

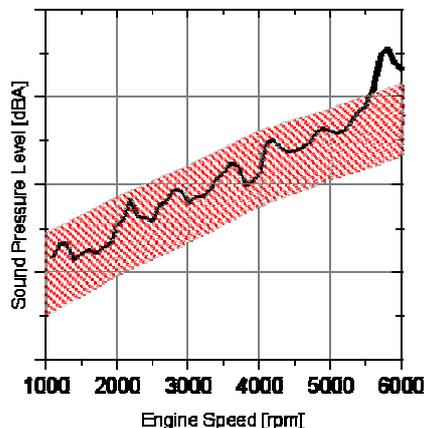
## Powertrain NVH Development Benchmarking

*The powertrain is a very important component of the vehicle, especially regarding customer expectations. Besides power and torque, the NVH behavior (sound & vibration) characterizes the quality of the powertrain and the vehicle respectively.*

One of the first steps in any engine development program is **target setting**. FEV utilizes extensive databases of competitive powertrains previously measured, as well as **powertrain benchmarking** of engines with unique design features, or competitor engines in the targeted market segment.

FEV has a number of state-of-the-art hemi-anechoic test chambers uniquely designed for accurately measuring the noise radiation and vibration from the powertrain. Data are acquired during tightly controlled operating conditions while monitoring and documenting various engine health parameters. FEV also routinely incorporates additional measurement points and test procedures to ensure compatibility with its customers' requirements.

FEV's benchmarking databases include spark-ignited gasoline, direct-injected gasoline, and direct injected diesel engines. Key benchmarking results are evaluated against a scatterband of engines in the same basic architecture as well as displacement, and power output to evaluate the NVH characteristics.



FEV has also conducted advanced benchmarking of various components and systems within the engine to evaluate the effectiveness of the designs, as well as for setting targets at a component and/or system level. For example:

- Combustion Noise
- Accessory Noise
- Valvetrain Noise
- Crankshaft Vibration

- **NVH Target Setting**
- **Powertrain Benchmarking Databases**
  - Radiated Noise
    - Spark-Ignited Gasoline
    - Direct Injection Diesel
  - Sound Quality Metrics
  - Accessory Noise
  - Combustion Noise
- **NVH Relevant Design Feature Documentation**

FEV has benchmarked hundreds of powertrains and engines. In addition to the NVH level testing, the design of the engine and its components are critically evaluated by FEV's highly experienced staff of NVH experts. One of the most important aspects of benchmarking is to understand the effects of the various design features on the noise and vibration characteristics of an engine. This ensures that the development of future engines is based on solid design features from an NVH perspective.



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