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| EE495/CME495 |
| Robotic Positioner System Requirement Matrix |
| Revision 4 |

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# Purpose

This document identifies the complete set of system requirements for the Doepker Industries Robot Rotator. It contains a matrix which identifies where the formal requirement is located, allocates each requirement to hardware or software or both, identifies one or more methods that will be used to verify each requirement, and identifies at which level of testing each requirement is verified.

As requirements are verified through analysis, inspection, demonstration or testing the documents containing the verification are identified in the matrix.

## Document Identifier

This document is identified as:

**CD3 – EE495/CME495 Robotic Positioner System Requirements Matrix**

## Applicable Documents

Applicable documents include:

**CD1 – EE495/CME495 Robotic Positioner Problem Definition**

## Revision History

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| --- | --- | --- |
| **Date** | **Revision** | **Changes** |
| October 27, 2019 | 1 | Initial Revision |
| October 28, 2019 | 2 | Formatting changes, added and edited requirements. |
| November 2, 2019 | 3 | Added new requirements for the user panel after meeting with client. |
| November 14, 2019 | 4 | Modified requirements to address comments made by client. |

## Abbreviations and Acronyms

The following is a list of abbreviations and acronyms used in this document:

FAT Factory Acceptance Test

HW Hardware

SRM System Requirement Matrix

SW Software

# Requirements Matrix

The matrix in this section identifies every system requirement. Its columns are described below:

1. **Requirement ID.** A unique identifier that can be used for purposes of traceability.
2. **Source.** An unambiguous reference to the origin of the requirement.
3. **Description.** The requirement text.
4. **Allocation.** The system object or objects to which the requirement is allocated.
5. **Verification Method.** This column indicates how the requirement will be verified:

* **Analysis.** Requirements are verified by applying indirect methods such as mathematical analysis, modeling, simulation, similarity assessments, review of design, and validation of records.
* **Inspection.** Requirements are verified by direct visual observation of passive characteristics, without the use of specialized equipment or services.
* **Test.** Requirements are verified by measurement of quantitative characteristics during or after the controlled application of stimuli under appropriately controlled conditions, or by direct visual observation of active qualitative characteristics.

1. **Test Level.** The level of testing at which the requirement will be verified. The column is subdivided into the three levels of testing at which the verification of the requirement will be shown.

* **Sub.** At the subsystem test level. Subsystem tests are generally performed to verify functionality on a unit level before the unit is integrated into the system. The tests are not witnessed by Doepker Industries, but the results of the test are available for review upon request.
* **FAT.** At the Factory Acceptance Test level. The factory acceptance is performed at Doepker Industries according to test procedures. The test procedures are submitted to Doepker Industries for approval before the start of testing. Doepker Industries is requested to witness FAT.

1. **Comments.** Used to clarify the group’s interpretation of a requirement, supplement any columnar information or to denote those rows in the table that are “Title Only”.
2. **Where Verified.** Identifies one or more documents that verify the requirement. Reference to a test procedure means the completed test procedure. This column is filled in before FAT.

| Table 2‑1 System Requirements Matrix |
| --- |

| **Requirement ID** | **Source** | **Description** | **Allocation** | | **Verification Method** | **Test Level** | | **Comments** | **Where Verified** |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **SW** | **HW** | **Sub** | **FAT** |
| **RD: Rotator Design Requirements** | | | | | | | | | |
| RD-1 | Client | The system shall continuously rotate a load 360° around the horizontal axis. |  | X | Test |  | X |  | System Test Plan, Section 5.4.1 |
| RD-2 | Client | The system shall be able to recall and rotate to a preset angular position. | X | X | Test |  | X | The position that the system can recall/rotate to will be parallel to the ground, facing upwards (0 degrees). | System Test Plan, Section 5.4.1 |
| RD-3 | Derived | The system shall support at minimum 1177 newton-meter (N m) of dynamic torque. |  | X | Test |  | X |  | System Test Plan, Section 5.4.1 |
| RD-4 | Derived | The system shall support at minimum 941 N m of static torque. |  | X | Test |  | X |  | System Test Plan, Section 5.4.1 |
| RD-5 | Derived | The system shall support a load of maximum 500 kilograms (kg) weight. |  | X | Test |  | X |  | System Test Plan, Section 5.4.1 |
| RD-6 | Derived | The system shall support a load offset of maximum 0.15 meters. |  | X | Test |  | X | The offset distance is calculated from the center of the rotator to the center of gravity of the load. | System Test Plan, Section 5.4.5 |
| RD-7 | Derived | The system shall rotate at a minimum speed of 1.0 rotations-per-minute (rpm). | X | X | Test |  | X |  | System Test Plan, Section 5.4.2 |
| RD-8 | Derived | The system shall rotate at a maximum speed of 5.0 rpm. | X | X | Test |  | X |  | System Test Plan, Section 5.4.2 |
| RD-9 | Derived | The load shall remain fixed along the rotational axis when the system is not rotating. |  | X | Test |  | X |  | System Test Plan, Section 5.4.1 |
| RD-10 | Derived | The system shall rotate to angle positions with a resolution of maximum 1°. | X | X | Test |  | X |  | System Test Plan, Section 5.4.4 |
| RD-11 | Client | The system shall be rotated using electrically powered means. |  | X | Analysis | X |  |  | System Design Document, Section 3.4 |
| **HD: Hardware Design Requirements** | | | | | | | | | |
| HD-1 | Derived | The system shall be built using two “A” frame supports provided by the client. |  | X | Inspection |  | X | Exact size of the supports is yet to be determined. | System Test Plan, Section 5.3.3 |
| HD-2 | Derived | The system shall remain stationary during operation. |  | X | Test |  | X |  | System Test Plan, Section 5.4.2 |
| HD-3 | Client | The total cost of system components shall not exceed $10,000 Canadian Dollars. |  | X | Analysis | X |  |  | BOM??? |
| **ED: Electrical Design Requirements** | | | | | | | | | |
| ED-1 | Derived | The system shall operate on any of the following electrical power voltages:   * 120 volts (V), single-phase * 208 volts (V), single-phase * 575 V, three-phase |  | X | Analysis | X |  |  | System Design Document, Section 2.2.1 |
| ED-2 | Derived | The system shall be operated between 0°C to 35°C. |  | X | Analysis | X |  |  | System Design Document, Section 3.1 |
| **SRR: Standards and Regulations Requirements** | | | | | | | | | |
| SRR-1 | Derived | The system shall use only RoHS compliant components. |  | X | Analysis | X |  |  | BOM??? |
| **SR: Safety Requirements** | | | | | | | | | |
| SR-1 | Client | The system shall have an easy-to-access emergency stop button, which stops all system operations when pressed. | X | X | Test |  | X | The emergency stop button will stop power from going to the rotator but will keep the control panel powered to protect the microcontroller. | System Test Plan, Section 5.4.3 |
| SR-2 | Derived | The system shall have a button to disable/enable rotation operations. | X | X | Test |  | X |  | System Test Plan, Section 5.4.3 |
| SR-3 | Derived | The system shall audibly alert the operator when rotating. | X | X | Test |  | X |  | System Test Plan, Section 5.4.3 |
| **UIR: User Interface Requirements** | | | | | | | | | |
| UIR-1 | Client | System operation shall only be performed using physical buttons. | X | X | Inspection |  | X |  | System Test Plan, Section 5.3.3 |
| UIR-2 | Client | The system shall have a control panel with buttons to rotate the system in angular steps in the clockwise and counterclockwise direction. | X | X | Inspection |  | X | RD-10 specifies the amount by which the system shall rotate per step. | System Test Plan, Section 5.3.3 |
| UIR-3 | Client | The system’s control panel shall be able to be moved up to 10 feet away from the rotating portion of the system. |  | X | Inspection |  | X |  | System Test Plan, Section 5.3.3 |
| UIR-4 | Derived | The system’s control panel shall indicate if the system is rotation locked. | X | X | Test |  | X |  | System Test Plan, Section 5.4.3 |
| UIR-5 | Derived | The system shall have an on/off button and indicator. | X | X | Test |  | X |  | System Test Plan, Section 5.4.3 |
| UIR-6 | Client | The control panel shall have buttons to rotate 45˚ clockwise and counterclockwise from the current position. | X | X | Test |  | X |  | System Test Plan, Section 5.4.4 |