PDR-MFG-2023-775: Clean Room Assembly Procedures for Polar Environment Sensors

1. PURPOSE AND SCOPE

1. This document establishes mandatory procedures for clean room assembly of Polar Environment Sensors ("PES") manufactured by Polar Dynamics Robotics, Inc. ("Company") at its ISO Class 6 (FED STD 209E Class 1000) clean room facility located at 4750 Arctic Way, Dover, Delaware.

2. These procedures apply to all Company personnel involved in the assembly, testing, and quality control of PES components designated for integration into the IceNav(TM) Navigation System and related cold-environment autonomous mobile robot platforms.

2. DEFINITIONS

1. "Clean Room" means the controlled environment meeting ISO 14644-1 Class 6 standards maintained at 20 C 1 C and 45% 5% relative humidity.

2. "PES Assembly" means the complete process of assembling, calibrating, and testing Polar Environment Sensors (Part No. PDR-SNS-2023-A through PDR-SNS-2023-F).

3. "Qualified Personnel" means employees who have completed PDR Clean Room Certification Program (CRCP-2023) and maintain current certification status.

3. CLEAN ROOM ENTRY PROCEDURES

1. Personnel Requirements

a) Valid CRCP-2023 certification

b) Completion of daily health screening

c) No application of cosmetics, fragrances, or volatile personal care products

d) Compliance with Company SOP-SAF-2023-112 regarding jewelry and personal items

2. Gowning Sequence

a) Initial air shower - minimum 30 seconds

b) Application of boot covers in pre-gowning area

c) Cleanroom suit application per Protocol PDR-CL-2023-441

d) Hood and face mask application

e) Double glove application using approved nitrile gloves

f) Final air shower - minimum 45 seconds

4. ASSEMBLY ENVIRONMENT SPECIFICATIONS

1. Environmental Controls

a) Temperature: 20 C 1 C

b) Relative Humidity: 45% 5%

c) Positive Pressure: 0.05" WC minimum

d) Air Changes: 30 per hour minimum

e) HEPA Filtration: ISO 14644-1 compliant

2. Monitoring Requirements

a) Continuous particle counting at 0.5 m and 5.0 m

b) Real-time temperature and humidity logging

c) Pressure differential monitoring

d) Monthly certification of monitoring systems

5. ASSEMBLY PROCEDURES

1. Pre-Assembly Requirements

a) Verification of component cleanliness per SOP-QC-2023-334

b) Tool and fixture sanitization using approved IPA solution

c) Documentation of lot numbers and traceability data

d) Calibration verification of all measurement equipment

2. Assembly Sequence

a) Primary sensor array alignment (Tolerance: 0.02mm)

b) Thermal interface material application

c) Optical component integration

d) Hermetic sealing (Test pressure: 2.0 bar)

e) Initial calibration sequence

3. Quality Control Points

a) Pre-assembly component inspection

b) Mid-process verification steps

c) Post-assembly functional testing

d) Environmental stress screening

6. TESTING AND VALIDATION

1. Required Testing Sequence

a) Thermal response verification (-40 C to +25 C)

b) Humidity sensitivity validation

c) Pressure response characterization

d) Cross-axis interference testing

e) Long-term drift analysis (24-hour minimum)

2. Acceptance Criteria

a) Response time: 50ms at -30 C

b) Accuracy: 0.1 C across operating range

c) Drift: < 0.05 C/24hr

d) Hermetic seal: < 1x10-8 cc/sec He

7. DOCUMENTATION AND RECORDS

1. Required Documentation

a) Assembly traveler with operator sign-offs

b) Environmental monitoring logs

c) Component traceability records

d) Test data packages

e) Non-conformance reports (if applicable)

2. Record Retention

a) Electronic records: 7 years minimum

b) Physical documentation: 3 years minimum

c) Calibration certificates: Duration of product life

8. REVISION CONTROL

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Approved by:

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9. PROPRIETARY NOTICE