REQUIREMENTS SPECIFICATION

for

FH Aachen Park Railroad Loco

Version 1.0 approved

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Contents

Revision History

Name	Date	Reason For Changes	Version
Pfaff	03.04.2020	Emission of new document	1.0
Pfaff	May 1, 2020	Added strength requirements, component weight, concept documentation requirements	1.1

1 Introduction

1.1 Purpose

This document describes the requirements for the FH Aachen rail vehicle engineering lab locomotives.

1.2 Document Conventions

Bold face is used for critical features or dimensions

1.3 Intended Audience and Reading Suggestions

This document is intended for FH Aachen's suppliers at all levels.

1.4 Project Scope

The product is intended to operate in the FH Aachen rail vehicle lab, mainly to test autonomous driving functionalities. A potential use in the IMechE railway challenge is optional.

1.5 References

- IMechE railway challenge specification 2019 edition

2 Overall Description

2.1 Product Perspective

The product shall operate in the lab continuously as well as in open environments.

2.2 Product Functions

The locomotive shall be able to propel trains without local emissions. It shall be able to operate on tracks with small track radii.

The locomotive shall provide interfaces for LiDAR scanners and cameras.

The locomotive shall have automatic couplers on both ends.

2.3 User Classes and Characteristics

Users will be students and staff of FH Aachen.

2.4 Operating Environment

Inside environment:

- Temperature: $15 \ldots 30°\mathrm{C}$
- Humidity: $0 \ldots 100°\%$

Outside environment as per IMechE specifications.

2.5 Design and Implementation Constraints

The locomotive shall be handleable with 1 person, except for carrying.

The locomotive shall have an attractive outward appearance.

2.6 User Documentation

Proof of car body strength and safety against derailment shall be provided with the vehicle. Full design files shall be accessible.

2.7 Assumptions and Dependencies

A standard drive train and brake control equipment can be assumed:

- 48 V power supply
- Electrical motors Dunker BG95x40, up to 4
- Pneumatic brake supply, de-energise to a activate

3 External Interface Requirements

3.1 User Interfaces

The following status shall visible to the user:

- Brake applied/released
- Wheel blocked

3.2 Hardware Interfaces

Coupler system interface are 4 M8 bolts as depicted in Figure 3.1:

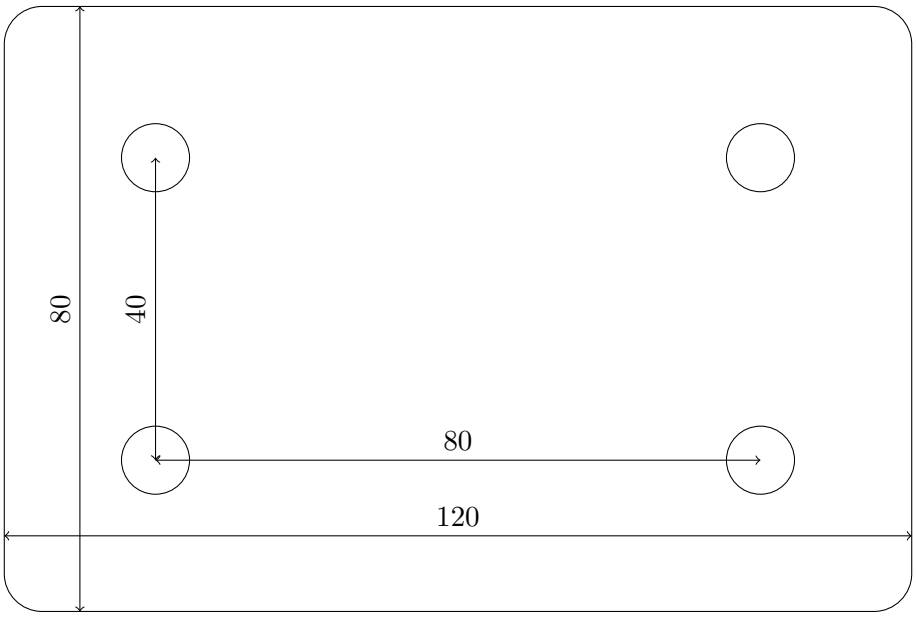

Figure 3.1: Coupler system interface

It shall be possible to fit an external sensor system by help of 4 M8 bolts in a □100 pattern to both vehicle fronts and the the top.

The car body shall provide space for the following installations:

- Battery system according to specification

  - Size of battery module: W190 x D361 x H125 mm
  - 2 (optionally 4) Modules to be placed in vehicle
  - Weight per module 15 kg
- Control system (app. (300x300x200)mm^3), weight ¡ 20 kg
- Compressor Dürr D30 with reservoir (10 l)

3.3 Software Interfaces

n/a

3.4 Communications Interfaces

n/a

4 System Features

Only additional features are listed in the sequel.

4.1 F1: Reduced curve radius

4.1.1 Description and Priority

For operation in the lab and on the test track, reduced curve radii must be negotiated by the vehicle.

4.1.2 Stimulus/Response Sequences

n/a

4.1.3 Functional Requirements

REQ-1: For operation in the lab, a 5 m curve radius must be negotiated.

REQ-2: For operation on the test track, a 10 m radius must be negotiated at a minimum velocity of 10 km/h.

4.2 F2: Visibility for LiDAR system

4.2.1 Description and Priority

It is desirable to provide 360° vision to the Ouster OS1-32 LiDAR sensor without obstruction in the space envelope described in the IMechE specification.

4.2.2 Stimulus/Response Sequences

n/a

4.2.3 Functional Requirements

REQ-3: The field of view for a top mounted LiDAR system shall remain free from obstructions, while maintaining the gauge from IMechE. Field of view is depicted in Figure 4.1 with $\theta = 16.6°$.

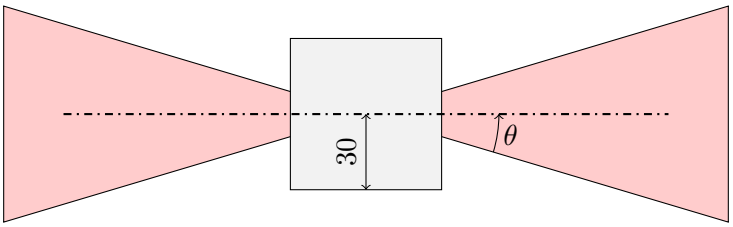

Figure 4.1: LiDAR field of view

5 Nonfunctional Requirements

5.1 Strength requirements

The vehicle shall be designed according to static strength requirements as per EN12663-1 for locomotives. For strength requirements given by a force, a scaling factor of $s_F = \frac{1}{5^3}$ shall be applied. Proof of strength shall be provided for the following cases:

- Buff and draft forces (Section 6.2.2 of EN 12663-1)
- Vertical load (Section 6.3.1 of EN 12663-1)
- Lifting (Section 6.3.2 of EN 12663-1)

5.2 Concept documentation

The concept documentation provided for the IDR milestone shall provide the following information:

- Description of the concept including specific features
- Outward appearance and dimensions:
  - Length, width and height
  - Estimated mass
  - Wheel base
  - Pivot distance
- Installation spaces
  - Dimensions
  - Accessibility
- Cost estimate
- Open issues in the specification
- Risks in the development process and mitigation measures

Documentation shall be provided as presentation (LaTeXor PowerPoint).

5.3 Performance Requirements

n/a

5.4 Safety Requirements

n/a

5.5 Security Requirements

n/a

5.6 Software Quality Attributes

n/a

5.7 Business Rules

n/a