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# VIRTUAL VALIDATION FOR CERTIFICATION

# Virtual Brake Performance Testing

On-track testing in the commissioning and authorization phase of railway vehicles shall ensure that the rolling stock and railway systems are compliant with relevant standards and regulations. However, physical tests have become increasingly difficult. The reasons include

- rising approval volumes,
- limited resources, e.g. access to equipment, test infrastructure,
- time and cost pressure for manufacturers,
- changing environmental conditions.

**Virtual Validation for Certification (VV4C)** addresses these challenges and presents a customizable solution to vehicle manufacturers. The product is designed to determine the brake performance of railway vehicles through combined virtual and physical testing.

Knorr-Bremse has experience with digital twin technology in many areas. Function and performance tests for doors, climate control and braking systems have been carried out as part of the development phase since 2017. As part of Europe's Rail Joint Undertaking (EU-Rail), this will be supplemented by the commissioning and approval of vehicles by 2027.

## Customer benefits

- Reduced number of required track tests
- Significant cuts of certification effort
- Shorter time-to-market
- Trustworthy simulation through...
  - Market-leading product quality & safety
  - Reliable statistical methods to control occurring uncertainties
  - Decades of experience in construction, manufacturing, and service of railway vehicle braking systems

## Applications

The product supports the design, commissioning and authorization phases for

- Regional & commuter trains
- High-speed trains
- Metros
- Light rail vehicles
- Locomotives
- Others

<sup>[1]</sup> The technology- and innovation program EU-Rail aims to speed up the shift from road to rail and supports a wide range of mobility-focused innovations. To achieve this goal, the major players in Europe's rail industry are pooling their respective areas of expertise. However, the views and opinions expressed in the paper are solely those of Knorr-Bremse and do not necessarily reflect those of the European Union or EU-Rail. Neither the European Union nor EU-Rail can be held responsible for the content.

## Product variants

VV4C is a configurable product that can be tailored to customer needs. Possible variants include:

Product variant	Responsibility	Description
As a Service	Knorr-Bremse	Virtual testing report delivered by Knorr-Bremse for use in authorization process
As a Platform	Knorr-Bremse & Customer	Preserved intellectual property: Customer vehicle model and Knorr-Bremse brake system model
As a Tool	Customer	Tailor-made software library provided by Knorr-Bremse

## Quality management

As an innovation leader, Knorr-Bremse takes a pioneering position and participates in the standardization of digital twins and virtual testing approaches. Knorr-Bremse aims at the provision of accredited, best-in-class services to support the entire authorization process related to brake performance.

## Statistical methods

Knorr-Bremse uses reliable statistical methods to determine the combined uncertainty of all relevant components of railway vehicles with respect to braking.

