THE DEVELOPMENT OF ELECTRICALLY ASSISTED TURBOCHARGERS FOR DIESEL ENGINE APPLICATIONS

S. M. Shahed, John Allen, and Jerry Artache
Garrett Engine Boosting Systems

Garrett Engine Boosting Systems, together with Turbodyne Systems Inc. and Navistar International Transportation Corporation, will carry out a development program leading to an electrically assisted turbocharger (EAT) which will demonstrate improved vehicle response, reduced fuel consumption and lower emission levels compared to a conventionally turbocharged diesel engine. The program will include an initial feasibility study where the technology will be demonstrated on a passenger car diesel engine in the 2.0 to 2.5 liter size, taking advantage of existing turbocharger and associated electrical hardware for this engine size range. A go/no-go decision will be made at the conclusion of the feasibility phase to then scale the resulting EAT for demonstration of the technology on a diesel engine of approximately 4.5 liter displacement intended for Sports Utility Vehicle (SUV) applications.

The EAT will be designed to operate in either a Motor Mode or in a Generator Mode. In the Motor Mode electrical power will be used to supplement the power from the turbocharger turbine when there is increased demand for air delivery to the diesel engine. For engine operating situations where there is excessive exhaust energy, the Generator Mode will be used for battery charging or for other vehicular electrical loads, thereby reducing the demand for electrical power from an alternator/starter directly attached to the engine shaft.

Laboratory tests of this EAT on a gas-stand will be carried out to evaluate the detailed performance characteristics of the turbocharger compressor and turbine as well as of the motor/generator and associated electronic controls. Additionally, steady-state and transient tests will be conducted on an engine installed on a dynamometer with both a Wastegate and a VNT turbocharger with Electrical Assist. Power, torque, fuel consumption, and emissions improvements over a range of operating conditions will be evaluated. For comparison identical tests with conventional Wastegate and VNT turbochargers will be carried out. The next phase will be to scale (and modify as required) the EAT from the preliminary design phase for application to a Navistar diesel engine of approximately 4.5 liter displacement targeted for SUV applications. Detailed drawings and performance demonstrator hardware will be procured for a production viable EAT, sized for the target engine. Detailed gas stand tests will be carried out to validate EAT component perfor-mance. This will be followed by tests of an EAT equipped engine on a dynamometer over a range of steady-state and transient operating conditions. Major performance characteristics to be measured will be peak torque levels over a range of speeds, load acceptance capability, fuel consumption rates and emission levels. Similar tests will be carried out with the same engine equipped with a conventional wastegate and a VNT turbocharger for direct comparison of results with the EAT. Durability tests will be carried out to validate that the EAT and engine meet life expectancy requirements for the intended application.