

AeroShell Performance Additive 101, developed for the USAF JP-8 +100 programme by BetzDearborn (now GE Betz) for high temperature, high performance jet fuel, helps improve engine reliability while reducing overall operating and maintenance costs.

AeroShell Performance Additive 101 is a unique, patented jet fuel additive designed to improve the thermal stability of military jet fuels. An extensive testing programme has demonstrated engine performance improvements and substantial cost savings.

AeroShell Performance Additive 101 is the only product to meet the goals of the U.S. Air Force JP-8 +100 Project. It has over three million flight hours in operation at USAF and ANG locations and is now available to non-U.S. military customers.

AeroShell Performance Additive 101 is approved for use in all military and civil engines manufactured by Pratt & Whitney and General Electric. Approval in Rolls-Royce and other manufacturers' engines is pending.

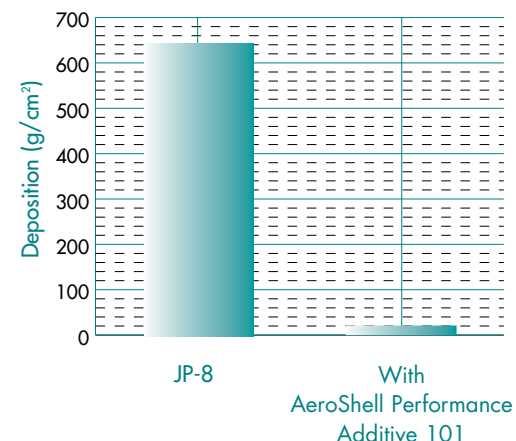
AeroShell Performance Additive 101 is designed to:

- provide greater fuel heat-dispersing capacity by allowing fuel temperatures to increase by as much as 56°C (100°F) without degradation.
- reduce deposits in turbine engines using all grades of jet fuel.
- prevent and clean up carbon in fuel system and combustion sections of turbine engines.
- reduce smoke signature.

Improves Jet Fuel Thermal Stability

In today's military aircraft, standard jet fuel can break down and form deposits on metal surfaces, when thermally stressed to temperatures above 150°C (300°F). This severe environment requires substantially improved fuel stability. In a variety of static and dynamic laboratory tests, along with advanced simulator rigs, Shell Aviation's additive programme, in conjunction with BetzDearborn (now GE Betz), has already demonstrated a minimum of 56°C (100°F) improvement over today's jet fuel in both the bulk and wetted wall areas of aircraft fuel systems.

Extended Duration Thermal Stability Test
Bulk Fuel 350 °F: Nozzle 550 °F for 56 Hours



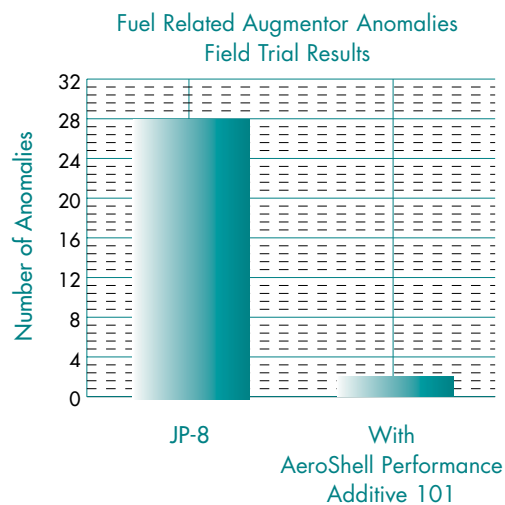
Reduces Fuel Manifold & Nozzle Coking

Carbon build-up (coking) can create back pressure in fuel manifolds, as well as distort fuel nozzle spray patterns. Altered flame patterns can contribute to metal fatigue in both the combustion and turbine sections of the engine. High engine cycle fatigue often occurs. In severe cases, turbine damage leading to catastrophic engine failure is possible.

Coke build up along the walls of the fuel manifold system can cause changes in hydraulic pressure and contribute to erratic fuel controller performance. In "real world" field testing and subsequent routine usage in JP-8 +100, AeroShell Performance Additive 101 has minimised equipment replacement costs by reducing coking, allowing optimum performance levels to be achieved.

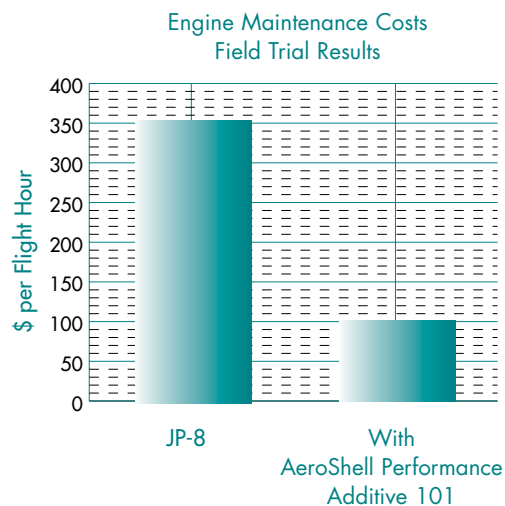
Reduces Unscheduled Engine Removals

Reports of after-burner and other fuel related malfunctions usually trigger a mandatory inspection to duplicate and correct the malfunction before the engine can be put back into active service. These engine inspections are costly but necessary to ensure pilot safety and aircraft integrity. In military field testing, continuous use of AeroShell Performance Additive 101 dramatically reduced the frequency of these fuel related incidents and consequently lowered the cost of engine removals by as much as 50%*.



Improves Engine Cleanliness

Following the introduction of JP-8 +100, hot engine sections, from the combustion zone through to the afterburner tail exhaust, previously covered with light carbon deposits, have actually cleaned up and remained clean. Visual inspection of aircraft tail sections, combined with field boroscope inspections of fuel manifolds and nozzles have confirmed this benefit.



Improved Flight Safety

Afterburner (reheat) malfunctions are dangerous and can place pilots and their equipment in jeopardy. Failures to ignite afterburner spray fuel rings can cause mechanical damage, place pilots at risk, and in combat, potentially mean the split-second difference between life and death.

AeroShell Performance Additive 101 has been field tested in a wide range of high performance jet engines as part of the USAF JP-8 +100 Programme and has shown that it significantly reduces these malfunctions - by as much as 80%*.

Reduces Operational & Maintenance Costs

Keeping the fuel system and jet engine clean from carbon deposits caused by the thermal stressing of jet fuel can reduce overall engine maintenance costs by as much as 70% per flight hour*.

Combine this with improved aircraft readiness, and the full benefit of AeroShell Performance Additive 101 can add up to a first-class return on investment.

Additive Injection

AeroShell Performance Additive 101 should be applied at the truck or vehicle refuelling operation using an injector system to meter the additive flow. Care should be taken if moving the injection point further up the refuelling process (such as into bulk storage tanks) in order to avoid deactivation of water coalescer systems by the detergent/dispersant action of the additive.

The recommended dose rate for AeroShell Performance Additive 101 in JP-8 is 256 ppm (mg/litre) or 1:4000. The product is oil soluble with good low temperature handling characteristics and can be injected undiluted in its delivered form.

Performance Evaluation

AeroShell Performance Additive 101 should be used in conjunction with a monitoring program designed to focus on fuel-related malfunctions. It is usual to measure the actual number of malfunctions, average time between occurrences, and the reduction in maintenance and labour costs. An additional measure is the effect on fleet readiness rate after treatment.

Caution: before using AeroShell Performance Additive 101, check with the aircraft/engine manufacturer to determine if the additive is approved for use in their equipment or, if not, under what terms and conditions the additive might be evaluated.

To learn more about how your operation can benefit today from the advanced technology of AeroShell jet fuel additives, contact email: APA101Project@aviation.shell.com

Summary of Benefits

- Improved Jet Fuel Thermal Stability
- Cleaner Engines and Components
- Reduced Operational Costs
- Fewer Engine Removals
- Lower Abort Rates
- Lower Maintenance Costs
- Improved Air Readiness
- Improved Flight Safety

*Based on data collected on the following engine types: F100-PW-100, F100-PW-200 Series, J85-GE-5, J69-T-25
Additional field tested engine types include: F110-GE-100, TF34-GE-100, T56-A-15

Non-Military Usage of AeroShell Performance Additive 101

Although the development of AeroShell Performance Additive 101 was the result of a requirement in military aircraft, benefits could also be achievable in commercial aviation. However, engine overhaul lives in civil aviation are an order of magnitude greater than those of military aircraft; consequently it is unrealistic to expect the same dramatic reductions in maintenance costs. What other benefits might be achievable?

By keeping fuel and combustion systems clean, optimum combustion conditions should be maintained for longer and this should have a beneficial effect on the normal performance deterioration rate seen during service. This could be translated into an improvement in specific fuel consumption, but any improvement is likely to be small and difficult to measure. Even so, an improvement of only 0.2%, say, in specific fuel consumption can still have a significant effect on an airline's fuel bill. Such benefits can only be quantified by prolonged flight trials and Shell Aviation is currently working with several airlines to generate these data.

Another benefit of AeroShell Performance Additive 101 has already been demonstrated in a number of combustor rig trials, where it was seen to actively reduce particulates and heavy unburned hydrocarbons in the exhaust emissions. Further rig and engine testing is planned to quantify the emissions reduction capability of AeroShell Performance Additive 101.