Innovation Days Efficient Dynamics.
Energy and Environmental Test Centre.

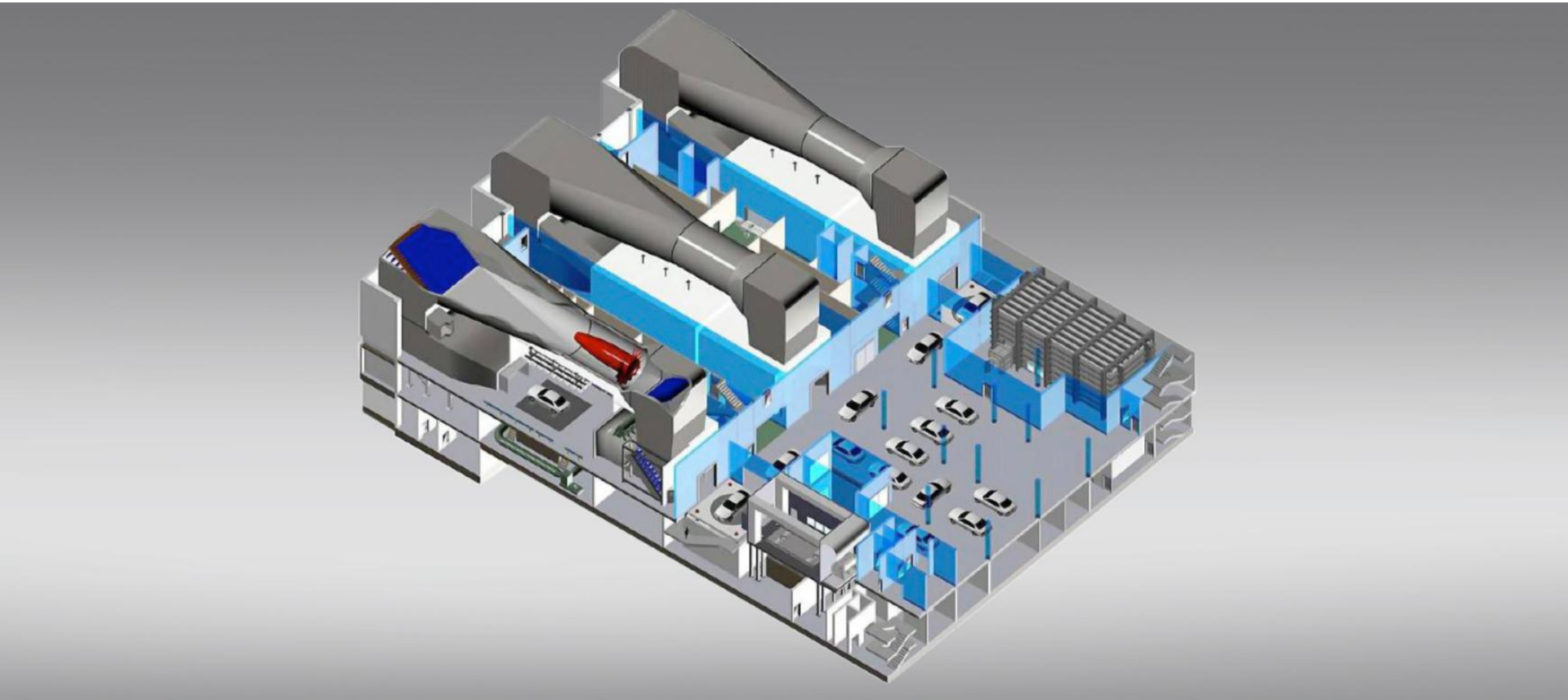
BMW Group

Energy and Environmental Test Centre (ETC).

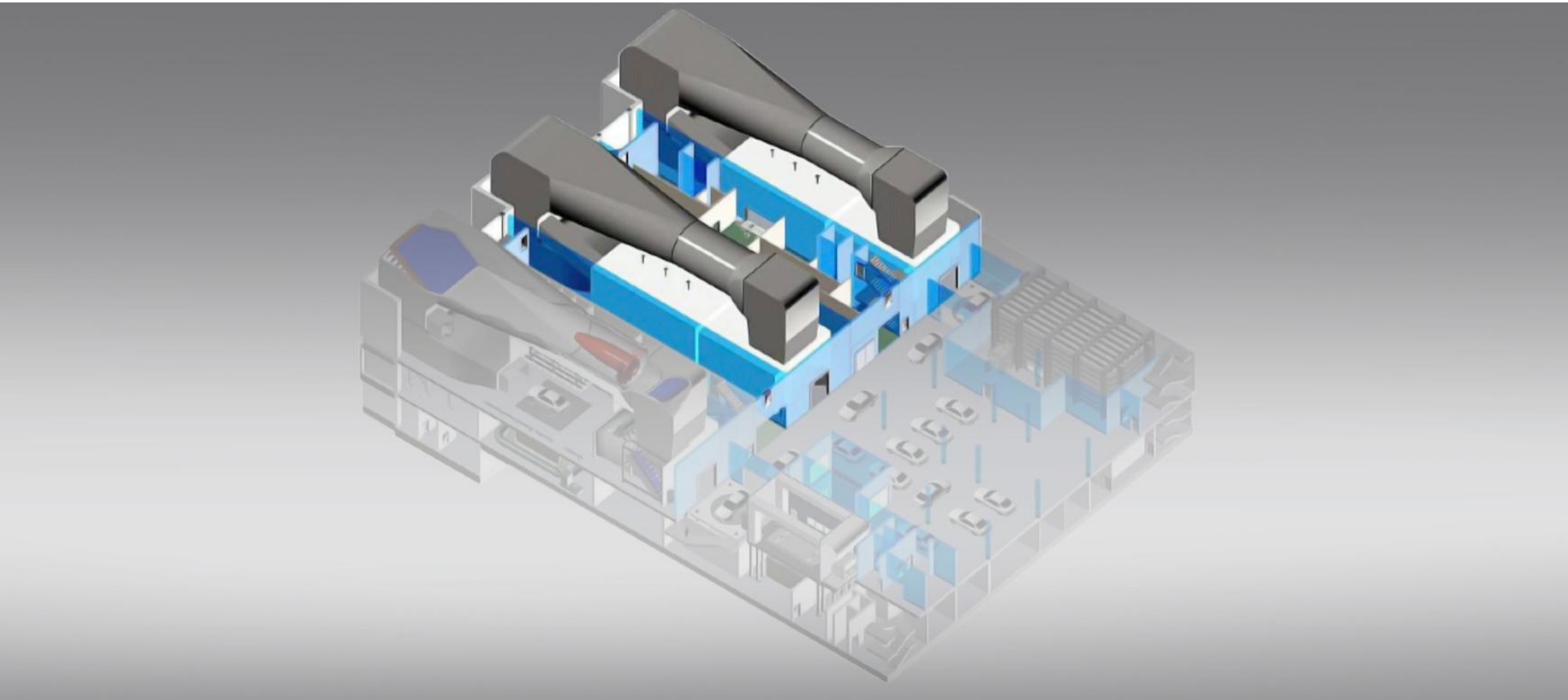
Climatic and thermal wind tunnel. From road to testbed.

Energy and Environmental Test Centre (ETC).

Climatic and thermal wind tunnel.



Energy and Environmental Test Centre (ETC).
Climatic and thermal wind tunnel.



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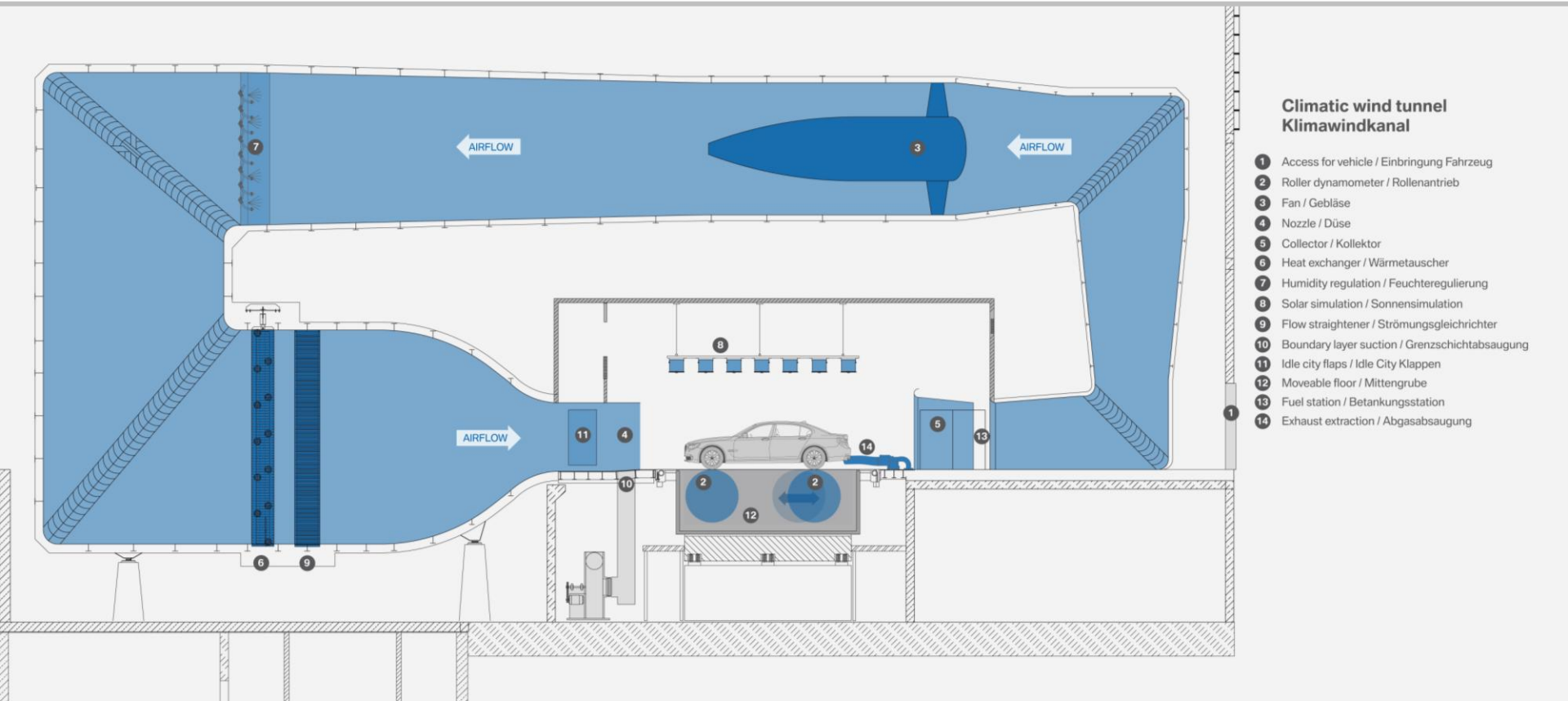
Climatic wind tunnel.



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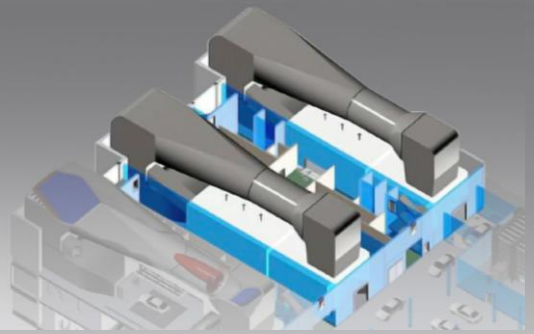
Test method engineering. From road to testbed.



- Intention & challenge
- The test: Dynamic uphill driving with a vehicle/trailer combination
- Free body analysis of “partial realities”
- Procedure
- Simulation of artificially recreated realities in a test bed
- Creating a synthetic route profile
- Implementation of a testing method
- Validation: The test is examined

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Background climatic and thermal wind tunnel.

Front-wheel-drive vehicles
up to 250 kW

Rear-wheel-drive vehicles
up to 500 kW

xDrive vehicles
up to 700 kW

Intention: Reproducible simulation of complex environmental and driving tests in a climatic wind tunnel in Munich – independent on specific seasons, weather and traffic conditions.

Challenge: To provide a testing method which allows the test engineers to work on their development programmes in a test bed without quality-related limitations.

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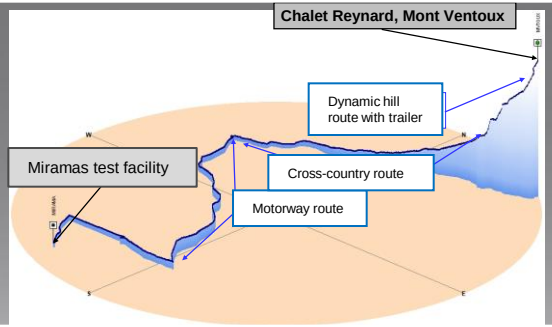
The test: Dynamic uphill driving with a vehicle/trailer combination.



Route profile

Approx. 100 km on a motorway: engine and colling system achieve thermal steady conditions

Dynamic cross-country route: engine, transmission and all components close to the engine become increasingly hot

Dynamic hill route: whole car is pushed to the limit both mechanically and in terms of temperature

Driving profile

Moderate motorway driving style, max. 90 km/h

Cross-country route: speeds between 60 km/h and 80 km/h, some sections at full throttle

Uphill: max. 60 km/h, 40km/h in corners, maximum acceleration

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Free body analysis of relevant influences.

Type of approach to the hill

Humidity

Air temperature

Air pressure

Weight of car

Driving style

Gradient of hill

Length of hill

Air conditioning setting

Weight of trailer

Test configuration of the car

What kind of trailer is the customer pulling?

After a suitable test has been worked out offering significant potential, all the factors impacting on the car during the test are identified through **“free body analysis”**.
These environment-related factors could also be described as “partial realities”, which together make up the conditions in which the road test is carried out.

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Climatic and thermal wind tunnel. A road inside a testbed. Procedure.

Simulation of the hill
Forces acting on the car are transferred through the test bed roller dynamometers. The forces to be simulated include tyre friction, drag, inertial forces and grade resistance.

Simulation of environmental conditions
Thermally conditioned air is used for the simulation of the airflow around and through the car in the climatic wind tunnel. Isolated factors in the environmental conditions to be simulated include air temperature, humidity and wind speed.

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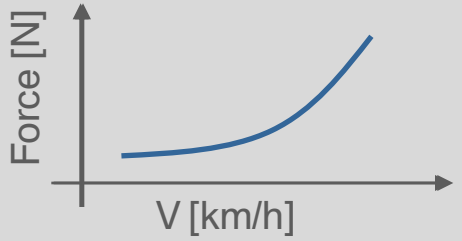
Climatic and thermal wind tunnel. Simulation of artificially recreated realities.

BMW database
Driving resistance components
Drag
Engine and transmission
Tyres

Calculation

Driving resistance simulation in the test bed



Engine, transmission, tyre and drag represented by a characteristic curve

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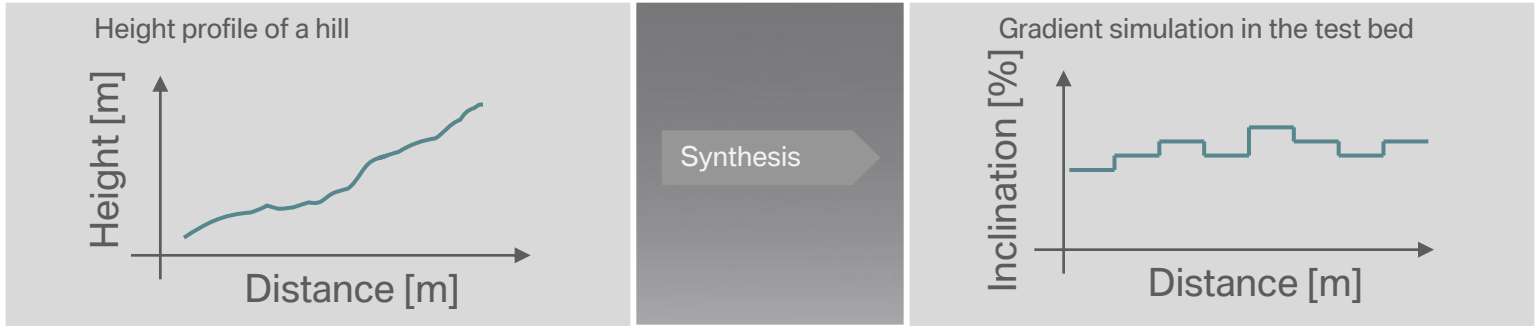
Climatic and thermal wind tunnel. Simulation of artificially recreated realities.



Depiction of **grade resistance** using a synthetic inclination profile.

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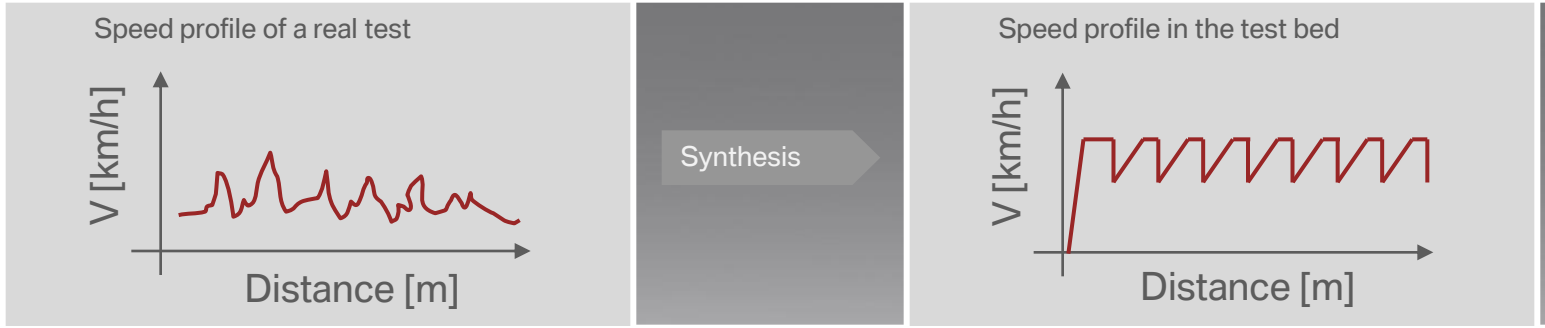
Climatic and thermal wind tunnel. Simulation of artificially recreated realities.



Depiction of the **speed of the vehicle/trailer combination** using a synthetic speed profile.

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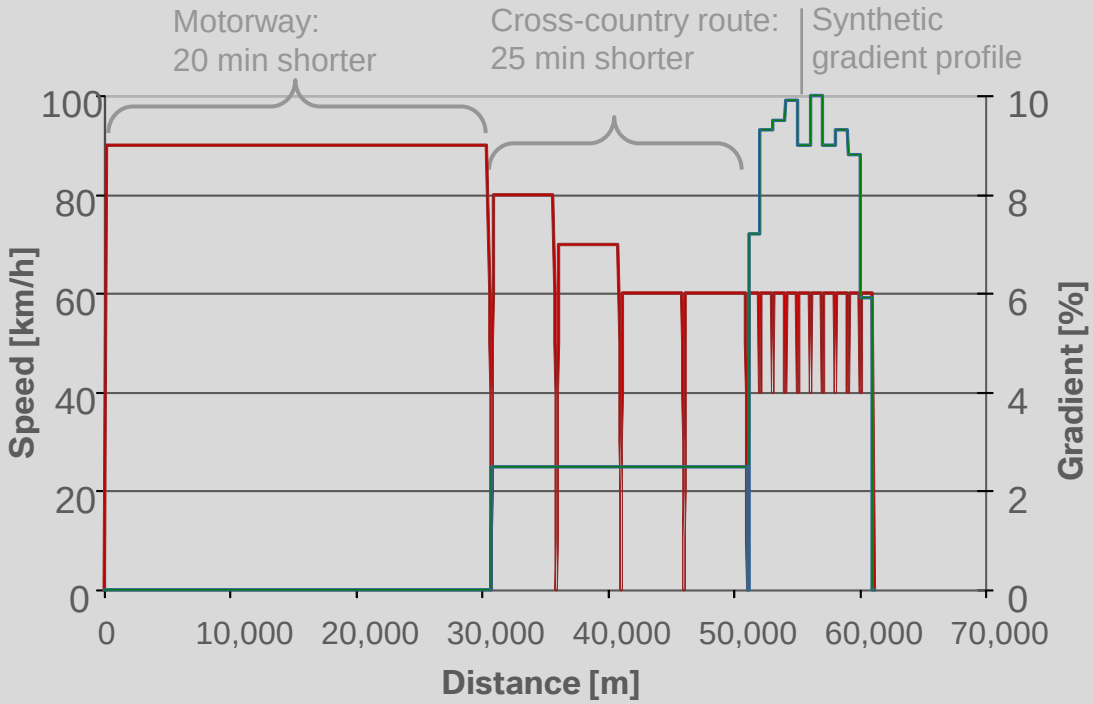
Climatic and thermal wind tunnel. Creating a synthetic route profile.



Duration of road test
120 minutes

Duration of simulation
75 minutes

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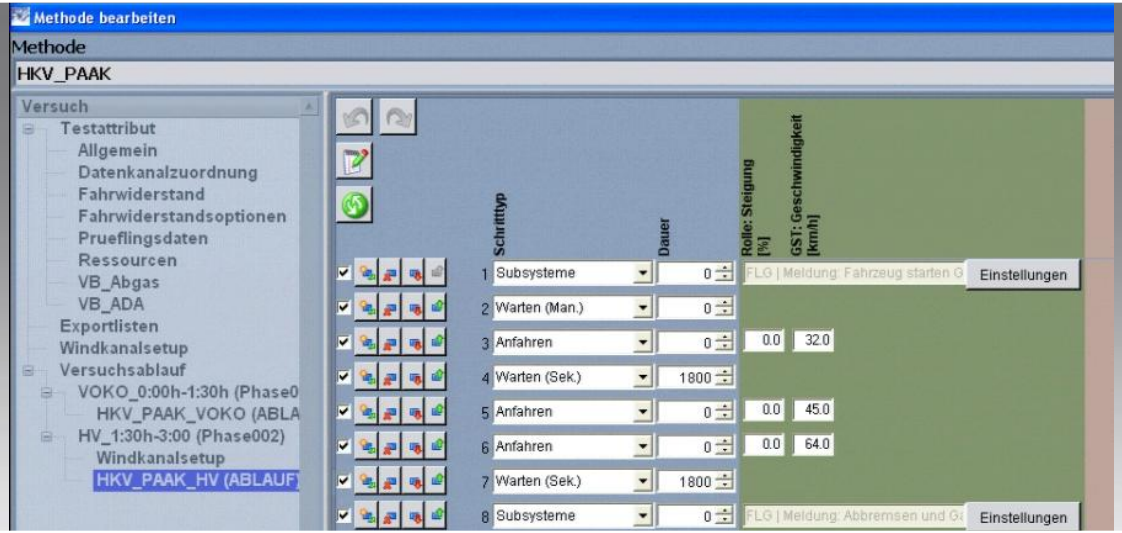
Climatic and thermal wind tunnel. Implementation of a testing method.



Creating a new testing method “Dynamic uphill driving with a vehicle/trailer combination” using a schedule in the test bed management system.

The test bed management system controls all the subsystems, each of which reproduces one of the artificially recreated realities previously simulated.

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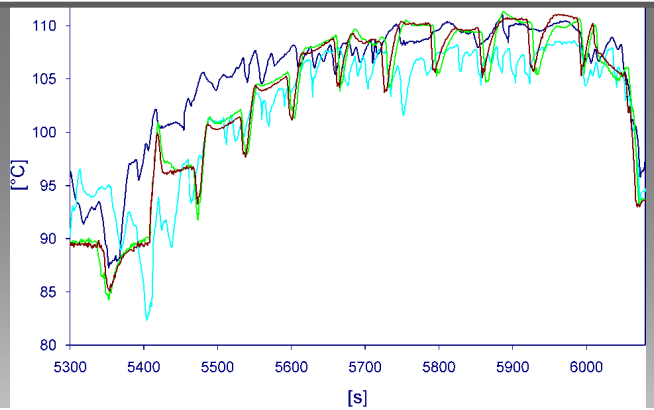
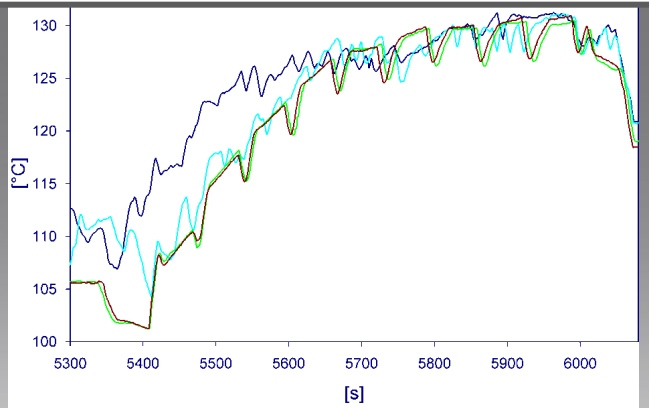
Climatic and thermal wind tunnel. Validation – the test is examined.



Gauge in the cooling water



Gauge in the engine oil

The validation compares the responses of relevant components between the road test and the “artificial” test in the test bed.

If the result is within the target tolerances, the new testing method can be approved for all test engineers.

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Thank you for your attention.