

CASE STUDY

France

Massey Ferguson – Beauvais, France NVH Testing Using PULSE

Automotive

PULSE, software, transducers

Massey Ferguson is a division of AGCO Corporation, one of the largest manufacturers and distributors of agricultural machinery in the world. Massey Ferguson tractors are the world's best selling brand and the company has been the leader in tractor sales since 1962. Massey Ferguson products are sold in more than 140 countries and are produced in company plants and by associates and licensee operations in 18 countries.

Massey Ferguson's facility at Beauvais in France produces up to 18 000 tractors each year. A PULSE™ Multi-analyzer system is used extensively to minimise noise and vibration levels in the development of new models.



Congratulations – A World Record

In March 2002, at Biscarosse, south of Bordeaux, France, a standard Massey Ferguson Model 8280 tractor, with a rated engine power of 390 hp, established a world record. In one 24-hour period, a single driver ploughed 251 hectares (620 acres), beating the existing world record of 209 hectares by a substantial margin.

History

The Massey Ferguson name was established in 1958 – a shortening of the name Massey-Harris-Ferguson Limited. The company had been formed in 1953 by a merger of the North American company Massey-Harris with Harry Ferguson Limited of Coventry, England. The merger ensured worldwide acceptance of the revolutionary Ferguson System of weight transfer with ground-engaging implements, making it possible for small, lightweight tractors to achieve the performance of tractors twice their size. Today, the majority of tractors made in the world utilise this principle for increased power and traction.

Today, Massey Ferguson is part of the American AGCO Corporation. But, as an individual brand, it is one of the biggest names in farm equipment throughout the world. Massey Ferguson products are sold in more than 140 countries and are manufactured in company plants and by associate and licensee operation in 18 countries. Massey Ferguson is one of the world's most powerful names and it has been the best selling tractor brand since 1962. At the Coventry factory in England alone, more than three million tractors have been manufactured since production began in 1946.

Beavais, France

Massey Ferguson employs some 1 500 people at its factory at Beauvais, 80 km (50 miles) north of Paris. The plant manufactures up to 18 000 tractors each year.

Massey Ferguson manufactures a wide range of tractors – from 40 hp up to 270 hp. Some models are produced in both 2- and 4-wheel drive configurations. The Beauvais factory specialises in the production of 4-wheel drive versions of the 6200 and 8200 models ranges. With the average size of farms in Europe increasing, these models are widely sold in the European market.

Research and Development

Massey Ferguson makes substantial investments in research and development programmes and in the latest high quality manufacturing systems. It is the world's benchmark for reliable operation, high work outputs and more efficient, more profitable farming.

Fig. 1
Sébastien Cauët is responsible for noise and vibration testing at Beauvais



Testing

Some 15 people work in the testing department at Beauvais. In addition to testing Massey Ferguson tractors produced at the factory, testing is also carried out on AGCO group tractors marketed under other brand names.

Sébastien Cauët is responsible for noise and vibration testing at the Beauvais factory. He has worked for Massey Ferguson for four years. Prior to this, Sébastien studied vibration and acoustics for three years at CETIM, and mechanical engineering at INSA in Lyon.

Sébastien says, “My job is very challenging and motivating. We use NVH (Noise Vibration Harshness) testing extensively in the development of new tractor models. These days, there are few mechanical problems and tractors are extremely reliable.

Tractors are now very sophisticated and about 95% of our tractors are fitted with air-conditioning. Many also have GPS fitted as an option”.

He continues, “As with passenger cars, our customers are focusing more and more on driver comfort, and noise and vibration are key factors. These are key selling points and are strong product differentiators. We also have to ensure that the noise levels both within the tractor cab and externally are within the limits specified by the relevant authorities around the world”.

Massey Ferguson has its own test track for durability testing. The roads around the Beauvais facility are ideal for general NVH testing.

Sébastien continues, “We also make vibration and noise tests on components purchased from our sub-suppliers, such as gearboxes, engines, drivetrain, pumps, etc. All these components collectively add to the overall noise and vibration levels of our tractors and therefore it is important to ensure that these components are within their specifications”.

Massey Ferguson bought a 6/1-channel PULSE system three years ago. In addition to the standard PULSE software Type 7700, MF has also purchased:

- Order Analysis Type 7702
- Time Capture Type 7705
- Modal Test Consultant™ Type 7753
- Noise Source Identification Type 7752

Fig. 2
PULSE and a laptop PC are placed in the tractor cab to evaluate noise and vibration

Sébastien explains, “I first used PULSE when studying acoustics at CETIM – I think it was the first PULSE in France. We chose PULSE because of its real-time multi-analysis capability. Another factor was that it’s easy to use and is so powerful. And we can easily expand our PULSE platform when our testing needs grow in the future. Most of our transducers are from Brüel & Kjær”.

The frequency range of interest is between 20 Hz and 6.4 kHz. A wide range of analysis methods are used:

- FFT
- CPB
- Overall
- Order analysis
- Time vs. frequency

Fig. 3
Triaxial Seat Accelerometer Type 4322 is used to measure whole body vibration

In addition to NVH testing in new product development, PULSE is also used for general troubleshooting – in the laboratory, in a tractor cab, in the production plant, or at supplier’s or customer’s premises.

Sébastien says, “Because it’s so portable, we can use our PULSE system and a laptop PC in the tractor cab. We also use it to carry out benchmark testing on tractors manufactured by our competitors.”



Noise Levels

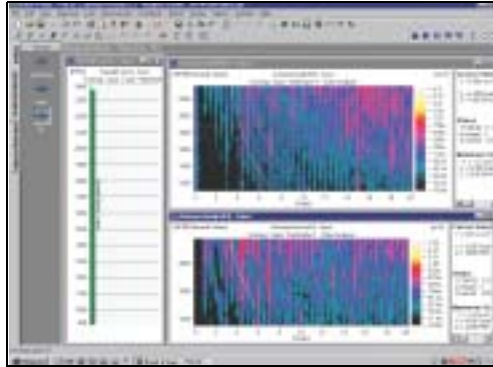
Cabin Noise

Under the EU Directive 77/311/EEC Annex II, the maximum permissible noise level in a tractor cab, measured at the position of the driver’s ear is 86 dB(A). PULSE and microphones are used to acquire the test data. Sébastien says, “Of course, we have to ensure that our tractors are below the specified level, but our goal is to achieve much lower noise figures, around 70 or 71 dB(A). In the future, I would like to use the new Brüel & Kjær Type 4100 Binaural Microphone to make these measurements”.

Pass-by Noise

The pass-by noise level for tractors within the EEC is 89 dB(A). It is controlled by EU Directive 74/151/EEC Annex VI. Massey Ferguson uses its PULSE system to make the measurements.

Fig. 4
Order analysis – a typical PULSE display showing two channels



The tractor speed tacho signal which corresponds to the engine RPM, and other parameters, are transmitted by wireless to the PULSE system during the pass-by test.

Sébastien continues, “Apart from the pass-by noise level calculation, we also make a waterfall plot analysis during the test and this shows the tractor’s acoustic signature. The data is very useful in R&D applications.”

“Currently, the EU Directive 2014 concerning sound power does not apply to agricultural tractors. It may be applied in the future. However, we do expect that the maximum levels for both cabin and pass-by noise will be constantly reduced over time”.

Sound Intensity Measurements

PULSE, Type 7752 Noise Source Identification software, Sound Intensity Probe Kit Type 3599 and OmniPower™ Sound Source Type 4296 are used to make sound intensity measurements. From the test data, noise maps are created that show acoustic leakage.

Fig. 5
Massey Ferguson uses sound intensity measurement techniques to develop effective noise reduction solutions



Sébastien explains, “We use sound intensity measurements extensively to develop cost effective noise reduction techniques, both in the R&D of new models, and improvements to current production tractors. The data helps us to design and specify acoustic materials, and where to place them in different areas of the tractor so that noise in the tractor cabin is reduced. We can test large structures and have designed and built our own large grid matrix.”

Whole Body Vibration

Another area of interest for Massey Ferguson is whole body vibration analysis. Currently, there is no legislation concerning whole body vibration exposure but there is a draft EU Directive that specifies a maximum figure of 1.15 m/s^2 over 8 hours.

Sébastien explains, “We currently make whole body vibration tests using a triaxial seat accelerometer connected to PULSE. The measurements are made according to ISO 2631-1. There is an ISO approved test track for whole body vibration just south of Paris. The test data is fine but the disadvantage is that it requires an experienced operator who is able to drive the tractor and control PULSE. Our intention is to use Brüel & Kjær’s new 3-channel Human Vibration Front-end Type 1700 connected to a Type 2260 Sound Level Meter. This setup will be used for data collection and does not require an operator that has NVH experience. We can then carry out the post processing analysis back in the test lab using Noise Explorer™ Type 7815 software installed on a standard PC.

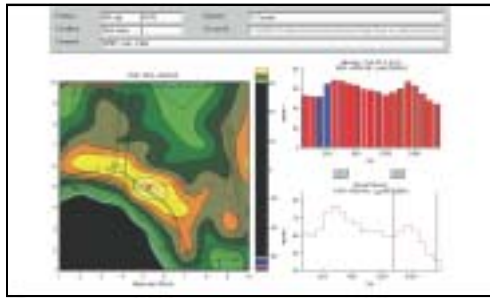
Fig. 6
Sébastien not only tests tractors – he also drives them. Here, he is moving a new tractor for testing to the NVH laboratory



Sébastien continues, “Our intention is to always be ahead of legislation and our competitors. Achieving a low whole body vibration exposure level on our tractors will be a major selling point. The data we collect from testing our tractors, and those of our competitors, will help us to optimise various components, for example, the front suspension, and the seat suspension, and make the whole tractor driving experience over a long period, more pleasant and less tiring”.

Data Handling and Reporting

Fig. 7
*A typical report
made following
noise source
identification
analysis using pink
noise as the source*



PULSE runs under Windows® 2000. The test data is initially stored on the PC's hard disk and then archived on a CD. Post-processing analysis of the test data is made by Sébastien and his colleagues in the test lab. He says, "We often need to compare old and new data and with PULSE this is very simple. We use Microsoft® Word for making reports – this is another area where PULSE is great. I really like the report facility"

Sound Quality

Sébastien says, "We intend to expand our NVH testing capabilities and Brüel & Kjær's Sound Quality software will be one of our next acquisitions. We think it is necessary to be able to make objective noise measurements – to measure and define the factors that together contribute to the overall sound. Of course, noise in the tractor cabin can never be completely eliminated. PULSE sound quality software will enable us to make accurate objective measurements. We can then "modify" the various metrics and play these to a jury and get their subjective opinions. By analysing the metrics, our goal is to accurately predict the jury's preferences and to optimise the sound quality of our tractors".

He concludes, "We are very pleased with our decision. PULSE has proved to be very reliable, and we get good technical support and backup. In short, I'm satisfied".

Key Facts

- Massey Ferguson is a division of AGCO Corporation, one of the largest manufacturers and distributors of agricultural machinery in the world
- Massey Ferguson tractors are the worlds best selling brand and the company has been the leader in tractor sales since 1962
- Massey Ferguson products are sold in more than 140 countries and are produced in company plants and by associates and licensee operations in 18 countries
- The company makes substantial investments in research and development programmes and in the latest high quality manufacturing systems
- Massey Ferguson uses NVH testing in the development of new tractor models
- "Customers are focusing more and more on driver comfort, and noise and vibration are key factors"
- Massey Ferguson has a 6/1-channel PULSE system and a large amount of software
- Most of Massey Ferguson's transducers are from Brüel & Kjær
- "Because it's so portable, we can use our PULSE system and a laptop PC in the tractor cab"
- Massey Ferguson's goal is to always be ahead of legislation and of their competitors
- "We use Microsoft® Word for making reports – this is another area where PULSE is great. I really like the report facility"
- Massey Ferguson intends to expand its NVH testing capabilities
- "PULSE has proved to be very reliable, and we get good technical support and backup – in short, I'm satisfied"