Building Technology Research Institute
香港建築科技研究院
Wholly Owned by the Financial Secretary Incorporated

Technical Specification for
Construction Painting Robots

Paint Spraying Robot, Putty Spraying Robot, and Putty Grinding Robot



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Foreword

Construction painting and finishing works are labor-intensive activities. With an aging skilled workforce and a shortage of new entrants, the productivity and sustainability of manual paint spraying, putty application and putty grinding are increasingly constrained. Traditional manual methods also face challenges in meeting increasingly stringent requirements for accuracy, consistency and quality.

Construction Painting Robots offer a safer, more precise and repeatable alternative through controlled movement, material delivery and process execution, together with integrated safety and environmental-control functions. They improve the consistency and quality of finishing works, reduce repetitive manual tasks and the need to work at height, limit workers' exposure to paint mist, dust, noise and ergonomic strain, and contribute to a safer construction environment.

To facilitate wider adoption of robotic painting technology, there is a need to align the diverse proprietary solutions offered by different Vendors and establish clear and consistent specifications to streamline procurement and deployment. This Technical Specification therefore sets out common technical and safety requirements for Vendors, Purchasers and Clients, providing a consistent framework for the selection and deployment of Construction Painting Robots that meet defined performance and safety benchmarks.

Building Technology Research Institute and

The Hong Kong University of Science and Technology

Preface

This Technical Specification provides a structured framework for deployment and operation of Construction Painting Robots in Hong Kong construction projects. It covers Paint Spraying Robots, Putty Spraying Robots and Putty Grinding Robots, including common system requirements and robot-specific functional requirements.

This specification is applicable to public and private construction projects. It sets out technical and safety requirements for construction painting operations, supporting productivity, worker welfare and on-site safety.

This specification draws on Hong Kong construction safety regulations and emerging robotic specifications, setting minimum requirements while encouraging innovation.

The drafting of this specification is the outcome of a collaborative effort between the Building Technology Research Institute and The Hong Kong University of Science and Technology. Contributions from the following organizations are gratefully acknowledged (in alphabetical order):

(a) Governmental Organizations / Industry Associations / Institutes

- Architectural Services Department, Government of the HKSAR
- Development Bureau, Government of the HKSAR
- Hong Kong Center for Construction Robotics
- Hong Kong Construction Association
- Hong Kong Construction Robotics Technology Society
- Hong Kong Construction Sub-Contractors Association
- Hong Kong General Building Contractors Association
- Hong Kong Housing Authority
- Hong Kong Institute of Construction
- Hong Kong Institution of Engineers
- Labour Department, Government of the HKSAR
- Occupational Safety and Health Council
- The Construction Industry Council
- The Hong Kong Polytechnic University
- The Hong Kong University of Science and Technology
- The Real Estate Developers Association of Hong Kong
- The University of Hong Kong

(b) Corporates

- Beijing Fangshi Robotics Co., Ltd.
- Bright Dream Robotics Co., Ltd.
- Hangzhou Fulltime Robotics Co., Ltd.
- Shanghai Weibuild Technology Co., Ltd.
- Shenzhen DaFang Intelligent Technology Co., Ltd.
- Shenzhen Legend Robot Technology Co., Ltd.
- VHSoft Technologies Co., Ltd.

The feedback from the aforementioned organizations is instrumental in shaping both the standards and the procedures outlined in this specification.

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The Hong Kong University of Science and Technology

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1 Overview

1.1 On top of statutory and contract requirements applicable to construction plant, machinery, electrical equipment and finishing works, this specification sets out minimum requirements for safe, repeatable and verifiable operation of Construction Painting Robots on construction sites.

1.2 The specification covers product capability, site deployment, Operating Modes, performance, safety functions, environmental controls, electrical and battery safety, Operator competence, site acceptance, inspection, maintenance and records.

1.3 This specification establishes a two-tier compliance framework:

(a) **Essential Requirements**: Mandatory requirements that shall be enforced through inspections, compliance checking and quality assurance.

(b) **Best Practices**: Recommended measures that can enhance system performance.

2 Extent of Application

2.1 This specification applies to Construction Painting Robots adopted for on-site construction in Hong Kong, for surfaces including but not limited to walls, ceilings and other Vendor-declared reachable areas, using water-based paint materials such as emulsion paint and acrylic paint.

2.2 This specification applies to mobile or relocatable Construction Painting Robots operating with Remote-Controlled Operation, Semi-Automated Operation, Automatic Operation or Self-Navigation within the Vendor-declared Operating Modes.

2.3 The specification applies to Paint Spraying Robots, Putty Spraying Robots, Putty Grinding Robots and multi-functional Construction Painting Robots that combine more than one of these functions.

3 Effective Date

3.1 This specification shall take immediate effect.

3.2 The specification shall be reviewed and revised from time to time upon technological advancement or regulatory amendment in the future.

4 Effect on Existing Specifications

4.1 This specification shall be read in conjunction with applicable Hong Kong legislation and standards listed in Section 8, contract documents, project specifications, approved quality acceptance criteria and manufacturer instructions.

4.2 This specification does not reduce any statutory duty. Where requirements conflict, applicable statutory requirements and any stricter contract, system, safety or manufacturer requirement shall take precedence.

5 Introduction

5.1 Traditional construction painting works expose workers to repetitive strain, dust and respirable silica, noise and hand-arm vibration. These exposures worsen fatigue, reduce situational awareness and increase musculoskeletal and respiratory risks.

5.2 Construction Painting Robots mechanize or automate part of the painting/spraying/grinding tasks, reducing worker exposure to hazards and improving surface finishing consistency.

5.3 Vendors offer different robot designs, operating methods and automation levels. This specification provides a common basis for evaluating and comparing these systems and sets out the technical and safety requirements for their safe and effective deployment and operation.

6 Terms and Definitions

No.	Term	Definition
6.1	Automatic Operation	Operation in which the robot carries out a defined movement or painting/spraying/grinding sequence automatically within stated Operating Limits after an authorized start.
6.2	BIM Compatible	Capable of receiving or using painting/spraying/grinding task data from a BIM-based project workflow through a documented interface, file exchange or conversion method.
6.3	Client	Project owner or its appointed representative responsible for defining project acceptance requirements and accepting the robot for project use.
6.4	Construction Painting Robots	Robotic or automated machine system used to perform different stages of surface finishing work, including paint spraying, putty spraying and putty grinding, with materials the system is declared capable of, with or without remote-control or mobile functions.
6.5	End Effector	Process tool, mechanism or module mounted on the robot to perform paint/putty spraying, grinding or related finishing works.
6.6	Exclusion Zone	A defined area from which personnel and obstacles shall be excluded during Automatic Operation.
6.7	Hazard Zone	Area in or around the robot where a person may be exposed to a hazard from robot movement, painting/spraying/grinding, movable tools, falling objects, dust or other work activities.

No.	Term	Definition
6.8	Manual or Local Control	Direct control at or near the robot used for set-up, jogging, teaching, maintenance or recovery. It is not a production painting/spraying/grinding mode under this specification.
6.9	Operating Limits	Declared limits for materials, painting/spraying/grinding tasks, reach, speed, load, floor conditions, clearances, environment and power.
6.10	Operating Mode	Selected method by which the robot's movement and painting/spraying/grinding operations are controlled.
6.11	Operating Zone	Area in which the robot moves, positions itself or carries out painting/spraying/grinding works.
6.12	Operator	Trained, competent and authorized person controlling or supervising the robot.
6.13	Operator Interface	Human-machine interface through which an Operator monitors, configures or controls robot tasks and operations.
6.14	Paint Spraying Robot	Construction robot used for automatic or semi-automatic spraying of approved water-based paint, primer, coating or another declared compatible finishing material on construction surfaces.
6.15	Powered Travel	Movement of the robot base under its own power, including travel, turning and repositioning.
6.16	Pre-Operation (PO) Check	Recorded site checks, demonstrations, measurements and evidence review confirming applicable requirements before routine project use.

No.	Term	Definition
6.17	Productivity	Actual processed area divided by the actual processing time under the declared operating conditions. It is the quantitative indicator of robot work efficiency. Actual processing time is the sum of the recorded cycle times for those processed surfaces.
6.18	Purchaser	Contractor, subcontractor, buyer or deploying party responsible for deployment, Operating Zone preparation, site services and safe working arrangements.
6.19	Putty Grinding Robot	Construction robot used for automatic or semi-automatic grinding or sanding of dried putty surfaces.
6.20	Putty Spraying Robot	Construction robot used for automatic or semi-automatic application of putty materials on construction surfaces, excluding use for plastering.
6.21	Remote-Controlled Operation	Operation in which the Operator continuously controls robot movement or a painting/spraying/grinding function from a separate control device or location.
6.22	Robot Configuration	Configuration used for assessment, including robot model and serial number, software or firmware, Operating Mode, tooling, sensors, positioning equipment, dust controls and power arrangement.
6.23	Safe State	Condition in which hazardous robot movement or painting/spraying/grinding is stopped or otherwise controlled such that the identified risk is reduced to an acceptable level.
6.24	Safe-Working Procedure	Documented site-specific instructions provided by the Purchaser, based on the risk assessment, for carrying out the robot’s site activities safely.

No.	Term	Definition
6.25	Self-Navigation	Mobile operation in which the robot travels to a selected location without continuous steering by the Operator.
6.26	Semi-Automated Operation	Operation in which the Operator initiates, authorizes or performs part of the task and the robot automatically performs a defined part of the movement or process sequence.
6.27	Vendor	Supplier, manufacturer or authorized representative responsible for the robot system and the technical information, evidence, instructions, training or support required by this specification.

7 Technical Specification for Construction Painting Robots

Section 7 sets out the technical requirements. **Annex A** provides supporting checks and verification methods, and **Annex B** outlines the deployment workflow. The annexes do not add to or override the requirements in the main clauses. **Section 8** lists the normative references.

7.1 General Requirements

Essential Requirements

Scope and Vendor Obligations

7.1.1 The robot shall be suitable for its declared construction painting/spraying/grinding uses and operated in the accepted configuration within its Operating Limits. The Vendor shall provide product information and evidence demonstrating compliance.

7.1.2 The Vendor shall identify all system equipment and any other equipment needed for safe painting/spraying/grinding, including the base or platform where provided, positioning mechanism, tooling, dust-control equipment, sensors, Operator Interface, power equipment and safety devices.

7.1.3 The Vendor shall declare intended and excluded uses, supported painting/spraying/grinding functions, supported types of process materials and orientations (including floor, wall, ceiling/overhead, angled and curved surfaces), safe maximum operational reach of the robot arm, operating range, dynamic reactive forces from the nozzles, power requirements, site conditions and other Operating Limits. The Client shall define project-specific requirements before procurement or the Pre-Operation (PO) Check.

Safety-Related Design and Risk Controls

7.1.4 The Vendor shall provide a documented risk assessment using ISO 12100 as guidance for hazard identification, risk assessment and risk reduction. The assessment shall address hazards and risks affecting the Operator’s safety and health, the Operating Zone and its surroundings during transport, set-up, movement, painting/spraying/grinding, tool change, cleaning, maintenance, disassembly and foreseeable abnormal conditions.

7.1.5 Before operation, all parts, guards, covers, fasteners, hoses, cables and connectors shall be securely installed and connected, with no visible deformation, cracks, corrosion, leakage, missing or loose components or damaged edges affecting safe operation, painting/spraying/grinding accuracy or any declared function. Fixed or movable guards shall prevent exposure to hazards during normal operation and foreseeable intervention, including at shafts, gears, drive belts or linkages. Grinding-disc and End Effector guarding shall comply with 7.7.7.

7.1.6 Where the system includes an industrial robot or manipulator within the scope of ISO 10218-1, in particular Sections 4 and 5, the Vendor shall provide evidence addressing the applicable requirements for it and its controller. Mobile-platform hazards shall be risk-assessed separately.

7.1.7 Safety-related control functions shall achieve the performance required by the risk assessment. The Vendor shall provide configuration-matched conformity, test or validation evidence for these functions.

Residual Risks

7.1.8 The Vendor shall identify residual risks, restrictions and site controls needed for safe use in the instructions supplied with the robot.

Best Practices

7.1.9 Where relevant to the supplied robot application, integration verification against applicable principles of ISO 10218-2 should be provided.

7.2 Hardware and Performance

Essential Requirements

Capability and Material Monitoring

7.2.1 The Vendor shall state supported painting/spraying/grinding operations and materials. The robot shall be able to perform specific operations for walls and ceilings, including paint spraying, putty spraying, scraping or grinding. The robot shall be able to process surfaces of height at least 3.2 m above the floor, or such other height as limited by any headroom requirement stated by the Purchaser.

7.2.2 Spray guns, nozzles, hoses, grinding discs and holders shall be suitable for the task, compatible with the robot and approved materials, and securely retained during operation. Damaged, blocked, excessively worn or unsuitable End Effector parts shall be removed from service.

7.2.3 For the Paint Spraying Robot and Putty Spraying Robot, the Vendor shall state the capacity of the paint/putty material feeding bucket of the robot. The remaining amount of paint/putty material in the bucket shall be automatically monitored and displayed on the Operator Interface.

7.2.4 The Putty Grinding Robot shall have a dust storage system with dust suction and collection functions. Where applicable, the Vendor shall state the storage capacity of such system. The amount of dust collected shall be automatically monitored and displayed on the Operator Interface, and the robot shall automatically cease grinding when such dust storage system is full or cannot operate normally.

Anomaly Detection and Response

7.2.5 The robot shall detect abnormal process conditions, including spray-gun blockage, spray-pressure loss/leakage and dust-collection failure, by a validated method.

7.2.6 Detection of an abnormal process condition under 7.2.5 shall trigger the safety response under 7.3.10. Restart shall require Operator assessment and deliberate authorized action under 7.7.3.

7.2.7 The Putty Spraying Robot shall issue low-material warnings when the remaining putty material falls below 20 L or its equivalent mass measured for the material container. When such balance falls below 5 L or its equivalent mass, the robot shall issue alarm signal and automatically stop its operation.

7.2.8 The Putty Grinding Robot shall issue full-storage warnings and automatically cease its operations when its dust storage system is full, under 7.2.4.

Best Practices

7.2.9 Where automatic tool changing is provided, secure tool engagement and the failure response should be verified. A failed or incomplete tool change should prevent automatic painting/spraying/grinding until the condition is corrected.

7.3 Site Preparation and Robot Movement

Essential Requirements

Platform Data and Site Preparation

7.3.1 The Vendor shall state the robot dimensions, mass, required clearances, transport configuration and any floor-loading or stability limits relevant to site use. The robot shall be secured against unintended movement during transport.

7.3.2 Before deployment, the Purchaser shall check the access route and Operating Zone for floor capacity, clearances, headroom, openings, loose materials, cables and other hazards that may affect safe movement or stability. Both shall be kept tidy and adequately lit for safe movement, inspection and supervision.

7.3.3 Where deployment involves work in a confined space within the scope of Cap. 59AE, the Purchaser shall ensure that applicable requirements of the Factories and Industrial Undertakings (Confined Spaces) Regulation and the Labour Department Code of Practice for Safety and Health at Work in Confined Spaces are met.

7.3.4 The Operating Zone for painting/spraying/grinding and traveling shall have an inclination below 1:10 and no step or level difference exceeding 20 mm. Any stricter Vendor limit shall apply. For robots capable of Powered Travel, the Vendor shall declare the rated travel gradient and obstacle-crossing capability, including load, speed, direction and surface conditions.

Stability and Access

7.3.5 The robot shall remain stable in all operating conditions and travelling movements, with any required stabilizers, outriggers or brakes correctly set before painting/spraying/grinding starts.

7.3.6 Whenever hazardous robot operation is enabled, the Purchaser shall maintain fully fenced, access-controlled Operating and Exclusion Zones covering the full operating range and foreseeable fall zone, with unobstructed access and egress. Conspicuous signs around the zones shall identify the Operating Zone and robot operation in simple Traditional Chinese, English and other languages understood by affected workers where required. The site layout and emergency escape route shall be displayed where applicable.

7.3.7 The robot shall be able to pass through the doorways and different Operating Zones identified in the site-specific requirements.

7.3.8 A bridge platform or ramp shall be provided and secured for the robot to pass through door entrances of rooms and lifts as necessary. Such platform or ramp shall be sufficiently wide for the robot to move safely, and shall not modify, obstruct or damage any components of the lift.

7.3.9 For inter-floor or inter-level robot transport by lift, hoist or other lifting equipment, the Purchaser shall confirm suitability for the robot mass and dimensions, use within certified or stated capacity, and compliance with applicable legal requirements.

Abnormality Protection and Powered-Travel Safety

7.3.10 Abnormality sensing and protection shall remain active in all Operating Modes and set-up modes whenever the associated hazard can arise. A detected safety-affecting fault or abnormality shall trigger an Operator warning and automatic stopping of the affected hazardous movement or operation, or another validated Safe State, without creating a further hazard.

7.3.11 Powered Travel shall remain within the Vendor-declared speed and protective separation limits from persons, obstacles and surfaces for the accepted configuration. Transport and operating speeds shall be stated separately where different. Under different travel modes:

(a) **Remote-controlled travel**: The Operator shall control travel in accordance with 7.4.4 and stop before unsafe contact or breach of the declared protective separation limits. Proximity sensing and Operator warning are Best Practices under 7.4.7.

(b) **Automatic Powered Travel (Self-Navigation and other travel continuing without hold-to-run control)**: Detection of a person or obstacle by the non-contact protective sensing under 7.4.5 shall trigger automatic stopping of hazardous movement before unsafe contact or breach of the declared protective separation limits. Applicable ISO 3691-4 protective stopping requirements shall be verified where the mobile platform is within its scope.

7.3.12 The following braking, stopping and stability requirements shall apply:

(a) A robot with Powered Travel shall have a braking system or equivalent function to slow, stop and hold or restrain it under the accepted configuration, load, route and surface conditions.

(b) Applicable stops under 7.3.10, 7.3.11 and 7.4.4 and manual emergency stopping shall meet the stopping-distance and stopping-time limits under those conditions. The Vendor shall declare these limits and verify compliance at the PO Check.

(c) Powered-Travel tests shall use suitable test objects, while people shall not be used as collision targets.

(d) The robot shall remain stable during Powered Travel, positioning, painting/spraying/grinding and protective or emergency stopping, including under foreseeable reaction forces. Stability-related Operating Limits shall be declared and verified for the accepted configuration.

<u>Best Practices</u>

7.3.13 Where permitted by the Vendor, the robot should be transported in its normal upright position, without dismantling, re-assembly, lying down, abnormal tilting or removal of any of its components. The Purchaser should provide a construction lift with adequate size and headroom to accommodate such transport of the robot in its normal upright position.

7.4 Operating Modes and Supervision

Essential Requirements

Operating Arrangements and Supervision

7.4.1 The following operating and supervision requirements shall apply:

(a) The Vendor shall declare travel, positioning and painting/spraying/grinding arrangements, including the controls, functions and supervision for each.

(b) The robot shall support at least one accepted remote-controlled or automatic painting/spraying/grinding workflow with required safety functions active.

(c) During Powered Travel, positioning or painting/spraying/grinding, the Operator shall continuously supervise the robot and be able to stop hazardous movement or painting/spraying/grinding operation immediately.

(d) Only one Operating Mode shall be active at a time. Mode selection shall use a lockable selector or equivalent authorized access control and shall not initiate hazardous movement.

7.4.2 Manual or Local Control shall be limited to set-up, jogging, teaching, maintenance or recovery, not production painting/spraying/grinding. Moving a non-powered robot base manually or by separate site equipment before operation does not constitute Powered Travel.

7.4.3 Fully Automated Operation: Where the robot uses Self-Navigation or automatic positioning and performs an authorized automatic painting/spraying/grinding sequence, the common supervision requirements in 7.4.1 shall apply.

7.4.4 Semi-Automated Operation with remote-controlled setup: During Powered Travel, the Operator shall be on the same floor as the robot, keep the robot in clear view and hold the travel control continuously (hold-to-run). Travel shall stop when the control is released or control communication is lost.

Powered-Travel Sensing and Safety Response

7.4.5 During automatic Powered Travel, the robot shall have active non-contact protective sensing to detect persons and obstacles. The Vendor shall declare sensing range, coverage, field of view and limitations. Abnormality and automatic protective-stopping responses shall comply with 7.3.10 and 7.3.11 respectively. This travel-sensing requirement does not apply to robots without Powered Travel or to remote-controlled travel under continuous Operator supervision and hold-to-run control in accordance with 7.4.4. For remote-controlled travel, this exemption shall be supported by the risk assessment under 7.1.4 and shall not waive the separation and stopping requirements in 7.3.11 and 7.3.12.

Best Practices

7.4.6 Automatic route replanning, where provided, should be verified at the Pre-Operation (PO) Check by a functional demonstration involving the Operator, with Vendor support, under the Vendor-declared operating conditions. Representative scenarios should include obstacle avoidance, work-sequence changes and site-condition changes, as applicable. For robots with Self-Navigation, navigation performance may be tested using applicable methods in ISO 18646-2 or GB/T 38834.2.

7.4.7 For remote-controlled Powered Travel, the robot should have active non-contact proximity sensing to detect persons and obstacles and warn the Operator. The Vendor should declare sensing range, coverage, field of view and limitations.

7.5 Operator Interface and Control

Essential Requirements

Operator Interface and Control

7.5.1 The robot shall be equipped with a controller which allows Operators to identify the robot's operational data on the Operator Interface, including its Operating Mode, battery level, operation start/end times, position coordinates, planned area, processed area, fault events, warnings, alarms and stop conditions. The remaining amount of paint/putty material, End Effector speed, spraying/grinding pressure and speed shall also be available to the Operator. The robot shall perform power-on self-diagnostics and issue a warning to the Operator upon detection of any system fault.

7.5.2 The Operator Interface shall allow the Operator to review and approve a configured task before execution, for example using a confirmation control. Automatic painting/spraying/grinding or automatic Powered Travel shall start only after an authorized Operator confirms the task and deliberately initiates operation. Restart shall comply with 7.7.3. Operating commands shall be accepted from a single active point of control at a time. All required emergency-stop controls shall remain effective.

7.5.3 Emergency-stop controls and functions shall meet the following requirements:

(a) The robot shall have clearly visible, readily identifiable and readily accessible emergency-stop controls at the active remote controller, where provided, and at least one on the robot.
(b) The emergency-stop function shall be designed for controlled stopping to Stop Category 1 under ISO 13850 or GB/T 16754.
(c) The safety-related control system implementing this function shall achieve Performance Level (PL) c or higher under ISO 13849-1, unless the risk assessment requires a higher Performance Level (PLr).
(d) A manual emergency stop during Powered Travel shall meet the Vendor-declared stopping performance under 7.3.12.

Network Access

7.5.4 The controller shall support authorized access over the Internet. The Vendor shall state how the connection is enabled, disabled and access-controlled. Loss of the external network connection shall not disable required safety functions.

7.5.5 Network access, remote-control commands, safety settings and operational logs shall be protected against unauthorized access or changes through role-based permissions or equivalent access controls. Access permissions shall not allow required safety functions to be bypassed.

Best Practices

7.5.6 Where remote diagnostics, remote software support or automatic data transfer is provided, access should be authorized, logged where practicable and limited to the intended support or data function.

7.5.7 The Operator Interface of the controller device should support language displays in Traditional Chinese and English.

7.5.8 Where recovery of an interrupted painting/spraying/grinding task is supported, the system should identify completed and outstanding surfaces or task steps before the Operator approves resumption. Resumption should require Operator review and deliberate authorization in accordance with 7.5.2 and 7.7.3.

7.5.9 The robot should be able to automatically navigate the surrounding site environment, with sensors such as LiDAR or cameras to generate a comprehensive map for its navigation and path planning during actual operation on site.

7.6 Positioning and Accuracy

Essential Requirements

Painting/Spraying/Grinding Task Data

7.6.1 Each working surface shall have Client-approved task data before painting/spraying/grinding. Such task data shall include the required areas, sequence and materials where specified. Changes shall be approved and recorded.

7.6.2 The robot shall be able to follow a pre-set travel path with positioning accuracy as declared by the Vendor. The Vendor shall submit proof documents and perform an on-site operation test of the robot to verify its claimed performance, including path repeatability, accuracy in positioning and orientation, and consistency of End Effector speed during operations.

7.6.3 Quality of the materials and finished surfaces, including dimensional tolerance, surface flatness, film thickness and adhesion strength, shall comply with project-specific requirements and acceptance standards stated by the Client, such as the General Specification for Building of Architectural Services Department or Specification Library of Hong Kong Housing Authority.

7.6.4 Automatic Operation shall be prevented when the required task data are missing or invalid. The system shall give the Operator a clear warning or message.

Positioning and Accuracy

7.6.5 Before the PO Check, the number and distribution of test surfaces shall be agreed to cover the project positions, painting/spraying/grinding task data and operating range being accepted. A single test surface shall not be the sole basis for acceptance.

7.6.6 The Vendor shall state the positioning/localization method and its operating limitations. Where sensors are used (such as LiDAR, cameras, inertial measurement units or others used for obstacle avoidance), the Vendor shall declare their functional specification, including but not limited to the sensing range, field of view and required lighting condition.

BIM Compatibility

7.6.7 The robot shall be BIM Compatible, and the Vendor shall state the interface, file-exchange or conversion method used to receive or use the task data from the project BIM workflow. Before automatic execution, the Operator shall be able to review and approve the active task data and any imported or generated maps, routes or painting/spraying/grinding sequence. For robots with Self-Navigation, the Operator shall be able to define or confirm Operating Zones and Exclusion Zones, start and end points, and the work sequence.

Best Practices

7.6.8 Where digital task data are used, the system should identify the active data set or revision before painting/spraying/grinding starts.

7.6.9 The Operator Interface should support import of BIM models, CAD drawings or site floor plans in formats supported by the robot, allowing Operators to conduct map-based navigation and path planning of the robot via the Operator Interface.

7.6.10 The robot should be able to utilize on-site environmental sensing/scanning to maintain a 3D digital twin model that visualizes the robot's operating statuses, including its real-time spatial location, processing progress and travel path where applicable.

7.7 Operational Safety and Health

Essential Requirements

Emergency Stop Function

7.7.1 The emergency-stop function shall stop hazardous robot and painting/spraying/grinding motion as quickly as practicable without creating a further hazard. Resetting the emergency stop shall not start movement or operation.

Anomaly Response and Restart Prevention

7.7.2 Abnormality sensing and protection shall comply with 7.3.10. The Vendor shall identify relevant safety-affecting system abnormalities through the risk assessment under 7.1.4, including the applicable conditions listed in 7.7.4.

7.7.3 After an emergency stop, protective stop, power interruption, communication loss or critical fault, hazardous operations shall not restart automatically. Such restart shall require deliberate authorized action after the hazard or fault condition has been cleared. Safety-critical control communication shall be monitored continuously, with loss beyond the Vendor-declared timeout established by the risk assessment triggering the applicable safe response.

7.7.4 A visual operation indication perceptible to the Operator and persons in or approaching the controlled Operating Zone shall be issued when powered movement or painting/spraying/grinding is in progress. Audible and visual alarm devices, such as flashing lights, shall warn the Operator and persons in or around the controlled Operating Zone of abnormal conditions. The required safety responses under 7.3.10 and power or battery conditions under 7.8.4 shall be complied with. Abnormal conditions include, but are not limited to:

(a) Collision with surrounding obstacles or unbalanced motion.
(b) Power interruption or loss of control communication signal.
(c) Critical safety-sensor fault, LiDAR fault, navigation or positioning error.
(d) Movement-related faults, such as steering, braking, control or protective-stopping faults, or movement outside the specified Operating Zone.

(e) Motor overload.
(f) Overspeed.
(g) Manipulator fault.
(h) End Effector fault.
(i) Spray-gun blockage.
(j) Spray-pressure loss or leakage.
(k) Full dust storage system.
(l) Battery or charger fault, or overtemperature.
(m) Low battery level.

Fault Response and Verification

7.7.5 The Vendor shall state in the operation instructions the required response to relevant faults and abnormal conditions, including when to stop, isolate, inspect, reset or service the robot.

7.7.6 Where faults cannot be safely induced on site, the corresponding safety functions shall be verified by suitable simulation, safe functional demonstration, configuration-matched test or validation evidence. Laboratory IP, battery-abuse and environmental-chamber tests shall not be repeated on site.

7.7.7 The following protective measures shall apply:

(a) **Robot-arm contact protection**: The robot shall be equipped with appropriate contact-sensing protective devices installed on the robot arm, manipulator and End Effector to protect against collision, crushing and trapping hazards, in accordance with ISO 10218-1 where applicable. Upon detecting contact with an obstacle, the robot shall issue visual and audible warnings under 7.7.4, automatically stop all robot movement and operations, and enter a Safe State under 7.3.10.
(b) **Rotating-part guarding**: Reachable rotating grinding parts shall be guarded during operation. Where such guarding is impracticable, a validated protective measure or risk-assessed controlled Exclusion Zone shall prevent access and provide equivalent protection under applicable machinery-guarding requirements.
(c) **Movable-part guarding**: Appropriate safety measures, such as interlocks of movable guards, shall be implemented to avoid loosening or ejection of grinding discs and other components during operations or sudden stops.

7.7.8 Smoking shall be strictly prohibited throughout the construction site and spraying area. Any naked flame shall be strictly prohibited inside and within 6 meters of the Operating Zone involving spraying operations, in accordance with Section 4 of A Guide to the Factories and Industrial Undertakings (Spraying of Flammable Liquids) Regulations.

7.7.9 The Purchaser shall provide appropriate fire-fighting equipment such as fire hoses, fire extinguishers, fire blankets and sprinkler systems on site. The types and quantities of fire extinguishing appliances shall comply with Clause 4.8 of A Guide to the Factories and Industrial Undertakings (Spraying of Flammable Liquids) Regulations.

Best Practices

7.7.10 The robot should issue audible alarms to the Operator and persons in or approaching the controlled Operating Zone during its operations. Routine operating sound may be omitted in a fully fenced, access-controlled Operating Zone where the risk assessment and applicable requirements permit. Required abnormal-condition alarms under 7.7.4 shall remain effective.

7.7.11 When human workers and robots are in the same Operating Zone, the robot should implement safety functions, such as speed and separation monitoring, power and force limiting, to ensure a safe collaborative working environment alongside on-site personnel.

7.8 Power Supply, Electrical Safety, Battery and Charging

Essential Requirements

Power Supply and Electrical Protection

7.8.1 The Vendor shall state the power-supply arrangement and, as applicable, rated voltage, current or power, required earthing or protective conductor arrangement, battery type and voltage, approved charger and Operating Limits.

7.8.2 The electrical equipment of the robot shall comply with the applicable requirements of IEC 60204-1 or GB/T 5226.1 for the supplied configuration:

(a) Hazardous live parts shall be protected against accidental contact.
(b) Accessible conductive parts that could become live under a fault shall have protective bonding or equivalent fault protection.
(c) Suitable isolation, overcurrent protection and, where applicable, residual-current protection shall be provided for operating and charging modes.

7.8.3 For lithium cells or batteries:

(a) Rechargeable lithium cells or batteries within the scope of IEC 62619 shall meet its applicable safety requirements, supported by configuration-matched test or certification evidence from the Vendor.
(b) For lithium cells or batteries transported separately, packed with or contained in the robot, the Vendor shall provide the applicable UN 38.3 test summary for each tested cell or battery type, including the required manufacturer and test-laboratory particulars, together with transport classification, state-of-charge and packaging evidence applicable to the mode of transport.

Battery Safety and Status

7.8.4 Battery-powered robots shall issue a low-battery warning when the remaining battery capacity reaches 20% or earlier, to allow the robot to enter a Safe State before the power is exhausted. Low battery, battery or charger fault, overtemperature and impending power loss shall trigger the defined safe response before hazardous control is lost, with safety-affecting conditions handled under 7.3.10.

7.8.5 External power cables, plugs, connectors and charging equipment shall suit the supply and site conditions and shall be arranged to prevent electrical and trip hazards, water exposure and physical damage.

Cables and Charging

7.8.6 Charging arrangements shall meet the following requirements:

(a) Charging shall use the approved charger and Vendor-stated procedure in a location suitable for the site conditions.
(b) Where electrical installation work is required for the charging facility, it shall comply with the Electricity Ordinance (Cap. 406) and subsidiary regulations and be undertaken by a Registered Electrical Contractor (REC) and a Registered Electrical Worker (REW) as required by law.
(c) Site-supply and charging installations within the scope of the EMSD Code of Practice for the Electricity (Wiring) Regulations shall comply with its applicable provisions, including Code 26K for construction or demolition works.

<u>Best Practices</u>

7.8.7 Where battery-powered, the robot should provide at least 4 hours of battery endurance without recharging under a declared representative duty cycle.

7.8.8 The Vendor should provide an electromagnetic compatibility (EMC) test report or conformity evidence appropriate to the declared site environment and supplied configuration. Where relevant, evidence should cover immunity and emissions under applicable product standards or generic standards such as IEC 61000-6-2 and IEC 61000-6-4, and demonstrate that foreseeable electromagnetic disturbance does not impair required safety functions or cause hazardous unintended operation.

7.9 Environmental and Worker Protection

Essential Requirements

Dust and Noise

7.9.1 Dust shall be controlled throughout painting/spraying/grinding at, or as close as practicable to, the active working surface. Control measures shall use suitably positioned and maintained dust collection, local extraction, wet suppression or another validated method suitable for the task. Where container, bag or filter condition can reduce effectiveness, the system or work procedure shall identify servicing needs before effective dust control is lost. To prevent the inhalation of dust by the workers, regular cleaning and maintenance schedule for air filters, dust collection container, bag or filter shall be established and implemented to ensure the effectiveness of the associated ventilation system and the provision of adequate ventilation at the site. Protection of motorized paint mixer and workers shall comply with the Hong Kong Legislation such as Cap. 509, Cap. 59 and their subsidiary regulations, Cap. 95, Cap. 406, and Guidance Notes on Paint Spraying and Related Coating Processes.

7.9.2 Where painting/spraying/grinding may expose workers or Operators to respirable silica or another hazardous air impurity, the work method and site controls shall comply with the current Hong Kong occupational exposure requirements such as the Occupational Exposure Limits. For details, refer to the Code of Practice on Control of Air Impurities (Chemical Substances) in the Workplace. Specialist workplace monitoring shall be arranged where required by the risk assessment including the assessment of risks to health of workers and monitoring exposure or project. Based on the assessment and monitoring results, appropriate measures shall be taken to prevent and control air impurities in the workplace.

7.9.3 Operators and other personnel entering the Operating Zone shall wear suitable personal protective equipment, including but not limited to protection of eyes, ears and respiratory systems, as required by statutory duties or site rules.

7.9.4 The Vendor shall provide noise information for representative painting/spraying/grinding and state the measurement conditions. Workplace noise exposure shall be assessed and controlled under the Factories and Industrial Undertakings (Noise at Work) Regulation (Cap. 59T). Suitable hearing protection shall be used where required by statutory duties or site rules.

Environmental Limits and Ingress Protection

7.9.5 The Vendor shall declare, with supporting manufacturer data or test evidence, the environmental limits for operation, storage and, where applicable, charging, including ambient temperature, relative humidity and altitude. Differences between these limits shall be stated separately, together with applicable storage duration, battery state of charge and maintenance conditions.

7.9.6 Painting/spraying/grinding tools shall be suitable for the specified site conditions and comply with the applicable electrical-safety requirements in Section 7.8 and the project specifications.

7.9.7 The robot shall not be operated in an explosion-risk environment unless the Vendor provides explosion-proof certification under IEC 60079, through an IECEx Certificate of Conformity for Explosive Atmosphere or flameproof reports certifying the robot's enclosure and electrical parts.

7.9.8 The paint and putty materials shall be non-flammable, of the type, brand and color approved by the Client, and supplied in sealed containers each labeled with the supplier’s name and details, manufacturer label, printed instructions, batch number, date of manufacture, expiry date, shelf life and color code, where applicable.

7.9.9 The Purchaser shall obtain documentary proof to indicate the materials’ compliance with the maximum limits of volatile organic compound content specified in Parts 2, 3 and 4 of Schedule 1 of the Air Pollution Control (Volatile Organic Compounds) Regulation (Cap. 311W). The paint and any thinner used shall contain no more than 0.01% by wet weight of formaldehyde.

7.9.10 The Operating Zone shall be kept dry and clean, with appropriate mechanical ventilation facilities to supply fresh air and remove accumulated paint mist and vapor.

Best Practices

7.9.11 The robot's components, including electronic control cabinets, battery packs, motors, manipulators, robotic arms and End Effectors, should have at least IP54 protection rating in accordance with IEC 60529 or GB/T 4208.

7.9.12 The robot should possess a dust filtration function to prevent the ingress of dust or other particles that could cause robot equipment malfunction.

7.9.13 The robot should be equipped with suitable filters with appropriate filtration effectiveness, such as Group H HEPA filters (H13/14) complying with BS EN 1822-1, to capture hazardous dust and prevent on-site personnel from inhaling airborne contaminants.

7.9.14 The wastewater or contaminated materials generated should be properly disposed of in a designated storage or treatment area on site.

7.10 Inspection and Maintenance

Essential Requirements

Pre-Delivery Inspection

7.10.1 Before delivery of the robot to site, the Purchaser shall confirm project requirements and robot suitability, and provide:

(a) A documented site-specific risk assessment identifying potential safety hazards and risks to the Operator and the surrounding of the Operating Zone, following the risk-assessment and risk-reduction principles of ISO 12100, and the applicable industrial-robot requirements of ISO 10218-1 where relevant.
(b) A Safe-Working Procedure based on the site-specific risk assessment and the Vendor's instructions, covering arrival, unloading, site movement, set-up, operation, maintenance, dismantling, removal and emergency response, with reference to Annex B.

The documents shall be reviewed and updated as necessary after changes affecting safety.

7.10.2 Before delivery, the Vendor shall check the proposed robot configuration, required safety functions and conformity documents and provide the evidence needed for the Purchaser to confirm transport and site arrangements, with reference to the pre-delivery (PD) checklist in Annex A.1.

Pre-Operation Inspection

7.10.3 Before the PO Check, the Purchaser shall confirm site readiness and implementation of the controls under 7.10.1, including safe access, Operating Zone controls, robot set-up and briefing of relevant personnel.

7.10.4 Before routine project use:

(a) The Operator shall conduct the PO Check of the delivered and installed robot using Annex A.2, with Vendor support for model-specific tests. Specialist checks or measurements, where needed, shall be performed by persons competent for the relevant work.
(b) The Purchaser shall organize site arrangements and checks.
(c) The Client shall define project-specific acceptance criteria and accept the recorded results only after failed requirements are corrected and re-tested.

Pre-Use Inspection

7.10.5 The Operator shall conduct the pre-use (PU) check of the robot and Operating Zone before each shift or use, and after relocation to another Operating Zone, material site-condition changes or any event that may affect painting/spraying/grinding performance or a safety function, following the Vendor instructions, Safe-Working Procedure under 7.10.1 and Annex A.3. Failed items shall be corrected and affected functions re-tested before use.

Inspection During Operation and Maintenance

7.10.6 The robot shall be inspected and maintained in accordance with the methods and intervals specified in the Vendor maintenance instructions. The Purchaser shall arrange the required inspections and maintenance. Following an event that may affect safety or painting/spraying/grinding accuracy, the affected functions shall be checked before further use.

7.10.7 Safety devices, measurement equipment and accuracy-related functions shall be checked or calibrated where required by the maintenance instructions or acceptance method.

Post-Maintenance Inspection

7.10.8 After maintenance, repair or a change affecting safety or painting/spraying/grinding accuracy, the Operator shall verify the affected functions before return to service in accordance with the Vendor instructions and applicable checks in Annex A, covering safety-related controls, positioning and painting/spraying/grinding accuracy, tooling retention, protective sensing, guarding and electrical protection where affected.

Inspection of Finished Works

7.10.9 The Operator shall visually inspect the finished works and report to the Vendor for re-inspection of the robot upon any of the following conditions:

Paint Spraying Robots

(a) Insufficient paint film thickness, visible undercoat or overlapped paint film.
(b) Uneven distribution of paint film or paint color.
(c) Irregular appearance on the paint surface, such as weeping, cracks, gaps, runs, sagging, curtaining, lifting, blistering or creasing.
(d) Poor straightness of spray strokes.

Putty Spraying Robots

(a) Non-uniform or poorly bonded coating on the surfaces.
(b) Defects on the surfaces, such as missed coating, substrate show-through, peeling, blistering, hollowing, cracking, efflorescence or pinholes.

Putty Grinding Robots

(a) Unevenly or inconsistently ground surfaces.
(b) Defects on the surfaces, such as lap marks, missed areas, substrate show-through, loose powder or overlap steps.

7.11 Documentation and Data Security

Essential Requirements

Product and Project Documents

7.11.1 The following documentation requirements shall apply:

(a) The Vendor shall provide a technical file that identifies the robot model and serial number, system configuration, supported painting/spraying/grinding capability, dimensions and mass, operating range, power arrangement, software/firmware and Operating Limits.

(b) Controlled technical documents shall carry suitable identification, including title or reference, issue date and revision/version, to distinguish current and superseded issues.

7.11.2 The Vendor shall provide operation and maintenance instructions covering:

(a) **Handling and deployment**: Lifting, handling, transport, storage and set-up, including approved handling/lifting points and methods, securing of movable parts and tooling, transport configuration and applicable storage/environmental limits.

(b) **Operation and safety**: Operation, Operating Modes, safety functions, emergency response, tool change, dust control, power and charging.

(c) **Inspection and servicing**: Inspection, maintenance and fault recovery under 7.7.5.

(d) **Site conditions and support**: Required site conditions and resources, and emergency contact or support arrangements where applicable.

7.11.3 The robot shall carry a durable and legible identification or nameplate in a readily visible position that displays, as applicable, product name, model, unique serial or production number, manufacturer, year/date of manufacture and rated electrical information.

Records and Retention

7.11.4 Records shall cover the following, as applicable:

(a) Site-specific risk assessments and Safe-Working Procedures, PO Checks and re-tests, and pre-use checks.
(b) Training, refresher training, competency assessments, authorization and relevant operation history of the Operator.
(c) Inspections, maintenance, repairs, calibration and verification, including any engineering reports and manufacturer approvals obtained.
(d) Safety-related incidents and investigated stops.
(e) Approved changes affecting safety or painting/spraying/grinding performance.
(f) Project task data used for acceptance;
(g) A valid Certificate of Fitness for the pressure vessel (air receiver connected with an air compressing plant) used for spraying or grinding.

PO Check records shall identify the Robot Configuration, test conditions, results and evidence references.

7.11.5 Documents and records required by this specification shall be kept for a retention period of at least 3 years from project completion, unless law or contract requires longer.

7.11.6 Where operational data logs are generated, including records of material usage, robot status and operating time, such logs shall be retained for at least 30 days from creation and shall be exportable to TXT, CSV or another readable project-approved format.

As applicable, the logs shall include:

(a) Operating Mode, task start and end times, position or location reference.
(b) Usage of painting/spraying materials.
(c) Warnings, alarms, protective stops and faults.
(d) Operator-authorized restarts.

7.11.7 Records shall be protected against unintended alteration or loss and shall remain retrievable for the required retention period. For electronic records, access and changes shall be controlled and traceable.

Best Practices

7.11.8 Productivity and painting/spraying/grinding cycle time should be recorded during deployment where required by the Client. Productivity should be reported as the amount of surface area finished per hour (m^2/h), calculated from the sum of recorded painting/spraying/grinding cycle times under declared conditions.

7.11.9 Where electronic records or Robot Configuration data are needed for operation, acceptance or traceability, suitable backup and recovery arrangements should be provided. Restored safety-relevant settings and approved painting/spraying/grinding task data should be checked before Automatic Operation resumes.

7.12 Conformity Evidence

Essential Requirements

7.12.1 Conformity evidence shall meet the following requirements:

(a) The Vendor shall provide applicable safety, electrical, battery and environmental-protection evidence for the supplied configuration, using relevant test results, test-report extracts, declarations or other verifiable evidence.
(b) Any claimed or project-required IP rating shall also be supported by configuration-matched evidence. Where conformity or certification is claimed, the Vendor shall provide verifiable supporting evidence.
(c) Each evidence item shall identify the product, component or organization covered and, as applicable, its configuration, the relevant technical clause, referenced standard and scope.
(d) The same evidence may support several clauses where its scope is applicable.

Complete certificates or reports need not be submitted unless specifically required by this specification, applicable legislation or the contract.

7.12.2 For any radio transmitter within the State Radio Regulatory Commission (SRRC) type-approval scope, the Vendor shall submit a valid Radio Transmitting Equipment Type Approval Certificate for the radio components.

7.12.3 For radio transmitting equipment used in Hong Kong, the Vendor shall classify the equipment under the Hong Kong Telecommunications Equipment Evaluation and Certification (HKTEC) Scheme in OFCA I 421(24) Issue 8.

(a) For equipment under the Compulsory Certification Scheme, the Vendor shall obtain a certificate before marketing or use.
(b) For equipment under the Voluntary Certification Scheme, the Vendor shall submit an accredited test report/declaration and evidence of compliance with the Telecommunications Ordinance (Cap. 106).

7.12.4 Any pressure vessel and applicable components of the robot shall comply with the Boilers and Pressure Vessels Ordinance (Cap. 56), including but not limited to the examination and certification requirements in Sections 3, 7, 33 and 40.

Best Practices

7.12.5 For a robot or its component falling within the current CCC catalogue, the Vendor should submit evidence of valid CCC certification or completion of the applicable self-declaration route under CCC where that route remains permitted.

7.12.6 Where applicable, the robot should hold valid CR construction-robot certification of Mainland China under CR-1-08, together with the associated test report(s) to CR-1-08TS-01, CR-1-08TS-02 and CR-1-08TS-03, where relevant. The certificate should identify the exact model and scope and should be supported by the applicable CR technical-specification test reports.

7.12.7 Where applicable, the robot should bear CE marking, which is recognized in the European Economic Area market as a demonstration of compliance with applicable health, safety and environmental protection requirements. The Vendor should ensure that the manufacturer has completed the applicable conformity assessment, prepared the technical documentation, issued the applicable Declaration of Conformity and affixed CE marking.

7.12.8 The Vendor should hold a valid ISO 9001 Quality Management System Certificate issued by a certification body accredited for ISO 9001 certification, covering the Vendor's quality management system for its relevant product design, manufacture and supply activities.

7.13 Personnel Training

Essential Requirements

Operator Qualification and Trade Registration

7.13.1 The Operator shall meet the following qualification requirements:

(a) The Operator shall be trained and competent to operate the robot in accordance with the requirements for mechanical equipment under the Construction Sites (Safety) Regulations (Cap. 59I).
(b) The Operator shall hold valid construction-worker registration under the Construction Workers Registration Ordinance (Cap. 583), as required for the assigned work.
(c) The Operator shall hold a valid Semi-skilled Worker Certificate in Painter and Decorator under the Construction Workers Registration Ordinance (Cap. 583).

Training, Assessment and Retraining

7.13.2 The Operator shall have received at least 50 hours of model-specific training that covers theoretical and supervised practical instruction and a competence assessment under 7.13.3. Training shall cover the following aspects, including but not limited to:

Basic operational safety of Construction Painting Robots, including:

(a) Introduction to the robot system and Operating Modes.
(b) Pre-construction planning and deployment, preparation of the Operating Zone and Operating Limits.
(c) Safety regulations and risk management, emergency stops and safety functions, abnormal conditions and recovery.
(d) Dust and noise controls, power and charging, pre-use checks and maintenance boundaries.

Practical operation, quality control and acceptance of Construction Painting Robots, including:

(e) Full-process hands-on operation.
(f) Integrated use of positioning equipment, painting/spraying/grinding tools and dust-control equipment.
(g) Preparation and verification of task data, positioning and tooling.
(h) Quality inspection and acceptance requirements for working surfaces.

The Vendor or an authorized training party shall provide the training. Alternatively, such training can be provided under the Certificate in Robotic Painting Application offered by the Hong Kong Institute of Construction, or equivalent courses of at least the same duration covering the robot model, relevant Operating Modes and the above aspects.

7.13.3 The following assessment and authorization requirements shall apply:

(a) The Operator shall have passed a competence assessment based on the specific robot models provided by the Vendor, covering at least the relevant Operating Modes, theoretical knowledge and practical skills.
(b) The training record and assessment result shall be documented.
(c) Upon successful completion of such assessment, the Vendor or an authorized training party shall issue a valid certificate specifying the name of the Vendor, robot model and authorized Operating Modes.
(d) The Operator shall not independently operate the robot in an Operating Mode not covered by the completed training and authorization.

7.13.4 The Operator shall complete refresher training at appropriate intervals recommended by the Vendor or an authorized agent. Records of the Operator's relevant operation history shall be documented. The Purchaser shall ensure that the Operator is competent to control and operate the robot on site.

7.13.5 Before entering a confined space, the Operator and relevant personnel shall comply with the qualification requirements stated in the Factories and Industrial Undertakings (Confined Spaces) Regulation (Cap. 59AE), and hold a valid certificate where applicable to the duties being carried out.

8 Normative References

The documents below apply only as specified in the relevant clauses of this specification. For undated references, including ISO, IEC, GB and GB/T standards, the latest edition and amendments apply. For dated references, the cited edition applies unless legislation or the contract requires otherwise.

1. Air Pollution Control Ordinance (Cap. 311);
2. Air Pollution Control (Construction Dust) Regulation (Cap. 311R);
3. Air Pollution Control (Volatile Organic Compounds) Regulation (Cap. 311W);
4. Architectural Services Department - General Specification for Building;
5. ASTM C1860, Standard Test Methods for Measurement of Tensile Strength or Bond Strength of Portland Cement-Based Plaster by Direct Tension;
6. ASTM D562, Standard Test Method for Consistency of Paints Measuring Krebs Unit (KU) Viscosity Using a Stormer-Type Viscometer;
7. ASTM D2486, Standard Test Methods for Scrub Resistance of Wall Paints;
8. ASTM D4414, Standard Practice for Measurement of Wet Film Thickness by Notch Gages;
9. Boilers and Pressure Vessels Ordinance (Cap. 56);
10. BS EN 1015-11, Methods of test for mortar for masonry - Determination of flexural and compressive strength of hardened mortar;
11. BS EN 1015-12, Methods of test for mortar for masonry - Determination of adhesive strength of hardened rendering and plastering mortars on substrates;
12. BS EN 1822-1, High efficiency air filters (EPA, HEPA and ULPA) - Part 1: Classification, performance testing, marking;
13. Building (Planning) Regulations (Cap. 123F);
14. Construction Industry Council, Technical Requirements for Construction Robots for Painting, Plastering and Welding;
15. Construction Sites (Safety) Regulations (Cap. 59I);
16. Construction Workers Registration Ordinance (Cap. 583);
17. CR-1-08, Implementation rules for CR certification of construction robots;
18. CR-1-08TS-01, Technical Specification for Safety of Construction Robots;
19. CR-1-08TS-02, Construction Robot – Electromagnetic compatibility – Generic standards – Immunity requirements and limits;
20. CR-1-08TS-03, Construction Robot – Electromagnetic compatibility – Generic standards – Emission requirements and limits;
21. DBJ50/T-542, Technical Standard for the Application of Construction Robots;
22. Development Bureau - Technical Circular (Works) No. 9/2025: Adoption of Construction Robots;

23. Electrical and Mechanical Services Department, Code of Practice for the Electricity (Wiring) Regulations;
24. Electricity Ordinance (Cap. 406);
25. Electricity (Wiring) Regulations (Cap. 406E);
26. Factories and Industrial Undertakings Ordinance (Cap. 59);
27. Factories and Industrial Undertakings Regulations (Cap. 59A);
28. Factories and Industrial Undertakings (Confined Spaces) Regulation (Cap. 59AE);
29. Factories and Industrial Undertakings (Dangerous Substances) Regulations (Cap. 59AB);
30. Factories and Industrial Undertakings (Electricity) Regulations (Cap. 59W);
31. Factories and Industrial Undertakings (Guarding and Operation of Machinery) Regulations (Cap. 59Q);
32. Factories and Industrial Undertakings (Noise at Work) Regulation (Cap. 59T);
33. Factories and Industrial Undertakings (Spraying of Flammable Liquids) Regulations (Cap. 59N);
34. Fire Services Ordinance (Cap. 95);
35. GB 2893, Safety colors;
36. GB 2894, Safety colors and safety signs;
37. GB 4943.1, Audio/video, information and communication technology equipment - Part 1: Safety requirements;
38. GB 11291.1, Robots for industrial environments - Safety requirements - Part 1: Robot;
39. GB 50210, Standard for construction quality acceptance of building decoration;
40. GB 50300, Unified standard for construction quality acceptance of building engineering;
41. GB/T 1.1, Directives for standardization - Part 1: Rules for the structure and drafting of standardizing documents;
42. GB/T 191, Graphical symbols marking for handling and storage of packages;
43. GB/T 1728, Determination of drying time of coating and putty films;
44. GB/T 2423 series, Environmental testing - Applicable low-temperature, high-temperature, damp heat and temperature-change test methods;
45. GB/T 2828.1, Sampling procedures for inspection by attributes - Part 1: Sampling schemes indexed by acceptance quality limit for lot-by-lot inspection;
46. GB/T 3836.18, Explosive atmospheres - Part 18: Intrinsically safe electrical systems;
47. GB/T 4208, Degrees of protection provided by enclosures (IP code);

48. GB/T 4857.23, Packaging - Basic tests for transport packages - Part 23: Vertical random vibration test method;
49. GB/T 5226.1, Electrical safety of machinery - Electrical equipment of machines - Part 1: General requirements;
50. GB/T 12643, Robotics – Vocabulary;
51. GB/T 13306, Plates and nameplates;
52. GB/T 13384, General specifications for packing of mechanical and electrical product;
53. GB/T 13452.2, Paints and varnishes - Determination of film thickness;
54. GB/T 14048.1, Low-voltage switchgear and control gear - Part 1: General rules;
55. GB/T 15706, Safety of machinery - General principles for design - Risk assessment and risk reduction;
56. GB/T 16754, Safety of machinery - Emergency stop function - Principles for design;
57. GB/T 16855.1, Safety of machinery - Safety-related parts of control systems - Part 1: General principles for design;
58. GB/T 17799.1, Electromagnetic compatibility - Generic standards—Immunity for residential, commercial and light-industrial environments;
59. GB/T 19001, Quality management systems - Requirements;
60. GB/T 30030, Automated guided vehicle - Vocabulary;
61. GB/T 38124, Performance test methods for service robots;
62. GB/T 38834.1, Robotics - Performance criteria and related test methods for service robots - Part 1: Locomotion for wheeled robots;
63. GB/T 38834.2, Robotics - Performance criteria and related test methods for service robots - Part 2: Navigation;
64. GB/T 38834.3, Robotics - Performance criteria and related test methods for service robots - Part 3: Manipulation;
65. GB/T 51212, Unified standard for building information modeling;
66. GB/T 51218, Standard for basic terminology of engineering design of machinery industry;
67. Hong Kong Housing Authority, Specification Library;
68. IEC 60079 series, Explosive atmospheres;
69. IEC 60204-1, Safety of machinery - Electrical equipment of machines - Part 1: General requirements;
70. IEC 60529, Degrees of protection provided by enclosures (IP code);
71. IEC 61000-4-3, Electromagnetic compatibility (EMC) - Part 4-3 : Testing and measurement techniques - Radiated, radio-frequency, electromagnetic field immunity test;

72. IEC 61000-4-4, Electromagnetic compatibility (EMC) - Part 4-4: Testing and measurement techniques - Electrical fast transient/burst immunity test;
73. IEC 61000-4-5, Electromagnetic compatibility (EMC) - Part 4-5: Testing and measurement techniques - Surge immunity test;
74. IEC 61000-4-8, Electromagnetic compatibility (EMC) - Part 4-8: Testing and measurement techniques - Power frequency magnetic field immunity test;
75. IEC 61000-6-1, Electromagnetic compatibility (EMC) - Part 6-1: Generic standards - Immunity for residential, commercial and light-industrial environments;
76. IEC 61000-6-2, Electromagnetic compatibility (EMC) - Part 6-2: Generic standards - Immunity standard for industrial environments;
77. IEC 61000-6-4, Electromagnetic compatibility (EMC) - Part 6-4: Generic standards - Emission standard for industrial environments;
78. IEC 61508-1, Functional safety of electrical/electronic/programmable electronic safety-related systems - Part 1: General requirements;
79. IEC 62368-1, Audio/video, information and communication technology equipment - Part 1: Safety requirements;
80. IEC 62619, Safety requirements for secondary lithium cells and batteries, for use in industrial applications;
81. ISO 2409, Paints and varnishes - Cross-cut test;
82. ISO 2808, Paints and varnishes - Determination of film thickness;
83. ISO 3691-4, Industrial trucks - Safety requirements and verification - Part 4: Driverless industrial trucks and their systems;
84. ISO 4624, Paints and varnishes - Pull-off test for adhesion;
85. ISO 4628-1, Paints and varnishes - Evaluation of degradation of coatings - Part 1: General introduction and designation system;
86. ISO 8373, Robotics - Vocabulary;
87. ISO 9001, Quality management systems - Requirements;
88. ISO 10218-1, Robotics - Safety requirements - Part 1: Industrial robots;
89. ISO 10218-2, Robotics - Safety requirements - Part 2: Industrial robot applications and robot cells;
90. ISO 11664-4, Colorimetry - Part 4: CIE 1976 L*a*b* colour space;
91. ISO 12100, Safety of machinery - General principles for design - Risk assessment and risk reduction;
92. ISO 13482, Robots and robotic devices — Safety requirements for personal care robots;
93. ISO 13849-1, Safety of machinery - Safety-related parts of control systems - Part 1: General principles for design;

94. ISO 13850, Safety of machinery - Emergency stop function - Principles for design;
95. ISO 18646-1, Robotics - Performance criteria and related test methods for service robots - Part 1: Locomotion for wheeled robots;
96. ISO 18646-2, Robotics - Performance criteria and related test methods for service robots - Part 2: Navigation;
97. ISO 18646-6, Robotics - Performance criteria and related test methods for service robots - Part 6: Lower-limb wearable robots;
98. ISO 22915-1, Industrial trucks - Verification of stability - Part 1: General;
99. JGJ/T 29, Specification for construction and acceptance of building painting operation;
100. JG/T 298, Putty for interior;
101. JGJ/T 313, Standard for basic terms of information technology applications in construction field;
102. JIS A6909, Coating materials for textured finishes of buildings;
103. JIS A6910, Multi-layer wall coatings for glossy textured finishes;
104. Labour Department, A Guide to the Construction, Installation, Operation and Maintenance of Air Receivers (3/2016-BPVB5a);
105. Labour Department, A Guide to the Factories and Industrial Undertakings (Noise at Work) Regulation (3/2004-2a-L21);
106. Labour Department, A Guide to the Factories and Industrial Undertakings (Spraying of Flammable Liquids) Regulations (10/2007-2-B11a);
107. Labour Department, Code of Practice for Safety and Health at Work in Confined Spaces (5/2024-2-COP15);
108. Labour Department, Code of Practice for Owners of Boilers and Pressure Vessels (5/2016-5-BPVB9);
109. Labour Department, Code of Practice on Control of Air Impurities (Chemical Substances) in the Workplace (4/2002-1-OHB84);
110. Labour Department, Guidance Notes on Factories and Industrial Undertakings (Noise at Work) Regulation (12/2017-4-B49);
111. Labour Department, Guidance Notes on Paint Spraying and Related Coating Processes (3/2003-1-B123);
112. Labour Department, Operational Guide for Air Receivers (3/2016-BPVL2a);
113. Noise Control Ordinance (Cap. 400);
114. Occupational Safety and Health Ordinance (Cap. 509);
115. Occupational Safety and Health Regulation (Cap. 509A);

116. Office of the Communications Authority - OFCA I 421(24), Issue 8: Hong Kong Telecommunications Equipment Evaluation and Certification (HKTEC) Scheme;
117. Telecommunications Ordinance (Cap. 106);
118. United Nations - Manual of Tests and Criteria, Eighth Revised Edition, as amended by Amendment 1, subsection 38.3.

Annex A: Pre-delivery (PD), Pre-operation (PO) and Pre-use (PU) Checklists

This Annex provides supporting pre-delivery (PD), pre-operation (PO) and pre-use (PU) checklists and verification methods for **Section 7**. Factory or type-test evidence may be used where appropriate. PO Checks include site demonstrations, measurements and evidence review before routine project use. The contract may require additional acceptance stages.

The Vendor shall supply product information and conformity evidence. The Purchaser shall organize site arrangements and checks. The Client shall define project-specific acceptance values and accept the PO Check results. Detailed responsibility allocation is not required for routine records unless the contract states otherwise.

A.1 Sample Pre-delivery (PD) Checklist

ID	Item	Acceptance Criteria / Requirement	Method
PD-01	Robot identification and configuration	Model, serial number, software/firmware, tooling and power configuration are identified and match the proposed supply.	Document review
PD-02	Technical and safety information	Operating Limits, positioning accuracy, collision-avoidance sensors, flashing alarm devices, risk assessment, residual risks, operation instructions and maintenance instructions are available.	Document review
PD-03	Safety-function evidence	Available conformity/test/validation evidence covers the required safety functions, all intended Operating Modes and set-up modes and the supplied configuration, including abnormality protection.	Document review
PD-04	Electrical, battery, IP and conformity evidence	Applicable electrical, battery and environmental-protection evidence identifies the supplied components/configuration. Claimed or project-required IP ratings and any claimed conformity or certification are supported by evidence. Applicable UN 38.3 test summaries for the tested lithium cell or battery type and Hong Kong radio-equipment evidence are available.	Document review
PD-05	Functional capability	The approved material types, storage capacity, supported Operating Modes, working orientations and reachable height are documented.	Document review

ID	Item	Acceptance Criteria / Requirement	Method
PD-06	Access and transport	(a) Robot mass/dimensions, access route, doorways and site lifts/hoists are suitable for delivery and inter-floor movement. Manufacturer-approved transport arrangements and securing against unintended movement are confirmed. Manufacturer-approved lifting/handling instructions and securing of movable parts and tooling under 7.11.2 are checked. (b) For robots capable of Powered Travel, the declared travel gradient and obstacle-crossing limits shall be checked against the intended access route and deployment.	Document review / visual inspection
PD-07	Floor and Operating Zone	Floor capacity, clearances, headroom and Operating Zone conditions are suitable.	Document review / visual inspection
PD-08	Operator qualification	Construction-worker registration, model-specific training/assessment, current authorization and competence, and the Semi-skilled Worker Certificate in Painter and Decorator under 7.13.1 are confirmed. The model/mode completion certificate under 7.13.3 and any required valid confined-space certificate under 7.13.5 are available.	Document review

ID	Item	Acceptance Criteria / Requirement	Method
PD-09	Project data	Approved painting/spraying/grinding task data and project acceptance values are available. The Purchaser's site-specific risk assessment and Safe-Working Procedure under 7.10.1 are prepared before delivery to site.	Document review
PD-10	Power and charging	Required electricity supply, charger and charging location are available and compatible with the robot.	Document review / visual inspection

A.2 Sample Pre-operation (PO) Checklist

ID	Item	Acceptance Criteria / Requirement	Method
PO-01	Identification and configuration	Robot configuration matches the approved submission.	Document review / visual inspection
PO-02	Operating Zone and access	(a) Floor capacity, access, headroom, clearances, openings and site hazards are acceptable. (b) The Operating Zone is fully fenced with controlled access under 7.3.6.	Document review / visual inspection
PO-03	Operating Zone condition	Operating Zone for painting/spraying/grinding and, where applicable, Powered Travel: inclination below 1:10; no step or level difference exceeding 20 mm; stricter Vendor limits met. For Powered Travel, declared gradient and obstacle-crossing limits are compatible with the accepted route and conditions.	Visual inspection / measurement
PO-04	Task data	Approved painting/spraying/grinding task data are available. Demonstrate Operator review and confirmation of the configured task and any map, route or task sequence, including supported Operating Zone and Exclusion Zone settings, before automatic execution.	Document review / measurement
PO-05	Positioning accuracy	Positioning accuracy within Vendor-declared values under Automatic Operation.	Function test
PO-06	End Effector quality	The spray gun, grinding discs, material delivery and dust collection pipes are free from damage, blockage or leakage.	Visual inspection

ID	Item	Acceptance Criteria / Requirement	Method
PO-07	Operating range	Required project reach and orientation are demonstrated.	Function test
PO-08	Remote-controlled Powered Travel	Demonstrate stopping on movement-control release and control-communication loss. Where 7.4.7 is adopted or required by the project, demonstrate proximity warning to the Operator at the accepted configuration and Vendor-declared travel-speed and protective separation settings. Record and check stopping distance/time under A-3 and A-4, including the Vendor-declared, risk-assessed communication-loss timeout and associated safe response under 7.7.3.	Function test
PO-09	Automatic Powered-Travel proximity protection	For Self-Navigation or other automatic Powered Travel, demonstrate proximity detection and automatic stopping before unsafe contact or breach of the declared protective separation limits using a suitable test object at the accepted configuration and Vendor-declared travel-speed and protective separation settings. Record and check stopping distance/time under A-3.	Function test
PO-10	Robot status feedback	The synchronization of operational statuses, generation of visual and audible warnings upon abnormal conditions operate correctly.	Function test

ID	Item	Acceptance Criteria / Requirement	Method
PO-11	Mode control, operation indicator, emergency stop and fault response	(a) Verify emergency-stop visibility, function, and visual operation indicators. (b) Test anomaly responses under 7.3.10, alarms, and restart prevention across all modes. (c) Confirm a single active Operating Mode under 7.4.1, and a single active point of control under 7.5.2, without disabling required emergency-stop controls. (d) Verify manipulator guarding under 7.7.7. (e) Safely test contact-sensing for warnings, automatic stopping, and Safe State entry.	Visual inspection / function test
PO-12	Dust control	Source-control method operates during representative painting/spraying/grinding operations without uncontrolled visible release. Where the project adopts 7.9.13, review filtration declaration and evidence	Function test
PO-13	Noise information	Vendor-declared noise information/test condition reviewed. Workplace assessment arranged if required.	Document review

ID	Item	Acceptance Criteria / Requirement	Method
PO-14	Electrical, battery and IP evidence	(a) Applicable electrical, battery, environmental-protection, UN 38.3 lithium-battery transport and radio-equipment evidence matches the supplied configuration and declared ratings. (b) Claimed or project-required IP ratings have configuration-matched evidence. Verify 7.9.11 where adopted by the project. (c) Painting/spraying/grinding tools suit the site conditions. Cables, connectors, charger, enclosures and protective devices are acceptable. (d) For in-scope site-supply or charging installations, review applicable EMSD Wiring CoP arrangements, including Code 26K, and installation evidence.	Document review / visual inspection
PO-15	Internet capability and access control	Authorized Internet connection capability is demonstrated without bypassing safety functions. Role-based or equivalent access controls prevent unauthorized remote commands and changes to safety settings or approved task data.	Function test
PO-16	BIM compatibility	Approved sample painting/spraying/grinding task data are received or used through the Vendor-stated BIM workflow method.	Function test / data review

ID	Item	Acceptance Criteria / Requirement	Method
PO-17	Documentation and records	Required manuals, site-specific risk assessments and Safe-Working Procedures under 7.10.1, evidence, model/mode completion certificates, confined-space certification under 7.13.5 where required, training/refresher records, competency assessments, authorization and relevant operation-history evidence, Operating Limits and retention arrangements are available.	Document review
PO-18	Best-practice functions	Any Best Practice function required by the project is verified. Otherwise N/A is recorded.	Function test / document review

Verification Methods

A-1 For each PO item, record the robot configuration, test conditions, result and evidence reference. Failed items shall be corrected and the affected requirement re-tested before acceptance.

A-2 The number and distribution of test surfaces shall be agreed before the PO Check and shall cover the project-specific positions, painting/spraying/grinding data and operating range being accepted. A single test surface shall not be the sole basis for acceptance.

A-3 Powered-Travel verification:

(a) Test sensing and automatic stopping for Self-Navigation or other automatic Powered Travel, and remote-travel proximity warning where required by the project, using a suitable test object at the accepted configuration and Vendor-declared travel-speed and protective separation settings.

(b) Record the configuration, test conditions, declared sensing range/coverage where applicable, travel speed, separation distance, stopping distance/time and achieved response.

(c) Verify declared stopping limits, including applicable manual emergency-stop performance, by a safe test or suitable evidence. People shall not be used as collision targets.

(d) Check applicable ISO 3691-4 protective stopping requirements where the mobile platform is within its scope. Self-Navigation performance may also be assessed under GB/T 38834.2 or ISO 18646-2.

A-4 For remote-controlled Powered Travel, demonstrate stopping on movement-control release and control-communication loss and, where required by the project, proximity warning to the Operator using a suitable test object at the accepted travel-speed and protective separation settings. Check stopping performance and the Vendor-declared, risk-assessed communication-loss timeout and associated safe response.

A-5 Abnormality-response verification:

(a) Representative abnormality sensing and protective responses shall be verified by safe methods for all accepted Operating Modes and set-up modes, including Remote-Controlled Operation, Semi-Automated Operation, Automatic Operation and Manual or Local Control.

(b) Record the mode, fault or abnormal condition, warning, applicable communication-loss timeout, safe response and restart prevention, including Operator review of completed and outstanding work before deliberate resumption where interrupted-task recovery is required by the project.

(c) Simulation or configuration-matched test/validation evidence may be used where inducing a real fault would be unsafe.

(d) Laboratory IP, battery-abuse and environmental-chamber tests shall not be repeated on site.

A-6 Workplace dust or noise exposure assessment required by applicable Hong Kong statutory duties shall be carried out separately from routine robot PO Checks, following the applicable occupational-hygiene and noise-at-work requirements.

A.3 Sample Pre-use (PU) Checklist

ID	Item	Acceptance Criteria / Requirement	Method
PU-01	Robot body/platform	The protective enclosures of the robot components are complete and secured, without visible damage, loose parts, leakage or unresolved alarm.	Visual inspection
PU-02	Tooling setup	The tooling is correctly fitted, securely retained and not visibly damaged or excessively worn. The End Effector can operate normally. The grinding discs are securely fixed and are not excessively worn.	Visual inspection / function test
PU-03	Guards and covers	Guards/covers are secure and undamaged. Interlocks on movable guards function properly. Verify normal status of the required robot-arm contact-sensing protective devices and other applicable collision protection under 7.7.7.	Visual inspection / function test
PU-04	Emergency-stop controls	Clearly visible, readily identifiable, readily accessible and functional.	Function test
PU-05	Protective sensing and abnormality status	(f) Required abnormality sensing and protective functions under 7.3.10 are ready for the intended operating or set-up mode. (g) Travel sensors under 7.4.5, and under 7.4.7 where adopted or required by the project, are clean, unobstructed and functional. Record N/A only where travel sensing is not applicable. (h) Guarding under 7.7.7 remains effective.	Visual inspection / function test

ID	Item	Acceptance Criteria / Requirement	Method
PU-06	Navigation sensing	The navigation sensors' surfaces are clean and unobstructed. The navigation map used by the robot is validated, and the positioning is accurate, without unresolved fault indication.	Visual inspection / function test
PU-07	Power, battery, cables and connectors	The electrical components have no visible damage, unsafe connection or overheating. The power switch device operates and is connected normally.	Visual inspection / function test
PU-08	Operator Interface / remote controller	Controls, warnings, mode indication, communications, visual operation indicator and required abnormal-condition alarms operate normally.	Function test
PU-09	Dust control	Extraction/suppression equipment is connected, ready and correctly positioned to control dust at the active working surface. Required eye, respiratory and hearing protection is available and used. Regular cleaning and maintenance schedule for air filters, dust collection container, bag or filter shall be established for implementation.	Visual inspection / function test
PU-10	Operating Zone and access route	Clear, stable and within the accepted operating-zone slope, level-difference and clearance limits under 7.3.4. For Powered Travel, declared gradient and obstacle-crossing limits and travel-speed/protective-separation settings match the accepted configuration and route. Fencing and access controls are checked under PU-11.	Visual inspection

ID	Item	Acceptance Criteria / Requirement	Method
PU-11	Hazard Zone controls	(a) Operating Zone and Exclusion Zone cover the full operating range and foreseeable fall zone, are fully fenced with controlled access, and have unobstructed access/egress. (b) Conspicuous signs identify the Operating Zone and robot operation in Traditional Chinese, English and other required worker languages. (c) Display the site layout plan and emergency escape route where applicable.	Visual inspection
PU-12	Stabilizers / brakes	Required stabilizers, outriggers and brakes are available and correctly set so the base remains stationary during painting/spraying/grinding under 7.3.5.	Visual inspection / function test
PU-13	Task data	The paint or putty materials' characteristics are compliant. The project task data are available to the Operator, with configured-task review and confirmation and applicable map/route/zone information before automatic execution.	Document review / function test
PU-14	Pressure vessel	The air receiver is in good condition and free from condensate. The safety valve and the pressure gauge attached to the air receiver are functioning properly. The safety valve seal is intact.	Visual inspection / function test

Annex B: Standard Workflow for Deployment and Maintenance

Stage	Action
1. Project requirements	(a) The Client defines and approves the painting/spraying/grinding task data, work scope and acceptance values. (b) The Purchaser confirms robot suitability and deployment arrangements before procurement (7.1.3), and provides the site-specific risk assessment and Safe-Working Procedure before delivery of the robot to site (7.10.1).
2. Product submission	The Vendor provides robot capability, Operating Limits, model-specific manuals, conformity/test evidence and intended operating arrangements.
3. Pre-delivery inspection	(a) The Vendor checks the robot configuration, safety functions and supply documents under 7.10.2. (b) The Purchaser confirms delivery access, transport, site services and personnel qualifications using Annex A.1.
4. Site preparation	The Purchaser confirms site readiness and personnel briefing under 7.10.3, including fenced Operating Zones and Exclusion Zones, controlled access/signage, power and charging, dust/noise controls, any platform/fall-zone controls and site conditions meeting Vendor-declared environmental limits.
5. Pre-operation inspection	(a) The Operator, with Vendor support, performs Annex A.2 checks and demonstrations under 7.10.4, including Operating Modes, abnormality responses and applicable proximity responses, emergency stops, painting/spraying/grinding accuracy and required collision/contact protection. Where needed, specialist checks or measurements are performed by persons competent for the relevant work. (b) The Purchaser arranges site checks. (c) The Client accepts PO results after failed requirements are corrected and re-tested.

Stage	Action
6. Pre-use inspection	The Operator checks the robot, guarding, required arm contact-sensing devices and other applicable collision protection, Operating Zone, PPE, alarms, and any safety controls before each shift or use and after relevant changes under 7.10.5 and Annex A.3. Failed items are corrected and affected functions re-tested before use.
7. Routine operation	(a) The Operator continuously supervises authorized painting/spraying/grinding and travel, works within declared limits and stops hazardous operation where required. (b) The Purchaser maintains fencing and controlled access. (c) The Operator restarts only deliberately after safe conditions are restored.
8. Maintenance, removal and records	The Purchaser arranges: (a) Maintenance and inspections under 7.10.6 to 7.10.8, with competent personnel and Vendor instructions. The Operator re-verifies affected functions before return to service. (b) Dismantling and removal under 7.10.1. (c) Retention of required records under 7.11.4 to 7.11.7. Backup/recovery under 7.11.9 is included where adopted by the project.