

CASE STUDY

France

Bosch – Drancy, France
Brake NVH Testing

Automotive

PULSE, Transducers

The world-renowned Bosch group is a major producer of a vast range of automotive components. The company is an OEM supplier of brakes to many of the world's leading automotive manufacturers.

Brake components are sent to the NVH Bench Testing department at the Bosch facility at Drancy, France, from Bosch manufacturing plants all over Europe. Six brake testing dynamometers are installed at Drancy. Each has a dedicated PULSE™ Multi-analyzer for data collection and analysis.



Automotive Components

The Bosch group is a supplier of automotive components to vehicle manufacturers throughout the world. The company is an OEM supplier of brakes to many of the world's leading automotive manufacturers.

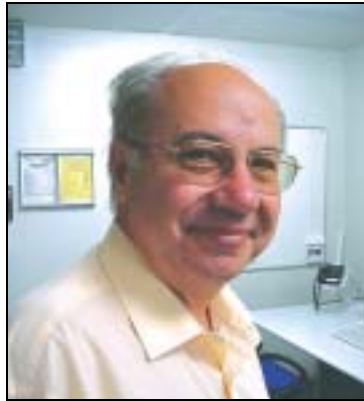
Braking Systems

Braking systems are a key market and brake components are supplied as OEM equipment to automotive manufacturers including Mercedes, Toyota, PSA, Renault, Ford, Jaguar, and Audi.

Bosch brake manufacturing plants throughout Europe send brake components and brake systems for testing and analysis to the NVH Bench Testing Department at the Bosch facility at Drancy, on the outskirts of Paris. The Drancy facility is one of Europe's leading centres for brake design and testing.

NVH Bench Testing

*Fig. 1
Dr. Luc Delage is
the Group
Manager of NVH
Bench Testing,
Engineering
Services at Drancy*



Some thirty people are employed in NVH brake testing at Bosch, Drancy and there's a wealth of highly qualified experience.

Dr. Luc Delage is the Group Manager of NVH Bench Testing, Engineering Services at Drancy. Dr. Delage has a Ph.D. from the University of Bordeaux. His thesis subject was thermodynamics. Prior to joining Bosch nearly five years ago, he worked in the NVH testing department of the Valeo Group and for the US-based Allied Signal group where he was involved in the development and testing of friction materials.

*Fig. 2
Thibault Hoguet is
an engineer in the
NVH Bench Testing
department*



Thibault Hoguet is an engineer in the NVH Bench Testing department. Thibault has a degree in engineering from ESTACA – each year, the university awards degrees to no more than 160 engineers that are specialists in the automotive, aeronautical, space and railway industries.

Dr. Delage says, “We needed a test system that could be used by everyone, even mechanics with no NVH experience. We have successfully used Brüel & Kjær transducers for more than 10 years and it was natural for us to work on the project together”.

Dr. Delage continues, “Starting in 1998, we combined our experience in brake testing with Brüel & Kjær's competence. They could recognise squeal frequencies at very low levels, which other potential suppliers couldn't, and they offered us a cost-effective solution. Together we developed the dedicated brake squeal test software that is used today. It's continuously updated – our goal is to always have the most advanced, state-of-the-art test system, and this is a key factor in Bosch remaining a market leader in our industry. We have the best possible brake squeal detector”.

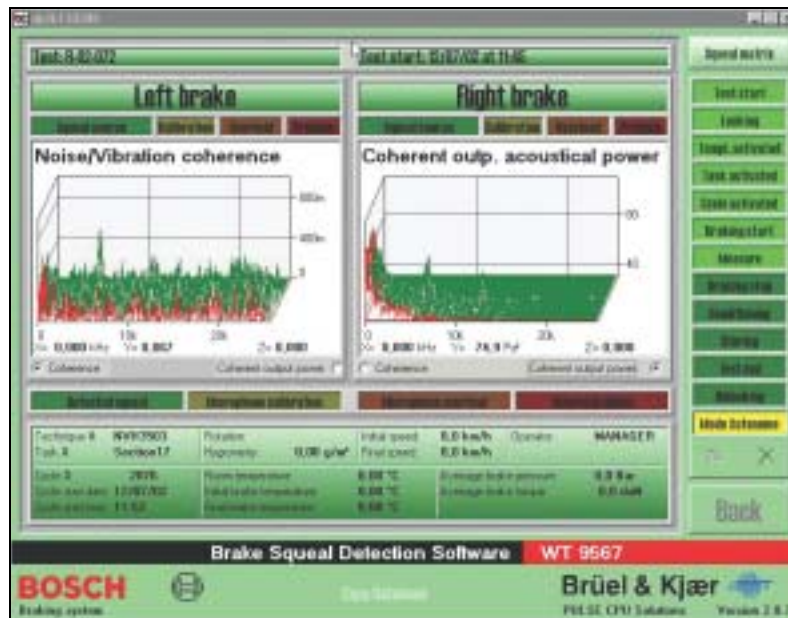
“Before adopting PULSE and the dedicated software, external noise for the vehicle transmission, noise from the dyno and road surface was a significant problem, especially at low frequencies”.

The NVH performance of vehicle braking systems is a critical aspect of the customer's perception of the vehicle. As such, it is crucial that NVH evaluations are able to replicate road noise performance on the vehicle. Drancy tests brakes and brake components for passenger cars and light trucks. Brake systems for large vehicles are tested at other facilities.

Dr. Delage explains, “Brakes and braking systems are driven by the automotive manufacturers. Of course safety and reliability are vital factors and brake noise is a leading warranty issue with all vehicle manufacturers, so we work closely with them during the development of new models. In addition to testing prototype and production brake components from our manufacturing plants, we also make benchmark tests on the brakes of our competitors”.

PULSE

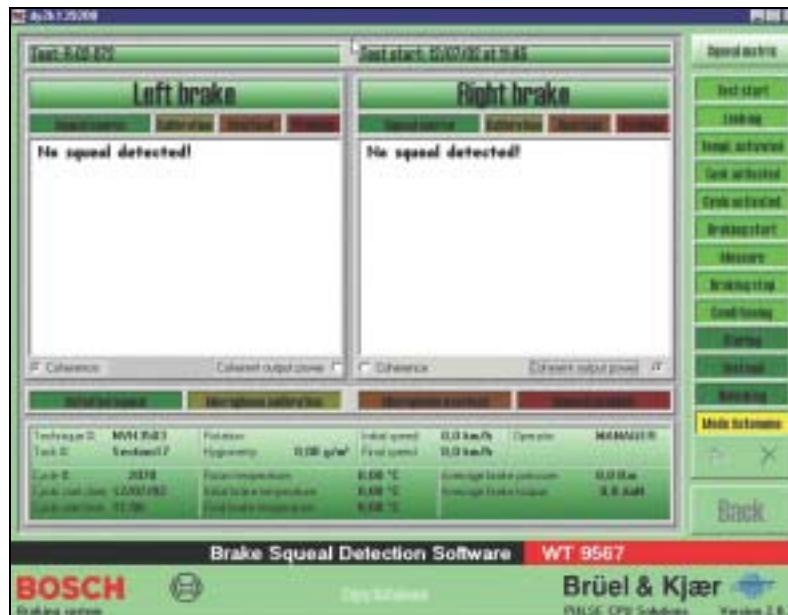
Fig. 3
 During a brake test cycle the brake noise vs. rpm or time is shown real-time on the screen of the test system



There are currently six brake-testing dynamometers installed at Drancy. Each has a dedicated PULSE Multi-analyzer for data collection and analysis. Thibault Hoguet says, “Now with PULSE and the dedicated software, brake NVH testing is a very automated process”. The software interface is in English enabling the system to be used in various countries.

Bosch, Drancy has a seventh PULSE system. If a test requires more channels, then two (or more) PULSE analyzers can be stacked. “This is a very useful and flexible feature”, says Thibault. A further brake testing dynamometer, together with its PULSE analyzer and software, is installed in the Bosch plant at Stuttgart, Germany.

Fig. 4
 In this example, no squeal has been detected



Thibault continues, “I think PULSE is easy to learn and to use. It’s very intuitive”.

Drancy currently has dynamometers manufactured by Schenk, Clemessy and Jurid. “The dedicated PULSE software easily integrates with the systems from different dyno suppliers and this is a great advantage” says Dr. Delage.

In addition to PULSE, Drancy also uses Brüel & Kjær power amplifiers, many Type 2635 Charge Amplifiers and accelerometers for quick troubleshooting tests. Drancy uses Brüel & Kjær transducers exclusively.

Thibault adds, “I worked very closely with Brüel & Kjær in Denmark while we were jointly developing the software. Now we are supported by the Brüel & Kjær French office, and I can say that their backup and service is excellent”.

Testing Processes

Testing at Drancy is focused on NVH. Brake performance testing is carried out at other Bosch locations. The chassis dynos are equipped with two metre diameter drums that simulate the road surface. The road belts are very wide and therefore provide excellent contact with the surface of the vehicle tyre. The brakes on one axle, either the front or rear, can be tested on both axles simultaneously providing they are run at the same speed.

The NVH Project Manager specifies the specific tests that are required and defines the testing parameters. A normal test uses three transducers – a microphone accurately placed in front of the car, and two accelerometers that are fixed as close as possible to the brake surface on each of the wheels. Dr. Delage explains, “We can test at up to 250 km/h (156 mph) but in practice we use speeds up to 130 km/h (81 mph). Brakes are either tested at a constant speed or by simulated inertia”.

He continues, “A typical test will last for about 30 hours and each brake application lasts for about 10 seconds. Surface temperatures can rise to more than 500°C. We use pressurised air to cool and control the brake surface temperature”.

The frequencies of interest are between 500 Hz up to 16.5 kHz, the practical upper limit of human hearing. We can measure squeals down to 40 dB. Squeals above a level of 50 dB are important. The first step is to choose a standard template and then define the setup for the type of test to be made. One PC then controls the complete testing process and records the details of each brake application, even if there is no squeal. With the dyno running, the system initially calculates the background noise in the test chamber.

The weight of the vehicle has an effect on the performance of the braking system. Therefore, either the vehicle weight is simulated to include just the driver, or fully loaded with passengers and goods to the vehicle’s maximum designed weight. The brake is applied via a hydraulic system to the brake servo. If a brake squeal occurs, it triggers the system and the squeal is recorded. The simple user interface shows if a squeal occurs. If required, the squeal noise can be played back as a wave file.

The test system records a number of parameters:

- Brake pressure level
- Application time
- Level of squeal – if detected
- Squeal frequency
- “Shape” of the squeal

Thibault says. “We keep the basic data of the squeal and this is processed in real time. Optionally, we can record and save the time data”.

The transducers are calibrated each time a series of tests are made.

The effects of water and oil on brakes can be simulated and, using a dyno in a climatic chamber, testing can be performed at temperatures from - 10°C up to +50°C, and from 5% to 95% humidity.

Reliability

The test systems each apply some 2000 brake applications in a 24 hour period, and they run continuously 7 days a week. Dr. Delage says, "We perform about 1000 separate tests each year and each takes about 30 hours so the dynos, PULSE and the software must be 100% reliable, and run without supervision".

Data Handling and Reporting

All test systems at Drancy, and the system at Stuttgart, run under Windows® 2000. The test data is stored in a database on one of the Bosch groups large servers. The network allows data to be accessed and analysed in both France and Germany.

Using the facility in PULSE, the data is sent directly into Microsoft® Excel and a report is automatically created. From this a PDF file is made which is sent to customers or colleagues within Bosch.

The Future

Dr. Delage says, "We have plans to install a further climatic dyno and work will start in the near future. As we have adopted PULSE as our standard analyzer, we will therefore be ordering an additional system".

Key Facts

- The world-renowned Bosch group is a major producer of a vast range of automotive components
- Bosch is an OEM supplier of brakes to many of the world's leading automotive manufacturers
- Brake components and systems are sent to the Drancy NVH Bench Testing department from Bosch manufacturing plants all over Europe
- Bosch needed a test system that could be used by everyone
- "We have used Brüel & Kjær transducers for more than 10 years so it was natural for us to work on the project together"
- Six brake testing dynamometers are installed at Drancy. Each has a dedicated PULSE Multi-analyzer for data collection and analysis
- "We have the best possible brake squeal detector"
- If a test requires more channels, two (or more) PULSE analyzers can be stacked
- PULSE and the dedicated software makes brake NVH testing a very automated process
- Bosch uses Brüel & Kjær transducers exclusively
- Bosch, Drancy, gets excellent backup and service from Brüel & Kjær's French office