MANIFOLD MAGIC

Intake Testing and Modification for Maximum Power

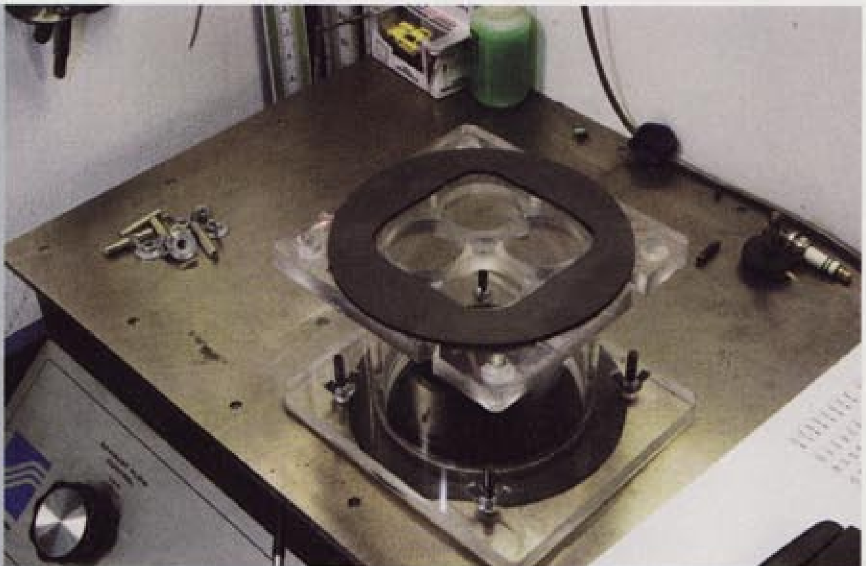
Text and Photography by Steve Dulcich

We have been around high-performance engine building long enough to witness plenty of builders sweat 5 to 10 cfm of cylinder head flow. In the realm of heads, people are downright greedy, thinking nothing of going through hours of grinding or a stack of cash dreaming about that cache of flow and the righteous power it will yield. The odd thing is the vast majority will also think nothing of bolting the intake on without knowing its flow capacity. Stranger still, they'll often balk and fight at the suggestion of flow work on the intake.

While bragging about cylinder head flow numbers is a staple of any respectable bench racing session, how many guys can tell you what their intake manifolds flow? Got a set of 300 cfm heads for your hot street small-block? How much air does the intake manifold bolted to it move? Well, it might be 320 cfm, but how would you feel about 240 cfm? Now there's some serious reason for denial, and it's surprising how many people will bury their heads in the sand rather than look at facts and empirical data. Really, the intake manifold can be viewed as an extension of the intake port, and its flow has a direct bearing on the flow of the overall system. As with cylinder heads, some manifolds are better endowed than others, and (again like heads) the flow of a manifold can usually be improved with porting. Sometimes these gains can be substantial.

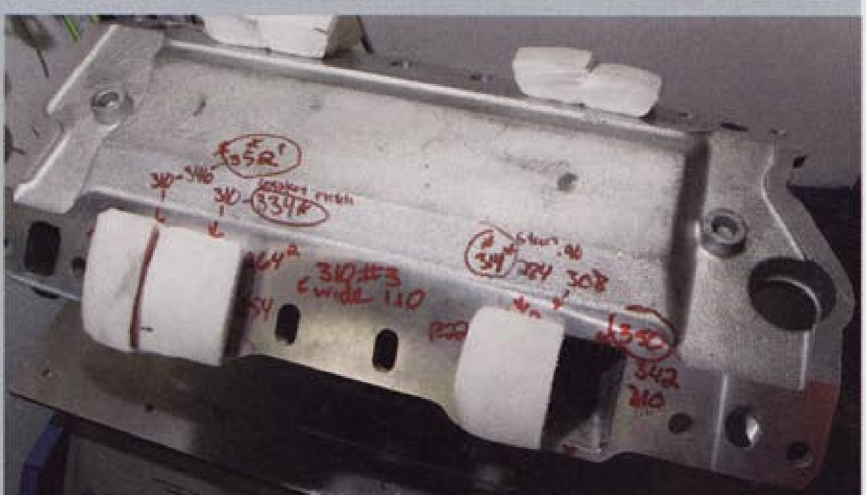
FLOW IT

Porting and flow testing go hand-in-hand, and herein lies the first hurdle. At first blush, flow testing an intake manifold seems like an awkward proposition, with eight ports connected to a common plenum. A popular flow arrangement is to mount the intake onto a head, and draw through the intake port with the



With this fixture from Dr. Air, an intake manifold can be quickly mounted to a typical SuperFlow bench for flow testing. The mounting face at the manifold's carb pad mimics the four holes of a four-barrel carb.

The adapter bases come in a variety of configurations to match the carb type, including 4150 squarebores, 4500 Dominators, and the spreadbore Quadrajet/ThermoQuad patterns. The entry side of the throttle bore simulators have a radiused form, providing airflow capacity exceeding the mightiest carb. O-rings provide the seal.

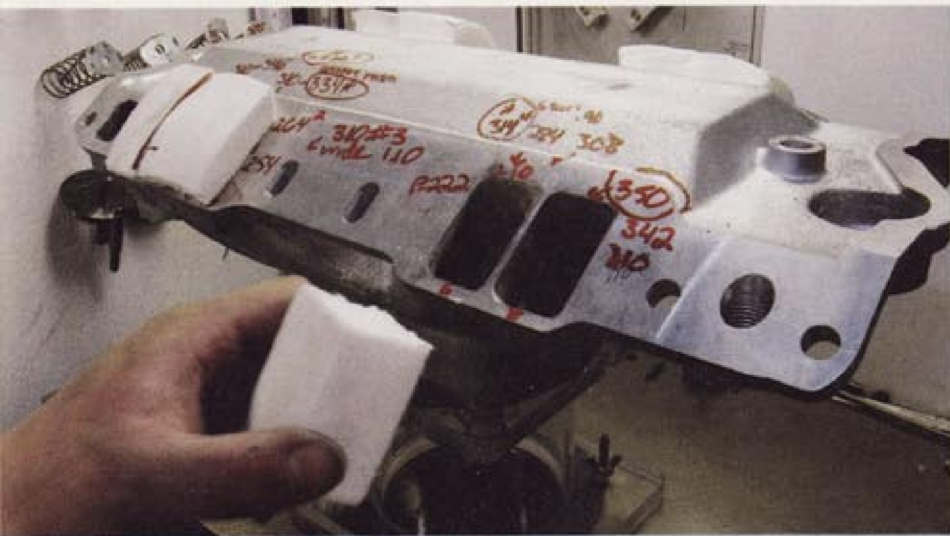


head mounted to the flow bench in the normal fashion. Though this arrangement has value, the setup is cumbersome and time-consuming, and the manifold runners' flow characteristics are influenced by the intake port in a way that makes it difficult to analyze the subtle manifold activity.

Another approach to a working test setup is to invert the manifold on the flow bench and blow through the plenum. Surprisingly, quite a few folks that should know better object to this concept, arguing that an engine sucks on the intake (while this arrangement blows). Actually, the bench creates a pressure differential, and it makes no difference which end of the test orifice generates the pressure change as long as correct flow direction is maintained. Don't believe it? What if you ram a piece of pipe through a wall where one room is at 10 psi and the other 15 psi? Air will obviously flow from the high-pressure room to the low-pressure room. Do you think it makes any difference to the cfm of flow through this pipe if the pressure difference between rooms is created because of an extraction system in the low-pressure room, or because air is being pumped into the high-pressure one? No, the only thing that matters is the differential, and the same is true with the bench.

Blowing through the plenum sets the stage for quick and easy flow testing of each intake manifold branch. All that is needed is a means of mounting the manifold's plenum to the bench, and a way to seal the runners that are not being tested. Dr. Air Products manufactures just such mounting fixtures for the popular SuperFlow plenum-box bolt pattern, with an intake manifold plenum plate that mimics the four holes of most configurations of four-barrel carburetors. Runners can be isolated for testing by simply plugging seven of the runners with closed-cell foam. In this arrangement, a plug is swapped over to another hole, and every runner in a manifold can be tested in minutes.

To prepare for a flow test, seven of the runners are plugged using closed-cell foam, leaving only the test runner open to airflow. This ProComp single-plane intake improved dramatically with full porting.



Testing from one port to the next is simply a matter of moving one foam plug at a time. With this arrangement, a full manifold test can be accomplished in a matter of minutes.

Flow testing will quantify the value of a porting modification. Exploring the port with a probe will provide clues to the necessary modifications.

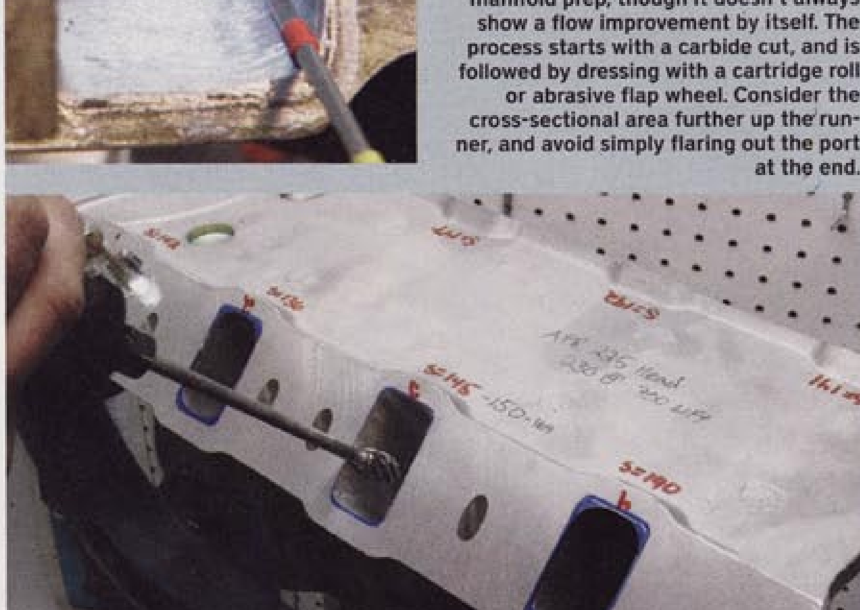
PORTING FOR POWER

Once the baseline flow figures are mapped out for each individual runner, an assessment of the manifold is in hand. The analysis may show quite a variation in runner flow, as some runners may record substantially more flow than others. In addition, the overall flow of the intake will be known, which can be compared to the flow capacity of the cylinder head as an indication of whether the manifold capacity will represent a restriction relative to the cylinder head's flow capacity. At this point, an objective can be set for improvements with porting, and progress can be measured with additional testing.

Porting an intake manifold is not unlike porting a cylinder head. The most basic level of preparation involves port-matching the runners to the cylinder head's port window. If the head's intake port is well developed and taking maximum advantage of the available cross-sectional area, an undersized manifold at the exit can represent a loss of flow and power. Each manifold has its own peculiarities, but most high-performance intakes are designed with some degree of port taper, and generally the exit is the smallest portion (in terms of area). This can represent a restriction, if undersized.

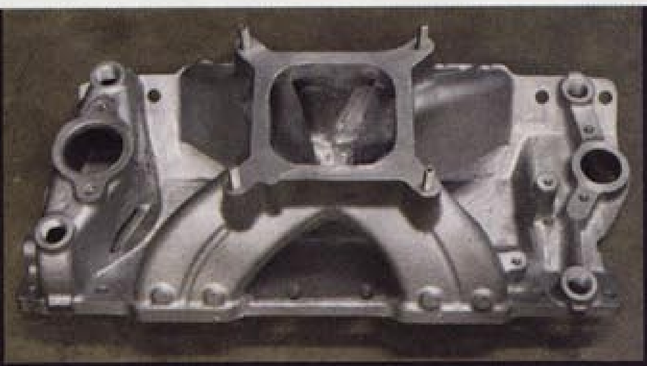
High- and low-speed areas, reversion, and problematic forms causing flow separation can be tracked down with a probe attached to a U-tube manometer.

Port matching is the most basic level of manifold prep, though it doesn't always show a flow improvement by itself. The process starts with a carbide cut, and is followed by dressing with a cartridge roll or abrasive flap wheel. Consider the cross-sectional area further up the runner, and avoid simply flaring out the port at the end.



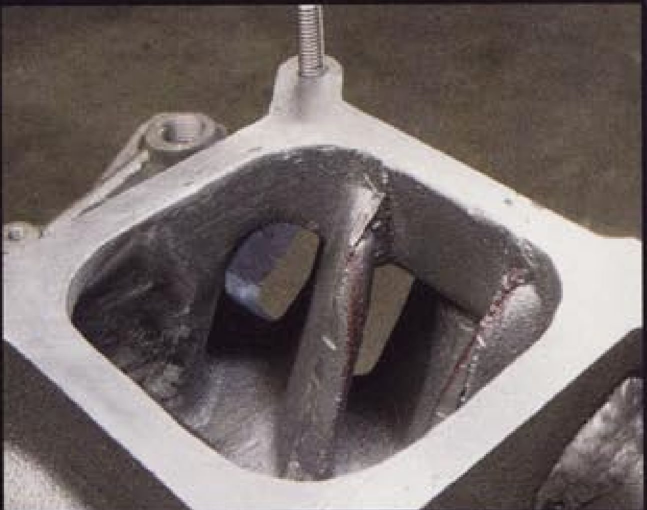
Plenum work is often rewarded with large flow gains. Even a manifold like this Parker Funnel Web for a small-block Ford (which is an outstanding intake as-delivered), can benefit.

Here is the final form of the fully ported Funnel Web's plenum. Reworked to this extent, the intake is more than a match for any Windsor head. Flow improved from 290 to 330 cfm.



This low-cost ProComp single-plane showed significant flow variation, with 300 cfm recorded on runner number two, and only 210 cfm at number six.

A look through the carb simulator adapter shows heavy shrouding and a restricted entrance into the unmodified center runners (bottom), especially when considering the context of the carburetor bores. The fully ported half of the plenum (top) shows improved form, with significantly increased area open to the center runners. Flow for the weakest as-cast runners improved by more than 100 cfm.



This view shows the torturous form found in the as-cast plenum. Considerable porting is required to make this intake flow to its potential. After the heavy carving, fine-tune with additional tests aided by the velocity probe.

A flow bench isn't really required to guess that plenum work would substantially improve this intake. Some porters theorize that a sharp edge at the divider is detrimental; however, Mulvey tells us the velocity probe suggests otherwise.

Edelbrock's Victor Jr. is a favorite intake for the small-block Chevrolet. Here we have a fully ported version exhibiting nice plenum form. Modifications improved the average airflow from 247 to 304 cfm, adding an average of 57 cfm.

Thorough port work includes exploring each runner for areas of constricted cross-section and making corrective cuts.

Taking runner work further, curves, turns, and shape changes are often reworked to streamline the port for flow. Of course, what you find will depend on the specific design of the intake manifold. Analysis here is aided by exploring with a velocity probe, looking for high- and low-speed areas and problematic forms that appear as flow separation or reversion. A simple U-tube manometer operating through a probe is useful for making this kind of assessment.

The plenum and runner entry form is one area of the intake manifold that is particularly influential on flow. Generally, the plenum roof leading to the runner is analogous to the short-turn radius in an intake port, and is a critical factor in flow. Here, a rolled, radiused form will typically show substantial flow improvement when compared to a sharp-edged transition. Divider walls can also benefit from carving, as can the shape of the runners' outer junction with the plenum walls. A reasonable objective when porting an intake for maximum power is to target consistent runner-to-runner flow at an overall capacity that exceeds the cylinder head flow by 10 percent.

To illustrate the testing procedure and potential flow gains from porting, we visited our pal Bryce Mulvey, who had several relevant examples. As can be seen from the flow figures, some of the intake manifolds tested in stock form fell well short of today's better cylinder heads. Also apparent are the substantial flow gains harvested with judicious porting. There are plenty of builders who would rather not know an intake's capabilities, and are seemingly content to have one less thing to worry about. But maybe they should worry about the guys who do. *EM*

FLOW RESULTS
SUPERFLOW 600 FLOW BENCH
DOCTOR J'S PERFORMANCE

Victor Jr. Intake

Runner	1	3	5	7	2	4	6	8
As-cast	252	248	239	251	256	246	237	250
Ported	302	296	304	308	316	298	306	302

Pro Comp Single Plane*

Runner	2	4	6	8
As-cast	300	254	210	294
Ported	352	334	314	356

*Left side of intake modified and tested only

SOURCE

DOCTOR J'S PERFORMANCE
Bryce Mulvey
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