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# New Demands New Oil



**Jet engines requiring more from lubricating oils led Mobil to create a new product. Mark Broadbent reports**

The introduction into service of airliners powered by new engines designed to significantly reduce fuel burn and emissions has created a need for an equally new generation of engine lubricants.

“New jet engine technologies are bigger, faster and run hotter, stressing lubricants as never before,” Susan Ardito, ExxonMobil’s Aviation Product Deployment Manager, told AIR International.

“As engine power, operating temperatures and time-on-wing climbs, more aircraft operators are looking for engine oils designed to manage the increased demands being placed on engines.”

Running hotter creates coking, or oil degradation, which leaves behind solid residues in the engine – leading to costs for airlines in removing the deposits and lost revenue from having an aircraft sitting on the ground.

One solution is to use high thermal stability oils that can handle the heat. But they have a downside.

“They can also be aggressive on elastomers,” Ardito explained. “Damaged seals and O-rings lead to oil leaks and can require more frequent, and costly, maintenance and parts replacement.”

## High Performance Capability

The issue led the industry to realise a new breed of high performance capability (HPC) oils was needed that provided both a low coking level to help engines deliver the required performance, while ensuring the integrity of the seals and O-rings.

SAE International, a global association that develops standards in aerospace engines, issued a new specification – SAE AS5780A for Aero and Aero-derived Gas Turbine Engines Lubricants – that defined the basic physical, chemical and performance limits for HPC oils.

Using that specification, lubricant manufacturers’ R&D departments went to work developing HPC products that could provide low coking without maintenance drawbacks. ExxonMobil’s response was Mobil Jet Oil 387.

## Meeting the Standard

To meet the specification, HPC lubricants must undergo extensive evaluation. Ardito said ExxonMobil spent more than a decade developing its oil in partnership with engine manufacturers. Trials were

carried out, she said, “on-wing as well as in laboratory and high-stress, land-based turbine tests, under conditions even more demanding than normal aircraft service”.

Mobil Jet Oil 387 was fully approved in February 2014 for the GE Aviation GENx turbofan (which powers the Boeing 747-8 and 787 Dreamliner) and the CF34-10 that’s installed in the Embraer E190/E195 and Lineage 1000. Rolls-Royce also cleared its use for the Trent 1000, Trent 900 and Trent XWB engines. In January, Virgin Atlantic Airways announced it would use the product for the Trent 1000s on its new 787-9 Dreamliners.

Mobil Jet Oil 387 is also approved against US military engine oil lubricant specification MIL-PRF-23699, which is equivalent to SAE AS5780. ExxonMobil says the oil is suitable for a wide range of civil, commercial and military aviation applications ranging from today’s most advanced, modern turbine engines to single-engine helicopters.”

## The Tests

Ardito expanded on the evaluations the product was put through to verify its performance and



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ensure it met the HPC classification.

A vapour-phase coker trial involved technicians heating the oil in a flask while bubbling air through it to create vapours and oil mist.

“In this process, deposits formed as the oil flowed through a heated stainless steel tube in a furnace,” Ardito explained.

“We then weighed the deposits to indicate the vapour-phase coking propensity. Our tests revealed that Mobil Jet Oil 387 [deposits are] typically 170mg lighter than the other oils tested.”

An anti-wear test measured the oil’s ability to resist gear scuffing. “Technicians applied oil to the gears at 90°C and added load in stages, recording the highest load stage reached before the gears scuff,” Ardito said. “Mobil Jet Oil 387 reached ten of 12 stages of load, a very strong performance.”

### Tensile Strength

The oil’s compatibility with seals was evaluated by testing the tensile strength of O-rings (also known as ‘dog bones’) that had been exposed to the lubricant..

“While the ‘dog bones’ exposed to other oils in our laboratory test cracked easily when technicians applied force, those exposed to Mobil Jet Oil 387 retained their tensile strength and didn’t become brittle,” Ardito said.

“Additionally, technicians assessed the weight change, or swell, using O-rings tested at 200°C. With competitive oils, the O-rings visibly increased in size, demonstrating approximately 55% volume swell, but Mobil Jet Oil 387 showed only about 22%.”

### Temperature

The oil’s low-temperature fluidity, which is important for cold starts, was examined by holding it at -40°C for 72 hours. To pass this test, oil must rank below 13,000 temperature shock transformation (Tst). The product scored less than 10,000 Tst during the trial.

Scientists assessed the oil’s performance at the other end of the temperature spectrum by heating a metal rod to 375°C (707°F) and circulating oil and air over it for 20 hours. They then measured the number of oil deposits left behind on the tube.

“We measured less than 0.1mg of deposits, which was a significantly lower level than seen in competitive oils,” Ardito said. “On a cleanliness scale of 1 to 100, it rated 96.4.” Cleaner engines mean longer intervals between maintenance.

### Viscosity

Another test analysed Mobil Jet Oil 387’s propensity to change its viscosity, or thickness, when exposed to high temperatures. This trial involved bubbling air through oil held at 200°C (392°F) for 72 hours. Its viscosity increased by around 10%, Ardito said (the test allows a limit of 22%). In other words, the oil resisted changes to its thickness despite the temperature increase. ExxonMobil says



**1** Virgin Atlantic Airways announced in January that the Rolls-Royce Trent 1000s on its new Boeing 787-9 Dreamliners, including G-VNEW (c/n 40956) pictured here, are using Mobil Jet Oil 387. *Ben Montgomery* **2** Susan Ardito, ExxonMobil’s Aviation Product Deployment Manager. *ExxonMobil* **3** GENx engines are among the engines for which Mobil Jet Oil 387 is approved. *KSK/AirTeamImages* **4** Mobil Jet Oil 387 is approved for several General Electric turbofans, including the CF34-10 used on the Embraer E190. *Felix Gottwald/AirTeamImages*

that shows the oil will help with hot-weather starts and reduce the potential for clogs.

“Additionally, we looked at the filter papers that collected deposits from stressed oil,” Ardito said. “The paper had very low levels of deposits, almost as clean as the filter paper that wasn’t in use.”

Finally, a thermal stability test evaluated the oil’s behaviour at high temperatures in the absence of air. “We held the oil at 525°F for four days and then evaluated the viscosity change, acidity and corrosion on metals,” Ardito said, adding that Mobil Jet Oil 387

“remained very stable under these conditions”.

### More Certifications

With the engine certified for the GENx, CF34 and Trents, Ardito told AIR International that ExxonMobil is now working to have the oil certified for other engines, including pursuing approvals in the complete line of Pratt & Whitney PurePower engines that will enter service on the Airbus A320neo, Bombardier CSeries and Embraer E-Jets E2 families.