

Thermal Barrier Coatings

The concept of thermal barrier coating, or TBC, involves placing a thermal insulating layer of material between a metallic engine component and the hot gas heat source to reduce heat transfer to the component. Such coatings, applied by plasma spray processing in thin films typically measuring less than a millimeter, have been



used for years to coat metal components of gas turbine and rocket engines for aircraft and spacecraft. Lewis Research Center is a world leader in developing TBC technology.

The successful employment of TBCs in aerospace applications has sparked interest in applying them to non-aerospace turbines and diesel engines. One company that has conducted extensive research in this area is Caterpillar Inc., Peoria, Illinois, a leading manufacturer of earthmoving equipment and heavy duty diesel engines. Caterpillar has been actively pursuing application of ceramic coatings to high temperature components of diesel engines, aided by technical assistance from Lewis Research Center and contractual support from the Department of Energy.

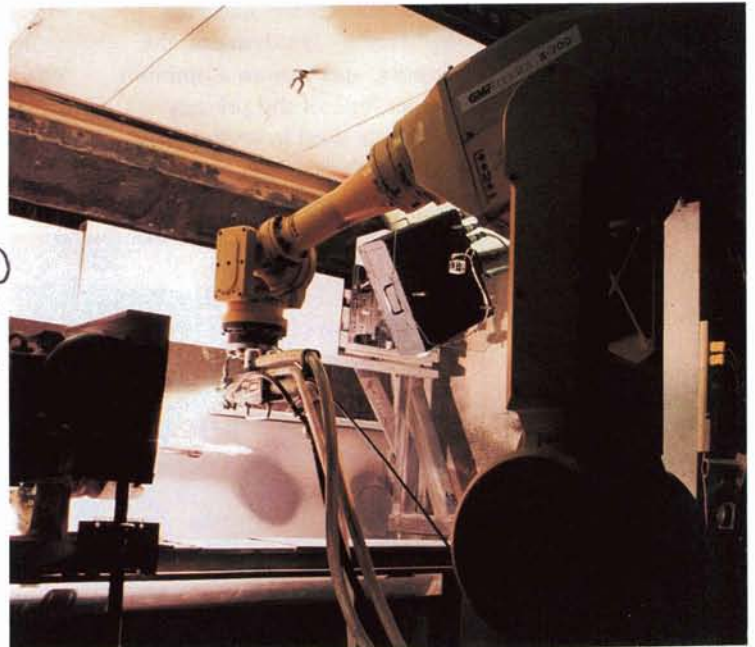
The cooperative effort has resulted in use of ceramic thermal barrier coatings on Caterpillar Series 3600 production

engines. These large engines, ranging from 1700 to 6700 horsepower, are used in stationary electric power generation and marine applications. Cat 3600 engines can be configured for optimized operation on distillate fuels or for running on the heaviest fuel available.

Heavy fuels contain high amounts of sulphur and vanadium that, at high combustion temperatures, form corrosive compounds on exhaust valves. With high vanadium fuels, the life of an engine valve can be reduced to as little as 50 hours without design measures to minimize the temperature of the exhaust valve. Caterpillar's answer is use of watercooled

coatings is accomplished by a process developed by the Caterpillar Technical Center in Peoria. High quality coatings are ensured by a fully automated plasma spray cell (*below*) that includes computerized plasma spray equipment capable of monitoring and controlling all spray variables, a six-axis robot for manipulating the spray gun, and a laser gauge for monitoring coating thickness as it is built up.

Caterpillar and NASA are continuing their collaboration, extending thermal barrier coating technology to other applications, such as heavy duty truck engines. For this application, they are testing TTBCs (thick



valve inserts, a corrosion resistant Nimonic 80A material in the exhaust valves, and a unique ceramic coating on the exhaust valve head (*left above*) to control temperatures, extend valve life and reduce operating cost.

Application of the ceramic

thermal barrier coatings), which are as thick as four millimeters. TTBCs applied to pistons and engine heads insulate the engine, raise the combustion temperature and increase the engine's fuel efficiency. ●

AN AEROSPACE ENGINE

COMPONENT COATING

TECHNOLOGY IS

EXTENDED TO

NON-AEROSPACE USE