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COCO LOCOMOTIVE PROJECT
Mass Distribution

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Revision History

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00	First issue	21/08/2025

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I. LIST OF TABLES

1 INTRODUCTION

1.1 SUBJECT

This document provides the Mass Distribution analysis For the CoCo Locomotive project.

1.2 DOCUMENTS AND STANDARDS

The CoCo Locomotive shall be designed, assembled and tested according to more recently published versions of EN, IEC, UIC, TSI and other international standards required by [Table 1], respected in the order of priority.

Table 1 reports the reference standards to the matter of the present document.

Standard	Title
EN 15663:2017	Railway applications - Vehicle reference masses
IEC 61133:2016	Railway applications - Rolling stock - Testing of rolling stock on completion of construction and before entry into service

Table 1 – Reference Standards

Table 2 reports the reference documents to the matter of the present document.

Ref.	Document	Title
[1]	TS 250.900	National Co-Co Type Mainline Locomotive Development Technical Specification
[2]	012GX1000201-000	General Layout Electric
[3]	012GX2000301-000	General Layout Diesel

Table 2 – Reference Documents

In the following sections, the two possible configurations (Electric and Diesel) will be analysed with respect to the mass distribution.

2 Requirements

The requirements relative to the mass distribution are the following:

- Maximum Axle Load = 22.5 tons

This requirement is derived directly from ref. [1]: in order to guarantee the traction effort the axle load is required to be as close as possible to the Maximum Axle Load.

3 Configuration ELECTRIC

3.1 Introduction

The ELECTRIC configuration is the more traditional one, where the required electric power is obtained by connecting the pantographs to the HV overhead catenary system.
One of the objectives of the CoCo Loco Project is to create a highly versatile locomotive, where the different configurations can be achieved by simply removing part of the equipment and adding a specific ballast.

3.2 Results

After the analysis, the resulting COG and Inertia for the Body (therefore without considering the Bogies) of the vehicle are reported in Table 7 and 8 respectively.

Body COG			
Mass [kg]	**X**	**Y**	**Z**
58395.8	-5.193	-0.007	1.892

Table 3 – Electric Configuration: Body Mass and COG

Body Inertia					
Ixx	**Iyy**	**Izz**	**Ixy**	**Ixz**	**Iyz**
92053	1650442	1635450	4032.56	-20321	-577

Table 4 – Electric Configuration: Body Inertia

Table 9 reports the mass and the COG of the whole vehicle (Bogies included, therefore).

	Nominal			
	Mass [kg]	**X**	**Y**	**Z**
CoCo Locomotive	113395.8	-5.390	-0.004	1.362

Table 5 – Electric Configuration: Vehicle Mass and COG

Finally, Table 10 reports the resulting Axle Loads of the vehicle.

CoCo Locomotive Front Motor Bogie [kg]	CoCo Locomotive Rear Motor Bogie [kg]
19607	18192

Table 6 – Electric Configuration: Axle Loads

As reported in Section 2, this situation is not respecting the considerations done to guarantee the traction.

To meet these considerations, an appropriately positioned ballast is proposed, as reported in Table 11. The value of this Ballast is obtained considering the Vehicle Mass to reach the maximum traction effort as target.

Target mass [kg]	Ballast Mass [kg]
135000	21500

Table 7 – Electric Configuration: Required Ballast Mass

Following Tables report the results after adopting the above-mentioned Ballast.

Body COG			
Mass [kg]	**X**	**Y**	**Z**
79895.8	-5.601	0.005	1.956

Table 8 – Electric Configuration, Ballasted: Body Mass and COG

Body Inertia					
Ixx	**Iyy**	**Izz**	**Ixy**	**Ixz**	**Iyz**
115791	2431715	2421836	-2398.72	-8484	-671

Table 9– Electric Configuration, Ballasted: Body Inertia

	Nominal			
	Mass [kg]	**X**	**Y**	**Z**
CoCo Locomotive	134895.8	-5.601	0.003	1.485

Table 10– Electric Configuration, Ballasted: Vehicle Mass and COG

CoCo Locomotive Front Motor Bogie [kg]	CoCo Locomotive Rear Motor Bogie [kg]
22479	22486

Table 11 – Electric Configuration, Ballasted: Axle Load

4 Configuration DIESEL

4.1 Introduction

The DIESEL configuration uses the electrical generator moved by the Diesel ICE to power the traction motors.

4.2 Results

The following Tables report the results of the locomotive without the ballast.

Body COG			
Mass [kg]	**X**	**Y**	**Z**
70587.04	-5.679	-0.009	2.107

Table 12 – Diesel Configuration: Body Mass and COG

Body Inertia					
Ixx	**Iyy**	**Izz**	**Ixy**	**Ixz**	**Iyz**
94821	1823633	1789825	8421.33	-26562	114

Table 13 – Diesel Configuration: Body Inertia

	Nominal			
	Mass [kg]	**X**	**Y**	**Z**
Loco Mass	125587.0	-5.644	-0.005	1.535

Table 14 – Diesel Configuration: Vehicle Mass and COG

CoCo Locomotive Front Motor Bogie [kg]	CoCo Locomotive Rear Motor Bogie [kg]
20765	21097

Table 15 – Diesel Configuration: Axle Loads

As for the Electric configuration, a ballast is required.

Target mass [kg]	Ballast Mass [kg]
135000	9400

Table 16 – Electric Configuration: Required Ballast Mass

Following Tables report the results after adopting the above-mentioned Ballast.

Body COG			
Mass [kg]	X	Y	Z
79987.04	-5.600	-0.008	1.974

Table 17 – Diesel Configuration, Ballasted: Body Mass and COG

Body Inertia					
Ixx	Iyy	Izz	Ixy	Ixz	Iyz
108449	1875218	1827161	8418.17	-36880	-3

Table 18 – Diesel Configuration, Ballasted: Body Inertia

	Nominal			
	Mass [kg]	X	Y	Z
CoCo Locomotive	134987	-5.600	-0.005	1.496

Table 19 – Diesel Configuration, Ballasted: Vehicle Mass and COG

CoCo Locomotive Front Motor Bogie [kg]	CoCo Locomotive Front Motor Bogie [kg]
22497	22499

Table 20 – Diesel Configuration, Ballasted: Axle Loads

5 Conclusions

For this preliminary phase, as reported in table 6, 15 and 24, it can be noticed that the requirements on the axle loads are respected for the ELECTRIC and DIESEL configurations respectively.

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