

# **OPERATIONS DOCUMENT 366**

## **STANDARD OPERATING PROCEDURES FOR AUTONOMOUS MOBILE ROBOT DEPLOYMENT AND MAINTENANCE IN TEMPERATURE-CONTROLLED ENVIRONMENTS**

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### **1. PURPOSE AND SCOPE**

1. This Standard Operating Procedure ("SOP") establishes the mandatory operational protocols for the deployment, maintenance, and decommissioning of Polar Dynamics Robotics, Inc. ("Company") autonomous mobile robots ("AMRs") in temperature-controlled environments ranging from -40 C to +25 C.
2. This document applies to all Series X-500 and X-700 AMR units incorporating IceNav(TM) navigation systems and ColdCore(TM) actuator technology.

### **2. DEFINITIONS**

1. "Cold Zone Operation" refers to AMR deployment in environments maintained below 0 C.
2. "Thermal Transition Protocol" means the Company's proprietary procedure for transitioning AMRs between temperature zones.
3. "Mission-Critical Systems" include primary locomotion, navigation, safety, and communication subsystems.
4. "IceNav(TM) Calibration" refers to the process of optimizing environmental sensors and navigation parameters for specific facility conditions.

### **3. PRE-DEPLOYMENT PROCEDURES**

1. Environmental Assessment
  - a) Conduct full thermal mapping of deployment zone

- b) Document all transition areas between temperature zones
- c) Verify floor surface conditions and friction coefficients
- d) Map RF interference patterns and communication dead zones

## 2. System Preparation

- a) Execute full diagnostic sequence on ColdCore(TM) components
- b) Verify thermal management system integrity
- c) Calibrate IceNav(TM) sensors to facility specifications
- d) Load facility-specific navigation maps and operating parameters

# 4. OPERATIONAL PROTOCOLS

## 1. Cold Zone Entry Sequence

- a) Initiate thermal conditioning cycle minimum 20 minutes prior to zone entry
- b) Verify actuator temperature within operational parameters
- c) Confirm sensor array calibration for target environment
- d) Enable enhanced safety protocols for low-temperature operation

## 2. Continuous Operation Requirements

- a) Maintain real-time monitoring of critical system temperatures
- b) Log all thermal events exceeding predetermined thresholds
- c) Execute automated diagnostic sequences every 4 operating hours
- d) Monitor power consumption patterns for thermal efficiency

# 5. MAINTENANCE REQUIREMENTS

## 1. Scheduled Maintenance

- a) Weekly inspection of thermal seals and insulation
- b) Monthly calibration of temperature sensors
- c) Quarterly replacement of thermal management consumables
- d) Semi-annual actuator stress testing

## 2. Preventive Measures

- a) Implementation of predictive maintenance algorithms

- b) Regular firmware updates for thermal management optimization
- c) Periodic validation of emergency protocols
- d) Documentation of all maintenance activities in central database

## **6. SAFETY PROTOCOLS**

### **1. Emergency Procedures**

- a) Automatic shutdown if core temperature exceeds specifications
- b) Emergency extraction protocol for compromised units
- c) Backup power systems for critical functions
- d) Remote override capabilities for safety personnel

### **2. Personnel Requirements**

- a) Mandatory cold environment training for maintenance staff
- b) Certification in Company's thermal management protocols
- c) Regular safety refresher courses
- d) Personal protective equipment specifications

## **7. COMPLIANCE AND DOCUMENTATION**

### **1. All operations must comply with:**

- a) ANSI/RIA R15.06-2012 Safety Requirements
- b) ISO 10218-1:2011 Robot Safety Standards
- c) Company's proprietary safety protocols
- d) Facility-specific operating requirements

### **2. Required Documentation**

- a) Daily operational logs
- b) Maintenance records
- c) Incident reports
- d) Performance metrics

## **8. PROPRIETARY NOTICE**

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## **9. APPROVAL AND REVISION**

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