# VTT Turbo Basics: WGDC *-what it is, what it means, and why it sometimes doesn't matter*

***C.J.Popovich 11/21/2016***

**In the beginning...** Let's start by describing the function of a wastegate. A wastegate is a device that diverts some exhaust flow around the turbine on a turbocharged engine as a means of regulating the speed of the compressor wheel. Wastegates can be internal to the turbo housing (like on OEM N54 turbos), or external (like on N54 single turbo kits).


**Figure 1: VTT OEM/Stage 1 manifold/housing with internal wastegate**

On the N54 engines the wastegates are vacuum actuated. The engine has a vacuum pump, some vacuum storage canisters, and wastegate solenoids ("Pressure Converters" in BMW lingo) that are used to control the amount of vacuum applied to the wastegate *actuators*, which in turn open or close the wastegate flapper valve. If you apply more vacuum to the wastegate actuators, the wastegates will close more, and more exhaust energy has to go through the turbine, thus the more boost you'll make. This is basic boost control in a nutshell.

**Where does wastegate duty cycle come in, and what does it mean?** Wastegate duty cycle is referring to the wastegate solenoid (pressure converter) duty cycle, which switches on and off very fast; 0% WGDC would mean that the solenoid is *not* allowing vacuum to the wastegate actuators (wastegates fully open, minimal/no boost being made), 100% WGDC would mean the solenoid is allowing full vacuum to the wastegate actuators (wastegates fully shut, maximum system boost being made).

**WGDC and spool?** For spool, we'd want to run a very high WGDC until the turbo spools, then we'd drop WGDC down into something manageable to maintain the boost in a steady-state configuration.

**WGDC evaluation.** We at VTT like to use WGDC as an indicator from tune-to-tune on the same car, or hardware change to hardware change as a rough guide to gauge system flow deltas (changes). If you changed hardware on the inlet side of things and WGDC goes down in order for you to reach a target boost, then you did the right thing! If your WGDC seems abnormally high to hit a given target boost the first thing you're going to want to look for is boost leaks.


**Figure 2: VTT upgraded wastegate valve pieces**



For questions please contact:
**sales@vargasturbo.com** or
**customersupport@vargasturbo.com**

Boost leaks will cause you to need more WGDC to reach your target, increasing shaft speeds (never good) and if the leak is bad enough you'll miss your target, all the while possibly overspeeding your turbo (very bad!). Having general ballpark knowledge of your expected WGDC ranges is useful when understanding the state of your turbo motor and diagnosing issues. One of the things we're working on at VTT is publishing expected WGDC ranges for a given boost/rpm target to help with troubleshooting issues.

You cannot, however, use WGDC as an indicator of system capacity unless it's at 100% (nothing more left). We've all heard the proclamations "I made 30 psi on just 47% WGDC! Plenty left in her!". Well, *maybe*. Remember that WGDC is merely the percentage of time that full vacuum is applied to closing the wastegate actuator. We can't tell anything at all about airflow from WGDC, we don't know anything about shaft speed based on WGDC (except more WGDC *should* mean higher shaft speeds), and we don't know anything about system efficiency based on WGDC. Not only that, but WGDC numbers can be "fudged" easily.

**Figure 3: Wastegate actuators; different lengths for different applications**

**Fudging WGDC.** What? How is that? Very simple actually. Tighten the wastegate actuator a few turns on each of your turbos, and instantly your WGDC will go down for a given boost level. All you did was make the wastegate valve position itself slightly more closed to start with; the vacuum system now doesn't have to close the valve *as much* to reach your target boost. Tighten it enough and you'll get *boost creep*, which is when the turbo is building boost even with low/no WGDC! This doesn't buy you a single bit more system capacity, it just gives you what you're going to get earlier. A good analogy for this is comparing standard throttle mapping versus linear throttle mapping. Some cars give you all the power in the first 50% of the accelerator pedal travel, others don't give you 100% until the pedal is on the floor. It's the same car with the same power -just controlled differently.

**Final Thoughts.** System capacity and ultimate horsepower capability requires an understanding of compressor maps, shaft speeds, and of the complete engine; reducing flow restrictions on the intake/inlet side to give the compressor easiest access to air, reducing flow restrictions on the compressor outlet (hot side charge piping and a free-flowing FMIC), and on the exhaust side of things removing as many bottlenecks and restrictions as possible to reduce backpressure will *always* help. Efficiency and shaft speed aside for a moment, when you increase WGDC and your boost doesn't increase, you ran out of turbo, if the WGDC is 90% or if it's 40% it doesn't matter -you have maxed the turbo. If you want more it's time for some hardware changes (do a boost leak check first though!).

The turbos and components should always be matched to the power, reliability, and response goals of the customer. From 100k+ stock motors to fully built dedicated track cars, let us know if we can help you sort out a package that will deliver what you're looking for.



For questions please contact:
sales@vargasturbo.com or
customersupport@vargasturbo.com