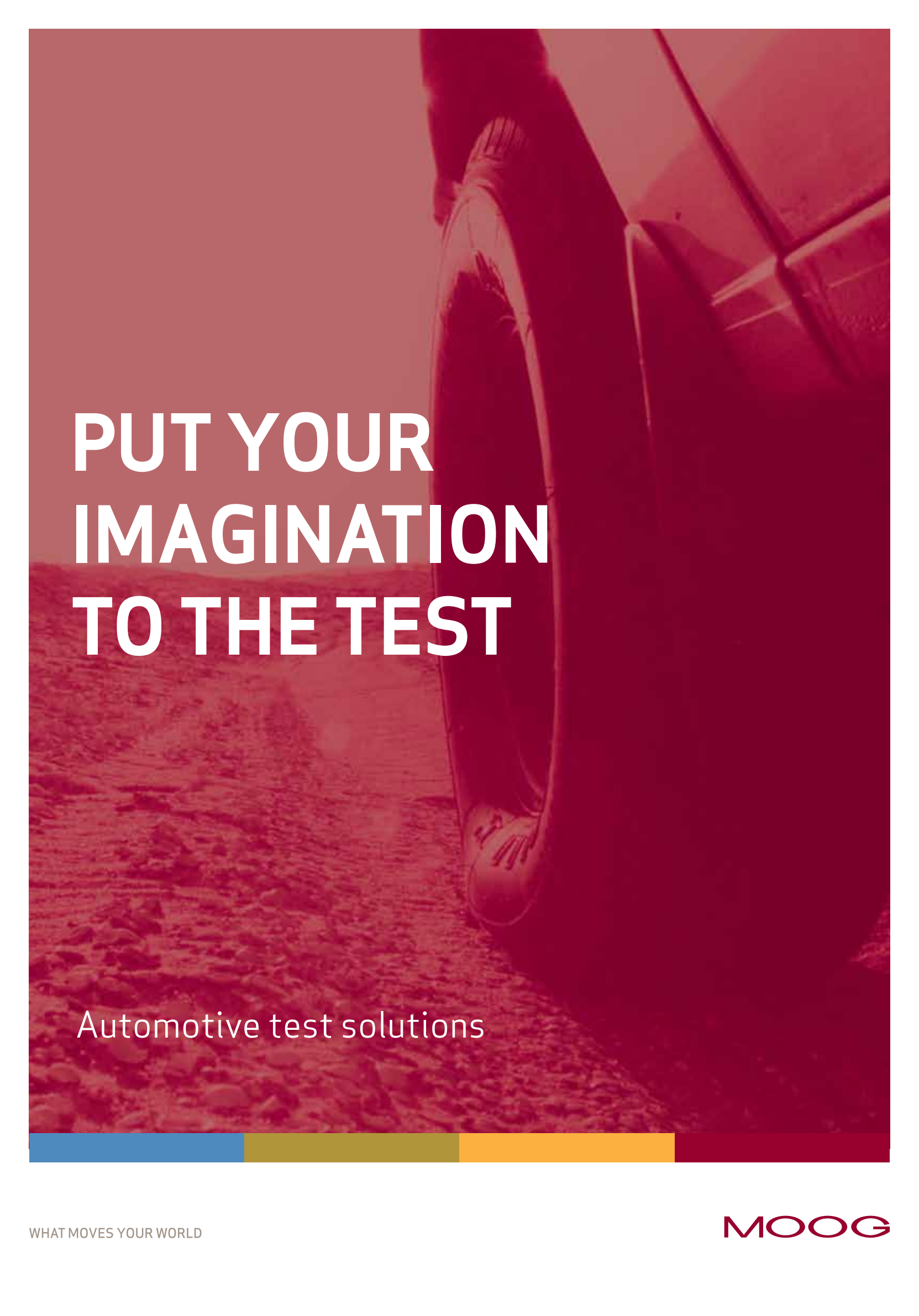




PUT YOUR IMAGINATION TO THE TEST

Automotive test solutions

TEST SOLUTIONS BUILT AROUND GOOD IDEAS. YOURS.

There's never been a more challenging time for professionals in the automotive test arena. New designs, shorter vehicle time-to-market, increased regulatory pressures and the drive for cost efficiencies mean today's test and application engineers must be innovative and resourceful in approaching every test. Technology is advancing, opening opportunities to integrate physical and virtual testing. And that means going beyond the same old test equipment you've used for decades.

At Moog, we understand what it takes to be successful in this industry. Combining the global resources of a billion-dollar corporation whose solutions are found in applications ranging from heavy industry to space and defense, and the flexibility of a forward-thinking engineering group with roots in testing and simulation, we deliver leading-edge solutions for automotive manufacturers and test labs around the world.

In fact, our solutions have been in test labs for years. Through a key strategic acquisition in 2003, we added a knowledge base in automotive testing that extends back to the 1970s. Today, our team draws from a solid, financially stable corporation to deliver smart automotive test designs. Over the years, we've installed more than 2,500 systems at more than 300 customers worldwide. What's more, almost every test lab in the world relies on Moog's Servovalves for precision motion control performance.

Our mission is to deliver the flexibility, innovation and trusted solutions you need for a fresh approach to automotive testing. To make your tests more reliable. More cost-efficient. More effective. And to help you take your ideas far beyond what's possible today.

THE RIGHT PARTNER FOR A NEW ERA IN AUTOMOTIVE TESTING

While our experience designing state-of-the-art automotive test systems, flight simulators and aerospace test systems helps our design teams stay ahead of the curve on testing technology, it's our customer-focused approach that truly sets Moog apart.

Understanding your challenges

No matter how long you've been in the industry, there is always room to improve your capabilities, develop new methods or systems, or take your test processes to the next level.

Serving the needs of both automotive OEMs and related suppliers ensures consistency on a global basis. What's more, we work hard to understand how you work, and design solutions around your needs, rather than relying solely on the same off-the-shelf systems that everyone else uses.

Instead, we collaborate with you to create the best test solution for your specific need—and then deliver a turnkey solution that incorporates high-performance components and software tailored to your particular applications. It's a more flexible approach that puts your ideas and input first.

When it comes to today's key challenges, Moog is out in front in a variety of ways including:

- Maintaining a presence in emerging markets
- Innovating testing technologies like human-in-the-loop
- Ensuring global consistency
- Integrating physical and virtual testing
- Spearheading new technologies such as electric actuation

Innovation that drives performance

Automotive testing may have been around for more than 100 years, but we're always focused on finding new and better ways of working.

For example, Moog pioneered the commercial servovalve in 1951, contributing to the test industry as we know it through the

application of precision motion control. Today Moog is a pioneer in introducing electric-based technologies to the test lab—creating cleaner, more power-efficient performance in equipment traditionally associated with hydraulics.

Our hexapod design is another example of how Moog's research and development has moved over from the aerospace world to help customers work more efficiently in 6-Degrees of Freedom (DOF) applications. It provides a minimal footprint and optimized power supply for a range of key test applications.

In addition, thanks to our experience in simulation and robotics, we're helping push the limits of human-in-the-loop testing; allowing customers to safely incorporate a dramatically higher degree of test control and more accurate data generation.

Finally, we're helping customers gain the benefits and savings of rapid prototype evaluations in the lab using testing technologies versus building costly prototype vehicles. It all adds up to a partner with the expertise and resources you need to develop new designs, reduce vehicle time-to-market, gain cost efficiencies and overcome tough regulatory pressures.

Global reach, personal touch on the local level

In more than 26 countries worldwide, Moog representatives are ready to respond to your auto test needs. Whether it's providing a key Moog component or facilitating the design of a one-of-a-kind test rig, our technical teams have earned a reputation for taking on the toughest challenges and making them our own. And because we're truly a global organization—working in the world's key automotive manufacturing centers like Japan, China, India, Korea, France, Germany and the US—you can expect prompt turnaround times and a close, face-to-face working relationship with a partner who understands your market.

Our global reach and experience working with the world's largest companies in aerospace and industry also means unsurpassed consistency in products, systems and solutions.

CAR ROOF MAKER THULE TWISTS AND TURNS WITH NEW MOOG TEST RIG

If you've ever had to carry bicycles, skis or even a surfboard on the roof of your car, you may know the Swedish roof rack maker Thule. For those who've hauled bikes or luggage on a road trip, a strong, reliable roof rack is indispensable equipment. And now Moog is helping to make that even more so.

The request

Thule - the world's leading supplier of car rack systems - picked Moog to supply a test rig, that simulates the conditions its products face when fastened to the roof of a car. Whether you're racing to the beach with a surfboard strapped to your roof rack, or facing buffeting winds in a mountain pass with luggage atop your SUV's rack, Moog's test rig simulates the twist and turns of the road.

The solution

Moog delivered to Thule the complete test system, including a Simulation Table, unlike any on the market. Moog's design stemmed



from work it had done with flight simulators. Rather than building a conventional orthogonal system, which has a table moved by actuators mounted on its base and sides, Moog took a unique approach. Moog's system has six degrees of freedom (DOF) in the table, moves in the x, y and z-axes with pitch, roll and yaw, and has files that are played by Moog's servo controller.

The result

Only Moog's Simulation Table could reach the performance specifications Thule needed to achieve. While the hexapod is proven technology, Moog is the first company to use it in this kind of application. The Simulation Table can run continuously for several days, a period equivalent to hundreds of thousands of road miles. Thule is pleased with its new test system that is part of its newly opened labs. It is compact, clean and user friendly, yet able to carry out complex tests.

REDEFINING PERFORMANCE THROUGH ADAPTED SOLUTIONS

From our open architecture approach to software that helps you maximize your current system investment to a wide array of components and test rigs designed for every conceivable test application, you'll find a Moog solution that's right for you.

This includes concept to reality solutions for component testing, turnkey test systems, dedicated test servocontrollers, and a wide range of the test application software in the test business.

One of our core competencies is in control for Hexapod-based systems. The Hexapod's parallel structure makes them well-suited for 6-DOF automotive testing. Its compact mechanical design reduces facility requirements and floor space, while providing large symmetrical excursions for translations and rotations.

Here is a broad overview of the products and systems we're delivering around the world.

SINGLE- AND MULTI-AXIS TEST SYSTEMS



For critical analysis and test flexibility, Moog' test rigs are designed for efficient operation in a range of single- and multi-axis applications including durability, vibration, shock and performance evaluations. All units can be modified to accept a range of test specimens.

DRIVING SIMULATOR



Our hexapod design enables human-in-the-loop testing and feedback of key ride and handling characteristics including ergonomic issues such as seat comfort. Recent applications include human evaluation of virtual tires and suspension designs.

RIDE AND COMFORT TEST SYSTEMS



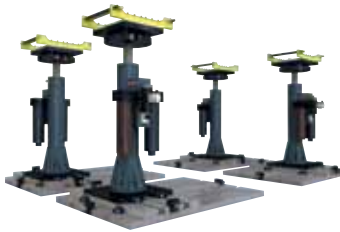
The human rated electric Simulation Table incorporates six electric actuators to deliver required 6-DOF accelerations. The hexapod design provides a minimal footprint. In addition, the test controller plays the files and provides exacting levels of control and operation to bridge the gap between digital data and human sensations.

KINEMATICS & COMPLIANCE SYSTEMS



Our 6-DOF Kinematics and Compliance measurement systems have been developed in partnership with automotive manufacturers seeking highly accurate stiffness and kinematics measurements using either force or displacement control. Our revolutionary hexapod technology and electric actuation provide simpler installation, less required space and low maintenance costs. In fact, we are the only company to incorporate electric hexapod design into automotive kinematics and compliance testing.

4-POSTER TEST SYSTEMS



Our 4-Poster Test Systems based on hydraulic test actuators with hydrostatic bearings are used in a variety of applications. They're found in research labs where they are used for ride quality assessment and Noise, Vibration and Harshness (NVH) testing. They're used in durability test labs to prove selected structural, chassis and suspension designs. And they're used in production facilities to assess squeak and rattle concerns. The systems incorporate fatigue-rated actuators for the specified vertical accelerations and they can withstand the side loads.

SUSPENSION TEST RIGS



Creating and measuring forces to simulate and to test real time fatigue of the car suspensions taking into account a maximum of vehicle dynamics and creating different test loads.

Our compact 6-DOF Suspension Test Rig is used by major automotive customers to perform complex and highly dynamic suspension and full vehicle chassis durability and fatigue testing. The rig incorporates Moog's latest force loop control and iteration software enabling you to accelerate set-up time. This test rig can apply forces up to 80 Hz to front and rear axles.

GENUINE PRODUCTS TO ENSURE BEST PERFORMANCE

MEETING THE CHALLENGE OF A NEW TESTING GENERATION WITH MAXIMUM VERSATILITY AND STIFFNESS

The hexapod configuration used by the Simulation Table is the optimum design to achieve simulation and test capability using acceleration, force and displacement inputs, and to reproduce data collected on proving grounds regardless of your test type, method or specimen. By understanding today's test trends and challenges, and listening closely to the needs of customers around the world, we provide the right tools and proactive expertise to take automotive test applications further than you ever thought possible. To meet the high demand for hydraulic Simulation Tables to accommodate loads up to 680 kg (1,500 lb), we developed a standard Simulation Table based on a new generation of hydrostatic actuators providing more stiffness and versatility.



Hydraulic Simulation Table

TEST CONTROLLERS

A customized approach for structural and performance automotive testing.



Portable Test Controller



Automotive Test Controller

Moog delivers the flexibility, innovation and trusted solutions you need for a smart approach to aerospace testing. The heart of all our solutions is the control hardware and software that sets the pace for the industry.

Test controller advantages include:

Test versatility — Single channel and multi-axis test systems, structural durability testing and fatigue test spectrums.

User-friendly operation — For maximum flexibility in your test lab and less set-up time.

Run test precisely and securely — Constant amplitude and phase matching engineering specifications, test interruption prior to catastrophic failure.

SOFTWARE SUITE



Moog provides open architecture control software developed specifically for your unique test needs in durability and fatigue, simulation, vibration, measurement and analysis.

The test software offers a unique straightforward approach to inherently complex processes. For example, it makes simulation using iteration,

a notoriously complex and time-consuming test technique, easy and fast to use, even for novice users. A rich integrated sequencing tool allows full block programming with loops, serialized and parallel instructions. Additionally, script instructions can be integrated in the sequence to perform custom actions. Online, frequency and time domain response based safety functions are also supported.

Moog delivers on a wide range of specific test application software packages for systems identification, iteration, sequences building and monitoring. In addition to custom application software, our standard interface allows customers to implement their own applications.

The test software suite is totally compatible with all common data formats on the market today. In addition, the PC-based test and our application-specific software solutions use standard TCP/IP hardware to connect to our test family of controllers, as well as to our test controllers.

ACTUATORS AND SERVOVALVES

Moog Servovalves, manifolds and actuators are just a few of the components that are critical to Moog' solutions. By focusing on the performance of these high-quality individual components, the entire system can reach higher levels of efficiency, reliability and longevity.



Servovalve



Hydraulic Test Actuator

WE'RE THERE FOR YOU, TEST AFTER TEST

Moog serves your needs well before the sale...and continues our commitment well afterwards.

From system commissioning to Moog Authentic Repair® services to ongoing product support and rig upgrades, such as replacing your analog servocontrollers with new digital models, our expert engineers are on call around the world for start-up and installation, troubleshooting, on-site repairs or replacements and maintenance. Whatever it takes to give you personal, turnkey support and help you get the most from your equipment investment.

Training tailored to your team

While our products and software are designed for simplicity and turnkey operation, our training programs can help your team work smarter, faster and more effectively. We offer a variety of training sessions designed around how you work. Simply call the Moog representative nearest you and we'll get you the answers you need.

A new era begins today

Whatever your automotive test application may be, we invite you to meet with us. Through collaboration on a global scale, state-of-the-art systems that challenge the status quo, and a nimble team of engineering experts dedicated to you, we can move your ideas ahead and help put your imagination to the test.

LEAVING THE ROAD... AND THE COMPETITION... BEHIND

Mercedes-Benz stands for pioneering automotive innovation for more than 100 years. With an average number of 7 patents each day, they secure their leading technological position on a consistent basis.

The request

To continue their trendsetting product development tradition, Mercedes Benz sought to combine comfort and agility in the ideal combination. This is the reason why they turned to Moog to create their ride and comfort testing solution.

The solution

Moog provided Mercedes-Benz with a test solution that met their technical requirements and supported their business objectives to take a new step in digital prototyping to test ride and comfort of their prototype. Our proven experience in flight simulation and our ability to enable human beings to participate in the testing (e.g. called human-in-the-loop in the testing industry) sets us apart from other system providers and was key in developing a test based on a Simulation Table. In this case, the human being would be able to



accurately assess feelings of comfort and realism which is very difficult to do remotely.

The result

Moog's technological expertise and proven experience were key to defining a customized test solution with Daimler's test lab engineers. The business challenge for Mercedes-Benz was to validate the results of the digital simulation in terms of ride and comfort. This testing approach was part of the first digital car prototype production pioneered by Mercedes Benz and that car is now on the road.

TAKE A CLOSER LOOK.

Automotive test solutions from Moog are available around the world. For more information, visit our Web site or contact one of the locations below.

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