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Sphere Brakes Successfully Tested on MTV and Stryker at Aberdeen Proving Ground

By Jennifer Reisch

Sphere Brake Defense, LLC (SBD) has designed an innovative patented sphere brake technology. The brakes are lighter than traditional drum or disc brakes, and brake pads can be changed in minutes.

"Our innovative patented sphere brake technology uses hemispherical brake pads that compress around the sphere brake surface. This generates more brake power with a smaller brake effective diameter," explained AJ Lewis, CEO of SBD. "What that affords our customers—right now mainly warfighters—is the unprecedented ability to change brake pads without any tools. They don't need any lifting devices; they don't need to perform work at a depot level. An 18-year-old with very minimal training can change out brake pads on a military vehicle in a matter of minutes."

Because the sphere brake is smaller, the wheel end weight is lighter. This affords increased payload optimization for units or for vehicle integrators. The vehicle can carry an increased payload of ammo or medical supplies or fuel or other materials, or gain fuel efficiency, depending on the mission.

This technology provides reduced maintenance time and effort costs: This is the first brake system that does not require wheel removal to change brake pads at the wheel end. The sphere brake is engineered to bolt onto existing drum and disc configured

SBD's test script includes performance stops, hill hold evaluations, and brake balance.

axles while integrating with anti-locking brake systems (ABS) and central tire inflation systems (CTIS). The sphere brake is expected to have a similar cost range as existing brake technology in the market today.

"At Sphere Brake Defense we use a process that follows the Build – Measure – Learn feedback loop of design to test iterations. When we design technology, there are multiple opportunities to get our products and prototypes into the hands of warfighters sooner rather than later so we're not designing in a box, we're designing in step with what the warfighter wants and needs. That helps us save money in development and testing. When we deliver a final product, the warfighter has no complaints. The transition can occur faster and it also helps the DoD draft the specific requirements when we do transition to ground vehicles. In the Build – Measure – Learn feedback loop we follow a pretty straightforward process. We'll design

the technology for the specific wheel ends. We provide them as a bolt on solution, a plug and play technology. That's at the forefront of everything we do," Lewis said.

When designing brakes for defense vehicles, SBD will scale brakes to bolt onto the vehicle they will be testing on. Once the brake is designed in CAD software, full scale parts of the assembly are 3D printed and attached to actual wheel end components to perform form, fit, and function tests. "There are usually one or two things or more that don't really line up right or don't fit well so we go back and iterate, design and fit again. Printing full scale functional 3D parts saves us a lot of money down the road; if we didn't do that step then we would have invested in production tooling and we'd be cutting metal on all of our test vehicle kits only to find out after the fact that things didn't fit well together. Once we go through our design control approval procedure process, we then release drawings to our supply chain and have parts manufactured," he explained.

Photo courtesy of SBD

Because SBD's sphere brake is smaller, the wheel end weight is lighter. Using sphere brakes on the Stryker allows the vehicle to carry an increased payload or gain fuel efficiency, depending on the mission.

"Before we put our commercial grade designed kits on vehicles, we dyno test a couple of them through Federal Motor Vehicle Safety Standards (FMVSS) requirements to ensure that they pass the stopping distance and retardation requirements and dissipate heat well and efficiently while falling within pressure limits. If it passes dyno testing, then we have the green light to manufacture all the kits. For our recent track test iteration, we've installed our kits on both the Medium Tactical Vehicle (MTV) A1P2 and the Stryker Double V-Hull. We have at least 28 kits, which includes spares."

A great deal of planning goes into testing. "Whether it's dyno testing in Detroit or vehicle testing at Aberdeen, we need to get on the schedule for installation, fit ups, and testing. Sometimes acquiring military vehicles or vehicle parts is more challenging than designing technology. In order to fit 3D printed parts or manufactured brake kits onto standalone wheel end assemblies or vehicles you need the wheel end components, so you need to know how to procure NSN parts from military surplus sites, and you also need to have a good relationship with a unit that will allow you to get up close to military vehicles or with your testing partner that has military testing vehicles," Lewis said.

Multiple stakeholders, including the new technology sponsors and also the Program Executive Offices (PEOs) are involved in vehicle tests, as well as the end customer. For SBD's test, the Army Training and Evaluation Command (ATEC) is administering and overseeing the testing at Aberdeen Proving Ground (APG). "We have to draft a test plan that satisfies the PEOs, but also reasonably compares apples to apples—in

this case our test brakes compared to disc or drum brakes on the same vehicles. In addition to ironing out and agreeing to a test plan between our sponsors, the PEO, and ATEC, there's a budget constraint, a time constraint, a maintenance technician constraint, and a vehicle availabilityconstraint. Fortunately, since we're sponsored by RCCTO our project is a Priority 1 project at Aberdeen so we get priority in resources while executing track testing."

One of the main challenges SBD had while scoping out testing was vehicle availability. "We don't have those military vehicles; they are owned by the programs. At the time we commenced our current contract, we didn't have an ACV available to use for testing. However, APG had an MTV A1P2 expando van they weren't using that we could utilize indefinitely so they put it on contract. So that was great; that was one vehicle."

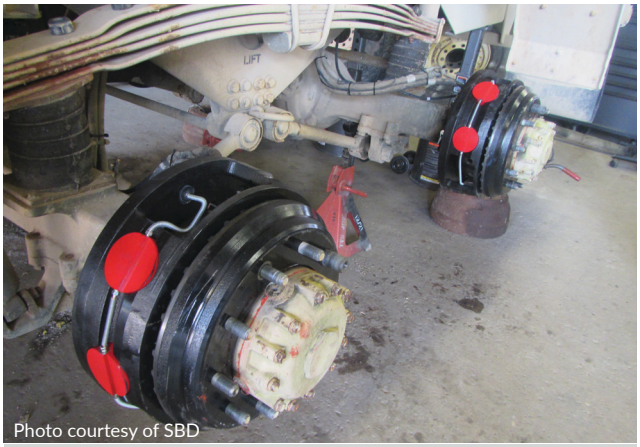

Photo courtesy of SBD

SBD's sphere brake is engineered to bolt onto existing drum and disc configured axles while integrating with anti-locking brake systems (ABS) and Central Tire Inflation Systems (CTIS).

The second one was a lot harder to find. "PEO Stryker found a Stryker that was available at Yuma Proving Ground so then we had to get that Stryker to APG. Originally PEO Stryker gave us a very limited time to use it so we had to reduce test scope to fit in everything that was needed. Fortunately, once we got into testing, other assets became available so they didn't need it back so fast and we have it now through the end of the contract. Because the vehicle was owned by the program we weren't allowed to modify the wheel ends on the actual test vehicle because it had to return to its mission profile for its next project or mission after ours. The Stryker brigade combat team had to find eight spare wheel ends somewhere that they could ship to us so that we could install our kits on those spare wheel ends here at our facility in Pennsylvania; once our kits were installed on the wheel ends here we shipped them to Aberdeen. There the maintenance technicians took off the vehicle's wheel ends and put ours on with the sphere brakes on them. That was a lot of finagling. There's the whole cost and fleet time around finding them and shipping them back and forth and everything else."

Because the Stryker has an operations and maintenance contract from its prime, General Dynamics, an agreement was needed for them to support the Stryker test effort as well. "So now you really have five major stakeholders involved to execute the vehicle testing: the sponsors, the programs, the contractor—in this case us, ATEC, and the prime."

The test plan contains sections and scripts, which determine which area or test track will be used. "There's a test officer who oversees the entire project, managing resources, ranges, track facilities, maintenance technicians, and schedules, and a test engineer who pretty much executes

the test plan with the support of test drivers. You go through the drafted test script. For us that includes performance stops, hill hold evaluations, and brake balance," he explained.

SBD is in its second testing iteration. Testing takes place five days a week and someone from the company has to be on site at APG the whole time serving as field technical reps. Lewis's team will rotate a week at a time and keep repeating that until testing is complete. "With the first test we developed stress fractures on the surface of the brake rotors about two days out from finishing track testing. We made the call to stop testing and pull the kits and perform root cause analysis replicating the test conditions we saw at the track. We improved material properties and some geometric features to strengthen the rotors. This was a very large concerted effort in partnership with our sponsors MCSC and RCCTO who provided assistance from the Navy Research Lab and MITRE, a federally funded research development center (FFRDC)."

At the end of vehicle testing a level 3 product level technical data package (TDP) along with thorough complete test reports will be made available to the sponsors. That complete package can be shared with PEOs or other government agencies to demonstrate the technology is ready for fielding. Sponsors are responsible for transitioning to programs; this transition can take many forms. Lewis is hoping for an SBIR Phase III transition.

"A Phase III transition affords us a lot of credibility and legal protection. The sponsor can write the Phase III requirement and transition it themselves or it can be interagency if another military branch is ready for the technology. A Phase III is a win for everyone."

SBD has scaled and prototyped sphere brakes for commercial vehicles, electric motorcycles, freight rail, and aircraft. The sphere brake system has applications for all heavy tactical vehicles and trailers.

"We have a project in partnership with a university this upcoming school year to scale the brake kit down to a passenger vehicle. Numerous vehicle platforms across different industries face similar challenges relating to reliability, fuel efficiency, and maintainability. We will continue developing sphere brake kits for the commercial vehicle industry, racing, rail, and e-mobility industries. In both heavy and lighter applications, the sphere brake delivers the same value to commercial vehicle fleets that it delivers to programs within the DoD."

As a participant in the Department of the Navy SBIR/STTR Transition Program (Navy STP), Lewis valued the regular webinars the program facilitates. "The webinars presented critical information about requirements planning, marketing, overviews of PEOs, the procurement process, and legal considerations," he said.

SBD is a veteran owned small business delivering game changing brake technology designed for ground and air tactical vehicles, enabling improved vehicle safety, fuel efficiency, weight savings, and unit readiness across the DoD. For more information, visit the company website at www.spherebrakedefense.com.

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