

Automotive Centre of Excellence

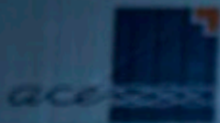
Facility Brochure



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What is ACE?

The Automotive Centre of Excellence (ACE) is more than just a product-testing facility, we are a solutions provider. At ACE we have consistently grown our base of satisfied clients. We partner with you to focus on whole vehicle testing in our Climatic Wind Tunnel. ACE is a world-class R&D facility and equipped with experienced engineers and technicians to deliver solutions to any testing problem.

Our environment can re-create any weather condition a vehicle will experience anywhere in the world, from the blistering desert heat of California's Death Valley to bone-chilling Arctic blizzards. We can test vehicles operating under full load with crosswinds and wind speeds up to 280 km/h.

We use our multiple chambers to:

- Test automotive, architectural and aerospace products.
- Improve the performance of elite athletes.
- Provide services to many other markets including the tech industry, film production and motorsports.
- Inspire students.
- Engage with the local community.
- Conduct research.

What do we value and want our customers to know?

ACE's connectivity with Ontario Tech University means our customers benefit from access to the best in technology. We can take any testing challenge and deliver viable, fully integrated solutions.

ACE is the first testing and research centre of its kind in Canada. It is owned by Ontario Tech University and located in Oshawa, Ontario at the university's north Oshawa campus location.

What is the core research facility?

The core research facility is a heavy lab area with five distinctive test chambers:

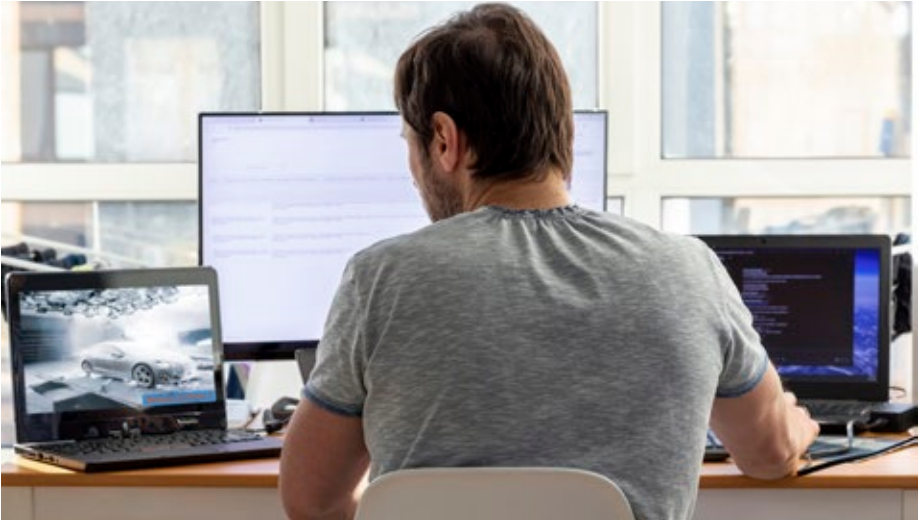
- **Climatic Wind Tunnel** – ACE has one of the largest and most sophisticated climatic wind tunnels in the world. In this test chamber, wind speeds can exceed 250 kilometres per hour, temperatures range from -40°C to +60°C and relative humidity ranges from 5 to 95 per cent. The climatic wind tunnel has a unique variable nozzle that can optimize the airflow from 7 to 13 metres squared allowing for an unprecedented range of vehicle and other test property sizes. Coupled with this feature is a large chassis dynamometer that is integrated into an 11.5-metre turntable. For the first time anywhere, vehicles and test properties can be turned into the airstream under full operating conditions to facilitate vehicle performance testing in a crosswind development. The large open chamber has a readily reconfigurable solar array that replicates the effects of the sun and is hydrogen-capable, allowing for alternative fuels and fuel cell development. New wireless generation and detection capabilities have been added to enhance product testing.
- **Climate Chambers** – ACE has a large and a small climate chamber that provide exacting conditions of both temperature and humidity. The large climate chamber is a high feature chamber that includes an input dynamometer coupled with a solar array. Temperatures range from -40°C to +60°C and relative humidity from 5 to 95 per cent.
- **Climatic Four-Post Shaker** – ACE has a drive-on four-post shaker within a climatic chamber. This vertical axis shaker provides the motion for simulated drive surfaces to validate suspension and body durability for applications like squeak and rattle. In addition, the four-post shaker is capable of providing highly accelerated motion further enhancing its capabilities to support advanced structural durability and life-cycle testing.
- **Multi-Axis Shaker Table (MAST)** – ACE has a multi-axis shaker table in a hemi-anechoic chamber. The six-axis inverted hexapod design allows for products to be tested for structural durability and the detection of noise and vibration in three dimensions.
- **Secure Preparation Garages** – ACE has three secure preparation garages, with exhaust extraction system, tool chest, work bench and electric power.

What is Innovation Garage?

- Prime, modern collaboration space for Industry, Academic Researchers and Student Experiential Learning.
- Fully Secure Office and Lab Space (controllable by tenant).
- Flexible space containing preparation areas, machine shop, offices, laboratories, conference. rooms and common work areas that are available to rent.

What are the potential markets?

In addition to conventional automotive applications, ACE is suitable for testing autonomous, alternative fuel, hybrid and electric vehicles. It is large enough to accommodate trucks, tandem drive systems, full coach buses, light rail transit, aerospace, military and agricultural applications, wind turbines and solar panels. ACE is also used to train military personnel, rescue crews and competitive athletes, and for performance testing of outdoor survival gear in severe wind, humidity, snow, icing or desert heat. The film and television industry uses ACE as a climate-controlled studio for made-to-order extreme-weather action scenes.



Are we able to test remotely?

ACE has always maintained its security protocols and high standards of confidentiality when dealing with client test objects. In addition to the existing security measures, ACE has developed a process to provide vehicle testing in the Climatic Wind Tunnel with remote real-time monitoring by clients in a secure fashion. This capability enables clients to complete testing even if they are unable to be onsite at ACE. With the COVID-19 situation, we believe this remote option offers value and maximum flexibility for current and future ACE clients.

Booking ACE

ACE is available to rent by those with a need for its unique capabilities, including: manufacturers of all descriptions, start-up companies and researchers in Canada and from around the world. Clients can rent the entire facility or specific chambers at an hourly rate that is globally competitive.

For more detailed information or to tour ACE, please visit ace.ontariotechu.ca.

ACE Wireless Environment

Key features

ACE has invested in additional capabilities to help developers of autonomous, connected car and wireless automotive systems.

Global Navigation Satellite Systems (GNSS) simulation: Allows generation of fixed and moving profiles of coordinates based on GPS, Galileo, BeiDou and/or GLONASS GNSS networks. Power levels are controllable and any coordinates and speed are possible. Useful for checking GNSS module sensitivity vs. climate or for doing other tests when a GNSS system like GPS is required to enhance the simulation.

V2X transmission standards: Specifically DSRC, ITS-G5 and WAVE power analysis vs. climate using the 802.11p standard. Set a reference power level with your module, change the environment and see how your transmission power has been affected. DSRC packet generation also possible at typical field power levels.

C-V2X testing: Real-time spectrum analysis to 10 MHz bandwidths, Interference analysis and band power measurements available from 9 kHz to 6.5 GHz. Over the air C-V2X testing utilizing LTE is also available on request. Measure baseline power of modules and change environment to see how transmission is affected.

High performance electronic troubleshooting equipment provided by Keysight (formerly Agilent) Technologies. An array of high performance equipment covering DC to 6.5 GHz and thermal imaging allow visitors to repair/troubleshoot modules without having to return or import/bring their test equipment.

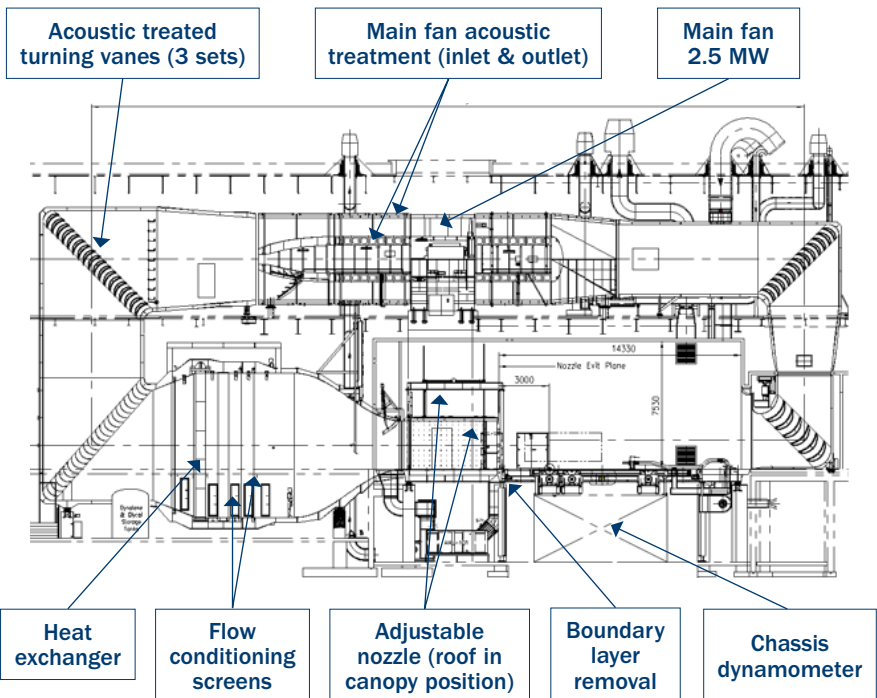
- 4.5 digit True RMS Handheld DMM with non-contact AC voltage detection.
- Digital multimeter, 6 1/2 digit, including voltage, current 4 wire resistance, capacitance and digitizing over LAN or USB.
- DC power supply, triple-output, 6 V, 10 A and 2 x 25 V, 2 A, 160 W: LAN, USB controllable with overvoltage and overcurrent protection.
- DC Power Supply 60 V, 12.5 A, 750 W; GPIB, LAN, USB, LXI compliant with overvoltage and overcurrent protection.
- Data Acquisition Switch Unit w/LAN + USB, 20 channel relay mux for multi-channel temperature, voltage, current, temperature, and strain measurements. Software included.
- Multifunction DIO and analog outputs.
- Oscilloscope, four-channel, 500 MHz with built in 20 MHz Arbitrary Waveform and Function Generator, CAN/LIN/I2C, SPI, and more decodes. USB controllable.
- 6.5 GHz FieldFox RF Analyzer with Vector Network analysis, Real-time Spectrum analyzer, preamplifier and interference analysis, CW RF signal generation TDR cable measurements and GPS receiver. Expandable to allow Over-the-Air LTE testing.
- BenchVue Control and Automation software including testflow for instrument control, data collection and export without programming.
- TrueIR Thermal Imager, -20°C to 350°C with 320 x 240 pixel resolution, time interval recording and tripod mount.



Climatic Wind Tunnel

Key features

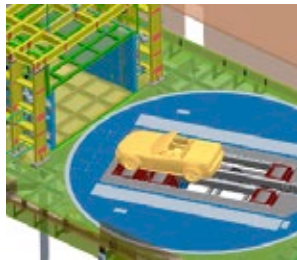
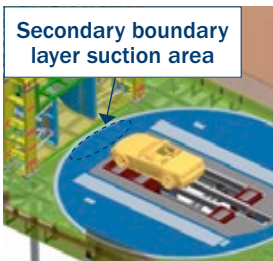
- Adjustable nozzle 7 to 13 m² and long test section to accommodate a wide range of vehicle sizes and type, from small cars to Class 8 trucks and buses, with wind speeds in excess of 240 km/h.
- Temperature from -40°C to +60°C and humidity from 5 to 95 per cent.
- Exceptional flow quality for advanced aerodynamic simulation in thermodynamic testing
- Low background noise level (64 dBA at 50 km/h) for the detection of vehicle drive-away anomalies such as misfires, transmission hesitation, etc.
- Unique independently-power rolls chassis dynamometer in a turntable to enable cross-wind testing.
- Solar simulation system up to 1200 W/m² intensity with sunrise-sunset simulation capabilities.
- Blowing rain, falling and blowing snow simulation.
- Complete suite of ancillary systems for customer vehicle operation, including hydrogen and electric vehicle compatibility.
- Wireless capability to generate and detect sub-6 GHz signals using integrated antennas.





Test section features

Overall dimensions	L 20.1 m x W 13.5 m x H 7.5 m
Useable length	<ul style="list-style-type: none"> • 14.3 m for cars & trucks • 19.1 m for trucks & buses
Vehicle entry clearance	W 3.93 m x H 4.49 m (Corner No.1 turning vane set open)
Adjustable nozzle	7.0 to 13.0 m ² : H 2.9 m x W 2.4 to 4.5 m
Canopy for buses	22 m ² : H 4.4 m x W 5 m (used with 13.0 m ² nozzle)
Turntable diameter	11.7 m
Boundary layer removal	<ul style="list-style-type: none"> • W 5.25 m main suction system • Provision for secondary suction
Vehicle exhaust extraction system	<ul style="list-style-type: none"> • Dual or single exhaust pipes • Open or closed mode with back pressure regulation • Maximum flow rate: 0.62 kg/s (8.5 L, 400 HP engine) • Maximum inlet exhaust temperature: 650°C
In-chamber fuelling	<ul style="list-style-type: none"> • Station for Regular, RVP and Diesel • Plumbed in for hydrogen
In-chamber power	Outlets for plug-in vehicles



Dual closed-pipe vehicle exhaust extraction system

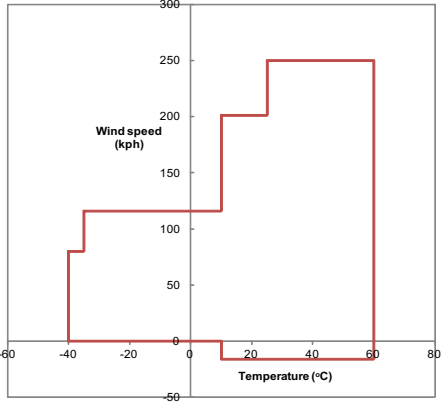


In-chamber refuelling station

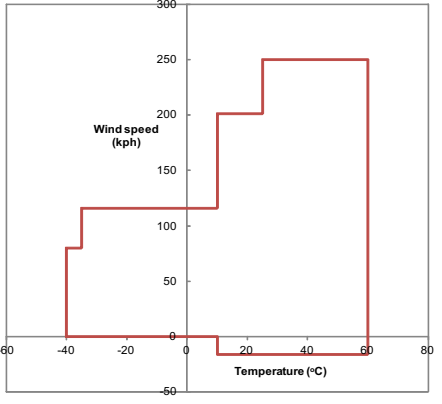
Wind speed and thermal performance

Full thermal control wind speed: 7.0 to 9.3 m² nozzle settings

7.0 m² nozzle



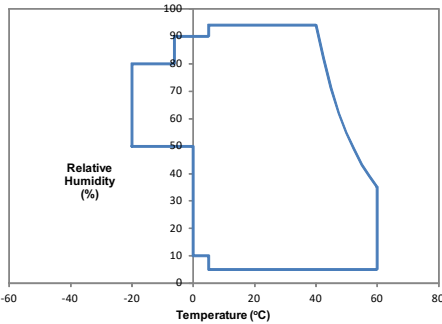
9.3 m² nozzle



Increased maximum wind speed: ambient conditions

Nozzle (m ²)	Wind speed (km/h)	Temperature (°C)
7.0	280	25
9.3	250	
13.0	225	

Humidity – temperature performance



Central floor track cover

Side floor track covers



Elevator

Air bearing



Thermal performance and flow quality specifications

Cooling system

- R507 primary loop with Dynalene HC-50 secondary loop
- Total heat capacity: 500 kW at -40°C , 2100 kW at ambient

Thermal performance

Parameter	Set Point Change	Rate	Test Condition
Temperature	<12°C	0.8°C/min	70 to 105 km/h; 32°C to 50°C
	<6°C	0.6°C/min	<115 km/h
	>6°C	0.08°C/min	<115 km/h
Humidity	20% RH	1.0% RH/min	38°C dry bulb

Flow quality

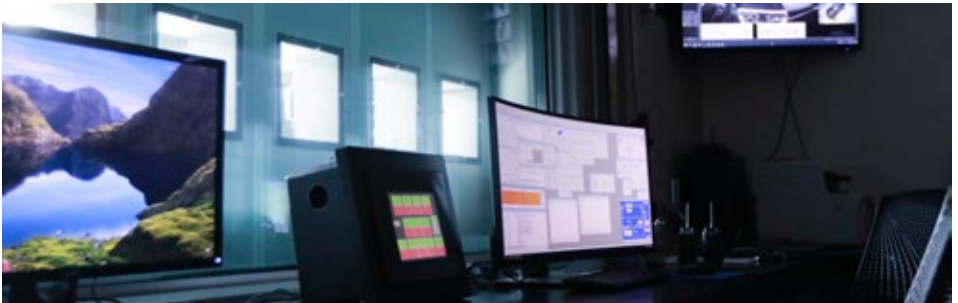
Parameter	Uniformity (σ)	Stability
Wind speed	1% of set point	± 0.5 km/h
Flow angularity	0.5°C	
Temperature	0.3°C	$\pm 0.2^\circ\text{C}$ at velocity > 48 km/h
Humidity	0.5°C (dew point)	$\pm 0.5^\circ\text{C}$ (dew point)

Boundary layer displacement thickness

δ^* less than 5 mm at 0.9 m ahead of the front chassis dynamometer roll set at 90 km/h, 25°C air temperature.

Background noise level: 9.3 m2 nozzle

Wind speed (km/h)	Out-of-flow SPL (dBA)
50	64
100	81
140	90
250	107



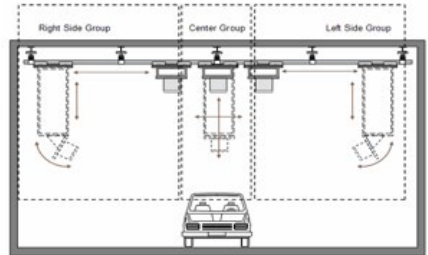
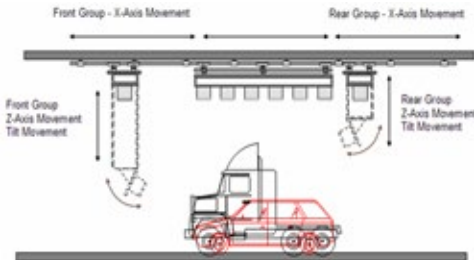
Chassis Dynamometer specifications

Manufacturer and Model	Burke E. Porter (custom design)
Vehicle types	Passenger car, light and medium duty trucks, buses
Axle configurations	FWD, RWD, 4WD, AWD (4 independent rolls)
Roll width	812 mm (4 identical)
Roll diameter	1219 mm (4 identical)
Roll surface	Tungsten carbide, aggressive finish (0.8 μ)
Clear space between rolls	1067 mm (identical front and rear)
Wheelbase range	1600 to 5842 mm
Location of front fixed axle from nozzle exit plane (0° yaw)	3000 mm
Location of rear fixed axle from nozzle exit plane (180° yaw)	9200 mm
Normal maximum yaw angle range	$\pm 30^\circ$
Floor features	<ul style="list-style-type: none"> • Automatic floor track and side roll cover system • Moveable central inspection port with infrared camera
Total inertial simulation range	907 to 9072 kg
Maximum axle load	5000 kg
Maximum vehicle weight	9072 kg
Maximum speed	250 km/h
Motor type	AC (Vector Drive Duty)
Nominal maxim power	187 kW per roll, motoring and absorbing; 92 to 250 km/h
Base speed	92 km/h
Continuous tractive force rating	7301 N per roll; 0 to 92 km/h
Tractive force overload	150% for 60 seconds; 0 to 92 km/h
Features	Robot driver; customer specified drive cycles
Configuration	Elevator and air bearings permit removal from test section

Solar Simulation System specifications

- Full diurnal function with azimuth and altitude.
- Full spectrum capability with vertical and biaxial movement.

Manufacturer	KHS Steuernagel
Target size	<ul style="list-style-type: none"> • L 6.5 m x W 2.5 m • 1.5 m above test section floor
Intensity range	600 to 1200 W/m ²
Intensity incidence	0 to 52.5°
Spectrum	ASTM Std E-892
Intensity quality	<ul style="list-style-type: none"> • Uniformity $\pm 10\%$ • Stability $\pm 2\%$
Lamps	<ul style="list-style-type: none"> • Metal halide • 21 total



Solar array showing front illumination
(9.3 m² nozzle)



Solar array arranged for a bus
(13 m² nozzle and 22 m² canopy)

Rain and Snow System specifications

Rain simulation system

Frontal rain simulation system located at the nozzle exit provides:

- Up to 12 nozzles of various sizes as needed to provide adequate coverage of a given vehicle.
- Designed for 150 km/h at 20°C but will operate as low as -5°C to perform freezing rain tests.



Blowing rain intrusion test



Measuring freezing rain on a bus

Snow simulation systems

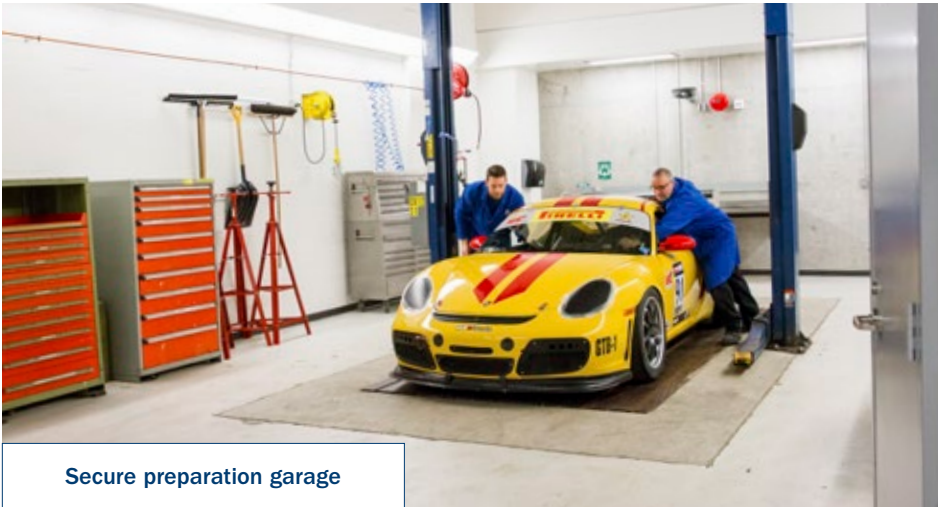
There are two configurations of snow simulation possible: frontal (blizzard) and overhead. In both cases, snow guns are used to create the snow.



Emergency blizzard simulation

Ancillary equipment

Vehicle starting power	200 amp, 12 V DC and 24 V DC
Pressure radiator fill	System capable of charging from a pressurized vessel
Gas tank and differential cooling	Cooling water system to provide cooling during high load tests
Refrigerant charging system	<ul style="list-style-type: none">• Two charging systems, one for R134A or equivalent, the other for alternative refrigerants.• Capability to pull a vacuum once refrigerant has been reclaimed.



Secure preparation garage



Electric vehicle and charger testing



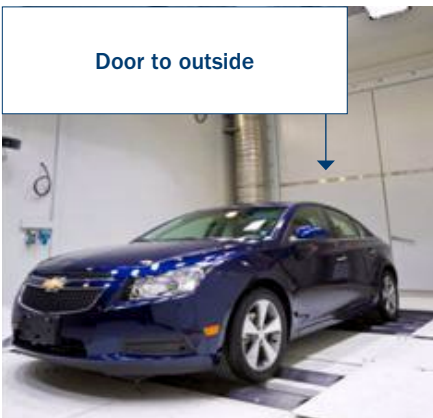
Large Climate Chamber

Key features

- Exceptionally long test section to permit articulated buses.
- Temperature from -40°C to +60°C and humidity from 5 to 95 per cent relative humidity.
- Chassis dynamometer.
- Solar simulation system up to 1200 W/m² intensity.
- Inter-chamber door to Small Climate Chamber to permit insertion of a test bench to effect a 'three-chamber' mode.
- Complete suite of ancillary systems for customer vehicle operation, including hydrogen and electric vehicle compatibility.

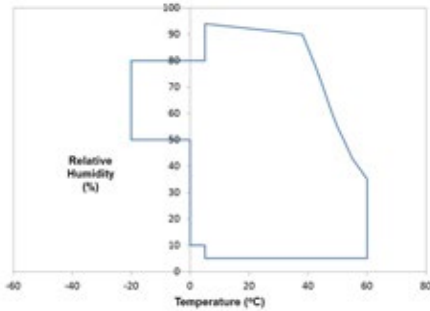
Ancillary equipment

Overall dimensions	L 20.8 m x W 6.0 m x H 5.55 m
Vehicle entry clearance	<ul style="list-style-type: none"> • W 3.93 m x H 4.49 m to outside • W 4.26 m x H 4.49 m to transfer area
Inter-chamber door clearance	W 2.01 m x H 2.01 m
Primary exhaust extraction system	<ul style="list-style-type: none"> • Dual mode: open pipe or closed pipe with back pressure regulation • Maximum flow rate: 0.62 kg/s (8.5 L, 400 HP engine) • Maximum inlet exhaust temperature: 650°C
Secondary vehicle exhaust extraction system	Garage type open pipe (2 pipes)
In-chamber power	Outlets for plug-in vehicles





Thermal performance specifications



Other performance:

- Maximum cooling rate: +60°C to -40°C in 6 hours
- Temperature uniformity: $\sigma = 0.33^\circ\text{C}$ (tested at 20°C)

Chassis Dynamometer specifications

Manufacturer and Model	Mustang Engineering Co. (MD-AWD-500-SE)
Vehicle types	Passenger car, light duty trucks
Axle configurations	FWD, RWD, 4WD, AWD
Roll width	940 mm (7 identical per side: 5 front, 2 rear)
Clear space between rolls	610 mm (identical front and rear)
Wheelbase range	2134 to 3556 mm
Mechanical inertia	<ul style="list-style-type: none"> • 636 kg front (motorcycle mode) • 888 kg front • 983 kg rear
Total inertial simulation range	655 (motorcycle) to 907 (single axle) to 5448 kg (dual axle)
Maximum axle load	2727 kg
Maximum vehicle weight	5448 kg
Maximum speed	<ul style="list-style-type: none"> • 280 km/h FWD • 240 km/h AWD
Motor type	Eddy current, power absorbing only
Nominal maximum power	<ul style="list-style-type: none"> • 447 kW Front roll set • 894 kW Total
Continuous tractive force rating	<ul style="list-style-type: none"> • 6227 N Front roll set • 12455 N Total

Solar Simulation System specifications

Manufacturer	KHS Steuernagel
Target size	<ul style="list-style-type: none">• L 5.6 m x W 2.5 m (fixed)• 1.5 m above test section floor
Intensity range	600 to 1200 W/m ²
Spectrum	ASTM Std E-892
Intensity quality	<ul style="list-style-type: none">• Uniformity $\pm 10\%$• Stability $\pm 2\%$
Lamps	<ul style="list-style-type: none">• Metal halide• 18 total



Small Climate Chamber

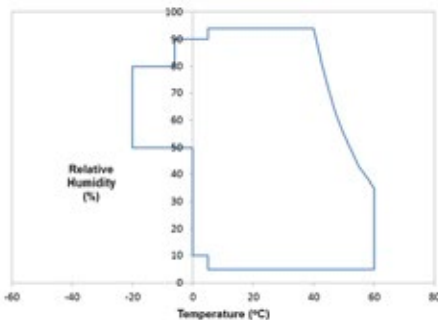
Key features

- Large enough to accommodate two cars, and a variety of architectural prototypes.
- Temperature from -40°C to +60°C and humidity from 5 to 95 per cent relative humidity.
- Inter-chamber door to Large Climate Chamber to permit insertion of a test bench to effect a 'three-chamber' mode.
- Directly linked to climatic wind tunnel via dry transfer area.
- Complete suite of ancillary systems for customer vehicle operation, including hydrogen and electric vehicle compatibility.

Test section features

Overall dimensions	L 9.0 m x W 6.0 m x H 5.5 m
Vehicle entry clearance	<ul style="list-style-type: none"> • W 3.68 m x H 4.49 m to outside • W 4.26 m x H 4.49 m to transfer area
Inter-chamber door clearance	W 2.01 m x H 2.01 m
Passive exhaust extraction	Garage type
In-chamber power	Outlets for plug-in vehicles

Thermal performance specifications



Other performance:

- Maximum cooling rate: +60°C to -40°C in 6 hours
- Temperature uniformity: $\sigma = 0.17^{\circ}\text{C}$ (tested at 20°C)



4-Post Climate Chamber

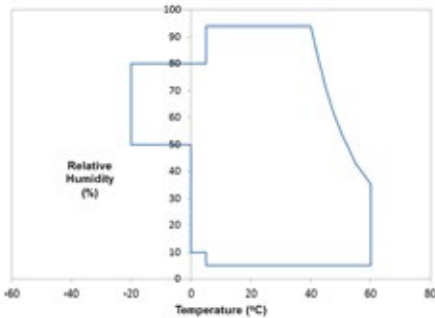
Key features

- Drive-on post feature with automatic positioning system.
- Temperature from -40°C to +60°C and humidity from 5 to 95 per cent relative humidity.
- Dual modes: road load simulation and high flow high-G.
- Complete suite of ancillary systems for customer vehicle operation.

Test section features

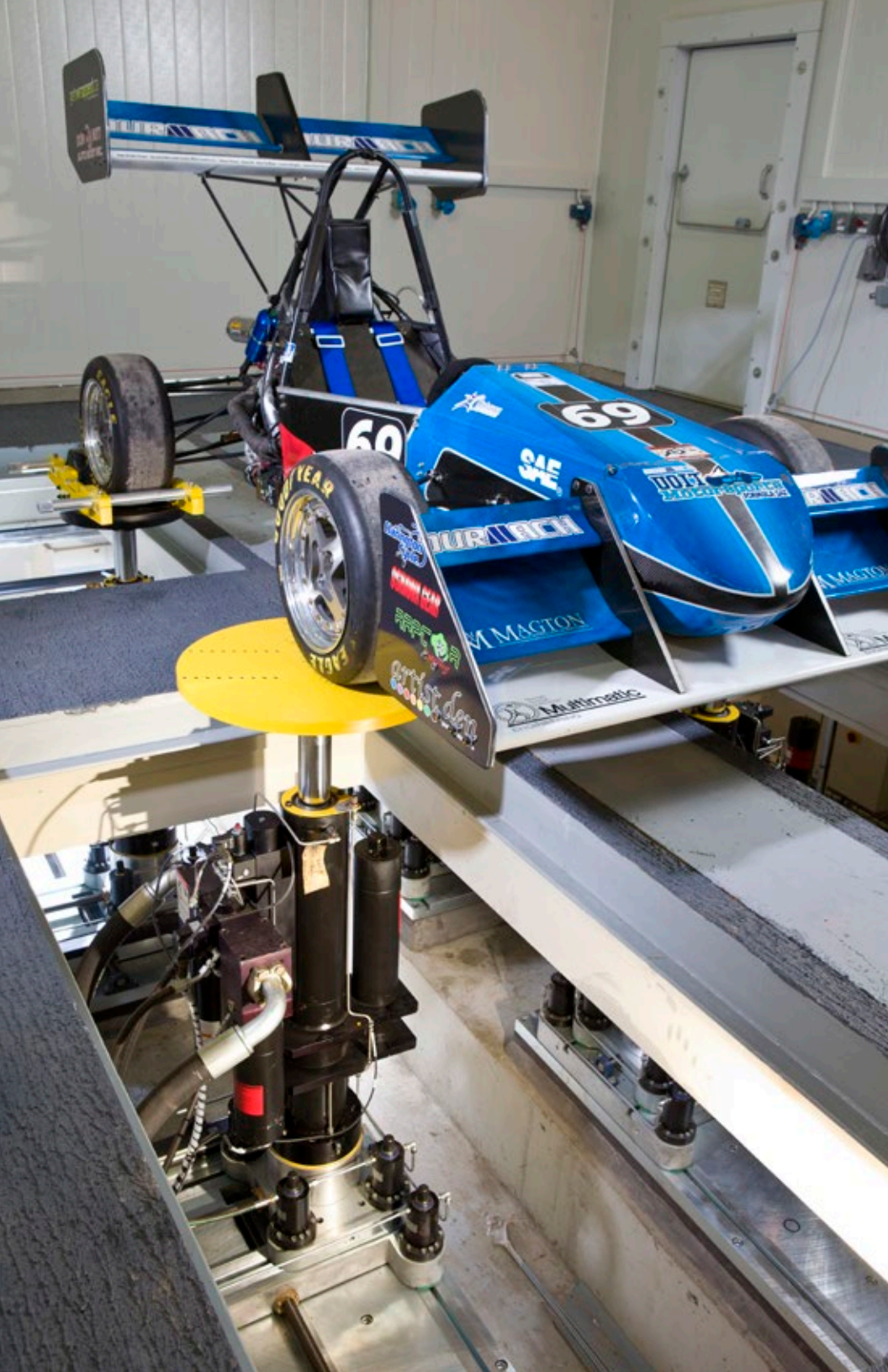
Overall dimensions	L 8.3 m x W 7.2 m x H 5.6 m
Vehicle entry clearance	W 4.26 m x H 4.49 m
Drive-on wheel pans	Remotely adjustable track and wheelbase
Exhaust extraction system	Garage type
Safety	Man-down pull cord
In-chamber power	Outlets for plug-in vehicles

Thermal performance specifications



Other performance (measured):

- Maximum cooling rate: +60°C to -40°C in 6 hours
- Temperature uniformity: $\sigma \leq 1.05^\circ\text{C}$ over the entire temperature range -40°C to +60°C
- Temperature stability: $\sigma = 0.28^\circ\text{C}$ over the entire temperature range -40°C to +60°C



4-Post Shaker specifications

Manufacturer and model	MTS 248.05
Control system	Flextest GT w/ 793 system software
Simulation software	MTS RPC Pro software
Actuator force	50,000 N
Servo valve flow	11.3 L/s
Vehicle types	Passenger car, light duty trucks
Track range	1270 mm to 2110 mm
Wheelbase range	1572 mm to 4572 mm
Vehicle weight	4500 kg
Range of motion	+/- 150 mm
Frequency response	0.5 Hz to 50 Hz
Maximum acceleration	19.5 g to 100 g (depending on moving mass)
Maximum velocity	5 m/s





PIRELLI

HUB tands

GTB

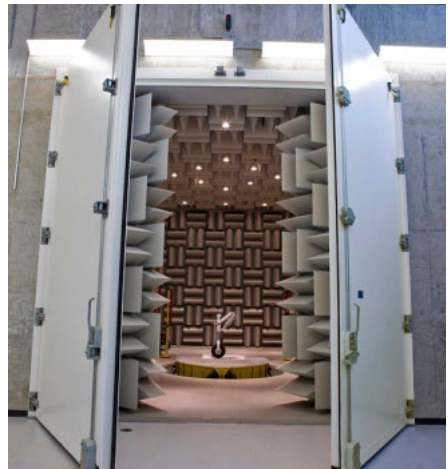
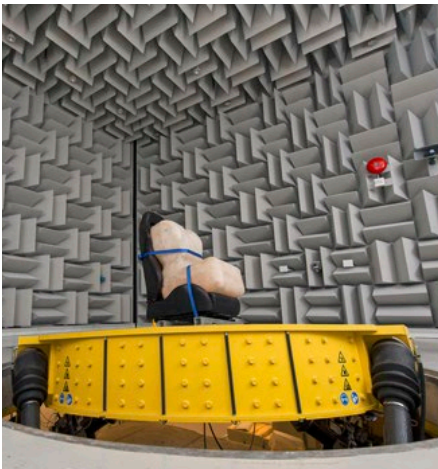
Hemi-Anechoic Chamber with Multi-Axis Shaker Table

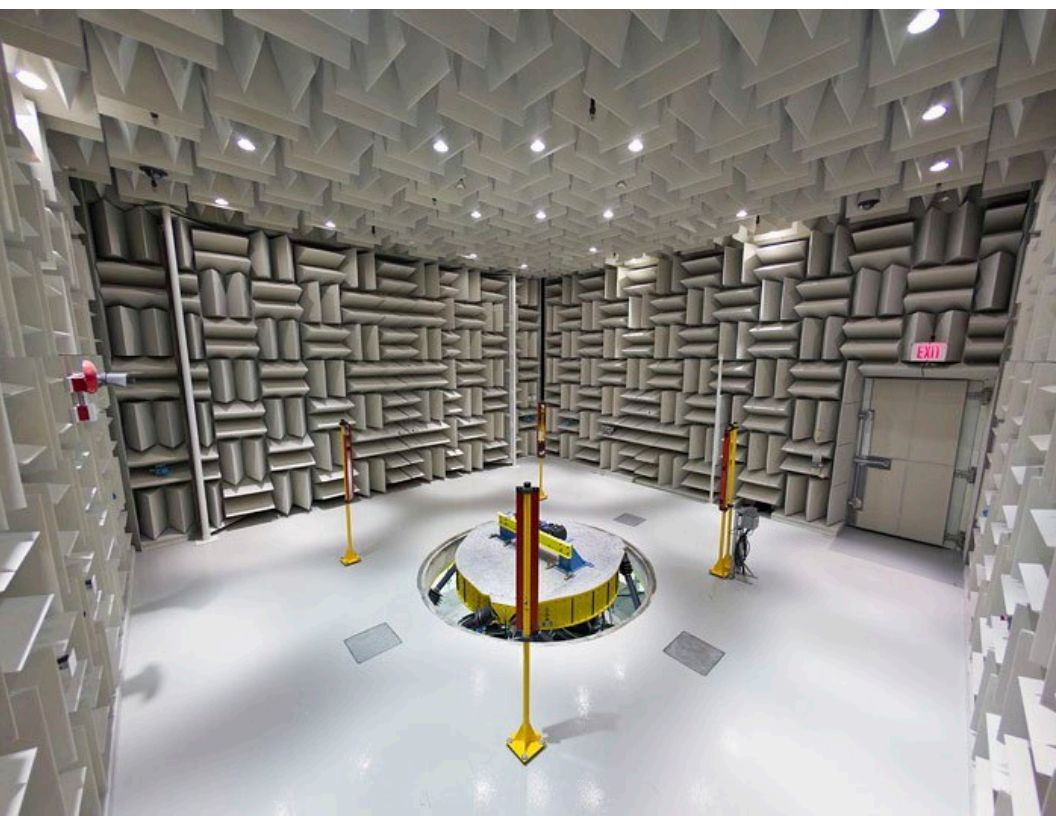
Key features

- Hemi-anechoic chamber, 150 Hz cutoff frequency with exceptionally low background noise.
- 6 degrees of freedom (3 translational, 3 rotational) inverted hexapod hydraulic shaker table.
- A 108 microphone Acoustical Array allows a customer to very quickly determine sources of noise, and then evaluate mitigation strategies.

Test section features

Overall dimensions	<ul style="list-style-type: none"> • Inside room surface: L 9.00 m x W 8.87 m x H 5.15 m • Clearance to acoustic treatment: L 7.6 m x W 7.5 m x H 4.4 m
Test object entry clearance	W 4.41 m x H 4.35 m
Chamber acoustics	<ul style="list-style-type: none"> • Cutoff frequency: 150 Hz • Background noise level measured to NC-16 with ventilation system operating (<25 dB above cutoff frequency)
Pit opening for shaker table	2.77 m diameter
Safety	Laser based light screen
Pure acoustic test set-up	Portable cover plates for pit





Multi-Axis Shaker Table specifications

Manufacturer and model	MTS MAST Table 353.20
Control system	Flextest 100 w/ 793 System Software
Simulation software	MTS RPC Pro Software
Table diameter	2.0 m
Test object max payload weight	680 kg
Maximum translation displacements	<ul style="list-style-type: none"> • Vertical: ± 150 mm • Lateral: ± 120 mm • Longitudinal: ± 120 mm
Maximum rotation displacements	<ul style="list-style-type: none"> • Pitch: $\pm 8^\circ$ • Roll: $\pm 8^\circ$ • Yaw: $\pm 6^\circ$
Maximum velocities	<ul style="list-style-type: none"> • Vertical: 1.0 m/s • Lateral: 0.8 m/s • Longitudinal: 0.8 m/s
Bare table response	<ul style="list-style-type: none"> • Frequency response: 150 Hz • Vertical Acceleration: 17.8 g • Lateral Acceleration: 10.5 g • Longitudinal Acceleration: 10.5 g
Maximum payload response	<ul style="list-style-type: none"> • Frequency response: 100 Hz • Vertical Acceleration: 11.0 g • Lateral Acceleration: 6.5 g • Longitudinal Acceleration: 6.5 g

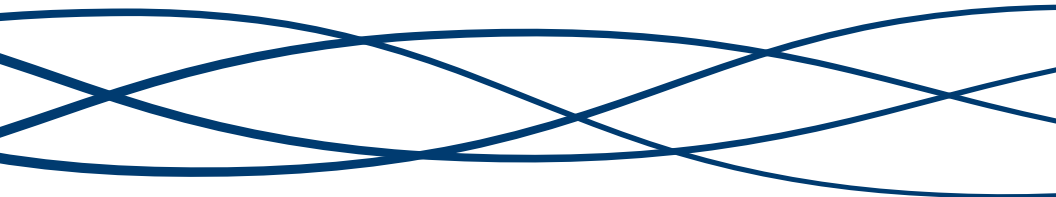
ACE Innovation Garage

Key features

- Prime, modern collaboration space for Industry, Academic Researchers and Student Experiential Learning.
- Fully Secure Office and Lab Space (controllable by tenant).
- Flexible space containing preparation areas, machine shop, offices, laboratories, conference rooms and common work areas that are available to rent.

Capabilities

First floor	<ul style="list-style-type: none">• Total area: 731 m²• Support shop with benches, machine tools, welding and grinding equipment and common use tools and equipment• High-bay heavy lab preparation hall with entry door to outside• Flexibility - let's discuss your needs
Fourth and fifth floors	<ul style="list-style-type: none">• Office space<ul style="list-style-type: none">• Outfitted with desks and Internet• Conference room available• Lab space (reconfigurable)<ul style="list-style-type: none">• Bare heavy lab floor• Drop-down power: single phase 120 V, single phase 240 V, three phase 575 V• Shop air 125 psi• Available natural gas and exhaust ventilation connections





Let's discuss your test plan
acemarketing@ontariotechu.ca

