ANSI/RIA R15.06-2012 Risk Assessment Documentation

Polar Dynamics Robotics, Inc.

Document Reference: PDR-RA-2023-112

Date of Assessment: December 15, 2023

Version: 2.0

1. Executive Summary

This document details the comprehensive risk assessment conducted for Polar Dynamics Robotics' IceNav-enabled Autonomous Mobile Robot (AMR) systems in accordance with ANSI/RIA R15.06-2012 Industrial Robots and Robot Systems Safety Requirements. The assessment evaluates potential hazards associated with the operation of PDR-Series AMRs in temperature-controlled environments ranging from -40 C to +25 C.

2. Scope of Assessment

1. Systems Evaluated:

- PDR-500 Series Cold Storage AMR
- PDR-750 Series Pharmaceutical Grade AMR
- IceNav(TM) Navigation System v4.2
- ThermalGuard(TM) Actuator Systems

2. Operating Environment Parameters:

- Temperature Range: -40 C to +25 C
- Humidity: 10% to 95% non-condensing
- Floor Conditions: Varied (including frost-covered surfaces)
- Operating Speed: 0.5 m/s to 2.0 m/s

3. Risk Assessment Methodology

1. Assessment Standards

- ANSI/RIA R15.06-2012
- ISO 10218-1:2011
- ISO 13849-1:2015

- ISO 12100:2010

2. Risk Assessment Process

- Task identification and analysis
- Hazard identification
- Risk estimation
- Risk evaluation
- Risk reduction measures implementation

4. Identified Hazards and Risk Levels

1. Mechanical Hazards

- Impact forces during automated movement
- Crushing hazards during docking
- Pinch points during payload handling
- Initial Risk Level: Medium
- Residual Risk Level: Low

2. Environmental Hazards

- Condensation accumulation
- Ice formation on sensors
- Thermal stress on components
- Initial Risk Level: High
- Residual Risk Level: Low

3. Control System Hazards

- Navigation system failures
- Emergency stop system reliability
- Sensor degradation in extreme cold
- Initial Risk Level: Medium
- Residual Risk Level: Low

5. Risk Reduction Measures

1. Engineering Controls

- Redundant safety sensors with heated housings
- Multi-zone LIDAR systems with environmental compensation
- Fail-safe emergency stop circuits
- Temperature-hardened control systems

2. Administrative Controls

- Operator training requirements
- Maintenance procedures
- Operating environment specifications
- Emergency response protocols

3. Warning Systems

- Visual and audible warning indicators
- Status monitoring systems
- Remote monitoring capabilities

6. Performance Requirements

1. Safety Functions

- Safety-rated soft limits: Performance Level d
- Emergency stop: Performance Level e
- Presence sensing: Performance Level d
- Speed monitoring: Performance Level d

2. Validation Testing

- Environmental chamber testing (-45 C to +30 C)
- Impact resistance verification
- EMC compliance testing
- Software validation procedures

7. Compliance Declaration

Based on the comprehensive risk assessment conducted, the PDR-Series AMRs, when installed and operated according to manufacturer specifications, comply with all applicable requirements of

ANSI/RIA R15.06-2012 and associated standards. The residual risks have been reduced to an acceptable level through implementation of appropriate risk reduction measures.

8. Documentation Requirements

1. Required Documentation

- Operating manual
- Maintenance procedures
- Installation guidelines
- Emergency procedures
- Training materials

2. Record Keeping

- Maintenance logs
- Incident reports
- Training records
- Software update history

9. Certification

This risk assessment has been conducted by qualified personnel in accordance with ANSI/RIA R15.06-2012 requirements.

Assessed by:

Dr. James Barrett

Chief Robotics Officer

Polar Dynamics Robotics, Inc.

Date: December 15, 2023

Reviewed by:

Sarah Nordstrom

Chief Operating Officer

Polar Dynamics Robotics, Inc.

Date: December 15, 2023

10. Legal Disclaimer

This risk assessment documentation is confidential and proprietary to Polar Dynamics Robotics, Inc. While every effort has been made to ensure accuracy and completeness, this assessment is based on conditions observed at the time of evaluation and may not account for subsequent changes or modifications. Implementation of risk reduction measures must be verified prior to operation.