

NORWEGIAN DEFENCE RESEARCH ESTABLISHMENT

MAPPING NOISE OF MILITARY VEHICLES

Top quality soldiers require the most realistic training possible. However, in Norway, the military's exercise areas face environmental legislation that dictates noise limits the military must stay within. Therefore, to maximize their window of operations, they sought to map the noise of their military equipment.

FFI Forsvarets
forskningsinstitutt
Norwegian Defence Research Establishment



CHALLENGE

Maximize the authenticity of military exercises while remaining within environmental limits

SOLUTION

Mapping the noise of operational military vehicles, to understand their contributions to the noise emissions emanating from the training area

RESULTS

Maximal use of the exercise area while using realistic noise levels, and satisfying environmental legislation



At the Rena exercise area, the elite Telemark Battalion trains for operations all over the world – in scenarios that are as realistic as possible

Norwegian Defence Research Establishment (FFI)

The main advisor to the Ministry of Defence and the Norwegian armed forces military organization on defence-related science and technology. The area around FFI is home to a variety of research institutes, technology centres and some of Norway's defence logistic organizations. Altogether, they employ some 3000 people.

BACKGROUND

At Rena, approximately 200 km north of Norway's capital, Oslo, the Norwegian military has a huge exercise area for its elite division, the Telemark Battalion. These professional soldiers operate in national and international operations.

The Rena military camp is divided into three areas: the accommodation area, shooting ranges, and the exercise area, where Leopard 2 battle tanks and their crews are stretched to their maximum capabilities.

The Norwegian Defence Research Establishment (FFI) was tasked with investigating noise emissions of military vehicles during combat training exercises. It is the prime institution for defence-related research in Norway.

CHALLENGE

The Norwegian military needs to give their soldiers highly realistic training, which means

recreating the dynamic movement and noise that soldiers experience on the battlefield. However, at the same time, the military has civilian neighbours who are affected by the noise from the 47-litre, 1200 horsepower engine of 60-tonne Leopard 2 battle tanks as they move at speed through the battle exercise area.

Maximizing use within legislation

Environmental legislation limits noise and vibration, so the military needed to be sure that they were remaining within these limits. However, they also need to be able to maximize the use of their battle exercise area. Therefore, to be able to use as much of the area as possible, they wanted to fully understand the amount of noise the machines make.

"To ensure that we can use our exercise areas to their maximum and still keep a long-lasting relationship with our civilian neighbours, we launched the project to measure the noise of military equipment," explains Morten Huseby, Senior Scientist at FFI. "We can look at this from many perspectives, but our objective is to ensure that our soldiers are getting the best and most realistic training possible while, at the same time, the Norwegian military adheres to the country's environmental legislations that include staying within the noise levels allowed from military exercise areas."

Capturing a realistic noise picture

To build a realistic picture of the noise generated during exercises, FFI needed to record the noise generated during operations that were as normal and unrestricted as possible. However, it is challenging to know the exact location of a free-roaming battle tank, and then relate that to the specific amount of noise it generates.

"OUR OBJECTIVE IS TO ENSURE THAT OUR SOLDIERS ARE GETTING THE BEST AND MOST REALISTIC TRAINING POSSIBLE WHILE, AT THE SAME TIME, THE NORWEGIAN MILITARY ADHERES TO THE COUNTRY'S ENVIRONMENTAL LEGISLATIONS."

Morten Huseby, Senior Scientist at FFI



The Norwegian military seeks to maximize the use they can make of the exercise area by mapping the noise levels

Equipment used

- PULSE In-vehicle system
- PULSE Ground station
- Weather Station
- Three microphones
- CAN logger
- Racelogic GPS system
- KMT RPM

“IN THE NEAR FUTURE, WE WILL SEE MORE LEGISLATION RELATING TO THE SOUND AND VIBRATION OF MILITARY EQUIPMENT AND WE WILL HAVE TO ADHERE TO IT.”

Morten Huseby, Senior Scientist at FFI

SOLUTION

Brüel & Kjær Application Specialist Bert van Amerongen describes the setup. “To obtain the most realistic data, the idea was that the Leopard tank would drive freely in the area, just as in any typical military exercise. The tank would pass microphones from all directions,

and under different driving conditions. A GPS unit similar to the one keeping track of the tank was used to define the exact location of all measurement sensors such as the microphones and seismic transducers measuring vibration on the ground.”

The system consisted of three microphones placed at different locations at the side of the testing area, connected to PULSE data acquisition hardware. The Leopard tank carried a second acquisition unit, in order to measure throttle position and GPS location. The two acquisition modules were connected via wireless LAN. High-resolution GPS location was achieved by using a GPS base station at a fixed position. This unit sent correction data to the GPS unit on the battle tank.

The setup measured data in real-time, in 1/3-octaves. This gave the operator a direct indication of the relevance of the measurement data, while at the same time storing



“EARLY IN THE PROCESS, IT WAS OBVIOUS THAT WE WEREN’T WASTING OUR TIME WITH BRÜEL & KJÆR’S ENGINEERS. THEY QUICKLY UNDERSTOOD THE REQUIREMENTS OF THE PROJECT.”

Morten Huseby, Senior Scientist at FFI

Morten Huseby, Senior Scientist at FFI with the in-vehicle box containing CAN Bus and the GPS speed sensor (V-box)

“TO OBTAIN THE MOST REALISTIC DATA, THE IDEA WAS THAT THE LEOPARD TANK WOULD DRIVE FREELY IN THE AREA, JUST AS IN ANY TYPICAL MILITARY EXERCISE.”

Bert van Amerongen, Application Specialist, Brüel & Kjær

the raw time data. The data from the exercise area was exported as PULSE ASCII files to be processed in MATLAB where the noise levels captured from each sensor were corrected for the distance to the Leopard tank. Here, the noise maps were created, displaying the measurement results with a resolution of just 2 cm.



A Type 4189 microphone records the sound pressure levels of a 60-tonne Leopard 2 battle tank

RESULTS

“During this project, we have had a strong working relationship with Brüel & Kjær,” says Morten. “And I don’t hesitate when I say that the Norwegian military has gained maximum use of its exercise ground by monitoring noise and vibration levels with the measurement system from Brüel & Kjær.”

“We had a clear idea of what we wanted, and our specifications in relation to our existing simulation programs were identified. But to what extent any of the potential suppliers could live up to these was a different question,” says Morten. “Already, early in the process, it was obvious that we weren’t wasting our time with Brüel & Kjær’s engineers. They quickly understood the requirements of the project and it was clear that Brüel & Kjær could supply us with a noise measurement system according to our wishes.”

“I DON’T HESITATE WHEN I SAY THAT THE NORWEGIAN MILITARY HAS GAINED MAXIMUM USE OF ITS EXERCISE GROUND BY MONITORING NOISE AND VIBRATION LEVELS WITH THE MEASUREMENT SYSTEM FROM BRÜEL & KJÆR.”

Morten Huseby, Senior Scientist at FFI

CONCLUSION

The partnership was able to successfully analyze the noise and vibration during military exercises, and maximize operations as a result.

Morten from FFI believed that noise legislation was likely to increase. “I am sure that, in the near future, we will see more legislation relating to the sound and vibration of military equipment and we will have to adhere to it. So this noise mapping initiative is just one of the projects that will place the Norwegian military at the forefront of this challenge,” he said.

FFI was very satisfied with the cooperation, which built on a long-standing relationship. FFI and Brüel & Kjær have known each other for a long time, and over the years Brüel & Kjær’s microphones, accelerometers and amplifiers have been used in programmes for sound and vibration measurement on vehicles and on other types of military equipment.

www.bksv.com/casestudies

Brüel & Kjær Sound & Vibration Measurement A/S
DK-2850 Nærum · Denmark
Telephone: +45 77 41 20 00 · Fax: +45 45 80 14 05 · www.bksv.com · info@bksv.com
Local representatives and service organizations worldwide

Brüel & Kjær 
BEYOND MEASURE

Photographs by kind permission of
The Norwegian Defence Research Establishment (FFI).

Copyright © Brüel & Kjær. All rights reserved.