



ENGINEERING REPORT

2015 WRX Cat-Back Exhaust | SKU: MMEXH-WRX-15

By Kevin McCardle, *Mishimoto Engineering Manager*

REPORT AT A GLANCE

- **Goal:** To create a high-quality Cat-Back for the 2015 WRX
- **Results:** Excellent sound whether you mate it with the stock J-pipe or an aftermarket one. Drone is almost nonexistent from inside the cabin. The look and style of the exhaust tips are aggressive and tailored to fit the rear bumper.
- **Conclusion:** Dyno testing showed consistent horsepower and torque increases (9 hp and 8 ft/lb) over the stock exhaust.

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DESIGN OBJECTIVES

The design requirements assigned to this project are as follows:

- Durable, and will last the life of the vehicle under various conditions
- Able to work with Mishimoto, stock, and most after market J-pipes
- Dual mufflers with quad tips that maintain maximum ground clearance
- Increased performance over the stock unit
- High-quality exhaust tone, with an emphasis on drone reduction

MATERIAL SELECTION

The material used is one of the most critical features of any performance exhaust system. Mishimoto engineers researched and considered various materials before starting any design work. Most performance exhausts are made from stainless steel, but what separates the good from the best? Some common material choices are 409 stainless steel, aluminized steel, and 304 stainless steel. Mishimoto engineers decided to use 304 stainless steel for its excellent rust and corrosion resistance despite its higher cost when compared to the other two options.

DESIGN AND FITMENT

The stock 2015 WRX exhaust is designed with a 2.375" diameter midpipe section until it hits the Y-pipe, where the exhaust splits into two separate sections, and finally into the mufflers. Just after this Y-pipe section the exhaust pipe diameter decreases to just 1.875". This exhaust size is pretty typical for WRX cars over the past few years. Mishimoto engineers decided to increase the diameters of these pipes to 3" for the midpipe section and 2.25" for the muffler sections. The decision to make the muffler sections out of 2.25" piping instead of something larger was a calculated one. The two key components to an exhaust system are back pressure and exhaust gas velocity.

The goal is to reduce backpressure and to maintain an even, high-velocity gas pattern.

Since the WRX splits its exhaust into two mufflers, the engineers wanted to distribute the flow by splitting the two equally and by increasing the overall volume by only a small amount. Moving from a single 3" pipe to two 2.25" pipes increases the volume by 11%. This means that the velocity stream stays relatively uninterrupted, maintaining high velocity until it reaches the muffler tips. This approach is similar to the stock exhaust, which moves from a single 2.375" pipe into two 1.875" pipe sections. See figure 2 for comparison of percentage increase from the stock exhaust to the Mishimoto exhaust.

TECH BRIEF

Why is some steel called stainless steel?

Stainless simply means steel that resists rust and corrosion. Steel becomes stainless when the chromium (Cr) content is greater than 10.5%, and the carbon (C) content is less than 1.2%. Cr produces a thin ("passive") layer of oxide (about 1-5 nanometers) on the steel. This passive layer prevents any further corrosion of the surface. The greater the Cr content, the more corrosion resistant the steel becomes.

409 SS	
Iron, Fe	86%
Chromium, Cr	11.3%
Carbon, C	0.08%
Other	2.62%

304 SS	
Iron, Fe	70%
Chromium, Cr	18-20%
Carbon, C	0.08%
Other	10-12%

Figure 1: elemental properties in % weight

Figure 1 shows the difference between the elemental breakdown of the two types of stainless steel. **304 stainless steel contains more Cr and less Fe, which means it is much more resistant to rust and corrosion.** The benefit of using 409 compared to 304 is cost. 409 stainless steel is one of the cheapest available and is often why companies will choose 409 over 304.

When looking at muffler materials, you will often see aluminized steel construction. Aluminized steel is a process by which the outside of the steel is coated with an aluminum-silicon alloy. The hot-dipping process creates a strong bond between the materials and gives the steel the benefit of high strength and low cost, as well as corrosion resistance from the addition of the aluminum-silicon alloy. Although aluminized steel is considered corrosion resistant, it does not have the life span that 409 and 304 stainless steel materials tend to have.

Mishimoto Exhaust % Increase in Volume Over Stock Exhaust for the 2015 WRX

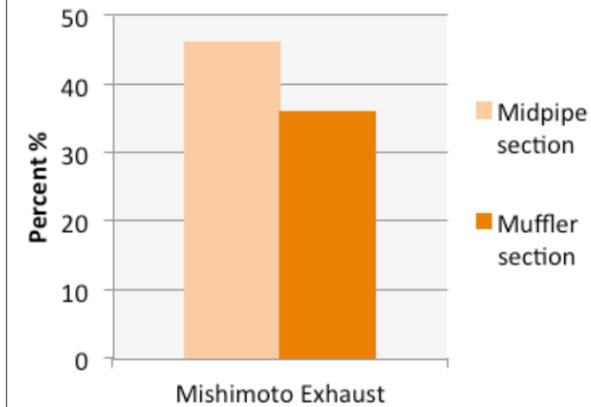


FIGURE 2: This chart shows a 46% increase in midpipe volume and a 36% increase in muffler section pipe volume.

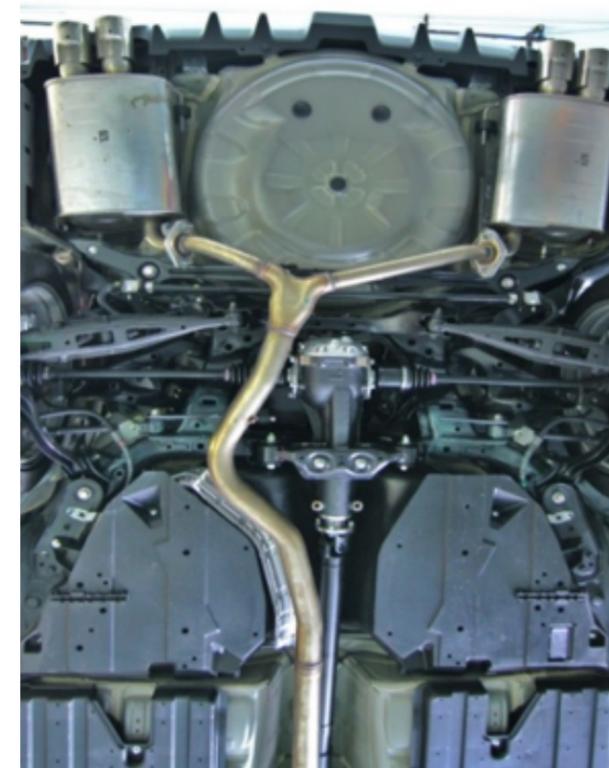


FIGURE 3: Stock exhaust. Notice the single entrance and dual-tip design. Stock mufflers will cause more backpressure and also detain more sound.

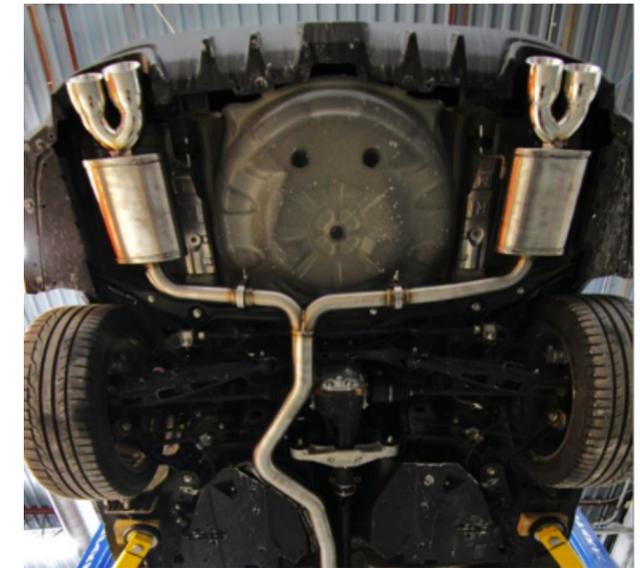


FIGURE 4: Mishimoto exhaust. Notice larger pipe diameters and the straight-through design of the mufflers. This reduces unwanted backpressure.

DESIGN AND FITMENT (CONTINUED)

The final pipe routing was made with ground clearance kept in mind. Engineers kept the exhaust at the same distance as the stock exhaust, from the top of the pipe to the heat shielding mounted on the car. This puts the Mishimoto exhaust less than one inch lower than the stock-mounted exhaust. This is a big plus for WRX owners who lower their ride heights and still use their vehicles on the street.

The quad-muffler tips are made from double-walled 304 stainless steel and feature slanted or slashed tips. The tips are also offset from each other to follow the lines of the rear bumper. Finally, the two outside tips have a small laser-etched logo that can be seen only if you look closely. This combination presented the best-looking tips in terms of fit and finish.

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SOUND TESTING

Exhaust tone is one of the most important features of a performance exhaust. Mishimoto focused on what the exhaust sounded like with a stock J-pipe compared to the Mishimoto 3" downpipe. Engineers tested wide-open throttle positions at various speeds and rpm ranges. Engineers also felt it was important to minimize drone inside the cabin during highway cruising speeds. What is drone? Exhaust drone is a constant and loud humming sound that is caused by a continuous vibration frequency between the exhaust, body, and interior of the car. As a benchmark, the stock 2015 WRX exhaust has almost no drone when cruising on the highway. We will consider this a 1 out of 10 on a droning scale.

To test which muffler would create the best exhaust note without too much drone, Mishimoto considered numerous mufflers, and narrowed the selection down to two sizes. These two sizes were prototyped and tested on the WRX so that engineers could select the very best option. Ultimately Mishimoto engineers choose an oval-shaped muffler that is significantly smaller than the stock mufflers.

If you would like to know more about the muffler selection process, please go to our engineering blog at <http://engineering.mishimoto.com/?cat=214>.

The engineers designed a straight-through muffler that uses a perforated baffle to ensure that the exhaust flow is not disrupted upon entering the muffler. This design style minimizes backpressure. The mufflers, along with all the other components, are made from 304 stainless steel.

The exhaust tone of a stock J-pipe on the Mishimoto exhaust is modest and with absolutely no highway drone. Engineers rated the drone 1 out of 10 when highway cruising. If the WRX has an aftermarket J-pipe, then the exhaust note gets a stronger tone and sounds its best. The drone is also kept to a minimum with a rating of 2 out of 10.

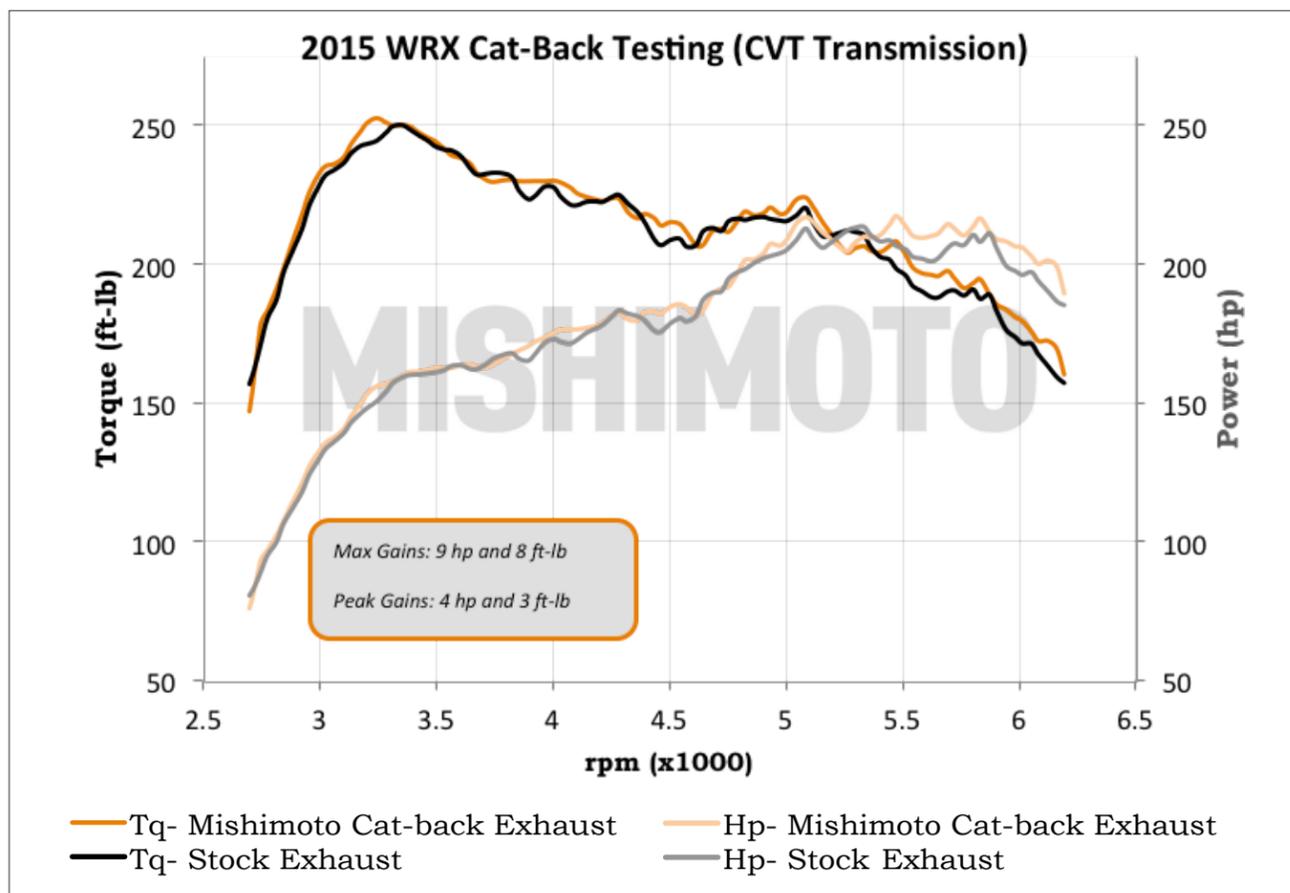


FIGURE 5: Dyno results. Note the increase of power after 5,000 rpm.



FIGURE 6: Eye-level view of the Mishimoto exhaust while strapped to the dyno during a performance testing cycle.

PERFORMANCE TESTING

Mishimoto engineers tested the exhaust on our in-house Dynojet 424Linx dynamometer. This allows us to accurately measure the power increases gained by bolting on the Mishimoto exhaust. The test results shown are an average of at least three dyno runs.

We do not take the highest or lowest dyno runs to prove artificial power gains. Testing was conducted on our 2015 WRX with a CVT transmission. Dyno runs were taken in 3rd gear in sport mode.

See figure 5 on previous page for final results. Results show a slight increase in horsepower and torque. Most of the gains can be seen in the higher rpm range at about 5,000 rpm. The max gain on average was 9 hp and 8 ft/lb. This is a pretty typical gain for a bolt-on part without tuning.

INSTALLATION NOTES

The Mishimoto performance exhaust can be installed on a completely stock car without any custom tuning. If the customer is running a Mishimoto intake without a tune and then installs the performance exhaust, Mishimoto recommends tuning the vehicle.

TESTING DONE BY

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