

Case Study: National Gas Machinery Laboratory

Kansas State University Research Laboratory Uses Opto 22 SNAP PACs for Turbocharger Testing Processes

The National Gas Machinery Laboratory (NGML), an Institute of the College of Engineering at Kansas State University, was formed in 1995 and is home to the Turbocharger Test and Research Facility, one of the nation's premiere full-performance turbocharger testing labs.

Turbochargers are exhaust gas-driven compressors used to increase the power output of an internal-combustion engine by compressing the air entering the engine, thereby increasing the amount of available oxygen. (This added oxygen for the engine allows for greater power output.) A key advantage of turbochargers is that they offer this considerable increase in engine power with only a slight increase in weight. Because turbocharged engines produce more overall power than the same engine without the charging, over the years, many automakers including BMW, SAAB, Mercedes Benz, and Porsche, have utilized turbocharger technology in the engine design of their sports and luxury models. But although most people hear the word "turbo" and think "fast cars,"



turbocharger technology is also used for other purposes. At the NGML, the focus is on energy transmission and distribution.

In the US, natural gas is transported through an extraordinarily extensive and invasive pipeline system powered by massive reciprocating and gas turbine engines operating anywhere from 1,000 hp to over 50,000 hp.

"Most of these engines were installed in the 1940's and 1950's, when energy efficiency and air pollution were not primary concerns," says NGML Director Kirby Chapman. "We need to ensure that these engines operate efficiently, reliably, and as cleanly as possible as they transport and distribute natural gas throughout the country."

To meet its mission of finding better ways to transport and distribute energy, the NGML's research and testing centers on improving the air flow rate through the large engines used to transport natural gas and petroleum products, optimizing pipeline operation, developing more efficient methods to heat and cool buildings, and effectively monitoring and reducing pollutant emissions from combustion processes.



The NGML contains a large assortment of resources to conduct a full battery of mechanical, performance, and load line tests.

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Towards this end, the NGML is using Opto 22 SNAP Ethernet systems as the foundation for all of the control, monitoring and data acquisition functions required for its turbocharger testing. Specifically, the NGML uses Opto 22's Ethernet-based SNAP Ultimate I/O and SNAP PAC systems as the key components of its Turbocharger Monitoring System and Turbocharger Booster System. These two systems are primarily deployed in the NGML's test cells where the myriad of tests conducted typically fall into one of three categories: Mechanical Run Tests, which determine the integrity of the turbocharger to see if it is sound; Performance Tests, which run the turbocharger over different operating ranges; and Load-Line Tests, which simulate turbocharger operation from start-up, to full-load, to shutdown.

"We use the SNAP-PAC-S1 as the cornerstone of our system that also includes SNAP PAC R-series controllers, SNAP Ultimate brains, and racks and racks of I/O modules connected to the test equipment" says Eric Figge, Senior Laboratory Supervisor at the NGML.

The Opto 22 controllers and brains connect to and run gas compressors, gas turbine engines, and other equipment, and are used to monitor and gather temperature and other test-related data. The Opto 22 systems also provide alarming and execute on/off control, PID control, and emergency shutdowns.



The NGML uses a unique closed-loop design, allowing for complete testing of the turbocharger compressor and turbine over the entire operating range.

For example, using PID routines (built into and executed with Opto 22's ioControl programming software), the SNAP-PAC-S1 is able to calculate and subsequently control how much pressure the gas compressor applies and maintains during turbocharger performance testing—typically in the range of 200–500 psi. The SNAP-PAC-S1 also

controls SNAP digital modules connected to pressure valves inside the turbocharger test cells to provide on/off and emergency shutdown capability.

"The SNAP PACs also provide similar types of temperature safeties," says Figge. "We use Ariel natural gas compressors that can be severely damaged if their operating temperature gets too high. We use ioControl to establish thresholds for these compressors and we monitor their temperatures using SNAP-AITM modules connected to type K thermocouples."

Additionally, during load-line testing, the SNAP systems regulate the amount of power applied to the turbocharger, gradually boosting power into the turbocharger and making it spin faster and faster to simulate a real-life application.

"We use Opto 22 SNAP PACs and ioProject throughout the entire lab, with the exception of some of the test cells, which use Opto's older SNAP-LCM4 controllers and ioProject's predecessor FactoryFloor," explains Figge. "ioControl is our control programming application. With it, we've created the strategies that operate both the turbochargers and the testing equipment. ioDisplay is the HMI development software we used to create easy-to-understand user interfaces where turbocharger test data is aggregated and presented to our technicians in the form of gauges, meters, and other graphics. The technicians also use ioDisplay to receive and acknowledge temperature and pressure alarms, which are generated if either of those variables reach their predefined danger level."

In its test cells, the NGML is using OptoConnect, a free FactoryFloor software application that creates a data transfer link between legacy Opto 22 controllers and Microsoft Access or SQL Server databases. Providing a quick and easy way to get test measurements and other data from its SNAP-LCM4 controllers into a database allows the NGML to take its time as it looks to upgrade its test cell hardware to SNAP PAC controllers and the complementary ioProject software. Figge explains that after the switch, he intends to start gathering and integrating data via OPC. Using the newest versions of ioProject's OptoOPCServer and OptoDataLink components, the NGML will be able to consolidate and publish I/O point readings and data from its source—SNAP PAC and SNAP-LCM4 controller-based systems—to its Microsoft Access databases. This type of seamless integration helps the NGML complete its turbocharger testing and publish and disseminate the results throughout the lab.

“Obviously, in a large testing facility like ours, you have to be able to access and share data easily. Switching to OPC lets us accomplish this more efficiently and enables us make that data available to the entire lab, as opposed to just a single cell. This is just another example of how the Opto 22 software complements the hardware so well. We don’t have to patch together a solution or spend time and money developing middleware just to be able to share data amongst ourselves.”

To date, the NGML has conducted tests for companies specializing in compressors, engines, and other heavy duty equipment; the US Department of Energy; and the Pipeline Research Council International (a non-profit corporation comprised of energy pipeline companies.)

“What we’re all about here at the NGML is determining the best ways to transport and distribute energy,” Chapman says. “To do this, we know we have to utilize the best tools available on the market. Opto 22 hardware and software gives us the precision control and data acquisition capabilities we need to achieve long-term success in all of our turbocharger testing processes.”

About Opto 22

Opto 22 develops and manufactures hardware and software products for applications in industrial automation, remote monitoring, and data acquisition. Using standard, commercially available Internet, networking, and computer technologies, Opto 22’s input/output and control systems allow customers to monitor, control, and acquire data from all of the mechanical, electrical, and electronic assets that are key to their business operations. Opto 22’s products and services support automation end users, OEMs, and information technology and operations personnel. Founded in 1974 and with over 85 million Opto 22-connected devices deployed worldwide, the company has an established reputation for innovation, quality, and reliability.

Opto 22 products are sold through a worldwide network of distributors, partners, and system integrators. For more information, contact Opto 22 headquarters at 800-321-6786 (951-695-3000) or visit the website at www.opto22.com.