

Battery Pack Testing Using MAST Systems

“SEES Vårkonferens 2026”

Presenter:

Stefan Pettersson

Staff Applications Engineer

Stefan.Pettersson@mts.com

MTS Systems

April 21, 2026



- About MTS
- Introduction to MAST Systems
- Battery Pack Testing Using MAST Systems
 - » Market Trends
 - » Overview
 - » Pros
 - » Cons
 - » Opportunities
- Conclusion
- Useful Links

■ History



- » Founded in 1966
- » HQ in Eden Prairie, Minnesota, USA
- » Part of Illinois Tool Works (ITW) since 2021

■ Four Business Units

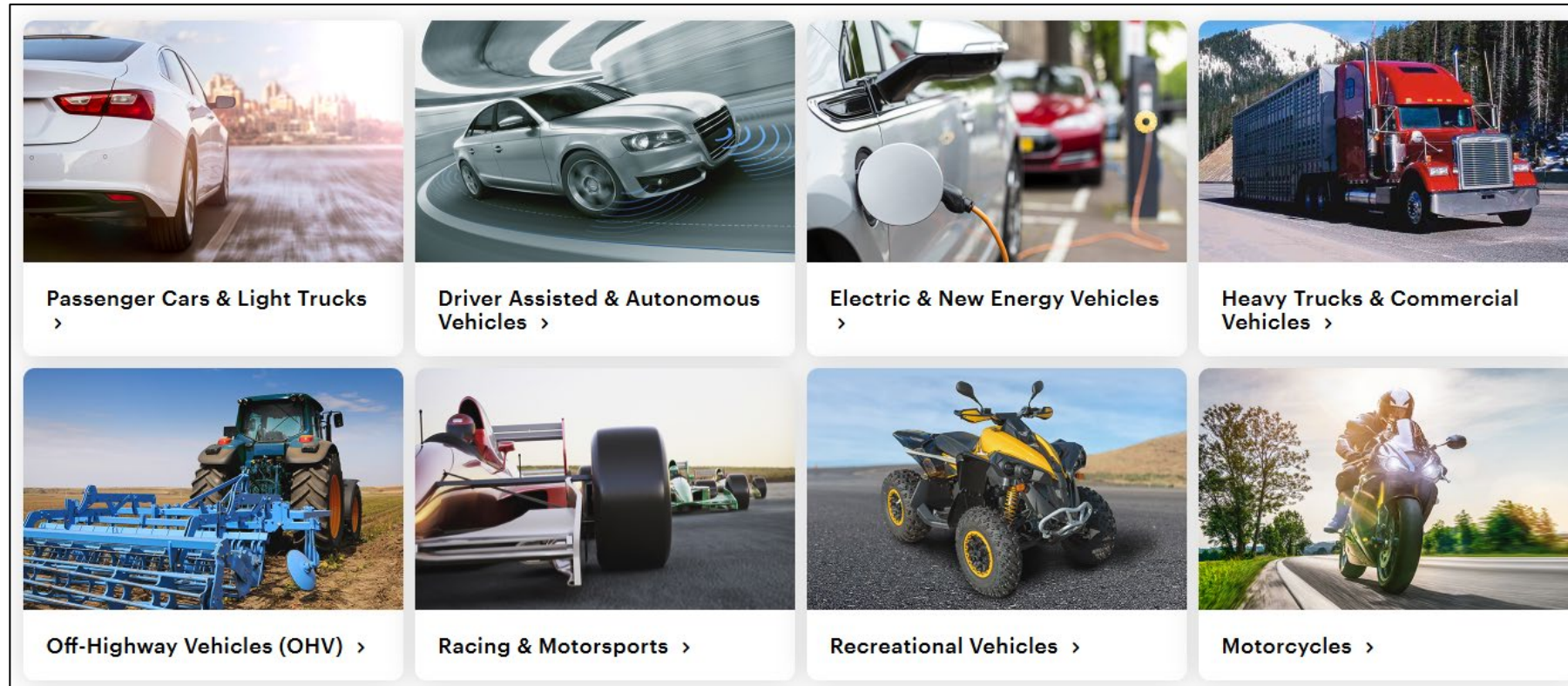
- » GRV (Ground Vehicles)
 - Automobile (cars, light trucks), Commercial Vehicles, Racing, Defense, Rail, etc.
- » Mat (Materials)
- » STR/AER (Structures and Aviation)
- » Service

■ Presence

- » Engineering & Manufacturing mainly in the USA
- » Global Sales and Service Operations through Affiliates and Business Partners



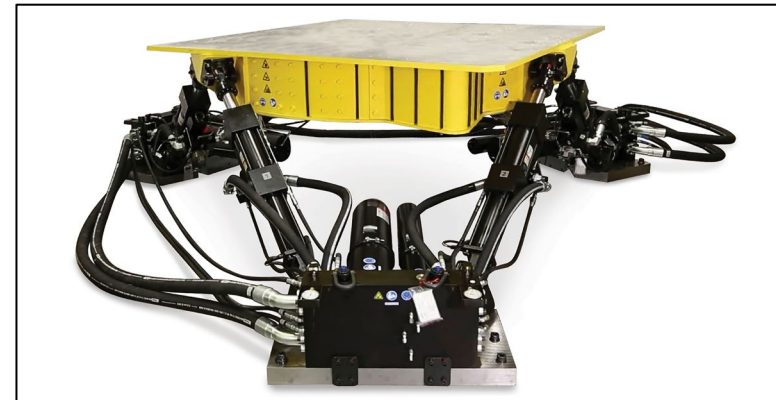
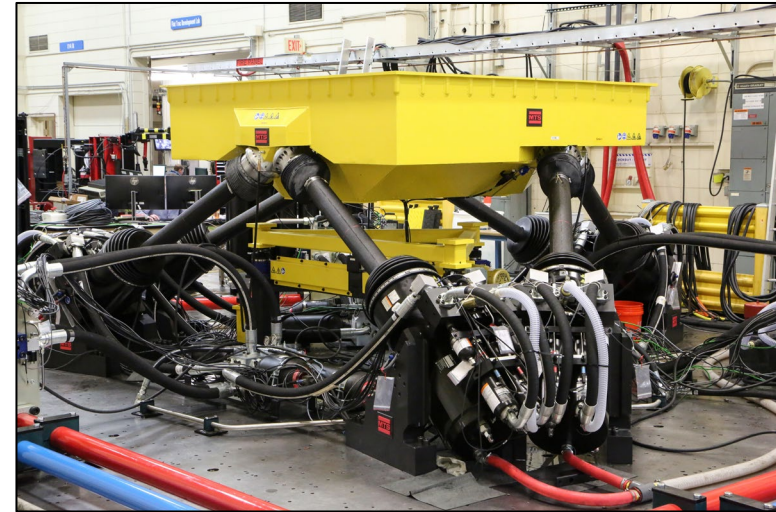
- GRV
- Customers
 - » OEM's, Contract Test Labs, Tier 1-2 Suppliers, Universities, Research Institutes, etc.
- Market



Introduction to MAST Systems

MAST
Multi-**A**xial **S**imulation **T**able

- What is a MAST Systems?
 - » Solution to introduce vibration & motions into a Component / Assembly
- Typical Solution
 - » Table
 - » Actuators
 - Servo Hydraulic Actuators
 - Fixed (with strut and swivel assemblies)
 - Pinned (between two swivels)
 - » Accumulation
 - » Hydraulic Power Unit (Pump)
 - » Motion Controller
 - » Software



MAST Systems – Examples of Device Under Test (DUT)

- Battery Packs
 - » BEV (Battery Electric Vehicle)
 - » PHEV (Plug-in Hybrid Electric Vehicle)
- Powertrain Mounts
- Fuel Tanks
- Radiators
- Seats
- Electrical Systems
- Instrument Panels
- Exhaust Systems
- *Seismic Applications
- *Transportation/Packaging Standards



■ Test Applications (Test Standards and/or Customer Correlated Proving Grounds (PG))

» Durability

- “Run to failure”
- Intended Service Life

» NVH

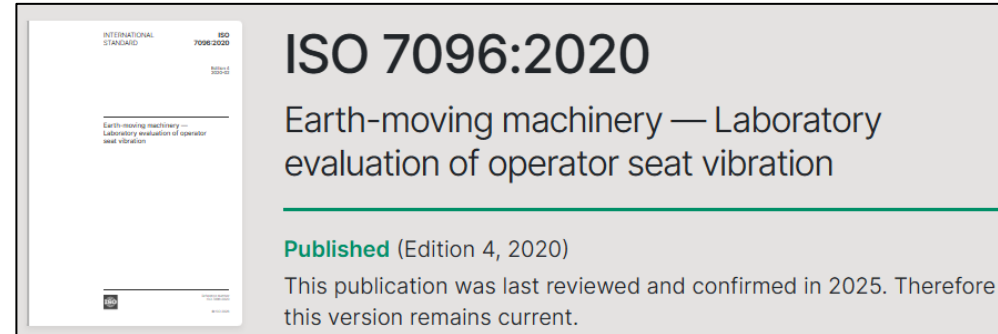
- Squeak & Rattle
- Noise Vibration & Harshness

» Performance Tests

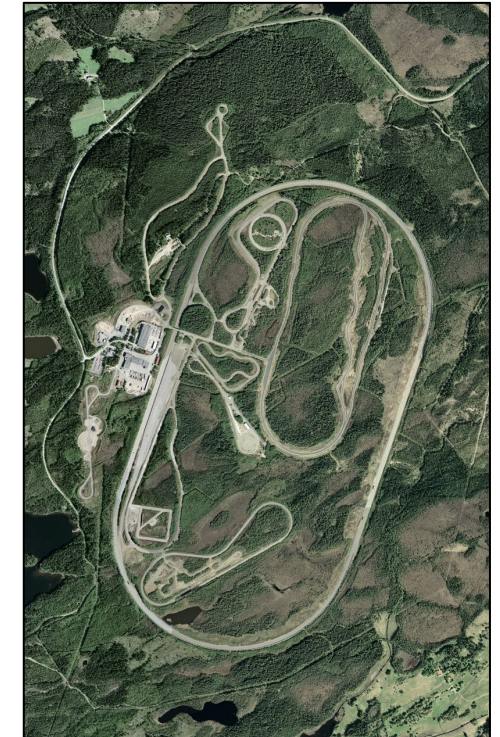
- Environmental Asepects
 - Temperature, Humidity, Heat Load (Solar)
- Transmissibility
 - Ride Comfort (Option for Human in Test Space)

» Quality Tests

- End of Line (EOL)

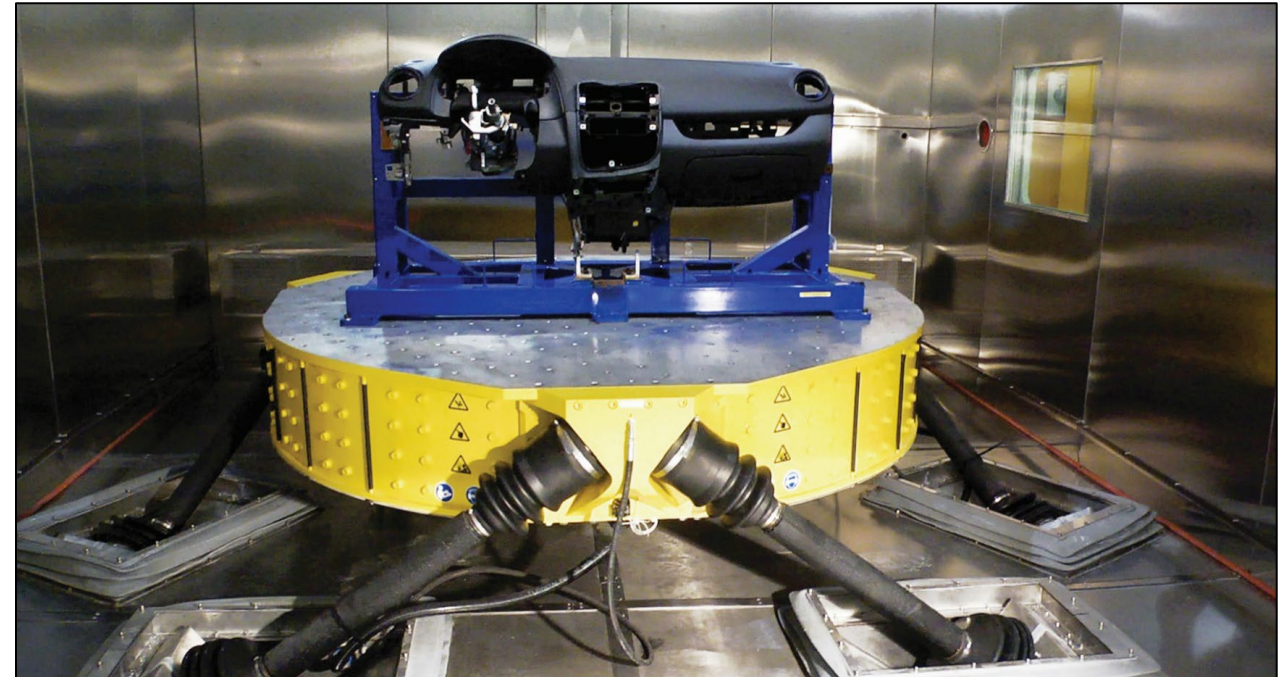


Hällered Proving Ground is Volvo Cars' primary 7-million-square-meter testing facility near Gothenburg, Sweden, featuring over 30 km of tracks for rigorous, around-the-clock vehicle durability, safety, and performance testing.



MAST Systems – Test Applications

- Anechoic Chamber Installation
 - » <https://vimeo.com/58445723>
- Environmental Chamber Installation
 - » <https://vimeo.com/58986001>



MAST Systems – Why Test on a MAST?

- Why do customers perform multi-axial simulation tests of components/subsystems?
 - » To more efficiently and accurately reproduce road inputs
 - » To more efficiently and accurately reproduce engine inputs
 - » In-phase DOF necessary to:
 - Validate durability life of vehicles, subsystems, and components
 - Ensure quality and reduce warranty expenses
- Advantages of testing in the lab:
 - » Increases consistency and repeatability of test inputs and test results
 - » Shortens vehicle development cycle:
 - Accelerate tests by eliminating non-damaging content
 - Perform test before full vehicle is available
 - Minimizes delays due to weather
- Reduces human injuries when running on proving ground

MAST Systems

- MTS is leading the MAST Market
- Over 230 Installations
 - » We have learned a thing or two...



MTS MAST Offerings

Orthogonal

323 Series

Hexapod

353.10

353.20

353.50

354.20

Custom Solutions





Model 353.10

- 1 meter round table
- Up to 500 kg payload
- Up to 500 Hz control bandwidth
- Durability applications
- NVH applications
- Environmental chamber integration
- Anechoic chamber integration



Model 353.20

- 2 meter round or 2.2 meter square table
- Up to 1,000 kg payload
- Up to 150 Hz control bandwidth
- Durability applications
- Ride Comfort applications
- Environmental chamber integration
- Anechoic chamber integration



Model 353.50

- 2.5 meter square table
- Up to 3,000 kg payload
- Up to 100 Hz control bandwidth
- Heavy-duty Durability applications
- Seismic applications



Model 354.20

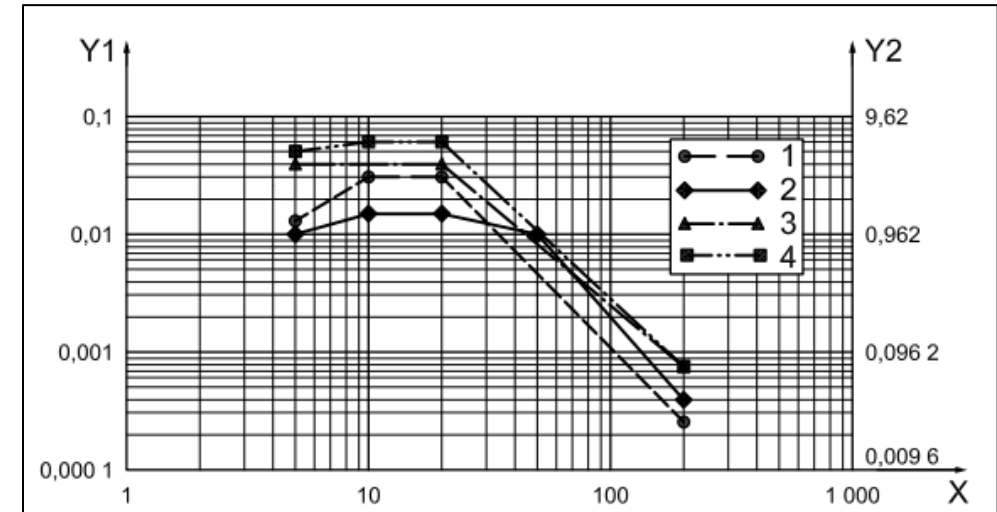
- 2 meter round or 2.2 meter square table
- Up to 2,000 kg payload
- Up to 100 Hz control bandwidth
- Heavy-duty Durability applications
- Seismic applications

Battery Pack Testing Using MAST Systems

- MAST Market Trend
 - » Vehicles are changing – Hybrid and fully electric vehicle focus
 - » New vehicle OEM's entering market
- Customer demands are changing
 - » **Increased focus on battery pack testing**
 - » Increasing product life expectancy
 - » Increased focus on ride comfort
 - » Less time to test and fewer prototypes available
 - » Shorter vehicle development cycles
- Warranty recalls are increasing with the EV Market
 - » Battery Packs is one contributor (but not only)
 - Engineering errors, Manufacturing defects, Software (thermal management)

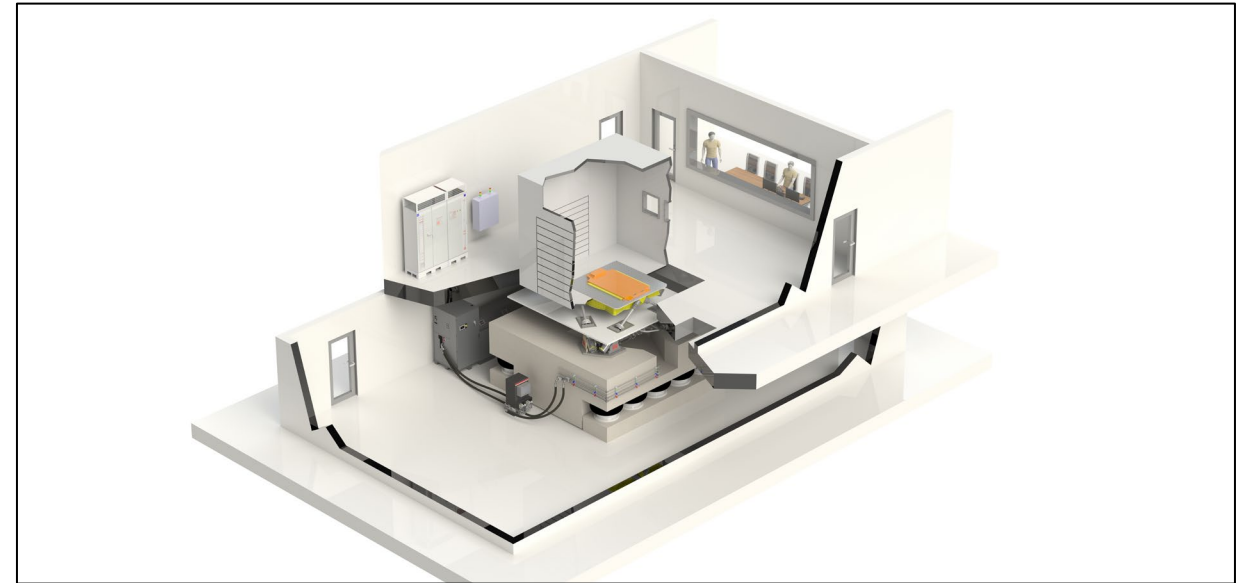
Battery Pack Testing - Requirements

- Applications
 - » Durability
 - » Performance Tests
 - » Quality Tests (EOL)
- Vibration Motion Platform
 - » Uniaxial (ED Shakers)
 - » MAST Systems
- Test Requirements
 - » Standards
 - ISO 12405, SAE J2380, UN 38.3, etc.
 - ISO 12405 Most Common (three parts; Vibration 200Hz, Vibration 2000Hz, Shock)
 - **Part 1:** “The test shall be performed in accordance with IEC 60068-2-64:2008, Tables 20 to 23, **or** according to a test profile determined by the customer and verified to the vehicle application”



Battery Pack – Example Installation

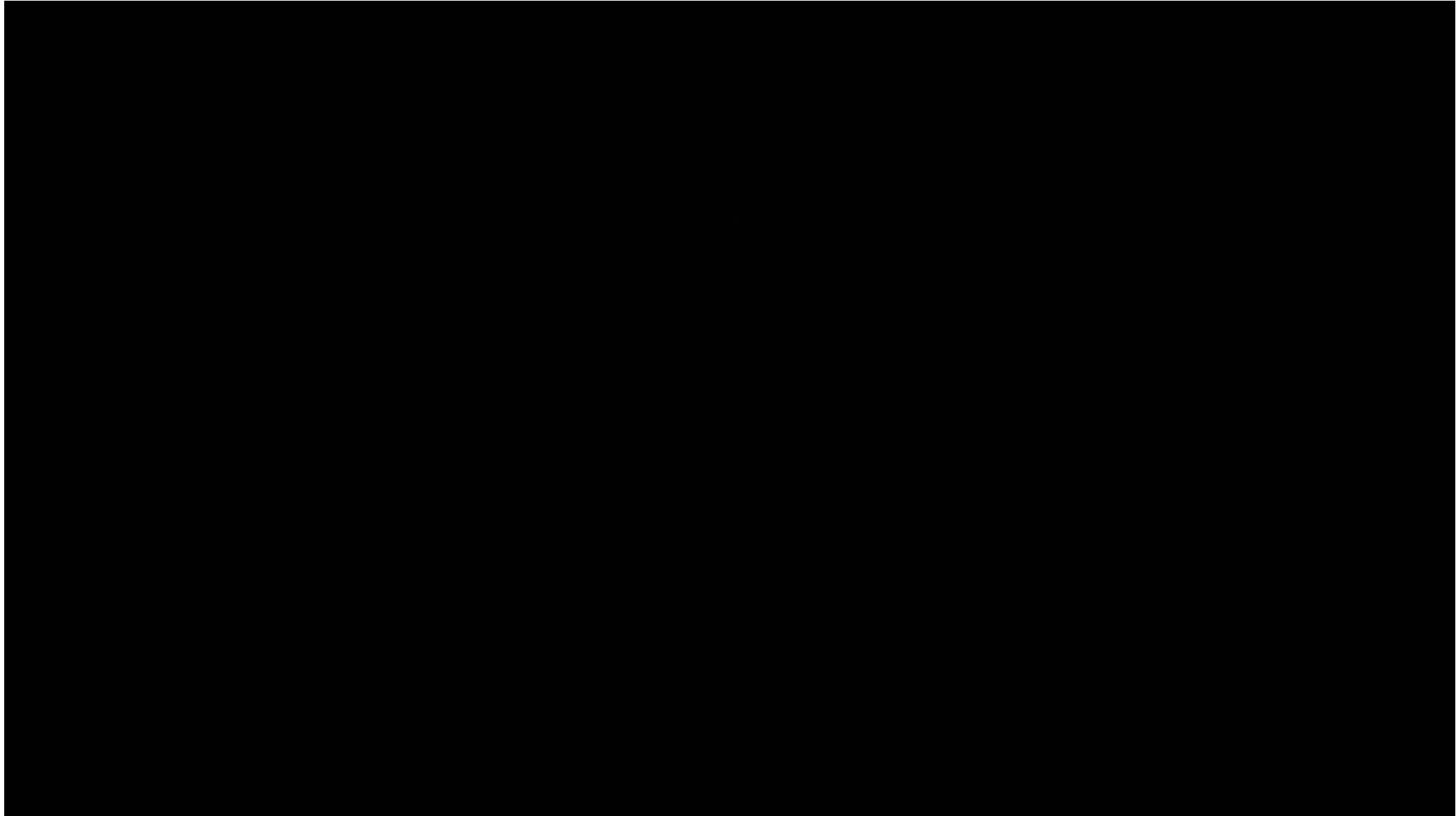
- Motion Platform (MAST)
- Environmental Chamber
- BMS – Battery Cyclers
- Safety Systems
- Specimen Monitoring System



Testing typically driven by charge and discharge schedules of battery packs that will trigger:

- Start/Stop of Vibration
- Temperature Schedules (Ramp to, Hold at)

Battery Pack – Example Installation (CTAG Spain)



Battery Pack Testing

■ MTS Has 21 installations, per ISO 13849

353.20 Qty 18

- 2.2m Table, 200Hz
- 1000kg

» 354.20 Qty 2

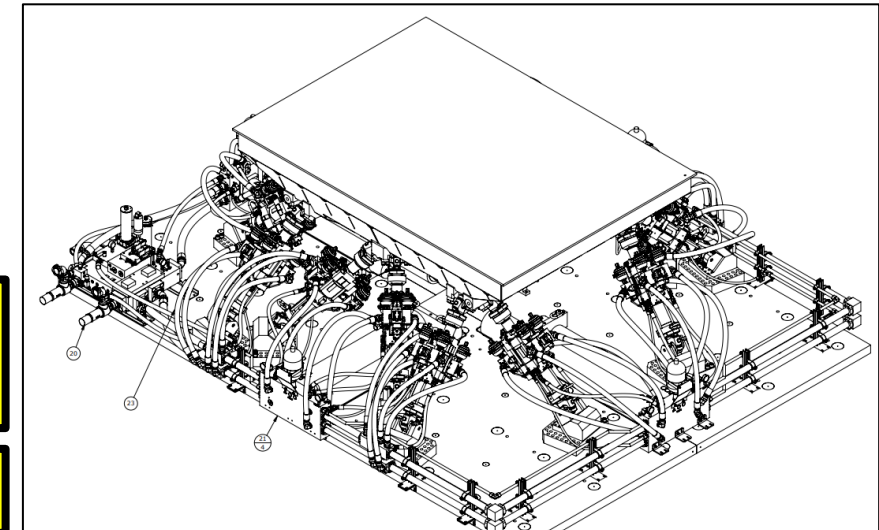
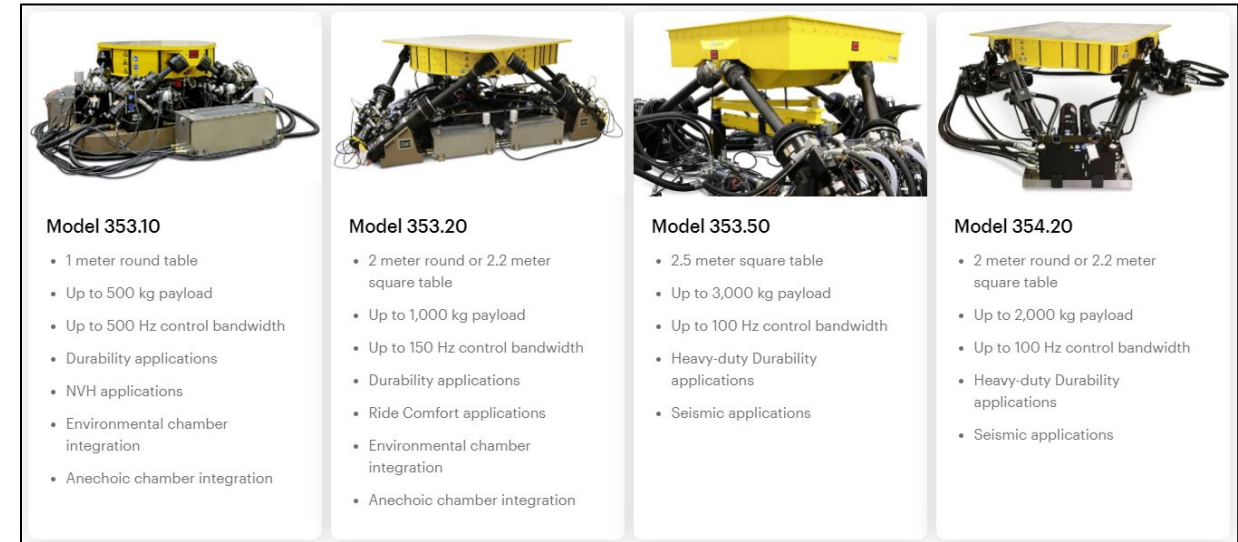
- 2.2m Table, 200Hz
- 2000kg

» 353.50 Qty 1

- 2.5m Table, 200Hz
- 3000kg

» Custom

- 3.5 x 2.5m Table, 200Hz
- 2000kg



Trends for larger tables and increased specimen mass

Our Customers Value Versatility

- Pros
 - » Quick Transition between Uniaxial Tests – No need to reconfigure the system and/or chamber
 - » Test using Proving ground data (6DOF)
- Cons
 - » Not meeting all testing requirements (high frequency, shock)
 - » Incorrect boundary conditions due to stiff tables
- Opportunities
 - » Improve boundary conditions (active/non active)
 - » Follow market trends for new technology (hydrogen, etc.)

Hydrogen Fuel Cell Trucks

In addition to combustion engines, Volvo is advancing hydrogen fuel cell technology through the Cellcentric joint venture with Daimler Truck and Toyota. This collaboration focuses on scaling fuel cell systems for heavy-duty trucks, enabling zero-emission electricity generation on board. Fuel cell trucks emit only water vapor and are ideal for long-range applications where battery-electric trucks may be impractical due to weight or charging constraints.

- Customers needs more than one system
 - » Not one system do it all...
- Non correlated test standards
- Testing quality can be improved
 - » MAST Systems
 - Durability of complete Battery Packs in 6 DOF
 - Need for improved/accurate boundary conditions
 - » ED Shakers
 - Components testing at cell level
 - Shock
 - Transportation and handling

- MTS Systems MAST Website
 - » <https://www.mts.com/en/products/automotive/subsystem-component-test-systems/multi-axial-simulation-table-systems>
- The Integrated EV Battery Vibration Test Cell (CTAG Spain)
 - » <https://www.mts.com/en/articles/automotive/ctag-battery>
- Electric Vehicle Battery Testing
 - » <https://www.mts.com/en/articles/automotive/battery-test>
- High Payload MAST Systems
 - » <https://www.mts.com/en/articles/automotive/high-payload-vibration>
- Large Geometry EV Battery Pack Testing
 - » <https://www.mts.com/en/articles/automotive/large-battery-vibration>
- Dual Use MAST System; Durability and Human Rated Ride Comfort
 - » <https://www.mts.com/en/articles/automotive/dual-use-mast>

Thank you!

