

Defence





Defence and Military Testing

At Millbrook, we are proud to support the World's finest Armed Forces with our independent and impartial test services.

We are the home of the UK's Battlefield Mission and we test front line vehicles against their System Requirements.

We provide the Armed Forces, vehicle manufacturers and system suppliers with engineering, trialling, safety, legislative requirements and performance support. Our services cover vehicle development, decision making and in-service operation. We plan and implement test and evaluation programmes and provide impartial test results.

We have 70 km of outdoor tracks and specialist laboratories to cover all of the tests required in the development and assessment of vehicles. We are the first choice for defence and military testing in the UK.

We are backed by a major UK-based engineering group, which gives us stability and allows us to invest for the long-term.

Please do not hesitate to contact us if we can be of service.

Alex Burns
President

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MoD Testing at Millbrook

Chosen by the MoD as their independent vehicle trials and engineering specialist in the Land Environment.

The UK MoD has entered a long-term formal agreement with Millbrook to provide through-life, cross functional support and engineering advice for its equipment programmes.

This arrangement provides a rapid response to customer needs. Subject matter experts provide test and engineering support, including assessment and advice on performance, to projects across the entire procurement cycle.

This includes:

- Analysis and formulation of requirements
- Planning and execution of integrated test and evaluation programmes
- Advice on safety and legislation requirements
- Mobility testing
- Reliability testing
- Environmental testing
- Human factors testing
- Electromagnetic compatibility testing
- Advice to optimise vehicle performance, availability and cost of ownership





Millbrook Group Overview



Millbrook Group is part of the Test and Measurement business segment of Spectris plc and consists of Millbrook in the UK and Test World in Finnish Lapland.

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

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, structural test laboratories, crash laboratories, interior systems laboratories, advanced emissions chassis dynamometers and innovative indoor winter test tracks.

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





Services

Millbrook has the knowledge, experience and facilities to support customers' trialling needs throughout the equipment procurement life-cycle.





Vehicle Testing



Millbrook can measure almost any parameter required for vehicle development, capability definition, benchmarking and homologation, and provide in-service support for any defence vehicle to optimise performance, availability and cost.

- Mobility
 - Reliability and Maintainability
 - Counter Surveillance
 - Environmental
 - Safety
 - Legislative Tests
- Signatures

Millbrook has the latest measurement and data acquisition systems for drive-by noise, vibration, braking, steering effort, internal noise, heating and cooling systems, refinement or the performance of any other vehicle subsystem or vehicle mounted system. Millbrook's unique combination of on and off-road tracks, features and venues provides an unrivalled location for benchmarking, demonstration and the rigorous measurement of vehicle mobility.

Millbrook provides systems engineering expertise including but not limited to:

- Translation of User Requirements Documents (URDs) and System Requirement Documents (SRDs) (in relation to the concepts of use, employment and operation documentation) for new and current in-service platforms and equipment;
- Integrated Test, Evaluation and Acceptance Planning (ITEAP);
- Generic Vehicle Architecture (GVA) expertise;
- Subject matter expertise in pan-Defence Lines of Development (DLOD) platform, systems and integration; and
- Land Open Systems Architecture (LOSA) subject matter expertise;
- Maintainability advice and assessment encompassing technical publications and maintenance verification against the UK MoD Land Standard.

Vehicle Testing: Environmental

Millbrook has the ability to test to all aspects of DEF STAN 00-35 or MIL STD 810, including:

- Hot
- Cold
- Solar
- Humidity
- Salt Mist
- Fungus and Mould
- Sand and Dust

Millbrook has a range of test chambers to meet customers' needs, including DEF STAN, MIL STD or unique System Requirement.

Millbrook performs vibration testing, ranging from one off tests to full block mileage accumulation programs.

For off-track testing, environments can be simulated through VSAC or chassis dynamometer tests. Millbrook offers extensive hydraulic and electro-magnetic vibration testing capabilities.



Millbrooks Large Climatic Chamber is used for conducting environmental tests to customer specifications and military and industry standards.

Chamber specifications:

- Internal dimensions:
14m × 6m × 6m
- Main vehicle door opening:
h 5.1m × w 5.0m
- Maximum temperature:
 $+85^{\circ}\text{C} \pm 2^{\circ}\text{C}$
- Minimum temperature:
 $-60^{\circ}\text{C} \pm 2^{\circ}\text{C}$
- Ramp rate:
0.5°C/min (average)
- Humidity:
3% RH to 98% RH
- Solar array compatibility



Vehicle Testing: Capability

Millbrook measures the capability and performance of any defence vehicle, including:



- Mobility
- Handling
- Counter-Surveillance Signatures
- Human Factors
- Load Capacity
- Range
- Advice on Requirement Setting

Assessing the capability and performance limitations of vehicle platforms, as laid out in DEF STANs 23-6, 23-9, 00-3, 00-6, 08-6, 00-25 and 00-250 is fundamental to development and sign-off.

Millbrook has a wide variety of on and off-road tracks and repeatable capability obstacles for the rigorous measurement of vehicle mobility, benchmarking and demonstration.

Millbrook has the experienced staff required to prepare test vehicles, collect data and assist with analysing results. They can assess performance, collect and read load data during a specific event or record real world driving to develop correlations for future laboratory or track-based testing.



Vehicle Testing: Durability

Millbrook is Home of the Battlefield Mission, including:

- Reliability Growth Trials
- Reliability Qualification Trials
- Reliability Demonstration Trials
- Product Reliability Acceptance Trials
- Structural Testing
- Reliability Sign-off



Millbrook assesses the reliability of military vehicles to the procedures laid out in DEF STAN 00-42.

A Battlefield Mission is a driven trial over hundreds of kilometres of appropriate repeatable terrain to evaluate the reliability and durability of a full vehicle or a system. All testing and reporting is undertaken independently and impartially.

Missions are split into Road, Track and Cross Country surfaces. These are repeatable, measured and consistent. The percentage, by distance driven on each surface, is determined by the role of the vehicle.

Millbrook monitors vehicles on trial and carries out detailed inspections at the end of each mission or after a failure. It provides full, immediate feedback to stakeholders.

Millbrook's technicians perform routine maintenance in line with vehicle manuals and manufacturers' specifications.

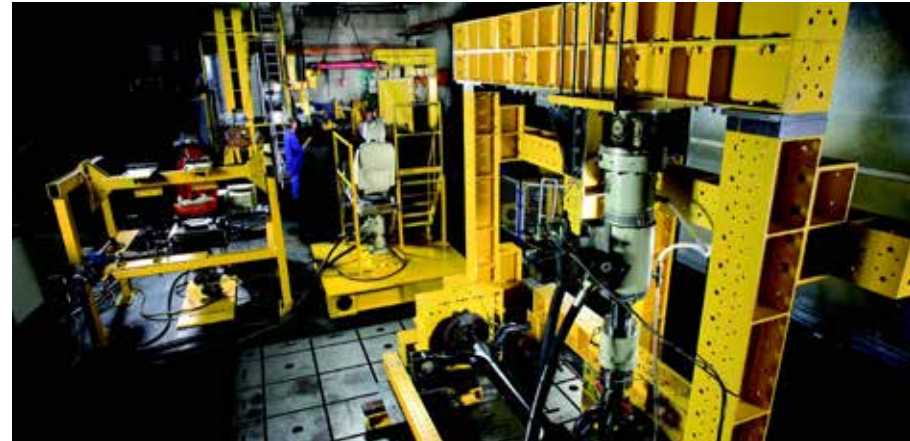
If required, Millbrook can also host Incident Sentencing Committees (ISCs), whereby a group of stakeholders discuss and categorise each mechanical or electrical failure by severity, as detailed in documentation created after each regular inspection.

Millbrook offers 800m² of structural test laboratories, supported with electro-hydraulic ring mains. A reinforced concrete strong floor grid and a dynamic modular beam system.

The laboratories can accommodate test samples from component level right up to full HGV vehicle bodies and bigger.

Durability, Strength and Fatigue

- Whole vehicle general quality, corrosion and structural durability
- Specialist durability schedule correlation team
- Proving Ground with high speed circuit, hill route including gradients up to 26%, specialist durability surfaces and features
- Corrosion chambers up to 12m x 7m x 3.5m, 50°C and 20% to 100% RH
- Climatic chambers up to 13.7m x 5.7m x 6m, -60°C to +150°C and up to 98% RH
- Ride simulator for wheelbase up to 15m, up to 3 axle, axle loads of up to 12 tonnes and gross vehicle weight up to 36 tonnes
- Hydraulic actuators up to 500kN
- Single and multi axis
- Road Load Simulation
- 600°C diesel burners
- Exhaust durability
- Stress and strain analysis



Working with Millbrook provides access to one of the most comprehensive arrays of commercially available test facilities and expertise anywhere in the world.

Millbrook can modify many of the test features to suit individual customer requirements. Please contact Millbrook to discuss particular requirements.

Vehicle Testing: Safety

ServoSled



Airbag
Deployment



Rollover



Electromagnetic
Compatibility
(EMC)



Blast and Ballistic
Protection Evaluation



Full Scale Crash



Performing high complexity tests to meet a wide range of global legislative and development test scenarios.

Millbrook's full-scale crash, ServoSled and safety systems laboratories have been at the forefront of vehicle, system and occupant protection testing for over 40 years and provide high complexity tests that meet a wide range of global legislative and development test scenarios. With the availability of ultra-compact data acquisition and digital camera systems, Millbrook can meet all the defence industry needs.

Testing to DEF STANS 59-411 and 61-5, Electromagnetic Compatibility (EMC), is a rigorous and vital part of bringing a vehicle into service and ensuring it is safe and provides a suitably quiet EM environment for C4ISTAR mission systems. Millbrook has access to one of the UK's largest EMC chambers. This is equipped with a rolling road providing load and drive to wheeled vehicles to ensure all modes of operation are covered during EMC testing.



Vehicle Testing: Legislative Compliance

Millbrook provides briefings on and trialling against prevailing legislation and requirements, tailored to the customer's needs.



- Hill Hold
- Drive-by Noise
- Speedometer Accuracy
- Exterior Projections
- WBV/HAV
- Internal Noise

Millbrook's engineers are experts in UK/ EC/ECE automotive legislation and with a VCA team based on-site (together with the experience of working with many other certification agencies), they efficiently manage homologation testing programmes.

Millbrook is able to provide advice against individual legislative regulations, make recommendations and offer pragmatic solutions where legislation may not be appropriate in a military environment



Case Studies





Mastiff 2 Baseline Assessments for Mastiff 1.95



Fig 1: An MoD Mastiff 2 reverses up the 500mm Step Climb to assess its mobility and usability

Vehicle: Mastiff 2

Contract Description

The MoD intends to upgrade all Mastiff 1 variants to the new Mastiff 1.95, using as many common components as possible with the Mastiff 2. The aim being that the user will not be able to tell a Mastiff 1.95 from a Mastiff 2 due to the similarity of the user experience. Therefore, the MoD contracted Millbrook to baseline the capabilities of a Mastiff 2 and in turn, set the user requirements for the Mastiff 1.95. To do this, Millbrook carried out a number of user experience-focussed tests in the forms of ITEAPs, including:

1. Tilt
2. Visibility
3. Wash-Wipe
4. J Turn
5. Double Lane Change
6. Brake-in-Turn
7. Steady State Turn
8. Steering Effort
9. Wire Cutter Capability
10. Hand Brake Hold
11. Secondary Braking
12. Isolation
13. 12V and 24V Sockets
14. EMC

Fig 2: Two MoD Mastiff 2 executing the towing test



15. Fuel Gauge Accuracy
16. Speedometer Accuracy
17. Drive-by Noise
18. Thermal Signature
19. Acoustic Signature
20. Fuel Tank Safety
21. Acceleration
22. Net Power at Wheels
23. Calibration and Gearbox Susceptibility
24. Towing
25. Engine Exhaust Brake
26. Braking and Fade
27. Transmission Locking
28. Articulation
29. Gradeability
30. Ground Pressure
31. Clearance Angles
32. Wading
33. Dynamic Tilt
34. Step Climb
35. Turning Circle
36. Dimensions
37. Masses
38. Whole Body and Hand Arm Vibration
39. Ingress and Egress
40. Ergonomics

41. Fuel Range
42. Cold Start
43. Cold Cycle
44. Hot Cycle
45. Rain
46. Defrost/Demist
47. Sand and Dust

Test Facilities Used

All on highway and off high way mobility facilities, environmental chambers, EMC chamber, workshop

Test Methodology/Standards

- Def Stan 23-6
- Def Stan 00-6
- Def Stan 00-35
- Def Stan 00-250



Legislative Noise and Vibration



Fig 1: The troop compartment of an MoD Ridgback ballasted and instrumented for legislative whole body vibration, hand arm vibration and workplace noise data gathering.



Fig 2: An MoD Jackal ballasted and instrumented for legislative whole body vibration, hand arm vibration and workplace noise data gathering, note the Anthropomorphic Test Device (ATD) in the gunner's position.

Contract Description

Millbrook is carrying out testing for the UK MoD to ensure compliance to legislation relating to noise and vibration and to protect the health and safety of the users of the PMVP fleet of vehicles. This legislation is the Control of Noise at Work Regulations 2005 and the Control of Vibration at Work Regulations 2005. This contract covers twelve PM priority vehicle platforms selected by the Authority, including:

1. Mastiff 3 TCV
2. Jackal 2a MWMIK
3. Husky TSV(M) UV
4. Ridgback TCV RWS
5. RWMIK+

Each vehicle is undergoing two weeks of trialling across 23 disparate surface types, in two load states. This will also assess each vehicle's ability to negate the effects of vibration imparted to the vehicle and any effect this may have on the occupants or munitions in the vehicle. In total, 128 channels of noise and vibration data will be acquired on each vehicle. All aspects of this test programme, including all the tri-axial accelerometer and microphone instrumentation is compliant to the stringent requirements of ISO 17025 accreditation.

Working with the Authority, this project has also included a number of innovations, including:

1. Implementing attenuation curves to the noise data in order to account for the noise cancelling effects of operators' headphones. Measurements are taken with and without these attenuation curves in place.
2. Use of ATD dummies to accurately represent the mass and seat pressure of real world occupants, especially in gunner positions.

Test Facilities Used

Off-Highway Track Facilities

Test Methodology/Standards

- ISO 5349-1
- ISO 2631-1
- Directive 2002/44/EC
- Directive 2003/10/EC
- Control of Noise at Work Regulations 2005
- Control of Vibration at Work Regulations 2005
- Def Stan 23-6
- Def Stan 00-35 Part 3 Issue 4

Further Information





Venues

Millbrook has a number of event venues around its proving grounds in the UK and in Finland, 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 located in a secure environment, allowing for total confidentiality.

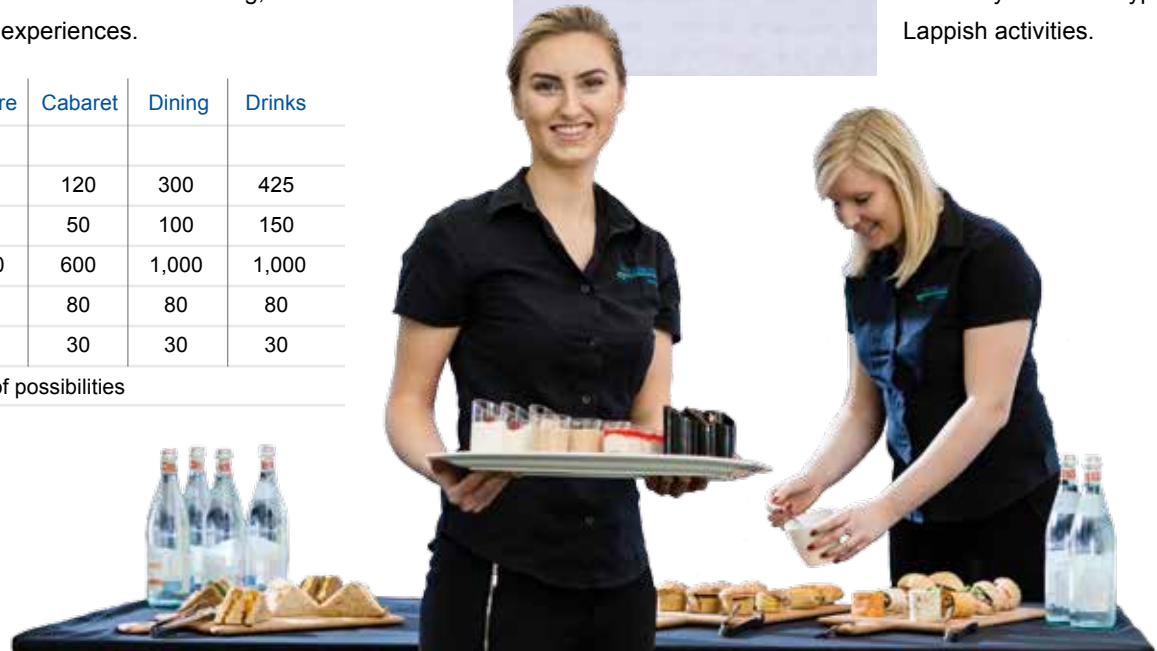
Millbrook offers customers the opportunity to combine top-grade hospitality and catering with access to private test tracks. This makes the facilities ideally suited to product launches or dealer training, with classroom sessions followed by driving experiences.

Venue	Area	Theatre	Cabaret	Dining	Drinks
Concept 1					
per wing	388m ²	350	120	300	425
per dome	160m ²	150	50	100	150
Concept 2	1,250m ²	1,000	600	1,000	1,000
Pod	375m ²	80	80	80	80
Cubo	120m ²	30	30	30	30
Test World	1,250 hectares of possibilities				



Test World

In Finland, 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.





Concept 2

1,250m² of open space for large events for up to 1,000 people.



Pod

A discreet, medium-sized venue close to the tracks with parking for vehicles.



Cubo

An intimate venue for up to 30 guests in the heart of the proving ground.



Concept 1

A flexible space that can be configured for 50 to 500 people, overlooking the steering pad.



Track Testing – UK

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

Millbrook Proving Ground 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. Steering Pad
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

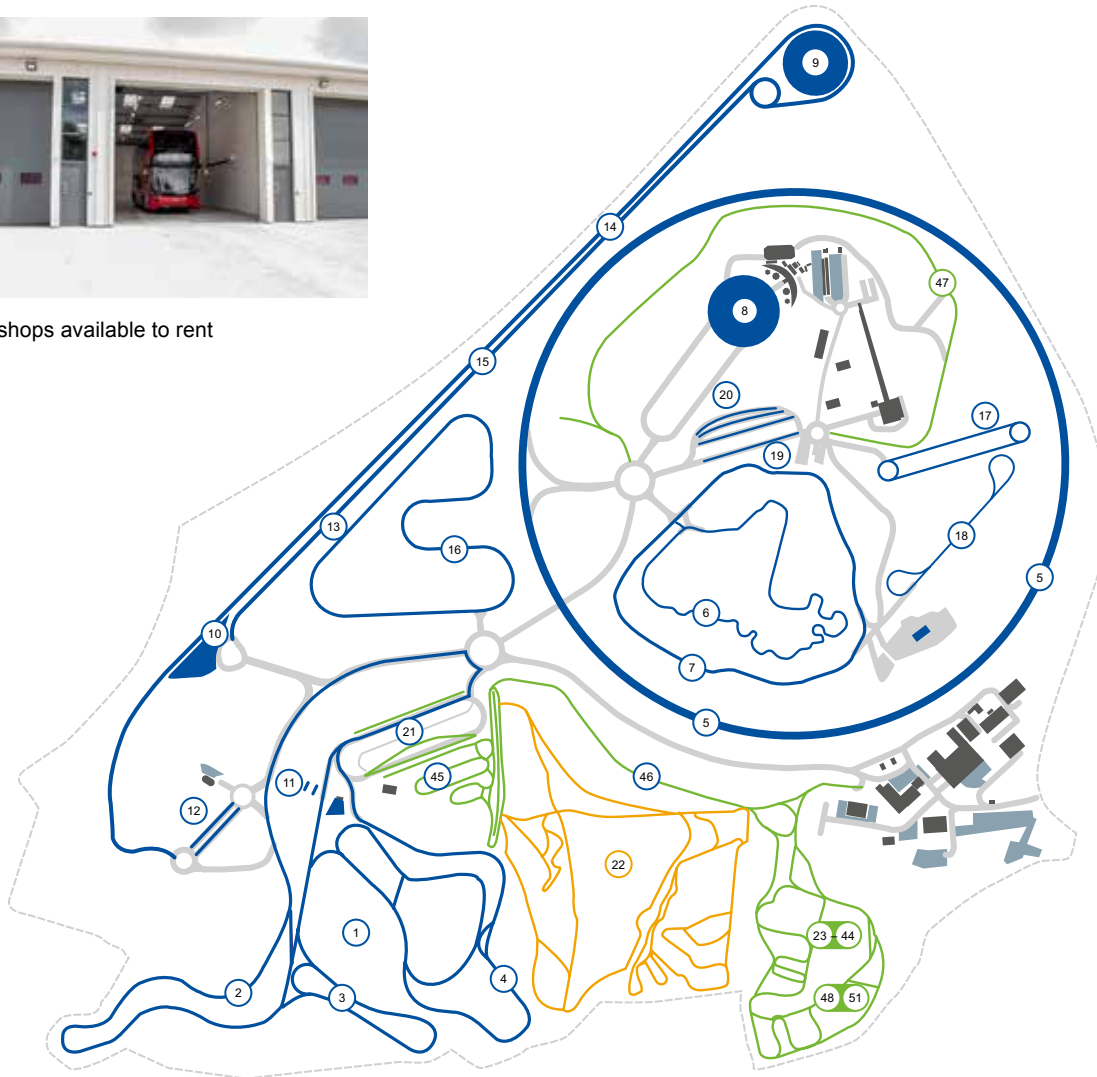
22. Off-Road and Severe Off-Road

● 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
39. 35% Gravel Hill and 155° Breakover
40. Snake Climb



Workshops available to rent



- 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



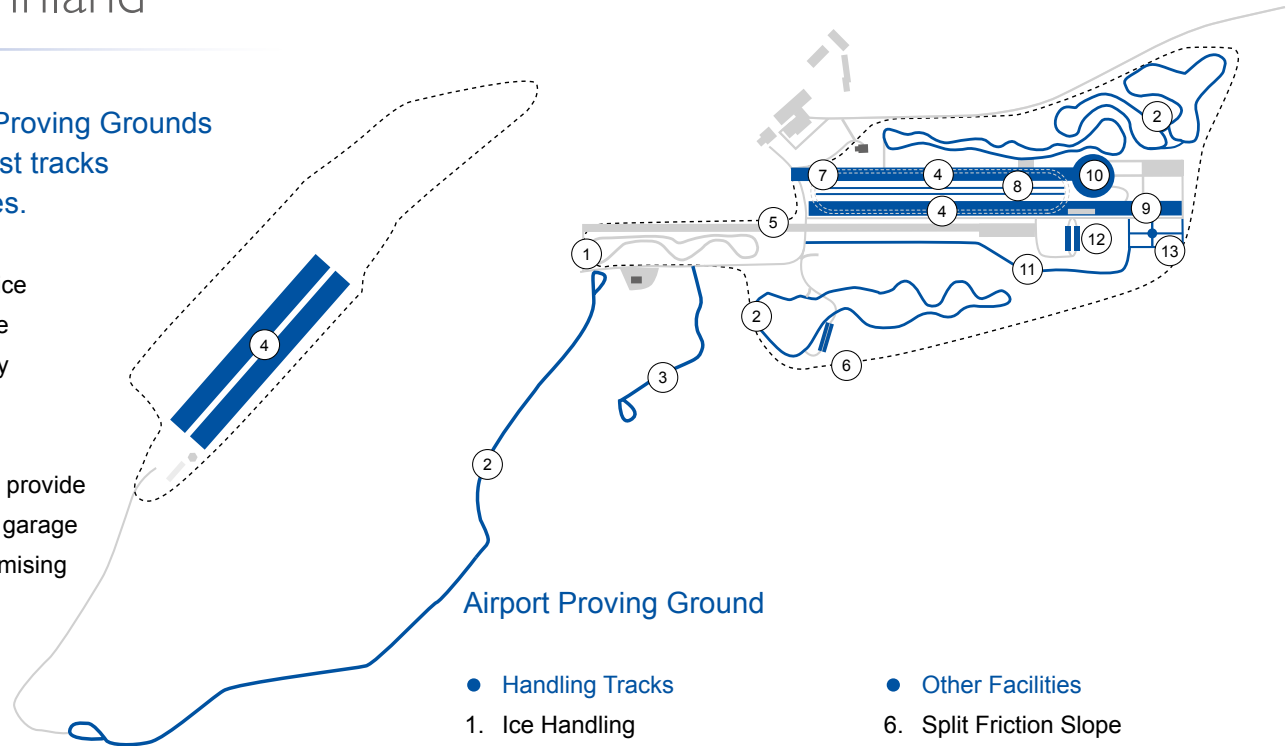
Track Testing – Finland

The Mellatracks and Airport Proving Grounds are home to superb winter test tracks and innovative Indoor facilities.

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.

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.

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



Airport Proving Ground

● Handling Tracks

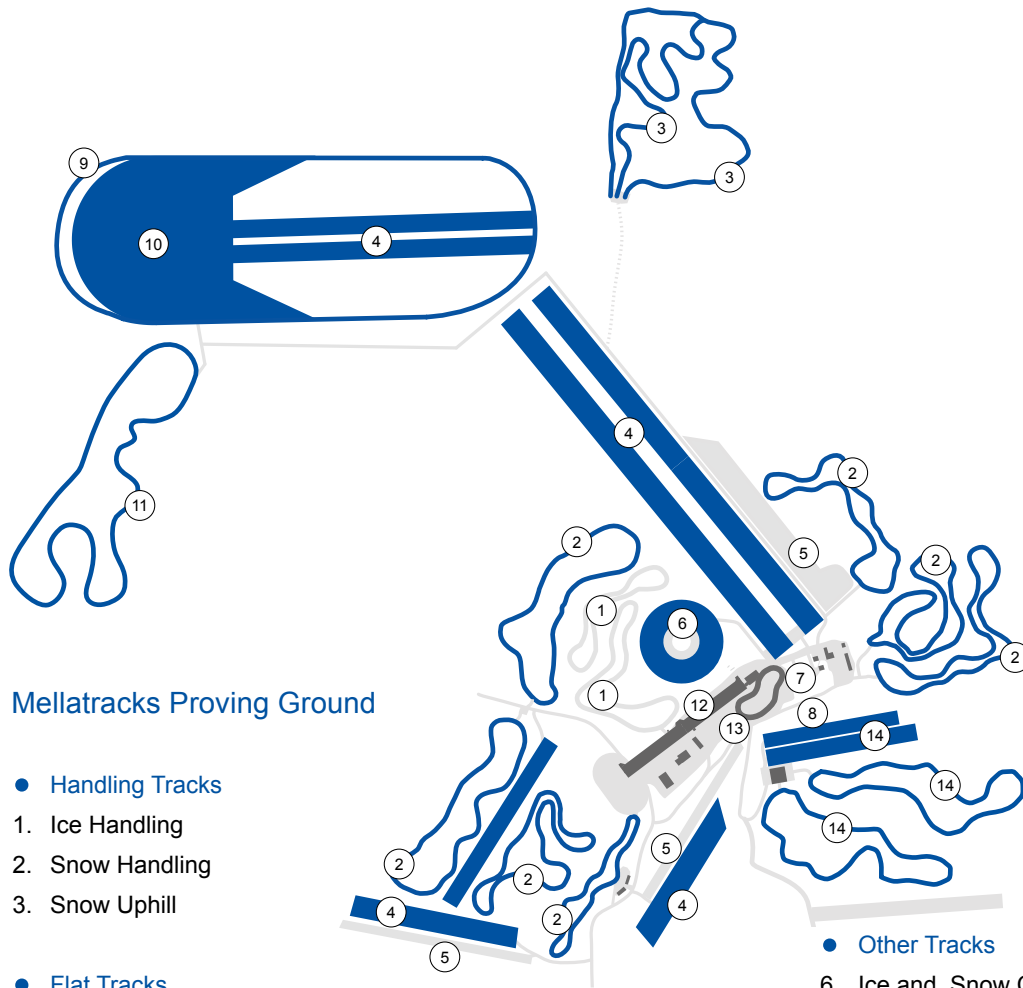
1. Ice Handling
2. Snow Handling
3. Snow Uphill

● Flat Tracks

4. Snow Flat
5. Ice Flat

● Other Facilities

6. Split Friction Slope
7. Oval Track
8. Soft Snow Tracks
9. Split Friction Track
10. Ice and Snow Circle
11. Comfort Road
12. Hill Slope
13. City Block



Mellatracks Proving Ground

● Handling Tracks

1. Ice Handling
2. Snow Handling
3. Snow Uphill

● Flat Tracks

4. Snow Flat
5. Ice Flat

● Other Tracks

6. Ice and Snow Circle
7. Hill Climb
8. Snowhill
9. High Speed Snow Circuit



10. Snow Vehicle Dynamics Area

11. Snow Vehicle Handling Track

12. Indoor 1, 3, 4, 5

13. Indoor 2

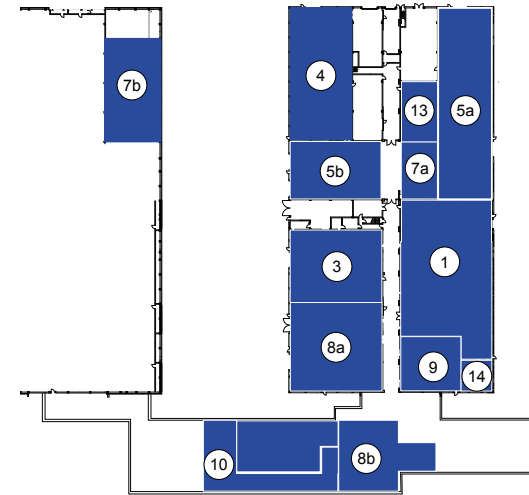
14. Customer Specific Areas

Laboratory Testing

At the Leyland and Bedford test facilities, Millbrook has a wide range of laboratories suitable for testing anything from a seatbelt to a 44 ton military vehicle.

Millbrook's laboratories have been providing vehicle testing and validation for nearly 50 years and remain at the forefront of technology.

The facilities offer exceptional in-house calibration capabilities and the flexibility to design and build rigs and tests to suit customers' individual needs. They accommodate the testing of whole vehicles, systems and components, including high performance car engines and batteries.



Leyland Site Map

● Powertrain Testing

1. Engine Testing
2. Driveline Testing
3. Electric Machine Testing

● Vehicle Testing

4. Semi Anechoic Chamber
5. Structural Testing

● Interior Systems Testing

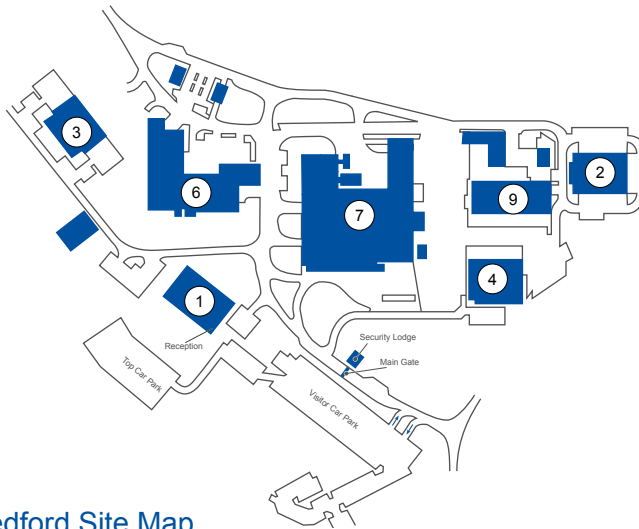
6. Vehicle Interior Environment Quality

7. Environmental Chambers

8. Seat Testing
9. Materials Testing

● Other

10. Offices
11. Stores
12. Fuel Stores
13. Vibration Testing
14. Instrumentation and Calibration



Bedford Site Map

- **Offices and Customer Workshops**

1. Main Reception Building
2. Workshops
3. Workshops
4. Innovation Centre
5. Commercial Vehicle Workshops

- **Powertrain Testing**

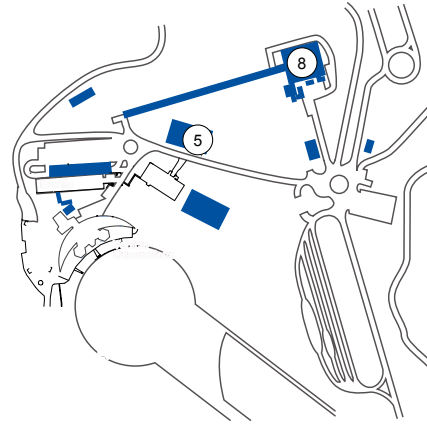
6. Dynamometer, PEMS and Engine Testing

- **Safety Testing**

7. ServoSled
8. Full-scale Crash and Safety Systems Testing

- **Vehicle and Interior Systems Testing**

7. Main Workshop Building and Instrumentation
9. Environmental Chambers and Component Testing



History



Locations

Millbrook Group operates facilities in the UK and Finland.

- UK

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