ROBOT OPERATING PARAMETERS

SubZero Pharmaceutical Storage Environment

Document No. PDR-SOP-2023-114

Effective Date: January 15, 2024

Version 3.2

1. SCOPE AND APPLICATION

1. This document establishes the mandatory operating parameters and safety protocols for Polar Dynamics Robotics, Inc. ("PDR") autonomous mobile robots ("AMRs") deployed in pharmaceutical storage environments maintaining temperatures at or below -20 C ("SubZero Environments").

2. These parameters apply to all IceNav(TM)-enabled AMR units, including models PDR-350F, PDR-500F, and PDR-750F, operating within validated pharmaceutical storage facilities.

2. DEFINITIONS

1. "Critical Operating Temperature" means the minimum temperature at which AMR units are certified to maintain full operational capability (-40 C).

2. "Safe Operating Zone" means the designated areas within SubZero Environments where AMRs are authorized to operate, as defined by facility mapping and IceNav(TM) geofencing protocols.

3. "Thermal Recovery Period" means the mandatory standby period following continuous operation in SubZero Environments (minimum 30 minutes per 4 hours of operation).

3. OPERATING PARAMETERS

1. Temperature Parameters

a) Minimum operating temperature: -40 C

b) Maximum operating temperature: +5 C

c) Temperature transition rate: 15 C per hour

d) Thermal equilibration period: 45 minutes minimum

2. Motion Parameters

a) Maximum velocity: 1.2 meters per second

b) Acceleration limit: 0.5 meters per second squared

c) Turning radius: minimum 1.5 meters at full load

d) Load capacity: 750 kg maximum

3. Power Management

a) Minimum battery charge: 30%

b) Operating voltage range: 44V - 52V DC

c) Maximum continuous operation: 4 hours

d) Required charging temperature: +10 C to +30 C

4. SAFETY PROTOCOLS

1. Emergency Shutdown Conditions

a) Temperature below -42 C

b) Detection of ice formation on critical sensors

c) Battery temperature outside -30 C to +45 C

d) Loss of IceNav(TM) positioning for >30 seconds

2. Mandatory Safety Features

a) Thermal monitoring system

b) Emergency stop buttons

c) Proximity detection system

d) Audio-visual warning indicators

e) Anti-condensation protocols

5. MAINTENANCE REQUIREMENTS

1. Scheduled Maintenance Intervals

a) Daily visual inspection

b) Weekly sensor calibration

c) Monthly actuator assessment

d) Quarterly full system diagnostic

e) Annual certification renewal

2. Component-Specific Requirements

a) Thermal management system inspection every 500 hours

b) Battery conditioning every 90 days

c) Sensor cleaning every 168 operating hours

d) Software updates within 7 days of release

6. COMPLIANCE AND VALIDATION

1. Regulatory Standards

a) FDA 21 CFR Part 11 compliance

b) GMP guidelines for automated systems

c) ISO 13485:2016 requirements

d) GAMP 5 guidelines

2. Documentation Requirements

a) Operating logs retained for 3 years

b) Maintenance records retained for 5 years

c) Validation documentation retained for 7 years

d) Incident reports retained indefinitely

7. LIABILITY AND INDEMNIFICATION

1. PDR warrants that AMR units operating within these parameters will maintain specified performance levels, subject to proper maintenance and operation.

2. Customer assumes all liability for operation outside specified parameters or in violation of safety protocols.

3. These parameters may be updated by PDR with 30 days written notice to maintain safety and regulatory compliance.

8. CERTIFICATION

The undersigned hereby certifies that these operating parameters have been reviewed and approved for implementation.

POLAR DYNAMICS ROBOTICS, INC.

By:

Name: Dr. James Barrett

Title: Chief Robotics Officer

Date: January 15, 2024

By:

Name: Sarah Nordstrom

Title: Chief Operating Officer

Date: January 15, 2024

9. REVISION HISTORY

Version 3.2 - January 15, 2024

- Updated thermal recovery period requirements
- Added anti-condensation protocols
- Revised maintenance intervals

Version 3.1 - July 1, 2023

- Updated regulatory compliance requirements
- Modified power management parameters

Version 3.0 - January 1, 2023

- Initial release of consolidated parameters
- Implementation of IceNav(TM) 2.0 requirements