

QUANTUM TECHNOLOGIES

OEM QUALITY POWERTRAIN INTEGRATION • CONCEPT VEHICLES • ALTERNATIVE FUELS

LEADING THE WAY WITH

Alternative Fuel Systems

H2 Hybrid Technology

Lightweight CNG Tanks

High Pressure H2 Storage

HYDROGEN IN MOTION

Quantum's HyHauler Solution for

Civilian and Military H2 Fueling





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F R O M C O N C E P T T O P R O D U C T I O N



CREATING 21ST CENTURY TRANSPORTATION

Vehicles on the road today offer exceptionally high levels of quality, safety, durability, and performance, yet, even after a century of advancing automotive technology, challenges remain. Growing dependence on petroleum imported far from North America, along with continuing air quality issues caused by motor vehicle emissions, have prompted increased interest in vehicles that offer greater environmental performance and use less petroleum fuels.

Quantum Fuel Systems Technologies Worldwide, Inc., (Nasdaq: QTWW)

storage systems. Many store hydrogen in 5,000 psi tanks, while some of the latest generation fuel cell vehicles make use of Quantum's 10,000 psi TriShield™ storage systems. These tanks, which broke new ground as the first to be certified and successfully tested for this purpose, offer the ability to store more hydrogen in the same amount of space. The result is improved driving range of up to 60 percent.

While Quantum is known for its advanced alternative fuel components

QUANTUM HAS PRODUCT COMMERCIALIZATION ALLIANCES WITH GENERAL MOTORS, AM GENERAL, AND SUMITOMO. THE COMPANY'S GROWING CUSTOMER BASE INCLUDES, GM, TOYOTA, OPEL, HYUNDAI, SUZUKI, FORD, DAIMLERCHRYSLER, AEROVIRONMENT, AND THE U.S. ARMY.

has over 40 years of proven success in providing solutions to these challenges. Quantum is widely recognized as the leading source for advanced gaseous fuel storage, fuel delivery and metering systems, electronic controls, and system integration for fuel cell applications, hydrogen refueling systems, and hybrid electric propulsion.

SYSTEMS INTEGRATION

Over the years, Quantum's enabling technologies have played a crucial role in helping automakers and other developers bring natural gas and propane cars, trucks, vans, and buses to the highway. Development programs with major automakers have also found Quantum's technologies incorporated into vehicles powered by hydrogen fuel cells and other advanced powerplants.

Some of the most well-known fuel cell vehicles now operating on public highways store their hydrogen in Quantum's lightweight composite TriShield™

and systems – and of course their important role as enabling technologies – it's the company's proven capabilities in vehicle integration that make Quantum much more than the sum of its parts. Simply, it's one thing to produce some of the industry's most advanced alternative fuel components, and another to design and integrate systems that use these components to produce Original Equipment Manufacturer (OEM)-quality alternative fuel vehicles. Quantum does both, specializing in designing and integrating complete OEM powertrain systems, either in all new ground-up vehicles or existing production vehicle models.

This process draws on the capabilities of Quantum's Advanced Vehicle Concept Center in Lake Forest, California, which features state-of-the-art engine development facilities, a complete emissions laboratory, and a chassis dynamometer. Here, Quantum manages the only commercial SULEV emissions laboratory on the West Coast recognized by the California Air

Resources Board (CARB). This lab is also one of only a few select West Coast emissions facilities capable of testing vehicles fueled with hydrogen.

As part of the services it offers, Quantum conducts engine and vehicle development, safety and emissions certification, and prototype development for the auto industry, and is the manufacturer of record for a major automaker's half-ton CNG powered pickup truck. Quantum performs and assumes responsibility for alternative fuel system validation, emissions testing, and obtaining vehicle certification from CARB as part of its role as the manufacturer of record.

Quantum's 45,000 square foot manufacturing/technical center in Troy, Michigan, features three separate dynamometer test cells for testing or tuning engines. One of these, a 2WD, 4WD, or AWD chassis dynamometer capable of handling engines up to 2000 hp, is one of the largest in North America.

EVOLVING HYDROGEN ACTIVITIES

An area of growing interest is hydrogen infrastructure. Quantum offers hydrogen refueling systems targeting fleets of one to 20 vehicles and is in development of the HyHauler Plus™, a trailer-mounted hydrogen generation, storage, and dispensing system for hydrogen vehicles. This system uses electricity to generate hydrogen from water for on-demand fast-fills to 5,000 psi.

In recent years, Quantum has focused on the integration of technologies to produce highly-efficient hydrogen hybrid vehicles. There is growing interest in combining the efficiency of hybrid internal combustion and electric power with the advantages of clean hydrogen fuel. Quantum has developed and delivered hydrogen hybrids based on the Prius sedan through a program with the South Coast Air Quality Management District in California, and is continuing production to fulfill orders with additional customers.

ADVANCED GASEOUS FUEL COMPONENTS

QUANTUM'S LINE OF ADVANCED FUEL SYSTEM TECHNOLOGIES include gaseous fuel injectors, high-and low-pressure regulators, on-board diagnostics, high-performance fuel system control modules, fuel lock-offs, and related components for application in the stationary and portable power generation fuel cell markets. Quantum also designs and manufactures computerized controls, regulators, and automatic shut-off equipment, as well as lightweight, high-pressure hydrogen and natural gas storage tanks.





**“OUR SUCCESSES WITH THE U.S. ARMY
ARE LEADING TO NEW OPPORTUNITIES FOR OUR
HYDROGEN AND HYBRID VEHICLE TECHNOLOGIES.”**

—ALAN P. NIEDZWIECKI, PRESIDENT AND CEO, QUANTUM TECHNOLOGIES

DEVELOPING DUAL-USE TECHNOLOGIES

THE TRANSPORTATION NEEDS OF TODAY'S U.S. MILITARY are often complementary to the needs of civilian transportation. In both cases, fuel efficiency and the integration of alternative fuels have become increasingly important. The cost of fuel on the battlefield is orders of magnitude higher per gallon than even the highest costs experienced at gas stations today, largely the result of the logistics involved in moving fuel to where it's needed anywhere in the world.

Quantum is addressing this need by developing technologies, powertrains, and vehicles that either make the most of a gallon of gasoline or diesel fuel, or displace the need for this fuel altogether. One example of this is a hydrogen hybrid created by Quantum for the National Automotive Center (NAC), a part of the Department of Defense. Based on a Ford Escape Hybrid, this hydrogen hybrid incorporates some of the same technology used in creating Quantum's hydrogen Prius hybrids for municipal use. Another example is the HyHauler Plus™ mobile refueling station to support hydrogen fueling in the field.

ADVANCED CAPABILITIES

Beyond fuel efficiency and near-zero emissions, hydrogen hybrids offer other unique features important to the military, including the advantage of stealth. Hybrids that operate solely on electric power have low thermal and auditory signatures that offer a tactical advantage on the battlefield. They also offer the ability to generate off-board electrical power.

Hydrogen fuel cell vehicles like Quantum's off road Aggressor, developed to meet the needs of the military's Alternative Mobility Vehicle program, represent next-step thinking. Offering near-silent operation, the hydrogen Aggressor provides the ability to run on an advanced fuel that can be created from diverse sources, with the potential for this fuel to be produced in decentralized locations. Fuel cells are also capable of silently producing large amounts of 120V AC off-board electricity to provide power in the field.

The enhanced capabilities offered by these advanced powerplant technologies have enormous potential for civilian and military use. Developing vehicles and technologies to the highest standards and specifications, featuring OEM quality integration, is what Quantum does best.



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