

[TB50170]  
[Rev. A]

## CoCo LOCOMOTIVE PROJECT

# SIL Definitions

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## 1. SUBJECT

The purpose of this document is to provide preliminary information about the SIL level of safety functions included in the National CoCo Loco project.

### 1.1 LIST OF ACRONYMS & ABBREVIATIONS

TCDD	General Directorate of Turkish State Railways
TÜRASAS	Turkish Railway Vehicle Industry Inc.
LOCO	Locomotive
PHA	Preliminary Hazard Analysis
SHA	System Hazard Analysis
TCMS	Train Control Management/Monitoring System
SIL	Safety Integrity Levels

## 2. APPLICABLE TECHNICAL DOCUMENTS AND STANDARDS

- TS400048 General Technical Specification of Electric CoCo Loco
- TS400049 General Technical Specification of Diesel CoCo Loco
- EN 50126: The specification and demonstration of Reliability, Availability, Maintainability and Safety (RAMS), as far as the implementation of safety process is concerned
- IEC 61508 – 5: Use of the qualitative method to determine the safety integrity levels
- EN 50128: Reference for the SW management throughout the life cycle
- EN 50129: Railway applications – Communication, signaling and processing systems – Safety related electronic systems for signaling
- EN 50716: Railway, tramway, trolleybus, and metro applications – Software development requirements

### **3. LOCO MAIN DATA**

The National Co-Co Type Mainline Locomotive project, which will be produced by TÜRASAS, is intended for freight service and has an operating speed of 120 km/h.

The loco has 2 different propulsion systems:

1. Electric Locomotive
2. Diesel Electric Locomotive

### **4. SIL LEVEL FOR LOCOMOTIVE**

#### **4.1 GENERALITY**

This document includes the SIL preliminary allocation for the safety functions regarding Co Co locomotive train and its equipment.

This preliminary allocation has the aim to establish the SIL targets of main sub-assemblies, taking into account:

- the SIL levels derived from safety analysis improved on similar vehicles (according to European standard) and applying them to specific features of the Co Co locomotive.

A more detailed analysis will be improved during the design development, according to the following process:

- ✓ Hazards identification
- ✓ Preliminary and System Hazard Analysis [PHA-SHA]
- ✓ SIL allocation to functions/systems according to IEC 61508 – 5

## 4.2 SIL LEVEL LIST

In the following table, there are the SIL levels proposed for the safety functions and related equipment of National Co-Co loco:

Equipment / function	SIL level
ETCS system	4
ATS system	2
Emergency brake	4
Vigilance system	2
Traction cut off	2
Tachymeter function	2
Passenger access doors command	2
Passenger doors status***	2
Parking brake	2
Holding brake*	2
WSP function**	2
Passenger alarm	2
Firefighting system****	2

**Table 4-1 SIL Allocation**

\* Immobilization during passenger access/egress

\*\* Mechanical brake

\*\*\* Open/close status during running

\*\*\*\* The functions of Fire-fighting system that send alarms to Driver must be SIL 2 ( $THR \leq 10^{-7}$ )

### 4.3 SIL PRELIMINARY ALLOCATION

The SIL levels targets required in table 4.1 are derived from safety analysis improved on similar vehicles, according to IEC 61508 – 5, and applying these data to specific features of the Co-Co loco.

The SIL safety classification is based on the following four risk parameters:

- A. Consequences of the hazardous event.
- B. Frequency and exposure time in the hazardous zone. This criterium is a combination of the probability and the time to be exposed to the risk.
- C. Possibility of avoiding the hazardous event. This parameter takes into account the operation of another mitigation process to reduce the risk and the way of appearance of the event.
- D. Probability of unwanted occurrence.

In conformity with this classification method, we can make follow considerations about SIL levels listed in table 4-1.

- According to experience in European railways field, SIL level = 4 is allocated to safety functions that, in case of serious fault, could have catastrophic consequences (collision, derailment) and have high exposure time in the hazardous zone:
  - ✓ Signalling system
  - ✓ Vigilance system
  - ✓ Emergency brake
- According to experience in European railways field, SIL level = 2 is allocated to safety functions that could have critical consequences, but there is possibility of avoiding the hazardous event by means of mitigation solutions (for example, redundancy of functions). So critical consequences are possible only in case of multiple faults:
  - ✓ Access doors (command and doors status)
  - ✓ Tachymeter functions)
  - ✓ Parking brake
  - ✓ Holding brake
  - ✓ WSP function
  - ✓ Passenger alarm
  - ✓ Fire-fighting system
  - ✓ Traction cut off

## **4.4 SOFTWARE BASIC INTEGRITY**

In addition to the SIL requirements above, all equipment software must comply with CENELEC EN 50716, which establishes the processes and technical requirements for the software development of programmable systems, intended for both railway control and protection applications and for rolling stock.

It must be applied to both critical and non-critical software, maintaining the same structure and types of information as previous standards.

Software previously developed according to CENELEC EN 50128 and CENELEC EN 50657 is not bound by the requirements for pre-existing software and is considered compliant with the new standard.

This allows software designed according to previous standards to be reused in new projects without the need for modifications.

Regarding software integrity level compliance, it is specified that for the development of non-safety-related functions (Basic Integrity), a process that ensures software quality is required.

This process can be achieved by applying the technical requirements set out in the CENELEC EN 50716 standard.



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