



**Project Name:** Compact High Pressure Hydrogen Pump  
**Industry:** Automotive  
**Customer:** Nissan Motor Company  
**Website:** <http://www.nissan-global.com>



## A COMPACT HIGH PRESSURE HYDROGEN PUMP

### BACKGROUND AND PROJECT CHALLENGE

Proton Exchange Membrane (PEM) fuel cells are being developed as an alternative method for powering automobiles. PEM fuel cells produce DC electrical power which can be used to power electric drive systems in hybrid cars or to charge the main battery pack. The PEM fuel cells require a rugged, high performance fuel pump to deliver the hydrogen to the fuel cells in order for them to produce electricity. The pump, and associated motor electronics, must endure extremes in temperature, voltage, and speed and the internals are exposed to two-phase flow with hydrogen rich gas and water. Additionally, the units must reside in an extremely small envelope.

### PROCESS AND SOLUTION

PADT has the product development processes and experience to approach difficult problems like this one in an efficient way. Our initial work involved a thorough conversation about product requirements balanced against the technical challenges associated with aerodynamic performance, motor/bearing durability, and component size. We used our in-house analysis and simulation expertise to aid in this evaluation. This process allowed us to identify and prioritize development risks. Understanding these risks lead to an effective plan for our testing. PADT's philosophy is to analyze quickly and "reduce to practice" early in the development in order to fully understand the identified risks and flush out unknowns.

To accelerate this process, we often use a testing methodology that involves the use of surrogates. For this project, PADT developed a



PADT worked with Nissan for 4 years to develop a high pressure, high performance hydrogen pump. We have now delivered over 200 working systems and have supported fielded vehicles since 2006.

### DISCIPLINES EMPLOYED

Electrical Engineering  
Aerodynamic Engineering  
Mechanical Engineering  
Verification Testing  
Low Volume Manufacturing

surrogate for the internal components of the Nissan pump and built a small test chamber capable of replicating the vibration, temperature, moisture, pressure, hydrogen, and voltage characteristics of the actual product. With this approach we simultaneously tested many variations of the blower design, using an inexpensive surrogate, and within an environment that was realistic. The result was a design that achieved the stringent durability specification required for automotive use.

Within this project, the electric motor was found to be one of the key challenges. PADT worked with Nissan and our supply chain to implement a tightly controlled motor production in order to meet the design specifications. Throughout the development, PADT maintained daily communication with Nissan, using simple but effective tools and WEBEX meetings. PADT worked intimately with Nissan for about 4 years to develop the final design. We have now produced over 250 prototypes for Nissan and have supported their field program since 2006.

## PROJECT HIGHLIGHTS

Implemented PADT IP into custom solution for Nissan

Worked closely with Nissan's fuel cell development team since 2004

Project involved mechanical, electrical, and aerodynamic engineering

Developed high performance over several phases

Extensive verification testing was done throughout the project.

Delivered more than 250 units since 2004

Final design meets wide range of automotive performance specifications

Have supported fielded vehicles since 2006

## TESTIMONIAL

*"PADT has demonstrated strong concept creation and development testing abilities – and have done so with very short time schedules. PADT was in charge of a key component development for our Fuel Cell System, and accomplished it as planned. Owing to PADT's challenging spirit, Nissan was able to lease the 2005 model FCV's to some customers in the early period of 2006. In addition, Nissan has been able to continue the FCV leasing program for five years with PADT's reliable support."*

Arai Takayuki  
Senior Manager, EV Systems  
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Nissan Motor Company

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