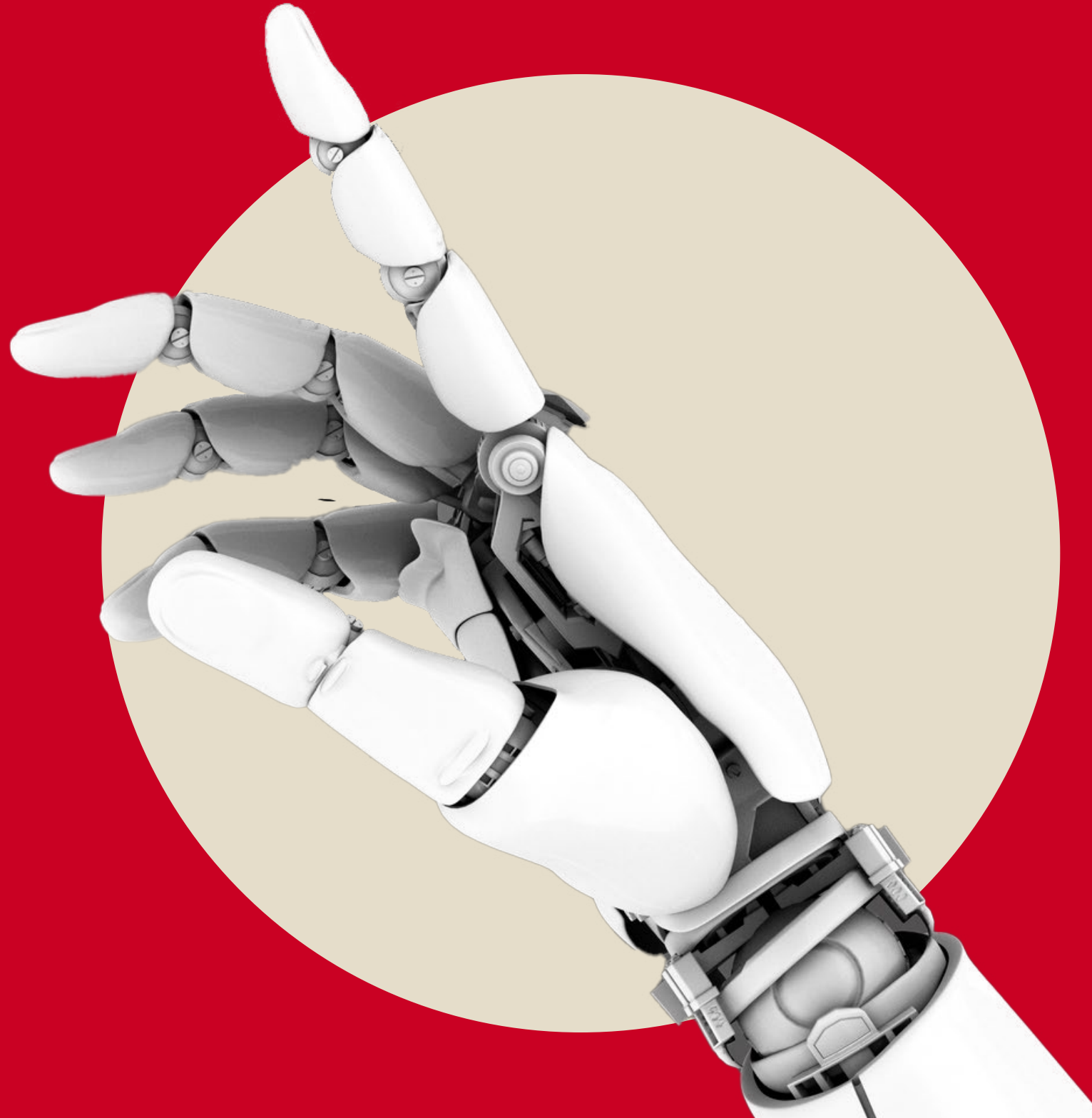
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Overview

As robotic technology continues to improve, asset owners are increasingly turning to robots for various tasks, which presents new opportunities and new risks. Service robots in particular work in close proximity to people, meaning risk mitigation is critical. UL Solutions is a trusted partner for robot manufacturers, system integrators and asset owners. Our testing and certification services help manufacturers demonstrate that their robotic systems are compliant with safety standards and will perform as expected. This guide provides a comprehensive understanding of our certification process.



Areas of expertise

We provide testing and certification services for the following robots:

- Communication, information robots
- Companion robots
- Delivery robots
- Education and STEM robots
- Entertainment robots
- Exoskeletons
- Guide robots
- Hobby robots
- Household, domestic and home functional robots
- Humanoid robots
- Mobile servant robots
- Person carrier robots
- Physical assistant robots
- Restaurant robots
- Retail robots
- Security robots
- Service and personal care robots
- Telepresence robots



Overview of relevant standards for robotics

In areas as diverse as product safety, cybersecurity, laser optical radiation, interoperability, performance, energy efficiency, functional safety and medical applications, UL Solutions helps customers demonstrate compliance with regulatory requirements, including:

ANSI/CAN UL 3300

The Standard for Service, Communication, Information, Education and Entertainment Robots

UL 62368-1

The Standard for Audio/Video, Information and Communication Technology Equipment – Part 1: Safety Requirements

UL 60335-1*

The Standard for the Safety of Household and Similar Electrical Appliances – Part 1: General Requirements

**May be applied in some cases*

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ISO 13482

Robots and robotic devices – Safety requirements for personal care robots

NFPA 70

National Electrical Code

UL 5500

The Standard for Remote Software Updates

ANSI/ISO 12100

Safety of Machinery – General Principles for Design – Risk Assessment and Risk Reduction

UL 60730-1*

The Standard for Automatic Electrical Controls – Part 1: General Requirements

ISO 13849-1

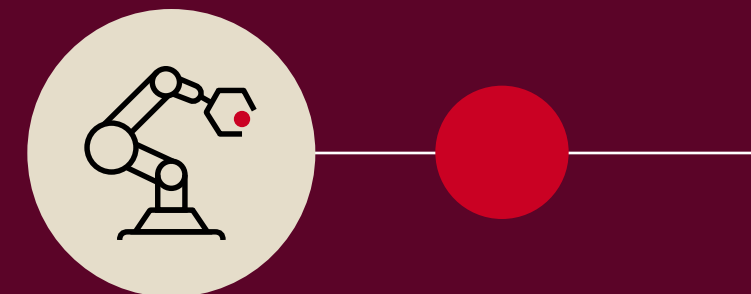
Safety of machinery – Safety-related parts of control systems – Part 1: General principles for design

EU Machinery Directive

(2006/42/EC)

EU Low Voltage Directive (LVD)

(2014/35/EU)





Compliance across the product lifecycle

UL Solutions supports manufacturers, system integrators and operators of robotic systems with a variety of services to help demonstrate consistent compliance throughout the product life cycle.

Advisory

Electrical, risk assessment and functional safety during product development

Training

Robotic safety, risk assessment and functional safety requirements

Testing/certification

- Functional safety, including personnel qualification
- Electrical safety
- Testing for specific robotic applications and corresponding standards

Gap analysis

Gap analysis with the International Organization for Standardization (ISO) requirements to facilitate market diversification and access certifications (i.e., China, EU Machinery Directive, CE, etc.)

Sourcing

UL Product iQ® database helps source compliant, certified components

EMC and wireless

Testing to help support seamless communication

Cybersecurity

Advisory, testing and assessment solutions to help avoid security breaches

Field evaluation

Evaluation of robots in use environments

Risk assessment

Full-system risk assessment: engineered systems compliance

HMI

Human-machine interface (HMI) safety services

How you can benefit

Gain peace of mind across the entire value chain for robotic systems. From selecting components to safer operations, cybersecurity checks to streamlined market access, UL Solutions is your partner of choice for robotic system compliance.

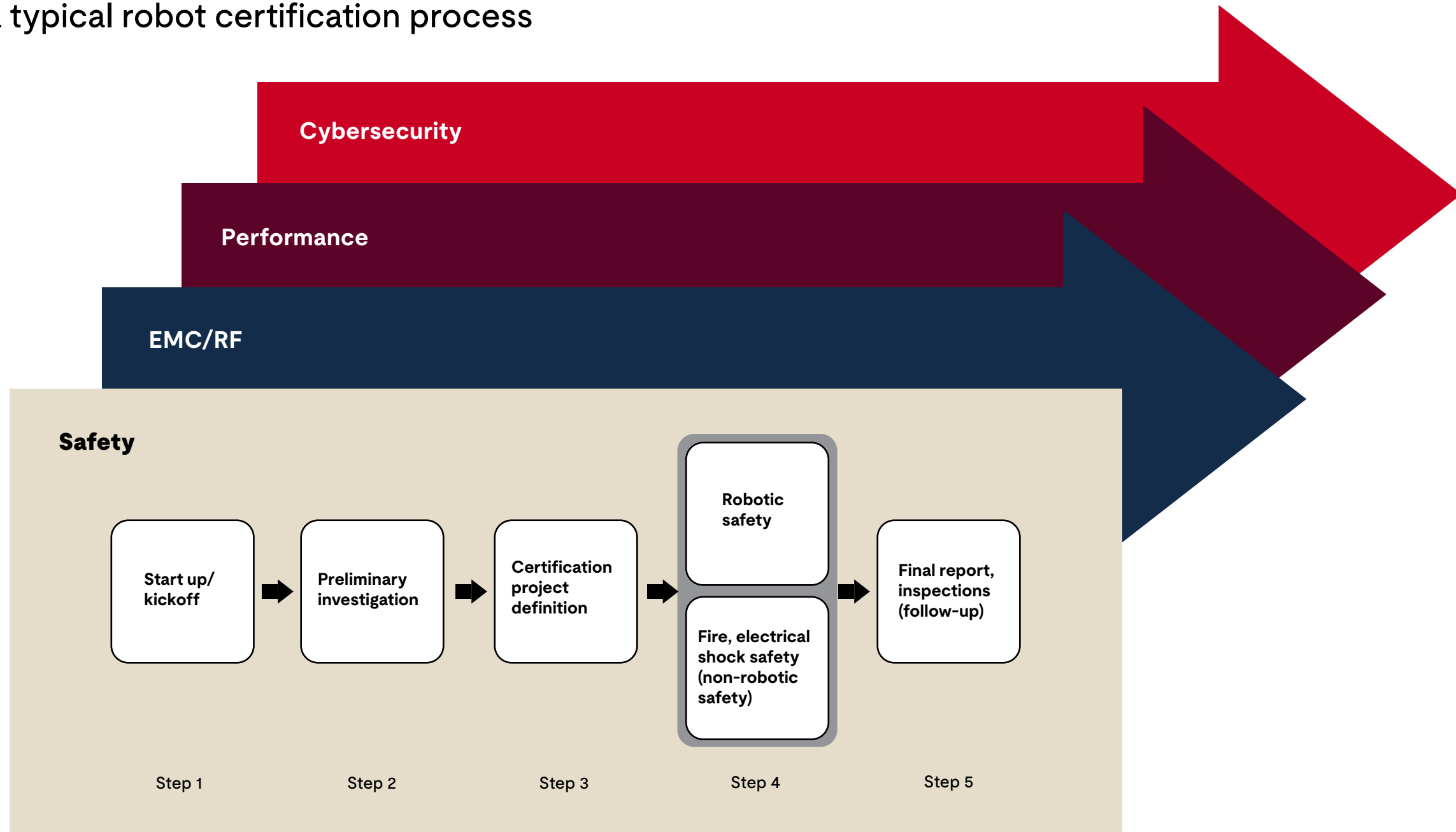
For answers to your questions or to start a project today, contact us at

[UL.com/SCIEE](https://www.ul.com/SCIEE)

[UL.com/Robots](https://www.ul.com/Robots)



Overview of a typical robot certification process





1. Kick-off

When you begin working with UL Solutions, we will help you understand the evaluation, testing and certification processes, along with the applicable technical and regional requirements within your target markets. Relevant standards and the corresponding certification will also be identified.



Key benefits

- Early determination of certification readiness
- Accurate identification of requirements in target market
- Seamless project planning and realization
- Clear overview of project scope and costs
- Reduced time to market during the launch or commissioning of the robotic system

Key deliverables

- Certification requirements for product launch
- Standards and compliance options
- Scope of work
- Work with the UL Solutions engineering team where appropriate (e.g., to walk through the certification process and help determine the readiness to pursue certification)
- Management of project start-up formalities (e.g., draft a formal quotation and address relevant service agreements)

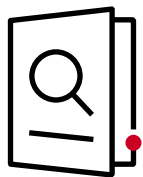




2. Preliminary investigation/ pre-certification review/ gap analysis

Engaging UL Solutions early in the product development and design cycle, even as early as the design drawing or prototype phases, allows you to benefit from expert guidance from the very beginning. A design or preliminary investigation of applicable construction requirements helps you identify areas that may need revision or rework before manufacturing processes are established.

While this is not a substitute for the complete product evaluation and does not lead to certification, it can provide significant time and cost savings later on.



Key benefits

- Compliance review of critical components and construction
- Reduced need for rework and changes in the manufacturing process
- Early identification of potential risks and effective management
- Time and cost savings

Key deliverables

- An engineering evaluation, including a review of the documentation and several factors without testing, such as the ratings, protection methods and construction, to the appropriate standard(s)
- A test program to determine the setup and sample requirements for the robot or robotic system submitted for certification
- Documentation review and identification of what is needed to prepare reports for all applicable target market certifications
- A letter detailing the compliance/non-compliance findings, documentation requirements, and testing plan



3. Certification project definition and confirmation of scope

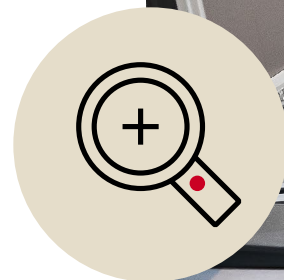
After the formal order is received, UL Solutions initiates a project, which includes the verification of applicable requirements and the customer's preferred method for project delivery. Additionally, a project number is generated, and the details of the scope of certification are agreed upon. The project will then be transferred to UL Solution's robotic engineering team to begin certification. The assigned UL Solutions engineer becomes the primary contact throughout the entire project.

Key benefits

- One single point of contact
- Transparency on project milestones and completion date

Key deliverables

- A project plan with defined delivery stages
- A preferred project completion date
- Mutually agreed date to submit additional documentation, such as schematics, bill of material and samples



4a. Robotic safety – robot standards

The Robot Standards assessment will be completed in accordance with applicable standards depending on the market and the type of robotic system. Standards include:

- ANSI/CAN UL 3300
- EN ISO 13482

UL Solutions' experts can work with your team to test various aspects, including performance on certain flooring surfaces, around obstacles, near critical edges/drop-offs, vibration testing and endurance testing.

Key benefits

- Confidence that the robot complies with relevant robotic safety standards

Key deliverables

- Completed test report





4b. Robotic safety – functional safety evaluation

Required documentation for evaluation:

Concept verification and system design

- Concept/risk assessment, functional safety management and concept, change and configuration management
- Verification and validation planning



Engineering review of documentation, audit and failure insertion testing

ISO 13849-1/IEC 62061/UL 60730-1* Annex H:

- Functional safety management plan including tool qualification, commercial off the shelf units (COTS) qualification plan, configuration and change management plan
- Hazard Analysis and Risk Assessment (including Safety Integrity Level (SIL)/Performance Level (PL) assignment)
- Quality manual/development procedures, ISO 9001 certificate
- System (safety) requirements specification including functional and safety integrity requirements.
- System architecture description, software architecture description
- Verification and validation plan
- Environmental and electromagnetic compatibility (EMC) requirements specification
- System design specification
- Fault Tree Analysis/Failure Mode Effects Design Analysis (FMEDA)/Probability of Dangerous Failures (PFD) calculation
 - Software and hardware requirements specifications/design documentation
 - Hardware-related documents (schematics, bill of materials (BOM), block diagram)
 - Verification and validation test results, including agreed fault insertion tests
 - Safety assessment report, e.g., prove of quantifiable aspects, systematic aspects, architecture requirements
 - Installation, operation and maintenance manuals

**May be applied in some cases*



4c: Non-robotic safety – risk of fire, electrical shock and injury

During technical evaluation and testing, the robotic system will be primarily tested to assess the risk of fire and electrical shock depending on the standards previously defined during the project setup. Your designated UL Solutions engineer will contact you directly to confirm the project scope and assumptions.

Typically, during this phase of the project, samples are sent, product construction is evaluated, documentation is reviewed, the test plan is developed and samples are prepared for testing. Testing may be conducted either in a UL Solutions laboratory or remotely at the customer's laboratory and witnessed by the UL Solutions engineer.

Associated working steps

- **Review of documentation and development of the test plan**
 - Evaluation of the construction
 - Determination of the final test plan plus creation of data sheets
 - Determination of samples needed for testing
- **If the tests are witnessed: information about the customer equipment specifics and calibration is required**
 - Witnessing of tests

**May be applied in some cases*

Key benefits

- Clear overview of work completed
- Identification of remaining gaps and missing information

Key deliverables

- Completed data sheet
- Draft of descriptive UL Solutions report
- Compliance to IEC/UL 62368-1 or IEC/UL 60335-1*

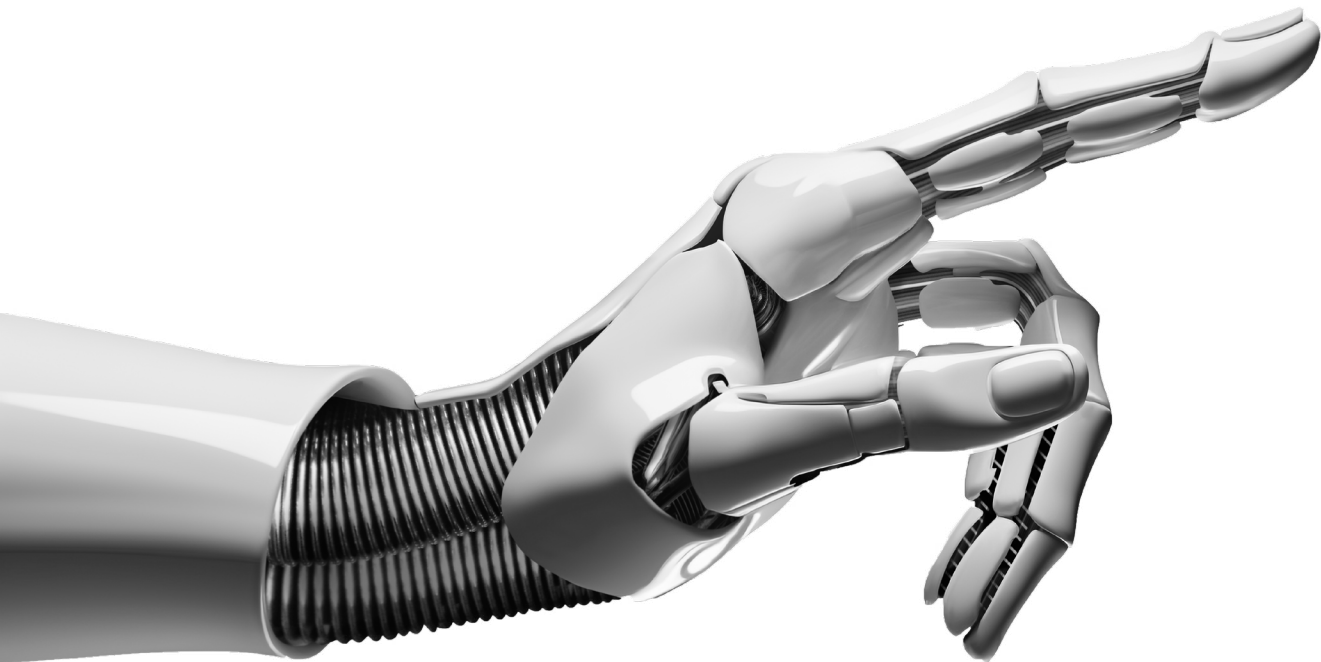




5: Final report for certification

If the robotic system complies with the respective standards based on the completion of all assessments, evaluations and tests, the certification process concludes.

This involves a final review of all evaluation data, resulting in the applicable certification documentation being issued to the customer, including the notice of authorization to apply the UL Mark and final certification documents, or notification of an initial product inspection prior to notice of authorization (see next page).



Key benefits

- Demonstrate product compliance
- Authorization to apply the UL Mark, one of the most widely recognized safety symbols in the world (as applicable)

Key deliverables

- European Commission (EC) type certificate (as applicable)
- Final functional safety report
- Review attestation and certification decision
- The UL Solutions certification or letter report (as applicable)
- Draft of descriptive UL Solutions report
- Compliance to IEC/UL 62368-1 or IEC/UL 60335-1*

**May be applied in some cases*

Inspections (UL Solutions Follow-Up Services)

To maintain UL certification, products undergo regular inspections at the manufacturing facility to verify continuous compliance with the respective certification documents. Regular follow up helps prevent disruption in application of the UL Mark and generally includes an initial production inspection (IPI) scheduled with a UL Solutions field engineer representative.

The frequency of these inspections is based upon several factors, including the type of product and quantity of Marks to be applied. Similarly, manufacturing visits may also be required for other certification schemes that allow the customer to use a certification Mark.

Key benefits

- Quality assurance.
- Continued compliance with certification documents.
- Technical on-site support



Additional assessments

EMC/wireless

Our EMC and wireless testing can evaluate whether your robots meet the requirements for your intended environments. UL Solutions offers a global network of EMC testing laboratories that provide convenient services. Our engineers have deep expertise in the field of EMC measurement and regulatory requirements. We will guide you through every step of the compliance process to help confirm your products meet applicable EMC requirements.



Additional assessments

Cybersecurity wireless



The Internet of Things (IoT) enables rapid innovation and incredible technology while also ushering in the need for enhanced safety and cybersecurity. Interconnected technology can expose all devices on a network to active threats, meaning manufacturers must build cybersecurity into the product design process. With these risks in mind, governing bodies are also stepping in to create requirements and offer guidance. For example, the European Commission's (EC) Radio Equipment Directive 2014/53/EU (RED) establishes a regulatory framework for radio equipment, which covers devices that can communicate over the internet.

The UL Cybersecurity Assurance Program (UL CAP) aims to minimize risks by creating standardized, testable criteria for assessing software vulnerabilities and weaknesses in embedded products and systems. Working to secure the software in your robots can help reduce exploitation, address known malware, enhance security controls, and expand security awareness. UL CAP offers trusted third-party support with the ability to evaluate the security of network-connectable products and systems, as well as vendor processes for developing and maintaining products and systems with a security focus. Based on the UL 2900 Series of Standards, UL CAP offers a full suite of resources designed to help you manage cybersecurity risks and validate your cybersecurity capabilities in the marketplace.

Similarly, The UL Verified IoT Device Security Rating was designed to assess the security of smart products when exposed to common attack methodologies and known IoT vulnerabilities. This efficient and comprehensive evaluation process helps establish a security baseline among the consumer IoT industry.

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Additional assessments



Global Market Access

Accessing multiple markets can be challenging, and standards often vary by region, country and even local jurisdiction. With global offices and expertise, UL Solutions can help you evaluate your robotics for compliance with the applicable standards and regulations in your target markets. Working with us also means you will enjoy the convenience of one single provider, streamlining communication to help you bring innovative robot technologies to market faster.

[UL.com/Solutions](https://www.ul.com/Solutions)



Global Compliance Management

Global Compliance Management (GCM) pairs UL Solutions' regulatory expertise with advanced machine learning and AI to help you keep pace with the changing regulatory landscape. You can easily monitor changes, manage your compliance portfolio, and access regulatory advice in one location.



UL Go

With an online subscription to UL Go, you can search for regulations, compare products, read news from UL Solutions regulatory experts and share requirements with colleagues.

Additional assessments

Performance



Standing out in a crowded market becomes challenging when brands can easily make unverified claims about their products. However, not all brands are created equal, and our UL Marketing Claim Verification service helps you demonstrate that the marketing and advertising claims you make are accurate, truthful and credible. Most importantly, relying on an independent third party helps you deliver confidence and peace of mind to your customers.

Key benefits

- Adds credibility to your marketing and advertising claims
- Customizable marketing claim Verification program based on your unique needs
- A specially designed UL Verified Mark which clearly describes the verified marketing claim and helps you leverage the UL Solutions brand
- Placement in UL Verify, our dedicated, consumer-friendly database showcasing products, systems, processes and facilities with a UL Verified marketing claim





Additional assessments

Optical radiation

Service robots rely on laser and LED technology to enable common tasks including lighting, sensing, surgical procedures, measurement, and mapping. Although this technology provides many benefits, lasers in robotics, including those that support (Light Detection and Ranging (LiDar) technology, also present a radiation risk.

Our laser and LED radiation safety testing and evaluation services help you address critical concerns for your customers. Our global network of optical radiation laboratories and engineers around the world will work to help you meet your goals, whether that means reducing your time to market, navigate complex global standards and regulations, or pursuing the UL Verified Mark for LED products. UL Solutions' team of experts can generate a wide variety of deliverables, ranging from simple optical output measurement results to IECCE CB Scheme Test Reports and Certificates.



The global robotics market today



According to World Robotics, over 5 million service robots (professional and consumer) were installed in 2022.

Five largest applications for professional service robots:

86,000

Transportation and logistics



24,500

Hospitality



9,300

Medical and healthcare



6,900

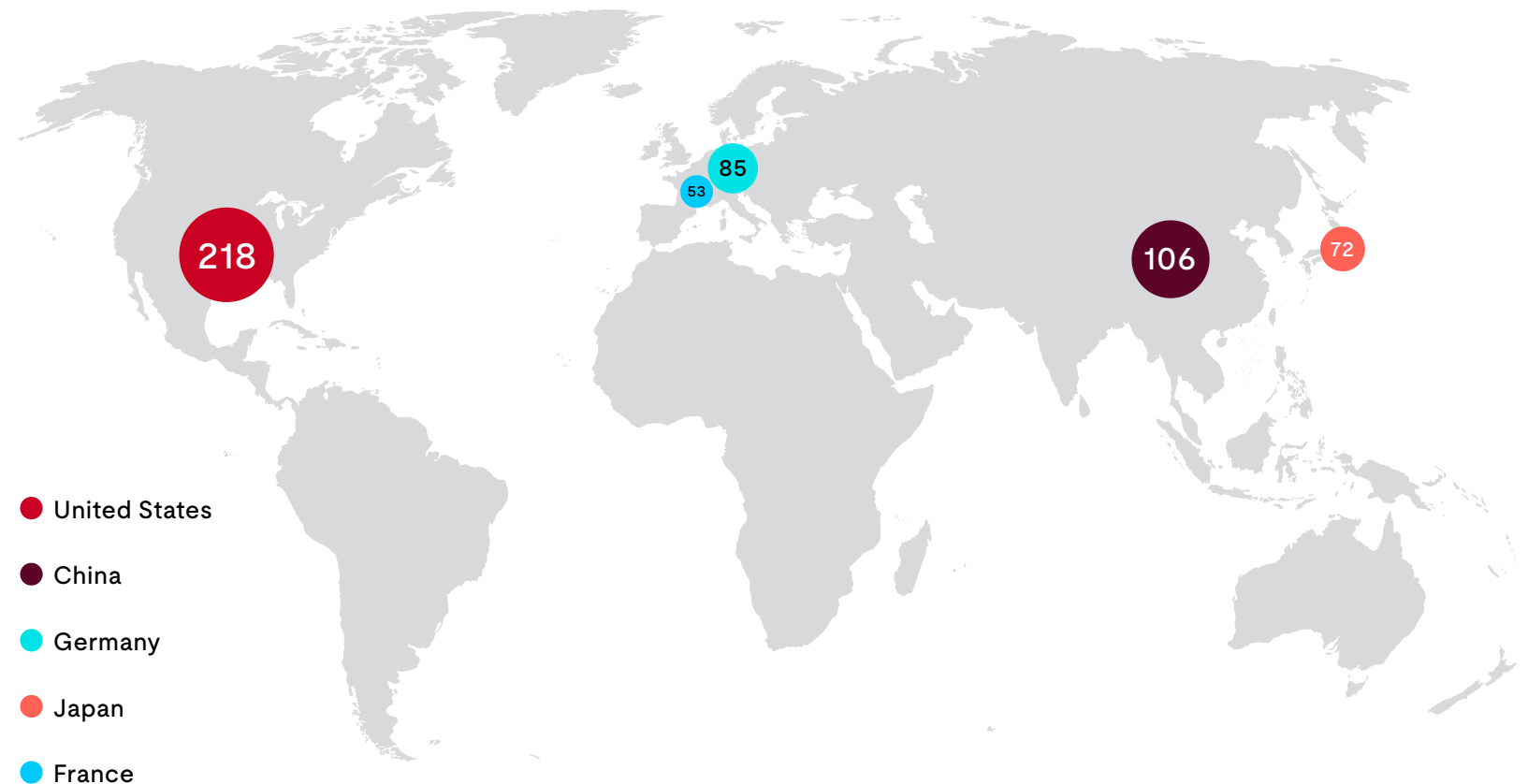
Professional cleaning

8,000

Agriculture



Top five countries (based on number of service robot suppliers)



*Data is for the year 2022. Source: International Federation of Robotics (IFR), World Robotics 2023



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