obbyists and pros build race engines to make the most power possible within the constraints of a budget and the design limits of the motor. For all the power that they produce, a keen eye must be kept on efficiency as well. Proper piston-ring seal is paramount to getting the most out of any engine.

Since the factory PCV system is not used on most race engines because it's less effective, positive pressure in the crankcase builds as engine rpm is increased. The result is pressure Header/collector systems work well on open-headered cars but generally only pull about 1-2 inches of vacuum from a race engine. Mufflers, now mandatory at a great many tracks in the country, can render this system ineffective as even minor backpressure from the exhaust system will drop the pumping efficiencies to almost zero.

Electrical vacuum pumps are available and easy to install but can't pump enough volume to produce more than 2-3 inches of vacuum.

From an effectiveness standpoint, a belt-

driven vacuum pump provides more vacuum to relieve the crankcase pressure, thus eliminating oil leaks and allowing the piston rings to seal better. Of course, there are downsides. The pump has to be mounted so that it can be driven off of the crankshaft pulley, bringing into consideration packaging constraints that presently will not allow the factory GM airconditioning units to remain unless custom brackets are fabricated.

According to David Butler of Butler Performance, "For street vehicles that see rou-

# GOT VACUUM FOR YOUR RACE ENGINE?

Butler Performance's Evac Pump Kit Nets 15RWHP and Stops Oil Leaks

#### **BY RANDALL D. ALLEN** PHOTOGRAPHY BY THE AUTHOR

on the underside of the piston on the intake and power strokes, which reduces efficiency by offering more resistance to the piston's downward movement in the bore. It also places more stress on the piston rings, thereby reducing their seal capabilities and increasing the chance of blow-by. If that weren't enough, high crankcase pressure also forces oil to evacuate through any seal it can breach. On Pontiacs, the rear main seal, valve covers, and oil-dipstick tube are usually the first to seep.

The addition of a vacuum pump to remove the positive pressure in the crankcase and introduce a few inches of negative pressure (vacuum) can increase power production and improve the seal of the piston rings and all those places where oil used to leak.

There are three common vacuum-pump methodologies on the market today; header/collector aspiration vacuum, electric vacuum pumps, and belt-drive vacuum pumps.





The Butler Performance Pontiac Evacuation Pump Kit (PN BPI-EVAC) retails for \$549 and includes a modified Ford-style remanufactured evac pump with a Moroso pulley, mounting kit with fasteners, breather tank, 3 feet of -10 stainless braided hose, along with all of the hose ends and valve-cover accessories. Since the Moroso pump kit would also be tested, the -10 braided hose that goes from the breather tank to the pump was upgraded to -12 braided hose as it was the standard rubber hose that goes from the pump to a push-in breather element.



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tine highway miles or spirited weekend-driving duties, owners should retain the factory PCV valve and standpipe with a breather element to reduce the chance of oil leaks, and use a vacuum pump only if those leaks occur.

"For aggressive engine builds that feature long strokes, high cylinder pressures, or elevated rpm potential, an Evac Pump Kit is a great way to stop oil leaks and pick up a few extra horsepower. To eliminate oil leaks on a Pontiac, we like to see between 5 and 10 inches of vacuum with a maximum of 14 inches. Some oil mist inside the engine is critical to ensure proper lubrication of the parts that don't have direct oil flow such as the wristpins.

"By designing custom brackets to fit either a modified Ford-style vacuum pump or a Moroso pump, we've created an easy solution to the issues created by too much crankcase pressure. In addition to solving the unsightly oil leaks, by reducing crankshaft pressure the intake manifold charge isn't contaminated with oil, and the additional ring seal consistently produces measurable horsepower gains. On a typical 500-horse engine, the modified Ford-style pump used in our standard kit generally creates 8-12 hp on an engine dyno while the Moroso pump gains 15-25 hp."

Follow along as we install and test both the Butler Performance standard and Morosobased Evac Pump Kits. Installation was completed by George Reaves, the owner of the '65 GTO test car at Real Performance Motorsports (RPM) in Lewisville, Texas. Once installation was complete, both systems were dyno tested at RPM and then raced at Redline Raceway in Caddo Mills, Texas.



After an inventory of the parts, the first order of business is to remove the lower crankshaft pulley from the engine. In this case, the alternator belt is removed and a ¼-inch socket is used to pull the four crankshaft-pulley bolts. The pump is driven by a crankshaft drive mandrel (left) designed to be bolted to the front of the lower pulley. The crankshaft drive mandrel is drilled to support either three- or fourbolt harmonic balancers. A three-bolt harmonic balancer is used on ATI or TCI harmonic balancers, while a traditional Pontiac balancer utilizes four holes. The standard four bolt holes of the GTO's crank pulley are lined up with the drive mandrel ...



... and the supplied bolts are threaded through the mandrel and pulley and tightened to the harmonic balancer.



The supplied 4-inch pulley is attached to the crankshaft mandrel after slipping in the pulley keyway (not shown). Set screws are used to secure the pulley to the mandrel, but before using Loctite and a final tightening of the screws with an Allen wrench, it's highly recommended that you first mount the evac pump so the pulley can be slid back and forth, lining it up so that the drivebelt runs true.



The Butler kit comes with 3 feet of braided hose to attach from the pump to the breather tank, so a suitable location within that length must be found for the breather tank. Since the '65 GTO test car didn't have inner fenders to provide an easy mounting solution, the owner fabricated a metal bracket for the passengerside framerail and bolted the Moroso catchcan bracket to it. The petcock is threaded into the bottom of the breather tank, and the breather filter is attached with a flat-blade screwdriver before the tank is lowered into the mounting bracket and tightened with a ½-inch wrench, oriented so that the bung for the pump hose points toward the rear of the car.



Pump installation begins by placing the pump's two-bolt aluminum bracket up against the passenger-side cylinder head and threading in the supplied %x3%-inch bolts and washers. The bolts are then tightened securely with a %-inch open-end wrench.



The ½-inch bolt underneath the water pump on the passenger side is removed in order to mount the evac pump's slotted adjustment arm. A spacer is placed behind the arm, and the supplied bolt and washer are slotted through the arm and secured with a ‰-inch wrench.



The evac pump is then mounted to the aluminum bracket with a %x6-inch bolt. Since the drivebelt has yet to be installed, the bolts are hand-tightened, as is the %x1-inch bolt and washer that attaches the pump-adjustment bracket to the back of the pump.



1Installation of the drivebelt begins by pushing down the evac pump, allowing maximum clearance to slip the drivebelt over the crankshaft mandrel drive and pump pulley. Since the provided belt is properly sized, rather than struggle with the belt installation, the drive pullev is removed, and the belt is slipped over the drive pullev and lined up evenly with the pump pulley before being stretched to fit over the pulley on the pump. Once the belt is installed, Loctite\_is applied to the set screws on the drive pulley, and the screws are tightened with an Allen wrench. The pump is then swung upwards and a %-inch wrench is used to tighten the pump mounting bolt. The pump adjustment bolt on the back of the pump is tightened with the same wrench, and a final check is made for belt tightness.



In order to operate correctly, the vacuum pump must have a sealed system to draw pressure out of. If so equipped with a PCV valve, the hole in the valley pan will have to be plugged. Since the car wasn't equipped with a PCV valve and had breathers in both valve covers, one breather would have to be capped while the other side was retrofitted to include a bung that would accept an AN-style fitting. Various options are available to adapt a standard set of valve covers to a bung, including both adjustable and non-adjustable Moroso positive seal fittings and Mr. Gasket oil filler plug.



Rather than utilizing the owner's tall Moroso chrome valve covers. a set of Butler Performance 2<sup>3</sup>/<sub>4</sub>-inch Pontiac billet valve covers were ordered (PN BFA-SVC2, \$298 retail). When combined with a set of %-inch thick valve-cover gaskets (PN SPM-11765-2, \$15 retail), the valve covers will clear aftermarket rocker-arm assemblies. Butler welded in a bung on the driver-side valve cover (PN LBR, \$35 retail) and then supplied a screw-in-style billet aluminum oil-fill cap (PN BSP-24110, \$39 retail) for the passenger-side valve cover that features an integral O-ring for leak-free sealing. Since the Moroso Evac Pump Kit was up next for testing, the aforementioned -12 AN braided hose was cut to length, and the supplied Aeroquip -12 AN 90-degree fitting was mounted on the valve-cover side .



... while a -12 AN straight fitting was secured to the pump.



To finish off the installation, the -12 hose length that goes from the pump to the breather was cut to size, and a 45-degree fitting was threaded onto the hose and attached to the breather tank. Since the standard pump is equipped with a -10AN pump outlet, a -12 to -10–AN 90-degree male elbow adapter was substituted for the standard -10 AN fitting and tightened securely. Once complete, the GTO was loaded onto the DynoJet chassis dyno at Real Performance Motorsports where it proceeded to pull a maximum of 5 inches of vacuum at 6,000 rpm while allowing the Goat to gain 6 hp without any signs of oil leakage as was the case in the baseline dyno runs.



After removing the standard pump and drive pulley, the Moroso Pump Kit installation begins by installing the Moroso-specific pump pulley onto the crankshaft. With a goal of 9 to 14 inches of vacuum, Butler suggested using either a 2<sup>1</sup>/<sub>2</sub> or 3-inch pulley. As the subject GTO's 455 was 8 years old and had accumulated over 500 passes at the dragstrip, the 3-inch pulley was chosen for its ability to generate additional vacuum over the smaller unit. The pulley is slid over the drive mandrel, and the set screws are lightly tightened.



With the standard evac pump dyno testing complete, the Moroso Evac Pump Kit (PN BPI-EVAC-MOR, \$799 retail) is readied for installation. Capable of generating up to 14 inches of vacuum, the pump is also fully rebuildable at home with a Moroso Service Rebuild Kit. Butler stocks a selection of pulleys that range in size from 2½ to 4 inches in ½-inch increments for \$15-\$18 each. For larger displacement engines, a four-vane Moroso Pump Upgrade is available for \$50.



The pump-mounting bracket is positioned onto the passenger-side cylinder head, and a %-inch bolt with a flat washer is handthreaded into the top mounting hole. An identical bolt is then inserted through the adjustable bracket and secured to the bottom of the head.



The supplied drivebelt that is matched to the 3-inch crank pulley and 5-inch pump pulley is slipped over the crank and pump pulley. Once the belt is on, the pump is pulled outward and a ‰-inch wrench is used to tighten the two bolts. The drive pulley is then adjusted and Loctite is used on the two set screws before they are tightened with an Allen wrench.



With the pump mounted, the braided hose that goes from the inlet on the pump to the valve cover is hand-threaded on and then tightened securely with either an AN or adjustable wrench.\



The 90-degree elbow is removed from the outlet side of the pump, and the braided hose is threaded onto the pump and breather tank before being tightened. As a result of the slightly shorter line size, the mounting bracket for the breather tank is loosened with a <sup>5</sup>/<sub>6</sub>-inch wrench, and the tank is rotated to prevent a line kink.



After a final check to make sure the pump is secured, a vacuum gauge is hooked up to a vacuum fitting that Butler Performance welded into the valve cover for testing. Having such a provision is very important as it will not only allow you to register vacuum at idle and full-throttle to tell how much vacuum is being pulled during installation, but it also provides another key diagnostic of the engine and pump as they age. If, for example, the pump generates 10 inches of vacuum for three racing seasons and suddenly is only registering 5 inches, it's a good clue that either the ring seal on the engine is going or the pump is due for a rebuild, or possibly both.



The completed Moroso Evacuation Kit looks great hanging on the front of the GTO race motor and should provide years of reliable performance. With installation complete, it was time to test the results of the pump on the dyno. This time around, the pump pulled 9½ inches of vacuum at 6,000 rpm and gained almost 15 hp over the baseline runs. As anticipated, not an errant drop of oil was found anywhere on the engine or drivetrain after the rollers stopped spinning.

## SOURCES

Butler Performance Dept. HPP 2336 Hwy. 43 S Leoma, TN 38468 (866) 762-7527 www.butlerperformance.com

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#### **CONCLUSION**

It is apparent that both Butler Performance Evac Pump Kits are complete and well designed. Installation can be accomplished in 1-2 hours with the hardest tasks being where to locate the breather tank and cutting the braided hoses to length.

The choice of pumps comes down to the hobbyist's budget and goals. If the primary purpose of the pump is to stop any oil leaks, the standard kit will provide reliable service for years. For enthusiasts looking to gain a bit more horsepower and have the ability to rebuild their own pumps, the Moroso three-vane pump is a great choice.

Other than the ability to stop the pesky oil leaks that plague high-performance engines, the vacuum pumps can and should be used as aids in prolonging piston-ring and cylinder-seal integrity as well as valuable diagnostic equipment.

According to Butler, "By utilizing a dash-mounted vacuum gauge, the enthusiast can carefully monitor the condition of the engine's sealing abilities pass after pass. From a reliability and cost-effectiveness standpoint, both pumps have very good service lives. The GeeTO Tiger's standard evac pump lasted for five years before needing replacement. With replacement pumps retailing for \$99 and the Moroso Rebuild Kit running \$105, both systems are relatively inexpensive to maintain." For hot street cars and drag racers, a Butler Evac Pump Kit might just be the cure for your pressurized oiling blues.

## DYNO TESTING

Testing of the '65 GTO was performed at Real Performance Motorsports in Lewisville, Texas. RPM has a Dynojet Model-248C dyno. The car was running on drag slicks, which pulls down the rear-wheel horsepower on a chassis dyno compared to street tires. Due to electrical interference present in the ignition system, rpm was not recorded consistently across all pulls. In addition, torque is not noted as the torque maximums were always dependent on when the engine was floored and the converter was flashed.

Key Engine Parameters: air-inlet temperature (AIT). Vacuum was measured on a sealed system at a valve-cover bung at idle and at 6,000 rpm in Third gear. Maximum horsepower was achieved at 5,400 rpm.

The GTO's big-cube mill put out 340.7 hp in its baseline configuration. Although the firewall and valve covers were clean before the run, the pressure that built up in the engine pushed oil out of the dipstick tube, and it dripped onto the passenger-side header. In addition, the back of the driver-side valve cover was wet, and both breathers had oil residue where they mounted to the valve covers.

After cleaning the mess and finishing the installation of the standard Butler Evac Pump Kit, a vacuum gauge was connected to the passenger-side valve-cover fitting. At idle, the car registered 0 inches of vacuum being pulled from the engine-not unexpected since the pump was rotating so slowly. Once the GTO was unleashed, it was evident that the Evac Pump Kit was performing its job. At a maximum rpm of 6,000 in Third gear on the Turbo 400 transmission, the pump pulled 5 inches of vacuum, and the decreased pressure and more

effective ring seal allowed horsepower to jump by almost 6. As significant was the fact that the pump completely eliminated the oil leaks that had previously plagued the car on the dyno.

Following a cool down, the Moroso Evac Pump Kit was installed, and the car was back on the dyno for testing. At idle, the three-vane

CONFIGURATION	AIT	<b>IDLE VAC</b>	MAX VAC	HP	GAINS
Baseline	103.6	0	0	340.7	N/A
Butler Std. Evac Kit	109.9	0	5	346.6	+ 5.9
Butler Moroso	105.8	1/2	9½	355.2	+8.6/+14.5
Three-Vane Kit					

9/30/2006 11:11:40 AM 9/30/2006 11:51:14 AM

Moroso pump pulled ½ inch of vacuum. Recorded at the same 6,000

rpm in Third gear, the pump generated 91/2 inches of vacuum and

out almost double the volume of pressurized crankshaft gases, allow-

ing even better ring seal and elevated horsepower numbers. Once

again, the reduction of crankcase pressure kept any oil from escaping

**Real Performance Motorsports** 

70

80 90 100 110 120

Speed (MPH)

As compared to the standard kit, the Moroso kit was able to pull

achieved an outstanding gain of 14.5 hp over the baseline.

the engine.

DYNORUN.001RO 9/3 DYNORUN.004RO 9/3 DYNORUN.006RO 9/3

400

350

300

250

150 SAE

100

50

0

30 40 50 60

Horsep 200

## DRAG TESTING

Drag testing was conducted at Redline Raceway in Caddo Mills, Texas. Redline raceway is an eighth-mile venue, and on this day, it was hosting a bracket series held by the Texas Muscle Car Club Challenge. As George Reaves routinely laces up his spurs as a member of the Dallas Area Pontiac Association, the other member clubs in the Texas Muscle Car Challenge were happy to put aside their brand biases and allow testing at the conclusion of the bracket race.

George Reaves' (of Whitewright, Texas) '65 GTO is a former "Pontiac Pavement Pounders" participant, and the same combination of parts routinely puts the GTO into the 11.1-second e.t. bracket in the guarter with 7.2s in the eighth-mile. Powered by a '71 455 with round-port H.O. heads, the 12:1-compression engine uses an Ultradyne roller cam and Harland Sharp 1.65 roller rockers. Intake duties are handled by an Edelbrock Victor manifold and Holley 950 DP carburetor before dumping exhaust out of a set of Hooker headers.

An Art Carr 2.500-stall torque converter sends power through a Turbo-400 transmission and out back to a 3.90-geared Ford 9inch rearend. ET drag slicks that measure 10.5x29x15 fill up the wheelwells.

The engine is shifted manually at 6,000 rpm and goes through the traps in the quarter-mile at 6,100 rpm. When run on an eighth-mile track, the car is barely able to shift into Third gear before the eighth-mile marker lights are tripped.

At the conclusion of drag testing, the difference in e.t. and mph between the best runs that were produced by the Moroso pump and the slowest runs without any vacuum pump were at or less than 0.04 in e.t. and 0.11 mph.

As expected, the short eighth-mile distance really didn't highlight the enhanced horsepower that the vacuum pump allows the engine to make, but more importantly, both units proved that they were the solution to stopping the oil leaks that would show up on the car at drag-racing venues. In addition to a clean engine compartment, there was no oil to be found on the bottom of the transmission pan, and the rear main seal was perfectly dry. 두

Configuration	Temp	60-ft	% ET/MPH
No Pump	82.0	1.57	7.236/93.89
		1.58	7.231/93.95
<b>Butler Standard</b>	82.0	1.58	7.213/93.99
		1.57	7.216/93.92
Moroso	82.0	1.57	7.193/94.02
		1.57	7.191/94.00

## **Recommended Tools** and Supplies

Standard socket set Standard wrenches Allen wrenches Cut-off wheel or fine-tooth hacksaw blade for cutting stainless braided hoses Vacuum gauge Loctite