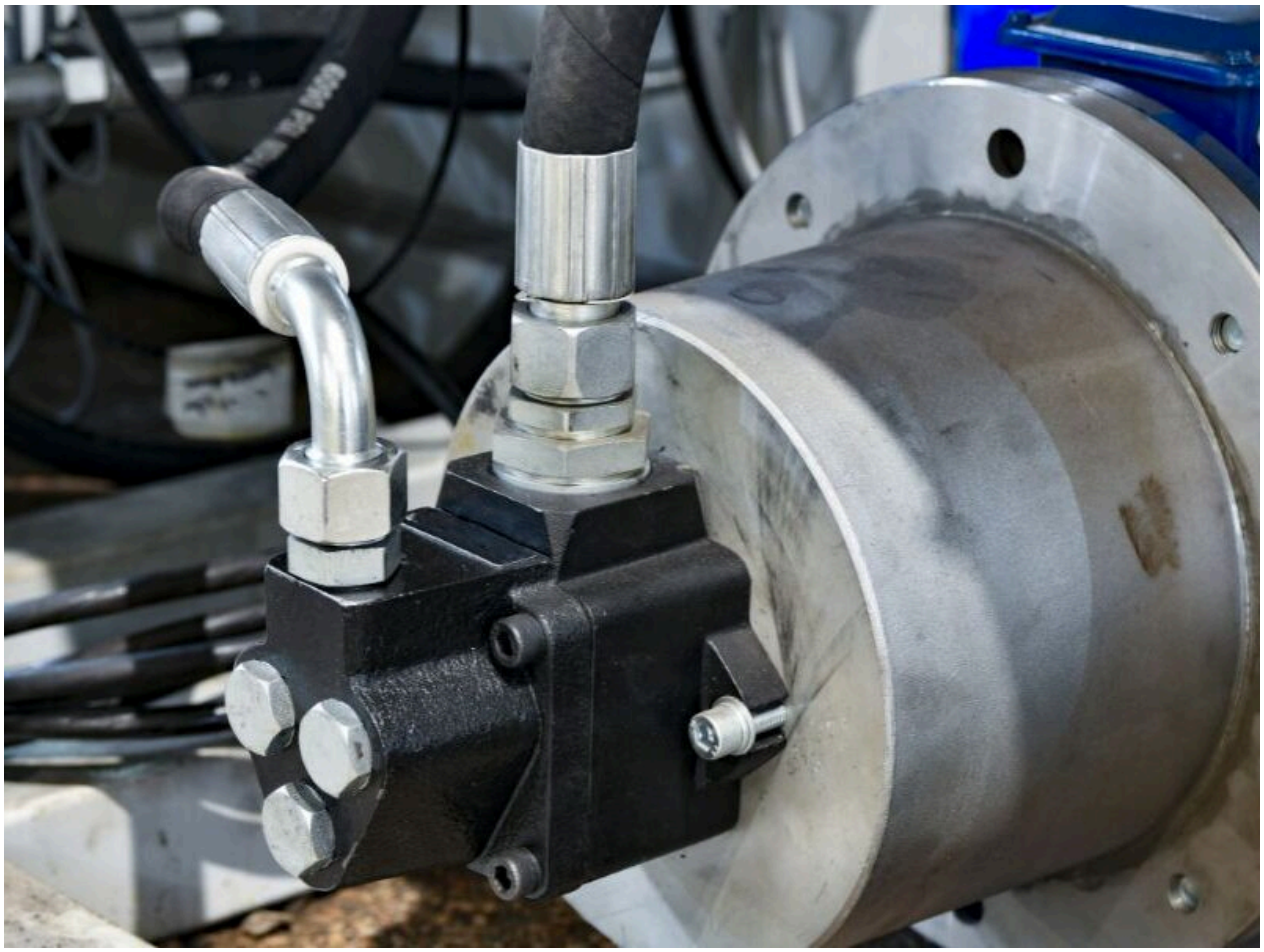
Application Case Study: Pressure Protection in Vehicle Hydraulic Testing



Introduction

Most readers will have a mental concept of surface mining, with big excavators and dump trucks zipping about a pit dug into the Earth in search of valuable materials such as copper, gold, and diamonds. We thought we had a good understanding of what open-pit mining entailed as well, until we learned just how big the equipment used in these operations really is. Not long back, we received an inquiry from a returning client looking to address an automation challenge with

their hydraulic test rigs – rigs that exclusively tested mining equipment hydraulics used in large open-pit mines. As the client described their test rigs and the mining vehicles they served, we realized that our mental image of mining equipment was way too small. Luckily, even such large equipment and the test rigs that keep them in tip-top operation still use normal sized instrumentation. With that, we turned our attention to the client's concerns about protecting their test rigs from significant, hazardous high pressure situations, and dug right in.

About Us

As a veteran-owned small business, Whitman Controls is dedicated to supplying premium quality, reliable, technologically advanced instrumentation for use in nearly any application. Our Bristol, CT manufacturing facility embodies over 40 years of engineering, fabrication, and customer service expertise, serving both end-user and manufacturing customers nationwide through direct and distribution channels.

Application Summary

Mining and extraction equipment make up some of the largest vehicles known to man, short only of sea- and space-faring ships. Common mining hauler trucks easily surpass one million pounds in weight, which takes every bit of at least four thousand horsepower motors to power. The hydraulic systems on such vehicles tend to exceed three thousand PSI (pounds per square inch) of fluid pressure, sufficient to lift, position, and dump over four hundred tons of load. These are big toys, no doubt.

Under such extreme applications, these hydraulic systems must be beyond dependable, as any failure can risk personnel safety, loss of load control, and even vehicle overturning. Routine maintenance for these systems is an understatement – at frequent intervals, a truck's entire hydraulic platform is run through rigorous testing batteries using centralized test rigs that simulate extreme loads, system upsets, component failures, and alarm reactions. Hydraulic testing rigs are sophisticated, computer-controlled diagnostic packages that utilize multiple layers of fluid control instruments to test subordinate equipment, and even take advanced education and certification to operate. Through this testing, hydraulic systems are assured to be in full working order, operating within specifications and demonstrating proper risk mitigation functions.

Challenge

Within our client's test rigs, a myriad of hydraulic test parameters and scenarios could be evaluated to detect performance declines, safety risks, efficiency losses, out-of-spec drifts, and even impending failures. One of the rigs' most important subsystems could simulate all types of over-pressure, under-pressure, and surge conditions. Because this test rig would generate pressure conditions stressing the upper band of any connected vehicle's hydraulic system, a critical control point was identified to protect against unsafe high-pressure conditions. The exact details of this protection are below:

- Major mining equipment vehicles would have their hydraulic systems connected to our client's test rig in series, such that both systems would share a common hydraulic circuit.

- The vehicle's hydraulic system would be activated, brought to a steady operating state, and then ran through all normal functions.

- The test rig would monitor the vehicle's system and record all pressure, flow, temperature, surge, and reaction time values, comparing them to the vehicle's onboard control system as well as published specifications to find any abnormal variations.

- Next, the vehicle's hydraulic system would be forced into alarm states created by the test rig, checking to see that the vehicle's system reacted as expected.

- Finally, the test rig would further simulate major abnormal operating conditions – multiple at once – to make sure that the vehicle's system would alarm, shut down, or relieve appropriately.

- Across all of these test steps, extreme pressures would be generated that had the potential to cause emergency failures in either the vehicle's or the test rig's hydraulic systems. Operating at over 5,000 PSI, even a small hydraulic leak anywhere in the system could be catastrophic.

- Given this risk, our client's test rigs were entirely automated and required no human operation during test runs. This meant that the last line of defense to abort testing before a major failure needed to be automated as well, which brought us to the challenge at hand.

- Our client's need of Whitman was to identify and provide an over-pressure protection solution that would immediately interrupt testing operations in the event of an excessive pressure condition automatically and reliably.

"Since we operate two of only four factory authorized warranty and repair centers for [an industry-leading large hydraulic equipment OEM] in the United States, we are held to a higher standard when it comes to testing safety and quality control. Our test rigs needed this extra layer of protection to make sure we'd push tests to the limit and get the results we needed while not putting our customers' systems or our technicians in harm's way." **- Senior Certified Technician, Confidential Hydraulic Equipment Service Company**

Solution

While our client's test rigs may be so highly specialized that only a few of them exist in the country, the solution to the inherent over-pressure protection challenge here only took a short walk out to our warehouse to pull one of several hundred stock sensors off the shelf!

The solution we landed on was to suggest duplex high-pressure switches to be installed into our client's test rigs that would be set at 6,000 PSIg. Our client's test rigs operated at up to 5,500 PSIg, driving us to select a switch point high enough above the operating pressure that we would avoid spike-induced switching chatter. We suggested a duplex configuration (installing two switches in series), so that in the unlikely event that one sensor failed, the second sensor would still function to protect the overall system. For even more protection, we suggested that they be wired across the normally closed contacts, so that any mechanical or electrical failures would open the circuit and break continuity, providing an extra level of safety.

After a final pressure capacity review, we ultimately recommended the Whitman J705G Pressure Switch model for the application based on these features:

- Severe-Duty Rating
- Stainless Steel Construction with BUNA N Elastomers
- Factory Setpoint from 500 to 6,000 PSIg
- Max System Pressure of up to 9,000 PSIg, allowing the sensor to withstand significant pressure spikes without failure
- High Reliability for Setpoint Accuracy even after experiencing pressure spikes
- High Switching Cycles up to 20 CPM

- High Temperature Range -65°F to 225°F
- Compatible with Oils, Waters, and Gases – able to easily withstand dirty hydraulic fluid
- Quick Disconnect Wiring Head for easy maintenance and electrical testing

Results

We've never gauged productivity in terms of "hundred thousands of pounds of ore per day", but that's exactly how our client on this project measured the equipment that they test. Since incorporating our high-pressure protection solution into their test rigs, our client has been able to more confidently get through test runs each day, as well as test right up to a reliable shut-down pressure of 6,000 PSIg. Using our high-pressure switches, test reports can now directly indicate that each equipment piece reached max test ratings and successfully shut down as expected. This allowed further equipment maintenance, overhaul, and testing work to be scheduled farther apart, giving back the equipment owners' a few productivity points here and there – or, in other words, millions more pounds of ore over a year.

Data Bullets

- **3%** higher mining equipment productivity by completing hydraulic testing faster, less often
- **100%** reduction in unexpected over-pressure test failures due to new automatic high-pressure detection
- **1-2** weeks' lead time on custom pressure instrumentation
- **75%** of all Southwest mining industry equipment is tested on our client's test rigs

Here at Whitman Controls, our values drive us to provide the highest level of servant partnership that you can find. To discuss your applications or to learn more about our capabilities, please contact us at (866) 868-8883, via email at info@whitmancontrols.com, or online at www.whitmancontrols.com.