



## RAILWAY EXPERTISE & TESTING

| Your 2018 Reference Guide





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# CONTENTS

## PART 1

### Type Approval / Qualification

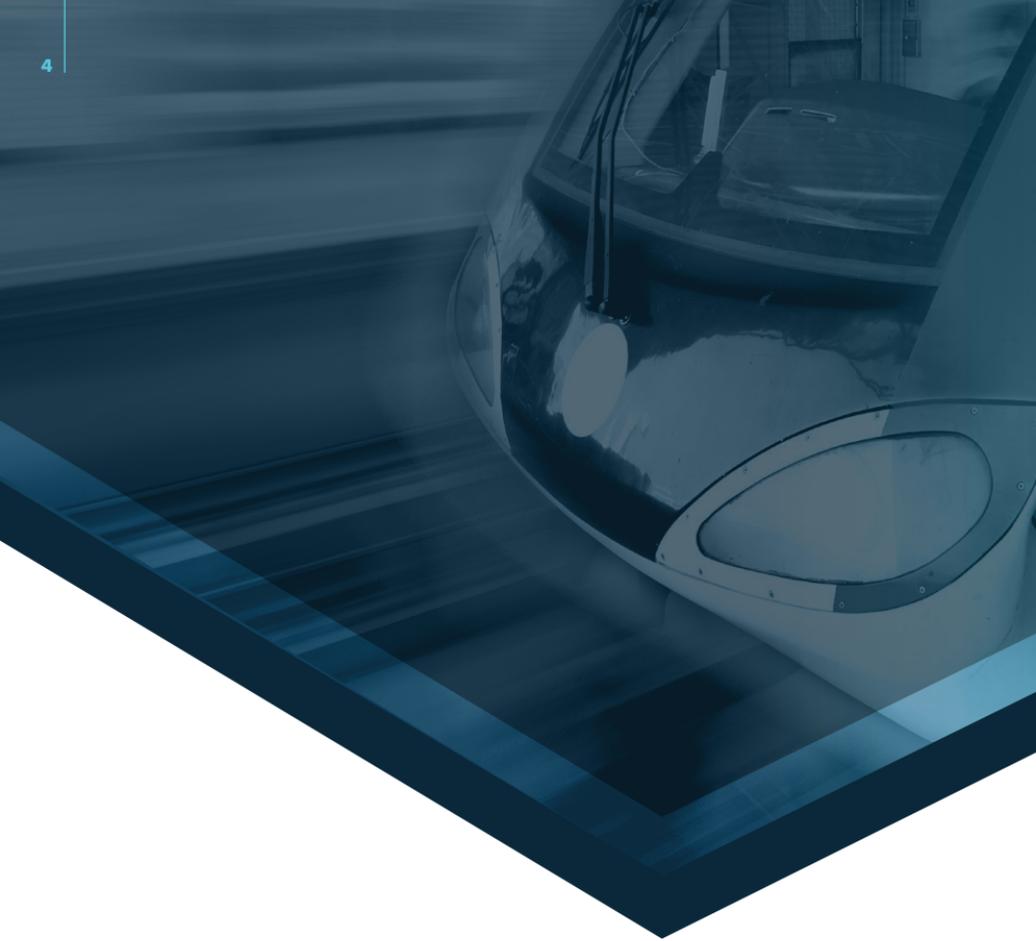
Rolling Stock .....	15
Infrastructure .....	41
Railway Equipment .....	65

## PART 2

### Measurements

Mechanical .....	95
Electrical .....	119
Physico-chemical .....	131
Acoustical .....	139
Health, Safety and Environment .....	143

Index .....	158
-------------	-----



# EDITORIAL

For nearly 20 years, Eurailtest has been providing railway test services and expertise worldwide.

The many events that have taken place over this period have helped to make Eurailtest what it is today: a dynamic company renowned for its ability to offer the best possible combination of skills and experience.

Founded on the strength of a partnership between two railway operators SNCF (SNCF Réseau and SNCF Mobilités) and RATP, Eurailtest has established its position as one of the leading railway test agencies offering cutting-edge services running the gamut from high speeds to urban light rail.

In 2014, to meet the growing demand of our customers and partners, we compiled a first version of this catalogue to give you a complete overview of our services. Since then our portfolio has not stopped growing, as you will discover when you leaf through this new 2018 edition. In it, we aim to guide you through the world of railway testing, and whether you are rolling stock or rail equipment manufacturers, infrastructure managers, operators or engineering companies, this catalogue is for you.

Our team will be happy to answer your questions and, of course, meet all your needs.

**MORE THAN 1,500 CUSTOMERS HAVE ALREADY PLACED THEIR TRUST IN US. WHY NOT JOIN THEM?**

CYRIL CHARBONNET  
Eurailtest Managing Director

## | WHO ARE WE?

A world leader in rail sector testing, Eurailtest is an independent Economic Interest Group **based in Paris** and working closely with certification authorities recognized **worldwide**.

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 **specialising in railway testing** can offer you the benefit of their skills and experience.

Today, Eurailtest is the **portal 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 rail industry sectors. These are set out in this catalogue.

It is, however, not exhaustive. With our extensive resources, we can offer tailor-made services to meet specific requests not necessarily within the usual railway test field.

One of our strengths is, in fact, our ability to combine all our skills and test capabilities in an almost infinite number of ways.

For more information, please contact us by email, at [contact@eurailtest.com](mailto:contact@eurailtest.com), or by phone at +33 1 44 61 93 20

   Eurailtest

# EURAILTEST IN FIGURES



## WHY CHOOSE EURAILTEST?

AS A MANUFACTURER, are 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, the infrastructure manager and the 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
- Provide Expert opinions

AS AN INFRASTRUCTURE MANAGER, a manufacturing consortium or a civil engineering company you need to establish the conformity of your infrastructure - new or renovated – for acceptance testing purposes?

Eurailtest can take charge of your test organization, provide special and/or instrumented vehicles and offer you expert advice.

YOU ARE AN ORIGINAL EQUIPMENT MANUFACTURER and you want 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.

YOU ARE A RAILWAY OPERATOR, a local authority or PTA and you are 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 in providing bespoke consultancy and testing services.

## OUR VALUES

- › CUSTOMER SATISFACTION
- › TECHNICAL EXCELLENCE
- › PROFESSIONALISM
- › INDEPENDENCE & NEUTRALITY

## OUR EXTERNAL RECOGNITIONS

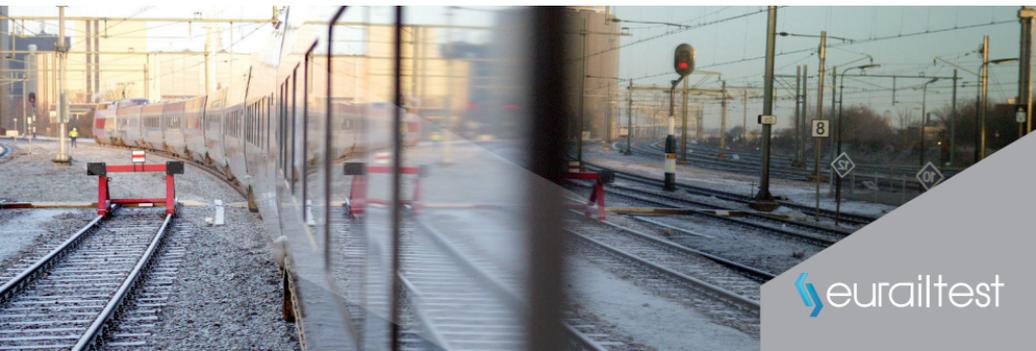
- **EURAILTEST laboratories** have been recognized by the following external bodies:



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 (allows companies paying tax in France to claim tax credit for amounts paid to Eurailtest)

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



# 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



These pages may be of interest to you



Heavy rail



Urban light rail

# RECENT REFERENCES

## ... IN FRANCE

Type approval tests for the SEA high speed line infrastructure  
*2016 - 2017*

Type approval tests for the Nimes-Montpellier  
bypass infrastructure  
*2017*

Type approval tests on BOMBARDIER Transport Regio 2N  
trainsets  
*2013 - 2016*

Type approval tests for the Coradia Multifunctional REGIONIS  
regional train (ALSTOM Transport)  
*2012 - 2013*

Type approval tests for ETR 500 and ICE 3 high-speed trains  
*2002 - 2007*

Organization of test and measurement campaigns for the  
world rail speed record: 574.8 km/h  
*2007*

## ... AND AROUND THE WORLD

Type approval tests on VELARO D and VELARO Eurostar  
*2014 - 2016 - Germany & France*

Type approval tests for FLIRT (STADLER Fast Light Innovative  
Regional Train)  
*2011 - 2012 - Switzerland & France*

Type approval tests for metro car and high-speed train bogies  
*2010 - 2011 - China*

Type approval tests for the Italo rolling stock (ALSTOM  
Transport) for the Italian private rail Operator NTV  
*2010 - 2011 - Italy*

Tests for the commissioning of the HLS-South (HSL-Zuid)  
*2006 - 2007 - Netherlands*





## PART 1

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# 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
- Infrastructure
- Railway Equipment



OP SHUNTING • ELECTROMAGNETIC COMPATIBILITY  
ELECTROMAGNETIC COMPATIBILITY  
ERODYNAMICS • DYNAMICS •  
MICS • DYNAMICS  
• ELECTROMAGNETIC  
ROMAGNETIC  
ERODY

Rolling  
Stock

ROLLING  
STOCK



# ROLLING STOCK



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

## REFERENCES

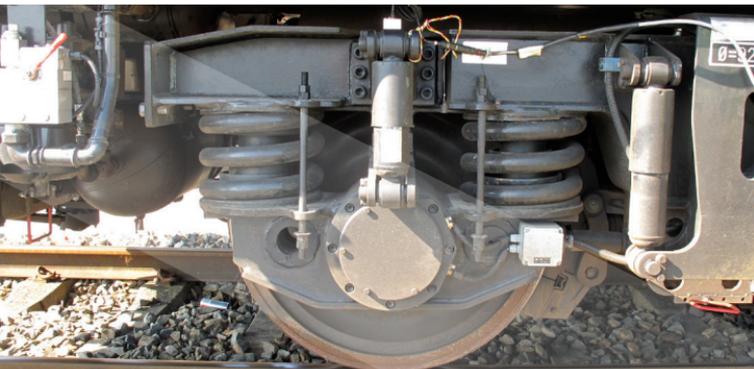
- ALSTOM
- BOMBARDIER
- CLERE
- COLAS RAIL
- COSEA
- SNCF
- STADLER
- SYSTRA
- SYSTRA Mexico
- VOSSLOH

## 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, 46, 68,  
98, 99, 101



# 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

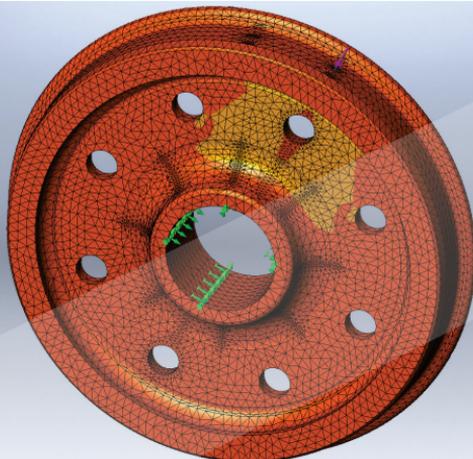
- Digital calculator for data acquisition and processing
- Calibration bench connected to reference gauges with the following characteristics:
  - Vertical axis: forces applied up to 200 kN
  - Lateral axis: up to 100 kN
  - Wheel diameter: 450 to 1,250 mm for a wide range of track gauges
- Multi-channel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

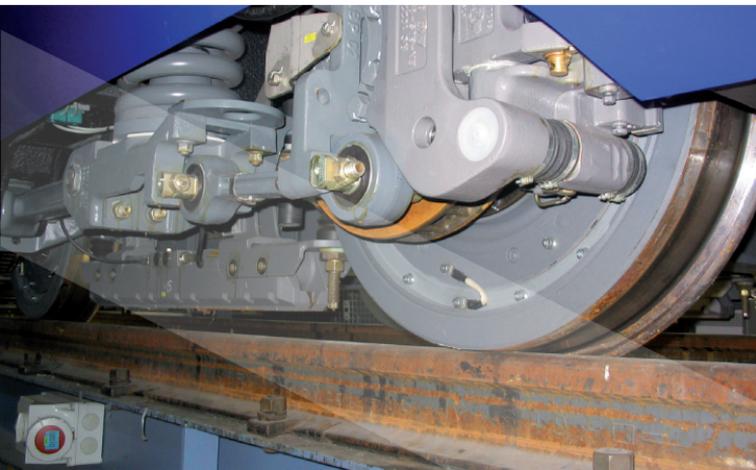
- Gauge for spot measurement of wheel and rail profiles
- Calculation software for wheel-rail contact parameters

## 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

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



# 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, 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

## 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 B 169/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

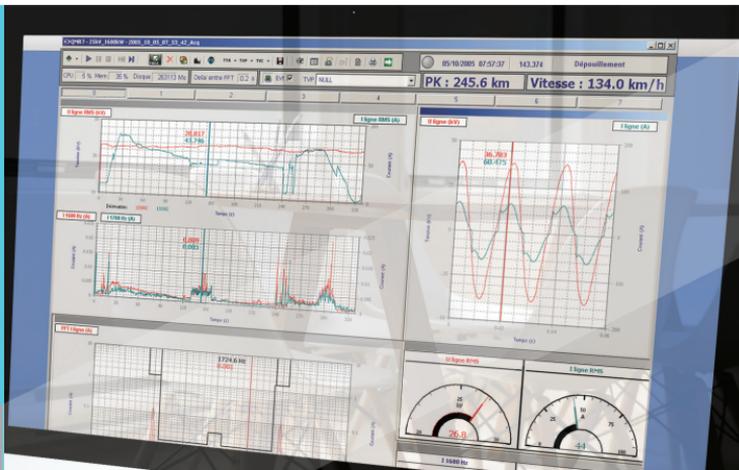
- ALSTOM
- ANSALDO BRED A
- BOMBARDIER
- RATP
- SIEMENS
- STADLER

## STANDARDS

- EN 50238 – Compatibility between rolling stock and train detection systems
- EN 50121-3-1 – 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,  
57, 125, 153





# ELECTROMAGNETIC EMISSIONS

Checking, for its type approval, 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

## TEST RESOURCES

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

## ACCREDITATIONS

ISO/IEC 17025 awarded by COFRAC

## REFERENCES

- ALSTOM
- BOMBARDIER
- STADLER

## STANDARDS

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



 See also pages

26, 28, 29, 54, 125, 153



# ELECTROMAGNETIC EMISSIONS AND HUMAN EXPOSURE

Checking that electromagnetic fields generated by rolling stock, or on railway premises, do not affect passengers or staff.

## OBJECTIVES

- Characterize electromagnetic fields with regard to human exposure (1 Hz - 20kHz)
- Measure electromagnetic field levels for all those parts of rolling stock accessible to passengers and employees
- Compare these levels with the limits set by European Directive 2013/35/EU on worker exposure and European Recommendation 1999/519/EC on exposure of the general public to electromagnetic fields

## REFERENCES

- ALSTOM
- BOMBARDIER
- 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

## TEST RESOURCES

- Magnetic field antennas
- Acquiris software
- Data acquisition board
- Electric field sensor
- Amperometric clamp

See also pages

26, 27, 29, 54, 125, 153





# 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, 29, 125, 153



# 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
  - Videonum (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, 47, 48, 106



# 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

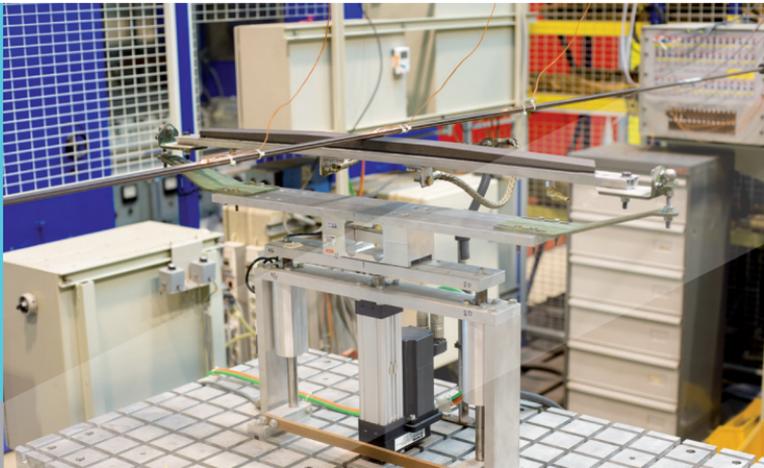
- ALSTOM
- BOMBARDIER
- FAIVELEY
- MORGAN
- RATP
- SIEMENS

## 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, 47, 48, 106





# 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



# 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

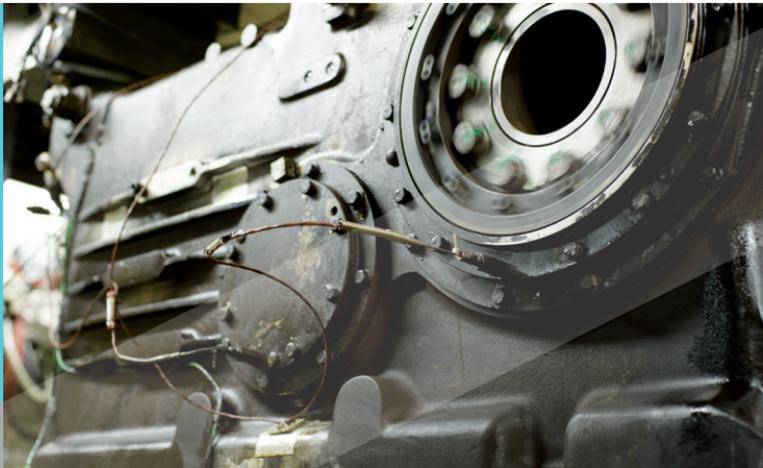
- ALSTOM
- BOMBARDIER
- SIEMENS
- SNCF
- STADLER

## 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, 104, 121, 122





# 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

104



# ROLLING STOCK - NOISE CHARACTERIZATION

Locating, characterizing and simulating the noise caused by trains as part of a type approval process.

## 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 - whether stationary or in motion
- Simulate passing noise, rolling noise and traffic noise

## TEST RESOURCES

- Acoustic antenna
- Masts measuring up to 40m high
- Multi-channel data acquisition device (100 channels)
- Microphone metering system (Class 1)
- Sound level meter (Class 1)
- Measuring device for rail and wheel roughness
- Sound intensity probe
- Portable analyzer
- Independent measuring system
- Simulation tools: twins, vampass, mithra fer

## ACCREDITATIONS

ISO/IEC 17025 awarded by COFRAC

## REFERENCES

- ALSTOM
- BOMBARDIER
- RATP
- SNCF-RÉSEAU
- SIEMENS
- STADLER

## STANDARDS

- EN ISO 3095 – Acoustics - Measurement of noise emitted by railbound vehicles
- S31-088 – Acoustics - Measurement of railway traffic noise for purposes of 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

See also pages

37, 38, 89, 140, 141





# ACOUSTIC COMMISSIONING OF LIGHT RAIL VEHICLES

Verifying the compliance of noise levels emitted by a vehicle with the specifications and standards in force.

## OBJECTIVES

Measure outside and/or inside noise emitted by stationary or moving rail vehicles for commissioning purposes or for approval of adaptations.

## REFERENCES

- ANSALDO BREDA
- RATP
- SNCF
- TRANSPOLE

## TEST RESOURCES

- Integrating sound level meters
- Sound calibrators
- Microphone conditioner
- Multichannel conditioning
- Multi-channel data acquisition device
- Software: dBTrait, dBFA

## STANDARDS

- EN ISO 3095 – Acoustics - Measurement of noise emitted by railbound vehicles
- NF S31-007 – Acoustics - Measurement of noise emitted by accelerating road vehicles - Method of expertise
- NF S31-086 – Acoustics - Measurement of noise inside road vehicles (public transport)
- EN ISO 3381 – Acoustics - Measurement of noise inside rail vehicles



 See also pages

36, 38, 89, 140, 141



# ON-BOARD ACOUSTICS

Qualifying, characterizing and simulating acoustics inside trains or 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 Speech transmission index STIPA (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
- Sound intensity probe
- Acoustic test chamber
- Statistics calculator software
- Simulation software

## 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

 See also pages

36, 37, 89, 140, 141





POWER SUPPLY • CURRENT COLLECTION • TRAC  
• OCL • POWER SUPPLY •  
• ELECTROMAGNETIC COMPATIBILITY •  
CTION • TRACTION CURRENT  
ACK • RAILS • STRUCTURES  
COMPATIBILITY  
M

INFRASTRUCTURE

# INFRASTRUCTURE



# INFRA- STRUCTURE



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 up 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.

# 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  
44, 46, 105



# 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  
43, 46, 105





# 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, 43, 44, 47, 48, 105





# 3D SIMULATION OF PANTOGRAPH-OCL INTERACTION

Optimizing current collection and the various components.

## OBJECTIVES

- Model all types of OCL system and pantographs
- Develop and optimize OCL or pantographs
- Validate systems during the design phase
- Provide effective and cost-efficient solutions in order to improve current collection quality
- Propose solutions to improve infrastructure and rolling stock components
- Provide customers with the simulations required for certification of interoperability components as defined in the Technical Specifications for Interoperability
- Assist in the design of test specifications

## REFERENCES

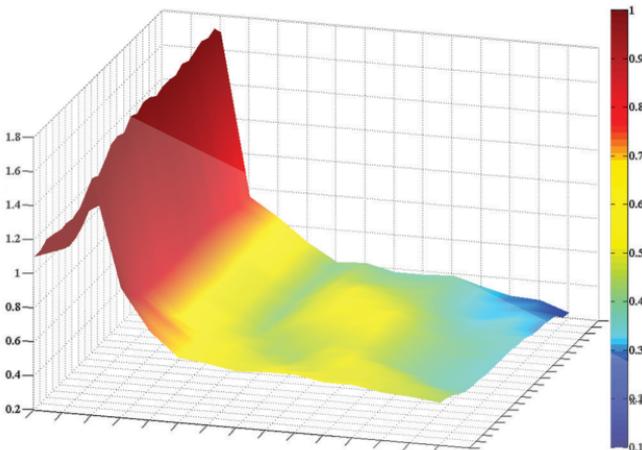
- ALSTOM
- ATKINS
- BOMBARDIER
- CFF
- NETWORK RAIL
- STEMMAN

## 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)

## TEST RESOURCES

OSCAR® software developed by SNCF  
(EN 50318 certified)



 See also pages

30, 31, 32, 46, 48, 106



# 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  $V = 350$  km/h
  - With an accuracy to under 5 mm
  - In all weather conditions (rain, fog, snow, etc.)
- Measure meteorological parameters at OCL level: wind speed and direction, humidity and temperature

## REFERENCES

- ALSTOM
- BOMBARDIER
- SNCF-RÉSEAU
- STADLER

## TEST RESOURCES

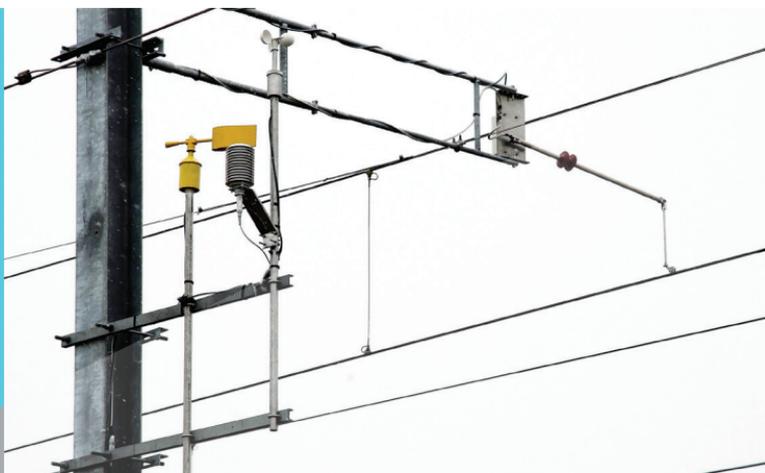
- “Catiris” measuring station
- Potentiometric uplift sensors
- Insulating arms for connection with contact wire
- Surge devices
- Reference power supply
- Data acquisition system (installed within 500 m of sensors)

## 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

See also pages

30, 31, 32, 47, 106





# 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

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

## 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  
50, 51, 123



# 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  
49, 51, 123



# 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
- VULCAIN test wagon - capable of absorbing nominal current
- Recorders and analyzers installed on trains and trackside



 See also pages  
49, 50, 123



# 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

## REFERENCES

- ALSTOM
- BOMBARDIER
- DB
- SIEMENS
- STADLER
- VOSSLOH

## STANDARDS

- OP 09913 (SAM S 005) – Protocol for testing compatibility of rolling stock with electronic wheel detectors
- CERTIFER capability certification

See also pages  
26, 57





# ELECTROMAGNETIC COMPATIBILITY OF ROLLING STOCK WITH ELECTRONIC WHEEL DETECTORS

Checking that the magnetic fields generated by a train are compatible with the 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 during static and dynamic tests on rolling stock
- Compare the levels of the magnetic fields generated by the rolling stock with the limits set by ERA in relation to the sensitivity of the electronic wheel detectors fitted on the European rail networks

## TEST RESOURCES

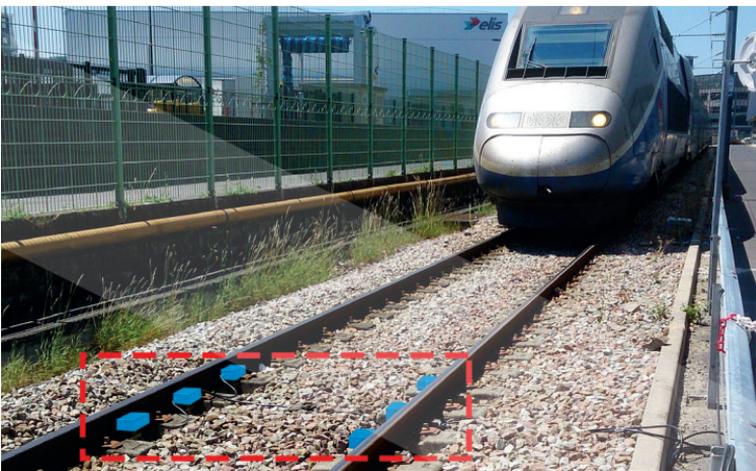
- Four antennas to detect magnetic fields in 3 directions (two per stretch of rails)
- Current sensor
- Train positioning system
- Electronic signal conditioning board
- Digital signal capture system (15 measuring tracks with simultaneous sampling)
- Measurement software as per the criteria of 50238-3

## REFERENCES

- CFL
- SNCF

## STANDARDS

- CLC/TC 50238-3 – Compatibility between rolling stock and train detection systems Part 3: Compatibility with axle counters
- PR EN 50592 – Testing of rolling stock for electromagnetic compatibility with axle counters
- Technical specification – ERA/ERTMS/033281 - Interfaces between the “Control-Command and Signalling” sub-system and other sub-systems



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, 125, 153





# 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
- EIFPAGE

## 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  
56, 78, 124



# 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 analyze 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

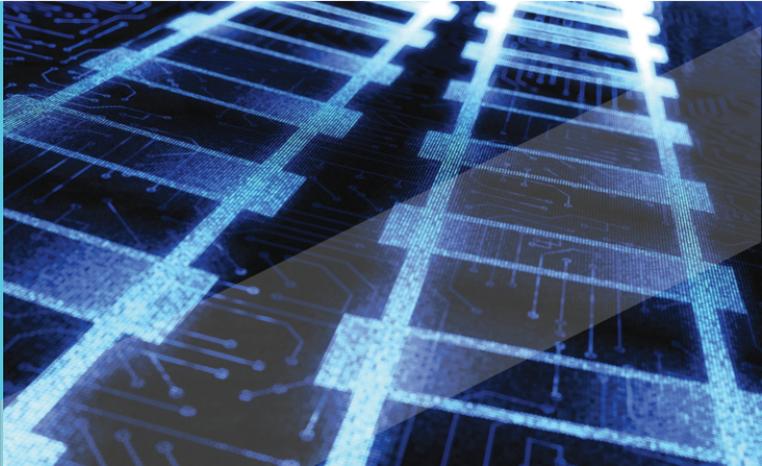
- EIFFAGE
- SNCF-RESEAU

## 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 the DMI (Driver Machine Interface)

 See also page

55





# SIGNALLING VIA TRACK CIRCUITS

Contributing to the type approval process of signalling systems for both new and modified 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 circuits (residual voltage)
- Investigate the causes of track circuit malfunction

## TEST RESOURCES

- Multi-channel data acquisition device
- Device installed on the LUCIE testing car

## REFERENCES

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

## STANDARDS

Domestic reference documents in force

 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  
90, 91





# REMOTE CONTROL OF SUB-STATION ELECTRICAL PARAMETERS – SENTINEL

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

## OBJECTIVES

- Real-time display of the electrical parameters of sub-stations and traction power sub-stations (25 kV – 50 Hz and 1.5 kV – d.c.)
- Detect, record and precisely locate electrical interference phenomena (transmitting warning messages)
- Compare data over time and establish trends
- Automatically identify phenomena such as pumping

## TEST RESOURCES

- 30 measuring sites on the French network: sub-stations, phase separation sections, boosters, etc.
- System for networking measurements recorded in the same power supply sector
- Real-time computing software
- Statistical computing software
- Secure internet access
- Consultable, real-time web interface

## REFERENCES

- SNCB
- SNCF





# TRAIN NUMBER RECOGNITION SYSTEM - SYRENE

Detecting and recognizing the number of a locomotive or power car by means of a camera affixed to an overhead line mast and including this data with the other recordings made along the line.

## OBJECTIVES

- Detect and recognise the number of a locomotive or power car moving along the line, by day and by night
- Associate this data with all the other data measured and recorded lineside

## REFERENCES

- SNCF

## TEST RESOURCES

- Cameras affixed to overhead line masts on conventional and high-speed lines
- Module for optimizing the position of the cameras in relation to the track
- Self-learning system for automatic recognition purposes
- Secure internet access
- Consultable, real-time web interface





# 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

## TEST RESOURCES

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

## REFERENCES

- INFRAPÔLES
- GARES & CONNEXIONS



Electronic control unit



Audio-visual warning device



Remote alarm  
cancellation device



# DYNAMIC MONITORING OF THE OVERHEAD CONTACT LINE

Overhead contact line geometry must be checked on a regular basis to avoid potential incidents. Our system can be placed on any flat unencumbered surface on the rolling stock roof and can be used to check contact wire geometry throughout the trip.

## OBJECTIVES

The system measures overhead line height and stagger using contactless technology

## REFERENCES

- SETRAM
- RATP
- INEO

## 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







BRAKING • BOGIES • AXLES • VIBRATION

CLIMATE • CABLES • PAINT -

CLIMATE • CABLES • PAINT - GLASS PANES

EQUIPMENT • BRAKING

EQUIPMENT • BRAKING • BOGIES • AXLES

CAR BODIES • ASSEMBLIES •

BOGIES • ASSEMBLIES • RADIO • CLIMATE

PAINT - GLASS PANES

N • CAR BODIES • ASSEMBLIES • RADIO  
GLASS PANES • SOFTWARE •  
• SOFTWARE • SAFETY HARDWARE  
• BOGIES • AXLES •  
KLES • VIBRATION  
RADIO •  
ATIC •

# RAILWAY EQUIPMENT

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# 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

- 3 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

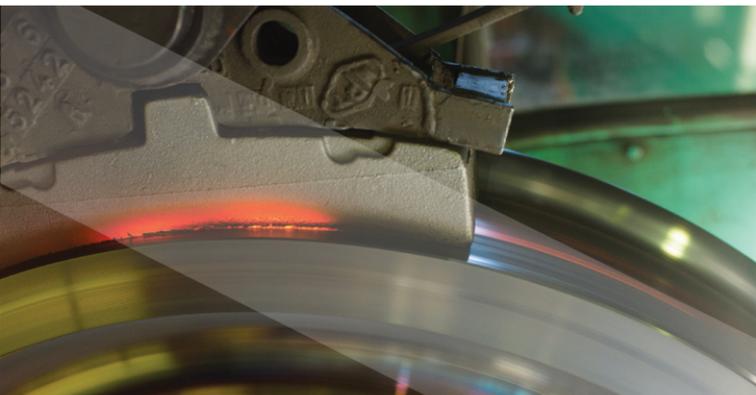
ISO/IEC 17025 awarded by COFRAC

## 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, 23, 117



# 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

## ACCREDITATIONS

ISO/IEC 17025 awarded by COFRAC

## REFERENCES

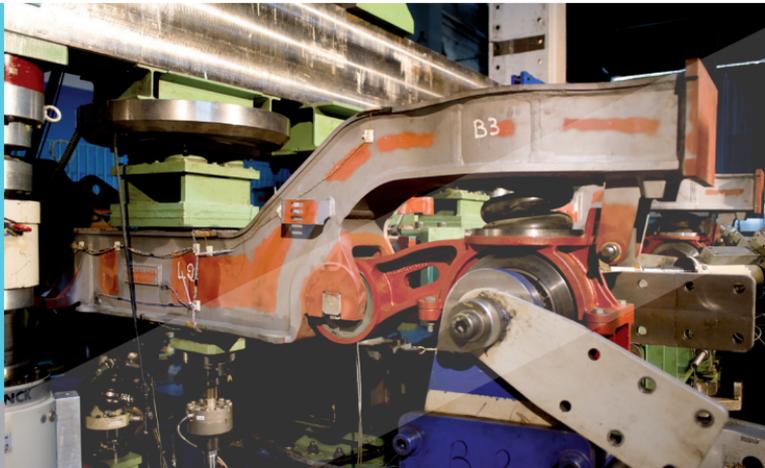
- ALSTOM
- BOMBARDIER
- CAF
- CSR

## 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, 101, 117



# AXLES

Checking and establishing axle dimensions and running gear failure analysis.

## OBJECTIVES

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

## REFERENCES

- ALSTOM
- BOMBARDIER
- CAF
- MG VALDUNES

## 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

## 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

## ACCREDITATIONS

ISO/IEC 17025 awarded by COFRAC



 See also pages  
68, 70, 101, 117



# 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 SEM 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:  $\varnothing 100$ mm ;  $\varnothing 120$ mm ;  $\varnothing 130$ mm ;  $\varnothing 150$ mm
  - other diameters made to order
  - possibility of adding vibration sensors

## ACCREDITATIONS

ISO/IEC 17025 awarded by COFRAC

## REFERENCES

- ALSTOM
- EPK-BRENCO
- KINEX
- NTN-SNR
- NSK
- 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

69, 71, 117





# 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

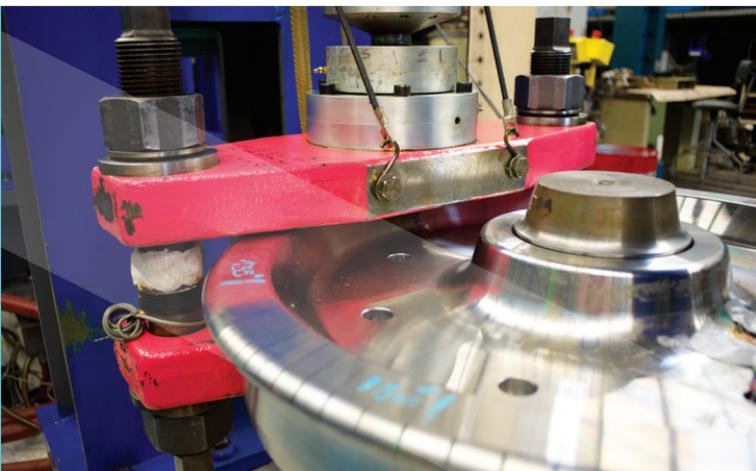
ISO/IEC 17025 awarded by COFRAC

## 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  
70, 108, 117



# 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

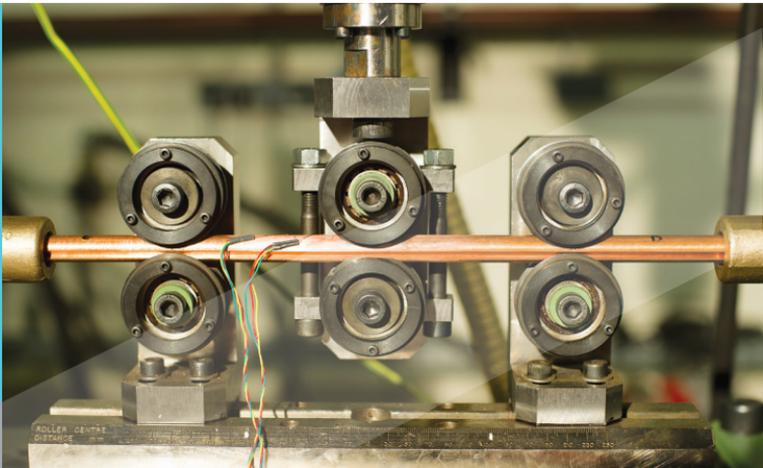
- 6 servo-hydraulic machines for tension and compression testing (from  $\pm 15$  kN to  $\pm 160$  kN)
- 1 servo-hydraulic machine for torsion ( $\pm 5,000$  N.m)
- 3 bending machines ( $\pm 50$  kN)
- Force and displacement sensors on each cylinder
- Parallel measurements for multiple monitoring: extensometry,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

100, 108





# 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



# 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

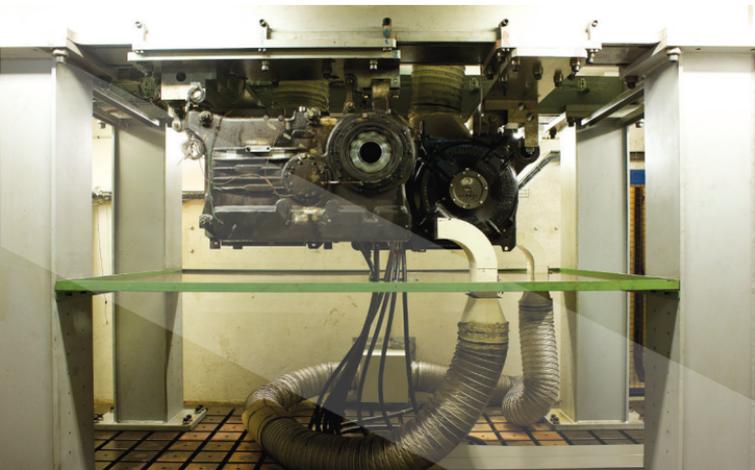
SNCF

## 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



# ELECTRICAL TESTING IN THE LABORATORY

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

## OBJECTIVES

- 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:
  - 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)

## STANDARDS

According to the customer's technical specifications

## TEST RESOURCES

- 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
- Digital data acquisition and processing system
- Voltage and current sensors
- Temperature measurement with or without electric potential
- Retractable roof access platform

## REFERENCES

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

See also page

77



# ELECTRICAL WITHSTAND TESTS

Qualify the performance of electrical insulators and assemblies

## OBJECTIVES

- Assess voltage withstand of materials or finished products
- Identify the creepage distance of an electrical assembly or the breakdown voltage of a component

## TEST RESOURCES

- HV generator 20 KVAC - 70 KVDC



 See also pages  
76, 79



# 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

55, 124





# THERMAL AND AIRFLOW TEST CHAMBER

Validating the temperature control parameters of a railway vehicle.

## OBJECTIVES

- Validate temperature controls on board trains by simulating outside climatic conditions and the presence of people on board
- Conduct investigations, research and development work on temperature control, with either new or renovated vehicles, in order to validate or improve passenger comfort



## TEST RESOURCES

Climatic test chamber capable of:

- Simulation of sunshine, humidity and outside temperature
  - temperature from -20°C to 60°C
  - relative humidity up to 100%
  - sunshine up to 1,200 W/m<sup>2</sup>
- Simulation of human presence by generation of sensitive latent heat
- HT power supply of 1,000 V DC to 2,000 V DC
- Automatic control of the climatic parameters in the test chamber (cyclic)
- Ability to cater for UIC-gauge vehicles up to 30m in length

## REFERENCES

- ALSTOM
- NESTLE WATER
- RATP
- SCHNEIDER ELECTRIC
- SNCF

## STANDARDS

- EN 13129-1 & -2 – Air conditioning for main line rolling stock - Part 1: Comfort parameters - Part 2: Type tests
- EN 14750-1 & -2 – Air conditioning for urban and suburban rolling stock - Part 1: Comfort parameters - Part 2: Type tests
- EN 14813-1 & -2 – Air conditioning for driving cabs - Part 1: Comfort parameters - Part 2: Type tests
- EN ISO 7730 – Ergonomics of the thermal environment - Analytical determination and interpretation of thermal comfort using calculation of the PMV and PPD indices and local thermal comfort criteria





# 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

## ACCREDITATIONS

ISO/IEC 17025 awarded by COFRAC

## REFERENCES

- COMUTITRES
- GEMALTO
- IXXI
- OBERTHUR
- PARAGON GROUP
- RATP
- 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
- 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  
85, 87, 155



# 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, 136



# 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
- 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

82, 83



# 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)

## 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



# LUBRICANTS

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



## 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
- Rheology
- Thermogravimetric analysis (TGA)

## ACCREDITATIONS

ISO/IEC 17025 awarded by COFRAC

## REFERENCES

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

## STANDARDS

Applicable standards according to customer requirements



# 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

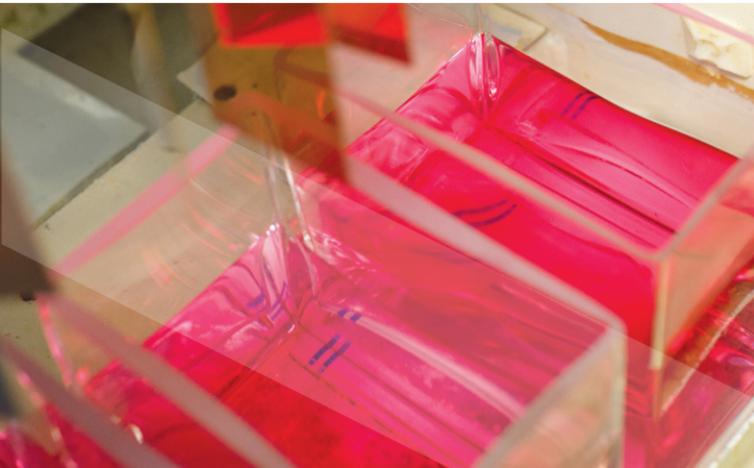
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## TEST RESOURCES

- 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 page

107



# 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, 38, 140, 141



# ASSESSMENT OF SAFETY-CRITICAL SOFTWARE

Evaluating the safety demonstration of safety-critical software used in the railway sector.

## OBJECTIVES

Demonstrate or assess the performance of safety-critical software (EN 50128 - SIL 3, 4) for CBTC ground and onboard equipment, computer-based interlockings, platform screen door control system, etc.

## TEST RESOURCES

- OVADO®
- Atelier B (B-Method)
- Prover CERTIFIER
- Polyspace
- Test benches

## ACCREDITATIONS

ISO/IEC 17020 awarded by COFRAC, Programme 152

## REFERENCES

- ALSTOM
- RATP
- SNCF-RÉSEAU
- SIEMENS
- Storstockholms Lokaltrafik (Stockholm)
- THALES

## STANDARDS

EN 50128 – Railway applications - Communication, signalling and processing systems - Software for railway control and protection systems

See also pages

58, 91





# 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

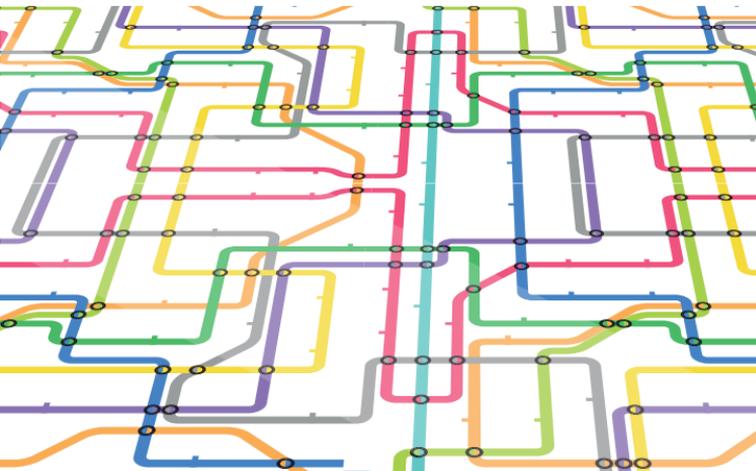
- ANSALDO
- AREVA
- RATP
- SIEMENS

## STANDARDS

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

## TEST RESOURCES

Electronics laboratory



 See also pages  
58, 90



# 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

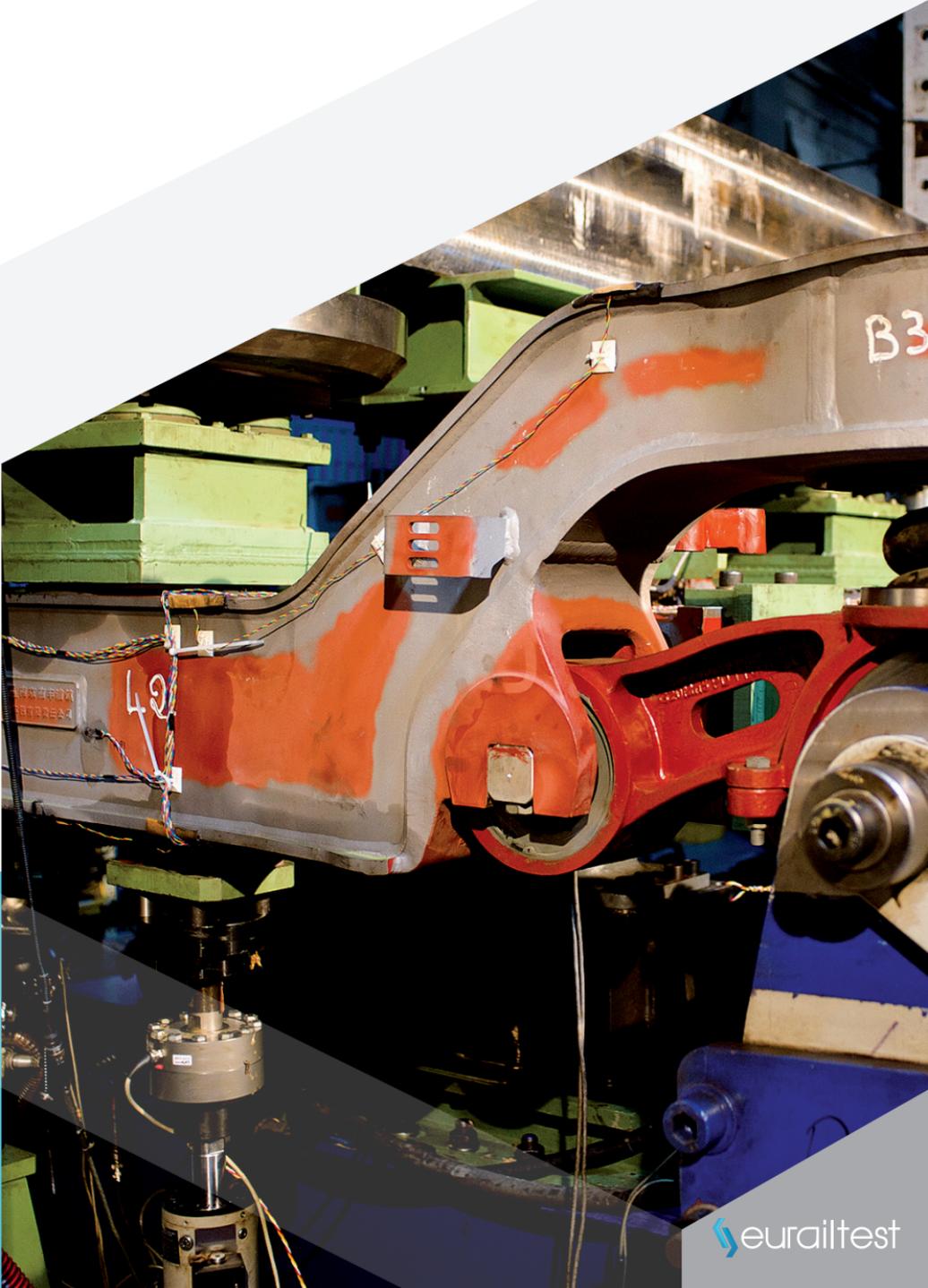
## REFERENCES

- CLERE
- COSEA
- SYSTRA
- BOMBARDIER CRESPIN

## TEST RESOURCES

- ESVE box









## 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
- Physico-chemical
- Electrical
- Acoustical
- Health, Safety and Environment (HSE)

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

LES • CURRENT COLLECTOR SHOES • BRAKING  
ING • WHEEL-RAIL CONTACT  
RESISTANCE TO MOTION • RESIDUAL STRESSES  
• RESIDUAL STRESSES •  
LURES • DROP SHUNTING  
T COLLECT  
IALS

MECHANICAL

MECHANICAL





# 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, 101



# 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.
- Shakers (various frequencies)

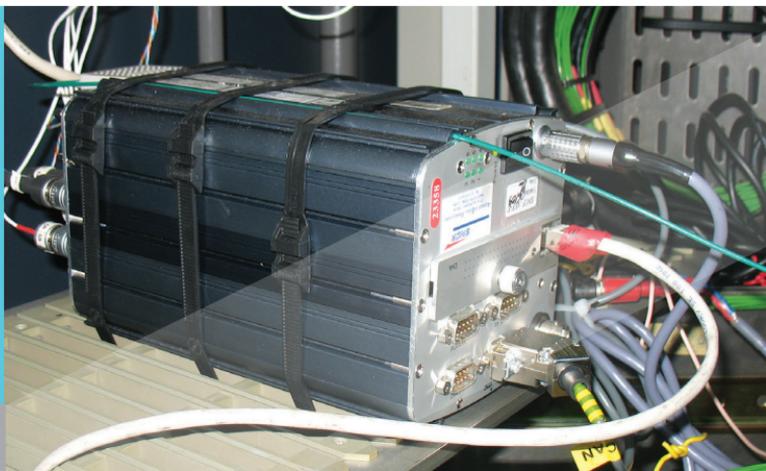
## REFERENCES

- 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, 102, 108





# 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-tired 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, 99



# 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

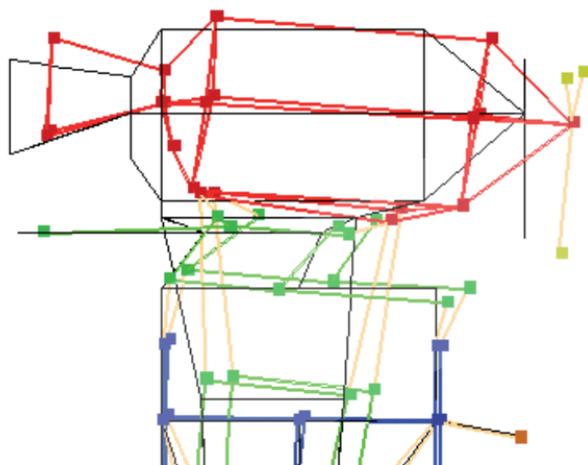
- Piezoelectric accelerometers
- Impact hammers
- Electrodynamic exciter
- Modal analysis software « LMS TEST LAB »

## 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

100





# 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





# 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 page

34

# 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-RÉSEAU
- SNCF
- SYSTRA

## STANDARDS

EN 14067 – Railway applications - Aerodynamics



 See also pages  
43, 44, 46



# 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 Metro
- RATP

## TEST RESOURCES

- Video cameras
- Obstacle detection device
- Doppler radar

 See also pages

30, 31, 32, 47, 48



# 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

88



# 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

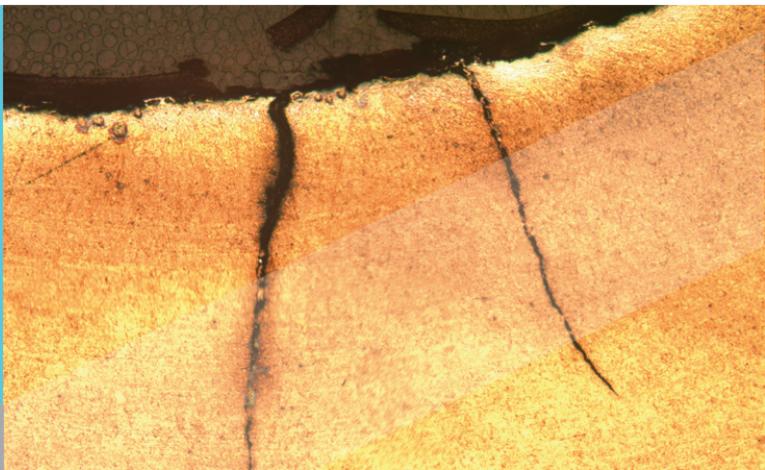
Laboratory of metallurgy and mechanical characterization

## REFERENCES

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

See also pages

71, 72, 100, 109, 110



# 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

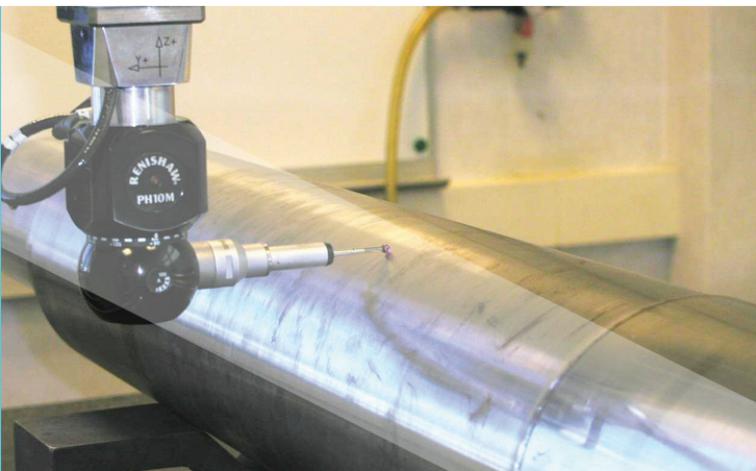
- 3D measuring machine (Tri-mesures)
- Profile projector
- Measuring column
- Numerous other measuring devices: micrometers, gauges, roughness testers, etc.

## 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

108



# 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

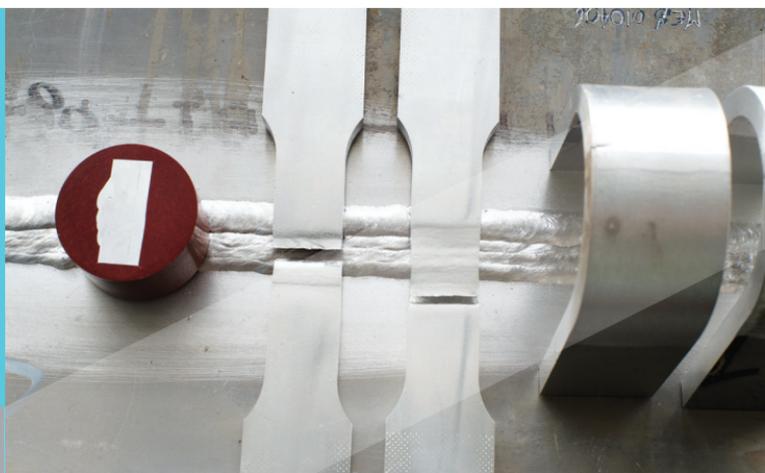
- EN 15085 - 1 to 5 – Welding of railway vehicles and components
- EN ISO 15614 – Specification and qualification of welding procedures for metallic materials - Welding procedure test

## 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

108, 111, 115





# 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  
108, 110



# 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



# 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 finalisation process
- Qualify parts or components according to technical requirements or specifications
- Analyze 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



See also pages  
108, 115



# RESIDUAL STRESSES

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 page

115



# 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

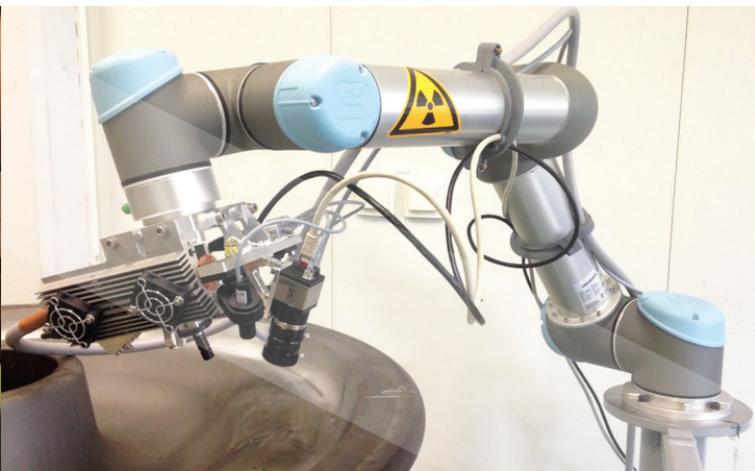
- iXRD MGR 40: portable system used for in situ measurements
- X-RayBot: Portable device for on-site measurements

## 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

110, 113, 114



# 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 RESOURCES

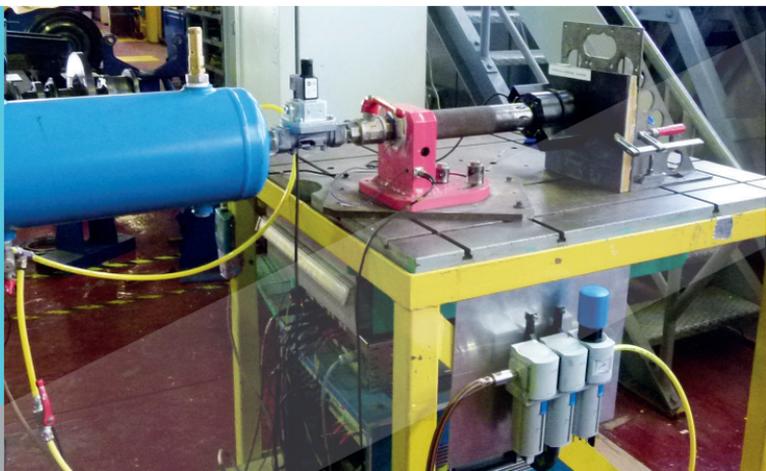
- Pneumatic test bench capable of projecting ballast at different speeds
- Climatic chamber to prepare samples for testing at different temperatures
- Pressure sensor to set impact force
- Speed recorder to check impact speeds up to over 300 km/h

## REFERENCES

- HUBNER
- BOMBARDIER
- ALSTOM
- CYTEC
- SIEMENS

## STANDARDS

- NF F 07-101 – Flying ballast impact simulation
- Norme 19293 – NF F 07-101 - 2002-03



# 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 (CFCM/COFREND)

## TEST RESOURCES

- Ultrasonic immersion inspection tank
- Magnetic particle test bench
- Wheel control test bench with magnetic particle testing
- Probes and other devices

## ACCREDITATIONS

COFREND certification according to EN 473 and ISO 9712 standards

## 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

VIBRATION • COMFORT • FATIGUE • AX  
CURRENT COLLECTOR SHOES • BRAK  
• WHEEL-RAIL CONTACT • PANTOGRAPH •  
PH • RESISTANCE TO MOTION •  
ELECTRICAL PERFORMANCE • CAUSES OF FA  
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RESISTANCE TO MOTION • RESIDUAL STRESSES  
• RESIDUAL STRESSES •  
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ELECTRICAL





# 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

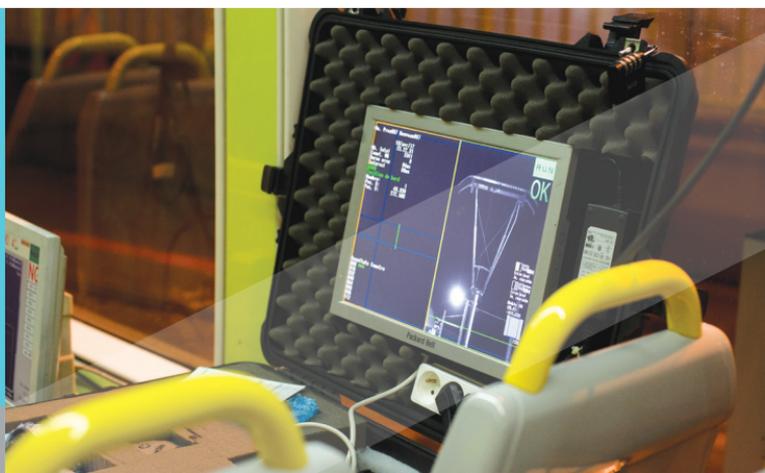
## STANDARDS

- 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  
58, 121, 122





# 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
- MORS SMITT

## 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, 120, 122, 126



# 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.

## TEST RESOURCES

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

## REFERENCES

- SNCF
- RATP

## STANDARDS

- EN 50163
- EN 50388

See also pages

34, 120, 121, 126, 127





# REMOTE SURVEILLANCE OF FEEDER STATIONS

Checking the quality of power supply over a long period of time and ensuring real-time reporting in the event of abnormal phenomena.

## OBJECTIVES

- Measure current and voltage from sub-stations
- Perform signal processing
- Send e-mails including examples of interference signals
- Display electrical parameters in real-time on a website

## REFERENCES

- KEOLIS LYON
- RATP
- SNCF

## TEST RESOURCES

- Voltage sensor
- Amperometric clamp
- Data acquisition board
- SENTINEL software
- 3G Modem

 See also pages  
49, 50, 51



# 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-RÉSEAU
- SNCF
- 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

55, 78



# 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





# 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

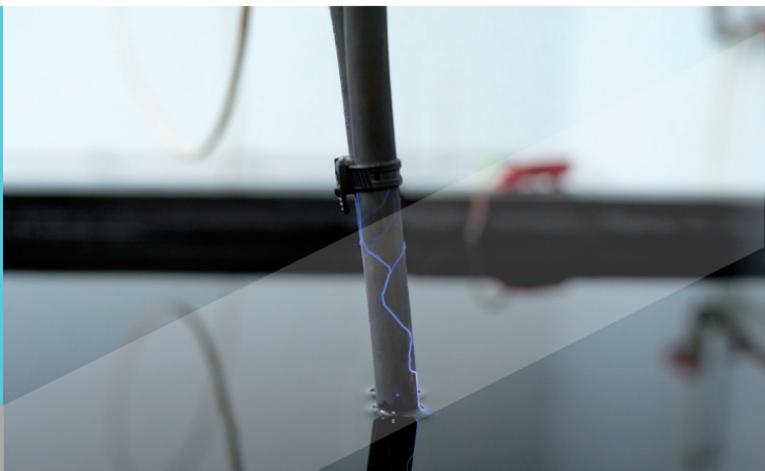
## REFERENCES

- BOMBARDIER
- ALSTOM
- COMECA
- EDILON SEDRA
- MERSEN
- PREFARAIL
- SEA Abrasif
- STUR (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  
120, 121, 122





# 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  
120, 122



# REMOTE MEASUREMENTS

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

## OBJECTIVES

- Collection of large volumes of data in regular operating conditions for statistical purposes
- Specific processing for infrequent occurrences requiring long-term monitoring to locate their geographical position and identify the conditions in which they occur

## TEST RESOURCES

- All types of sensors
- SPU-Box / QMR-X

## REFERENCES

- MA42100





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• WHEEL-RAIL CONTACT • PANTOGRAPH •  
PH • RESISTANCE TO MOTION •  
ELECTRICAL PERFORMANCE • CAUSES OF FA  
• DROP SHUNTING • CURREN  
• ELECTROMAGNETIC COMPATIBILITY • MATER  
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RESISTANCE TO MOTION • RESIDUAL STRESSES  
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# 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

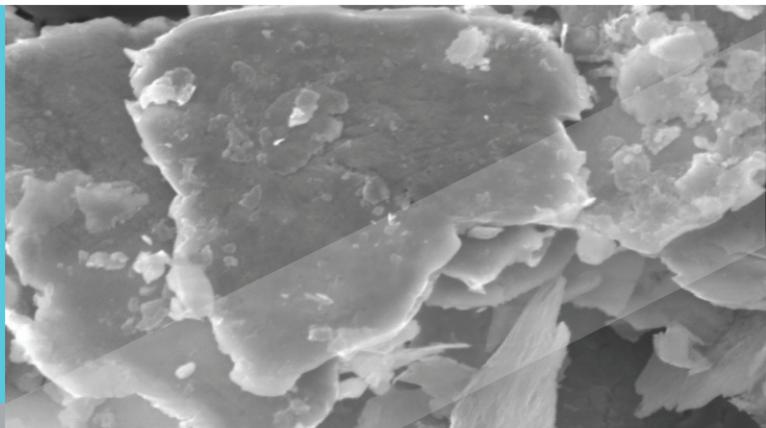
## TEST RESOURCES

- 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, 134, 135





# 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

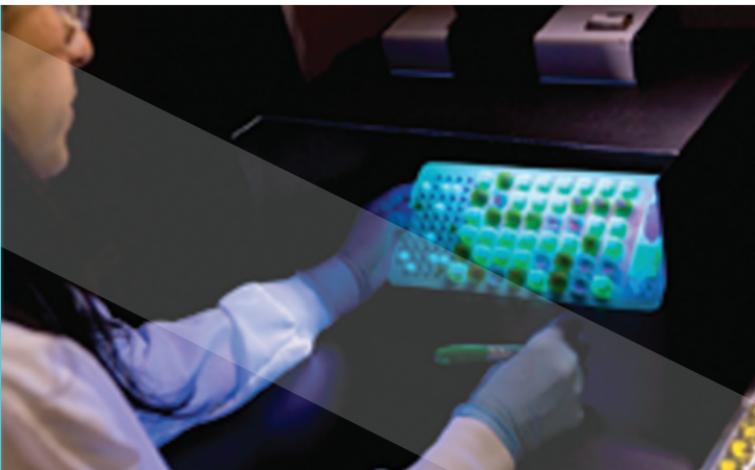
- ISO/IEC 17025 awarded by COFRAC

## 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 pages

137



# METAL MATERIAL EXPERTISE

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

## REFERENCES

- RATP
- SNCF

## TEST RESOURCES

- Analytical coupling TGA / GC-MS – Thermo Gravimetric Analysis
- Infrared spectrometry
- Plasma spectrometry (ICP)

See also pages

132, 135



# 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

## STANDARDS

- EN 13913 & STM R 702 – Rubber suspension components - Elastomer-based mechanical parts
- NF F00-071 – Moulded parts in compact rubber
- NF F00-072 – Extruded parts in compact rubber
- NF F11-380 – Flexible rubber-based hoses for compressed air
- EN 15807 – Pneumatic half couplings
- STM D-001 & D-002, STM D-050, STM F-024, STM F-602, STM D-802 & D-803

## 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

132, 134



# 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

See also page

83



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

Providing expertise with regard to waste water and micro-pollutants from railway 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><sup>-</sup>, NO<sub>3</sub><sup>-</sup>, metal elements (Al, Fe, Cu, Pb, Ni, Cr, Mn...), ASA, Alkyphenols, 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 pages

133

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CURRENT COLLECTOR SHOES • BRAK  
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# 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

 See also pages

36, 37, 38, 89, 141



# 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, 38, 89, 140

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CURRENT COLLECTOR SHOES • BRAK  
• WHEEL-RAIL CONTACT • PANTOGRAPH •  
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# HEALTH, SAFETY AND ENVIRONMENT

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# WORKPLACE NOISE

Checking that level of daily noise exposure of personnel in the workplace complies with relevant standards and regulations, and improve 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
- Analyze 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 ISO 4869-2 – Hearing protectors – Part 2: Estimation of effective A-weighted sound pressure levels when hearing protectors are worn
- Labour Code applicable
- Order of 11 December 2015
- 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, 38, 89, 140, 141



# 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

146



# 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
- NF EN ISO 28927 (all parts from 1 to 8)

See also page

145



# WORKPLACE AIR QUALITY – OCCUPATIONAL HAZARDS

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

## OBJECTIVES

- Study workstations
- Define sampling strategies specific to individual measurements
- Define measurement strategies to be performed in the ambient atmosphere
- Estimate level of exposure to chemical agents present in the air: particles, wood dust, fibres (asbestos, glass fibres, refractory ceramic fibres), metals, silica, hydrocarbons, gases, etc.
- Measure concentration 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
- Chemical hazards: COFRAC reference document LAB REF 27
- Asbestos: COFRAC reference documents LAB REF 26 and 28

## TEST RESOURCES

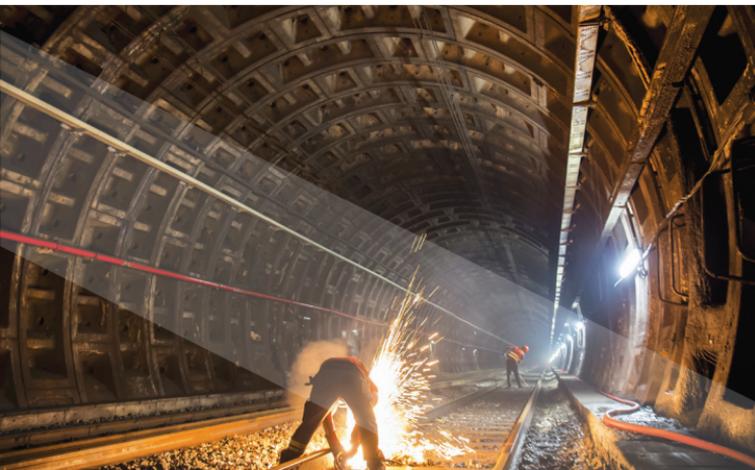
- Sampling probes
- Sampling devices for recording air on operators
- Sampling devices for recording air at fixed points

## REFERENCES

- ADP
- EUROFINS
- RATP
- TSO
- ASTEN
- LAFARGE
- SFP

## STANDARDS

- EN ISO 16000-7 and its application guide GA X46-033
- French Labour Code – Order and decree No. 2009-1570 of 15 December 2009
- French Labour Code – Decree No. 2012-639 of 4 May 2012 and order of 14 August 2012
- French decree No. 2013-594 of 5 July 2013
- French Circular DGT 2010/03 of 13 April 2010
- NF X 43-050, NF X 43-257, NF X 43-262, NF X 43-264, NF X 43-267, NF X 43-275, NF X43-294, XP X 43-269, etc.



 See also pages

148, 149, 150, 151, 152



# 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 in conducting work where there is a risk of exposure to asbestos
- Support them in their choice of technical solutions
- Take the statutory air samples (Labour Code, Public Health Code)
- Interact with the Unions

## TEST RESOURCES

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

## REFERENCES

- AREP
- PARVIS

## ACCREDITATIONS

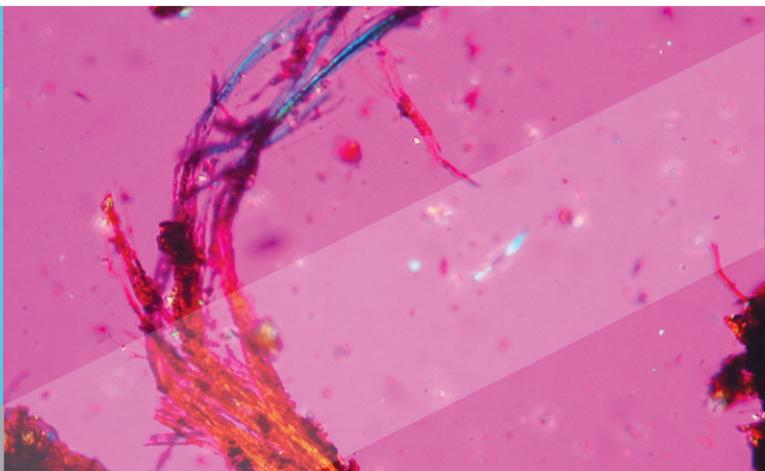
- COFRAC according to the NF EN ISO 17025 standard
- Asbestos: COFRAC reference documents LAB REF 26 and 28

## STANDARDS

- Labour Code – Decree 2012-639 of 4 May 2012 – Order of 14 August 2012 – Decree 2015-789 of 29 June 2015
- NF 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, 144, 145, 146





# TUNNEL AIR QUALITY - OCCUPATIONAL HAZARDS

Monitoring air quality in tunnels during construction or maintenance work.

## OBJECTIVES

- Continuously monitor gas concentrations ( $O_2$ ,  $CO/CO_2$ ,  $NO_x$ ,  $SO_2$ ,  $H_2S$ ) and check that threshold limit values during construction work are not exceeded (alerts)
- Control occupational exposure to chemical agents (diesel particulates, respirable dust, crystalline silica, metals, etc.)
- Check air renewal in tunnels

## TEST RESOURCES

- Gas detectors
- Anemometer
- Individual sampling probes
- Sampling devices for recording air on operators
- Sampling devices for recording air at fixed points

## REFERENCES

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

## ACCREDITATIONS

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

## STANDARDS

- French Labour Code
- French circular of 9 May 1985 regarding the technical review of decrees 84-1093 and 84-1094 of 7 December 1984
- French orders of 8 and 9 October 1987
- LAB REF 27



 See also pages

147, 148, 150, 151, 152



# 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 – 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...

See also pages

149, 151





# UNDERGROUND AIR QUALITY - EXPOSURE OF THE PUBLIC AT LARGE

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<sub>10</sub> and PM<sub>2.5</sub> (particulate matter)

## TEST RESOURCES

- Stationary analyzers : CO<sub>2</sub>, NO<sub>x</sub> and particles
- Stationary analyzers
- Vehicle laboratory
- GSM connections
- Continuous sites SNCF
- Measuring racks (TEOM)

## ACCREDITATIONS

ISO/IEC 17025 awarded by COFRAC

## REFERENCES

- RATP
- RATP Réseau SQUALES
- SNCF
- TCL (Lyon)

## STANDARDS

- NF X20-380 – Gas analysis - Carbon dioxide analysis - Guide for the choice of the analysis methods
- NF X43-044 – Air quality - Ambient air - Determination of carbon monoxide (CO) by infrared absorption - Gaseous filter correlation method



 See also pages  
148, 149, 150, 152



# 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

 See also pages

147, 149, 151



# 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, 125



# 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 Technicentre

## 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

## REFERENCES

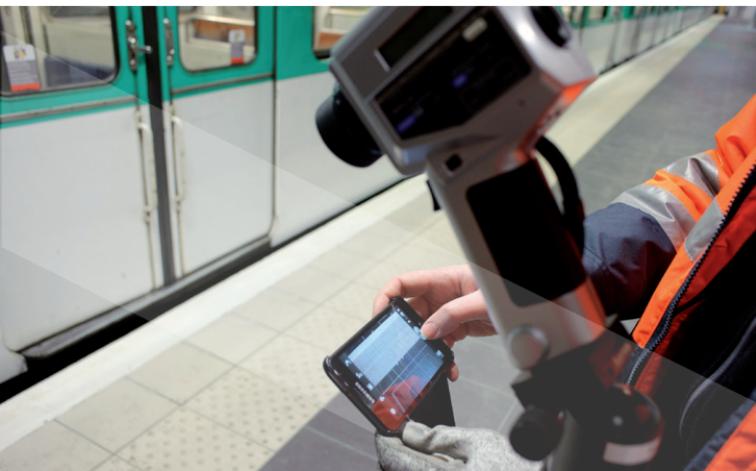
- DG Construction
- General Council of Hauts-de-Seine (nearParis)

## TEST RESOURCES

- Luminance meter
- Lux meter

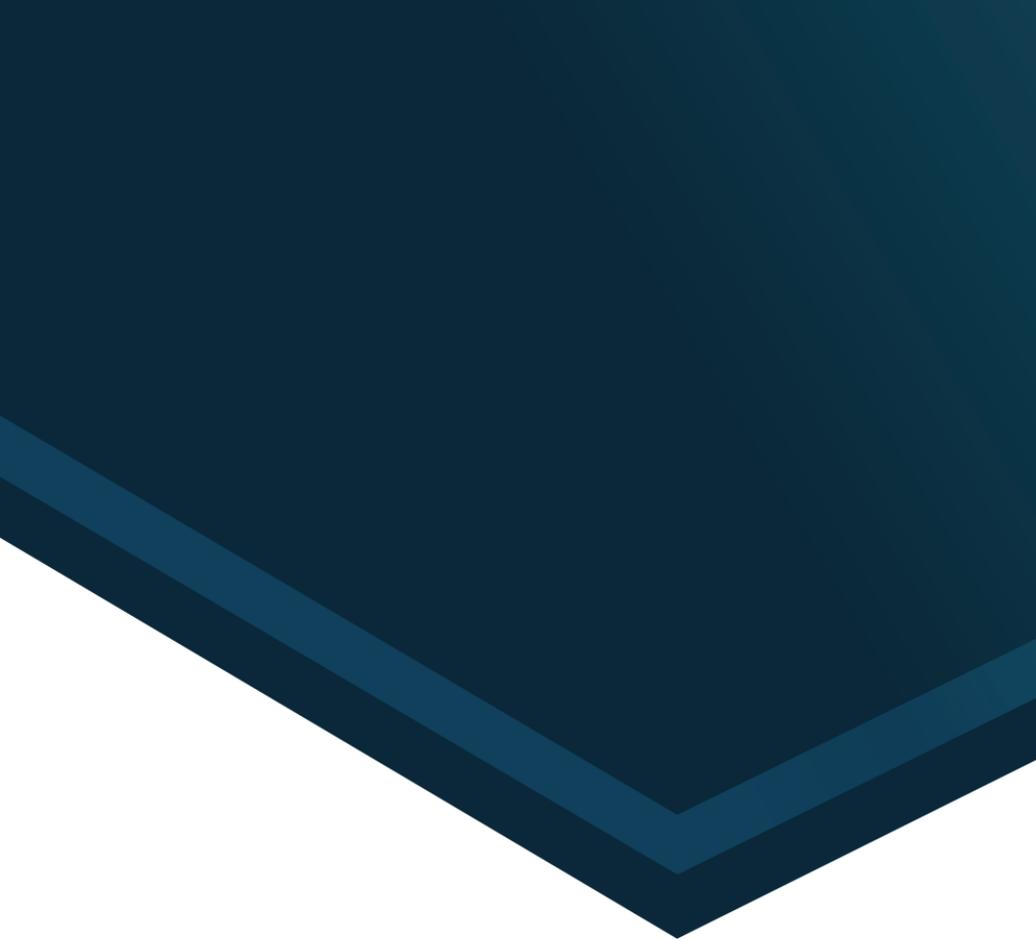
## STANDARDS

- 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, 155
- Acoustics
  - Industrial sites .....141
  - Intelligibility .....38
  - Inside and on-board .....37, 38
  - Outside noise - Residents....36, 37, 140
  - Safety equipment .....89
  - Workplace .....144
- Aerodynamics .....35, 104, 105
- Air quality
  - Control in the emission.....67
  - Tunnel.....149
  - Underground areas .....151
  - Ventilation and air filtration .....150
  - Workplace .....148
- Anti-tag.....85
- Asbestos .....147, 148
- Axles.....18, 69, 71
- Axle boxes.....70

**B**

- Bearings .....70
- Bogies .....68, 71, 101, 114
- Bolted assemblies.....72, 111
- Braking
  - Components .....22, 67
  - On open line .....21, 22
  - Test rig .....25, 67

**C**

- Cables.....81, 83, 136
- Cleaning.....81, 85, 87, 132
- Climate .....79, 88
- Coatings .....81
- Comfort
  - Climatic .....79
  - Vibratory.....98
- Contactless cards .....80
- Current collection
  - On track .....30, 31, 46, 48, 104
  - Stationary test bench .....32, 33
- Current collector shoes.....103

**D**

- Dependability .....58
- Detonators .....89

- Diffraction .....114, 115
- Dimensional control.....69, 71, 109
- Doors .....107
- Drop shunt .....24, 25
- Dye penetrant testing.....117

**E**

- Electric traction power supply .....26, 49, 125, 127
- Electrical equipment .....76
- Electrical insulation.....100, 101
- Electrical performance .....76, 120
- Electromagnetic compatibility .....26
- Electromagnetic field
  - Human exposure .....28, 153
  - Modelling and expertise .....125
  - Railway system .....54
  - Rolling stock .....27, 53
- Electromagnetic interference.....29, 125
- Electronic wheel detectors .....52
- Energy meter .....121
- Equipment
  - Metal.....72, 113, 134, 155
  - Running gear...67, 68, 69, 70, 71, 72, 117
- ERTMS.....55, 56

**F**

- Failures.....43, 67, 70, 71, 72, 75, 86, 100, 108, 109, 110, 111, 113, 114, 115, 134, 135
- Fatigue
  - Characterization .....19, 72
  - Vibration.....88, 100, 108
- Fire & smoke .....82, 83, 84

**G**

- Geared motors .....75
- Glazing .....61, 68
- Graffiti.....81, 85, 132
- GSM-R.....55, 78

**H**

- Heat-shrink tubing .....82
- Human exposure.....28, 153

**I**

- Infrastructure.....30, 35, 43, 44, 45, 46, 120, 125
- Infrastructure-rolling stock interaction ..122

- L**  
Lighting..... 155
- M**  
Magnetic particles ..... 117  
Materials ..... 72, 81, 84, 113,  
126, 132, 134, 135  
Modal analysis ..... 102
- N**  
Non-destructive testing ..... 67, 68, 69, 70,  
71, 72, 117
- O**  
Occupational exposure..... 145, 148, 149  
Overhead contact line (OCL)  
Interaction with pantograph..... 30, 31,  
32, 46, 47, 48  
Uplift ..... 48
- P**  
Paint..... 81, 85, 116, 132, 150  
Pantograph  
Gauge ..... 31, 106  
Instrumented pantograph..... 31  
Video-based obstacle detection ..... 104  
Pantograph-OCL interaction..... 30, 31,  
32, 46, 47, 48  
Petrochemicals ..... 86  
Physical and chemical properties ..... 117,  
132, 133, 134, 135  
Polymers ..... 134  
Power supply ..... 54, 123
- R**  
Radio ..... 55, 78, 124  
Radio coverage ..... 124  
Railway dynamics ..... 17, 18, 19,  
69, 71, 101  
Residual stresses ..... 65, 69, 110,  
113, 114, 115  
Roll flexibility coefficient..... 99  
Rolling resistance ..... 34, 35, 103  
Rolling stock  
Electrical performance ..... 120  
Weighing ..... 20  
Rubber..... 135
- S**  
Safety  
Electrical ..... 49, 51, 127  
Hardware ..... 58, 91  
Software ..... 58, 90  
Safety-critical software ..... 90  
Safety hardware & equipment .58, 89, 91  
Signalling ..... 26, 29, 51, 57, 58, 90, 91  
Skidding ..... 81  
Structures ..... 45, 105
- T**  
Testing  
Climatic ..... 79  
Electrical ..... 76  
Thermal & airflow ..... 79  
Ticketing ..... 80  
Track  
Behaviour..... 46, 105  
Measurements ..... 105  
Rail and turnouts ..... 43  
Track components ..... 44  
Traction current..... 50, 51  
Traction drive ..... 34
- U**  
Ultrasonic..... 43, 69, 71, 110, 111,  
114, 117
- V**  
Vehicle components..... 100  
Vehicle structure  
Mechanical resistance ..... 73  
Torsional rigidity of car bodies ..... 74  
Vibration  
Hand-arm ..... 146  
Whole-body ..... 145  
Vibratory ..... 98, 100, 102, 108, 140  
Visual contrast ..... 81, 155
- W**  
Water ..... 133, 137  
Welded assemblies ..... 72, 110  
Wheels ..... 18, 67, 71, 105, 114, 117  
Wheel-rail contact..... 18, 19  
Wheel slide protection..... 23  
Weighing ..... 20



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