

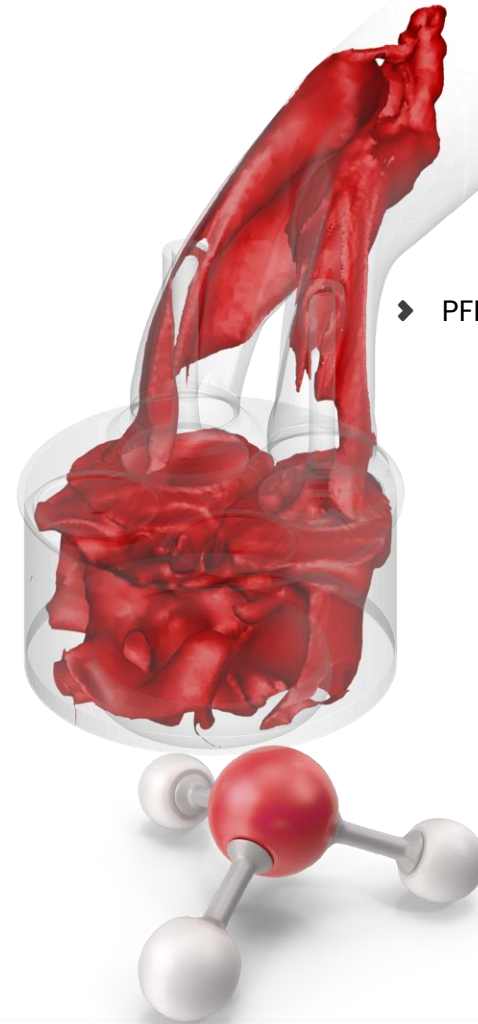
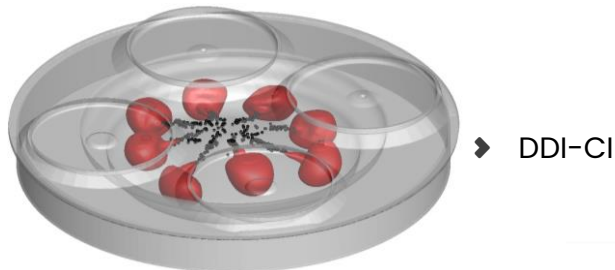
Ammonia Combustion System Development and Testing

FEV SIGNATURE SOLUTIONS

Powering your Future with the Optimal Ammonia Combustion Solution

FEV offers

- ▶ Design, engineering and consulting of new powertrains or conversion of your current engine
- ▶ Gas exchange and ammonia combustion simulation with specific ammonia combustion models based on in-house experimental data
- ▶ Established test field for liquid and gaseous ammonia infrastructure for engine testing
- ▶ Risk assessment for ammonia systems via FEV's safety matrix and definition of countermeasures



Why FEV

- ▶ 45+ years of automotive engineering excellence, trusted by global OEMs and Tier-X suppliers.
- ▶ Extensive experience developing engines and vehicles powered by hard-to-handle alternative fuels
- ▶ Complete lifecycle support from concept to series maturity, including design, simulation, prototyping, testing, industrialization, and implementation
- ▶ Transparent and customizable solutions, enabling you to extend, integrate, and scale your own development

Selected reference projects

AMMONIA COMBUSTION SYSTEM DEVELOPMENT

Internal Research Project

Positive ignition ammonia engine development

- › Conversion of heavy-duty single cylinder engine to a spark-ignited ammonia combustion system
- › Completion in 2023

FEV responsibility

- › Implementation of spark plug and pre-chamber into heavy-duty cylinder head
- › Layout design of ammonia fuel injection system
- › Engine testing to optimize hardware and operating parameters
- › 3D and 1D simulation validation and model optimization

Internal Research Project

Diesel engine ammonia retrofit

- › Proof of concept of ammonia retrofit system for diesel engines developed by FEV
- › Completion in 2024

FEV responsibility

- › Hardware selection and implementation of ammonia fuel injection system into the base diesel engine layout
- › Engine testing to develop optimized operating strategies and parameter configurations
- › Adaptation of ECU functions to implement diesel pilot ignition

Large Bore Engine OEM

Demonstrator vehicle development

- › Development of high-pressure diesel-ammonia dual-fuel single cylinder engine
- › To be completed in 2026

FEV responsibility

- › Design, validation and procurement of SCE hardware
- › Consulting for hardware definition
- › Definition of test program and test execution

Reference project

Ammonia combustion system development on medium-speed SCE

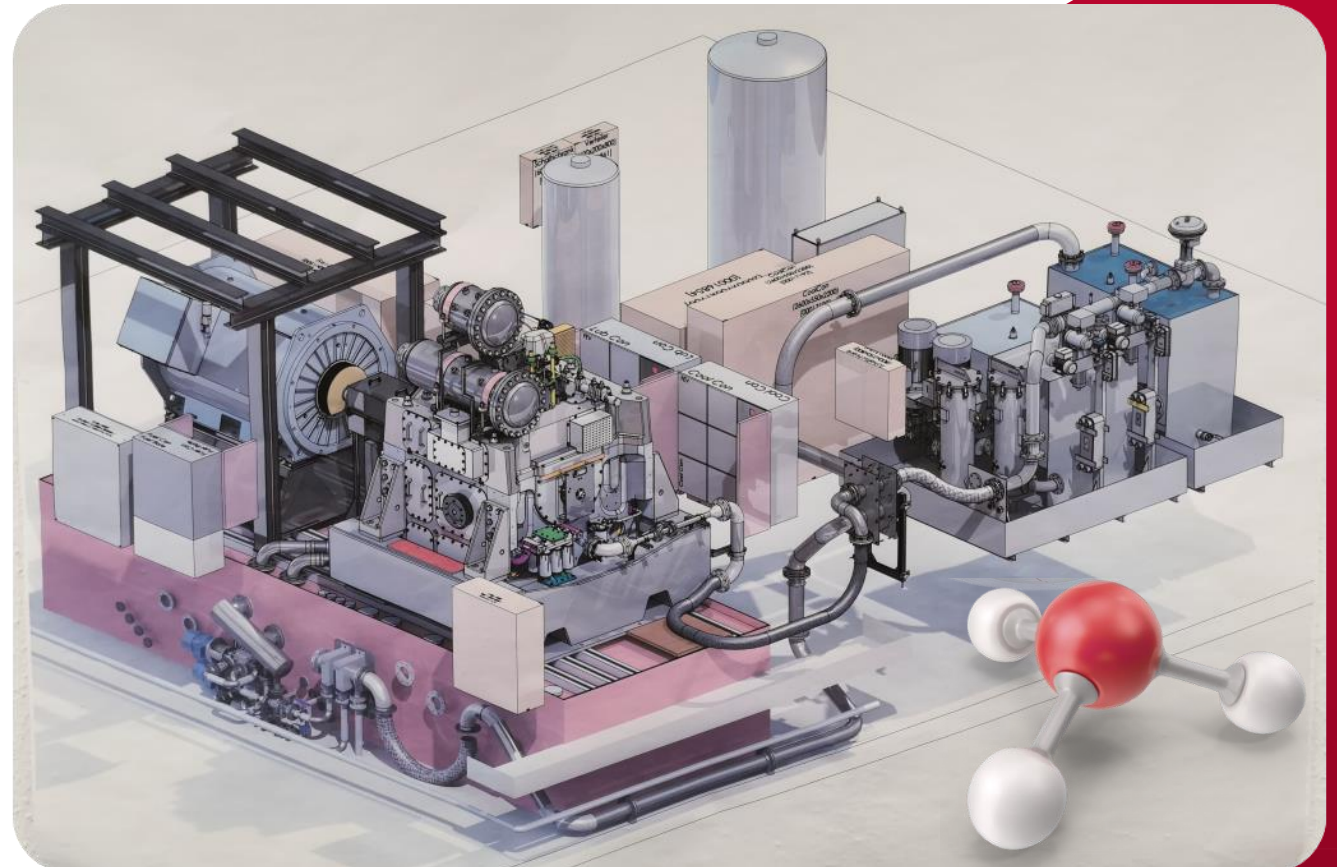
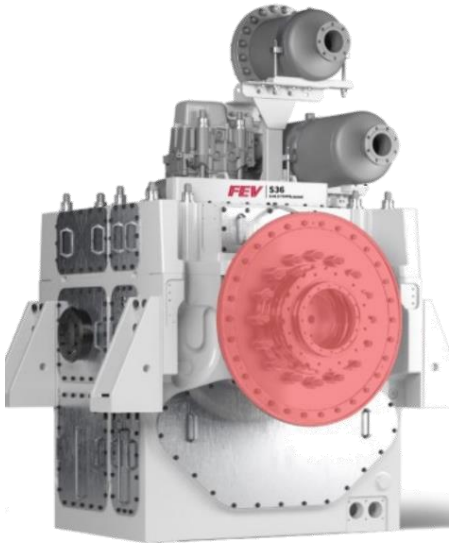
MS SCE PROGRAM – AMMONIA COMBUSTION SYSTEM DEVELOPMENT FOR OEM

MS SCE testing

- ◆ Medium-speed large bore engine

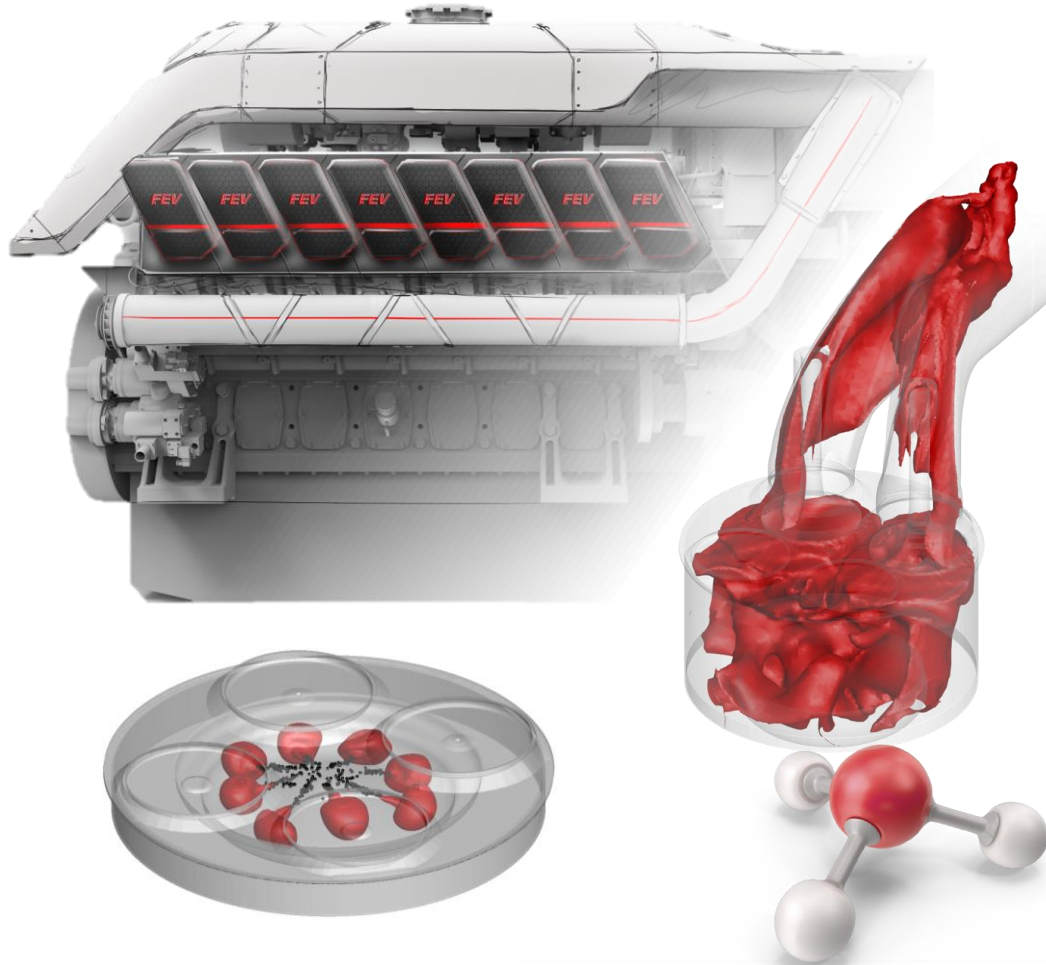
FEV deliverables

- ◆ Design, validation and procurement of SCE hardware
- ◆ Consulting for hardware definition
- ◆ Definition of test program and test execution



We offer the complete range of services

FEV SIGNATURE SOLUTIONS



Risk assessment

Lead risk assessments and FMEAs, developing countermeasures and safety systems for ammonia engines and supporting peripheral systems.

Material compatibility & durability analysis

Component and material compatibility analysis and selection of alternatives. Durability testing to confirm long-term performance and maintenance intervals.

Combustion system design

Selecting combustion systems for a given application or engine, using simulation-based optimization to achieve best performance.

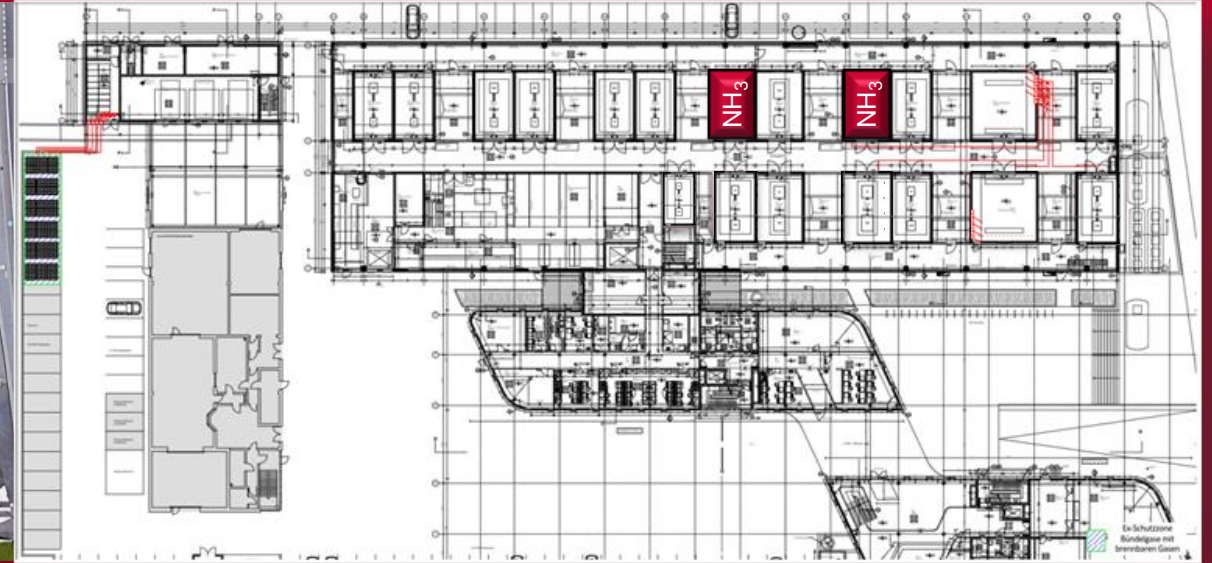
Boosting and aftertreatment layout

Design boosting systems using 1D simulation and define aftertreatment layouts for ammonia engines to achieve performance and legislative targets.

Engine testing

Plan and conduct engine testing for ammonia engines, optimizing parameter configurations and validating performance, emissions, and durability against targets.

Infrastructure for optimized supply of hydrogen, natural gas and ammonia. Ammonia testing for ICE and FC!



- Two test cells with up to 600kW capability equipped with NH_3 infrastructure ready for testing
- All NH_3 test benches are equipped with H_2 & liquid fuel supply
- NH_3 infrastructure for large-bore single-cylinder engine

Get in touch with us for further information



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signature-solutions](http://www.fev.com/en/signature-solutions)