### PDR-2023-778 HYDRAULIC SYSTEM COLD WEATHER PERFORMANCE

# PDR-2023-778 HYDRAULIC SYSTEM COLD V

**Product Design Requirements Document** 

Revision 2.1 - December 15, 2023

#### 1. DOCUMENT CONTROL

**Document Number: PDR-2023-778** 

**Classification: Confidential & Proprietary** 

**Department: Engineering - Hydraulics Division** 

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Approved By: Dr. Elena Frost, CEO

Effective Date: January 1, 2024

# 2. PURPOSE AND SCOPE

1 This Product Design Requirements Document ("PDR") establishes

2 This PDR applies to all current and future hydraulic system compon

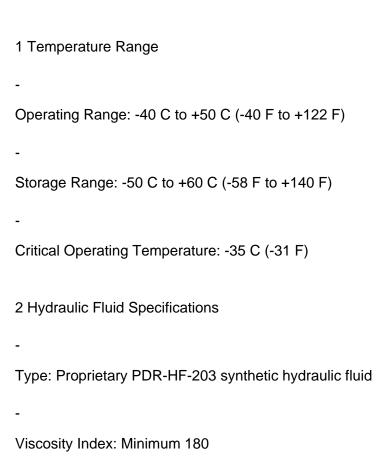
#### 3. DEFINITIONS

1 "BlueCore(TM) Technology" means Company's proprietary cold-env

2 "Critical Operating Temperature" means the minimum temperature

3 "Performance Degradation" means any reduction in hydraulic system

# 4. PERFORMANCE REQUIREMENTS



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Pour Point: -45 C (-49 F)

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Flash Point: >200 C (392 F)

3 System Performance Metrics

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Maximum System Pressure: 3,500 psi at -35 C

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Minimum Flow Rate: 15 GPM at -35 C

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Response Time: 100ms at -35 C

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Leakage Rate: <0.1% of total volume per 1000 operating hours

# **5. TESTING REQUIREMENTS**

1 Environmental Chamber Testing
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Duration: Minimum 72 hours continuous operation
-
Temperature Cycling: 5 complete cycles between +20 C and -40 C
-
Load Testing: Full rated load at 15-minute intervals
2 Field Validation
-
Minimum 500 hours of operation in cold storage facilities
-
Documentation of all performance metrics specified in Section 4.3

- -5-

Weekly calibration and measurement of all critical parameters

### **6. SAFETY AND COMPLIANCE**

1 The hydraulic system shall comply with:

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ISO 13849-1:2015 Performance Level 'd'

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IEC 60204-1:2016 Electrical Safety Requirements

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ANSI/RIA R15.06-2012 Industrial Robot Safety

2 Emergency Systems

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Redundant pressure relief valves
-
Emergency shutdown capability within 500ms
-
Automatic fault detection and reporting
7. DOCUMENTATION REQUIREMENTS
1 The following documentation must be maintained:
-
The following documentation must be maintained:     Design validation test results
-
-
- Design validation test results
- Design validation test results
- Design validation test results - Material certificates for all critical components -
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7-
Failure mode and effects analysis (FMEA)
-
Operating procedures and maintenance schedules
8. QUALITY CONTROL
1 Each production unit shall undergo:
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Pressure testing at 1.5x maximum operating pressure
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Temperature cycling verification
Flow rate validation at minimum and maximum temperatures
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Response time measurement at critical operating temperature

### 9. PROPRIETARY INFORMATION

1 This document contains confidential and proprietary information of F

### **10. REVISION HISTORY**

Version | Date | Description | Approved By

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0 | 2023-09-15 | Initial Release | M. Chen

0 | 2023-11-30 | Updated temperature specifications | E. Frost

1 | 2023-12-15 | Revised testing requirements | E. Frost

# 11. APPROVAL AND AUTHORIZATION

The undersigned hereby approve this Product Design Requirements I

Dr. Elena Frost

Chief Executive Officer

Date: December 15, 2023

Dr. Marcus Chen

Chief Technology Officer

Date: December 15, 2023

Dr. James Barrett

**Chief Robotics Officer** 

Date: December 15, 2023