Turntable for Locomotives
Technical Specification

1. Version history

<table>
<thead>
<tr>
<th>Revision</th>
<th>Date</th>
<th>Changed</th>
<th>Reason of change</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>01.07.17</td>
<td></td>
<td>First Draft</td>
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2. Introduction
This document is intended to outline the concept of Turntable for Locomotives.

The purpose of the Turntable is:

✓ 180° rotation for the locomotive in both directions, back and forth.
✓ 180° rotation in case one side of the locomotive is not allowed for travel
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3. Overview

Israel Railways has 40 freight locomotives with driver cab on one side of the locomotives and the engine on the other. Driving to the side where the engine is located is not safe and makes it difficult to operate the locomotive. Israel Railways plans to purchase two turntables for 180 degree rotation. The systems are designed for installation in the cargo division in Ashdod and Tzefa.
4. General requirements:

4.1 Robust and durable structure

4.2 Low-wear and maintenance-free components

4.3 Anti-friction bearings designed for a minimum of 20,000 operating hours

4.4 High quality standards through regular checks on material and workmanship

4.5 Simple operation

4.6 Easy access to all wear and service items such as running wheels, motors, gearboxes etc.

4.7 High Reliability above 99%

4.8 High availability above 99%

4.9 MTBF above 15,000 hours

4.10 All components and systems must work in safety manner to protect the workers & facility according to OHSAS 18001:2007, Safety Management Standard

4.11 The system should be protected from lightning strike, voltage fluctuations and power outages. The system must return to function correctly after completion of the event.

4.12 Friendly for use and easy for maintenance

4.13 The equipment should not cause any disturbing for the train's system.

4.14 Permissible ambient operating temperature: -5 °C to +70 °C (operation), -5 °C to +85 °C (storage)

4.15 Shock and vibration resistance: DIN EN 61373, Category 1, Class B

5. RAMS

RAMS (Reliability, Availability, Maintainability, Safety)

5.1 General

The RAMS process includes either the definition of the requirements and the demonstration of compliance.
System redundancy requirements shall be defined by the supplier in appropriate fashion to meet the RAMS targets defined according to EN 50126, EN 50128 and EN 50129. The list of applicable should be supplemented by the Standards EN 50126, EN 50128, EN 50129 and EN 61508-1.

5.2 Reliability
The reliability of the system shall be under the condition that the maintenance is performed in accordance with the maintenance manual. The Reliability should be above 99%. MTBF should be above 15,000 hours.

5.3 Availability
The daily availability of the system shall be above 99%.

5.4 Maintainability
The following general rules are to be followed:

- All components shall be designed in order to achieve a running time of 6 years without special maintenance. No components shall require maintenance below 1 year of running.
- Components shall be installed easily accessible. Identical parts must be interchangeable, similar parts, which are not interchangeable must be keyed, so that they cannot be misplaced. It should be possible to replace Faulty Components without the need to remove the rest of the assemblies.
- Functional units shall be designed as easily exchangeable modules.
- Design to minimize adjustment requirements
- Design to minimize maintenance personal skills and training
- Design to minimize number of special tools

6. FUNCTIONAL DESCRIPTION
The turntable shall be used for turning locomotives by 180° in order to enable safe driving with the locomotive in both directions. The turning action should initiated from a control panel on the turntable itself. The control panel shall be housed in protective cage. After completing the round the device will locked in place automatically. The rail vehicle can enter the turntable under its own power or it can be pulled on and off by using a shunting device. The turntable shall include rotating flash lights on both sides, horn and emergency-STOP buttons.
7. TECHNICAL DATA

Turntable Load capacity: up to 150 ton
Max locomotive's length: 21 m
Max locomotive's wide: 3 m
Width of turntable: approx. 6,800 mm
Rail type on turntable: UIC – 60, UIC – 54, U – 50
Track gauge on turntable: 1,435 mm
Max Turning speed at outer diameter: up to 1 m/s.
Electrical motors - operating voltage: 380 V / 50 Hz (3 phases)
Control voltage: 230 V / 50 Hz
General Protection: IP 55
Ambient temperature: -5°C, +50 °C (in shade)
Climatic conditions are continental, dry, dusty, and rainy
Insulation issue: F

8. Main Components

8.1 SUPPORTING STRUCTURE
The structure shall made of hardened steel with torsion beam. All joined should be by heavy-duty screw connections. The structure shall includes jack-up points in case of a fault r for maintenance work.

8.2 RAIL TRACK on supporting structure
The running rails, R50, shall be mounted directly onto the bridging beams where they are held in place by rail clamps. The rail type R50 is in accordance to UIC60 with hardness not less than 340 HB. Track gauge is 1,435 mm.

8.3 CATWALKS at each side of the turntable
Catwalks shall be provided either side of and in between the rails. The catwalks shall be designed of non-slip grid galvanized panels. The grid elements should be designed for loads of up to 300 kg/m². Walkways for persons at the turntables, parallel to the track, furnished with grid floors, width 1 m, shall be outside of the loading gauge.
Safety hand rails at both sides must provided as fall-off protection complies with rules and directives for work safety.

8.4 CONTROL STAND – PROTECTIVE CAB

The control stand shall be located in protective galvanized steel housing, enabling the operator to operate in a safe manner. The operator cab should be protected from rain and equipped with electrical heater. It shall equipped with wall-mounted fan allow work even in the hot summer days. It shall equipped with lights for night work. Socket of 220V should be installed for general usage.

8.5 WHEEL PENDULUM

Heavy-duty pendulum twin-wheel assemblies, shall be align with the radius of the pit rail. Means for adjustment should be supplied. All lubricating points at pendulum assembly and wheels should be easily accessible for routine service. The running wheels should be easy to replace.

8.6 RUNNING WHEEL

Non-driven & driven wheels with outer bearings should be used. The wheels shall be made from 42CrMo4 with surface hardness of 56 HRC. The bearings should be industrial self-aligning, low maintenance & dust-proof.

8.7 ELECTRICAL DRIVE SYSTEM

The electrical drive system enabling the turning mod in the desirable speed to insure accurate and safe operation. The isolation level should be class F and the protection level should be IP 55. In case of failure the system should be be operated in an emergency mode. Normal braking wear-free should be used. In case of an Emergency-STOP situation or after a loss of electric power, spring-actuated brakes at the drive motors will engage and stop the turntable. In case of a fault, the brakes can be manually released and locked in this state. In case of a failure in the electric supply the turntable can be turned manually.

8.8 LOCKING OF TURNTABLE

Locking means should be guarantee accuracy of +/- 3 mm in relation to the rail center.
8.9 CENTRE SUPPORT BEARING

The vertical load is approx. 1/3 of the total load, 2/3 of the load will be taken from the outside running wheels. The horizontal load is in accordance with the maximum braking force of the locos.

8.10 PIT RAIL - RUNNING RAIL

The pit rail (turntable running rail) shall be single rail. The rail shall be fixed with suitable rail clamps.

8.11 SIGNAL DEVICES

- Horn plus Emergency-STOP buttons which are actuated from the cabin position.
- Yellow rotating flash lights at the approach and departure ends of the crossing track.
- Warning signs (No unauthorized persons allowed) at the approach and departure ends of the crossing track.
- Warning Lights In case of rail vehicle extends beyond the end of the turntable, Overweight, Blocked drive motor etc.
- Green light after completion of the turning, when ready to drive.

8.12 SWITCH CABINET, CONTROL SYSTEM, SAFETY DEVICES

The switch cabinet should be designed according to current industrial standards and should be installed in the protective cabin using vibration-dampening mounting elements. All electric mounts and terminals should be secured with rust-free or corrosion-resistant screws. The control stand shall include a programmable logic control - PLC for all drive units. It should have diagnostic features for status & faults reports.

In case of rail vehicle extends beyond the end of the turntable, Overweight, Blocked drive motor etc., the controller should stop immediately the turntable and operate the emergency lights.
9. **Electrical requirements**

The turntable and the electric installation shall be provided with filters and screened wires according to the “Directive for the electromagnetic compatibility CE 2004/108/EC”.

Supply voltage with neutral conductor: 230 V; 3 x 400 VAC. Frequency 50 Hz. All diagrams shall be detailed and indicate the manufacturer of each of the components assembled. The diagrams shall be enclosed with the panels, attached to the inside wall/door of the cabinet.

All circuits will be correctly marked, labels fitted on the front and side of the panel shall be arranged to allow unique identification of all of the elements.

To achieve good EMC characteristics separate cable ducts or cable platforms must be provided for power and control/measurement cables. Power cables must be laid with strict separation from control and measurement cables. The cable ducts should be sheet metal ducts with large surface conductive connection to one another over the entire length and grounded as necessary.

There should be a potential compensation between system parts.

The electric system shall design under CE rules, with sealed IP 52 metal protection, low voltage 24 volt controls.

10. **INSTALLATION & acceptance tests**

A detailed drawing of the turntable’s foundation (pit) including mechanical, electrical, hydraulic & pneumatic schemas should be delivered by the supplier at least six months prior the shipping of the turntable. The supplier responsibility to mount and install the turntable.

The acceptance tests will be conducted according to procedure made by the supplier and approved by ISR.

11. **Applicable standards**

11.1 **Machinery and steel construction**

- Machinery Directive 2006/42/CE


Impact on structures
Design and construction of steel structures
Design of steel structures and aluminum frameworks

11.2 Electrical engineering

- Erection of power installations with nominal voltages up to 1000 V
- Electrical equipment of machines
- Electromagnetic compatibility, noise emission for industrial applications
- Electromagnetic compatibility, immunity for industrial applications
- Electromagnetic Compatibility
- Low Voltage Directive
- Electromagnetic compatibility (EMC) - Product family standard for machine tools Part 1: Emission
- Electromagnetic compatibility (EMC) - Product family standard for machine tools Part 2: Immunity

11.3 Safety

<table>
<thead>
<tr>
<th>Standard No</th>
<th>Standard's title</th>
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<tr>
<td>EN 953:1997</td>
<td>Safety of machinery – Guards General requirements for the design and construction of fixed and moveable guards</td>
</tr>
<tr>
<td>EN 1037:2008</td>
<td>Safety of machinery – Prevention of unexpected start-up</td>
</tr>
<tr>
<td>EN 1088:1995</td>
<td>Safety of machinery – Interlocking devices associated with guards- Principles for design and selection</td>
</tr>
<tr>
<td>EN 60204-1:2006</td>
<td>Safety of Machinery - Electrical Equipment of Machines Part 1: General Requirements</td>
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<tr>
<td>ISO EN 12100-1:2011</td>
<td>Safety of machinery - General principles for design - Risk assessment and risk reduction</td>
</tr>
<tr>
<td>ISO EN 13849-1:2008</td>
<td>Safety of machinery - Safety-related parts of control systems – Part 1: General principles for design</td>
</tr>
</tbody>
</table>
11.4 Quality

ISO 9001 quality management system

The System design shall relate and consider to the following standards (In any case of Contradiction, the strictest standard shall apply):

12. Quality Assurance Plan

12.1 General

The quality assurance program shall include regulating procedures, methods and processes used to ensure compliance with the Technical Spec and shall be documented, subject to the review and approval of ISR. The program shall be executed such that an acceptable level of quality of the supplied equipment is provided. The program shall conform to acknowledged procedures (ISO 9001). The concept of total quality assurance shall be based on the principle that quality is a basic responsibility of each segment of the Contractor's organization and shall be evidenced by:

(a) Producible and inspectable designs
(b) Firm procurement and job performance specifications
(c) Firm procedures for transmission of quality requirements and standards to Sub-Contractors and suppliers and ensuring their compliance
(d) Adequate testing to ensure repetitive product conformity to design requirements
(e) Total program surveillance and verification of physical conformance and configuration accountability.

13. Documentation

The Supplier shall submit an electronic documentation (IETM). A complete set of all drawings/specs should be provided with the first delivery. The supplier shall be responsible for the periodic update of the IETM until the end of the warranty.
ISR shall get a free license for the use and the maintenance (updating) after warranty of the IETM. The IETM shall include:

- Description of the main components: Technical data & drawings (mechanical, electronic & control, hydraulic & pneumatic)
- Installation instructions: electrical installation: hardware schematics; auxiliary, connecting and assignment schematics; parts lists
- Control system/software: software modules; program description; operating and installation instructions for the control system.
- Operation & maintenance instructions (Preventive & Corrective maintenance)
- Safety requirements
- Setting: software; backup; updates; services
- Messages: interrupt, error and operational messages

**Attachments**

**A Climate and Environment**

**A.1 Climate conditions**

**Climate and Environmental Conditions**

- Max. Ambient temp. 47 °C (shade)
- Min Ambient temp. Minus 5 °C
- Relative humidity 10% to 90%
- Altitude -400 m to +800 m
- Sunny hours per year 3300 h
- UV Radiation MJ/m² per year 360 - 600
- Rainfall mm/year 400 - 800

**Dust Conditions in the atmosphere**

(Microgram per m³ atmosphere)

<table>
<thead>
<tr>
<th></th>
<th>Maximum Half-hour Value</th>
<th>Maximum Daily Value</th>
<th>Average</th>
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<tbody>
<tr>
<td>NOx</td>
<td>1064</td>
<td>560</td>
<td>71</td>
</tr>
<tr>
<td></td>
<td>SO2</td>
<td>O3</td>
<td>Suspended Dust</td>
</tr>
<tr>
<td>-------</td>
<td>-----</td>
<td>----</td>
<td>----------------</td>
</tr>
<tr>
<td>Value</td>
<td>780</td>
<td>312</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>260</td>
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<tr>
<td></td>
<td>21</td>
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</tr>
</tbody>
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**Suspended Particulate Matter (SPM)**

Particle size to 0.5-1 micron

**Sea Salt Concentrations in the Atmosphere**

(Micrograms per m³ atmosphere)

<table>
<thead>
<tr>
<th>Salt Element</th>
<th>Na</th>
<th>Cl</th>
<th>SO4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Position:</td>
<td>Season</td>
<td>Season</td>
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</tr>
<tr>
<td></td>
<td>Dry</td>
<td>Wet</td>
<td>Dry</td>
</tr>
<tr>
<td>Sea Air at Coast Line</td>
<td>7.3</td>
<td>16.0</td>
<td>12.0</td>
</tr>
<tr>
<td>600 m from Shore</td>
<td>3.1</td>
<td>4.8</td>
<td>4.2</td>
</tr>
<tr>
<td>6000 m from Shore</td>
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<td>1.4</td>
<td>1.5</td>
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