# ROBOT SPEED AND SEPARATION MONITORING PROTOCOL

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**Issuing Authority: Safety & Compliance Department**

**Approved By: Dr. James Barrett, Chief Robotics Officer**

## 1. PURPOSE AND SCOPE

1. This Protocol establishes mandatory safety requirements and operational procedures for implementing Speed and Separation Monitoring (SSM) systems on all Polar Dynamics Robotics, Inc. ("Company") autonomous mobile robots (AMRs) operating in shared workspaces with human personnel.

2. This Protocol applies to all IceNav(TM)-enabled AMR units manufactured by the Company and deployed in customer facilities, including but not limited to cold storage warehouses, pharmaceutical manufacturing facilities, and temperature-controlled logistics environments.

## 2. DEFINITIONS

1. "Protected Zone" means the dynamically calculated safety area surrounding each AMR unit, which varies based on robot speed, payload characteristics, and environmental conditions.

2. "Minimum Separation Distance" refers to the required clearance between an AMR and any human operator, calculated according to ISO/TS 15066:2016 specifications and adjusted for cold-environment operation parameters.

3. "Speed Control Zones" means the graduated approach areas around each AMR where velocity adjustments are automatically implemented based on proximity detection.

## 3. TECHNICAL REQUIREMENTS

1. Sensor Systems

1.1. Each AMR must be equipped with:

- Primary LiDAR scanning system with minimum 270 field of view

- Secondary infrared proximity sensors
- Thermal imaging cameras for enhanced detection in cold environments
- Redundant emergency stop mechanisms

1.2. Sensor calibration must account for condensation and ice crystal formation in sub-zero environments.

2. Speed Control Parameters

2.1. Maximum speeds shall not exceed:

- Zone 1 (>3.0m separation): 2.0 m/s
- Zone 2 (1.5m - 3.0m): 1.2 m/s
- Zone 3 (0.5m - 1.5m): 0.5 m/s
- Zone 4 (<0.5m): Full stop

2.2. Speed limits must be automatically adjusted based on:

- Floor surface conditions
- Payload mass and dimensions
- Ambient temperature
- Visibility conditions

## 4. OPERATIONAL PROCEDURES

1. System Initialization

1.1. Prior to operation, each AMR must complete:

- Full sensor diagnostic check
- Environmental parameter scanning
- Protected Zone calculation verification
- Speed control system validation

2. Continuous Monitoring

2.1. The IceNav(TM) system shall maintain continuous monitoring of:

- Human presence within all control zones
- Environmental condition changes

- Sensor system performance
- Speed control system response times

3. Fault Response

3.1. In the event of system faults:

- Immediate speed reduction to safe level
- Notification to central control system
- Automated incident logging
- Safe zone expansion by 50%

## 5. COMPLIANCE AND DOCUMENTATION

1. Testing Requirements

1.1. SSM systems must undergo:

- Daily operational verification
- Weekly comprehensive testing
- Monthly performance audits
- Quarterly third-party certification

2. Record Keeping

2.1. The following records must be maintained for 3 years:

- System initialization logs
- Incident reports
- Maintenance records
- Certification documentation

## 6. UPDATES AND REVISIONS

1. This Protocol shall be reviewed and updated annually or upon:

- Significant technology changes
- Regulatory requirement updates
- Incident investigation findings
- Customer safety requirement modifications

## 7. LEGAL COMPLIANCE

1. This Protocol complies with:

- ANSI/RIA R15.06-2012
- ISO 10218-1:2011
- ISO/TS 15066:2016
- OSHA Guidelines for Robotics Safety

## 8. CERTIFICATION

The undersigned hereby certifies that this Protocol has been reviewed and approved for implementation across all Company operations and customer deployments.

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Dr. James Barrett

Chief Robotics Officer

Date: January 15, 2024

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Sarah Nordstrom

Chief Operating Officer

Date: January 15, 2024
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## 9. DISCLAIMER