MILLBROOK

Fuels and Lubricants

www.millbrook.co.uk

Contents

spectris

Millbrook Group is part of the Test and Measurement business segment of Spectris.

Spectris plc is a leading supplier of productivity-enhancing instrumentation and controls.

Millbrook Group Overview

Millbrook Group is made up of Millbrook Proving Ground in the UK and Test World in Finnish Lapland.

Millbrook is best known for its test tracks where it performs repeatable tests in a safe and secure environment. Millbrook also has a range of test facilities for full vehicles, tyres and components, including engine dynamometers, crash laboratories, advanced emissions chassis dynamometers and innovative indoor winter test tracks.

Millbrook supports its customers with specialist vehicle conversions, accommodation in its Technology Park and vehicle-related events.

MILLBROOK


High Performance
Customer Focus
Restless Innovation
Values
Absolute Integrity
Safety
Empowerment
Tyre Development
Compliance
FINAS
TraFi
VCA
RDW
Special Vehicles
Vehicle Development
Services
Safety
Powertrain
Technology Cluster

Facilities and Tests

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Fuels and Lubricants at Millbrook

Millbrook is one of the most comprehensive test facilities in the world for conducting fully independent fuels and lubricants testing. Customers include petrochemical companies, vehicle fleet operators and passenger car, bus, truck and off-highway vehicle manufacturers.

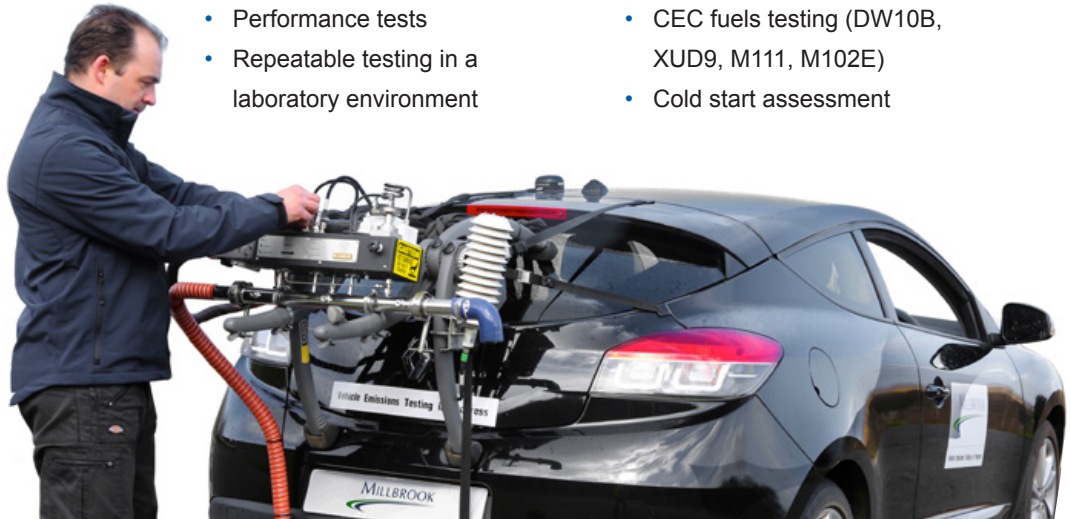
Millbrook provides a one-stop shop for testing, so minimising customers' management, vehicle and fuel transportation overheads.

Test facilities include:

- 4WD climatic emissions chassis dynamometer
- 2WD hub dynamometer
- World class proving grounds
- Environmental test chambers
- Engine test cells
- Secure fuel storage, transportation and handling

Test procedures include:

- Fuel consumption measurement, volumetric or gravimetric
- Real world test cycle assessment and development
- Standard drive cycle tests
- Real world driving emissions tests
- Performance tests
- Repeatable testing in a laboratory environment
- On-track mileage accumulation
- Powertrain and driveline durability testing (lubricants)
- Powertrain and driveline performance testing (lubricants)
- Independent validation of fuel products
- Accreditation support
- CEC fuels testing (DW10B, XUD9, M111, M102E)
- Cold start assessment



CEC Engine Test Cells

Millbrook's powertrian facilities include 16 engine test cells, 4 of which have been installed specifically for CEC fuel additive testing with ISO 17025 accreditation.

The tests examine the performance of a fuel and/or additive and its keep clean or clean-up potential.

Measurements are based on a cleanliness rating or a power loss rating.

CEC method capability:

- XUD9 – Critical flow loss caused by injector nozzle coking
- DW10B – Power loss caused by nozzle coking
- M102E – Valve cleanliness
- M111 – Valve cleanliness
- Waterboxer – Valve stick

Fuel blending capability up to 1,000L per batch.


IMPORTANT
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Dynamometer Facilities

Dynamometer testing facilities include a VTEC (Variable Temperature Emissions Chamber), a new 4WD climatic emissions chassis dynamometer and a 2WD hub dynamometer.

Real world drive cycles can be performed and logged and then run on the dynamometer under highly repeatable conditions.

The dynamometer facilities are used for emissions and fuel consumption measurement and mileage accumulation testing. They are also used for performance and durability evaluation of driveline lubricants through comparative testing.

VTEC

Vehicle type: bus, truck and off-highway

The VTEC meets Federal and European specifications and is equipped with a 200kW, single roll 48-inch chassis dynamometer capable of handling large vehicles, with up to 20,000kg inertia simulation.

It operates at temperatures between −30°C and +50°C and is used to perform repeatable fuel consumption tests and accelerative performance testing.

The VTEC is also used for hot and cold start testing and driveability testing at extreme temperatures.

4WD climatic emissions chassis dynamometer

Vehicle type: light duty

Millbrook's new 4WD climatic emissions chassis dynamometer operates at temperatures between −20°C and +50°C and is used to measure fuel consumption and emissions under repeatable conditions. It allows comparative measurements to be made in order to compare the effects of a fuel or lubricant against a baseline condition.

The chassis dynamometer is also used for driveability testing, supplementing on-track driveability tests in laboratory conditions.


DISCOVERY
XS

2WD hub dynamometer

Vehicle type: light duty

Used for mileage accumulation, power and torque assessment and to condition a vehicle with a particular fuel or lubricant. Typically used to perform fuel dirty-up or clean-up processes and to perform lubricant degradation tests.

Driveline lubricant testing

Millbrook uses track testing and chassis dynamometers to assess driveline lubricants. These could be development or market ready lubricants designed to reduce fuel consumption while providing sufficient protection for driveline components.

Friction measurement and temperature profiling form the basis of comparative performance and durability testing in high and low ambient temperatures. Comprehensive tear-down facilities and high resolution photography allow rapid feedback of durability results to the customer.


DISCOVERY
MILLBROOK

Vehicle Test Chambers

Millbrook's facilities include climatic and evaporative emissions chambers.

Climatic test chambers

Vehicle type: all

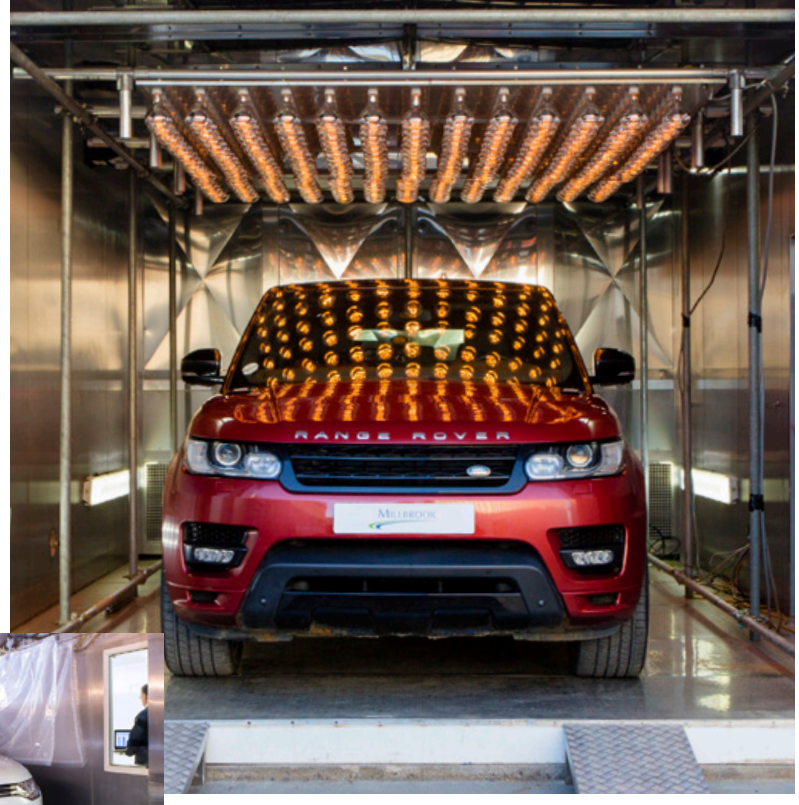
Cold/hot start capability and noise/vibration evaluations of cold starts on light duty and heavy duty vehicles.

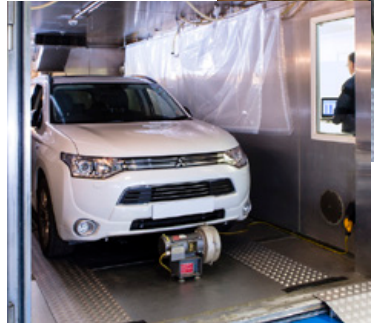
Light duty climatic chamber:

- Temperature range: −55°C to +85°C
- Humidity range: up to 95%RH between 40°C and 60°C
- Size: L6m × W4m × H2.9m
- Vehicle weight limit: 4,000kg

Large climatic chamber:

- Temperature range: −60°C to +85°C
- Humidity range: up to 98%RH between 23°C and 60°C
- Size: L13.5m × W5.7m × H6.0m
- Vehicle weight limit: 44,000kg





VTSHED (Variable Temperature Sealed Housing for Evaporative Determination)

Vehicle type: light duty

Millbrook can perform evaporative emissions tests to UNECE Regulation 83. The tests measure hydrocarbon emissions from the vehicle when it is not running.

Fuel Storage, Transportation and Handling

Millbrook provides secure on-site fuel storage for small blends (barrels and IBC's) and large volume batch storage, from 5,000L above ground to 18,000L underground storage tanks.

Millbrook also has the capability to blend fuel with additives on-site under laboratory conditions.

Millbrook can manage the logistics of importing fuel in barrels, IBC's, and tankers from international destinations and the UK.

Security in relation to the intellectual property of new formulations is given a high priority. Facilities are rigorously maintained to ensure no contamination takes place.

Track Testing

Mileage accumulation, volumetric fuel measurement and durability testing.

Vehicle type: all

Millbrook's safe and secure proving ground in the UK provides all the facilities required for mileage accumulation. Testing is conducted for accelerated durability and mileage accumulation, driveability assessment and fuel consumption measurement.

Fuel consumption tests judge the performance of a particular fuel or lubricant formulation against a baseline condition. Driveability tests are used to assess the performance of different fuel additives on a subjective basis.

Trained drivers conduct mileage accumulation on pre-determined routes for in-vehicle powertrain running-in (de-greening) and Public Road Simulation (PRS). The individual PRS modules replicate real world driving scenarios such as:

- UK Motorway
- European Motorway
- German Autobahn
- Major and Minor roads
- Urban with optional Rush hour
- Mountain roads
- Unpaved roads
- High speed driving

Driveability procedures assess aspects such as rough pulling away, surges, clean pickup, idle racing, deceleration fuel cut off quality, engine stumble and engine idle characteristics.

Millbrook can propose customised tests to cover specific drive cycles or can develop tests to include a number of individual modules such as urban, rush-hour and motorway.

Compared to public road testing, PRS has substantial health and safety benefits in relation to other road users. It also protects brand integrity in the event of a vehicle breakdown and makes vehicle retrieval more efficient and cost effective. Vehicles can be retrieved swiftly from anywhere on the site for immediate investigation in a secure workshop.

Powertrain accelerated testing emulates given mileages over a much shorter physical distance to measure, for example, the performance of new powertrain lubricant formulations.

Millbrook's test track facilities greatly reduce the variables experienced in public highway testing, such as traffic impacts. This allows long and short term test assessments to be completed in a repeatable manner that can be later reproduced accurately. The repeatability of the environment make it ideal for utilising Millbrook's Portable Emissions Measuring Systems (PEMS) in development and unique applications.

Further Information

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Track Testing – UK

Millbrook Proving Ground in the UK contains an unrivalled combination of tracks suitable for virtually every vehicle test.

It was purpose-built as a test facility for passenger cars and heavy duty vehicles. The on-road tracks include the famous Millbrook Hill Route, which simulates challenging European roads, the high speed circuit and numerous special surfaces.

The off-road tracks contain a large number of obstacles that test the capabilities of the finest civilian and defence vehicles.

- On-Road Tracks and Features

1. Hill Route
2. Hill Route Loop 1
3. Hill Route Loop 2
4. Hill Route Loop 3
5. High/Constant Speed Circuit
6. City/Handling Circuit
7. Outer Handling Circuit
8. Steering Pad
9. Valley Park
10. Mile Straight/Mile Straight Apron
11. Driveway Ramps
12. Truck Slopes
13. Sine Waves
14. Random Waves
15. Noise Generating
16. Belgian Pavé
17. ABS and Traction Control
18. Drive-by External Noise
19. Twist Humps
20. Troughs
21. Rough Tracks, Kerbs and Features

- Off-Road Tracks

22. Off-Road and Severe Off-Road

- Off-Road Technical Features

23. Wading Pond
24. Semi Axle Bumps
25. Axle Bumps
26. Severe Vehicle Twist
27. Rock Run
28. Wading Trough
29. Concrete Ditches
30. Concrete Kerbs
31. Ditch Run
32. Mortar Holes
33. Log Roll
34. Log Run
35. Steps
36. One in One
37. 25° Traverse
38. Gravel Hills

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39. 35% Gravel Hill and 155° Breakover
40. Snake Climb
41. Sand Hills
42. Deep Ditches
43. Twist Climb
44. Offset Sinusoidals
45. Structural Test Features
46. Berm Road
47. Gravel Road
48. 60% Hill Slope
49. Severe Articulation/Hummer Hollows
50. Recovery Vehicle Winch Anchor Points
51. Gravel Pits

Track Testing – Finland

The Mellatracks and Airport Proving Grounds are home to superb winter test tracks and the innovative Indoor facilities, backed by Test World's exceptional "snowhow".

Test World prepares the snow and ice tracks to give consistent, repeatable test results that are highly valued by tyre and passenger car test teams alike.

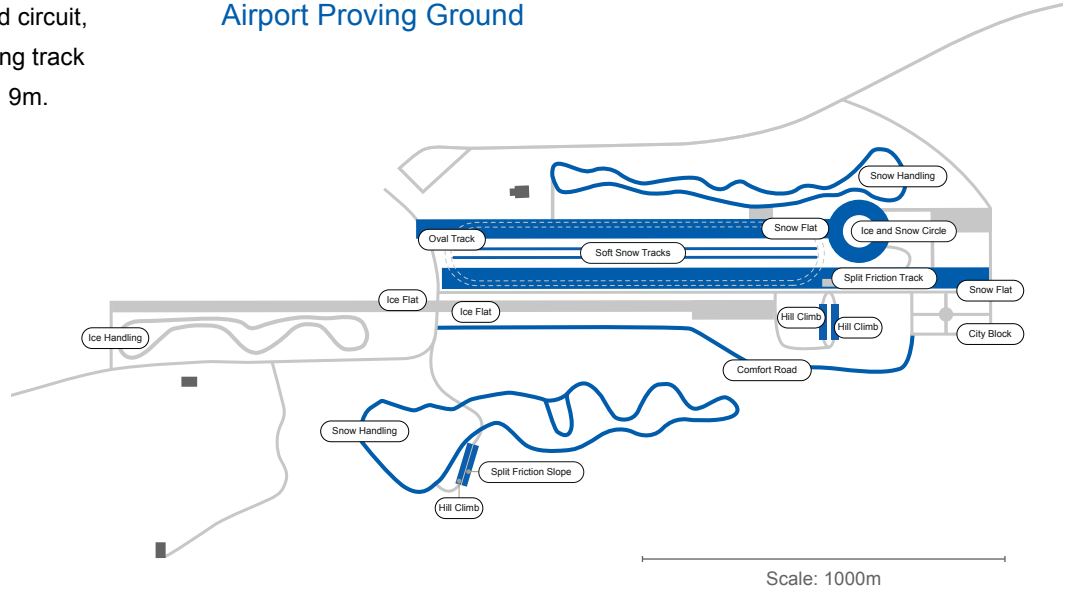
Indoor 1 has 160m × 16m of snow and ice for objective acceleration and braking work.

Indoor 2 is a closed circuit, with a snow handling track measuring 350m × 9m.

Both of the indoor facilities contain natural snow that is carefully managed to give excellent test results all year round.

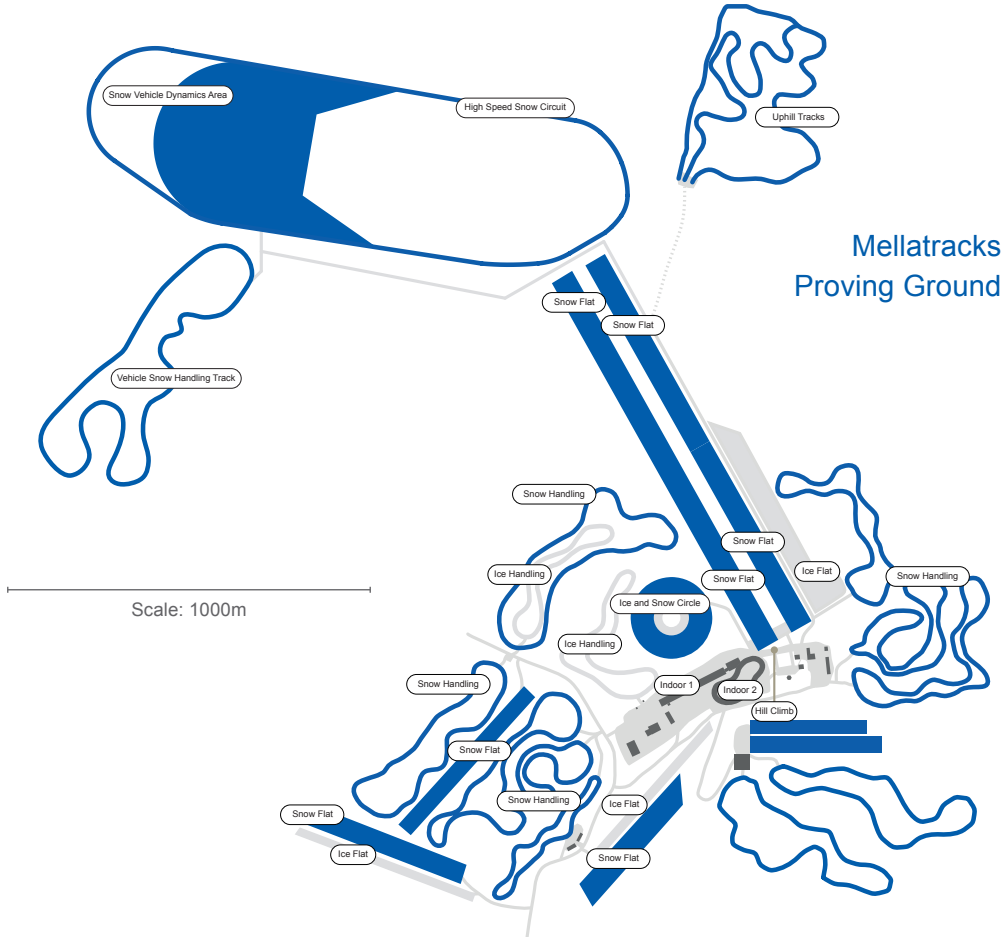
The proving grounds are laid out to provide each visiting test team with its own garage and set of handling tracks, so maximising test efficiency and confidentiality.

Airport Proving Ground

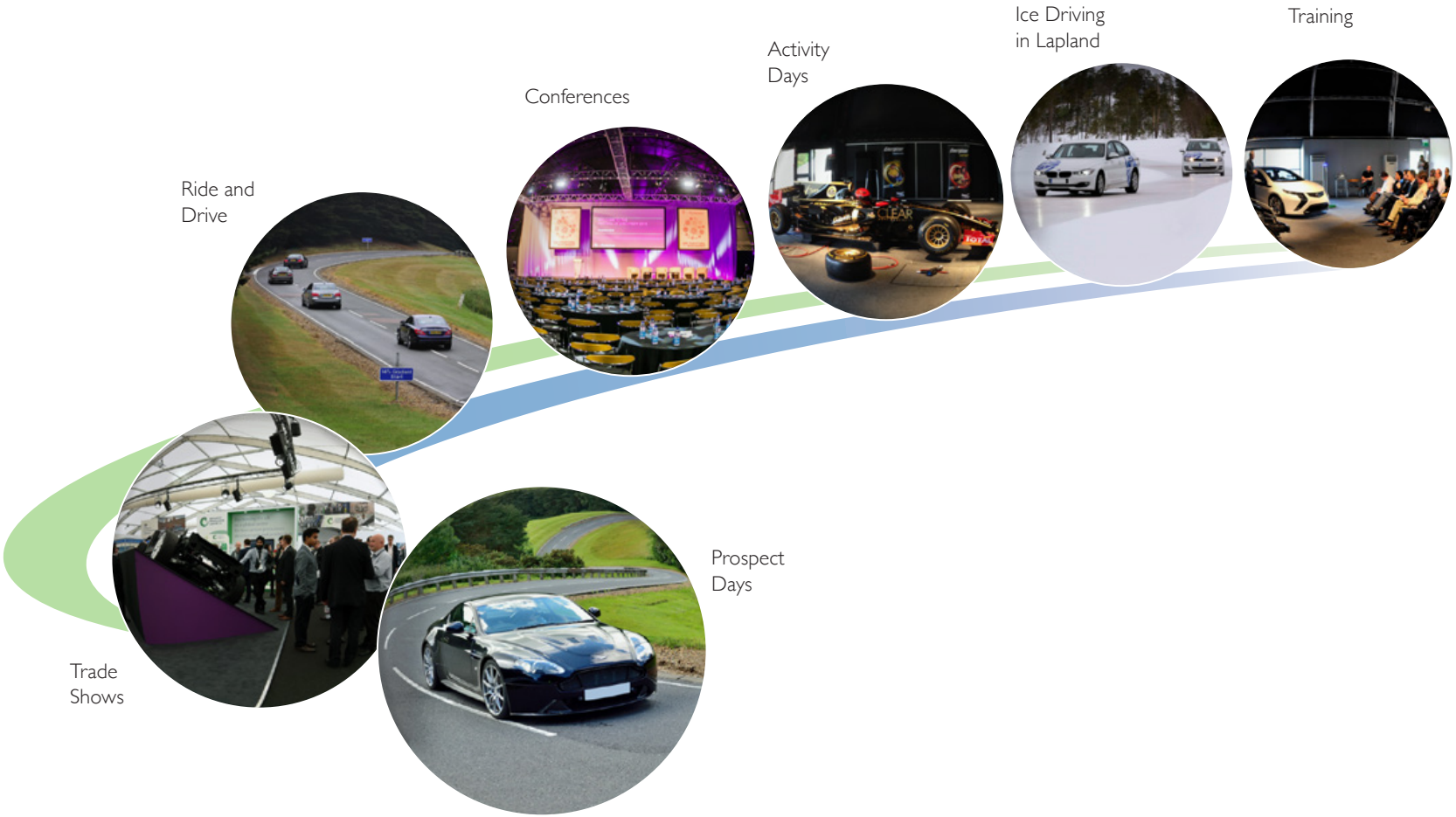


The location 300km North of the Arctic Circle provides an exceptionally long winter test season, with outdoor tracks typically open from October to April and indoor tracks open year round.

Mellatracks Proving Ground



Venues and Events



Millbrook has a number of event venues around its proving ground in the UK, each with its own atmosphere.

Millbrook's events team give customers complete flexibility for event design, with each venue being available on an exclusive basis. They are all in a secure environment, allowing for total confidentiality.

In Lapland, Millbrook is able to offer tailored events, combining driving on snow and ice with skiing, husky dog sledging, Northern Lights discovery and other typical Lappish activities.

Millbrook offers customers the opportunity to combine top-grade hospitality and catering with access to private test tracks. This makes the facilities ideally suited to product launches or dealer training, with classroom sessions followed by driving experiences.

At both locations, vehicle manufacturers are able to demonstrate their vehicles to their customers on the very tracks used in development – genuinely a unique selling point.

Vehicle Technology Cluster

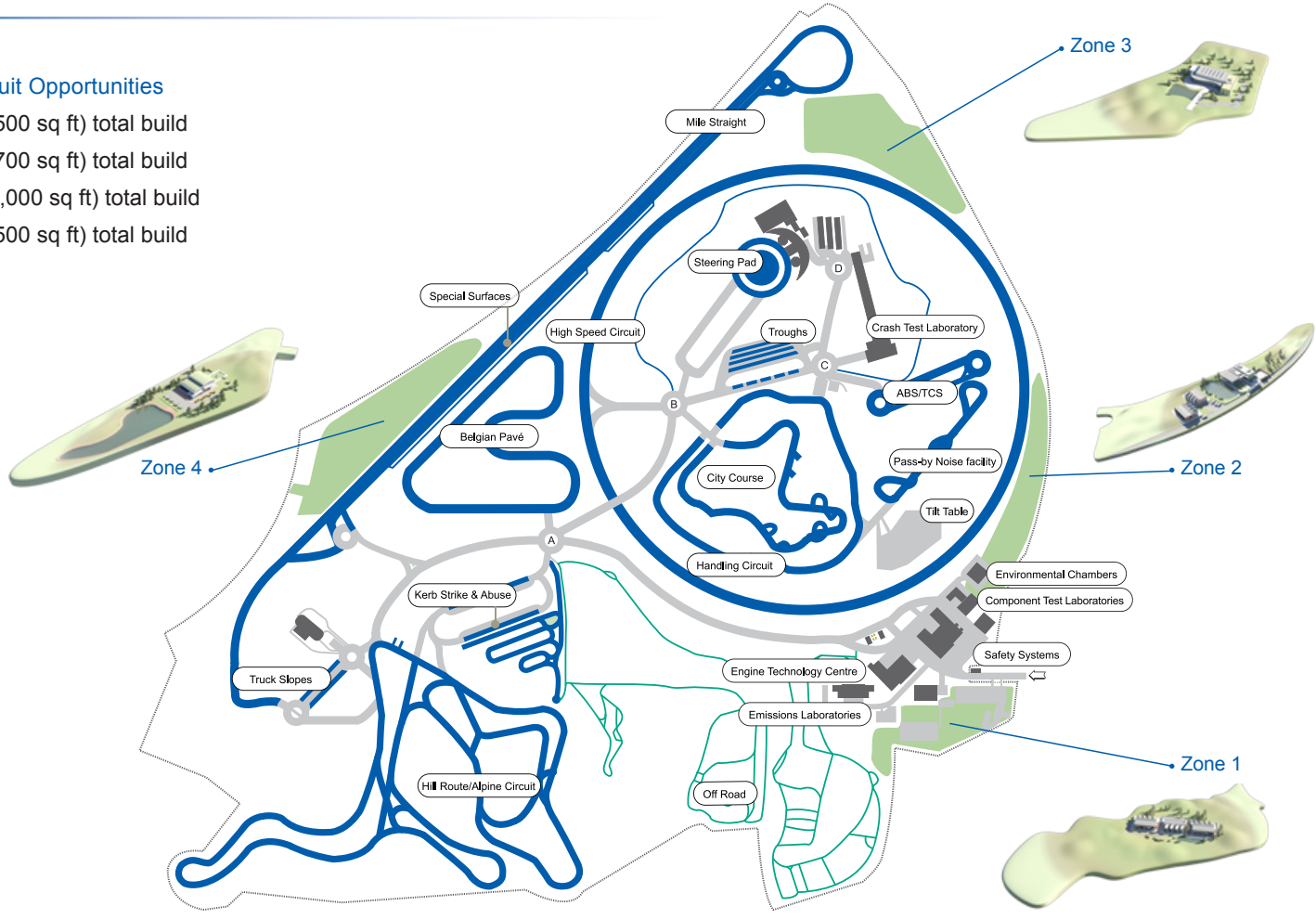
Rental and Build To Suit Opportunities

Zone 1: 7,200 m² (77,500 sq ft) total build

Zone 2: 3,600 m² (38,700 sq ft) total build

Zone 3: 9,600 m² (103,000 sq ft) total build

Zone 4: 4,500 m² (48,500 sq ft) total build



Millbrook Technology Park is home to an increasing number of vehicle technology companies, who each benefit from having immediate access to Millbrook's tracks, test facilities and expertise.

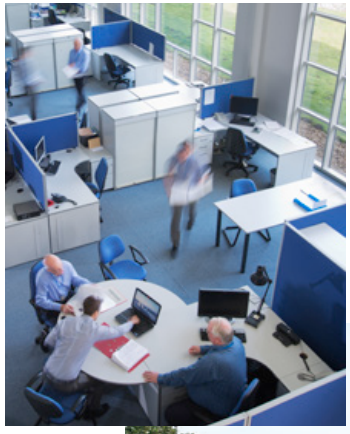
Millbrook supports its tenants with:

- Test and engineering services
- Product development
- Facilities management
- Catering and hospitality
- Product demonstrations

It has individual garages, workshops and offices available for immediate occupation on flexible terms.

Outline planning permission is in place for 24,900m^2 of single or multiple occupancy Build to Suit units across four development sites. These would be suitable for a Research and Development Centre or Regional Office.

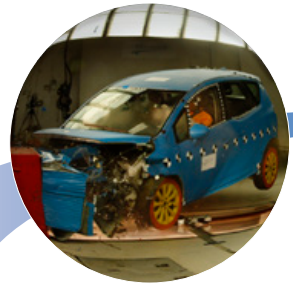
Millbrook is set in beautiful countryside and is also close to major transport links, making it a great place to live and work.



History

1970
General Motors opens Millbrook Proving Ground

1988
Millbrook starts to serve third party customers



1991
Test World founded

1999
Engine test centre opens

2012
World's first indoor winter test facility opens

2013
Rutland Partners acquire Millbrook

2015
Millbrook Group formed

2016
Millbrook joins Spectris plc

1.0

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