PDR-AMR-003 MAINTENANCE MANUAL

Document Number: MM-2023-V4.2

Effective Date: January 1, 2024

Classification: CONFIDENTIAL

1. INTRODUCTION

1 This Maintenance Manual ("Manual") is the proprietary and confidential document of Polar Dynamics Robotics, Inc. ("PDR") governing the maintenance procedures for the PDR-AMR-003 Autonomous Mobile Robot system ("AMR-003").

2 This Manual supersedes all previous versions and must be strictly followed by authorized maintenance personnel to ensure safe operation in cold storage environments ranging from +20 C to -30 C.

2. DEFINITIONS

1 "Authorized Service Provider" means a technician or entity certified by PDR to perform maintenance on AMR-003 units.

2 "Critical Components" refers to the proprietary cold-resistant actuators, thermal management systems, and IceNav(TM) navigation components.

3 "Maintenance Interval" means the manufacturer-specified period between required service procedures.

3. SAFETY PROTOCOLS

1 All maintenance procedures must be performed in compliance with:

a) ANSI/RIA R15.06-2012 Safety Requirements

b) ISO 10218-1:2011 Robot Safety Standards

c) PDR Cold Environment Safety Protocol PS-2023-01

2 Required Personal Protective Equipment:

a) Cold-environment protective gear rated to -40 C

b) Anti-static safety equipment

c) PDR-approved diagnostic tools

4. SCHEDULED MAINTENANCE PROCEDURES

1 Daily Inspection Requirements:

a) Visual inspection of thermal seals

b) Verification of IceNav(TM) sensor calibration

c) Battery thermal management system check

d) Emergency stop system validation

2 Weekly Maintenance Requirements:

a) Actuator lubrication with PDR-approved cold-resistant lubricant

b) Thermal management system performance validation

c) Navigation sensor cleaning and alignment check

d) Power system efficiency verification

3 Monthly Service Requirements:

a) Complete diagnostic scan using PDR Maintenance Tool v4.2

b) Firmware validation and updates if required

c) Mechanical stress analysis of cold-resistant components

d) Battery capacity verification test

5. COMPONENT REPLACEMENT SCHEDULES

1 Critical Components must be replaced according to the following schedule:

a) Thermal Management System: Every 2,000 operating hours

b) Cold-Resistant Actuators: Every 3,000 operating hours

c) Navigation Sensors: Every 4,000 operating hours

d) Battery Units: Every 1,500 charge cycles

2 Only PDR-certified replacement parts may be used. Use of unauthorized components voids all warranties and safety certifications.

6. TROUBLESHOOTING PROCEDURES

1 IceNav(TM) System Errors:

a) Error Code IC-001: Sensor misalignment

b) Error Code IC-002: Thermal compensation failure

c) Error Code IC-003: Navigation algorithm error

2 Actuator System Errors:

a) Error Code AC-001: Thermal protection trigger

b) Error Code AC-002: Torque limitation error

c) Error Code AC-003: Position feedback failure

7. WARRANTY AND LIABILITY

1 Maintenance performed by non-authorized personnel voids the manufacturer's warranty.

2 PDR assumes no liability for damages resulting from:

a) Unauthorized modifications

b) Failure to follow maintenance procedures

c) Use of non-approved replacement parts

8. DOCUMENTATION REQUIREMENTS

1 Maintenance Records:

a) All maintenance activities must be logged in PDR's digital maintenance system

b) Records must include technician ID, date, time, and specific procedures performed

c) Diagnostic data must be uploaded within 24 hours of service completion

9. REVISION CONTROL

1 This Manual is subject to revision by PDR without notice.

2 Current version must be verified via PDR's online documentation portal prior to performing maintenance.

CERTIFICATION

The undersigned hereby acknowledges receipt and understanding of this Maintenance Manual:

Service Provider: _

Certification Number: _

Date:

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