



 eurailtest

# EXPERTISE, TESTS & TEST ENGINEERING

Land transport - Energy - Environment  
Infrastructure - Mechanics



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# EDITORIAL

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With over 1,500 customers and 25 years of experience, Eurailtest is now a major key player in the railway sector, present and recognized around the world.

The wide range of standard services presented here illustrates our laboratories' expertise in testing, measurement and engineering. This guide will enable you to find an initial response to your requirements, whether they apply to the research and development of innovative solutions, the type approval and commissioning of complex transport systems, or the maintenance of your infrastructures and equipment in operational conditions.

Today, Eurailtest is breaking from its traditional model and opening a new chapter in its history, offering customized engineering services in the fields of measurement, testing and monitoring. This unique offering is designed to support our customers' innovative initiatives and provide an effective and cooperative response to the global transport sector.

The expansion of our service portfolio, combined with the diversification of our activities in the energy, environment, signalling and autonomous transport sectors, means that we can provide you with reliable, customized turnkey solutions that meet the most stringent standards requirements.

Whether you are looking for standard or customized services, the ambition of Eurailtest employees is to offer you high value-added services and effectively develop your search for solutions to reduce your environmental footprint.

We invite you to contact our teams to discuss your project and obtain a personalized study.

ELECTROTECHNICAL PLATFORM | 5

FAILURE ANALYSIS AND NON DESTRUCTIVE TESTING (NDT) | 4

PHYSICOCHEMICAL TESTING LABORATORY | 3

INFRASTRUCTURE TESTS | 2

ONLINE TESTS AND SAFETY EQUIPMENT | 1

TEST BENCHES HALL | 6

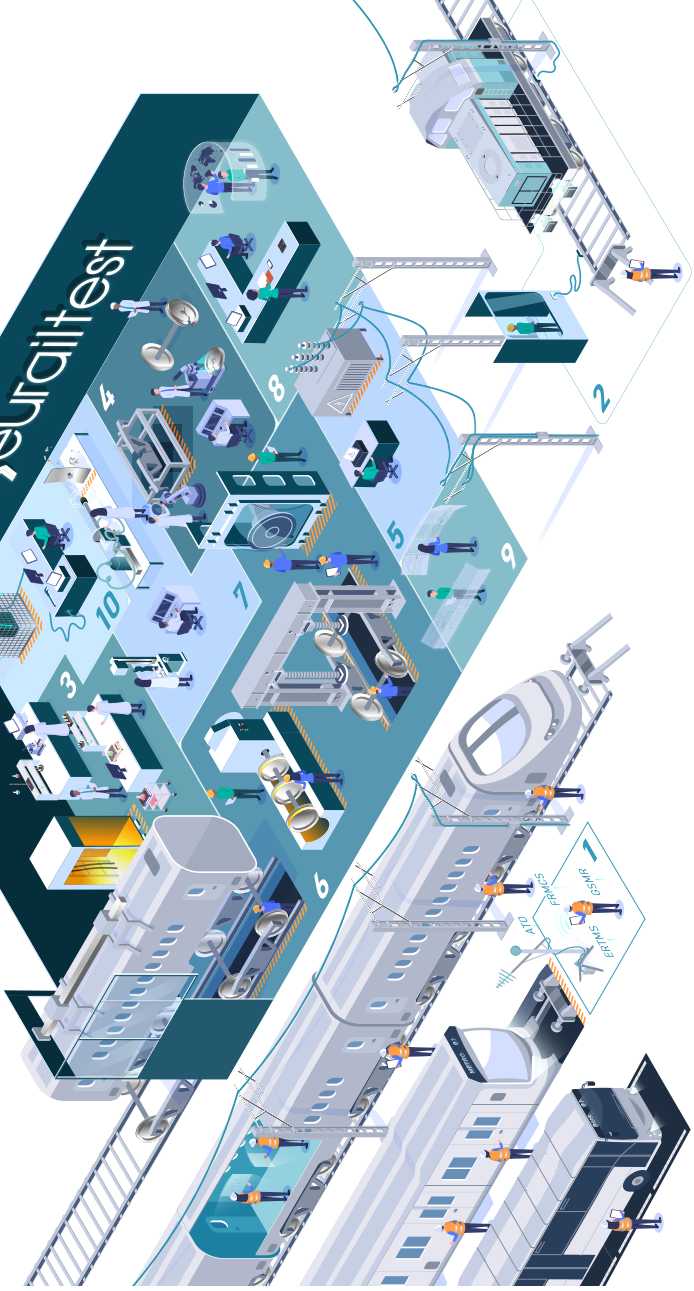
PRODUCTS QUALIFICATION | 7

DATA PROCESSING AND DIGITAL SIMULATION | 8

TEST CAMPAIGN PLANNING | 9

METROLOGY AND MEASUREMENT INNOVATION | 10

# neuraitest



# CONTENTS

## Part 1

### Type Approval / Qualification

Rolling Stock .....	15
Infrastructure .....	39
Railway Equipment .....	65

## Part 2

### Measurements

Mechanical .....	95
Electrical .....	117
Physico-chemical .....	127
Acoustical .....	135
Health, Safety and Environment .....	139
Index .....	153

# WHO ARE WE?

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A specialist in engineering and railway testing, Eurailtest is an independent Economic Interest Group **based in Paris** and works closely with **world-renowned** certification authorities.

Eurailtest coordinates some **dozen laboratories**, each of them boasting many years of experience in the heavy and urban light rail sectors.

For over **80 years**, our laboratories have performed tests geared towards ensuring the highest levels of safety and reliability for hundreds of technical solutions.

More than **400** engineers and technicians **specializing in railway testing** are on hand to offer you their skills and experience. Eurailtest is your one-stop shop for accessing this experience and know-how.

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From **high speeds to urban light rail**, we are able to offer more than one hundred tests and other expert services covering all railway industry sectors. These are set out in this catalogue.

We also offer tailored services to meet specific requests not necessarily within the usual railway test field. One of our strengths is our ability to combine all our skills and test capabilities in an almost infinite number of ways.

Eurailtest and its laboratories are constantly developing new test resources, including those that use **connected technologies** or standalone black box type measuring systems. **Virtual type approval** is the latest challenge we are meeting. **Digital simulation**, now central to our methods, has already been applied to several test campaigns.

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For more information, please contact us by email,  
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or by phone at +33 6 62 32 51 14  
[www.eurailtest.com](http://www.eurailtest.com)





## EURAILTEST IN FIGURES



**361**  
YEARS  
SERVICE OFFERS



**25 YEARS**  
OF EXPERIENCE



**110**  
CUSTOMERS\*



**+200**  
ACCREDITED  
TESTS

**1462**   
ONLINE TESTS  
CARRIED OUT

★★★★★  
**4,8/5**   
CUSTOMER  
SATISFACTION



**+ 270 000 KM**  
TRAVELED IN TEST TRAINS

# WHY CHOOSE EURAILTEST?

## AS A MANUFACTURER

Are you looking to have your rolling stock type approved and therefore need to have tests carried out?

Eurailtest can act as your single partner to coordinate the entire test campaign with the operator, infrastructure manager and authorities responsible for railway safety. We will be happy to assist you in:

- Drafting test specifications
- Obtaining the necessary authority for conducting tests on the open line (depending on local regulations)
- Performing tests and issuing the test reports required for type approval
- Providing expert opinions

## AS AN INFRASTRUCTURE MANAGER, A MANUFACTURING CONSORTIUM OR A CIVIL ENGINEERING COMPANY

Do you need to establish the conformity of your infrastructure - new or renovated - for acceptance testing purposes?

Eurailtest can also assist you with your daily operations by providing a fleet of special vehicles dedicated to measurement and worksites.

## ARE YOU AN ORIGINAL EQUIPMENT MANUFACTURER

Wanting to have tests performed on your components to demonstrate their compliance with the standards in force and validate the technical solutions you wish to market?

Thanks to its laboratories and engineers, Eurailtest can partner you in organizing all the tests required before you can market your products and innovations.

## ARE YOU A RAILWAY OPERATOR, LOCAL AUTHORITY OR PTA

Faced with operating difficulties that affect your maintenance costs, safety or the comfort of your staff or users?

On the strength of 80 years of experience in transport network operation in complex environments, our experts can give you the benefit of their skills and knowledge.

Eurailtest can work on a case by case basis, providing real-time analysis of sensitive areas in your service and offering non-invasive solutions that do not disrupt your traffic. Eurailtest is there to help you optimize your transport and maintenance operations, offering consultancy, analytical and testing services.



# OUR VALUES



- Customer satisfaction



- Technical excellence



- Professionalism



- Independence & neutrality

# OUR EXTERNAL RECOGNITION

**EURAILTEST LABORATORIES** are recognized by the following external bodies:

## COFRAC

More than a hundred tests are accredited by COFRAC, the French accreditation body. For a current list of our laboratories' accreditations, please visit [www.cofrac.fr](http://www.cofrac.fr) and type SNCF or RATP in the 'Search accredited bodies' field.

## CERTIFER

We work closely and regularly with CERTIFER. Our test methods have been recognized by this certification body.

Our customers can therefore have every confidence in the results of our services, whether in the field of type approval or expert assessment.

**EURAILTEST HOLDS ISO 9001** certification for its "consultancy, engineering and railway test" activities obtained from SGS, world leader in inspections, verifications, analyses and certifications. This certification was awarded in September 2011 and is recognition of the processes set in place to ensure the highest possible levels of service in an increasingly complex railway environment.

**EURAILTEST HAS ALSO BEEN AWARDED RESEARCH TAX CREDIT APPROVAL** by the French Ministry of Higher Education and Research (allowing companies paying tax in France to claim tax credits for amounts paid to Eurailtest).



# RECENT REFERENCES

## ... in France

Type approval tests on BOMBARDIER & HITACHI high speed train:  
ZEFIRO  
*2019 - 2020*

Type approval tests, routine tests and delivery of the BOMBARDIER  
trains: Regio 2N, NAT and OMNEO Premium  
*2009 - 2020*

Dynamic behaviour tests and EMC on the ALSTOM metro: MP14  
*2018 - 2019*

Type approval tests on the ALSTOM Coradia Multifunctional regional  
train: REGIOLIS  
*2012 - 2019*

Type approval tests on the STADLER locomotive: EURODUAL  
*2017 - 2018*

Type approval tests for the Nîmes-Montpellier bypass infrastructure  
and the SEA and BPL high speed line infrastructures  
*2016 - 2017*

## ... and around the world

Testing of infrastructure for the London CROSSRAIL line  
*2017 - 2019 - United Kingdom*

Type approval tests on STADLER trains: FLIRT and FLIRT LEX  
*2011 - 2012 / 2017 - 2019 - Switzerland & France*

Type approval tests on ALSTOM high speed train and type  
approval for the Morocco high speed line infrastructure  
*2016 - 2018 - Morocco*

Type approval tests on SIEMENS high speed trains: VELARO D  
and VELARO Eurostar  
*2014 - 2016 - Germany & France*

# HOW TO USE THIS CATALOGUE?

To help you quickly find the products and services you need, this catalogue is divided into two parts that correspond to our two core businesses:

## Part 1

The first part of this catalogue lists and describes the **tests** performed by EURAILTEST tests for the **type approval** and **qualification of railway sub-systems**.

Tests are classified according to sub-system:

- **Rolling Stock**
- **Infrastructure**
- **Railway Equipment**

## Part 2

Part 2 sets out the list of **tests, measurements** and **investigations** essential to guarantee the **safety, performance** and **comfort of your installations**.

It is organized according to subject area to help you locate the tests or services you are looking for:

- **Mechanical**
- **Electrical**
- **Physico-chemical**
- **Acoustical**
- **Health, Safety & Environment**



At the beginning of each section is a summary introducing the services provided.



These pages may be of interest to you.



Heavy rail



Urban light rail



# Part 1



## Type Approval / Qualification

The first part of this catalogue lists and describes the tests performed by EURAILTEST for the type approval and qualification of railway sub-systems.

Tests are classified according to sub-system:

- Rolling Stock ..... 15
- Infrastructure ..... 39
- Railway Equipment ..... 65





# ROLLING STOCK



Railway dynamics .....	17
Design and manufacture of measuring axles .....	18
Characterization of wheel-rail contact .....	19
Rolling stock weighing procedures .....	20
Brake testing on the open line .....	21
Static brake tests .....	22
WSP device characterization .....	23
Drop shunt phenomena .....	24
Drop shunt test rig .....	25
Rolling stock electro-magnetic compatibility .....	26
Electromagnetic emissions .....	27
Electromagnetic emissions and human exposure .....	28
Electromagnetic interference .....	29
Current collection - pantograph / ocl interaction .....	30
Design and measurement of instrumented pantographs .....	31
Rig for testing current collection of vehicles at standstill .....	32
Current collection quality at standstill .....	33
Traction drive performance .....	34
On-board aerodynamic measurements .....	35
External noise from rolling stock and light rail vehicles .....	36
On-board acoustics .....	37

# ROLLING STOCK

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Rolling stock type approval is a complex process.

In addition to tests, our experts play an essential role in the completion of the type approval process.

From agreeing on the client's needs through to final test results, our experts are on hand at all stages to guide and advise.

- They help clients to establish the tests needed as part of the type approval process
- They assist them, where necessary, in drawing up test specifications designed in relation to specific vehicle characteristics and the standards in force
- They play a part in obtaining the necessary authorisations for conducting tests on the line
- They provide the necessary explanations on the results of the tests performed by our laboratories



# RAILWAY DYNAMICS

Characterization of the dynamic behaviour of railway vehicles on the track for type approval or development purposes.

## OBJECTIVES

- Establish the dynamic behaviour of new and modified rolling stock or rolling stock whose operating conditions have changed, in relation to a particular track, for all types of vehicle (up to 25t/axle) and at all speeds (up to 574.8 km/h)
- Develop and investigate methods for verifying railway dynamics on all European networks
- Optimize Testing of running behaviour through numerical simulation in railway dynamics

## TEST RESOURCES

- Measuring axles for determining the Y, Q and X forces of vehicles under test (with remote transmission of measuring signals)
- Digital measuring chains for data acquisition and processing
- Track geometry data production

## REFERENCES

- ALSTOM
- BOMBARDIER
- CLERE
- COLAS RAIL
- COSEA
- SNCF
- STADLER
- SYSTRA
- SYSTRA Mexico
- VOSSLOH

## ACCREDITATIONS

ISO/IEC 17025 awarded by COFRAC

## STANDARDS

- Infrastructure TSI
- Loc and Pass TSI
- EN 14363 – Testing for the acceptance of running characteristics of railway vehicles - Testing of running behaviour and stationary tests
- EN 15687 – Testing for the acceptance of running characteristics of freight vehicles with static axle loads higher than 225 kN and up to 250 kN
- EN 15686 – Testing for the acceptance of running characteristics of railway vehicles with cant deficiency compensation system and/or vehicles intended to operate with higher cant deficiency than stated in EN 14363 (2005 - Annex G)
- UIC 518 OR – Testing and approval of railway vehicles from the point of view of their dynamic behaviour - Safety - Track fatigue - Ride quality
- UIC 432 OR – Wagons - Running speeds - Technical conditions to be observed



 See also pages

18, 19, 20, 45, 68,  
90, 96, 97, 99



# DESIGN AND MANUFACTURE OF MEASURING AXLES

Measuring the wheel-rail contact forces using a specially equipped axle.

## OBJECTIVES

- Conduct finite element analysis
- Develop a “measuring axle” sensor to establish wheel-rail contact forces
- Modify the original axle in order to measure the lateral and vertical forces exerted on the track
- Install strain gauges on the wheel centre to obtain the basic signals typical of wheel-rail contact forces and, by means of processing, of the lateral and vertical forces
- Study into mechanical adjustment of devices fitted at each end of the axle (e.g. return current, coder, etc.)

## REFERENCES

- ALSTOM
- BOMBARDIER
- SIEMENS
- SNCF (world record 574.8 km/h in 2007)

## TEST RESOURCES

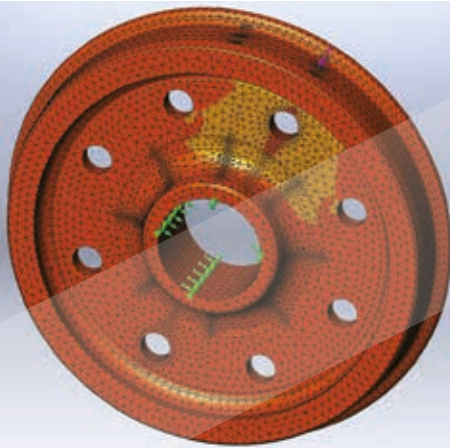
- Digital calculator for data acquisition and processing
- Calibration bench connected to reference gauges with the following characteristics:
  - Vertical axis: forces applied up to 200 kN
  - Lateral axis: up to 100 kN
  - Wheel diameter: 450 to 1,250 mm for a wide range of track gauges
- Multi-channel digital telemetry system for signal transmission

## STANDARDS

- NF F00-702 – Dynamic interaction between vehicles and tracks
- NF EN 14363 – Railway applications
  - Tests for dynamic behaviour type approval of railway vehicles - Testing of running behaviour and stationary tests

See also pages

17, 19





# CHARACTERIZATION OF WHEEL-RAIL CONTACT

Assessing the main wheel-rail contact parameters for international type approval and check rolling stock behaviour in relation to the risk of instability.

## OBJECTIVES

- Measure wheel and rail profiles
- Establish wheel-rail contact parameters: equivalent conicity, real conicity, radial steering index, etc.

## TEST RESOURCES

- Gauge for spot measurement of wheel and rail profiles
- Calculation software for wheel-rail contact parameters


## REFERENCES

- ALSTOM
- BOMBARDIER
- SNCF

## STANDARDS

- EN 14363 – Testing for the acceptance of running characteristics of railway vehicles - Testing of running behaviour and stationary tests
- EN 15302 – Method for determining the equivalent conicity
- UIC 518 OR – Testing and approval of railway vehicles from the point of view of their dynamic behaviour - Safety - Track fatigue - Ride quality
- UIC 519 OR – Method for determining the equivalent conicity



 See also pages  
17, 18, 68, 69, 71



# ROLLING STOCK WEIGHING PROCEDURES

Characterizing vehicle loads for type approval or an expert assessment purposes in situ with or without lifting systems.

## OBJECTIVES

- Determine the static load at each wheel, the centre of gravity and the unloading rate for all types of vehicle (for type approval, modification, renovation or expert assessment of a vehicle)
- Two types of weighing:
  - weighing in compliance with the NF F00-701 standard
  - weighing performed on maintenance, construction or vehicle maintenance sites on workshop tracks with or without vehicle lifting.

## TEST RESOURCES

- Load cells (10,000 or 20,000 daN)
- Topographical viewfinder to ensure wheel levelling
- Weighing frame with lifting equipment
- Movable frame that can be installed on track to offset levelling defects of up to 15 mm.

## ACCREDITATIONS

ISO/IEC 17025 awarded by COFRAC

## REFERENCES

- ALSTOM
- CFD
- RATP
- SNCF
- VFLI

## STANDARDS

- NF F00-701 – Measurement of static loads per wheel of vehicles - Weighing installations and weighing operations
- EN 14363 – Testing for the acceptance of running characteristics of railway vehicles - Testing of running behaviour and stationary tests
- EN 15663 – Definition of vehicle reference masses

See also page

17





# BRAKE TESTING ON THE OPEN LINE

Measuring the braking performance and associated forces for the type approval or development of all kinds of rolling stock.

## OBJECTIVES

- Develop, validate and measure braking performance during:
  - tests carried out on a trainset, a convoy or a traction unit
  - slip brake tests on all kinds of rail vehicles
- Characterize wheel/rail adhesion under normal and downgraded conditions: emergency brake, service brake, holding brake, parking brake
- Determine key parameters: equivalent response time, jerk, corrected stopping distance, average equivalent deceleration
- Monitor related parameters: pressure in brake cylinders, brake component temperature, axle speed, test conditions (temperature, relative humidity)
- Characterize and qualify brake parts
- Measure forces applied to the wheels and discs

## REFERENCES

- ALSTOM
- BOMBARDIER
- RATP
- SIEMENS
- STADLER
- ROUEN TRAMWAY (France)

## TEST RESOURCES


- Tachometric measuring chain
- Doppler radar
- GPS
- Measuring system for various types of parameter: temperature (disc/wheel), acceleration, voltage and current (electric brake, track brake, etc.), pressure, etc.
- Brake activation device
- Track watering system
- Optimization of testing campaigns through numerical simulation of breaking performance

## ACCREDITATIONS

ISO/IEC 17025 awarded by COFRAC

## STANDARDS

- EN 13452-1 & 2 – Braking - Mass transit brake systems
  - Part 1: Performance requirements.
  - Part 2: Methods of test
- UIC 540 – Air brakes for freight trains and passenger trains
- UIC 541-03/04/05 – Brakes - Regulations concerning manufacture of the different brake parts
- UIC 544-1 – Braking power
- TSI: Rolling stock – Conventional rail, High speed, Freight wagons
- Network Technical Specifications
  - STM F014
- Loc and Pass TSI

 See also pages

22, 23, 67



# STATIC BRAKE TESTS

Contributing to the type approval process of a braking system by means of static tests

## OBJECTIVES

- Validate brake control components (driver's brake valve, self-adjusting brake valve, etc.)
- Validate and measure the application forces generated by the braking system
- Measuring the holding capacity of the brake when the train is at standstill by establishing the friction coefficient or the adhesion (wheel/brake block or wheel/rail)

## TEST RESOURCES

Measuring chain equipped with sensors for automatic compliance checks (measurements + functional analysis + validation)

## STANDARDS

- UIC 540 – Air brakes for freight and passenger trains
- UIC 541-03/04/05 – Regulations concerning manufacture of the different brake parts
- TSI: Rolling stock - Conventional rail, high speeds, freight wagons

See also pages  
21, 23, 67, 148





# WSP DEVICE CHARACTERIZATION

Gauging the efficiency of WSP devices for type approval or development purposes.

## OBJECTIVES

- Characterize performance of wheel slide protection devices during emergency and service braking for various rail adhesion conditions (normal, downgraded, highly downgraded)
- Monitor and record the following parameters: axle speed, reference speed, brake cylinder pressure, brake component temperature, test conditions (temperature, relative humidity)

## TEST RESOURCES

- Brake activation device
- Pressure sensors
- Thermocouples
- Data acquisition and processing chain
- Tachometric measuring device associated with doppler radar
- System for reducing rail adhesion (by spraying water or oil onto the track)
- Current/torsion sensors

## ACCREDITATIONS

ISO/IEC 17025 awarded by COFRAC

## REFERENCES

- ALSTOM
- BOMBARDIER
- FRAMAFER
- RATP
- ROLANFER
- SNCF

## STANDARDS

- EN 15595+A1 – Railway applications - Braking - Wheel slide protection
- UIC 544-1 – Braking power
- UIC 541-05 – Brakes - Regulations concerning manufacture of the different brake parts - Wheel slide protection
- Loc and Pass TSI



 See also pages

21, 22, 67



# DROP SHUNT PHENOMENA

Checking the drop shunt capacity of rolling stock for type approval purposes.

## OBJECTIVES

Monitor and record all the drop shunt characteristics of tractive and trailing stock

## TEST RESOURCES

- Synchronization of data acquisition systems by GPS-CLOCK
- Specially equipped track section in Plouaret (Brittany, France)
- Data acquisition and processing chain

## ACCREDITATIONS

Recognition by CERTIFER capability certification

## REFERENCES

- ALSTOM
- BOMBARDIER
- SIEMENS
- STADLER
- VOSSLOH

## STANDARDS

OP 009912 (SAM S 004) – Drop shunt capacity of rolling stock and brake shoes

 See also page

25







# DROP SHUNT TEST RIG

Checking the influence of brake shoes on track circuit shunting.

## OBJECTIVES

- Conduct reduced scale simulations of “wheel-brake shoe” braking
- Provide decision-making support for selecting the best friction material (for a given application)
- Help demonstrate the drop shunt capacity of the materials used to make the brake shoes installed on wagons
- Help optimize drop shunt tests on the open line for rolling stock equipped with brake shoes (other than wagons)
- Measure the effects of pollution of a brake shoe or material on a sample of wheel steel

## REFERENCES

- ICER-RAIL
- FAIVELEY
- SNCF


## STANDARDS

UIC B169/RP 33 – Effect of composite braking materials on track shunt

## TEST RESOURCES

- Drop shunt test rig (including 2 samples of brake shoes rubbing on a disc)
- Tools for measuring engine speed, contact force and braking torque
- 2 thermocouples embedded in the wheel steel sample



 See also page

24



# ROLLING STOCK ELECTRO-MAGNETIC COMPATIBILITY

Checking that electrical signals generated by the train are compatible with the signalling, telecommunications, sub-stations and overhead lines for type approval purposes.

## OBJECTIVES

- Carry out dynamic tests, on trains or at standstill, during development or qualification of trains or components
- Establishing in real time the current:
  - generated by rolling stock
  - that can interfere with signalling
- Determine psophometric intensity
- Ensure coordination between traction units and fixed installations used for electric traction: power factor, power consumption, inrush current, peak voltage value, etc.

## TEST RESOURCES

- Single-phase or DC power supply under, high potential
- QMR-7/QMR-X
- Digital data acquisition systems (up to 1 MHz)
- Voltage and current sensors, single-phase and DC (up to 20 kHz)

## ACCREDITATIONS

ISO/IEC 17025 awarded by COFRAC

## REFERENCES

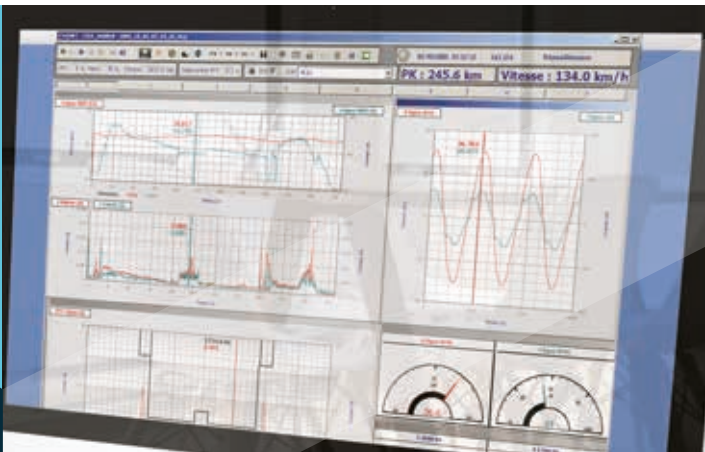
- ALSTOM
- ANSALDO BREDA
- BOMBARDIER
- RATP
- SIEMENS
- STADLER

## STANDARDS

- EN 50238 – Compatibility between rolling stock and train detection systems
- EN 50121-3-1 and EN 50592 – Electromagnetic compatibility - Part 3-1: Rolling stock - Train and complete vehicle
- EN 50388 – Power supply and rolling stock - Technical criteria for the coordination between power supply (substation) and rolling stock to achieve interoperability
- OP 09911 (SAM S 003) (IN 2724) – Compatibility between signalling systems and rolling stock
- TS 50238-2 – Compatibility between rolling stock and train detection systems - Part 2: Compatibility with track circuits
- SAM-S-006 (Electromagnetic compatibility) and SAM-T-004 (Power supply and rolling stock)

See also pages

27, 28, 29, 52, 53, 54,  
55, 59, 149



# ELECTROMAGNETIC EMISSIONS

Checking, for type approval purposes, that rolling stock complies with EMC regulations.

## OBJECTIVES

- Measure the electromagnetic field released by rolling stock into the outside environment (between 9 kHz and 1 GHz)
- Compare these levels with the limits set by standard EN 50121-3-1
- Ensure the train is electromagnetically compatible with the surrounding systems and other systems along the track to avoid interference (signalling, GSMR transmitter, radio, etc.)

## TEST RESOURCES

- Spectrum analyser
- Measuring receiver
- Loop antenna
- Biconical antenna
- Log periodic antenna
- Specific measurement software for real-time analysis of results
- Specific measurement software for conducting tests while reducing the number of runs (optimized planning)

## ACCREDITATIONS

ISO/IEC 17025 awarded by COFRAC

## REFERENCES

- ALSTOM
- BOMBARDIER
- SNCF VOYAGEURS
- STADLER

## STANDARDS

- EN 50121-2 – Electromagnetic compatibility - Part 3-1: Rolling stock - Train and complete vehicle
- EN 121-2



 See also pages

26, 28, 29, 54, 55, 149



# ELECTROMAGNETIC EMISSIONS AND HUMAN EXPOSURE

Checking that electromagnetic fields generated by apparatus in rolling stock or the railway environment complies with human exposure regulation.

## OBJECTIVES

- Assess electromagnetic field levels (0 to 20 kHz) in areas accessible to the public and workers, in rolling stock or on a railway or industrial site
- Compare these levels with the limits imposed for the public and workers
- Assist the operator in putting preventive provisions and precautionary measures in place should these limits be exceeded

## TEST RESOURCES

- Magnetic field antennas
- Acquiris software for further investigation should any excesses be identified
- Recorded voltage of component characterized
- Three tests run simultaneously

## REFERENCES

- ALSTOM
- BOMBARDIER
- SNCF Voyageurs maintenance centres
- STADLER

## STANDARDS

- EN 50500 – Measurement procedures of magnetic field levels generated by electronic and electrical apparatus in the railway environment with respect to human exposure
- Recommendation 1999/519/EC of 07/1999, [European Council Recommendation], on the limitation of exposure of the general public to electromagnetic fields
- Directive 2013/35/EU of 06/2013, [European Parliament Directive], on the minimum health and safety requirements regarding the exposure of workers to the risks arising from physical agents (electromagnetic fields)

See also pages

26, 27, 29, 54, 55, 149





# ELECTROMAGNETIC INTERFERENCE

Checking that electrical equipment exposed to electromagnetic interference works properly for type approval purposes.

## OBJECTIVES

Ensure the proper functioning of on-board electrical equipment subject to electromagnetic interference

- Measure interference levels at the input and output of this equipment
- Protect electrical equipment with filters

## TEST RESOURCES

- Anechoic chamber
- Solenoid
- Oscilloscope
- Spectrum analyzer
- Amperometric clamp (HF)
- Voltage probe
- Capacities, ferrites, filters, etc.


## REFERENCES

- ALSTOM
- CONVERGIE
- SNCF

## STANDARDS

EN 50121-4 – Electromagnetic compatibility - Part 4: Emission and immunity of the signalling and telecommunications apparatus



 See also pages  
26, 27, 28, 55, 149



# CURRENT COLLECTION - PANTOGRAPH / OCL INTERACTION

Optimizing the vehicle-infrastructure combination and the quality of current collection while limiting wear in the contact wire and pantograph strips, for type approval and development purposes.

## OBJECTIVES

- Characterize and optimize the aerodynamic behaviour of the pantograph (uplift test)
- Measure the lift force on the vertical axis of the pantograph strips, when not in contact with the overhead line
- Evaluate pantograph-OCL interaction, by measuring the arcs and the contact force between pantograph and OCL, in order to reduce incidents (e.g. dewiring)
- Measure the displacements and amplitudes of the pantograph and its components
- Measure raising and lowering time of the pantograph, as well as the time taken for the delivery of power to cease
- Determine the approach speed of the pantograph
- Pinpoint possible anomalies on the network
- Record additional parameters: air pressure on the pantograph, speed and distance, video monitoring of the pantograph, environmental conditions (temperature, humidity, wind speed)
- Measure contact wire uplift

## REFERENCES

- ALSTOM
- BOMBARDIER
- DEUTSCHE BAHN
- RATP
- SIEMENS
- SNCF
- STADLER

## TEST RESOURCES

- Data acquisition and processing devices (real time)
- QMR-Cap: load cells, accelerometers, wire displacement sensors, arc detection sensors
  - Videum (video camera)
  - Thermo-Hygrometer
  - Anemometer
  - OCL mast detectors

## ACCREDITATIONS

ISO/IEC 17025 awarded by COFRAC

## STANDARDS

- EN 50367 – Technical criteria for the interaction between pantograph and overhead line
- EN 50317 – Requirements and validation of measurements of the dynamic interaction between pantograph and overhead contact line
- EN 50119 – Fixed installations - Electric traction overhead contact line
- EN 50206 1 & 2 – Pantographs: characteristics and tests - Part 1: Pantographs for main line vehicles - Part 2: Pantographs for metros and light rail vehicles
- OP 09932 (SAM E 903) (IN 2781) – Current collection - Pantograph-OCL interaction
- OP 09944 (SAM E-009) – Crossing phase separation sections
- SAM X 001 – Technical requirements, recommendations and best practices based on the experience acquired
- TSI High Speed / Conventional Rail - Rolling Stock and Energy
- Order of 19 March 2012



# DESIGN AND MEASUREMENT OF INSTRUMENTED PANTOGRAPHS

Contributing to the current collection type approval process by checking pantograph-OCL interaction.

## OBJECTIVES

- Design and validate the instrumented pantograph
- Define instrumentation required for the test
- CAD modelling of the pantograph
- Design and develop specific sensors
- Calibrate the instrumented pantograph on the test bench

## TEST RESOURCES

- 3D CAD software
- 3D printer
- Wind tunnel and calibration test bench
- Sensors and patented systems: force, displacement, accelerometer


## REFERENCES

- ALSTOM
- BOMBARDIER
- CADEMCE
- SIEMENS
- SNCF
- STADLER

## STANDARDS

- EN 50317 – Current collection systems - Requirements and validation of measurements of the dynamic interaction between pantograph and overhead contact line
- UIC 505-1 – Railway transport stock - Rolling stock construction gauge



 See also pages

30, 32, 33, 46, 47, 104



# RIG FOR TESTING CURRENT COLLECTION OF VEHICLES AT STANDSTILL

Qualifying the current collection of trains at standstill for access to the French network.

## OBJECTIVES

- Validate the contact strips of a pantograph of a train at standstill, during current collection, in order to ensure that the OCL does not heat up beyond the limits specified.
- Validate current collection at standstill under 1,500 V electrification
- Investigations in the static current collection field

## TEST RESOURCES

- Test bench: current collection at standstill
- Real-time data acquisition and processing devices
- System measuring the temperature of the contact wire
- System measuring contact forces and voltage in the overhead line
- Ammeters

## ACCREDITATIONS

ISO/IEC 17025 awarded by COFRAC

## REFERENCES

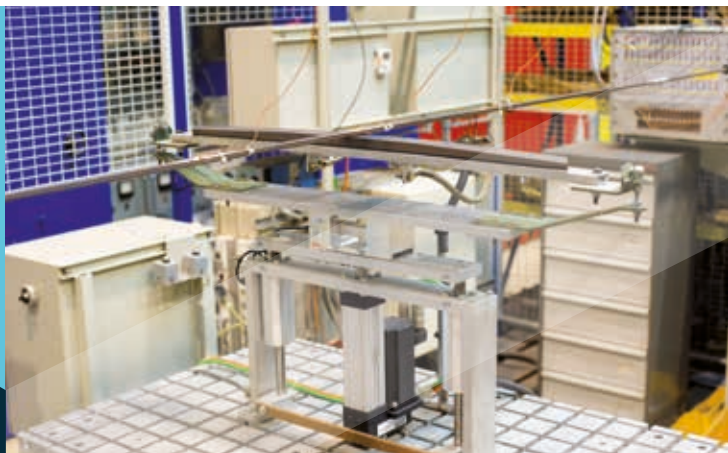
- ALSTOM
- BOMBARDIER
- FAIVELEY
- MORGAN
- RATP
- SIEMENS

## STANDARDS

- EN 50119 – Fixed installations
  - Electric traction overhead contact line
- TSI: conventional rail “Rolling stock” and “Energy”
- OP 09932 (SAM E 903) – Current collection - Pantograph-OCL interaction
- French order of 19 March 2012

See also pages

30, 31, 33, 46, 47, 104







# CURRENT COLLECTION QUALITY AT STANDSTILL

Monitoring the behaviour of the electrical equipment on conventional or high-speed lines and, where necessary, issuing remote warnings.

## OBJECTIVES

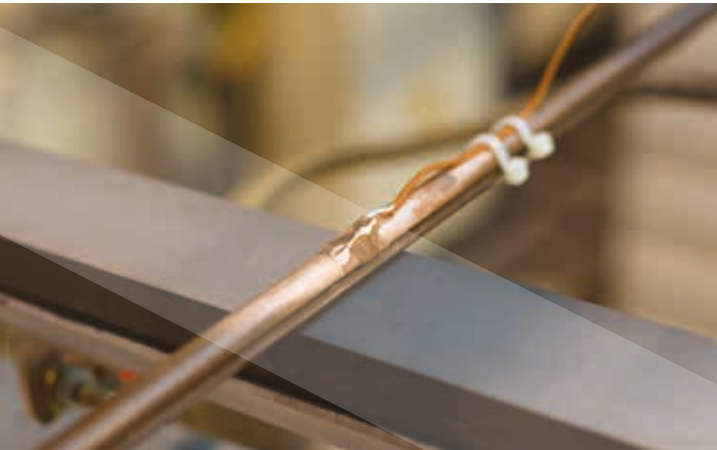
- Characterize the thermal (fracture) and electrodynamic behaviour of the electrical contact between the pantograph strip and the contact wire:
  - in nominal operation
  - under maximum operating current
  - in the presence of a fault current (e.g. short circuit)
- Simulate critical events in the pantograph-OCL environment in the following modes:
  - nominal
  - maximum operating current
  - fault current


## TEST RESOURCES

- Design of mock-ups based on the particular specifications
- Power supply sources - direct current up to 40 kA and alternating current up to 15 kA
- Data acquisition chain for interpreting the values recorded

## REFERENCES

- ALSTOM
- SNCF



 See also pages  
30, 31, 32



# TRACTION DRIVE PERFORMANCE

Contributing to the development or qualification of traction drive for all types of rail vehicle - electric or diesel.

## OBJECTIVES

- Check traction drive performance criteria in relation to the TSI (energy consumption: acceleration and startability)
- Determine performance of a power unit:  $F_j = f(V)$  curves during traction and electric braking
- Determine power and energy (active, reactive and apparent)
- Establish the power balance: performance, power factor, etc.
- Establish the energy balance
- Determine resistance to forward motion values

## TEST RESOURCES

- Data acquisition and processing devices (based on QMR-7/QMR-X)
- Voltage and current sensors (single-phase and DC)
- Tachometric measuring device

## REFERENCES

- ALSTOM
- BOMBARDIER
- SIEMENS
- SNCF
- STADLER

## STANDARDS

- EN 14067 – Aerodynamics - part 1: Symbols and units - part 2: Aerodynamics on open track
- SAM X 006 – Data necessary for matching rolling stock to routes, establishing hauled load limits and potential acceleration
- TSI: energy, rolling stock – Conventional rail, high speed

See also pages

75, 102, 119, 120





# ON-BOARD AERODYNAMIC MEASUREMENTS

Characterizing railway aerodynamic phenomena for the type approval of rolling stock and infrastructure.

## OBJECTIVES

- Characterize aerodynamic forces on the structure of the train
- Characterize resistance to pressure waves
- Characterize the aerodynamic parameters involved when a train goes through a tunnel through tests on board the train
- Conduct aero-acoustic measurements
- Monitor flying ballast
- Carry out computer simulations in order to determine specific eligibility criteria according to TSI (e.g. pressure loads)

## TEST RESOURCES

- Multi-channel data acquisition device
- Absolute and differential pressure sensors
- 3D ultrasonic anemometer
- Prandtl probe
- System for counting ballast impacts under the car body (patented device)


## REFERENCES

- ALSTOM
- BOMBARDIER
- INFRABEL
- SNCF-RÉSEAU
- SIEMENS

## STANDARDS

- EN 14067 – Railway applications - Aerodynamics
- UIC 651 – Layout of driver's cabs in locomotives, railcars, multiple-unit trains and driving trailers
- UIC 660 – Measures to ensure the technical compatibility of high-speed trains
- Loc and Pass TSI



 See also page

102



# EXTERNAL NOISE FROM ROLLING STOCK AND LIGHT RAIL VEHICLES

Locate, characterize and simulate noise from rolling stock.

## OBJECTIVES

- Characterize noise emitted by vehicles
- Characterize infrastructure (rail roughness and decay rate)
- Characterize rail traffic noise
- Investigate: locate and characterize noise sources (power and direction) on rolling stock, both stationary and in motion
- Simulate passing noise, rolling noise and traffic noise

## TEST RESOURCES

- Measuring masts up to 15m high
- Multi-channel data acquisition system (45 measuring channels)
- Microphone metering system (Class 1)
- Sound level meter (Class 1)
- Measuring systems for rail and wheel roughness
- Sound intensity probe
- Portable analyser
- Standalone measuring station
- Simulation tools
- Software: dBTrait, dBFA

## ACCREDITATIONS

ISO/IEC 17025 awarded by COFRAC

## REFERENCES

- ANSALDO BREDA
- ALSTOM
- BOMBARDIER
- RATP
- SNCF
- SNCF RÉSEAU
- SIEMENS
- STADLER
- TRANSPOLE

## STANDARDS

- NF EN ISO 3095 – Acoustics - Measurement of noise emitted by railbound vehicles
- NF S31-088 – Measurement of railway traffic noise in view of its characterization
- French Order of 8 November 1999 – Railway infrastructure noise
- French Order of 19 March 2012 – Objectives, methods, safety indicators and safety and interoperability regulations applicable on the French rail network
- Loc and Pass TSI
- NF S31-007 – Measurement of noise emitted by accelerating road vehicles - Engineering method

See also pages

37, 89, 136, 137, 140





# ON-BOARD ACOUSTICS

Qualifying, characterizing and simulating acoustics inside railway and road vehicles as well as premises.

## OBJECTIVES

- Qualify rolling stock: Indoor noise during running, deceleration and stopping, reverberation time, signal audibility, speech intelligibility
- Evaluate speech intelligibility on board trains through the STIPA speech transmission index (determined by measurement of the modulation transfer function, impulse response and values of "speech level/noise level measured" or directly by pseudo-random sequences)
- Characterize rooms: room criteria, impulse response, speech intelligibility, wall transparency
- Investigate: vibroacoustics, psychoacoustic criteria, audibility of safety signals, acoustic characteristics of sources
- Simulate acoustics of premises: modelling and improvement
- Determine the threshold of audibility

## TEST RESOURCES

- Sound level meters (Class 1)
- Multi-channel data acquisition device
- Sound level meter system (Class 1)
- Omnidirectional sources
- Artificial mouth
- Calculation software for psychoacoustic criteria

## REFERENCES

- ALSTOM
- BOMBARDIER
- RATP
- SIEMENS
- SNCF

## ACCREDITATIONS

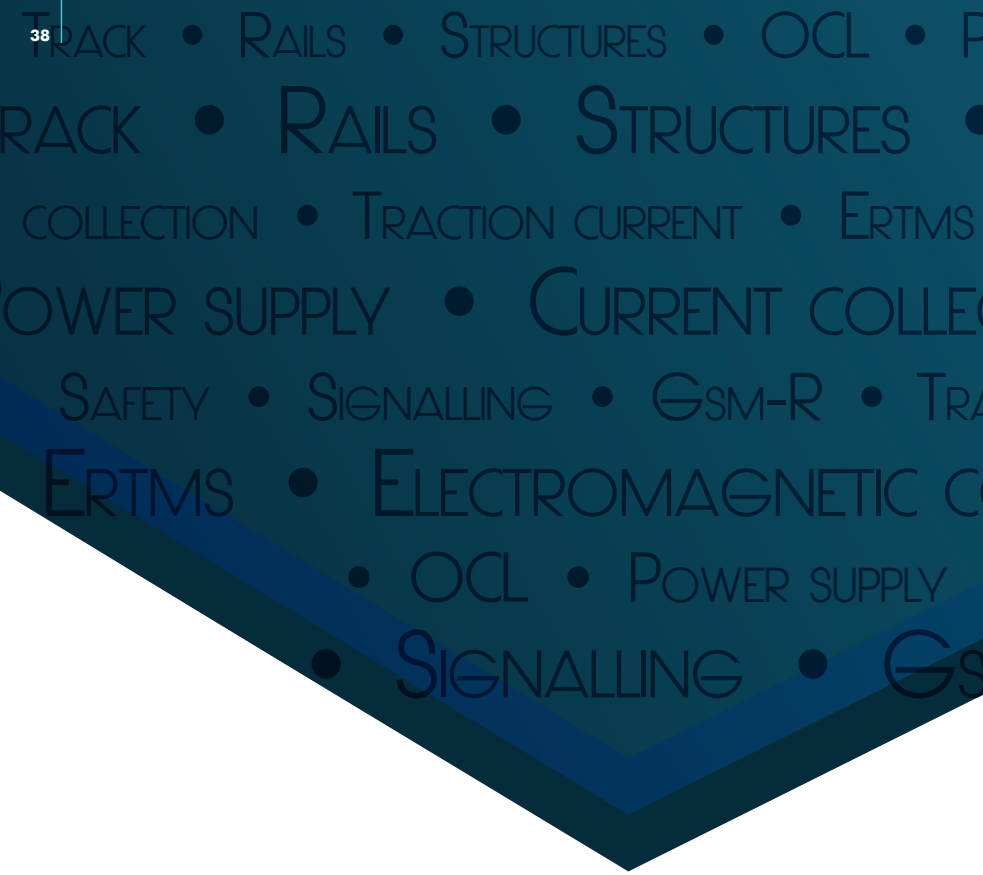
ISO/IEC 17025 awarded by COFRAC

## STANDARDS

- EN ISO 3381 – Acoustics - Measurement of noise inside rail vehicles
- EN ISO 3382-2 – Acoustics - Measurement of room acoustic parameters - Part 2: Reverberation time in ordinary rooms
- NF S31-088 – Acoustics - Measurement of railway traffic noise for its characterization
- EN ISO 60268-16 – Sound system equipment - Part 16: objective rating of speech intelligibility by speech transmission index
- Loc and Pass TSI – Noise and PRM
- NF S31-086 – Acoustics – Measurement of noise inside road vehicles (public transport)

 See also pages

36, 89, 136, 137, 140





## INFRASTRUCTURE

Diagnosis of cables and malfunction detection in high-voltage overhead lines .....	41
Rails and turnouts .....	42
Track components .....	43
Rolling stock and rail structures .....	44
Railway line commissioning .....	45
3D Simulation of pantograph - OCL interaction .....	46
OCL uplift .....	47
Electric traction power supplies .....	48
Traction return current circuit characterization .....	49
Traction return current .....	50
Dynamic monitoring of the overhead contact line .....	51
Compatibility of electronic wheel detectors with rolling stock .....	52
Compatibility of rolling stock with axle counters .....	53
Radiated electromagnetic field - railway system .....	54
Electromagnetic impact - modelling and expertise .....	55
Inspection and expertise of electrical systems and installations .....	56
Qualification of GSM-R network for ETCS level 2 .....	57
ERTMS .....	58
Signalling via track circuits .....	59
System dependability .....	60
Remote monitoring of electrical and power units .....	61
Train number recognition system .....	62
Vibralerte .....	63

# INFRA- STRUCTURE

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For rolling stock, EURAILTEST offers type approval tests specifically for railway infrastructure.

EURAILTEST experts are involved during the final stages of the type approval process, during which infrastructure is approved through dynamic testing via speed ramp-up tests.

On the basis of expert opinions it is possible to move step by step from one speed band to the next for track and OCL type approval. These opinions concern:

- Vehicle-track interaction (dynamic behaviour testing)
- Electric traction (current collection testing)

Following these tests, measurements of pressure on railway structures (bridges and tunnels) can also be made.

The results can then be submitted to other experts who will then reproduce in the laboratory the pressure levels observed for different types of traffic. An expert opinion will then be delivered regarding the conformity of the railway structures with the regulations in force.





# DIAGNOSIS OF CABLES AND MALFUNCTION DETECTION IN HIGH-VOLTAGE OVERHEAD LINES

Take delivery of new installations, assess the remaining life expectancy of connections and locate defects on cables in high-voltage overhead lines.

## OBJECTIVES

Detect ageing or downgrading of cable insulation by measuring the insulation resistance

- Detect an electric current leakage that may indicate the presence of humidity or downgrading of cable insulation by measuring the tangent delta
- Locate a weak point on the cable by measuring the partial discharge
- Pre-locate a clear defect by measuring the pulse reflection
- Pre-locate an unclear defect by performing a surge arc reflection
- Determine the condition of the external sheath of a cable by conducting sheathing defect tests

## TEST RESOURCES

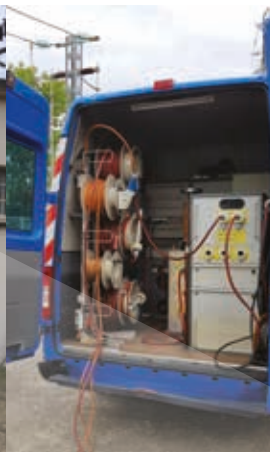
- Baur vehicle laboratory
- FLUKE FL 1555
- Hagenuk vehicle laboratory
- MEGGER MT1025
- PA-TaD (Baur)
- PROTRAC (Baur)
- VIOLA TD (Baur)


## REFERENCES

- SNCF RESEAU

## STANDARDS

- IEEE 400.2 – Guide for Field Testing of Shielded Power Cable Systems Using Very Low Frequency



 See also pages  
42, 43, 122, 123



# RAILS AND TURNOUTS

Contributing to the type approval process through metallurgical testing of infrastructure equipment - especially rails and turnouts.

## OBJECTIVES

- Analyze rails and other metal track components at our dedicated centre or in the field as part of studies, failure analysis and product or equipment type approvals
- Approve thermit and electric welds
- Monitor the electric welding process (bending test)
- Classify broken rails
- Reconstitute defects in 2D or 3D using destructive machining
- Analyze damage to:
  - infrastructure equipment
  - rail welds
  - frogs
- Perform tests for validating electrodes or automatons

## TEST RESOURCES

- Macrographic and micrographic examinations
- Hardness tests
- Press (bending tests)
- Ultrasonic tests
- Eddy current test
- Miniprof (measurement of rail cross-sections)

## REFERENCES

- ALSTOM
- EUROTUNNEL
- RAILTECH
- RATP
- SNCF
- TSO

## STANDARDS

- EN 14730 – Track - Aluminothermic welding of rails
- EN 14587 – Track - Flash butt welding of rails
- UIC 712 R – Catalogue of rail defects

See also pages  
41, 43, 45, 103



# TRACK COMPONENTS

Testing and qualifying track components in the laboratory, especially sleepers, fastening systems and elastic components.

## OBJECTIVES

- Conduct sleeper tests
- Perform tests on fastening systems according to standards
  - repetitive loading
  - salt spray tests
  - electrical resistance
- Carry out specific testing of elastic components
  - Stiffness testing: fasteners, rail and sleeper pads, ballast and under ballast mats
  - Attrition and fatigue tests on ballasted track components: fasteners, sleepers, rail and sleeper pads, ballast and under ballast mats
  - Fatigue testing of bonded insulated joints
  - Lateral resistance testing of sleepers

## TEST RESOURCES

- Hydraulic pulsators
- Climate chamber
- Salt spray chamber

## REFERENCES

- ALSTOM
- CERTIFER
- EUROTUNNEL
- International railway operators
- VOSSLOH
- RATP

## STANDARDS

- EN 13230 – Track - Concrete sleepers and bearers
- EN 13481 – Track - Performance requirements for fastening systems
- EN 13146 – Track - Test methods for fastening systems



 See also pages

41, 42, 45, 103



# ROLLING STOCK AND RAIL STRUCTURES

Checking the compliance of rolling stock movements on bridges and tunnels on a given route for type approval purposes.

## OBJECTIVES

Determine running and clearance gauge conditions of a new rolling stock or new rolling stock configurations in relation to the structures (bridges and tunnels) on a particular railway network

## TEST RESOURCES

- Tools for calculating the loads exerted by new rolling stock on rail structures - static and dynamic
- Measuring systems used at tunnel portals and for geometric studies (Elise)
- Instruments installed on structures to assess the impact of passing trains (under test or not)

## REFERENCES

- ALSTOM
- DEUTSCHE BAHN
- RATP
- SIEMENS
- SNCF-RÉSEAU
- SNCF
- VOITH
- VOSSLOH

## STANDARDS

- EN 15528 – Line categories for managing the interface between load limits of vehicles and infrastructure
- Eurocode 1 - Part 2 and Annex A2





# RAILWAY LINE COMMISSIONING

Contributing to the track and overhead contact line commissioning process for high-speed and conventional lines.

## OBJECTIVES

Qualify track and OCL by analyzing dynamic behaviour and current collection (contact force and arc measurements)

## TEST RESOURCES

- Arc detector on the OCL
- Instrumented pantograph
- Accelerometers for track monitoring
- TSI trainset
- Measurement of OCL uplift

## ACCREDITATIONS

ISO/IEC 17025 awarded by COFRAC


## REFERENCES

- ALSTOM
- CLERE
- COSEA
- INFRABEL
- LLOYD'S
- OC'VIA
- SNCF-RESEAU
- SYSTRA
- TP FERRO

## STANDARDS

- EN 50367 – Current collection systems - Technical criteria for the interaction between pantograph and overhead line (to achieve free access)
- IN 2542 – Raising train and similar speed limits - technical provisions
- UIC Technical document - Guide for the approval of high-speed lines
- TSI Energy, High-speed and Conventional rail



 See also pages

17, 30, 42, 43, 46, 47, 103



# 3D SIMULATION OF PANTOGRAPH-OCL INTERACTION

Optimizing current collection and the various components.

## OBJECTIVES

- Optimize pantograph adjustments and determine critical configurations for testing running behaviour. This saves a significant amount of time in the type approval test phases
- Optimize the design of catenary and pantographs
- Check the interaction between systems during their design phase
- Provide effective and cost-efficient solutions in order to improve current collection quality
- Propose solutions to improve infrastructure and rolling stock components
- Optimize maintenance rules
- Provide customers with the simulations required for certification of interoperability components as defined in the Technical Specifications for Interoperability

## TEST RESOURCES

OSCAR® software developed by SNCF (EN 50318 certified)

## REFERENCES

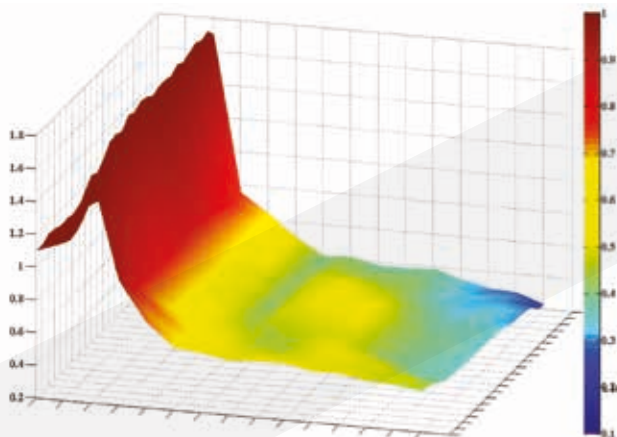
- ALSTOM
- ATKINS
- BOMBARDIER
- CFF
- NETWORK RAIL
- STEMMAN

## STANDARDS

- EN 50318 – Current collection systems - Validation of simulation of the dynamic interaction between pantograph and overhead contact line
- EN 50367 – Current collection systems - Technical criteria for the interaction between pantograph and overhead line (to achieve free access)

See also pages

30, 31, 32, 45, 47, 51, 104





# OCL UPLIFT

Checking that overhead contact line uplift is compliant with the standards in force.

## OBJECTIVES

- Check compliance with the criteria regarding contact wire uplift caused by the pantograph, in accordance with requirements mentioned in the interoperability standards and directives
- Measure and record uplift of the contact wire due to passing trains:
  - On various rail networks: 25 kV AC, 15 kV AC, 3 kV DC and 1.5 kV DC
  - On 2 adjacent tracks
  - Up to 4 consecutive masts per track
  - In both traffic directions
  - Up to  $V = 574.8$  km/h
  - With an accuracy to under 1 mm
  - In all weather conditions (rain, fog, snow, etc.)
- Measure meteorological parameters at OCL level: wind speed and direction, humidity and temperature
- Measure running speed and corrected train speed

## REFERENCES

- ALSTOM
- BOMBARDIER
- CFL
- CrossRail
- OC VIA
- SEA
- SNCF-RÉSEAU
- STADLER

## TEST RESOURCES

CATIRIS® v2 measuring station:

- Real-time data acquisition and processing system
- Uplift sensor
- Insulating arm
- Reference power supply

## STANDARDS

- EN 50317 – Current collection systems - Requirements for and validation of measurements of the dynamic interaction between pantograph and overhead contact line
- EN 50119 – Fixed installations - Electric traction overhead contact lines
- Conventional rail ENE TSI
- High-speed ENE TSI
- Loc & Pas TSI
- EPSF SAM E903

## ACCREDITATIONS

CERTIFER No. 9285/0004 edition 1



 See also pages

30, 31, 32, 46, 51, 104



# ELECTRIC TRACTION POWER SUPPLIES

Checking that the electric power in sub-stations and on the track is correctly dimensioned when commissioning new and modified lines.

## OBJECTIVES

- Characterize the “energy” parameters in sub-stations and the power supply delivered to the OCL in sub-stations and on the track:
  - In steady state: revenue service and test trains
  - In transient state: during operation of equipment and OCL/rail short-circuits
- Highlight abnormal phenomena

## TEST RESOURCES

- VULCAIN and LUCIE trainsets
- Recorders and analyzers installed onboard trains and trackside

## REFERENCES

- Mulhouse Tramway
- Nantes Tramway
- Oc’Via
- SNCF
- SYTRAL

## STANDARDS

- EN 50163 – Supply voltages of traction systems
- EN 50122-1 – Protective provisions against electric shock
- Technical Specifications for Interoperability “Energy” (ENE TSI)

See also pages

49, 50, 61







# TRACTION RETURN CURRENT CIRCUIT CHARACTERIZATION

Checking that the traction return current is consistent with studies and locate defects in the event of an incident on the line.

## OBJECTIVES

- Measure current flowing in the rails in order to characterize the traction return current circuit (1,500 V DC / 25,000 V, 50 Hz AC)
- Measure line voltage and absorbed current in order to characterize the influence of traffic on line voltage
- Measure the relative temperature of the electrical components in the OCL at constant power


## REFERENCES

- ANSALDO STS
- INFRABEL
- NETWORK RAIL
- PRORAIL
- SNCF-RÉSEAU

## TEST RESOURCES

- LUCIE testing car - to monitor electric power facilities
- VULCAIN test wagon - capable of absorbing nominal current
- Dedicated measuring chain equipment
- Operators specializing in LUCIE and VULCAIN train operation
- Thermographic camera (for detecting abnormal heating in the vicinity of the OCL)



 See also pages  
48, 50, 61



# TRACTION RETURN CURRENT

Ensuring the safety of staff and passengers on the track, checking there is no loss of power loss and guaranteeing signalling installation availability

## OBJECTIVES

- Characterize in sub-stations and at specific places on the rail line:
  - traction return current
  - rail/ground voltage
- In steady state: revenue service and test trains
- In transient state: during OCL/rail short-circuits

## REFERENCES

- ANSALDO STS
- INFRABEL
- SNCF

## STANDARDS

EN 50122 – Protective provisions against electric shock

## TEST RESOURCES

- LUCIE testing car - to monitor electric power facilities (If dynamic measurements are not possible, measurements on the ground may be possible)
- VULCAIN test wagon - capable of absorbing nominal current (If dynamic measurements are not possible, measurements on the ground may be possible)
- Recorders and analyzers installed on trains and trackside

See also pages  
48, 49, 51, 61





# DYNAMIC MONITORING OF THE OVERHEAD CONTACT LINE

Check contact wire geometry and avoid potential incidents.

## OBJECTIVES

The system measures overhead line height and stagger using contactless technology


## REFERENCES

- INEO
- RATP
- SETRAM

## TEST RESOURCES

- Measuring system to detect the position of the overhead line (maximum two wires)
- Camera to locate the position of the masts
- GPS and radar to correlate measurements and locations



 See also pages  
46, 47, 50



# COMPATIBILITY OF ELECTRONIC WHEEL DETECTORS WITH ROLLING STOCK

Contributing to the type approval process of rolling stock by verifying the electronic wheel detectors.

## OBJECTIVES

Check that the electronic wheel detectors used in electronic treadles, axle counters and hot box detectors are not affected by rolling stock movements

## TEST RESOURCES

- Multi-channel digital recorder
- Standalone temperature and humidity logger
- Distortion meter

## ACCREDITATIONS

Recognition by CERTIFER capability certification

## REFERENCES

- ALSTOM
- BOMBARDIER
- DEUTSCHE BAHN
- ORIENT EXPRESS
- SIEMENS
- STADLER
- VOSSLOH

## STANDARDS

- OP 09913 (SAM S 005) – Protocol for testing compatibility of rolling stock with electronic wheel detectors
- EN 50238-2003 – Railway applications - Compatibility between rolling stock and train detection systems
- ERA ERTMS V2.0 033281 – Interfaces between control - Command and signalling trackside and other subsystems
- PR EN 50592 – Railway Applications - Testing of rolling stock for electromagnetic compatibility with axle counters

See also pages

26, 59





# COMPATIBILITY OF ROLLING STOCK WITH AXLE COUNTERS

Checking that the magnetic fields generated by a train are compatible with the axle counters (electronic wheel detectors), as part of the type approval process.

## OBJECTIVES

- Measure the magnetic field in the 10 kHz to 1.3 MHz range at rail level
- Compare the levels of the magnetic fields generated by rolling stock with the limits set by the regulation in relation to sensitivity of axle counters fitted on European rail networks

## TEST RESOURCES

- Two sets of high and low-frequency measurement antennas on each stretch of rails
- High performance data acquisition system (sampling at 4 MHz)
- Train positioning system
- Specific measurement software for real-time analysis of results


## REFERENCES

- BOMBARDIER Italy
- CFL
- SNCF

## STANDARDS

- EN 50592 (May 2017) – Railway applications - Testing of rolling stock for electromagnetic compatibility with axle counters
- CLC/TS 50238-3 Part 3, of 06/2013: CENELEC technical specification for railway applications, electromagnetic compatibility between rolling stock and train detection systems
- STI CSS, Index 77 ERA/ERTMS/033281 Version 4.0 of 20/09/2018, ERA technical document, Interfaces between control-command and signalling trackside and other subsystems



 See also page

26



# RADIATED ELECTROMAGNETIC FIELD - RAILWAY SYSTEM

Checking that a railway system complies with regulations regarding the electromagnetic emissions released into the outside world.

## OBJECTIVES

- Measure levels of electromagnetic radiation - from 9 kHz to 1 GHz - released by the system into its environment
- Compare these levels with the limits set by the EN 50121-2 standard
- These tests can be performed at low speed, to test the effect of power stations (substation, power booster) on rolling stock, or trackside during the passage of a train at full speed

## TEST RESOURCES

- Spectrum analyzer
- Measuring receiver
- Loop antenna
- Biconical antenna
- Log periodic antenna
- Masts

## ACCREDITATIONS

ISO/IEC 17025 awarded by COFRAC

## REFERENCES

- ALSTOM
- COSEA
- SNCF

## STANDARDS

EN 50121-2 – Electromagnetic compatibility - Part 2: Emission of the whole railway system to the outside world

See also pages

26, 27, 28, 29, 55, 149





# ELECTROMAGNETIC IMPACT - MODELLING AND EXPERTISE

Studying the electromagnetic compatibility of railway infrastructure projects from the design phase.

## OBJECTIVES

- Model existing systems in order to simulate electromagnetic interference
- Assess dysfunctional facilities
- Define methods of protecting employees with regard to electrical hazards and electromagnetic protection of equipment in accordance with standards and legal texts
- Optimize electric traction and traction return systems as well as earthing networks

## TEST RESOURCES

- ARCVIEW: mapping software
- Caryn: SNCF plug-in for the GIS ArcMap® software that calculates the influence of one circuit on another
- ModRGT and Graphcapture: exploitation and interpretation of results
- Modalf: calculation of current and voltage at any point of a multicore model representing a rail system
- CEPS: helps estimate increase of soil voltage levels due to electricity pylons located near the railway line

## REFERENCES

- CTRL (Channel Tunnel Rail Link)
- COSEA
- OCVIA Construction
- CANARAIL (Canada)
- SETEC
- SYTRAL

## STANDARDS

- EN 50121-2 – Electromagnetic compatibility - Part 2: Emission of the whole railway system to the outside world
- EN 50443 – Effects of electromagnetic interference on pipelines caused by high voltage AC electric traction systems and/or high voltage AC power supply systems
- EN 61000-2-12 – Electromagnetic compatibility (EMC) - Part 2-12: Environment - Compatibility levels for low-frequency conducted disturbances and signalling in public medium-voltage power supply systems
- EN 50121-1 – Electromagnetic compatibility - Part 1: General
- IN 399 – Single-phase AC power line - Provisions to be applied to protect against the dangers from 25,000 V 50 Hz current
- CEN TS 15280 – Evaluation of AC corrosion likelihood of buried pipelines - Application to cathodically protected pipelines
- Volumes II to VII, IUT-T Directives – Protection of telecommunications lines against the harmful effects of electrical power and electrified railway lines, Geneva edition, 1999
- IUT-T K.68 - Management of the electromagnetic interference on telecommunication systems caused by power systems
- French interministerial order of 17 May 2001 - Technical conditions to be met by energy distribution
- French decree No. 2002-775 regarding limit values for public exposure to electromagnetic fields





# INSPECTION AND EXPERTISE OF ELECTRICAL SYSTEMS AND INSTALLATIONS

Studying specific characteristics of the railway power supply system and installations to deliver and implement suitable measurement provisions to ensure their compliance.

## OBJECTIVES

- Assist customers with their projects by analysing the parameters for their installations and their electrical systems to ensure compliance:
  - Eurailtest provides advice and assistance to the project manager in the development of specifications for designing future installations (earthing circuits, equipotential earthing and traction return current)
  - Provide support for the project during the works phase using the technical skills acquired on numerous projects associated with the development of rolling stock maintenance installations
- Ensure that the installation is efficient in both nominal and downgraded mode and carry out checks on the protective provisions to ensure the safety of staff, primarily from electrical risks:
  - Compliance tests (visual inspection and functional checks, recording and analysing electrical phenomena) in operational mode or equivalent, to check that the installation complies

with the regulations and/or technical characteristics defined by prior studies or simulations

- Short-circuit tests in response to specific needs and in respect of risk analysis conducted to validate a study or to check behaviour in relation to the power supply diagram

## TEST RESOURCES

Adaptable to each maintenance centre or substation

## STANDARDS

- NFC 15-100 – Regulations on electrical installations
- EN 50 122 – Railway applications – Fixed installations – Electrical safety, earthing and return circuit
- EN 50 163 – Supply voltages of traction systems

See also pages

26, 48, 50, 54, 57, 58, 59,  
60, 118, 120







# QUALIFICATION OF GSM-R NETWORK FOR ETCS LEVEL 2

Qualifying GSM-R network and assessing its compatibility with the operational requirements of ETCS Level 2 (ERTMS).

## OBJECTIVES

- Measure transmission errors in a specific environment
- Qualify call setup performance
- Carry out availability measurements and establish disconnection rates
- Assess GSM-R network operation, redundancy and mobility in an environment with dual coverage
- Define the optimization plan

## REFERENCES

- CLERE
- EIFFAGE


## TEST RESOURCES

- Radio measurement system and onboard frequency scanner
- Signal generator and train/ground data logger
- Post-analysis tool for quality of service
- Specific on-board system for measuring disconnection rates
- Protocol analyzer

## STANDARDS

- Informative documents UNISIG – Subset 93
- UIC references – O2475, O3031



 See also pages  
58, 79, 121



# ERTMS

Contributing to the type approval process for the different levels of ERTMS on lines in revenue service by validating system compliance.

## OBJECTIVES

- Test and analyse the software part of the ERTMS system on board a laboratory train for qualification purposes
- Validate the different software versions of the ERTMS ground-to-train system with a dedicated power car

## REFERENCES

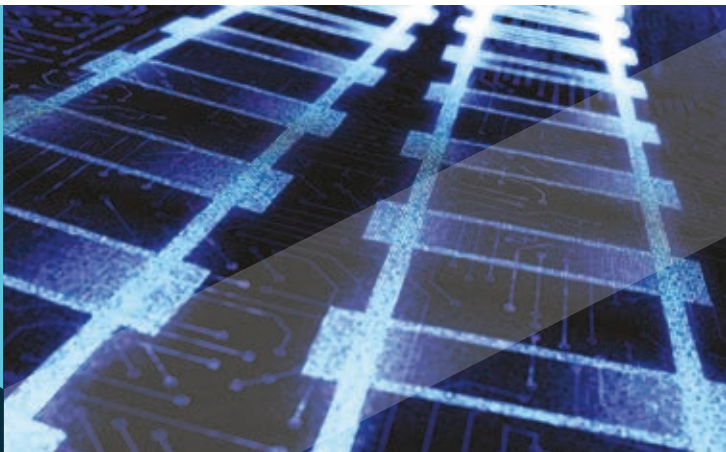
- EIFFAGE
- SNCF-RÉSEAU

## TEST RESOURCES

- High-speed train equipped with dual standard (POS TGV, Dasye TGV, 2N2 TGV) authorized to run on HSL
- Recorder of dual standard internal parameters ("Simulate" software)
- System for recording train parameters: ATESS file, JRU file, default file MID
- Equipment that can simulate different parameters corresponding to a train travelling normally: speed, brush signals, etc.
- Video cameras with real-time recording of the track and DMI (Driver Machine Interface)
- Dedicated railcars X72633/72634

 See also page

57





# SIGNALLING VIA TRACK CIRCUITS

Contributing to the type approval of signalling systems for new and modified lines, and investigation of operated lines.

## OBJECTIVES

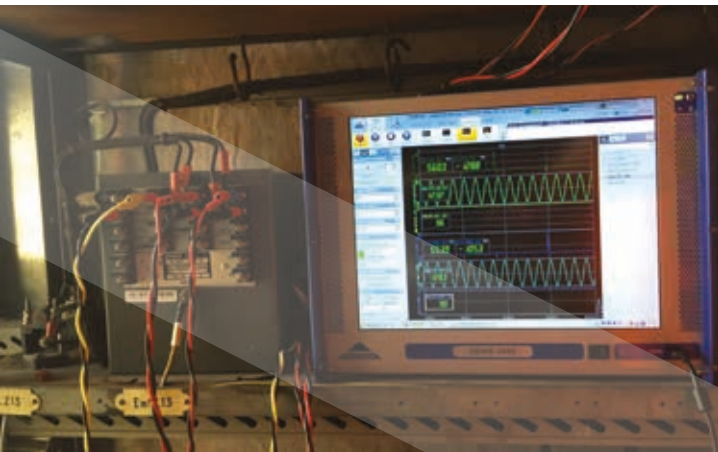
- Check short-circuit current (levels, crosstalk, etc.)
- Check the presence of lateral impedance
- Check continuous data transmission
- Check intermittent data transmission
- Check the wiring of phase-shift loops
- Monitor track circuit signals (residual voltage, voltage to track, power supply, etc.)
- Monitor track circuits (residual voltage)
- Investigate the causes of track circuit malfunction
- Measure intrinsic characteristics of track (primary parameters, insulation, tuning frequency of electrical separation joints, etc.)
- Measure impedance of signalling equipment (cables, shunt bar, etc.)

## TEST RESOURCES

- Multi-channel data acquisition device
- Device installed on the LUCIE testing car
- Synchronized digital recorders
- Long-distance monitoring via remote interrogation

## REFERENCES

- COSEA
- INFRABEL
- NETWORK RAIL
- NS
- Oc'Via
- OPERE
- SNCF
- SNCF-RÉSEAU



 See also pages

26, 52



# SYSTEM DEPENDABILITY

Demonstrating the Reliability/Availability/Maintainability/Safety of urban rail transport systems.

## OBJECTIVES

- Conduct safety studies on the signalling/ automation sub-system at the general design stage in accordance with the French "STPG" (Safety of Public Guided Transport) decree
- Develop and independently evaluate the dependability of systems, safety-critical software and hardware at the detailed design stage, manufacture and implementation of "signalling-drive automation" sub-systems (metro, regional rapid transit and trams) in accordance with EN 50126
- Study usability: implementation of the new system in operating conditions
- Develop overall "Reliability & Availability" processes: definition of indicators, setting targets for each indicator, target allocation, predictive analysis at the design stage, design of validation tests, statistical analysis of feedback during operational monitoring, establishing replacement vehicle requirements

## REFERENCES

- ANSALDO
- AREVA
- RATP
- SIEMENS
- THALES

## STANDARDS

- EN 50126 – Specification and demonstration of Reliability, Availability, Maintainability and Safety (RAMS)
- EN 50128 – Communication, signalling and processing systems - Software for railway control and protection systems
- EN 50129 – Communication, signalling and processing systems - Safety related electronic systems for signalling

See also pages

56, 57, 58, 59, 91, 118





# REMOTE MONITORING OF ELECTRICAL AND POWER UNITS

Monitor the behaviour of electrical components of Substations, Electric Traction Fixed Installations (IFTE) and power units for signalling. Detect and record electrical interference phenomena and issue warnings in accordance with alarm configurations.

## OBJECTIVES

- Continuously monitor “critical” electrical installations to ensure high-quality power supply (under normal or downgraded operating conditions)
- Use SENTINEL software for occasional expert analyses (rolling stock / infrastructure interaction, unexpected defects on a substation, etc.)
- View electrical parameters of SENTINEL instrumented substations in real time
- Monitor and issue warnings remotely via secure web platform
- Establish power and consumption assessments (study of fallback plans, dimensioning, etc.)

## REFERENCES

- SNCB
- SNCF RÉSEAU – 70 equipped electrical units (25 kV – 50 Hz, 1,500 V CC and 750 V DC) - substation, paralleling station, power booster, energy station, etc.

## TEST RESOURCES

- Two types of formats for industrialized system – fixed box unit (up to 64 measuring channels) or portable case (up to 16 measuring channels)
- Real-time status monitoring of all SENTINEL installations
- Dedicated HMI accessed via secure web platform
- Access to real-time data and historical data in less than 2 minutes
- Evolving data processing and calculation software
- Statistical analysis algorithms specific to physical phenomena and adapted for railways (pumping, protection system functioning, etc.)
- Voltage sensor
- Amperometric clamp
- Data acquisition board
- Voltage sensor



 See also pages

48, 49, 50, 56



# TRAIN NUMBER RECOGNITION SYSTEM

SYRENE (the train number recognition system) can link an event occurring on the track to a specific train in real time.

## OBJECTIVES

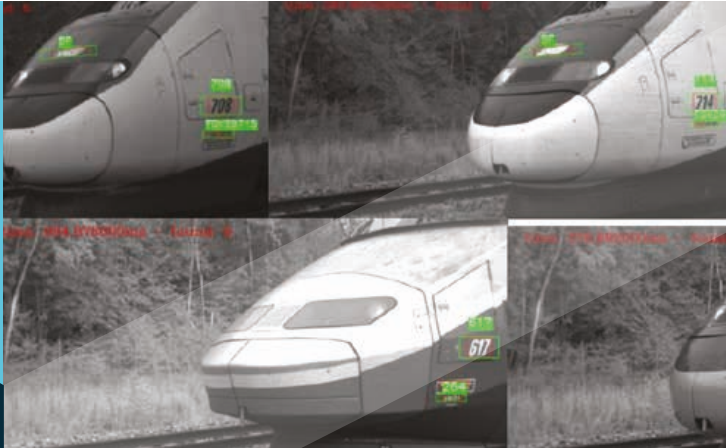
- Detect and identify all characters on all types of rolling stock in all weather and running conditions
- Deliver digitized data via a secure website and via a system that interfaces easily with any measurement or monitoring system

## TEST RESOURCES

- Optical module (camera, lens, filter, lidar)
- Data acquisition module
- Position-finding software with image return in real time, requiring limited on-site adjustment
- HMI that can be consulted and updated in real time via a secure web platform

## REFERENCES

- SNCF





# VIBRALERTE

VIBRALERTE is a vibration detection system.

## OBJECTIVES

- Warn of potential malfunctions in signalling equipment caused by vibrations
- Detect open relay contacts in de-energized state in excess of a given threshold
- Detect a change in relay contact status beyond a set timeframe

## TEST RESOURCES

- Electronic control unit
- Typical relay (representative of the signalling equipment to be monitored)

## REFERENCES

- GARES & CONNEXIONS
- INFRAPÔLES



BRAKING • BOGIES • AXLES • VIBRATION  
CLIMATE • CABLES • PAINT – GLASS PANES  
CLIMATE • CABLES • PAINT – GLASS PANES  
WARE & EQUIPMENT • BRAKING  
& EQUIPMENT • BRAKING • BOGIES • AXLES  
CAR BODIES • ASSEMBLIES • PAINT – GLASS PANES  
BOGIES • ASSEMBLIES • RADIO • CLIMATE  
PAINT – GLASS PANES





# RAILWAY EQUIPMENT

Brake components .....	67
Bogies .....	68
Axles .....	69
Bearings and axle boxes .....	70
Wheels .....	71
Fatigue behaviour characterization .....	72
Mechanical resistance of vehicle structures .....	73
Torsional stiffness of vehicle bodies .....	74
Endurance test rig for geared motors .....	75
Mechanical tests on catenary components .....	76
Electrical testing in the laboratory .....	78
Cab radio qualification .....	79
Qualification of contactless cards .....	80
Qualification of coatings .....	81
Qualification heat-shrink tubes and sleeves .....	82
Fire behaviour of cables .....	83
Fire behaviour of materials .....	84
Paint and adhesive films .....	85
Lubricants .....	86
Cleaning products .....	87
Glazing .....	88
Acoustic checks on safety equipment .....	89
ESVE .....	90
Safety assessment of signalling and command-control equipment .....	91

# RAILWAY EQUIPMENT



For railway equipment qualification purposes, EURAILTEST also offers a comprehensive service consisting of measurements, testing and expert opinions.

To qualify your components, our experts will advise you by:

- Helping with the drafting of test specifications
- Checking their compliance with the standards in force
- Contributing to the preparation of the submissions to the national authorities and certification bodies
- Making expert assessments with regard to in-service behaviour, based on test results and/or digital simulation, in order to assess the impact of components on comfort, safety and reliability
- Analysing an accident or identifying failure causes
- Making suggestions for improvements or modifications in the event of damage



# BRAKE COMPONENTS

Contributing to the type approval process of brake shoes, brake pads and wheels.

## OBJECTIVES

- Assess braking performance and endurance for “disc-pad” and “wheel-brake shoe” combinations
- Conduct tests for wheel thermomechanical resistance and failure
- Estimate life cycle costs: weighing of pads and shoes + measuring disc and wheel profiles
- Measurements:
  - friction and stress coefficients
  - noise during braking (initial noise and dBA level)
  - temperature
  - wheel deflection by means of optical sensors
  - surface roughness
- Quantify pollutant emissions into the air

## TEST RESOURCES

- 2 full-scale test rigs: up to 500 km/h (maximum simulation speed on a wheel of 920 mm in diameter) and up to 30 tonnes (maximum simulated axle load)
- Infrared thermography
- Non-destructive test instruments

## ACCREDITATIONS

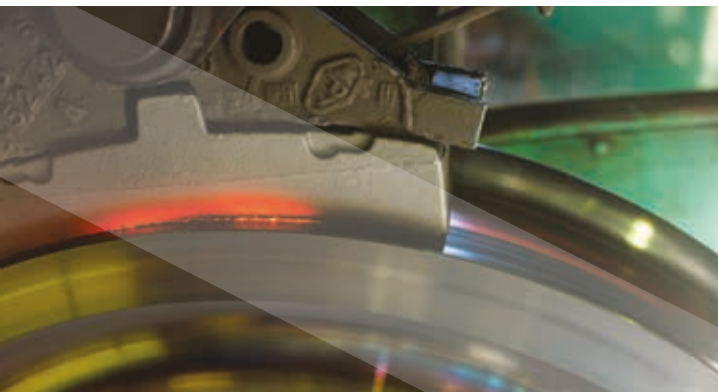
ISO/IEC 17025 awarded by COFRAC

## REFERENCES

- ALSTOM
- BECORIT
- BOMBARDIER
- ECR
- FAIVELEY
- FLERTEX
- ICER RAIL
- KNORR
- SIEMENS
- TALLANO
- TMD
- UIC

## STANDARDS

- EN 13979-1 – Wheelsets and bogies - Monobloc wheels
- UIC 510-5 – Technical approval of monobloc wheels
- UIC 541 – Brakes - Regulations concerning manufacture of the different brake parts - Driver’s brake valve
- UIC 541 – Brakes - Regulations concerning the manufacture of brake components - Braking components
- Application document for standard EN 13979-1 – Technical approval procedure. Part 1. Forged and rolled wheels
- EN 16452 – Railway applications. Braking. Brake blocks



 See also pages

21, 22, 23, 115, 148



# BOGIES

Checking the dimensions and overall design of all types of bogie frame for type approval purposes.

## OBJECTIVES

- Perform static tests to check the dimensions of a bogie frame under:
  - regular mechanical loads (vertical, lateral, twist)
  - specific mechanical loads (derailment, brakes, anti-roll bar, etc.)
  - preparatory analysis for fatigue tests (GOODMAN and HAIGH diagrams)
- Conduct fatigue tests in order to verify the overall design and manufacture of a bogie frame:
  - regular tests (vertical, lateral and twist with roll and bounce)
  - specific tests: traction, braking, inertia, etc.

## TEST RESOURCES

- 1 test rig - for static and fatigue tests - totally modular
- 30 dynamic cylinders (40 to 400 kN)
- Non-destructive testing for crack detection
- Strain gauges
- Dynamic data acquisition system

## REFERENCES

- ALSTOM
- BOMBARDIER
- CAF
- CSR

## STANDARDS

- EN 13749 – Wheelsets and bogies
  - Method of specifying the structural requirements of bogie frames
- UIC 615-4 – Bogies and running gear
  - Bogie frame structure strength tests
- UIC 515-4 – Trailer bogies - Running gear
  - Bogie frame structure strength tests
- UIC 510-3 – Wagons - Strength testing of 2 and 3-axle bogies on test rig

See also pages

17, 69, 70, 71, 99, 115



# AXLES

Checking and establishing axle dimensions and running gear failure analysis.

## OBJECTIVES

- Conduct failure analysis on worn axles
- Check the conformity of axle design
- Perform fatigue tests on axles

## TEST RESOURCES

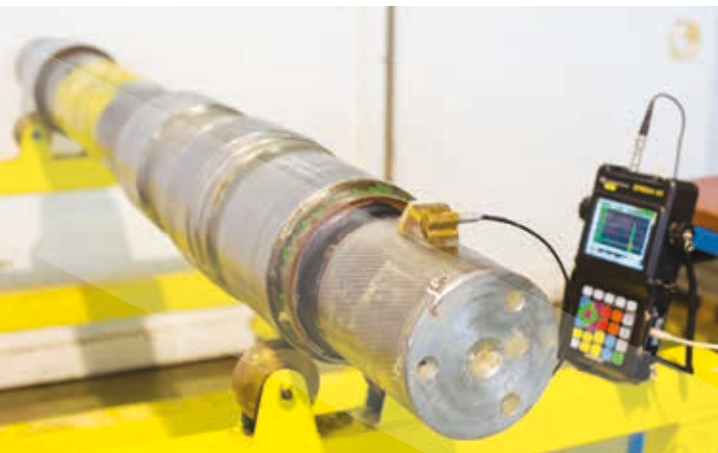
- Tensile, resilience and hardness testing machines
- Dynamic test bench for rotational bending of axles
- Roughness tester
- Optical microscope
- Scanning electron microscope
- Non-destructive test instruments

## REFERENCES

- ALSTOM
- BOMBARDIER
- CAF
- MG VALDUNES

## STANDARDS

- EN 13103 – Non powered axles
- EN 13104 – Powered axles
- EN 13260 – Wheelsets
- EN 13261 – Axles
- STM-R 102 – Wheelsets – Product requirements
- STM-R 103 – Axles – Product requirements



 See also pages

68, 70, 71, 86, 99, 115



# BEARINGS AND AXLE BOXES

Contributing to the type approval process of all types of bearings and axle boxes test rigs.

## OBJECTIVES

- Identify the performance of an axle box roller bearing
- Optimize potential useful life and life cycle
- Monitor behaviour and damage patterns thanks to thermal, acoustic and vibration measurements
- Conduct failure analysis. Analyse the lubricant

## TEST RESOURCES

- Four machines for testing axle boxes: adjustable axial force  $\pm 50$  kN + Radial force up to 150 kN + Acceleration up to  $\pm 4$  m/s<sup>2</sup> + Rotational speed up to 3,000 rev/min
- Non-destructive test instruments:
  - axle shafts in stock:  $\varnothing$  100mm ;  $\varnothing$  120mm ;  $\varnothing$  130mm ;  $\varnothing$  150mm
  - other diameters made to order
  - possibility of adding vibration sensors
- Sealing test bench

## ACCREDITATIONS

ISO/IEC 17025 awarded by COFRAC

## REFERENCES

- ALSTOM
- EPK-BRENCO
- KINEX
- NSK
- NTN-SNR
- SCHAEFFLER
- SKF
- SNCF
- TIMKEN

## STANDARDS

- EN 12080 – Axle-boxes - Rolling bearings
- EN 12082 – Axle-boxes - Performance testing
- UIC 515-5 – Running gear - Tests for axle-boxes
- STM-R104

See also pages

68, 69, 71, 86, 115





# WHEELS

Establishing wheel dimensions to optimize their performance and conduct failure analysis.

## OBJECTIVES

- Determine the fatigue limits of wheels
- Assess fatigue behaviour of non-axisymmetric wheels (calculations and biaxial testing)
- Study crack propagation
- Conduct failure analysis

## TEST RESOURCES

- Fatigue test bench for wheel (vertical force up to 150 kN and lateral force up to 100 kN)
- Dynamic measuring chains
- Strain gauges
- Scanning electron microscope

## ACCREDITATIONS

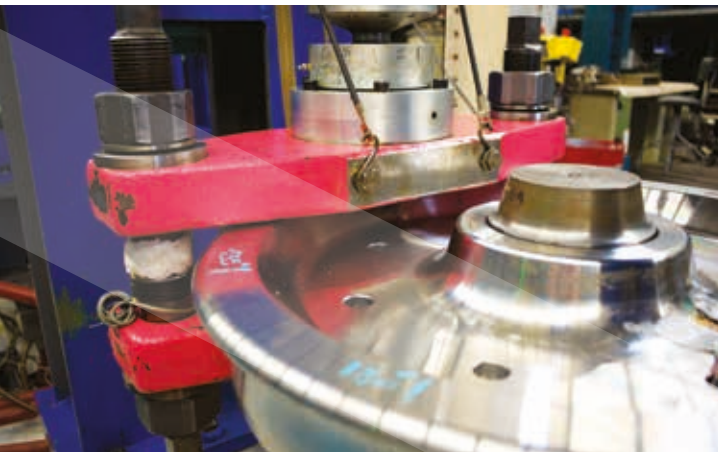
ISO/IEC 17025 awarded by COFRAC


## REFERENCES

- ALSTOM
- BONATRANS
- CAF
- MG VALDUNES

## STANDARDS

- EN 13260+A1 – Wheelsets and bogies - Wheelsets - Product requirements
- EN 13261+A1 – Wheelsets and bogies - Axles - Product requirements
- EN 13979-1 – Wheelsets and bogies - Monobloc wheels
- EN 13262 – Wheelsets and bogies - Wheels
- ERRI B169/RP9



 See also pages  
68, 70, 106, 115



# FATIGUE BEHAVIOUR CHARACTERIZATION

Performing sizing of new parts and characterize fatigue behaviour of mechanical parts and materials and establish potential.

## OBJECTIVES

- Assess fatigue behaviour of:
  - small equipment (bearing cages, shock absorbers, brake beams, suspension parts, etc.)
  - bolted, welded and riveted assemblies
  - metallic and composite materials
- Determine the laws of crack formation
- Determine the critical plane stress intensity factor (K1C)
- Assess the fatigue limits of metal and composite materials and establish Wöhler curves and endurance diagrams for materials and assemblies

## REFERENCES

- ALSTOM
- BEA-TT (French Land Transport Accident Investigation Bureau)
- SNCF

## TEST RESOURCES

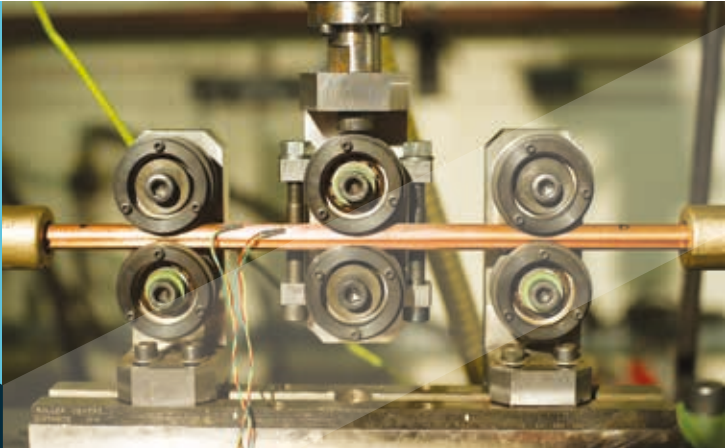
- 6 servo-hydraulic machines for tension and compression testing (from  $\pm 15$  kN to  $\pm 160$  kN)
- 1 servo-hydraulic machine for torsion ( $\pm 5,000$  N.m)
- 3 bending machines ( $\pm 50$  kN)
- Force and displacement sensors on each cylinder
- Parallel measurements for multiple monitoring: extensometry, displacement, temperature
- Non-destructive test instruments

## STANDARDS

- EN 13261+A1 – Wheelsets and bogies - Axles - Product requirements
- NF A03-400 – Iron and steel - Fatigue testing - General principles
- NF A03-405 – Metal products - Fatigue testing - Statistical data processing

See also pages

76, 98, 106







# MECHANICAL RESISTANCE OF VEHICLE STRUCTURES

Contributing to the type approval process of steel rolling stock by checking its resistance.

## OBJECTIVES

- Check if rolling stock built with steel frames (wagons, locomotives, cars) can resist operating conditions:
  - conduct tension, compression and pressure tests
  - simulate lifting and torsion
  - perform simulations with different loading conditions
  - conduct tests with specific loads

## TEST RESOURCES

- Lifting track: loads consist mainly of ballast. Lifting is done with four lifting cylinders (at one or both ends) or at two opposite corners (torsion test)
- Tension/compression test rig: two cylinders are used to apply compression forces up to 3,600 kN and tension forces up to 2,200 kN
- Strain gauges for strain measurements
- Gauge sensors for measuring forces
- Comparators used for deformation measurements

## ACCREDITATIONS

ISO/IEC 17025 awarded by COFRAC


## REFERENCES

- ALSTOM
- BOMBARDIER
- CAF

## STANDARDS

- EN 12663 – Structural requirements of railway vehicle bodies
- UIC 566 – Loadings of coach bodies and their components
- UIC 577 – Wagon stresses
- B12/RP60 – Tests to demonstrate the strength of railway vehicles - Regulations for proof tests and maximum permissible stresses



 See also page

74, 114



# TORSIONAL STIFFNESS OF VEHICLE BODIES

Measuring the torsional stiffness of a vehicle body structure to ensure railway operating safety.

## OBJECTIVES

Determine the torsional stiffness of a vehicle structure around its longitudinal axis - for all types of vehicles: trailers, rail vehicle frames, containers and swap bodies, road trailers

## REFERENCES

- ABRF
- FRANCE WAGONS
- GEFCO

## TEST RESOURCES

- Lifting cylinders
- Force and displacement sensors
- Accessibility to RFN network

## STANDARDS

UIC 530-2 – Wagons - Running safety

## ACCREDITATIONS

ISO/IEC 17025 awarded by COFRAC

See also page

73



# ENDURANCE TEST RIG FOR GEARED MOTORS

Assessing the reliability of geared motors and conduct failure analyses.

## OBJECTIVES

- Check the behaviour of a geared motor unit over time
- Assess the various components of the geared motor
- Identify and analyze failures of the geared motor (electrical and mechanical)
- Conduct investigations
- Measure vibration, torque, speed and temperature
- Conduct physical and chemical analyses of grease and lubricants
- Assessment of geared motor output, balancing temperatures and lubricant performance

## REFERENCES

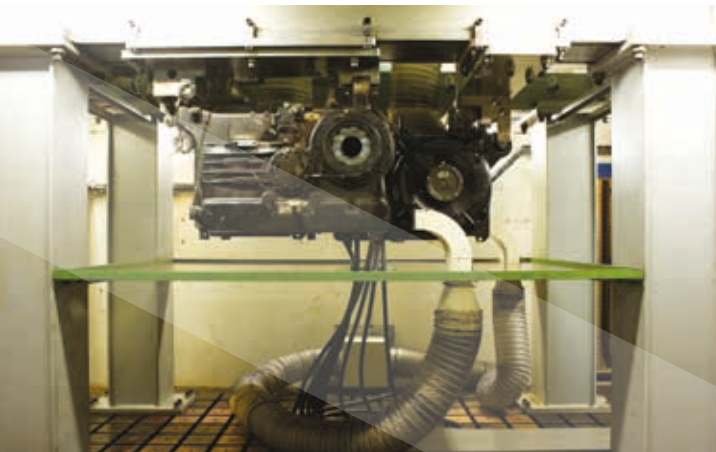
SNCF

## STANDARDS

According to the customer's technical specifications

## TEST RESOURCES

- 2 three-phase converters used for powering two geared motors connected via a drive shaft:
  - a "motor" unit
  - a "load" unit
- Test rig operation:
  - operating cycles adapted to requirements: thermal loads, trip simulation
  - operates round-the-clock, 7 days a week
- Real-time monitoring and measuring system
- Control systems capable of powering synchronous and asynchronous geared motors
- Remote control monitoring
- Variable parameterizable forced ventilation to simulate running conditions on the line



 See also page

34



# MECHANICAL TESTS ON CATENARY COMPONENTS

Mechanical testing of individual catenary parts as well as fully-mounted assemblies.



## TEST OBJECTIVES AND TYPOLOGIES

- Tensile shear tests: measure the resistance and determine the mechanical tensile behaviour of catenary components
- Cyclic tests: check the mechanical endurance of a component under cyclic stress
- Creep tests: measure the deformation and behaviour of a component over time, under an applied load at ambient temperature
- Gyration tests: measure the rotation and turning force of a component for a given tractive effort
- Clamping tests: check the correct placement and ease in which the clamp can be closed and monitor any wire damage
- Failure analysis: conduct an expert analysis of broken parts and investigate causes of breakage

See also pages

30, 72, 106



## ⚙️ TEST RESOURCES

- Tensile test rig - 2 to 30 kN
- Tensile test rig - 100 kN and 5 metres in length
- Tensile test rig - 200 kN and 8 metres in length
- Tensile test rig - 300 kN and 2 metres in length
- Mechanical stress machines for pendulum, with or without low frequency load (0.5 to 5 Hz)

## ☰ REFERENCES

- ACCUM infrastructure project
- EUROTUNNEL
- RATP
- SWLI

## 🏠 STANDARDS

- EN 61284 – Overhead lines - Requirements and tests for fittings
- EN 50149 – Railway applications - Fixed installations - Electric traction - Copper and copper alloy grooved contact wires
- EN 50119 – Railway applications - Fixed installations - Electric traction overhead contact lines
- NF C34110 series
- EN 50182 – Conductors for overhead lines - Round wire concentric lay stranded conductors
- EN 10264 – Steel wire and wire products - Steel wire for ropes - Part 2: cold drawn non alloy steel wire for ropes for general applications
- EN 12385 – Railway applications - Fixed installations - Electric traction overhead contact lines
- IN 1071 – Installing a splicing clamp for contact wires





# ELECTRICAL TESTING IN THE LABORATORY

Qualifying the performance of electrical equipment and simulating incidents encountered in revenue service.

## OBJECTIVES

- Assess voltage withstand of materials or finished product
- Determine the creepage distance of an electrical assembly or the breakdown voltage of a component
- Check the functioning of low power and high power products according to a standard or a technical specification
- Check the conformity of a product or a series
- Check that equipment functions properly
- Assess life potential of a component
- Conduct tests as required by the customer

Examples:

- Electrical withstand tests. Qualify the performance of electrical assemblies and insulators
- overheating of electrical components
- behaviour at high voltage (120 kV - 50 Hz) and with strong direct or alternating current (100 ms window, 40 kA at 1,800 V DC)
- performance of electrical equipment: rheostats, static converters, etc.
- short-circuit tests on specific equipment (e.g. transformers)
- evaluation of switchgear performance: contactors, circuit breakers, switches, etc.
- measurement of harmonic current
- tests on roof gear (catenary simulation)

## TEST RESOURCES

- High voltage generator 120 kV AC - 70 kV DC
- DC power system: 1.5 kV/3 kV DC - 5 MVA
- Single-phase power system: 50Hz, 8 to 30 kV AC - 12 MVA
- Three-phase power system: 50Hz, 0 to 2 kV AC - 1.5 MVA
- High-intensity power system: 0 to 20 kA, 10 V DC
- High-voltage resistance equipment: 0 to 120 kV AC - 50 Hz
- Climatic test chamber (-40°C)
- Switchable outdoor OCL: 25 kV/50 Hz, 1.5 kV, 3 kV

## REFERENCES

- ABB Sécheron
- ADVENTEN
- ALSTOM OBT
- FAIVELEY
- FRAMAFER
- JST
- MCB
- MERSEN
- SDCEM
- SOREEL
- TE CONNECTIVITY
- TECH POWER ELECTRONICS

## STANDARDS

According to customer technical specifications

- EN 50124
- EN 60060
- EN 60077

See also page

122





# CAB RADIO QUALIFICATION

Qualifying the radio installed in the cab used by drivers to communicate with the network operator.

## OBJECTIVES

- Perform technical qualification of the GSM-R and/or UIC cab radio:
  - check compliance with EIRENE, GSM-R and UIC standards
  - perform functional qualification
  - check the interface with the rail network: nominal operation, lack of impact between the “Ground” and “Train” subsystems
  - check equipment integration on trains
- Deliver technical assessment for the use of GSM-R and/or UIC cab radio on the network

## TEST RESOURCES

- Laboratory equipped with a GSM-R test network and a UIC ground-to-train radio network
- 60 km of lines equipped with UIC ground-to-train radio and GSM-R
- Telecommunication laboratory on board the IRIS 320 train (up to 320 km/h)
- Railway test cars


## REFERENCES

- ALSTOM
- CENTER SYSTEMS
- DB
- FUNKWERK
- RENFE
- STADLER

## STANDARDS

- EIRENE FRS (Functional Requirement Specification), SRS (System Requirement Specification)
- UIC 751-1 – Railway radio equipment - Fixed and mobile units - General technical considerations
- UIC 751-2 – Railway radio equipment - Technical specifications
- UIC 751-3 – Technical regulations for international ground-to-train radio systems



 See also pages

57, 121



# QUALIFICATION OF CONTACTLESS CARDS

Ensuring proper operation of contactless cards used for ticketing - whatever their environment.

## OBJECTIVES

Check technical compliance of physical and chemical characteristics of contactless cards with regard to the customer's standards or technical specifications

## TEST RESOURCES

- Test rig for radio
- Test rigs for bending and torsional stress
- Climatic test chambers and heat chambers
- Abrasion test rig
- Peel strength test rig
- Profile projector
- Inflammability, colorimetry and chemical contamination tests

## REFERENCES

- COMUTITRES
- GEMALTO
- OBERTHUR
- PARAGON GROUP
- RATP
- RATP Smart Systems
- SNCF
- STM (Montreal Metro)

## STANDARDS

- ISO/IEC 7810 – Identification cards - Physical characteristics
- ISO/IEC 10373 – Identification cards - Test methods
- ISO/IEC 24789 – Identification cards - Card service life





# QUALIFICATION OF COATINGS

Ensuring passenger safety and accessibility in railway stations and on rolling stock with regard to contrasts, colours, tags and skid resistance.

## OBJECTIVES

- Ensure cleanability of coatings and compatibility of cleaning products thanks to effectiveness and chemical aggressiveness tests on materials intended for rolling stock and infrastructure
- Measure skid resistance of floor coatings
- Measure luminance contrast in passenger areas (accessibility)
- Maintain operator visual identity by means of colour codes

## REFERENCES

- 3M
- ADAPTA COLOR
- HEXIS
- MONDO
- PEDRAZZINI
- PROMATCO
- SCHOEPF
- SFC

## TEST RESOURCES

- Spectrocolorimeter
- Pendulum SRT (Skid Resistance Tester)

## STANDARDS

- NF F31-112 & STM-C-004 – Railway rolling stock - Protection in relation to graffiti - Tests procedures and methods of evaluation, behaviour of materials and removal products
- EN 13036-4 – Road and airfield surface characteristics - Test methods - Part 4: Method for measurement of slip/skid resistance of a surface: The pendulum test
- ISO 7724-2 – Paints and varnishes - Colorimetry - Part 2: Colour measurement
- PRM TSI (EU Official Journal L64/134 of 7 March 2008)



 See also pages

84, 85, 87, 110, 151



# QUALIFICATION HEAT-SHRINK TUBES AND SLEEVES

Ensuring that these components comply with standards and technical specifications.

## OBJECTIVES

Check conformity of mechanical, electrical and physico-chemical behaviour, and the fire resistance of heat-shrink tubes and electrical cables

## TEST RESOURCES

- Climatic test chambers for accelerated product ageing
- Tensile testing machines for plastomers and elastomers
- High voltage cage for rigidity tests
- Megohmmeter

## ACCREDITATIONS

ISO/IEC 17025 awarded by COFRAC (for Fire & Smoke tests)

## REFERENCES

- DSG CANUSA
- GREMCO
- HELLERMANNTYTON

## STANDARDS

- NF F00-608 – General railway equipment - Identifiable heat-shrink sleeves
- NFF and NFC standards applicable to cables

 See also pages

83, 84





# FIRE BEHAVIOUR OF CABLES

Checking the behaviour of electric cables under fire conditions and conducting type approval tests for the EC marking of cables.

## OBJECTIVES

- Assess the ability of cables not to propagate fire via 3 tests:
  - 1 kW flame propagation
  - Fire propagation on stranded wires
  - Fire propagation on ribbon cables
- Evaluate heat generated by measurement of oxygen consumption coupled with measurements of fire propagation on ribbon cables
- Characterize smoke toxicity and opacity from cables in the event of fire

## TEST RESOURCES

- 27 m<sup>3</sup> test chamber
- 1 kW flame
- Testing booth
- Test device for ribbon cables (with or without calorimeter hood)

## ACCREDITATIONS

ISO/IEC 17025 awarded by COFRAC

## REFERENCES

- ACOME
- CGP
- LCIE
- NEXANS
- OMERIN
- PRYSMIAN

## STANDARDS

- EN 61034 – Measurement of smoke density of cables burning under defined conditions
- NF C 32-070 – Classification tests on cables and conductors with respect to their fire behaviour
- IEC 60 332 – Tests on electric and optical fibre cables under fire conditions
  - Procedure for 1 kW pre-mixed flame
- EN 50266-2-4 & EN 50305 (§9.1) – Test for vertical flame spread of vertically-mounted bunched wires or cables
- EN 50399 – Heat release and smoke production measurement on cables during flame spread test
- EN 45545 – Railway applications - Fire protection on railway vehicles



 See also pages

82, 84, 131



# FIRE BEHAVIOUR OF MATERIALS

Checking the compliance of materials intended for rolling stock with regard to fire behaviour.

## OBJECTIVES

- Assess fire behaviour of railway materials through various measurements:
  - toxicity - by gaseous effluent dosage
  - smoke opacity in a non-renewed atmosphere
  - behaviour of materials under intermittent thermal loads
  - threshold limit value of oxygen for sustaining combustion
  - critical heat flux
  - critical flux at extinguishment
  - oxygen consumption calorimetry of rail materials
- Categorize materials according to requirement levels

## TEST RESOURCES

- Smoke chamber combined with a Fourier transform infrared analysis system
- Smoke chamber
- Radiant heating panels (horizontal and vertical)
- Cone calorimeter

## ACCREDITATIONS

ISO/IEC 17025 awarded by COFRAC

## REFERENCES

- ALSTOM
- ETA
- GERFLOR
- HITACHI
- HUTCHINSON
- SNCF Maintenance centres
- STRAIL

## STANDARDS

- EN 45545 – Railway applications - Fire protection on railway vehicles
- NF F16-101 – Rolling stock - Fire behaviour - Choice of materials
- NF F16-102 – Railway rolling stock - Fire behaviour - Choice of materials, application to electric equipment

See also pages

81, 82, 83, 131



# PAINT AND ADHESIVE FILMS

Contributing to the type approval process of adhesive films and paints and to application conditions.

## OBJECTIVES

- Validate anti-corrosion paints (salt spray, corrosion fatigue)
- Qualify railway paints according to a given standard
- Conduct accelerated and normal ageing tests at specific sites
- Conduct tests on rail vehicles used in revenue service
- Characterize tags
- Study and develop representative inks – in order to test anti-tag coatings and cleaning products
- Provide advice on paint processes following expert analysis

## TEST RESOURCES

- Specific sites in which tests are performed (laboratories or paint booths)
- Simulation tool for accelerated ageing (ARTACC)
- Folding and quartering tools
- Impact test equipment (to check paint behaviour)
- Salt spray chamber


## REFERENCES

- 3M
- BECKERS
- BONATRANS
- CAF
- GSDI
- HEXIS
- LUCCHINI
- MG VALDUNES
- SBB

## STANDARDS

- NF F 19-201 – Paint materials and markings - General instructions and test methods
- NF F 31-112 – Protection in relation to graffiti - Tests procedures and methods of evaluation, behaviour of materials and removal products
- EN 13261 + A1 – Wheelsets and Bogies - Axles - Product requirements
- STM N 805/807/808
- NF F 19-481 – Railway rolling stock - Self adhesive labels
- NF F 19-223 – Railway rolling stock - Paint systems for protecting axle shafts



 See also pages

81, 87



# PETROLEUM PRODUCTS

Proposing the most suitable lubricant in relation to conditions of use and assessing the potential life span of lubricated rolling stock components in service.

## OBJECTIVES

- Qualify lubricants
- Determine potential life
- Check new products for commissioning
- Set up test equipment on a maintenance site in order to monitor part and component wear
- Perform on-site assistance
- Conduct failure analysis
- Dispense training in axle box grease expertise
- Increase potential
- Monitor in-service lubricant wear on parts

## TEST RESOURCES

- Bearing test rigs (R2F and ROPECS)
- Cone penetration, dropping point, moisture content
- Viscometer
- Acidity measuring device
- DSC - Differential Scanning Calorimetry
- X-ray fluorescence
- Plasma / Plasma MS
- Rheology
- Thermogravimetric analysis (TGA)

## ACCREDITATIONS

ISO/IEC 17025 awarded by COFRAC

## REFERENCES

- CFC
- CFL
- NTN-SNR
- SAMARO
- SPIREL
- SHELL
- SKF
- TIMKEN
- TOTAL
- TOUAX

## STANDARDS

Applicable standards according to customer requirements

- Infrared spectrometry
- Total acidity titrator (TAN)
- RapidOxy (oxidation measurement)
- Karl Fischer titrator (water determination)
- Tribometer
- Scanning Electron Microscopy (SEM)

See also pages

69, 70



# CLEANING PRODUCTS

Reducing environmental impact of cleaning products while optimizing their quality and efficiency.

## OBJECTIVES

- Qualify products
- Develop dose calculation methods and product quality control
- Establish compatibility between products and materials
- Characterize physical and chemical properties of products: Mass per unit volume, outflow time, etc.
- Evaluate the effectiveness of cleaning products
- Develop test in revenue service conditions
- Give technical assistance and expert assessments on cleaning processes

## REFERENCES

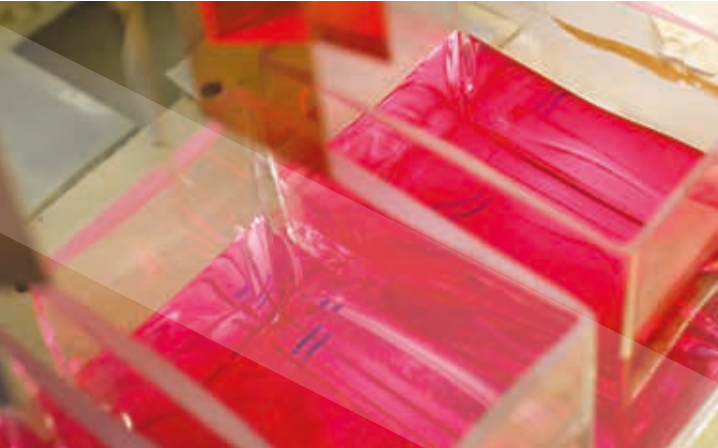
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## TEST RESOURCES

- Viscometer
- Flash point
- Foaming power
- Soaking bench
- Car wash test bench
- Cleanability
- Tensiometer
- X-ray fluorescence
- X-ray diffraction
- ICP (Inductively Coupled Plasma)
- Infrared equipment

## STANDARDS

- STM N601 – Qualification procedure for cleaning and sanitation products
- STM C702 – Additive product used in retention toilets



 See also pages

81, 85



# GLAZING

Contributing to the type approval process of window glass by testing its strength and effectiveness.

## OBJECTIVES

- Measure pressure resistance: simulate pressure changes produced when two trains cross each other in the open air or in tunnels - on all types of glass panes (flat or curved, new or downgraded, etc.)
- Measure soft body impact resistance: check that a person inside a vehicle is not projected outside after the impact of a 50 kg pendulum
- Check water tightness
- Check hard body impact resistance
- Assess rupture strength of the structural bonded seal
- Measure dew point

## REFERENCES

- AGC FLAT GLASS
- ALSTOM
- BOMBARDIER
- RUSTIN
- SAINT GOBAIN SEKURIT
- SESSA KLEIN

## TEST RESOURCES

- Two test rigs:
  - Pressure up to +/- 8,000 Pa
  - Sine, rectangular or square wave (on request)
  - Frequency up to 6 Hz
  - Rig dimensions: 1,800 x 2,500 mm
- Watering system (used during test)
- Dynamic measurement system of glass pane deflection

## STANDARDS

- NF F31-129 – Railway rolling stock - Tempered safety glass
- EN 1279-2 – Insulating glass units - Part 2: Long term test method and requirements for moisture penetration
- UIC 566 – Fatigue tests
- NF F01-492 – Railway rolling stock - Windows
  - Water tightness tests
  - Soft body impact resistance tests
  - Negative/positive pressure fluctuation resistance tests
  - Bonding strength fracture resistance tests
  - Climatic ageing cycle resistance tests

See also pages

105, 110





# ACOUSTIC CHECKS ON SAFETY EQUIPMENT

Evaluating the audibility of sound-based safety equipment for its type approval.

## OBJECTIVES

Measure sound levels of shunting whistles, detonators and audible warning devices

## TEST RESOURCES

- Sound level meters (Class 1)
- Multichannel data acquisition system

## ACCREDITATIONS

ISO/IEC 17025 awarded by COFRAC


## REFERENCES

- ALSTOM
- BOMBARDIER
- DB SCHENKER RAIL
- RATP
- SIEMENS
- VOSSLOH

## STANDARDS

- EN 15153-2 – External visible and audible warning devices for high-speed trains - Part 2: Warning horns
- EN ISO 7731 – Danger signals for public and work areas - Auditory danger signals
- UIC 643 – Regulations regarding the audibility of shunting whistles and detonators in the driving compartments of powered units
- UIC 644 – Warning devices used on tractive units employed on international services
- Technical specifications for interoperability



 See also pages  
36, 37, 136, 137



# ESVE

Perform tests in overspeed controlling/monitoring a chosen speed profile and staging points/hold points.

## OBJECTIVES

- Perform test by crossing the maximum allowed speed for a rolling stock or an infrastructure
- Record the train cabin environment in audio and video by a camera kit

## REFERENCES

- BOMBARDIER CRESPIN
- CLERE
- COSEA
- SYSTRA

## TEST RESOURCES

- ESVE box

See also page

17





# SAFETY ASSESSMENT OF SIGNALLING AND COMMAND - CONTROL EQUIPMENT

Demonstrating or assessing the conformity of safety-critical railway equipment.

## OBJECTIVES

- Approve all signalling equipment (point motors, printed circuit boards, etc.) impacting safety of urban and intra-urban rail transport systems
- Ensure usability: implementation of the new system in operating conditions
- Give expert advice on maintaining network equipment in good operating condition from a safety perspective
- Analyze hardware malfunctions in operating conditions: laboratory and field investigations

## REFERENCES

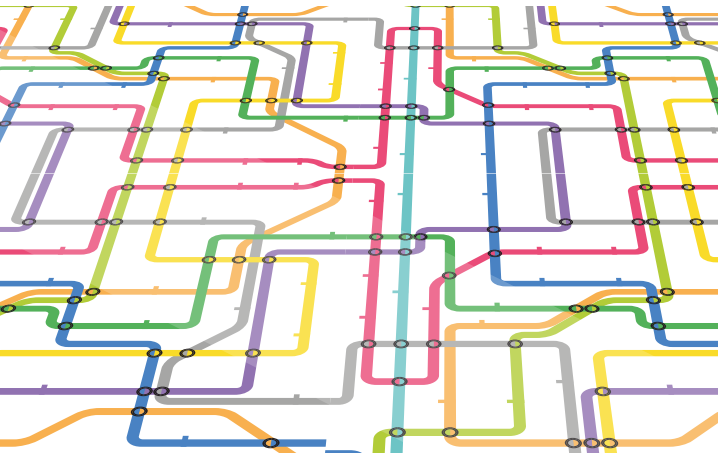
- ANSALDO
- AREVA
- RATP
- SIEMENS

## STANDARDS

EN 50129 – Communication, signalling and processing systems - Safety related electronic systems for signalling

## TEST RESOURCES

Electronics laboratory



 See also page

60



## Part 2

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### Measurements

The second part of this catalogue describes our tests related to measurements and investigations.

These tests may be essential to ensure the safety, performance, comfort and availability of your equipment or railway facilities both for your employees and agents and for the users of the rail network.

To help you find the tests you are looking for, this second part is organized according to technical speciality:

- Mechanical ..... 95
- Electrical ..... 117
- Physico-chemical ..... 127
- Acoustical ..... 135
- Health, Safety and Environment (HSE) -- 139

VIBRATION • COMFORT • FATIGUE • AX  
CURRENT COLLECTOR SHOES • BRAK  
• WHEEL-RAIL CONTACT • PANTOGRAPH •  
PH • RESISTANCE TO MOTION •  
ELECTRICAL PERFORMANCE • CAUSES OF FA  
• DROP SHUNTING • CURREN  
• ELECTROMAGNETIC COMPATIBILITY • MATER  
MATERIALS



## MECHANICAL

Passenger vibratory comfort .....	96
Roll flexibility coefficient .....	97
Vibration fatigue of vehicle components .....	98
Dynamic behaviour of metros and trams .....	99
Modal analysis .....	100
Metro line recording train .....	101
Rolling resistance .....	102
Trackside measurements .....	103
Video-based pantograph gauge detection .....	104
Door closure forces .....	105
Failure analysis .....	106
Dimensional controls .....	107
Welded assemblies .....	108
Bolted assemblies .....	109
Bonded assemblies .....	110
Mechanical and metallurgical characterization .....	111
Residual stresses .....	112
Residual stress analysis by x-ray diffraction .....	113
Flying ballast impact simulation .....	114
Non-destructive testing (ndt): magnetic particle, ultrasonic and dye penetrant testing .....	115



# PASSENGER VIBRATORY COMFORT

Assessing the comfort experienced by passengers on a train.

## OBJECTIVES

- Characterize vibrations inside a railway vehicle as a function of track condition
- Determine dynamic characteristics of train seats (natural frequencies)

## TEST RESOURCES

- Measuring devices installed at the passenger-seat interface
- Device for conducting measurements at floor level
- Dedicated system for automatic analysis
- Accelerometer chain (with or without passengers)
- Data acquisition system (4 to 16 channels)
- Data acquisition system (SCADA type) coupled with TestLab LMS software (full measurement)

## ACCREDITATIONS

ISO/IEC 17025 awarded by COFRAC

## REFERENCES

- ALSTOM
- BOMBARDIER
- LOHR INDUSTRIE
- RATP
- STADLER

## STANDARDS

- EN 12299 – Ride comfort for passengers - Measurement and evaluation
- UIC 513 – Guidelines for evaluating passenger comfort in relation to vibration in railway vehicles

See also page

17







# ROLL FLEXIBILITY COEFFICIENT

Checking that the roll flexibility coefficient of a rail vehicle provides a good interface with the infrastructure.

## OBJECTIVES

Determine the roll flexibility coefficient of railway vehicles by means of measurements on the line (rotation of the vehicle body around its longitudinal axis)

## TEST RESOURCES

- Accelerometers
- Displacement sensors


## REFERENCES

- ALSTOM
- BOMBARDIER
- SNCF

## STANDARDS

- EN 14363 – Testing for the acceptance of running characteristics of railway vehicles - Testing of running behaviour and stationary tests
- UIC 505-1 – Railway transport stock - Rolling stock construction gauge



 See also pages

17, 99



# VIBRATION FATIGUE OF VEHICLE COMPONENTS

Optimizing rolling stock maintenance by evaluating the severity of vibratory stresses and their effect on the life of vehicle components via tests conducted on the line.

## OBJECTIVES

- Predict life expectancy of a rolling stock component with regard to the stresses measured
- Quantify severity of various vibratory stresses applied on vehicle components using a method based on Fatigue Damage Spectrum (FDS) and Shock Response Spectrum (SRS) calculations
- Compare FDS of vibratory signals measured on components "Normative and functional FDS", calculated from the Power Spectral Density (PSD)
- Understand the causes of failures and check that repaired parts keep their integrity over time
- Study component behaviour on track and in revenue service traffic - with or without people onboard ("black box" test)

## TEST RESOURCES

- Multi-channel data acquisition device
- Calibrators
- Data processing software
- Portable and independent recorder "CleA"
- PULSE measuring system
- Piezoelectric accelerometers, strain gauges, force sensors, displacement and pressure sensors, ammeters, voltmeters, etc.

## REFERENCES

- ALSTOM
- RATP
- SNCF

## STANDARDS

- EN 61373 – Rolling stock equipment - Shock and vibration tests
- MA 42100 – Authorization to perform measurements on trains in revenue service

See also pages

72, 100, 106





# DYNAMIC BEHAVIOUR OF METROS AND TRAMS

Analyzing the behaviour of a vehicle following abnormal behaviour in revenue service.

## OBJECTIVES

- Determine by means of a device installed onboard the train:
  - tri-axial acceleration in the vehicle, bogies and axles
  - displacement of primary and/or secondary suspensions as well as pressure on air suspensions
  - lateral force on rubber-tyred rolling stock by means of a wheel force transducer
  - wheel lift ("wheel tread-railhead" height) over a short distance (e.g. turnout)
  - forces and displacements for couplers, buffers and rods
  - yaw, roll and pitch
- Establish an image of the Y/Q ratio through equipment installed on the track

## TEST RESOURCES

- Triaxial accelerometers
- Displacement sensors
- Pressure sensors
- Strain gauges
- Doppler radar

## REFERENCES

- Lyon Tramway (France)
- RATP
- Valenciennes Tramway (France)

## STANDARDS

- EN 14363 – Testing for the acceptance of running characteristics of railway vehicles - Testing of running behaviour and stationary tests
- EN 15686 – Testing for the acceptance of running characteristics of railway vehicles with cant deficiency compensation system and/or vehicles intended to operate with higher cant deficiency than stated in EN 14363:2005, Annex G



 See also pages

17, 19, 68, 69, 97



# MODAL ANALYSIS

Determining the modal characteristics of a structure - in addition to vibration testing for example.

## OBJECTIVES

- Understand vibratory phenomena
- Adjust "finite element" models
- Measure the in-situ response of a structure subjected to one or several known excitations in order to determine its modal characteristics - frequency, damping, modal deflection curve associated with each mode

## TEST RESOURCES

- Piezoelectric accelerometers
- Impact hammers
- Electrodynamic exciter
- Modal analysis software « LMS TEST LAB »

## STANDARDS

- ISO 7626-1 – Mechanical vibration and shock - Experimental determination of mechanical mobility - Part 1: Basic terms and definitions, and transducer specifications
- ISO 7626-5 – Vibration and shock - Experimental determination of mechanical mobility - Part 5: Measurements using impact excitation with an exciter which is not attached to the structure

 See also page

98



# METRO LINE RECORDING TRAIN

Carrying out a dynamic diagnosis of sens interfaces (positive and negative break pads v. Vignole rails and traction rail), electrically and mechanically.

## OBJECTIVES

- Electrical and mechanical interface fault diagnostics
- Target and prioritizable maintenance
- Identification of defects and their exact location
- Expert technical analyses of the interfaces of rubber-tyred and light rail metro systems


## REFERENCES

- CEF (Alstom)
- Mexico Metro
- RATP
- RTM (Marseille Metro)

## TEST RESOURCES

- Cameras for continuous break observation
- Accelerometers to quantify the number of impacts
- Voltage and current sensors to localize loss of power supply and current peaks



 See also page

104



# ROLLING RESISTANCE

Determining rolling resistance values in order to adjust the traction power of a new railway vehicle and/or infrastructure and/or validate the coefficients taken into account for the theoretical train path for every run.

## OBJECTIVES

- Determine the factors increasing the resistance to forward movement of a vehicle (rolling resistance and aerodynamic drag) by measuring several parameters: axle speed, acceleration, forces, traction current and wind speed
- Check the coefficient of the polynomial function of train rolling resistance by means of experiment

## TEST RESOURCES

- Load cells
- Doppler radar
- Accelerometers
- Anemometer
- Weather station and tachometer unit

## REFERENCES

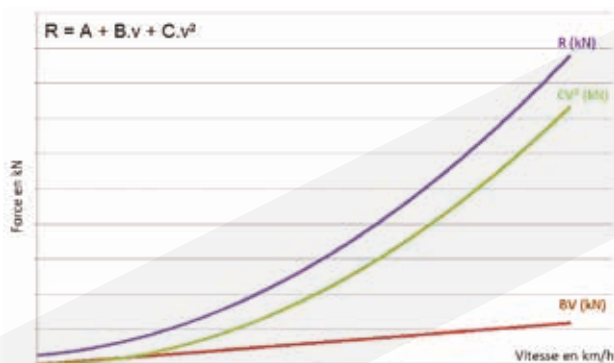
- ALSTOM
- BOMBARDIER
- Lille Metro
- RATP
- SIEMENS
- SYTRAL

## STANDARDS

- EN 14067-3 – Aerodynamics - Part 3: Aerodynamics in tunnels
- EN 14067-4 – Aerodynamics - Part 4: Requirements and test procedures for aerodynamics on open track

See also pages

34, 35



# TRACKSIDE MEASUREMENTS

Understanding the physical behaviour of the “vehicle-track” system through trackside measurements.

## OBJECTIVES

- Perform and supervise dynamic measurements on passing trains
  - Physical phenomena: vertical and lateral forces exerted by the wheels on rails, stresses, forces and displacements on track components, structure deflection, accelerations on the rail, sleepers, track bed, etc.
  - Aerodynamic phenomena around the train, pressure in tunnels and in the open air
  - Acquisition and use of data: identification and characterization of traffic, natural frequencies and damping calculations, automating the acquisition and use of data
  - Remote monitoring of dynamic behaviour
- Perform and supervise measurements of slow phenomena
  - Meteorological parameters
  - Development physical parameters over time - on track or on structures
  - Levelling checks, settlement monitoring
  - Measurement of neutral temperatures of CWR (Continuous Welded Rail) - nondestructive method VERSE
  - Lateral track resistance
  - Remote monitoring of slow phenomena


## REFERENCES

- ALSTOM
- EUROTUNNEL
- RATP
- SNCF
- SNCF-RÉSEAU
- SYSTRA

## STANDARDS

EN 14067 – Railway applications - Aerodynamics



 See also pages  
42, 43, 45



# VIDEO-BASED PANTOGRAPH GAUGE DETECTION

Identifying the mechanical causes of abnormal wear in a pantograph.

## OBJECTIVES

- Equip a pantograph with a removable device the geometry of which replicates the theoretical gauge of the pantograph bow
- Pinpoint and identify the presence and the nature of an obstacle on the line

## REFERENCES

- Montpellier Tramway
- RATP

## TEST RESOURCES

- Video cameras
- Obstacle detection device
- Doppler radar

 See also pages

30, 31, 32, 46, 47, 104







# DOOR CLOSURE FORCES

Checking that the doors of a railway vehicle or the platform screen doors close properly for safety enhancement reasons.

## OBJECTIVES

Make an accurate assessment of the following during door closure:

- impact forces
- door closure holding forces
- closing speed

## TEST RESOURCES

- Multi-channel data acquisition device
- Displacement sensors
- S-shaped extensometer

## REFERENCES

- RATP
- SYSTRA

## STANDARDS

- EN ISO 286 – Geometrical product specifications (GPS) - ISO code system for tolerances on linear sizes
- EN 22768-1 & 2 – General tolerances - Part 1: Tolerances for linear and angular dimensions without individual tolerance indications



 See also page

87



# FAILURE ANALYSIS

Identifying the contribution of each possible cause of failure.

## OBJECTIVES

- Conduct a comprehensive investigation after a failure
- Assess the contribution of each possible cause of failure: Vibration fatigue, mechanical, track defect, impact, design, materials, etc.
- Propose appropriate and sustainable solutions

## TEST RESOURCES

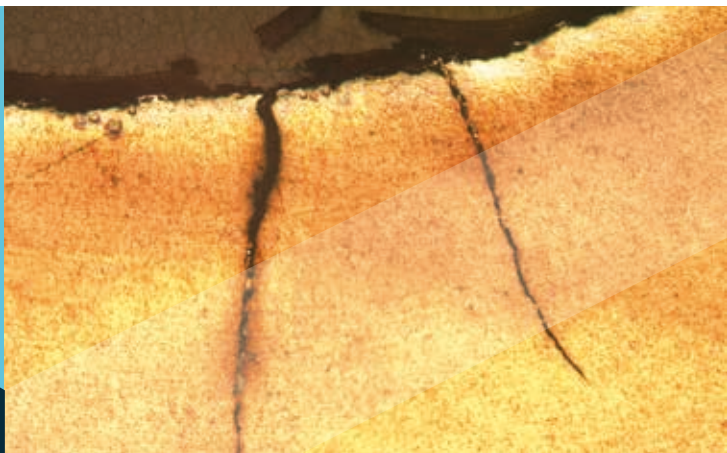
- Laboratory of metallurgy and mechanical characterization
- Hardness testing machines
- Tensile testing machines
- Resilience testing machines
- Diffractometer to assess residual stresses
- 3D scan
- Electron and optical microscopes

## REFERENCES

- ALSTOM
- BOMBARDIER
- CFC
- CFL
- ECR
- EUROTUNNEL
- Legal experts
- RATP
- SNCF
- THI (THALYS)
- VTG

See also pages

71, 72, 76, 98, 107,  
108, 109, 111, 112



# DIMENSIONAL CONTROLS

Better understand fracture, wear and deformation phenomena for both new and used parts.

## OBJECTIVES

- Take dimensional measurements (radius, diameter, depth, angle, etc.):
  - for complex and three-dimensional parts
  - for new or used parts - measurement of dimensions specified on the plan (railway safety components, equipment, etc.)
- Measure shape and position defects: straightness, flatness, circularity, cylindricity, circular shape, parallelism, perpendicularity, coaxiality, concentricity, etc.
- Measure surface condition, thread dimension, threads or grooves

## TEST RESOURCES

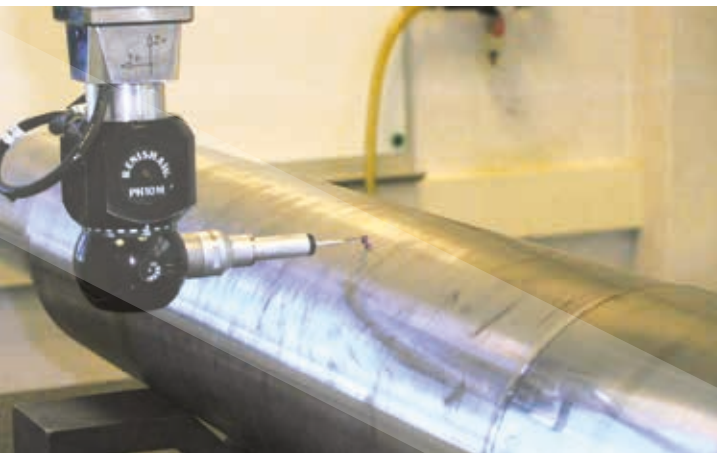
- 3D measuring machine (Tri-mesures)
- Profile projector
- Measuring column
- Numerous other measuring devices: micrometers, gauges, roughness testers, etc.

## REFERENCES

- CIRCOR
- GREMCO
- RATP
- SNCF

## STANDARDS

- EN ISO 286 – Geometrical product specifications (GPS) - ISO code system for tolerances on linear sizes
- EN 22768-1 & 2 – General tolerances - Part 1: Tolerances for linear and angular dimensions without individual tolerance indications - Part 2: Geometrical tolerances for features without individual tolerance indications
- NF F00-037 – Railway equipment in general - Tolerances on metal parts - Permissible deviations on dimensions without tolerance indications - Allowance for machining
- ISO 965 – ISO general purpose metric screw threads - Tolerances
- ISO 4288 – Geometrical Product Specifications (GPS) - Surface texture: profile method - Rules and procedures for the assessment of surface texture



 See also page

106



# WELDED ASSEMBLIES

Checking welded assemblies, appraise them in the event of failure and qualify procedures.

## OBJECTIVES

- Advise and participate in the development and validation of specifications
- Assist in the finalisation process (feedback, failure analysis and fatigue)
- Develop welding records
- Qualify welding procedures
- Verify compliance of assemblies (acceptance record)
- Appraise and analyze failures
- Qualify finishing processes of welding beads
- Ensure the development of finishing methods

## REFERENCES

- Legal expertise
- RATP
- SNCF
- TSO

## STANDARDS

- EN 15085 - 1 to 5 – Welding of railway vehicles and components
- EN ISO 15614 – Specification and qualification of welding procedures for metallic materials - Welding procedure test

## TEST RESOURCES

- Tension/compression and bending machines
- Hardness testing machines, pendulum, optical microscopes, etc.
- Scanning electron microscope
- Portable diffractometer to assess residual stresses
- Electron microscope

See also pages

106, 109, 113



# BOLTED ASSEMBLIES

Assessing, qualifying and verifying bolted assemblies, analyze their weaknesses and propose solutions.

## OBJECTIVES

- Qualify bolted assembly procedures:
  - study bolt assembly procedures via clamping (on site or in laboratory)
  - study the behaviour of assemblies in revenue service
- Check the conformity of products (tooling, nuts and bolts, etc.)
- Fix bolted assembly dimensions
- Conduct failure analyzes

## TEST RESOURCES

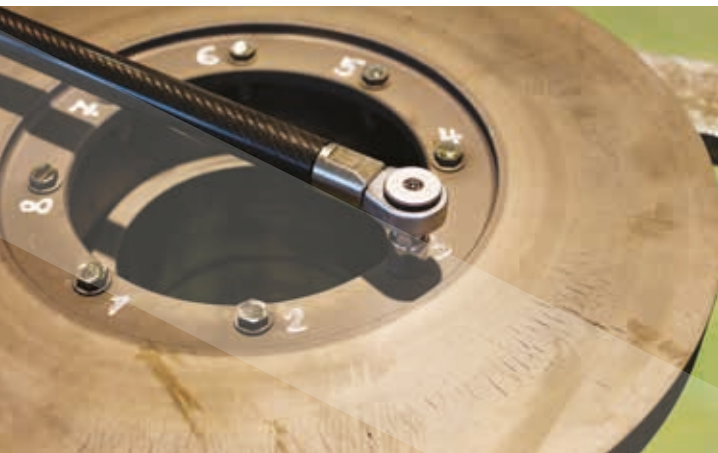
- Ultrasonic and strain gauge testing equipment for measuring clamping forces
- Test rigs for bolted assemblies
- « Torque/angle » analyses
- Scanning electron microscopy, micrography, hardness, tension
- COBRA calculation tool


## REFERENCES

- ALSTOM
- RATP
- SNCF
- THI (THALYS)

## STANDARDS

- STMX 810 – Recommendations for bolted and screwed connections of components used in passenger rolling stock
- ST 001 – Fasteners, etc.
- EN ISO 898-1
- EN ISO 898-2



 See also pages  
106, 108



# BONDED ASSEMBLIES

Contributing to the qualification of bonded assemblies.

## OBJECTIVES

- Check assemblies bonded to floor coverings, glazing sealants, etc.
- Perform characterization tests (tensile strength, lap shear, peel, ageing)

## TEST RESOURCES

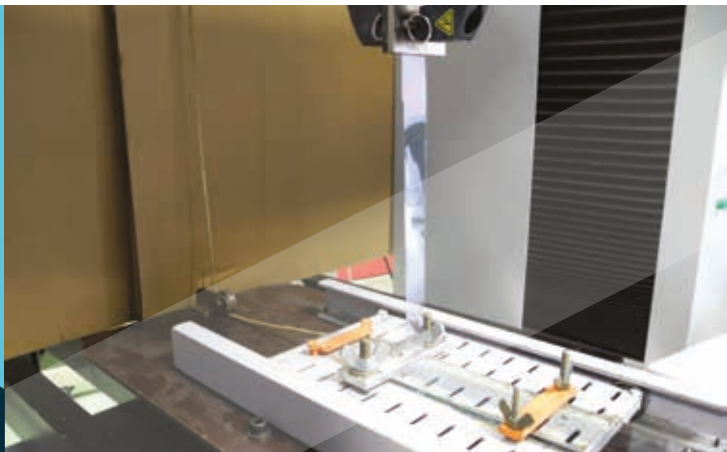
- Tensile/compression testing machine: tensile shear test, lap shear test, peel test, adhesion strength test, etc.
- Ageing chambers: heat, cold, humidity
- Thermal shock bench: heat with or without humidity/cold

## STANDARDS

- EN 1372 – Peel test
- EN 1465 – Lap shear strength
- EN ISO 9142 – Ageing
- NF F 31-812

 See also pages

81, 88





# MECHANICAL AND METALLURGICAL CHARACTERIZATION

Designing, developing, qualifying and conducting expert appraisals on a wide variety of metal parts.

## OBJECTIVES

- Perform services related to the life cycle of a metal part or component (all types of bearings and springs, engine and drive train components, couplers, etc.)
- Assist in the development of specifications
- Assist in the finalization process
- Qualify parts or components according to technical requirements or specifications
- Analyse failures during the life of the part or component
- De-specialize
- Assess life potential
- Perform expert legal analyses

## REFERENCES

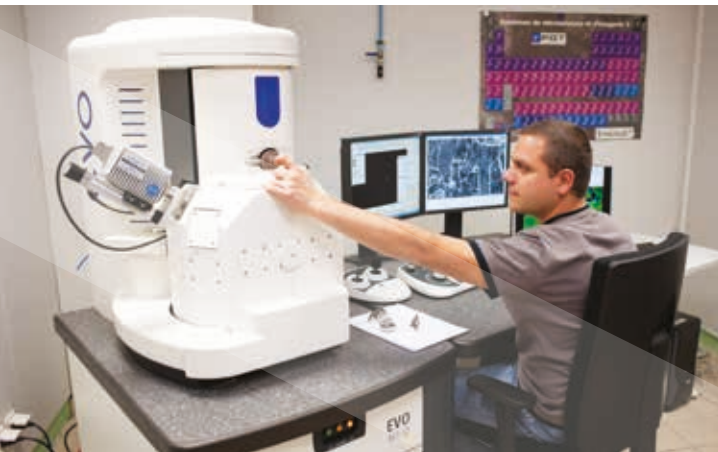
- CASTOLIN
- COLAS RAIL
- EUROTUNNEL
- RATP
- THI (THALYS)

## STANDARDS

According to the part or component to be tested

## TEST RESOURCES

- Tools used to characterize materials and their heat treatment: tension/compression and hardness testing machines, pendulum, optical microscopes, etc.
- Scanning electron microscope
- Roughness tester
- Portable diffractometer to assess residual stresses and residual austenite
- Spark spectrometer



See also pages

106, 113



# RESIDUAL STRESSES

Quantify the residual stresses of running gears or catenaries to prevent the occurrence of failures. Implementation of a new device.

## OBJECTIVES

Evaluate residual stresses in railway components through three types of measurement:

- ultrasonic
- extensometry
- X-ray diffraction

## TEST RESOURCES

- Ultrasonic measurements: device for measuring on a test bench or under the vehicle (with or without contact)
- Extensometry: strain gauges used to measure stress after successive cuttings of the part (destructive method)
- X-ray diffraction measurements: portable system (iXRD MGR40) for on-site measurements - non-destructive method for surface evaluation + semi-destructive method for sub-layer evaluation

## REFERENCES

- ALSTOM
- BONATRANS
- CAF
- MG VALDUNES

## STANDARDS

- EN 13261 – Railway applications - Wheelsets and bogies - Axles - Product requirements Measurements on axles using X-Ray diffraction
- EN 13262 – Wheelsets and bogies - Wheels - Product requirements. Extensometric measurements
- EN 13979-1 – Wheelsets and bogies - Monobloc wheels - Technical approval procedure - Part 1: Forged and rolled wheels. Ultrasonic measurements
- UIC 510-5 OR – Technical approval of monobloc wheels - Application document for standard EN 13979-1

See also pages  
106, 113





# RESIDUAL STRESS ANALYSIS BY X-RAY DIFFRACTION

Quantifying the residual stresses of a component on the client's premises using a portable diffraction system to prevent the occurrence of failures.

## OBJECTIVES

Assess residual stresses for both new and used parts:

- Validate repair methods based on welding
- Qualify products
- Characterize finishing treatment, stress relieving treatment, etc.
- Monitor constraints in revenue service
- Quantify residual austenite formed during poorly controlled heat treatments that can cause component breakages (bearings, springs)

## TEST RESOURCES

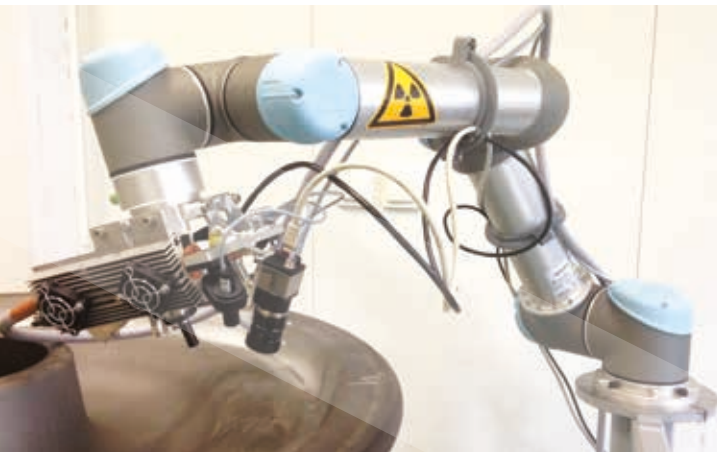
- iXRD MGR 40: portable system used for in situ measurements
- X-RayBot: Portable device for on-site measurements

## REFERENCES

- ALSTOM
- BONATRANS
- CAF
- IBRE
- ROLANFER
- SNCF
- VNF

## STANDARDS

EN 15305 – Non-destructive testing  
- Test method for residual stress analysis  
by X-ray diffraction



 See also pages

106, 111, 112



# FLYING BALLAST IMPACT SIMULATION

Contributing to the validation/type approval of protective products or coatings by checking their resistance to flying ballast.

## OBJECTIVES

- Check the ability of a material to withstand flying ballast impact
- Tests with different degrees of impact force
- Tests at different temperatures
- Test with different incidences

## REFERENCES

- ALSTOM
- BOMBARDIER
- CYTEC
- HUBNER
- SIEMENS
- SNCF

## TEST RESOURCES

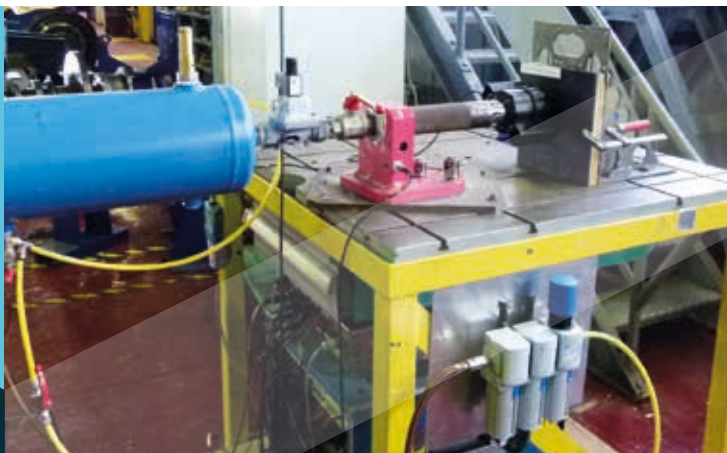
- Test bench capable of projecting ballast at different speeds
- Climatic chamber to prepare samples for testing at different temperatures
- Speed recorder to check impact speeds up to over 400 km/h
- Impact can be analysed and recreated in 3D

## STANDARDS

- NF F 07-101 – Flying ballast impact simulation
- Standard 19293

 See also pages

73





# NON-DESTRUCTIVE TESTING (NDT): MAGNETIC PARTICLE, ULTRASONIC AND DYE PENETRANT TESTING

Non-destructive testing of railway parts, helping to select the best method and qualify products, equipment and methods.

## OBJECTIVES

- Advise on the choice of testing methods
- Assess railway parts with magnetic particle, ultrasonic and dye penetrant testing
- Develop new inspection methods
- Advise and develop specifications for non-destructive testing equipment
- Qualify equipment, products, testing instruction sheets, automated facilities and working standards
- COFREND examination centre for rail sector certification (CFMC/COFREND)

## TEST RESOURCES

- Ultrasonic immersion inspection tank
- Magnetic particle test bench
- Wheel control test bench with magnetic particle testing
- Probes and other devices
- Multi-component ultrasound unit
- Eddy-current testing (conventional and multi-component)

## ACCREDITATIONS

CFMC Level 3 certification for ultrasonic, magnetic particle and dye penetrant testing, and CIFM – COFREND Level 2 certification for Eddy current testing (according to ISO 9712)

## REFERENCES

- AIS
- ALSTOM
- BOMBARDIER
- BONATRANS
- CAF
- LUCCHINI
- MG VALDUNES
- RATP

## STANDARDS

- Magnetic particle testing: EN ISO 9934, EN 1369, EN 10228, EN 17638, EN 23278, ISO 6933
- Ultrasonic testing: EN 12668, EN 583, ISO 5948
- Dye penetrant testing: EN 571, EN ISO 3452, EN ISO 12706
- Certification of personnel ISO 9712



 See also pages

67, 68, 69, 70, 71

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• WHEEL-RAIL CONTACT • PANTOGRAPH •  
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• DROP SHUNTING • CURREN  
ELECTROMAGNETIC COMPATIBILITY • MATER  
MATERIALS



## ELECTRICAL

Electrical performance of infrastructure and rolling stock ..	118
Power meter validation .....	119
Infrastructure-rolling stock interaction .....	120
Radio-electric coverage .....	121
Electrical characterization of materials .....	122
Track conductivity .....	123
Instrumentation and remote measurements .....	124



# ELECTRICAL PERFORMANCE OF INFRASTRUCTURE AND ROLLING STOCK

Checking electrical characteristics of rolling stock and infrastructure in relation to customer technical specifications.

## OBJECTIVES

- Check the consumption and/or quality of electric power supplies to sub-stations, rectifier sub-stations, complete railway lines or even escalators
- Simulate the capacity of the line and its equipment under normal or downgraded conditions
- Check the compliance of the electrical performance of rolling stock with specifications

## REFERENCES

- CTS (Strasbourg)
- RATP

## STANDARDS

- All reference documents in force
- Particular technical specifications

## TEST RESOURCES

- Data loggers
- Voltage sensors and data processing software
- High-speed thermal cameras
- Network analyzer with associated sensors (AC)

See also pages  
60, 119, 120



# POWER METER VALIDATION

Checking the on-board power metering system.

## OBJECTIVES

- Characterize the power consumption meter installed on a train
  - Measure pantograph voltage and current on board the train
  - Calculate energy consumed and injected back into the network
  - Check the behaviour of associated systems ( circuit breaker, voltmeter, relay...)

## REFERENCES

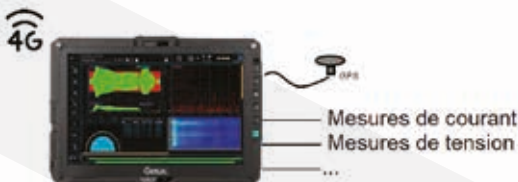
- ALSTOM

## STANDARDS

- EN 50463

## TEST RESOURCES

- Voltage sensor
- Current sensor
- Power metering software
- Data acquisition board
- Power source / variable current
- Climatic chamber (-40°C / +85°C)



 See also pages

34, 118, 120, 122



# INFRASTRUCTURE-ROLLING STOCK INTERACTION

Understanding the origin of malfunctions related to interaction between infrastructure and rolling stock.

## OBJECTIVES

- Measure current and voltage from the traction sub-station
- Perform signal processing in order to identify the emergence of disruptive phenomena: Unexpected activation, pumping, harmonics, impedance, etc.

## REFERENCES

- RATP
- SNCF

## STANDARDS

- EN 50163
- EN 50388

## TEST RESOURCES

- Voltage sensor
- Amperometric clamp
- Data acquisition board
- SENTINEL software
- Voltage and current sensors, QMR7/ QMR-X SPU-Box

 See also pages

34, 118, 119, 122, 123







# RADIO-ELECTRIC COVERAGE

Checking that the radio coverage of railway equipment is compliant with the criteria in force.

## OBJECTIVES

- Install measuring and testing tools on test rail vehicles
- Measuring RF power levels and potential interference (dynamic measurement at low and/or high speed) and convert information into ASCII or cartographic formats
- Perform statistical processing of radio coverage and convert coverage criteria into graphic format
- Measure the voice quality of the radio link
- Develop optimization plans
- Conduct technical and functional tests on the GSM-R ground-train radio system - in order to verify proper operation (static and dynamic tests)

## REFERENCES

- SNCF
- SNCF-RÉSEAU
- TEP

## TEST RESOURCES

- Railway coaches, road vehicles, "railway bicycles" (on the French network)
- Radio measurement system
- Radio measuring receivers
- Trace mobiles
- Test benches
- Specific antennas installed on the test car roof
- Positioning systems: odometry, locator, GPS
- GSM-R cab radio, GSM-R portable systems

## STANDARDS

- UIC 751 – Railway radio equipment - Fixed and mobile units - General technical considerations
- EIRENE FRS (Functional Requirement Specification) and SRS (System Requirement Specification)
- ISO 9001 V2000

 See also pages

57, 79



# ELECTRICAL CHARACTERIZATION OF MATERIALS

Checking electrical properties of materials for their qualification.

## OBJECTIVES

Determine insulation characteristics (volume and surface resistivity) and the behaviour under voltage of an insulating material (dielectric strength)

## TEST RESOURCES

- High voltage cage (AC/DC):
  - up to 100 kV AC and up to 100 mA for leakage current
  - up to 20 kV DC and up to 5 mA for leakage current
- Teraohmmeter Picoammeter

## REFERENCES

- ALSTOM
- BOMBARDIER
- COMECA
- EDILON SEDRA
- MERSEN
- PREFARAIL
- SEA Abrasif
- STAR (Rennes, France)

## STANDARDS

- IEC 93 (NF C 26215) – Methods of test for volume resistivity and surface resistivity of solid electrical insulating materials
- IEC 167 (NF C 26210) – Methods of test for the determination of the insulation resistance of solid insulating materials
- Standards produced by operators

See also pages

41, 78, 118, 119, 120





# TRACK CONDUCTIVITY

Avoiding power losses, reducing corrosion due to non-railway underground equipment near the track, and ensuring proper track insulation.

## OBJECTIVES

- Check without “mechanically” cutting the track that it does not generate stray currents
- Monitor compliance of track insulation during commissioning or preventive maintenance

## REFERENCES

- COLAS Rail
- ETF
- FRATER OF POURCQ (Belgium)
- PREFER (Portugal)
- STIB (Belgium)
- TSO/CIM GROUP (Ecuador)


## TEST RESOURCES

- Dedicated power supply
- Voltmeters and ammeters
- Data acquisition and processing system

## STANDARDS

EN 50122-2 – Fixed installations - Electrical safety, earthing and the return circuit - Part 2: Provisions against the effects of stray currents caused by DC traction systems



 See also pages

41, 118, 120



# INSTRUMENTATION AND REMOTE MEASUREMENTS

Installation of black box type instruments to record various parameters on vehicles in revenue service operation.

## OBJECTIVES

- Deliver turnkey measurement tools
- Instrument on-demand components (axle, pantograph, coupler, buffer, etc.)
- Develop and deliver black box type systems according to need
- Supply reliable instrumented sensor heads (wire sensors, optical fibre, wireless sensors)
- Collect large volumes of data during service conditions for statistical processing
- Specific processing for infrequent occurrences requiring long-term monitoring to locate their geographical position and identify the conditions in which they occur

## TEST RESOURCES

- IMC measuring chains
- Internal data acquisition and extraction software
- Automated data collection and treatment on our servers
- Remote control
- All types of sensors

## REFERENCES

- 2007 world speed record (600 measurements – excluding fieldbus)
- RATP
- Recording on trains in revenue service operation
- Régiolis
- Régio2N ONO (introduction of new measuring chain)
- RER NG
- Tram-train
- V360



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• ELECTROMAGNETIC COMPATIBILITY • MATER  
MATERIALS



## PHYSICO-CHEMICAL

Product or materials characterization .....	128
Expert analysis of non-metal materials .....	129
Rubber and rubber-metal materials expertise .....	130
Fire behaviour tests on cables in accordance with the construction products regulation (CPR) .....	131
Quality of on-board water supplies .....	132
Water quality - waste water and micro-polutants from railway activity .....	133



# PRODUCT OR MATERIALS CHARACTERIZATION

Checking that a product or a material complies with user specifications.

## OBJECTIVES

- Determine the quantitative and qualitative composition of samples of liquids or solids: analysis of products and materials (crystalline silica, components of a cleaning product, paint, sintered brake shoe, polymer, etc.)
- Assess corrosion resistance of a material with regard to a product
- Determine material-product compatibility
- Characterize material behaviour with regard to tags and cleaning products

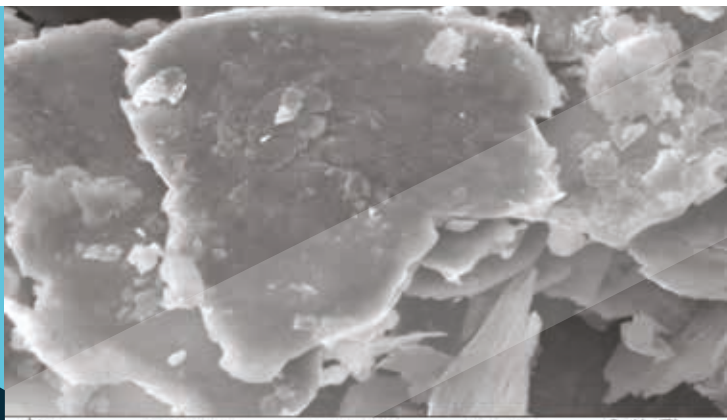
## TEST RESOURCES

- X-ray fluorescence
- X-ray diffraction
- Atomic emission spectroscopy
- Infrared equipment
- Characterization of physico-chemical properties
- Thermal analyses (DSC, TGA)
- pH meter
- Conductivity meter

## REFERENCES

- AVERY DENNISON
- GERGONNE
- GSDI
- HEXIS
- SESALY

See also pages  
87, 129, 130





# EXPERT ANALYSIS OF NON-METAL MATERIALS

Determining the causes of failure and life cycles of polymers and elastomers and their compatibility with other products.

## OBJECTIVES

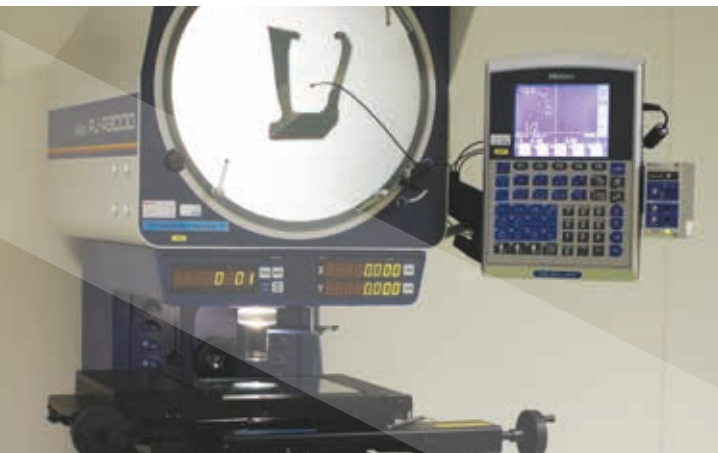
- Determine physico-chemical properties of a material (mainly polymers or elastomers)
- Conduct comparative studies between two materials
- Study compatibility of a material and its environment
- Understand the ageing process by conducting polymer deformation or hardness measurements


## TEST RESOURCES

- Analytical coupling TGA / GC-MS – Thermo Gravimetric Analysis
- Infrared spectrometry
- Plasma spectrometry (ICP)
- Compression set and residual deformation after elongation (DRC and DRA)
- Measurement of hardness (micro DIDC, DIDC, Shore A and D), tension, tear and resistance to low temperatures (TR10 and brittle point)
- Tools for testing pressure resistance (seals, pipes, hoses)
- Tools for measuring resistance to environmental conditions (heat, oil, coolant, etc.)

## REFERENCES

- RATP
- SNCF



 See also pages  
128, 130



# RUBBER AND RUBBER-METAL MATERIALS EXPERTISE

Analyzing and assessing failures and lifetime of rubber-based parts as well as their compatibility with other products.

## OBJECTIVES

- Qualify products and parts
- Analyze failures
- Develop specifications
- Assess potential life cycle (standards and specifications)
- Study rubber compatibility with oil
- Check resistance to cleaning products
- Study and develop products for operation at low temperature

## REFERENCES

- ALSTOM
- BOMBARDIER
- SNCF

## TEST RESOURCES

4 tension/compression testing machines:  
0-20kN / 0-100kN / 0-200kN / 0-400kN

### **Rubber Parts**

- Thermogravimetric Analysis (TGA), Differential Scanning Calorimetry (DSC), IR Spectroscopy - for physico-chemical analysis of rubber
- DRC and DRA: compression set + Residual deformation after elongation
- Devices for measuring hardness, DIDC, Shore A and D, tension, tear and resistance to low temperatures (TR10 and Brittle point)
- Equipment for testing pressure resistance (seals, pipes, hoses)
- Tools for measuring resistance to environmental conditions (heat, oil, coolant, etc.)

### **Rubber–Metal Parts**

- Instruments for measuring:
  - static stiffness (before and after ageing, and at high and low temperature)
  - dynamic stiffness (before and after ageing)
  - creep and stress relaxation
  - adhesion
  - resistance to environmental conditions

 See also pages

128, 129



# FIRE BEHAVIOUR TESTS ON CABLES IN ACCORDANCE WITH THE CONSTRUCTION PRODUCTS REGULATION (CPR)

The CPR has been developed by the European Commission to provide a legal framework for ensuring that construction works are designed and executed so as not to endanger the safety of persons, domestic animals or property nor damage the environment. The CPR states that, in order to market construction products covered by a harmonised standard or compliant with a European technical assessment document, manufacturers will have to produce a performance statement and include the CE marking on such products, thereby taking responsibility for the conformity of their products with regard to the performance standards declared.

## OBJECTIVES

To establish the Euroclass of a cable (indicating its fire behaviour). For most applications, cables are subject to fire safety requirements and their performance in this respect has to be declared to earn the CE marking

## TEST RESOURCES

- Tube furnaces, conductometer and pH meter to establish the acid number
- Test unit for calorimeter and opacimeter measurements on bunched cables
- 27m<sup>3</sup> chamber to establish the smoke-developed index
- 1kW burner test unit for insulated cables

## ACCREDITATIONS

- ISO 17025
- LAB REF 33 (system 3)

## STANDARDS

- EN 13501-6
- EN 50575
- NF EN 50399
- NF EN 60754-1 & -2
- NF EN 60332-1-1 & -2
- NF EN 61034-1 & -2



 Voir aussi pages

83, 84



# QUALITY OF ON-BOARD WATER SUPPLIES AND MICROBIOLOGY

Providing expertise with regard to the quality of the water on board trains.

## OBJECTIVES

- Conduct analyses and audits on the quality of the on-board water supplied to washbasins, especially microbiological analyses (*Escherichia Coli*, *coliform bacteria*, *enterococcus*, *Pseudomonas Aeruginosa*, *germs*)
- Check to ensure that water is potable and that suitable disinfection procedures are in place
- Establish the inspection resources needed and the corresponding inspection frequencies for a rolling stock fleet

## TEST RESOURCES

- Basic chemistry measurement equipment
- IDEXX
- Potability test bench – Disinfection test bench

## ACCREDITATIONS

- ISO/IEC 17025 awarded by COFRAC

## REFERENCES

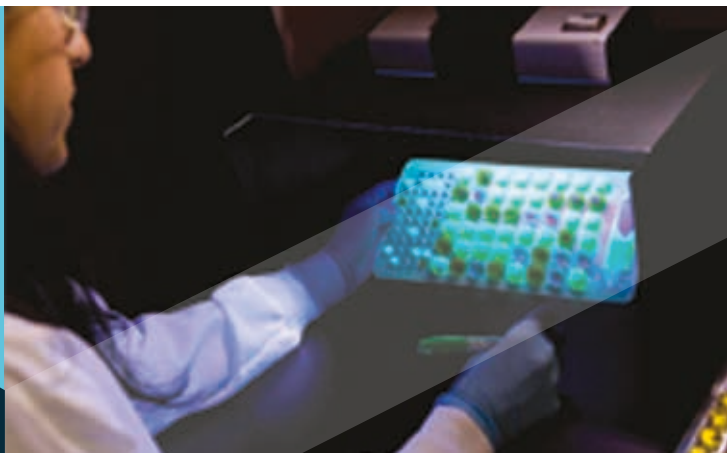
- ALSTOM
- SNCF

## STANDARDS

- LAB GTA 29 – Water intended for human consumption
- FD T 90-520 – Technical guidelines for sampling and health monitoring of the waters ; French public health code applicable
- NF EN ISO 19458 – Quality of water - Sampling for microbiological analyses,
- NF EN ISO 10523 – pH determinations
- NF EN ISO 7393-2 – Dosage of free chlorine and total chlorine

 See also page

133



# WATER QUALITY – WASTE WATER AND MICRO-POLLUTANTS FROM RAILWAY ACTIVITY

Providing expertise with regard to waste water and micro-pollutants from railway and industrial activity.

## OBJECTIVES

Waste water:

- Conduct pollution assessments
- Optimize the efficiency of waste water treatment plants
- Make proposals to reduce pollution at source
- Check compliance with regulations for industrial sites
- Conduct analyses: pH, T, MES, DCO, HCT, Pt, NTK, NO<sub>2</sub>, NO<sub>3</sub>, metal elements (Al, Fe, Cu, Pb, Ni, Cr, Mn...), ASA, Alkylphenols, HAP, PFOS, DEHP...

## TEST RESOURCES

- UV spectrophotometry
- Plasma spectrometer
- Basic chemistry measurement equipment

## ACCREDITATIONS

- ISO/IEC 17025 awarded by COFRAC

## REFERENCES

- ALSTOM
- SNCF

## STANDARDS

- LAB GTA 05 – Physico-chemical water analyses
- NF EN ISO 10523 – pH determinations
- NF EN ISO 17294 – Inductively coupled plasma application (ICP-MS) – Part 2: dosage of 62 elements
- NF EN 872 – MES dosage
- NF EN 903 – Dosage of anionic surfactants
- NF EN 25663 – Dosage of Kjeldhal nitrogen
- NF EN 15705 – Determination of the chemical oxygen demand index (St DCO)



 See also page

132

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• WHEEL-RAIL CONTACT • PANTOGRAPH •  
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ELECTRICAL PERFORMANCE • CAUSES OF FA  
• DROP SHUNTING • CURREN  
• ELECTROMAGNETIC COMPATIBILITY • MATER  
MATERIALS



## ACOUSTICAL

Railway noise and vibration - local residents .....	136
Noise from industrial sites .....	137



# RAILWAY NOISE AND VIBRATION - LOCAL RESIDENTS

Assessing the noise and vibration pollution caused by rail transport.

## OBJECTIVES

- Characterize situations that can create discomfort for local residents caused by vibro-acoustic phenomena due to structure-borne underground or ground vibrations
- Characterize the operation of specific equipment (fans, escalators, air conditioning, air vents, etc.) from an acoustics point of view before and/or after renovation work
- Produce an environmental noise map and study the impact by means of digital simulation

## TEST RESOURCES

- Class 1 integrating sound level meters
- Sound calibrators
- Accelerometers
- Data acquisition system (4 to 16 channels)
- Processing software

## ACCREDITATIONS

ISO/IEC 17025 awarded by COFRAC

## REFERENCES

RATP

## STANDARDS

- NF S31-010 – Acoustics - Environmental noise characterization and measurement - Special measuring methods
- NF S31-110 – Acoustics - Description and measurement of environmental noise - Basic quantities and general evaluation methods
- NF S31-088 – Acoustics - Measurement of railway traffic noise with a view to its characterization
- French Decree of 31 August 2006 regarding local noise abatement requirements and amending the Public Health Code
- French Order of 8 November 1999 – Railway infrastructure noise

 See also pages

36, 37, 89, 137, 140





# NOISE FROM INDUSTRIAL SITES

Checking that noise emitted by industrial sites complies with relevant standards and regulations.

## OBJECTIVES

- Check at regular intervals, through measurements of ambient and residual noise defined by regulations, that industrial activity does not cause noise pollution for neighbours
- Qualify the risk of noise-induced discomfort for those living in the vicinity

## TEST RESOURCES

- Class 1 integrating sound level meters
- Sound calibrators
- Processing software
- Measuring masts (up to 15m high)
- All-weather kits for long-term measurements (7 days)
- Weather station

## ACCREDITATIONS

ISO/IEC 17025 awarded by COFRAC

## REFERENCES

RATP

## STANDARDS

- NF S31-010 – Acoustics - NF S31-010 Environmental noise characterization and measurement. Special measuring methods
- NF S31-110 – Acoustics - Description and measurement of environmental noise - Basic quantities and general evaluation methods
- French order of 23 January 1997 regarding the reduction of noise emitted into the environment by facilities classified for environmental protection
- French decree of 31 August 2006 regarding local noise abatement requirements and amending the Public Health Code
- See European Directive 2003/10/EC of the European Parliament and of the Council of 6 February 2003 on the minimum health and safety requirements regarding the exposure of workers to the risks arising from physical agents (noise)
- Order of 15 December 2015 on the methods for calculating the physical parameters indicative of the risk of exposure to noise and the conditions for measuring noise levels in a work environment



 See also pages

36, 37, 89, 136, 140

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CURRENT COLLECTOR SHOES • BRAK  
• WHEEL-RAIL CONTACT • PANTOGRAPH •  
PH • RESISTANCE TO MOTION •  
ELECTRICAL PERFORMANCE • CAUSES OF FA  
• DROP SHUNTING • CURREN  
ELECTROMAGNETIC COMPATIBILITY • MATER  
MATERIALS



## HEALTH, SAFETY AND ENVIRONMENT

Workplace noise .....	140
Whole-body vibrations .....	141
Hand-arm vibration .....	142
Workplace air quality - occupational hazards .....	143
Workplace air quality - Asbestos .....	144
Tunnel air quality - occupational hazards .....	145
Ventilation and workplace filtration systems .....	146
Underground air quality monitoring -	
Exposure of general public .....	147
Air quality - characterization of brake shoe emissions .....	148
Human exposure to electromagnetic fields (lf/hf) .....	149
Protection against radiation .....	150
Visual contrasts and lighting in buildings .....	151



# WORKPLACE NOISE

Checking that level of daily noise exposure of personnel in the workplace complies with relevant standards and regulations, and improving hearing comfort.

## OBJECTIVES

- Measure daily exposure of employees to noise at their individual workstations in relation to the regulations in force
- Predict noise levels of production sites by means of calculations
- Study hearing protectors
- Analyse measurements with regard to health and safety at work regulations
- Check conformity of new and improved workstations

## TEST RESOURCES

- Portable noise dosimeters, sound level meters and sound calibrators
- Software dedicated to noise measurements at the workplace
- Data acquisition systems for architectural measurements
- Software used for predictive measurements of noise levels in workshops
- Acoustic test chamber
- Data acquisition software for subjective study (CNRS/INRS)
- Software: dBTrait, dBWed, dBLEXD

## ACCREDITATIONS

ISO/IEC 17025 awarded by COFRAC

## REFERENCES

- CNRS
- RATP
- INRS
- SNCF

## STANDARDS

- EN ISO 9612 – Acoustics - Determination of occupational noise exposure - Engineering method
- EN 458
- EN ISO 4869-2 – Hearing protectors - Part 2: Estimation of effective A-weighted sound pressure levels when hearing protectors are worn
- French Labour Code applicable
- French Order of 11 December 2015
- French Order of 15 December 2015 on the methods for calculating the physical parameters indicative of the risk of exposure to noise and the conditions for measuring noise levels in a work environment
- See European Directive 2003/10/EC of the European Parliament and of the Council of 6 February 2003 on the minimum health and safety requirements regarding the exposure of workers to the risks arising from physical agents (noise)

See also pages

36, 37, 89, 136, 137





# WHOLE-BODY VIBRATIONS

Checking the compliance of the exposure of works vehicle operators and train drivers to vibrations propagated throughout the whole of their bodies.

## OBJECTIVES

- Assess vibrations transmitted through the seat or feet of employees who use mobile machines or other work vehicles
- Measure vibration exposure experienced by employees at their individual workstations
- Compare the degree of exposure with the statutory limits
- Validate workstation improvements

## TEST RESOURCES

- Tri-axial accelerometers
- Multi-channel data acquisition device
- Chair seat pads used with tri-axial accelerometers (that can be placed on the seat)
- Vibrometry equipment
- Dosimeters

## REFERENCES

- RATP
- SNCF

## STANDARDS

- EN 14253+A1 – Mechanical vibration - Measurement and calculation of occupational exposure to whole-body vibration with reference to health - Practical guidance
- Labour Code applicable
- See European Directive 2002/44/EC of the European Parliament and of the Council of 25 June 2002 on the minimum health and safety requirements regarding the exposure of workers to the risks arising from physical agents (vibrations)
- Directive 2002/44/EC of the European Parliament and of the Council of 25 June 2002 on the minimum health and safety requirements regarding the exposure of workers to the risks arising from physical agents (vibration)



 See also page

142



# HAND-ARM VIBRATION

Checking the compliance of the vibrations transmitted into the palms, fingers and arms of employees when handling power tools.

## OBJECTIVES

- Measure worker exposure to hand-transmitted vibrations in the workplace - primarily for track maintenance and rolling stock staff
- Compare the degree of exposure with the statutory limits
- Validate workstation improvements

## TEST RESOURCES

- Regular and tri-axial accelerometers
- Multi-channel data acquisition device

## REFERENCES

- RATP
- SNCF

## STANDARDS

- EN ISO 5349-2+A1 – Mechanical vibration - Measurement and evaluation of human exposure to hand-transmitted vibration -- Part 2: Practical guidance for measurement at the workplace Amendment 1
- Labour Code applicable
- EN ISO 28927 (all parts from 1 to 8)

See also page

141





# WORKPLACE AIR QUALITY – OCCUPATIONAL HAZARDS

Monitoring employee exposure to chemicals in the air and contribute to the improvement of workstations.

## OBJECTIVES

- Define the sampling strategy for identifying individual measurements to perform in compliance with the regulatory requirements
- Propose a strategy for performing measurements in an ambient atmosphere via fixed point sampling
- Estimate the individual level of exposure to chemical agents present in the air: particles, wood dust, fibres (glass fibres, refractory ceramic fibres), metals, silica, hydrocarbons, gases, etc.
- Measure fixed point concentrations of gases, solvents, dust and products subject to heat degeneration in premises with specific and non-specific pollution
- Establish a diagnosis of compliance (or not) with Occupational Exposure Limits (OEL)

## ACCREDITATIONS

- ISO/IEC 17025 awarded by COFRAC
- COFRAC reference document LAB REF 27

## TEST RESOURCES

- Air sampling devices for recording air on operators (pump, CIP10, flowmeter, thermo-hygrometer, etc.)
- Sampling devices for recording air at fixed points
- Gas detector

## REFERENCES

- ADP
- ASTEN
- EUROFINs
- LAFARGE
- RATP
- SFP
- TSO

## STANDARDS

- French Labour Code – Order and Decree No. 2009-1570 of 15 December 2009
- French Circular DGT 2010/03 of 13 April 2010
- NF X 43-257, NF X 43-262, NF X 43-264, NF X 43-267, NF X 43-275, NF X 43-294, NF X 43-298, XP X 43-269, etc.



 See also pages

144, 145, 146, 147, 148



# WORKPLACE AIR QUALITY – ASBESTOS

Assist rail industry partners in managing asbestos issues on a day-to-day basis or during specific works operations.

## OBJECTIVES

- Help the client carry out works where there is a risk of exposure to asbestos and assist them in their choice of technical solutions
- Define a sampling strategy to determine dust levels in compliance with the regulatory requirements
- Conduct measurements of asbestos fibre dust in building constructions and at workstations
- Interact with the Unions

## TEST RESOURCES

- Sampling devices for recording air on operators
- Sampling devices for recording air at fixed points
- Intellectual services

## REFERENCES

- PARVIS
- ADP

## ACCREDITATIONS

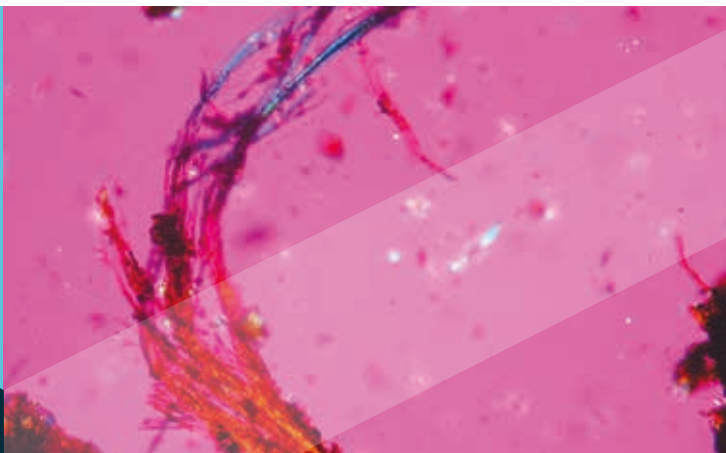
- COFRAC according to the NF EN ISO 17025 standard
- Asbestos: COFRAC reference documents LAB REF 26 and 28

## STANDARDS

- French Labour Code – Decree 2012-639 of 4 May 2012 – Decree 2013-594 of 5 July 2013 - Decree 2015-789 of 29 June 2015 - Order of 14 August 2012 – Order of 30 May 2018
- EN ISO 16000 -7 and its application guide GA X 46-033
- NF X 43-269 and NF X 43-050

See also pages

143, 145, 146, 147





# TUNNEL AIR QUALITY - OCCUPATIONAL HAZARDS

Monitoring air quality in tunnels during construction or maintenance work.

## OBJECTIVES

- Monitor, in real time, gas concentrations ( $O_2$ ,  $CO/CO_2$ ,  $NO/NO_2$ ,  $SO_2$ ,  $H_2S$ ) and check that threshold limit values during tunnel work are not exceeded (alerts)
- Perform a regulatory control of occupational exposure to chemical agents (diesel particulates, respirable dust, crystalline silica, metals, etc.)
- Check that there is sufficient air renewal in tunnels to dilute pollutants emitted

## TEST RESOURCES

- Gas detectors
- Anemometer
- Individual sampling probes
- Sampling devices for recording air on operators (pump, CIP10, flowmeter, thermo-hygrometer, etc.)
- Sampling devices for recording air at fixed points

## REFERENCES

- COLAS Rail
- EOLE
- MARUB
- RATP
- SNCF
- TSO

## ACCREDITATIONS

- EN ISO 17025 awarded by COFRAC
- Chemical risk: COFRAC LAB REF 27 reference

## STANDARDS

- French Labour code – Order and Decree 2009-1570 of 15 December 2009 – Order of 8 June 1990
- French Circular DGT 2010/03 of 13 April 2010
- NF X 43-257, NF X 43-262, NF X 43-264, NF X 43-267, NF X 43-275, NF X 43-294...



 See also pages

143, 144, 146, 147, 148



# VENTILATION AND WORKPLACE FILTRATION SYSTEMS

Verifying that ventilation and air cleaning systems installed in premises and workspaces are compliant with relevant standards and regulations.

## OBJECTIVES

- Conduct air quality audits in premises with specific and non-specific air pollution (e.g. offices)
- Measure airflow rate and/or air velocity in the workplace and in pollutant collection systems at source (e.g. paint booth)
- Provide technical assistance for the development of gas and particle cleaning systems

## TEST RESOURCES

- Anemometers
- Smoke generators

## REFERENCES

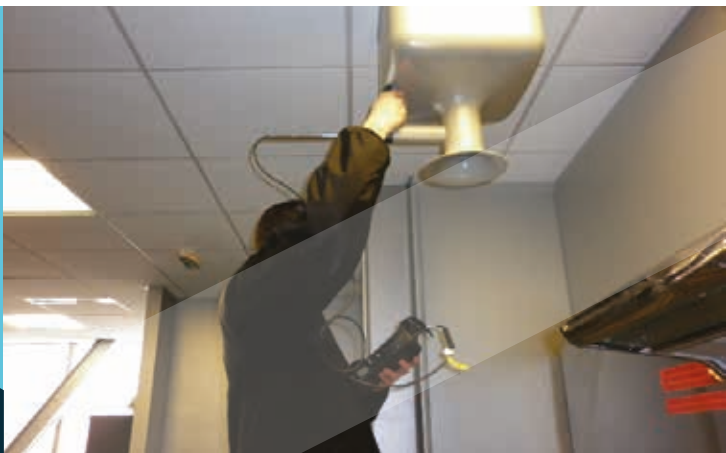
- RATP
- SNCF

## STANDARDS

- French Labour Code – Articles R. 4222-2 to R. 4222-18 and R. 4212-1 to R. 4212-7
- French Circular of 9 May 1985 regarding the technical review of Decrees 84-1093 and 84-1094 of 7 December 1984
- Orders of 8 and 9 October 1987
- NF X43-406 – Air Quality - Strategy for environmental investigation following an alert - Buildings for residential, educational or office use

See also pages

145, 147



# UNDERGROUND AIR QUALITY MONITORING - EXPOSURE OF GENERAL PUBLIC

Continuously monitor air quality in railway stations and underground stations.

## OBJECTIVES

Collect and study concentrations of traffic-related air pollutants:

- Nitrogen oxides
- Carbon dioxide
- Carbon monoxide
- $PM_{10}$  and  $PM_{2.5}$  (particulate matter)

## TEST RESOURCES

- Analysers:  $NO$ ,  $NO_2$ ,  $CO_2$ ,  $PM_{10}$  and  $PM_{2.5}$
- Data acquisition and processing systems
- Continuous sites SNCF and RATP

## ACCREDITATIONS

ISO/IEC 17025 awarded by COFRAC

## REFERENCES

- RATP / SQUALES network
- SNCF

## STANDARDS

- EN 14211 – Ambient atmosphere - Standardized method for measuring concentration of nitrogen dioxide and nitrogen monoxide using chemiluminescence
- NF X 43-055 – Ambient atmosphere - Metrology applied to measuring gaseous atmospheric pollutants - Sampling of ambient atmosphere and implementation of calibration gases



 See also pages

144, 145, 146, 148



# AIR QUALITY - CHARACTERIZATION OF BRAKE SHOE EMISSIONS

Characterize the emissions from brake shoes during brake tests in the laboratory.

## OBJECTIVES

- Characterize and study the concentrations of pollutants produced by brake shoes (particles, metal, VOC, etc.)
- Provide support for the choice of technical solutions

## STANDARDS

- LAB REF 22
- ISO 10780
- NF X 44-052, NF EN 13284-1, NF EN 14385...

## TEST RESOURCES

- Brake rig
- Devices for measuring air emissions
- Intellectual services

## REFERENCES

- RATP
- TALLANO TECHNOLOGIE

 See also pages

22, 67, 143, 145, 147



# HUMAN EXPOSURE TO ELECTROMAGNETIC FIELDS (LF/HF)

Checking that electromagnetic fields occurring in a specific area affect neither the general public nor employees.

## OBJECTIVES

Measure public and staff exposure to electromagnetic fields

## TEST RESOURCES

- Electromagnetic field measuring devices (Low frequency and High frequency) - from 5 Hz to 6 GHz
- Gaussmeter for continuous magnetic field
- Spectrum analyzer
- Electric and magnetic field antennas (from 5 Hz to 6 GHz)
- Measuring systems based on ANFR protocol (French Frequency Agency)

## ACCREDITATIONS

- Case A according to the ANFR protocole

## REFERENCES

- ALSTOM
- BOUYGUES TELECOM
- ORANGE
- PARIS HABITAT
- SFR
- SIEMENS

## STANDARDS

- EN 50492 – Basic standard for the in-situ measurement of electromagnetic field strength related to human exposure in the vicinity of base stations
- EN 50500 – Measurement procedures of magnetic field levels generated by electronic and electrical apparatus in the railway environment with respect to human exposure
- Directive 2013/35/EU (employees)
- European Recommendation 1999/519/EC (general public)
- ANFR (French frequency agency) protocol



 See also pages

26, 27, 28, 29, 54, 55



# PROTECTION AGAINST RADIATION

Controlling the degree of exposure to ionizing radiation as part of efforts to obviate occupational hazards. Fulfilling the functions of the Radiation Protection Officer (RPO).

## OBJECTIVES

- Produce an inventory of the sources of emission at the workplace
- Assess ionizing radiation risks
- Conduct the periodical internal checks required by the regulations
- Organize/supervise the external verifications conducted by an approved authority
- Contribute to the production of the requisite documents: single reference document, prevention plan, job reference sheets
- Define and ensure the appropriate dosimetry
- Define areas subject to the regulations or to the special regulations
- Define the corresponding individual or collective forms of protection
- Calculate the doses emitted by the sources of ionizing radiation to include this information in the staff exposure records
- Train staff and make them aware of the dangers of ionizing radiation
- Analyse contamination
- Interact with the Occupational Health & Safety Committee and the departments to broadcast the results of analyses
- Conduct expert assessments of radiation protection

## TEST RESOURCES

- Atomtex AT1121 radiation dosimeter (for X-ray and gamma radiation)
- Contamination meter (for alpha and beta rays)

## REFERENCES

- Gares & Connexions
- SNCF Maintenance centers

## STANDARDS

- NF C74-100
- NF C15-160





# VISUAL CONTRASTS AND LIGHTING IN BUILDINGS

Checking that the contrasts and lighting in buildings accessible to the public and workplaces comply with the regulations and standards.

## OBJECTIVES

Measure visual contrast and lighting levels in the workplace, metro and railway stations

## TEST RESOURCES

- Luminance meter
- Lux meter


## REFERENCES

- DG Construction
- General Council of Hauts-de-Seine (near Paris)

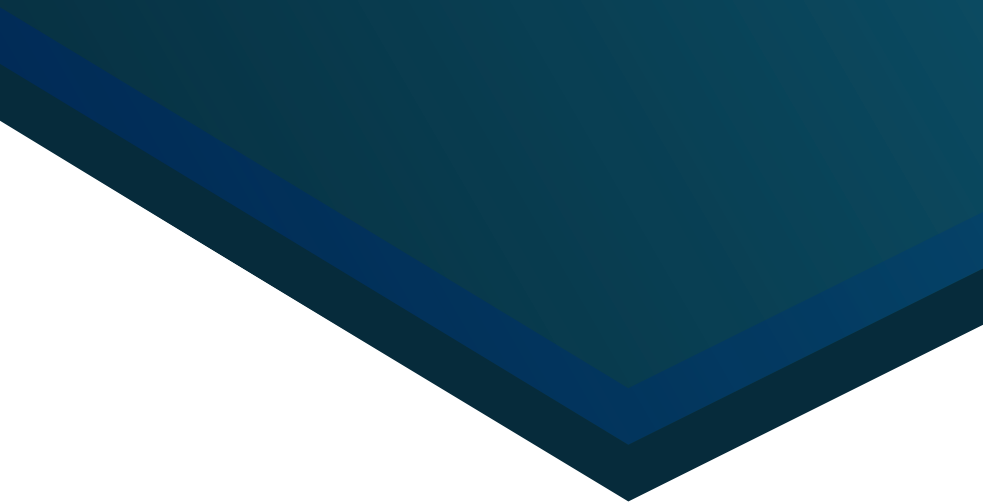
## STANDARDS

- EN 12464-1 – Light and lighting - Lighting of work places - Part 1: Indoor work places
- NF P98-351 – Pathways - Allowance for the needs of the mobility impaired – Tactile warning systems - Characteristics, tests and rules governing the position on the ground of tactile warning strips for the guidance of the blind or partially sighted
- French Labour Code



 See also page

81





# INDEX



**A**

- Accessibility ..... 81, 151
- Acoustics
  - Industrial sites..... 137
  - Inside and on-board ..... 37
  - Intelligibility ..... 37
  - Outside noise - Residents ..... 36, 136
  - Safety equipment ..... 89
  - Workplace..... 140
- Aerodynamics..... 35, 102, 103
- Air quality
  - Control in the emission ..... 67, 148
  - Tunnel ..... 145, 147
  - Underground areas ..... 145, 147
  - Ventilation and air filtration ..... 146
  - Workplace..... 144, 146
- Anti-tag ..... 81, 85
- Asbestos..... 144
- Axles ..... 18, 69, 71
- Axle boxes ..... 70

**B**

- Ballast ..... 114
- Bearings..... 70
- Bogies..... 68, 71, 99, 112
- Bolted assemblies ..... 72, 109
- Bonded assemblies ..... 110
- Braking
  - Components..... 22, 23, 67, 148
  - On open line ..... 21, 23
  - Test rig ..... 21, 25, 67, 148

**C**

- Cables ..... 41, 82, 83, 131
- Chemical hazard ..... 132, 133, 145
- Cleaning ..... 81, 85, 87, 128
- Climate ..... 88
- Coatings ..... 81
- Comfort
  - Vibratory ..... 96
- Contactless cards..... 80
- Current collection
  - On track..... 30, 31, 45, 47, 51, 104
  - Stationary test bench..... 32, 33
- Current collector shoes..... 101

**D**

- Dependability ..... 60
- Detonators ..... 89
- Diffraction ..... 112, 113
- Dimensional control..... 69, 71, 107
- Doors..... 88, 105
- Drop shunt ..... 24, 25
- Dye penetrant testing ..... 115

**E**

- Electric traction power supply..... 26, 48, 49, 55, 56, 123
- Electrical insulation ..... 98, 99, 123
- Electrical performance..... 56, 78, 118
- Electromagnetic compatibility .... 26, 52, 53
- Electromagnetic field
  - Human exposure ..... 28, 149
  - Modelling and expertise ..... 55
  - Railway stock..... 54
  - Rolling system..... 27, 52, 53
- Electromagnetic interference..... 29, 55
- Electronic wheel detectors..... 52, 53
- Energy meter ..... 78, 119
- Equipment
  - Metal ..... 72, 107, 111
  - Running gear..... 68, 69, 70, 71, 98, 112
- ERTMS..... 58, 59

**F**

- Failures ..... 42, 67, 70, 71, 72, 75, 86, 98, 106, 107, 108, 109, 111, 112, 113, 129, 130
- Fatigue
  - Characterization ..... 19, 72
  - Vibration ..... 88, 96, 106
- Fire & smoke ..... 82, 83, 84, 131

**G**

- Geared motors ..... 75
- Glazing ..... 88
- Graffiti ..... 81, 85, 128
- Grease..... 86
- GSM-R ..... 57, 79

**H**

- Heat-shrink tubing ..... 82
- Human exposure ..... 28, 149

**I**

- Infrastructure..... 30, 35, 42, 43, 44, 45, 55, 118
- Infrastructure-rolling stock interaction ... 120

**L**

Lighting..... 151

**M**

Magnetic particles .... 68, 69, 71, 73, 74, 115

Materials .....72, 81, 84, 112,  
122, 128, 129, 130

Modal analysis ..... 100

**N**

Non-destructive testing.....67, 68, 69,  
70, 71, 72, 115

**O**

Occupational exposure .....140, 141, 142,  
143, 144, 145, 146

Oil ..... 86

Overhead contact line (OCL)

Interaction with pantograph..... 30, 31,  
32, 45, 46, 47

Uplift..... 47, 51

**P**

Paint .....81, 85, 114, 128, 146

Pantograph

Gauge ..... 31, 104

Instrumented pantograph ..... 31

Video-based obstacle detection ..... 104

Pantograph-OCL interaction..... 30, 31,  
32, 46, 47, 51

Petrochemicals..... 86

Petroleum products ..... 86

Physical and chemical properties .....115,  
128, 129, 130

Polymers..... 129

Power supply ..... 54, 56, 61

**R**

Radio ..... 57, 79, 121

Radio coverage..... 121

Radioprotection ..... 150

Railway dynamics..... 17, 18, 19,  
45, 69, 71, 99

Remote monitoring

Electrical..... 61

Residual stresses .....69, 106, 108,  
112, 113, 114

Roll flexibility coefficient..... 97

Rolling resistance ..... 34, 35, 102

Rolling stock

Electrical performance..... 118

Weighing..... 20

Rubber ..... 130

**S**

Safety

Electrical..... 48, 49, 123

Hardware..... 60, 91

Software..... 60

Safety hardware & equipment .... 60, 89, 91

Signalling ..... 26, 29, 50, 57, 58, 59, 60, 91

Skidding..... 81

Structures ..... 44, 103

**T**

Testing

Electrical..... 78

Ticketing..... 80

Track

Behaviour..... 45, 103

Measurements ..... 103

Rail and turnouts..... 42

Track components..... 43

Traction current..... 49, 50

Traction drive..... 34, 75

**U**

Ultrasonic.....42, 69, 71, 108,  
109, 112, 115

**V**

Vehicle components ..... 98

Vehicle structure

Mechanical resistance ..... 73

Torsional rigidity of car bodies ..... 74

Vibration

Hand-arm ..... 142

Whole-body ..... 141

Vibratory ..... 63, 96, 98, 100, 106, 136

Visual contrast ..... 62, 81, 151

**W**

Water ..... 132, 133

Welded assemblies ..... 72, 108

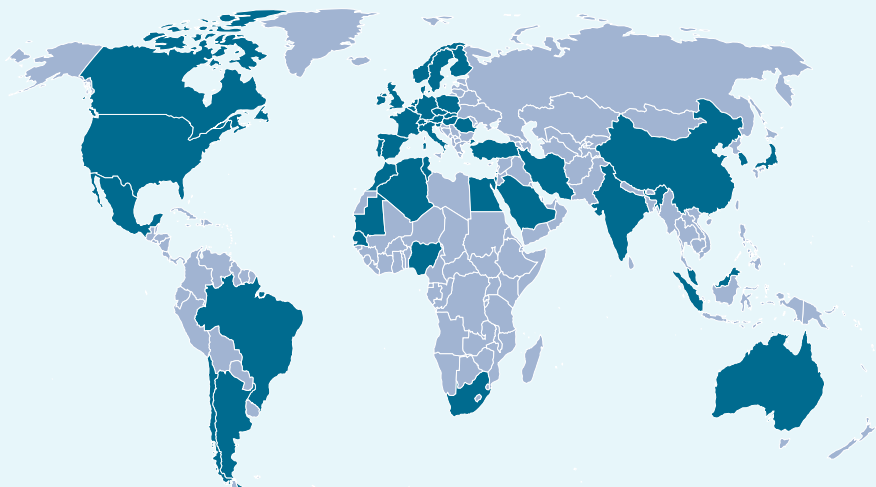
Wheels.....18, 19, 67, 71, 103, 112, 115

Wheel-rail contact..... 18, 19

Wheel slide protection..... 23

Weighing..... 20

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