

March 2025

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Module	Block	Part	Section	Training
RAMS	3	0		Block 3 – RAMS Intensification
RAMS	3	0	0	RAMS Intensification
STANDARDS	3	1	1	IEC 61508, ISO 13849 – Industrial Security
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SAFETY	3	2	0	Application of RE No. 402
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SAFETY	3	2	2	Application of RE No. 402
TECHNICAL	3	0		Block 3 – Railway Technology III



TC-0.0.0: Initial RAMS Concepts / First Steps in RAMS

CONTENTS

RAMS ENGINEERING CONCEPTS

- a. a. Definitions
- b. b. The importance of context
- c. c. Background (up to 1960)
- d. d. Brief history and origin
- e. e. Evolution of RAMS and RAMS in the railway sector.
- f. \ f. Application of RAMS in Functional Safety

RAMS STANDARDS AND REGULATION

- g. CENELEC Standards
- h. Scope of CENELEC standards
- i. Non-CENELEC Standards
- j. Common Safety Method (CSM)
- k. Independent Evaluator
- l. Typical Hierarchy of Evaluators in an EU Project
- m. Test

OBJECTIVES To provide the initial concepts of RAMS	ATTENDANCE New RAMS resources	PREREQUISITES Reading EN-5012x standards		INSTRUCTORS Various
ORGANIZATION Duration: 2h Location: On-site / Remote	TARGET AUDIENCE Awareness New recruits	TYPE General technical	LEVEL Block 0	CROSS-CUTTING MODULES 0.2.3 – EN50126-1 0.2.4 – EN50126-2 0.2.5 – EN50128 0.2.6 – EN50129

TC-0.0.1: RAMS Fundamentals (part 1)

CONTENTS

RAMS FUNDAMENTALS

- a. Definition of RAMS: Reliability, Availability, Maintainability and Safety.
- b. Weighting in RAMS
- c. RAM Mission

d. Reliability

- i. / Reliability Parameters: Failure Rate and MTBF
- ii. Reliability: The bathtub curve model.
- iii. Distinction between Failure Rate and Service Life
- iv. Intrinsic and Service Reliability
- v. Maintainability and its objectives

e. Maintainability

- i. Cost of Possession
- ii. Repairable Maintainability Systems
- iii. Maintainability Parameters: MTTR and MDT
- iv. Maintainability Time Decomposition
- v. Inspection Periods and Low Demand Models
- vi. Failure Rate versus Probability of Occurrence
- vii. Preventive and Corrective Maintainability

f. Definition and types of Availability

- i. Availability Calculation
- ii. Intrinsic and Service Availability
- iii. TDM and MTBF Calculation
- iv. Versatility of data and concepts

- v. Newcomer's warning: what to consider and the importance of structuring, formulating and operating correctly.
- vi. Exercises and Examples of Availability Calculations

g. Security Management

- i. Objective
- ii. Distinction between the Concept of Hazard and the Concept of Risk
- iii. Quiz on Hazard vs. Risk
- iv. The concept of Hazard
- v. The concept of Function
- vi. Definition of Security Requirements
- vii. Security Integrity: Systematic Failures
- viii. Security Integrity: Random Failures
- ix. Safety: TFFR, THR, PFD and SIL
- x. / Example of Safety process
- xi. Safety Test

On-site / Remote

OBJECTIVES To provide the initial concepts of RAMS	ATTENDANCE Awareness New RAMS resources	PREREQUISITES 0.0.0 – Initial RAMS concepts		INSTRUCTORS Various
	TARGET AUDIENCE Awareness New recruits	TYPE General technical	LEVEL Block 0	CROSS-CUTTING MODULES 0.3.0 - RAMS Tools



TC-0.0.2: RAMS Life Cycle

CONTENTS

RAMS LIFE CYCLE

- a. Project Life Cycle
- b. RAMS activities by phases
- c. Guiding Summary for RAM Documentation
- d. Verification and Validation
- e. Live Documentation
- f. CENELEC V-cycle: Pros and Cons
- g. CENELEC vs. CSM Life Cycle
- h. CSM Life Cycle
- i. Generic and application specific projects
- j. SW Life Cycle
- k. Test

OBJECTIVES To provide the initial concepts of RAMS.	ATTENDANCE Awareness New RAMS resources	PRERREQUISITES 0.0.1 – RAMS Fundamentals (part 1)		Various
ORGANIZATION Duration: 3h Location: On-site / Remote	CAPACITY Awareness New recruits	TYPE General technical	LEVEL Block 0	CROSS-CUTTING MODULES N/A





TC-0.0.3: Risk Management

BASES DE LA SAFETY

- a. Safety Policy
- b. Safety Management System: SGS; EN: SMS
- c. Organization
 - Roles and independence in a RAMS Project
 - ⁄ii. Roles and independence in SW development.
 - Roles and independence in the development of Signaling iii.

RISK MANAGEMENT

- d. Hazard classification: Threat or Risk
- Threat Identification Basis System Definition Document
 - Threat identification
 - Evaluation and closure
- Basis of Risk Management CSM
- g. Threat identification process
- h. RAP Selection (Risk Acceptance Principle)
 - Code of Practice (CoP)
 - ii. Reference System (SRS)
 - Explicit Risk Estimation (ERA): qualitative and quantitative
- i. Acceptable Risks and Risk Acceptance Principles
- j. CoP and SRS

- i. The use of Codes of Practice
- ii. The use of Reference Systems
- k. ERE
 - i. The use of Explicit Risk Estimation: Frequency and Severity. Initial Risk, Risk Reduction and Final Risk.
 - ii. Risk Classification: Risk Levels, Severity Levels and Risk Categorization Levels.
- l. Risk Acceptance Criteria: ALARP, GAME and MEM.
- m. As Low As Reasonably Practicable (ALARP)
 - i. Advantages
 - ii. Disadvantages
 - iii. Remarks
- n. Benefit-Cost Analysis (BCA)
- o. "Globalement Au Moins Equivalent "(GAME)
 - i. Advantages
 - ii. Disadvantages
 - iii. Remarks
- p. "Minimale Endogene Mortalität" (MEM)
 - i. Advantages
 - ii. Disadvantages
 - iii. Remarks
- q. Preliminary Hazard Analysis (PHA)
 - i. Definition and characteristics
 - ii. Examples: 1, 2 y 3
- r. Mitigations and Requirements: Definition and characteristics
- s. Hazard Log
 - i. Definition and characteristics
 - ii. Examples: Continued 2 and 3

- t. Exported risks vs SRACs (Safety-Related Application Conditions)
- u. Safety Case and Risk Management: Policy, Organization, Processes, Activities
 and Deliverables. Conditions of Application.
- v. Test

Face-to-face / virtual

OBJECTIVES PRERREQUISITES INSTRUCTORS ATTENDANCE 0.0.1 RAMS To provide the Awareness Various initial Fundamentals I New RAMS concepts of 0.0.2 Life Cycle RAMS. **ORGANIZATION CROSS-CUTTING** CAPACITY LEVEL **TYPE** Duration: 4h Awareness General Block 0 **MODULES** New recruits technical Location: 0.3.0 – RAMS Tools



TC-0.0.4: RAMS Fundamentals (II)

CONTENTS

INTENSIFICATION IN RAM BASICS

a. Reliability

- i. Definitions of Reliability
- ii. Exponential Distribution
- iii. Reliability Parameters
- iv. Cumulative Failure Frequency
- v. Failure Rate
- vi. Failure Density
- vii. Reliability: cumulative failure probability
- viii. Distribution laws
- ix. Series/parallel repairable systems
- x. Vessely's law for latent failures
- xi. Exercises

b. Maintanability: objectives, inputs and strategy

- xii. Ownership costs
- xiii. Improved Maintainability
- xiv. The Five Levels of Maintenance
- xv. Decomposition of Maintenance Times
- xvi. MTTR Calculation
- xvii. Obtaining Failure Rates: Organic FMECA, Modelling
- xviii. FRACAS: Failure Reporting, Analysis and Corrective Action System
- xix. From FRACAS to GMAO, the next level

c. Availability

xx. Non-Repairable Element and Repairable Element

- xxi. Series Systems and Rarallel Systems
- xxii. RAM analysis
- d. Demonstration of RAMS Objectives
- e. Cheat-Sheet

INTRODUCTION TO RAMS TOOLS AND HOLDING COST METHODOLOGIES

- f. Integrated Logistics Support (ILS)
- g. Reliability Centered Maintenance (RCM)
- h. Life Cycle Cost (LCC)
- i. Markov Diagrams
- j. Fault Tree Analysis (FTA)
- k. Reliability Block Diagram (RBD)
- l. Test/

OBJECTIVES To provide the initial concepts of RAMS.	ATTENDANCE Awareness New RAMS	PRERREQUISITES 0.0.1 – RAMS Fundamentals I		INSTRUCTORS Various
ORGANIZACIÓN Duration: 6h Location: On-site / Remote	CAPACITY Awareness New recruits	Type General technical	LEVEL Block 0	CROSS-CUTTING MODULES 0.3.0 –RAMS Tools



TC-0.0.5: RAM - LCC Exercise

CONTENTS

RAM - LCC Exercise

- Statement
- Exercise, for practice:
 - o Reliability forecast,
 - o Maintainability forecast,
 - o Discrimination of the times that are part of the MTTR,
 - o LCC,
 - o Quantification of inventories on MTBF and maintenance policy.

OBJECTIVES
To provide the
initial
concepts of
RAMS.
ORGANIZATION

Duration: 2h + 2h self-work Location: On-site / Remote ATTENDANCE New RAMS resources

CAPACITYNew recruits

PRERREQUISITES
0.0.1- RAMS
Fundamentals I
0.0.4 -RAMS
Fundamentals II

TYPE LEVEL
General Block 0
technical

INSTRUCTORS GCA

CROSS-CUTTING MODULES N/A



TC-0.0.6: Safety Integrity

CONTENTS

Safety Integrity

Safety

- i. Safety Integrity: definition
- ii. The concept of Function
- iii. Definition of Requirements
- iv. TFFR, THR, PFD and SIL
- v. Random failures
- vi. Systematic failures

ASSIGNMENT OF REQUIREMENTS

- Requirements Assignment: Quantitative ERA, CoP and Qualitative ERA Reference System.
- Assignment of Requirements that require Quantitative ERE
- Requirements Assignment: Safety Integrity and Basic Integrity Levels (SIL 1, 2, 3 and 4), both systematic failures and random failures.
- Distribution of THRs
 - i. Approximation 1: Obtaining the THR from the global risk. Conversion to SIL and distribution.
 - ii. Approximation 2: Obtaining the THR from each complex risk, taken one at a time.
 - 1. Obtaining THRs and examples.
 - 2. Obtaining functions
 - 3. TFFR distribution
 - 4. SIL Assignment. CENELEC Techniques and Procedures for SIL.
 - 5. FR distribution up to component level. SIL is not equivalent to failure rate.

OBJECTIVES

To provide the initial concepts of RAMS.

ORGANIZATION

Duration: 3h + 2h self-work Location: On-site / Remote **ATTENDANCE**

Awareness

New RAMS

CAPACITY

Awareness New recruits **PRERREQUISITES**

INSTRUCTORS Various

0.0.1 RAMS

Fundamentals I

0.0.3 Risk Management

TYPE LEVEL

General Block 0 technical

CROSS-CUTTING MODULES

0.3.0 -RAMS Tools



0.0.2 Life Cycle

TC-0.2.3: EN50126-1

CONTENTS

EN50126-1

Support for understanding the standard section by section.

OBJECTIVES ATTENDANCE PRERREQUISITES INSTRUCTORS
Familiarization New RAMS None Various

with the resources standards

ORGANIZATION
Duration: 4h
Location:

TYPE
Standards
Block 0
Block 0
0.0.1 RAMS
Fundamentals I

On-site or self work as a prelude to other RAMS **courses**



TC-0.2.4: EN50126-2

CONTENTS

EN50126-2

Support for understanding the standard section by section.

OBJECTIVES
Contact with the standards

ATTENDANCE

New RAMS resources

PRERREQUISITES

None

Block 0

TYPE

Standards

INSTRUCTORS

Various

ORGANIZATION

Duration: 4h Location:

Face-to-face or self

work as a prelude to other RAMS **courses**

LEVEL CROSS-CUTTING MODULES

0.0.1 RAMS Fundamentals I 0.0.2 Life Cycle



TC-0.2.5: EN50128

CONTENTS

EN50128

Support for understanding the standard section by section. For organizations that are still making use of the moratorium before adapting to EN50716.

OBJECTIVES
Contact with the standards

ATTENDANCE New RAMS

resources

PRERREQUISITES

None

INC

INSTRUCTORS

Various

ORGANIZATION

Duration: 8h Location:

TYPE Standards **LEVEL** Block 0 CROSS-CUTTING MODULES 0.0.1 RAMS Fundamentals I 0.0.2 Life Cycle

Face-to-face or self work as a prelude to other RAMS **courses**



TC-0.2.6: EN50129

CONTENTS

EN50129

Support for understanding the standard section by section.

OBJECTIVES
Contact with the standards

ATTENDANCE New RAMS

resources

PRERREQUISITES

None

INSTRUCTORS

Various

ORGANIZATION

Duration: 4h Location:

Face-to-face or self work as a prelude to other RAMS courses

TYPE LEVEL Standards Block 0

CROSS-CUTTING MODULES 0.0.1 RAMS Fundamentals I 0.0.2 Life Cycle



Training cycles

TC-0.2.7: EN 50716

CONTENTS

BASIC CONCEPTS

- a. Scope of EN 50716
- b. Introduction to safety procedures
- c. Safety
 - i. Introduction to safety procedures
 - ii. The concept of Threat
 - iii. The concept of Function
 - iv. Definition of Requirements

SIL FOR SW

- a. SIL (Safety Integrity Level)
 - i. Security integrity
 - ii. Security-related application requirements for SW
 - iii. Independence between functions: Composite intrinsic safety, reactive intrinsic safety, inherent intrinsic safety.
 - iv. Concept of Non-Interference
 - v. Prevention of SIL Misuse
 - vi. Test

SECURITY SOFTWARE LIFE CYCLE

- a. SW life cycle
 - i. Linear life cycle
 - ii. V-shaped life cycle
 - b. Verification and Validation
 - c. Modelling

ROLES, ORGANIZATION AND

- a. Requirements Management
 - i. Designer
 - ii. Implementer
 - iii. Tester in charge of testing
 - iv. Verifier
 - v. Project Manager
 - vi. Configuration Manager
 - vii. Validator
 - viii. Evaluator
 - b. Multiple organizations

SW WARRANTY

- a. Software Warranty
 - i. Software Testing
 - ii. Software Verification
 - iii. Software Validation
 - iv. Software Quality Assurance
 - v. Modifications and Modification Control
 - vi. Support tools and languages: T1, T2 and T3. Usage, diversity and validation methods.

INTERACTION BETWEEN SAFETY CASES

- a. Generic products (GPSC), generic projects (GASC) and specific applications (SASG).
 - b. Safety-related application conditions (SRAC)
 - i. Mandatory characteristics
 - ii. Desired characteristics
 - c. Security Cases and their Interaction: Test

GENERIC SW DEVELOPMENT

- a. Generic SW Development Life Cycle and Documentation
 - b. Planning

- c. Requirements
- d. Design Architecture
- e. Component Design
- f. Component Implementation and Testing
- g. Integration
- h. Overall, SW Testing/Final Validation
- i. Systems configured using application data/algorithms
- j. Software Implementation
- k. Software Maintenance
- L. Software Evaluation

SYSTEMS CONFIGURED USING DATA/ALGORITHMS

- a. Objectives
 - i. Generic software Generic software with application-specific data/algorithms.
 - ii. Generic interlocking Specific interlocking
- b. Procedure
 - i. Application Development Process
 - ii. Application Requirements Specification
 - iii. Architecture and Design
 - iv. Application Data/Algorithm Production
 - v. Application Integration and Test Acceptance
 - vi. Application Validation and Evaluation
 - vii. Application Preparation Procedures and Tools
 - viii. Generic Software Development
- c. Input Documentation and Output Documentation

SW IMPLEMENTATION AND MAINTENANCE

- d. Implementation + Maintenance
- e. Implementation Requirements
- f. Maintenance Requirements

CRITERIA FOR THE SELECTION

a. Requisites: "M" Mandatory, "HR" Highly Recommended, "R" Recommended "NR" Not Recommended

EXEMPLES

OBJECTIVES

To provide the initial concepts of RAMS.

ATTENDANCE

Confirmed RAMS resources

PRERREQUISITES

0.0.2 Life Cycle

0.0.6 Safety Integrity

INSTRUCTORS

Various

ORGANIZATION

Duration: 8h Location: On-site / Remote CAPACITY

RAMS Staff RAMS study validators TYPE Specific technical **LEVEL** Block 0 CROSS-CUTTING MODULES

0.3.0 RAMS Tools



TC-0.3.0: RAMS Tools

CONTENTS

RAMS TOOLS

- FMEA/FMECA (Failure Mode, Effects and Criticality Analysis)
- FTA (Fault Tree Analysis)
- RBD (Reliability Block Diagram)
- RPA (Reliability Prediction Analysis)
- CCA (Common Cause Analysis)
- Beta Factor

On-site / Remote

- ZSA (Zonal Safety Analysis)
- PRA (Particular Risk Analysis)
- FMECA-FTA Exercise
- Assignment of Requirements that need Quantitative ERE

To provide the initial concepts of RAMS.	RAMS Staff RAMS managers,	0.0.3 Ri	sk Management afety Integrity	Various
ORGANIZATION Duration: 4h+3h self-work Location:	CAPACITY RAMS staff training, validators, project managers	TYPE Tools	LEVEL Block 0	CROSS-CUTTING MODULES 0.0.4 –RAMS Fundamentals II



TC-0.3.1: RAMS Tools - FMECA

CONTENTS

CONCEPTS AND GENERALITIES

- a. Definition
- b. Introduction
- i. Types and typology
- ii. Considerations
- iii. Failure modes
- c. Functional FMECA
 - iv. Methodology of the 4 questions
 - v. Example of application
 - vi. Development of a list of functionalities
 - vii. Correct approach
- d. System analysis
 - viii. Block Diagrams
 - ix. Functional Analysis
- e. Organic FMECA
 - x. Examples 1 and 2
 - xi. Criticality assessment
- f. FMECA: Functional vs. Organic (Pro's & Con's)
- g. FMEA or FMECA
- h. Breakdown of failure modes by component
- i. Test

OBJECTIVES

Equipping the RAMS tool: FMECA

ATTENDANCE

RAMS Staff Responsible, RAMS validators **PRERREQUISITES**

0.0.3 Risk Management 0.0.6 Safety Integrity **INSTRUCTORS**

Various

0.0.4 – RAMS Fundamentals

ORGANIZATION

Duration: 2h Location: On-site / Remote CAPACITY

RAMS staff training, validators, project managers TYPE CROSS-CUTTING

Tools **MODULES**

LEVEL 0.3.2 – FTA

Block 0 0.3.3 – Exercise FMECA-FTA

0.3.4 -RBD



TC-0.3.2: RAMS Tools - FTA

CONTENTS

CONCEPTS AND GENERALITIES

- a. Definition
- b. FTA Stages
 - i. Definition of the TOP Event
 - ii. System Analysis
 - iii. Construction
- c. Morphology
 - i. Events: Top and Intermediate, Basics, House and Non-Developed.
 - ii. Static gates: AND, OR, TRANSFER, k/n voting, Inhibition, Null.
 - iii. Denied gates: NOT, NOR and NAND, XOR
 - iv. Dynamic gates: AND Priority
 - v. Order and sequence: Initiator and Enabling
- d. Cutting sets
- e. Probability calculation without specialized SW
 - i. Basic AND OR
 - ii. Upper limit approximation method
 - iii. Vesley's Law Equivalent Mean Lambda Method
- f. CCF Common Cause Mode Failures
 - i. Definition
 - ii. The reason
 - iii. BETA Factor
 - iv. ARP4761 (Civil Aeronautics): CMA, ZSA, PRA

- g. Use of the FTA associated with the LIS
 - v. Distribution and demonstration of objectives
 - vi. SIL Demonstration
- h. Use of FTA to calculate occurrences and examples.
- i. FTA vs FMECA: Pro's & Con's
 - i. Complementary Techniques
- j. Test
- k. Quiz

OBJECTIVES Equip with RAMS tool: FTA	ATTENDANCE RAMS staff RAMS managers, RAMS validators	PRERREQUI 0.0.3 Risk M 0.0.6 Safety	anagement Various
ORGANIZATION Duration: 4h Location: On-site / Remote	CAPACITY Personal trainings RAMS, validators, project managers	TYPE Tools LEVEL Block 0	CROSS-CUTTING MODULES 0.0.4 – RAMS Fundamentals II 0.3.1 – AMFEC 0.3.3 – AMFEC-FTA Exercise 0.3.4 – RBD Training



TC-0.3.3: RAMS Tools -

FMECA and FTAs Exercise

CONTENTS

FMECA AND FTAs EXERCISE

- a. Statement
- b. Exercise: FMECA
 - i. Adequate analysis by FTA from a reliability point of view.
 - ii. Adequate analysis by FTA from a safety point of view.

OBJECTIVES To provide practical resources to use the RAMS tools of AMFI and FTAs.	ne managers, RAMS	PRERREQUISI 0.0.3 Risk Management 0.0.6 Safety Integrity	TES INSTRUCTORS Various
ORGANIZATION Duration: 1h+3h Location: On-site / Remote	CAPACITY Training of RAMS personnel, validators, project leaders	TYPE Tools LEVEL Block 0	CROSS-CUTTING MODULES 0.0.4 – RAMS Fundamentals II 0.3.1 – FMECA 0.3.2 – FTA 0.3.4 – RBD



TC-0.3.4: RAMS Tools -

Reliability Blocks Diagram

CONTENTS

CONCEPTS

- a. RBD Definition
- b. RBD Calculation
 - i. Non-repairable or latency-free systems: series and parallel elements.
 - ii. Non-repairable systems or without latencies: failure 1 of 2, failure 2 of 2, failure 1 of 3, failure 2 of 3, failure 3 of 3.
- c. Reliability Block Diagram (RBD)
- d. Basic Reliability Review
- e. FTA vs RBD
- f. Assumptions or evidence of RBDs
- g. Surprising characteristics of the RBDs
- h. Railway examples
 - iii. Calculation of energy harvesting failure in the train
 - iv. Calculation of pantograph elevation failure
 - v. Verification of contract compliance and distribution of RAM requirements
- i. Conclusions: Reliability Myths, Pros and Cons of RBDs
- i. Test

OBJECTIVES

Equipping the RAMS tool:

ATTENDANCE

RAMS staff RAMS managers, RAMS validators

ORGANIZATION CAPACITY

Duration: 2h RAMS personal trainings, validators, On-site / Remote project managers

PRERREQUISITES

0.0.3 Riskmanagement0.0.6 Safety Integrity

TYPE

INSTRUCTORS Various

CROSS-CUTTING MODULES

Tools

0.0.4 – RAMS Fundamentals II

0.3.1 – AMFEC

LEVEL 0.3.2 – FTA

Block 0 0.3.3 – AMFEC-FTA Exercise



TC-0.3.5: RAM - RBD Exercise

CONTENTS

RAM - RBD EXERCISE

- Statement
- Exercise
- Solutions

OBJECTIVES

Equipping the RAMS tool: **RBD**

ORGANIZATION

Duration: 2h Location:

On-site / Remote

ATTENDANCE

RAMS staff RAMS managers, RAMS validators

CAPACITY

Personal training for RAMS, validators, project managers, etc.

PRERREQUISITES

0.0.3Risk management 0.0.6 Safey integrity

CROSS-CUTTING MODULES

INSTRUCTORS

Various

TYPE 0.0.4 – RAMS Fundamentals II Tools

0.3.1 - AMFEC **LEVEL** 0.3.2 - FTA

Block 0 0.3.3 – AMFEC-FTA Exercise



TC-0.5.1: Railway concepts

that every railroader should know

CONTENTS

BASIC TECHNICAL CONCEPTS

- What is the railroad?
- Difficulties to overcome
- Land transportation progress line
- Characteristics of the system (guidance, fixed part and moving part)
- Steel/steel contact system
- Adhesion coefficient
- Sensitivity to the layout
- Unidirectional fixed guidance system
- Track gauge
- Demystifying myths (I)

TIMELINE OF RAILROAD ACHIEVEMENTS

- Milestones in railroad history (I) from 1769 to 1830
- Milestones in railroad history (II) from 1837 to 1890
- Milestones in railroad history (III) from 1897 to 1941
- Milestones in railway history (IV) from 1950 to 1990
- Milestones in railroad history (V) from 1992 to the present
- Upcoming rail challenges
- Anticipation Block I and II: Interoperability

PRERREQUISITES INSTRUCTORS OBJECTIVES ATTENDANCE None Various Providing the Beginners in railway initial railway technology **CROSS-CUTTING** concepts **MODULES** 0.5.0 Railway Technology **LEVEL ORGANIZACIÓN TYPE** 0.5.2 Rolling Stock -I CAPACITY Specific Block 0 Duration: 2h Rail subsystems 0.5.3 Signaling -I technical training Location: 0.5.4 Infrastructure and On-site / Remote Energy -I



TC-0.5.2: Rolling Stock I

CONTENIDO

ROLLING STOCK CLASSIFICATIONS

- a. Type of material
 - i. Motor equipment
 - ii. Towed material
- b. Type of material for your service
 - i. Long and medium distance
 - ii. Mass Transit
 - iii. Others
- c. Classification of UIC lines
 - i. By axle load
 - ii. Per meter charge
- d. Concentrated traction vs. distributed traction
- e. Demystifying myths (II): non-conventional systems (light rail, VAL and APM, Maglev, rail-less tramway).

RAIL TRACTION

- a. Electric drive vs. diesel
- b. Electrification systems
 - i. Direct current
 - ii. Single-phase alternating current
 - iii. Three-phase current

c. Traction chain

- i. Main components
- ii. Transmission of motive power
- iii. Traction equipment cabinet
- iv. Efficiency
- v. Line responsiveness
- vi. Energy capture
- d. Energy conversion by static converters
- e. Types of traction by their control
 - i. Rheostatic control
 - ii. "Chopper" control
 - iii. Frequency inverter
 - iv. By rectifier
 - v. By pulse width modulation
- f. Types of autonomous traction
 - i. Diesel drive
 - ii. Diesel-electric drive
- g. Types of transmission
 - i. Hydraulic transmission (hydrostatic and hydrodynamic)
 - ii. Mechanical transmission
 - iii. Electrical transmission
- h. Dual/multiple traction
 - i. Locomotives
 - ii. RFIG electrification systems in Europe
 - iii. Adaptation between electrified and non-electrified track.

ROLLING

- a. Bogies
- b. End crossbeam / End transversal beam
- c. Curve inscription
- d. Typology:
 - i. Tramway bogies
- e. Patent Talgo stands
- f. Automatic width changes systems
- g. Classification of UIC rolling stock by axle distribution.

BRAKING

- a. Braking systems and mode
- b. Types
 - i. Electric braking
 - ii. Mechanical braking
 - iii. Magnetic braking

ETI ROLLING STOCK

- a. Classification of UIC rolling stock by axle distribution: Axle arrangement
- b. UIC Rolling Stock Registration
 - iv. By type of car
 - v. By type of goods
- c. Registration of special UIC vehicles

OBJECTIVES Providing the initia concepts of Rolling Stock	ATTENDANCE Beginners in railway technology		REQUISITI None	ES INSTRUCTORS Various CROSS-CUTTING MODULES
ORGANIZATION Duration: 4h Location: On-site / Remote	CAPACITY Capacitation in railway subsystems	TYPE Technical specifical	LEVEL Block 0	0.5.0 Railway Technology 0.5.1Railway concepts that every railroader should know 0.5.3 Signaling -I 0.5.4 Infrastructure and Energy -I



TC-0.5.3: Signaling I

CONTENTS

GENERAL CONCEPTS: Introduction

- Introduction
- Objectives and definition of Signaling
- Security Objectives

SIGNALING

- a. Definition: General concepts
- b. Parts and aspects
- c. ADIF Types
- d. Luminous
- e. ADIF AV
- f. Main Functions
- g. Positioning

TRAIN DETECTION

- a. Track detection canton (block)
- b. Occupancy detection
- c. Track circuits and constraints
 - i. Insulating Joints
 - ii. Direct Current
 - iii. Alternate Current
 - iv. Of Impulses
- v. Audio frequency (without seals)

- d. Audio frequency path circuits
 - i. Short-circuit loops + tuning units
 - ii. Complementary tuning boxes
 - iii. S-loops with complementary tuning units
 - iv. Operating mode of a generic audio-frequency CV
- e. Train detection: axle counters
 - i. Definition
 - ii. Principle of operation
 - iii. Axle counter vs. track circuit
 - iv. Applications
 - v. Advantages
 - vi. Disadvantages
- f. Components of an axle counter
 - i. Detector heads
 - ii. Track unit
 - iii. Transmission system
 - iv. Evaluator
- g. States of an axle counter
 - i. Free
 - ii. Occupied
 - iii. Amended
 - iv. In process of release
- h. Treadle
 - i. Electromechanical
 - ii. Electronics
- i. Odometer systems
 - i. Electronics

DEVIATIONS

- a. Track devices
 - i. Crossings
- b. Deviations
- c. Switches: types
 - i. Switch blades
 - ii. Movable point frogs
 - iii. Switches with multiple point machines
- d. Switches: Concepts
 - i. Switch Heel
 - ii. Stock rail heel
 - iii. Frog heel
 - iv. Trailable switches
 - v. Trailing of a turnout
- e. Tie rods
- f. Frog
- g. Electric point machine
- h. Rail expansion devices
- i. Crossings
- j. Switchovers
- k. Complex track layouts
 - i. Diamond crossings
 - ii. Escape track
 - iii. Double slip
 - iv. Diagonal
 - v. Track triangle and flyover or (grade-separated junction)
 - vi. Derailers and chocks

- Level crossings
 - i. Definition
 - ii. Types: protected and unprotected
- m. Bouré locks
- n. Local switch controls
- o. Trackside posts

CONTROL CENTERS

ELECTRONIC INTERLOCKINGS

- a. Interlockings
- b. Historical development
- c. Electronic interlockings

BLOCK SYSTEMS

- a. General concepts: Single track, double track, bi-directional double track.

 Manual mutual exclusion, BT, BTC, BTS, CCR, ABS (Automatic Block

 Signaling), Occupancy block, BAU, BAD, BAB or BVB
- b. Types of block systems
 - i. Manual mutual exclusion
 - ii. Telephone block
 - iii. Centralized telephone block
 - iv. Supplementary telephone block
 - v. Radio-based traffic control
 - vi. Track occupancy block
 - vii. Automatic block for single, double, and bi-directional double tracks

ROUTES

- a. General concepts and conditions
- b. Types of routes
 - i. Routes within a facility
 - ii. Between stations
 - iii. Shunting routes
 - iv. Set route
 - v. Slip route
- c. Route setting table and conflicts
- d. Legend

OBJECTIVES

Training newcomers in Signaling

ORGANIZATION

Duration: 6h Location: On-site / Remote **ATTENDANCE**

RAMS resources working in Signaling

CAPACITY

RAMS Staff RAMS study validators **PRERREQUISITES**

None

TYPE

Specific

technical

LEVEL Block 0 **INSTRUCTORS**

Various

CROSS-CUTTING MODULES

N/A



TC-0.5.4: Railway Technology Energy I

CONTENTS

BASIC TECHNICAL CONCEPTS

- a. System components
- b. Overhead Contact System OCS
- c. Not all OCS are catenary systems

OVERHEAD CONTACT LINE

- a. Types and components of the OCS
 - i. Conventional catenary
 - ii. High-performance conventional catenary: cantilever
 - iii. Rigid catenary
- b. Other types of current collection systems
 - i. Third rail
 - ii. Ground-level power supply (APS)
 - iii. Rapid charging systems
- c. Power supply systems
 - i. PROs & CONs: Conventional catenary
 - ii. PROs & CONs: Rigid catenary
 - iii. PROs & CONs: Tramway catenary
 - iv. PROs & CONs: APS and/or ACR systems
 - v. Electrification systems in Spain
- d. Catenary components
 - i. Span
 - ii. Portals / Gantries
 - iii. Conductors
 - iv. Staggering (o lateral displacement)

v. Sectioning, compensation, and neutral sections in conventional and high-speed railways

TRACTION SUBSTATIONS

- a. Basic general concepts: DC and AC electrification
- b. AC vs DC: Why energy conversion is introduced
- c. Operation schemes: Urban conventional railways, Interurban conventional railways, High-speed rail
- d. Urban conventional railways: Pi-type layout
- e. Interurban conventional railways: Cantilever-type layout
- f. High-speed rail
- g. Remote control systems (SCADA)
- h. Conclusions
- i. Energy Supply Part II (preview)

OBJECTIVES To provide the initial concepts of Energy in Railway Technology.	n technology	PRERREQ Nor		INSTRUCTORS Various
ORGANIZATION Duration: 2h Location: On-site / Remote	CAPACITY Rail subsystems training	TYPE Technical specifical LEVEL Block 0	0.5.1 - Co railroader 0.5.2 - Ro 0.5.3 - Sig	s-CUTTING MODULES Incepts that every Is should know Illing Stock Ignaling I - Field elements If rastructure Ignaling II



TC-0.5.5: Infrastructure I

CONTENTS

BASIC TECHNICAL CONCEPTS

- a. Railway infrastructure and track
- b. Load distribution

INFRASTRUCTURE ELEMENTS

- c. Rail types
- d. Fastenings and baseplates
 - i. Types: rigid fastenings
 - ii. Types: elastic fastenings
- e. Ballast and alternatives
- f. Conventional ballast vs Neoballast
- g. Sleepers (Rail ties)
 - i. Typologies
 - ii. Other types: Aerodynamic sleepers

TYPES OF RAILWAY INFRASTRUCTURE

- a. Track on conventional ballast
 - i. Main functions
 - ii. Typical section
- b. Slab track or ballastless track (concrete slab track)
 - i. Types: slab track with embedded sleepers
 - ii. Types: slab track using prefabricated slabs
 - iii. Other types: track on ballast with under-ballast mats or geotextile blankets
- c. Ballasted track vs Slab track

SECTIONS

- a. Standard cross-section for high-speed ballast track
- b. Open-cut section
- c. Tunnel section
- d. Viaduct section

PARAMETERS DEFINING TRACK GEOMETRIC QUALITY

- a. Track gauge
- b. Longitudinal level
- c. Cross level (cant)
- d. Alignment
- e. Warp (track twist)
- f. Track layout
- g. Track geometry in curves → Superelevation (cant)
- h. Evolution of horizontal geometric characteristics in high-speed lines

RAILWAY TUNNELS

- a. Special case: L9 of Barcelona Metro
- b. Longest railway tunnels
- c. Helical tunnels:
 - i. Gotthard Base Tunnel
 - ii. Toses or Cargol Tunnel
- d. Determining the cross-sectional area of a railway tunnel
- e. Summary of current comfort and health criteria regarding pressure variations
- f. Influence of the train cross-section on tunnel design
- g. Variation of tunnel cross-section with train speed
- h. Typical tunnel cross-sections

INSTRUCTORS OBJECTIVES PRERREQUISITES ATTENDANCE Providing initial None Various Beginner in railway infrastructure technology concepts **CROSS-CUTTING MODULES** 0.5.1 - Concepts that every railroader **TYPE ORGANIZATION CAPACITY** should know Duration: 2h Technical Rail subsystems 0.5.2 - Rolling Stock Location: 0.5.3 - Signalling I - Field elements training specifical 0.5.4 - Railway Technology Energy On-site / Remote **LEVEL** 0.5.6 - Signaling II Block 0