

## An Equation for Engine Boosting Excellence

Rugged Commercial Turbo DNA +  
 Leading Edge Passenger Car Technology +  
 Passion for Imagination and High Expectations =  
 Advanced Aftermarket Products or AAP

The EFR line of turbos was born out of an internal BorgWarner Turbo Systems program labeled Advanced Aftermarket Products or AAP. So, the first thing you might be wondering is what does a new product line of high-performance turbochargers have to do with commercial applications? Commercial/industrial turbo products have extreme requirements for durability, reliability, and aerodynamic performance. Since modern passenger car applications use turbos smaller than 55mm in turbine wheel diameter, it's the aerodynamic development from the commercial side of the business (i.e. everything larger) that feeds into what the performance enthusiast wants and needs for big power production. Boost pressures of 45-50 psi (3 bar+) are the norm, not the exception. Also required is resistance to abusive thrust loads, high vibrations, and robustness for a wide range of lubrication conditions. Additionally, our commercial product validation standards are among the highest in the engine boosting industry; all good things that also benefit the performance enthusiast or racer.

Those are the commonalities, now here are the differences. Unlike commercial applications, high performance users want lightweight, compact, versatile designs. They also deliver the turbocharger very high exhaust gas temperatures and have high expectations for fast response. They also place value in cosmetic appearance and want integrated features that aid the installation process and remove the need for other turbo related accessories. Those performance and packaging requirements are quite common among the modern aftermarket passenger car turbo customer. So, what happens when you tie together all those necessities and put them in front of passionate car people looking to advance the pace of aftermarket boosting solutions? There is a discovery that something new is needed in order to meet the needs of the next generation turbo consumer. There is the need for an "it" that really changes the game or raises the bar or whatever other metaphor you care to use.

Under the product leadership of Brock Fraser, Director, Global Commercial Diesel Application Engineering, a team was assembled and the project began with the proverbial clean-sheet of paper. No legacy products, no preconceived notions of what a turbo could or could not have; no restrictions. The aerodynamics for the product line were selected using a range of optimized combinations that would give users turbo solutions anywhere between 250 and 1000 horsepower capability per turbo. Next, a list of every notable design characteristic for an engine boosting device was tabled. Specific interest was given to new ideas that had never been formed in metal or had never been combined into an aftermarket turbo. Ninety-five percent of the input "stuck" with only the truly exotic being excluded as those elements that would take too long to develop. Moreover, the turbo would be so expensive that the average performance enthusiast who wanted to buy the product could not afford it!

After the AAP program took shape, the concept was presented to members of the BorgWarner senior management team. It didn't take long for them to embrace the vision of giving the performance aftermarket something truly remarkable. Management's approval to proceed with our mission led to one of the most aggressive new program introductions in the history of BorgWarner's independent aftermarket. Weeks and months of product development would bring forth a creation that would set a new standard in the performance aftermarket.

The result is the new EFR (Engineered for Racing) line of turbos from BorgWarner. These turbos contain a bevy of key attributes such as Gamma Ti turbine wheels, dual ceramic ball bearing cartridges and investment cast stainless steel turbine housings. Collectively, those features help give the EFR line its innovative appeal and will provide a breakthrough experience in durability, device responsiveness and installer/user satisfaction.

**Forged Milled Compressor Wheels (FMW)**  
 EFR turbos contain wheels that are fully milled from forged aluminum, commonly known as "billet". Cut from custom forgings, their strength exceeds that which is available from typical bar-stock and also exceeds the material properties of an aluminum casting.

**Gamma Ti turbine Wheel & Shaft**  
 Gamma-Ti turbine wheel cuts turbine inertia by roughly 50% dramatically improving turbo response. Turbine sizes range from 55 to 80mm in exducer diameter.

**Stainless steel turbine housings**  
 Investment cast stainless steel turbine housings improve durability and offer an extremely smooth internal flow channel. Turbine housings have thin walls to reduce weight and thermal inertia.

**High Flow Wastegates**  
 Purpose designed large wastegate ports give the wastegated EFR turbos the capability of handling the flow requirements of high performance applications.

**High Turbine Efficiency**  
 Superback™ and Fullback™ back-disk shapes offer very high efficiencies and have been paired with our ". The Superback shape adds a curved profile to the backdisk and has the effect of lowering centrifugal stress and permitting higher rotational speeds.

**Adjustable Wastegate**  
 The fabrication and installation task is simplified with wastegated EFR models that feature adjustable wastegates available in three different canisters.

**Ease of Orientation**  
 Turbo orientation flexibility is facilitated by the wastegate bracket to bearing housing mounting arrangement.

**Enhanced Turbo Response**  
 EFR turbochargers use a dual-row ball bearing cartridge with ceramic balls and metal cage. This bearing system provides substantial friction reduction at low turbo speeds and in the process helps improve turbo response.

**Flexible Compressor Cover**  
 The "large" cover has a dual-machined outlet, both for a hose connection and a v-band connection.

**Simplified Installation**  
 Integrated compressor recirculation valve (CRV) to help avoid compressor surge and backflow during a throttle lift event. This feature helps to simplify the installation task and lowers overall system install cost.

**Boost Control Solenoid Valve (BCSV)**  
 A boost control solenoid valve (BCSV) is included with every EFR turbo.

**Sensor Mounting Convenience**  
 Speed sensor mounting provisions are also supplied on every compressor cover. Speed sensors are sold separately.