ROBOT PROGRAMMING SPECIFICATIONS

PharmaCool Inc. Implementation Project

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Version: 2.1

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1. OVERVIEW AND SCOPE

1. This Robot Programming Specification ("Specification") is issued by Polar Dynamics Robotics, Inc. ("PDR") for the implementation of IceNav(TM)-enabled autonomous mobile robots ("AMRs") at PharmaCool Inc.'s temperature-controlled pharmaceutical storage facility located at 2300 Cryogenic Drive, Memphis, TN 38116 ("Facility").

2. This Specification governs the programming, configuration, and operational parameters for a fleet of twelve (12) PDR ColdBot-X750 units to be deployed at the Facility.

2. DEFINITIONS

1. "Control System" means PDR's proprietary IceNav(TM) AI navigation and control platform, version 4.2 or higher.

2. "Operating Environment" refers to the Facility's controlled temperature zones ranging from -30 C to +8 C.

3. "Safety Protocols" means the integrated safety systems and fail-safes as defined in PDR's Safety Standard PS-2023-11.

3. TECHNICAL SPECIFICATIONS

1. Navigation Parameters

a) Mapping resolution: 1cm precision

b) Path planning update rate: 10Hz

c) Obstacle detection range: 25 meters

d) Maximum operating speed: 2.0 m/s

e) Minimum turning radius: 1.2 meters

2. Temperature Management

a) Actuator operating range: -40 C to +50 C

b) Thermal monitoring frequency: 200ms

c) Auto-shutdown threshold: -45 C or +55 C

d) Thermal equilibration period: 45 minutes

3. Load Handling

a) Maximum payload: 750kg

b) Load detection sensitivity: 0.5kg

c) Center of gravity tolerance: 5cm

d) Platform leveling accuracy: 0.2

4. PROGRAMMING REQUIREMENTS

1. Software Configuration

a) IceNav(TM) Core Version: 4.2.7

b) Safety Module Version: 3.1.4

c) Load Management Module: 2.8.3

d) Communication Protocol: PDR-Secure v3

2. Custom Programming

a) Facility-specific navigation maps

b) Zone-specific speed limits

c) Traffic management algorithms

d) Battery management optimization

e) Emergency response procedures

5. OPERATIONAL PARAMETERS

1. The AMRs shall be programmed to:

a) Maintain minimum separation of 3 meters between units

b) Observe zone-specific speed limits

c) Priority override for human-operated equipment

d) Automatic docking when battery level reaches 15%

e) Maintain operation logs for 90 days

2. Safety Configurations

a) Emergency stop activation distance: 1.5 meters

b) Maximum deceleration rate: 2.0 m/s

c) Personnel detection zone: 5 meters

d) Automatic speed reduction in high-traffic areas

6. INTEGRATION REQUIREMENTS

1. Warehouse Management System

a) Protocol: REST API

b) Authentication: OAuth 2.0

c) Data encryption: AES-256

d) Maximum latency: 100ms

2. Environmental Monitoring

a) Temperature sensor polling: 1Hz

b) Humidity monitoring: 0.5Hz

c) Air pressure differential: 0.1Hz

7. COMPLIANCE AND CERTIFICATION

1. The programming shall comply with:

a) FDA 21 CFR Part 11

b) ISO/IEC 27001:2013

c) ANSI/RIA R15.06-2012

d) CE Machinery Directive 2006/42/EC

8. VALIDATION AND TESTING

1. Required Testing Protocols

a) Factory Acceptance Testing (FAT)

b) Site Acceptance Testing (SAT)

c) Performance Qualification (PQ)

d) Operational Qualification (OQ)

2. Performance Metrics

a) Navigation accuracy: 5cm

b) Task completion rate: 99.9%

c) System uptime: 99.5%

d) Battery cycle efficiency: 90%

9. PROPRIETARY RIGHTS

1. All software, algorithms, and programming configurations remain the intellectual property of PDR.

2. Customer-specific configurations are licensed to PharmaCool Inc. pursuant to the Master Service Agreement dated December 1, 2023.

10. DOCUMENT CONTROL

Version: 2.1

Approved By: Dr. James Barrett, Chief Robotics Officer

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