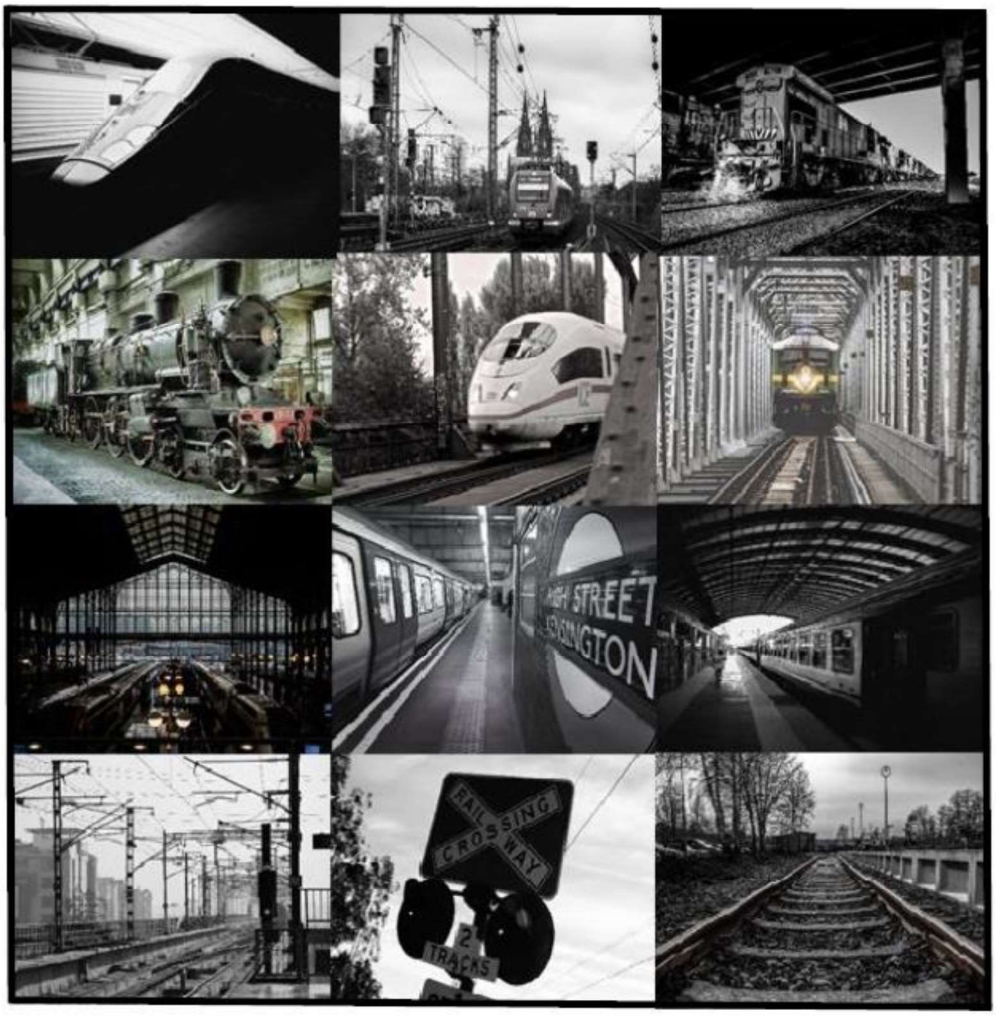
ECC

EDUARDO CALIXTO

CONSULTING

“Reliability and Maintainability Database for Railway Industry”

(Rail Infrastructure, Electric Power Supply, Signalling and Rolling Stock)



2020

TABLE OF CONTENTS

ABBREVIATIONS

2P	Two Parameters
ETF	Expected Time to Failure
FMEA	Failure Mode and Effect Analysis
PDF	Probability Density Function
RAM	Reliability Availability and Maintainability

1. INTRODUCTION

1.1 PURPOSE OF THIS DOCUMENT

The ECC reliability database aims to provide the information of equipment reliability performance of railway industries. The reliability database provides reliability data based on Weibull 2P (to parameters) values and expected time to failure or Meantime to failure (MTTF). In addition, the repair/replace time is represented by the Normal PDF.

Based on such data, this information enables to reliability, maintenance and asset management professional to apply as reference for reliability requirement, input for RAM analysis, Risk analysis.

1.2 METHODOLOGY

In order to build up such database, the historic of hundred equipment as well as my experience over 20 years as reliability engineering in oil and gas industry was considered.

However, this database, different of others, is defined in component level. Because of different equipment configuration, it was considered the most critical component that affect the equipment reliability performance.

The reliability data base is presented in level 1 (equipment) and level 2(component). The main equipment of railway are divided in different types of equipment and system such as:

- Rail;
- Power Supply ;
- ETCS;
- Rolling Stock.

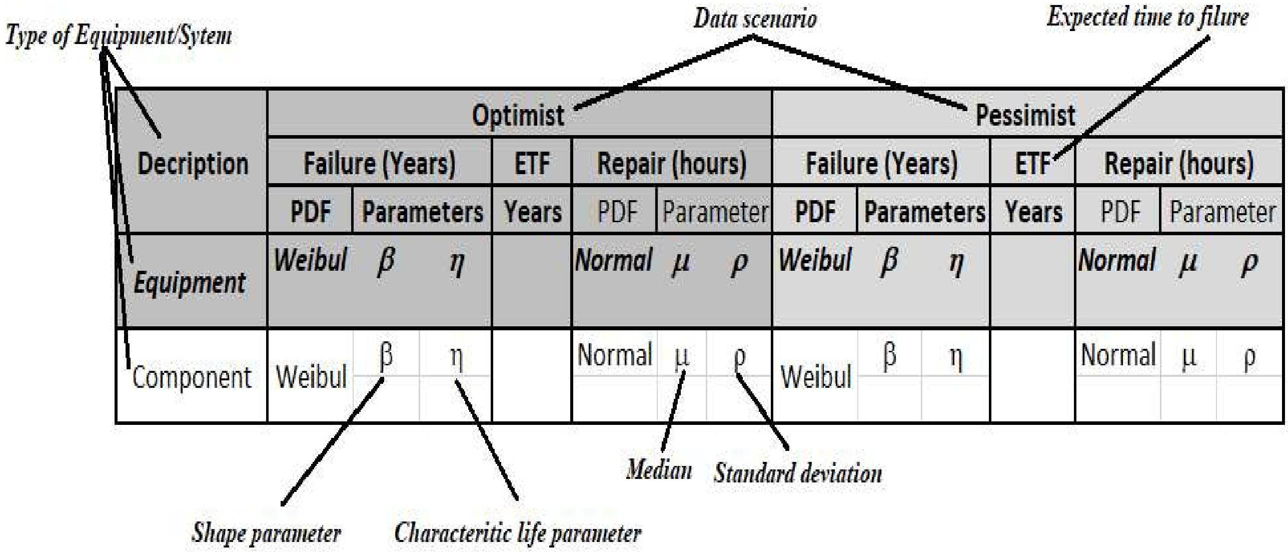
1.3 DATABASE STRUCTURE

The reliability database is structured in a template divided in two scenarios such as optimist and pessimist. In the scenario optimist the first quartile (best 25%) of the historical data are used to define the Weibull 2p PDF and Normal PDF data. By the other hand, in the pessimist scenario, use the 3rd quartile (25% worse) of the historical data.

Suh scenarios definition enable the users to choose the data that better applies to the reality of their system/ equipment.

In the first column, the equipment and component description are defined in the second and third lines. The second column is divided in failure (years), ETF and repair (hours). Below this line, the PDF and the parameters are defined for both scenarios (optimist and pessimist).

The ETF is reference of failure time to make easier the users that are not reliability experts to have an easier understand about the occurrence time of the failure. However, I suggest using the PDF parameter for any reliability performance prediction as well as graph description.



The most famous PDF among reliability engineers is the Weibull function, which based on its generic characteristics, can represent exponential, lognormal, normal and Gumbel shape features. In fact, the Weibull PDF can have any of those characteristics, which means a random failure occurrence over the life cycle, or failure occurrence at the early life phase or in the wear out phase, which represents the Exponential, Normal or Gumbel PDFs. The Weibull PDF shape behavior depends on the shape parameter (β), which can be:

- $0<\beta<1$ (Asymptotic shape);
- $\beta=1$ (Exponential asymptotic Shape);
- $1<\beta<2$ (Lognormal Shape);
- $2<\beta<4$ (Normal Shape);
- $\beta>4$ (Normal and Gumbel Shape).

Regarding shape parameter, as the beta value gets higher, the PDF shape starts to change from early life phase to wear out phase. The Weibull 3P PDF has three parameters: a shape parameter (β), a characteristic life parameter (η), and a position parameter (γ). If the position parameter is zero, which is the most common case, the Weibull PDF has two parameters (Weibul 2P). The characteristic life or scale parameter means that 63.2% of failures will occur until the η value, that is, a period of time. The position parameter represents how long equipment has 100% reliability; in other words, there will be no failure until the γ value is achieved, which is a certain period of time. The brief description of the Weibull PDF is described above. For more technical details please see the appendix A.

2. RAIL INFRASTRUCTURE

2.1 **Rail System** (Rail, Stock Rail, Check Rail, Frog Rail, Wong Rail, Switch Machine, Fastener, Sleepers and Ballast)

Decription	Optimist							Pessimist						
	Failure (Years)			ETF	Repair (hours)			Failure (Years)			ETF	Repair (hours)		
	PDF	Parameters		Years	PDF	Parameter		PDF	Parameters		Years	PDF	Parameter	
Screw Compressor	***Weibul***	*β*	*η*		***Normal***	*μ*	*ρ*	***Weibul***	*β*	*η*		***Normal***	*μ*	*ρ*
Rail	Weibul	β	η		Normal	μ	ρ	Weibul	β	η		Normal	μ	ρ
Stock Rail	Weibul	β	η		Normal	μ	ρ	Weibul	β	η		Normal	μ	ρ
Check Rail	Weibul	β	η		Normal	μ	ρ	Weibul	β	η		Normal	μ	ρ
Frog Rail	Weibul	β	η		Normal	μ	ρ	Weibul	β	η		Normal	μ	ρ
Wing Rail	Weibul	β	η		Normal	μ	ρ	Weibul	β	η		Normal	μ	ρ
Switch Machine	Weibul	β	η		Normal	μ	ρ	Weibul	β	η		Normal	μ	ρ
Fastener	Weibul	β	η		Normal	μ	ρ	Weibul	β	η		Normal	μ	ρ
Sleepers	Weibul	β	η		Normal	μ	ρ	Weibul	β	η		Normal	μ	ρ
Ballast	Weibul	β	η		Normal	μ	ρ	Weibul	β	η		Normal	μ	ρ