

EQUIPMENT QUALIFICATION DOCUMENTATION

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Polar Dynamics Robotics, Inc.

Document No.: EQD-2023-112

Effective Date: December 15, 2023

Version: 2.1

1. PURPOSE AND SCOPE

1. This Equipment Qualification Documentation ("EQD") establishes the

2. This documentation applies to all AMR units designated for operation

2. REFERENCED DOCUMENTS

1. ISO 10218-1:2011 Robots and robotic devices -- Safety requirements
2. ANSI/RIA R15.06-2012 Industrial Robots and Robot Systems Safety
3. PDR-SOP-2023-07: Standard Operating Procedures for Cold Environment
4. PDR-QMS-2023-11: Quality Management System Documentation
5. BlueCore(TM) Technical Specifications (Rev. 3.2)

3. EQUIPMENT DESCRIPTION

1. Primary Systems Under Qualification:

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BlueCoreTM Navigation Module (Model BC-NAV-2023)

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Reinforced Chassis Assembly (Model RCA-450-X)

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Cold-Resistant Power Distribution System (Model CR-PDS-2.1)

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Environmental Sensing Array (Model ESA-103)

2. Supporting Components:

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Temperature Monitoring Systems

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Emergency Stop Mechanisms

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Backup Power Systems

Environmental Protection Enclosures

4. QUALIFICATION REQUIREMENTS

1. Performance Requirements:

- a) Navigation accuracy within 2cm at -40 F
- b) Minimum 8-hour continuous operation capability
- c) Battery performance retention of 85% at -40 F
- d) Emergency stop functionality within 0.5 seconds
- e) Sensor array accuracy within 98% at extreme temperatures

2. Environmental Requirements:

- a) Operating temperature range: -40 F to 32 F

b) Humidity tolerance: 15% to 95% RH

c) Condensation resistance

d) Ice accumulation resistance

e) Thermal shock tolerance

5. QUALIFICATION PROCEDURES

1. Installation Qualification (IQ):

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Component verification against specifications

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Installation parameter documentation

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Calibration verification

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Safety system validation

2. Operational Qualification (OQ):

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Cold chamber testing protocols

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Navigation system verification

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Power system performance testing

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Emergency response validation

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Communication systems testing

3. Performance Qualification (PQ):

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Extended operation testing (minimum 168 hours)

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Load capacity verification

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Navigation accuracy assessment

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Battery life validation

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System recovery testing

6. ACCEPTANCE CRITERIA

1. All qualification tests must meet the following criteria:

- a) 100% pass rate on safety-critical functions
- b) 95% success rate on navigation accuracy tests
- c) 90% success rate on extended operation tests
- d) Zero critical failures during thermal cycling
- e) Complete compliance with referenced standards

7. DOCUMENTATION REQUIREMENTS

1. Required Records:

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Test results and data logs

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Calibration certificates

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Deviation reports

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Corrective action documentation

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Training records

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Maintenance logs

2. Record Retention:

All qualification documentation shall be maintained for a minimum of 5 years from the date of equipment retirement.

8. REQUALIFICATION REQUIREMENTS

1. Periodic requalification shall be performed:

- - 9 -

Every 24 months

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Following major repairs or modifications

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After significant environmental events

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Upon software updates affecting critical functions

9. QUALITY ASSURANCE

1. All qualification activities shall be overseen by authorized Quality A

2. Deviations from specified parameters require documented justificat

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Quality Assurance Manager

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Chief Robotics Officer

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Director of Engineering

10. CERTIFICATION

The undersigned hereby certify that this Equipment Qualification Document
has been reviewed and approved:

Dr. James Barrett

Chief Robotics Officer

Date: December 15, 2023

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Victoria Wells

Quality Assurance Director

Date: December 15, 2023

11. REVISION HISTORY

Version 2.1 - December 15, 2023

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Updated temperature specifications

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Added new sensor array requirements

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Revised requalification criteria

Version 2.0 - June 30, 2023

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Major revision incorporating BlueCore(TM) technology

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Updated environmental parameters

Version 1.0 - March 15, 2022

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Initial release

