Robot-Human Interaction Safety Guidelines v3.2

Polar Dynamics Robotics, Inc.

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1. Purpose and Scope

1. These Robot-Human Interaction Safety Guidelines ("Guidelines") establish mandatory safety protocols for all interactions between Polar Dynamics Robotics, Inc. ("PDR") autonomous mobile robots ("AMRs") and human personnel in temperature-controlled environments.

2. These Guidelines apply to all PDR AMR models, including but not limited to the IceNav(TM) Series 200, 300, and 400 platforms operating in environments ranging from +20 C to -40 C.

2. Definitions

1. "Safety Zone" means the designated operational area surrounding an AMR, consisting of:

a) Inner Zone: 0-1.5 meters

b) Warning Zone: 1.5-3.0 meters

c) Awareness Zone: 3.0-5.0 meters

2. "Emergency Stop (E-Stop)" means the immediate cessation of all AMR movements through either physical emergency stop buttons or wireless safety systems.

3. "Cold Environment Operation" means any operation in environments below 0 C where PDR's proprietary cold-resistant systems are actively engaged.

3. General Safety Requirements

1. All PDR AMRs must maintain:

a) Functional safety-rated sensors with cold-environment certification

b) Operational IceNav(TM) navigation and obstacle detection systems

c) Visible status indicators and warning lights

d) Audible movement signals calibrated for cold-environment acoustics

e) Emergency stop capabilities accessible from all sides

2. Human operators must:

a) Complete PDR's certified safety training program

b) Wear high-visibility clothing meeting ANSI/ISEA 107-2020 standards

c) Maintain proper personal protective equipment for cold environments

d) Carry emergency stop remote controls when working within Safety Zones

4. Operational Protocols

1. Speed Restrictions

- Maximum speed in human-occupied areas: 1.5 meters/second
- Reduced speed zones near intersections: 0.75 meters/second
- Crawler mode in high-density areas: 0.3 meters/second

2. Safety Zone Management

a) AMRs must automatically reduce speed when humans enter the Warning Zone

b) Complete stop required when humans enter the Inner Zone

c) Minimum 3-meter separation between AMRs in motion

3. Cold Environment Specific Protocols

a) Enhanced sensor cleaning intervals every 4 operating hours

b) Thermal management system verification before each shift

c) Ice accumulation monitoring and removal procedures

d) Cold-specific emergency response protocols

5. Emergency Procedures

1. In the event of system failures:

a) Immediate E-Stop activation

b) Personnel evacuation from affected zones

c) Notification of shift supervisor

d) Implementation of Manual Override Protocol PDR-MOP-2024

2. Recovery Procedures

a) System diagnostic verification

b) Safety sensor recalibration

c) Graduated return to service protocol

d) Incident reporting and documentation

6. Maintenance and Inspection

1. Daily Inspection Requirements:

- Safety sensor functionality verification
- E-Stop system testing
- Visual inspection of all safety markings
- IceNav(TM) system calibration check
- Thermal management system verification

2. Weekly Maintenance:

- Comprehensive sensor cleaning and calibration
- Safety zone detection system testing
- Emergency response system verification
- Software safety protocol validation

7. Training and Certification

1. Required Training Modules:

- Basic AMR safety orientation
- Cold environment operational procedures
- Emergency response protocols
- IceNav(TM) system interaction guidelines
- Safety zone management

2. Certification Requirements:

- Initial certification valid for 12 months
- Annual recertification required
- Additional certification for cold environment operations
- Supervisor-specific safety management training

8. Compliance and Documentation

1. All safety incidents must be reported through PDR's Safety Management System within 24 hours.

2. Monthly safety audits must be conducted and documented.

3. Safety compliance records must be maintained for 5 years.

9. Amendments and Updates

1. These Guidelines shall be reviewed and updated annually or as required by operational changes.

2. All amendments must be approved by PDR's Safety Committee and Chief Robotics Officer.

10. Legal Disclaimer

These Guidelines are proprietary to Polar Dynamics Robotics, Inc. and are protected under applicable intellectual property laws. While PDR has made every effort to ensure the accuracy and completeness of these Guidelines, they are provided "as is" without any warranties of any kind. PDR reserves the right to modify these Guidelines at any time to maintain compliance with applicable laws and regulations or to incorporate technological advances.

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Approved by: Dr. James Barrett, Chief Robotics Officer

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