



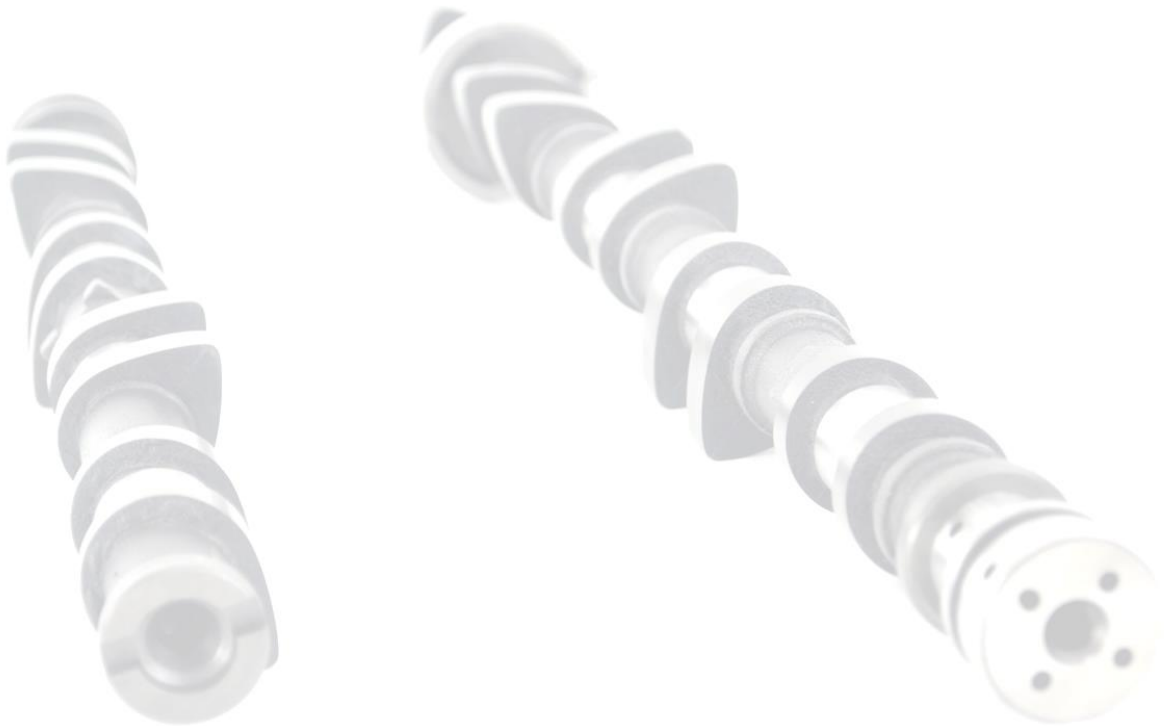
Whitepaper

CorkSport MZR DISI Camshafts

for Mazdaspeed MZR Turbo

Table of Contents

- ▽ [Page 1 – Introduction](#)
- ▽ [Page 1 – Camshaft Basics](#)
- ▽ [Page 1 – MZR Flow Testing](#)
- ▽ [Page 2 – Limitations of Existing Options](#)
- ▽ [Page 2 – Camshaft Design](#)
- ▽ [Page 4 – Fuel Pump Lobe](#)
- ▽ [Page 4 – Conclusion](#)



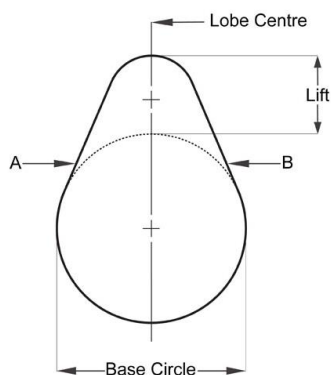
Introduction

After two years of testing, design and research, CorkSport is proud to announce its release of camshafts specifically designed around the MZR DISI platform. This kit is engineered to reliably provide an increase of power and torque without lower rpm sacrifices.

The turbocharged MZR DISI engine was first introduced in the 2006-2007 Mazdaspeed6 and was later put in the 2007-2013 Mazdaspeed3 and 2007-2012 CX-7. This engine has a High Pressure Fuel Pump (HPFP) that is driven off the intake camshaft. Other MZR engines use different camshafts and don't have a HPFP lobe to run the fuel pump. This has been a limitation in the market since the engines introduction.

Camshaft Basics

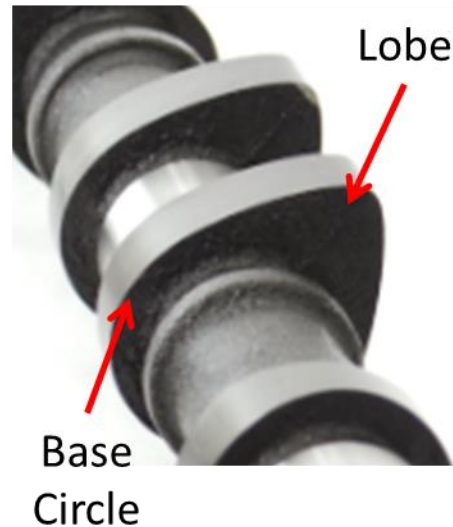
In order to understand the basics you need to know some camshaft terminology. The most common terms are lobe, lift, duration and base circle.



Common Drawing of Camshaft Terminology

Base Circle – The circle on the backside of the lobe. When the base circle faces the valve the valve is closed.

Lobe – The lobe is the portion of the camshaft surface that is not the base circle. This is when the valve is opening or closing.



Lift – The distance between the base circle and the top of the lobe. This will be the amount the valve is allowed to open.

Duration – The distance, in degrees, that the camshaft is in the lift section. This controls the time that the valve will be open. This is shown in the diagram from A to B.

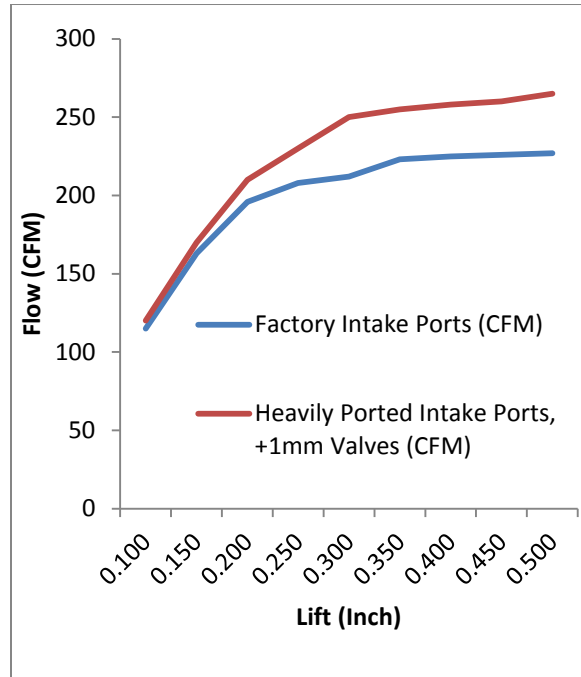
MZR Flow Testing

The first thing to do was flow test the head to figure out where restrictions might occur. To flow test, a constant vacuum was applied through the head and while slowly opening the valves. This is similar to what the engine is doing while running.

Intake lift

The factory intake ports do not flow much air above 0.350" of lift on the flow bench. The factory camshaft runs rough at 0.370" of lift. Shown in the graph below, minimal flow was

increased between 0.350" and 0.400" on the factory head.



Intake Ports of MZR DISI Head

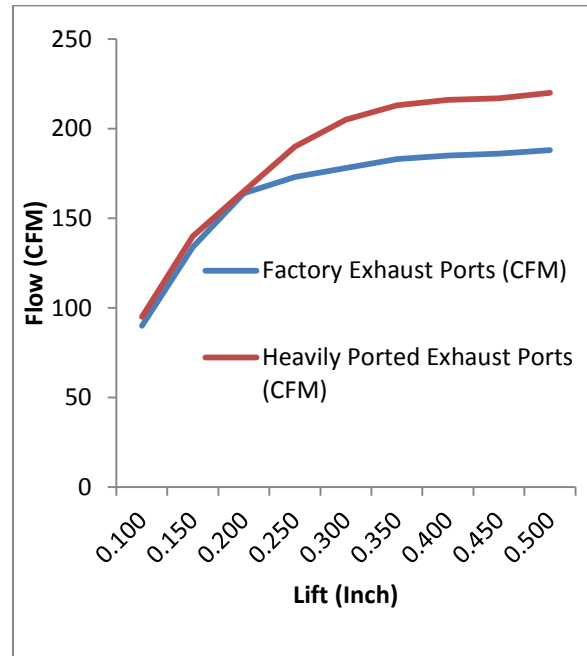
Porting is the process of modifying the intake and exhaust ports of an internal combustion engine to improve the quality and quantity of the air flow. After porting the head, there were significant increases in flow, but around 0.400" of lift there was again minimal increase in flow with more lift. Testing suggests a proper maximum lift of 0.390" for the intake camshaft. Factory heads or one with a large port should show gains from this increase in lift.

Why Stop at 0.390"?

More lift above 0.390" would require very extensive head work to gain much more power. Another down side of going above 0.390" lift is the valves will require stronger valve springs to maintain proper operation of the valves at high boost or high rpms. Upgraded valve springs should not be required for a factory head with 0.390" of lift camshafts.

Exhaust lift

A similar process to that described during the intake lift process was used on the exhaust ports and an optimal lift of 0.355" was chosen. For comparison, the factory runs 0.321" lift on the camshaft.



Exhaust Ports of MZR DISI Head

Limitations of Existing Options

The factory camshafts were designed around a compromise of performance and emissions; from that design criteria, there is still more power and torque available. The reader can now understand why increased lift and duration can release this power. There are limited options to increase lift and duration on the MZR DISI engine.

Reground Factory Camshafts

In order to increase lift and duration on a reground camshaft, the factory camshaft must be welded and reground to the new profile, but commonly the base circle is reduced. This

allows the lift to increase and also the duration to be adjusted.

There are limitations with this approach. When reducing the base circle many other parts in the head will have to make up for the amount ground away. Basically, it is limited to the amount ground away. It is also limiting with the duration because the profile must fit within the factory profile design.

In order to regrind a camshaft it must be removed from the engine or a new camshaft must be bought. A used camshaft can have wear that cannot be fixed. Buying new camshafts to send out is expensive and adds to the total cost of installing the camshafts.

Aftermarket Camshafts

The only camshafts currently made are not designed for the MZR DISI engine. This means the intake camshaft does not have the ability to run the HPPF.

The existing camshafts for the MZR engine were also designed around naturally aspirated (non-turbocharged) engines so the duration, lift and overlap between the intake and exhaust camshafts are not optimal for forced induction applications.

The best option to upgrade camshafts is to buy those designed and made for the MZR DISI engine specifically.

Camshaft Design

In order to start testing camshafts on the car, a blank camshaft is needed. This requires making a mold and casting a generic camshaft from a mold. Then the bearing services were machined to factory specs and after that a few dozen durations, ramp rates, and overlaps based on

the engines natural pumping ability were chosen.



Blank Camshaft with Bearing Surfaces Ground

After carefully grinding all of the blanks, it was time to dyno the engine and determine the difference in power and torque.

An engine is basically a vacuum pump with the camshaft helping determine at what rpm the pump is efficient. Camshafts allow the power under the curve to be manipulated. If you have ever taken a calculus or thermodynamics class you might have flashbacks.



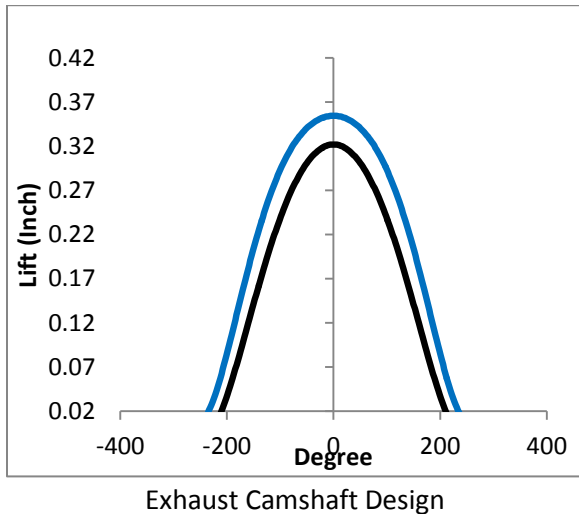
Power/Torque Factory Camshaft vs CorkSport Camshaft

Potential variations in the engine tune, fuel, outside temperature, and other factors were monitored. The result is clear improvements in power and torque throughout the rpm range. The final design was chosen to limit lower rpm power decrease with a large band of power improvement over 4000rpms.

Exhaust Camshaft Comparison

Further examination of the exhaust lobe design is a good example of where the power comes

from. When looking at the lift versus degrees as the cam spins, the changes to the lobe profile become apparent.



This change allows the camshaft to lift the valve more and for longer. This allows more air to flow out of the engine.

Intake and Exhaust Relationship

The intake camshaft is electronically controlled. With additional tuning, turbo spool and power can be increased by controlling the overlap between the intake and exhaust camshafts. Overlap is the time when both intake and exhaust are open at the same time. Typically in a turbo car overlap is much smaller than in naturally aspirated cars. Below shows intake and exhaust camshafts placed over each other and the area that would be considered overlap.

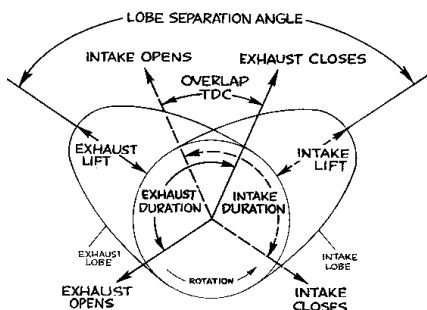


Diagram of Overlap

Fuel Pump Lobe

Recall the intake camshaft drives the mechanical HPFP. In order to allow the end user to have the best camshaft possible and also have reliable fueling and limited wear the fuel pump lobe on the CorkSport intake camshaft is ground to match the factory camshaft lobe and then rechecked to ensure no clearance issues.



Conclusion

Installation:

The installation of camshafts in the Mazda MZR engine is not easy. Camshaft upgrades should be considered by an experienced enthusiast or professional installation is appropriate. To aid an experienced installer, detailed installation instructions are provided. Successful installation is supported in two different ways.

- Color installation instructions
- Excel Tappet guide available for download online

The [CorkSport Camshafts](#) for DISI MZR feature:

- Created from brand new castings.
- Break-In coating included on lobes to extend life of camshaft.
- Designed exclusively for the MZR DISI engine.
- Extensive testing to determine optimal camshaft design then manufactured to exact tolerances