EASTMAN

Eastman Aviation Solutions

Product guide

Eastman turbo oils

EASTMAN TURBO OILS AVIATION LUBRICANTS

Proven performance | Technical excellence | Dedicated support

Eastman Aviation Solutions brings together Eastman turbo oils, Skydrol® aviation hydraulic fluids, and SkyKleen® solvents to provide industry-leading products, technical resources, dedicated support, and enhanced service to all aviation customers.

This global team of aviation experts with its wide range of experience builds strong relationships with airlines, manufacturers, and all members of the industry to help understand specific needs, enabling us to seek out innovative and flexible solutions to meet exacting requirements. We are committed to supporting the industry with exceptional products, technical services, and engineering consultancy to partners worldwide.

Contact your local representative for further details or visit **www.EastmanAviationSolutions.com**.

Eastman Aviation Lubricants Academy

Demonstrating operational value

Eastman Aviation Solutions is dedicated to developing the advanced aviation lubricant expertise your company relies on.

The program is made up of eight modules covering all aspects of the aviation industry, from identifying aeroplane types to engine operation.

The module questions can be taken in any order and at a pace which suits both your available time and learning speed.

On completion of the Eastman Aviation Solutions academy, you will receive a certificate in recognition of your achievement.

EASTMAN
TURBO OILS
AVIATION
LUBRICANTS

Value tool

Adding lasting value to your business

We are committed to supporting the industry with exceptional products including the world's leading high-performance turbo oil, Eastman Turbo Oil 2197. We now offer a visual demonstration of this performance via our Value Proven tool.

Using current industry data and with variable calculations applied to your operations model, you can view a demonstration as to how our lubricants will help you run your business even more cost-effectively.

Building strong customer relationships helps us to understand your specific needs, enabling us to seek out innovative, flexible, and value proven solutions to meet your exacting requirements.

Engine type	Import	Quantity	Volume	Per gallon	Total
CF6-80	-	25	2,000	$16.48	$32,956
CFM56-5B	-	40	8,000	$1.09	$8,733
Trent 700	-	12	600	$8.02	$4,810
V2500	-	10	500	$17.90	$8,950
Other engines			0		
Total		87	11,100		
		Average savings per gallon for entire fleet			**$5.00**
		Estimated maintenance savings per year			**$55,449.21**

Example calculation

Tested above industry standards

Eastman's in-house formulation expertise enables us to design, develop, and evaluate our lubricant products in a unique manner, maximizing the performance benefits from the latest advances in additive and base stock technologies.

Developing outstanding products for our customers

Eastman has several global research facilities responsible for developing and supporting jet engine lubricants for the aviation businesses.

Our world-class technology team comprises chemists, engineers, and analytical experts respected industrywide in the field of lubricant formulation research, analytical chemistry, and lubricant performance testing.

With more than 150 combined years of aviation lubricant experience, the team offers a winning combination of product and application expertise.

Our research facility houses state-of-the-art chemical analysis instrumentation plus one-of-a-kind high-temperature dynamic deposition test equipment unique to Eastman and the aviation industry. These testing capabilities set Eastman apart from the competition and provide the very highest level of confidence for customers when using our products in the ever-demanding environments within the engine.

Pioneering lubricant testing beyond aviation industry requirements

The jet engine presents one of the most demanding and stressful environments for lubricants for several interrelated reasons including operating temperature extremes, lubricating system design, aircraft operation profiles, and maintenance practices. During the design, development, and testing stages for a new oil, many aviation industry standard tests are mandated, aimed at assessing future performance in a jet engine and are covered within both MIL-PRF-23699 and SAE AS5780 specifications. Individual OEMs may then also require specific additional testing.

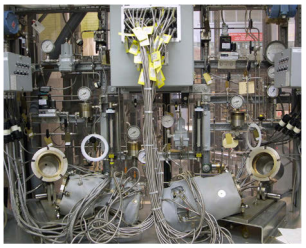
Despite this gamut of testing, Eastman considers these tests to be considerably removed and incomplete in terms of simulating jet engine conditions. Indeed, history supports this viewpoint with instances where new oils have passed all the required industry tests yet performed very differently and unexpectedly in service.

Coker Mister

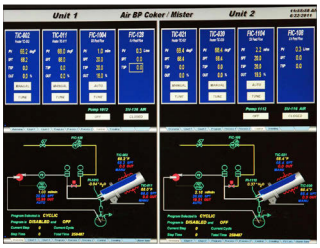
Given the credibility gap between industry tests and in-service performance, we developed an additional testing capability that offers a much closer simulation of in-service conditions based on the No. 5 bearing compartment of the P&W JT8D-200. The result is the Coker Mister; a high-temperature, dynamic lubricant deposition test rig unique to Eastman and the industry.

Offering the best and closest in-service simulation possible, it has been used extensively in the development of high-performance oils such as Turbo Oil 2197 and for evaluating other commercial oils. The proven success of Turbo Oil 2197 is attributable to the performance validation testing undertaken in this test rig during its development.

The Coker Mister test chamber is rated and ranked following a 72-hour test program covering many cycles simulating takeoff, cruise, reverse thrust on landing, taxiing, and shutdown (with heat soak effect). All carbonaceous deposits are weighed and the residual oil after test is filtered and deposits weighed. Very clear coking propensity differentiation is observed between STD/SPC and HTS/HPC lubricant types and more importantly, clear differentiation within classes.



Coker Mister Test Apparatus



Coker Mister Advanced Control and Monitoring Dashboard

Eastman Turbo Oil 2197

The world's leading high-performance turbo oil

Built on more than 50 years of experience with industry-leading products, Eastman Turbo Oil 2197 is designed to exceed the demands of current and future jet engines. Turbo Oil 2197 is the oil of choice for airlines choosing to operate their fleets on High-Performance Capable (HPC) oils, with more than 300 million engine/accessory hours of proven and trusted performance. It was the first oil approved to AS5780A specification and exceeds all the requirements of AS5780 HPC Class.

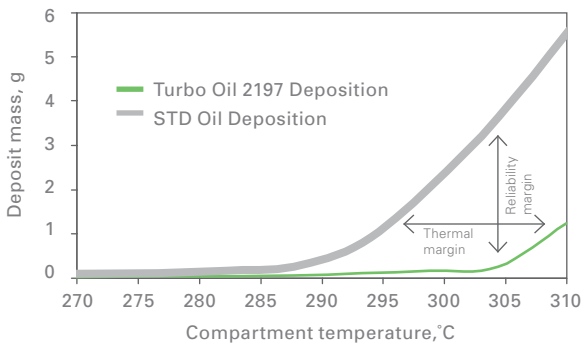
Approved by all leading engine manufacturers, Turbo Oil 2197 is qualified to MIL-PRF-23699 High Thermal Stability (HTS) class and is by far the most widely used HTS fleet oil in the world.

Turbo Oil 2197 is manufactured in our own facility ensuring worldwide quality and consistency of this globally available product. A full list of approvals is available on request.

Improved reliability

Turbo Oil 2197 brings you exceptional performance which leads to extended on-wing engine life and improved reliability. The ability of Turbo Oil 2197 to maintain very low levels of deposition under severe thermal stress leads to significant improvements in engine cleanliness compared with all other commercially available oils. Turbo Oil 2197 is recognized as a problem solver for high-severity engines, i.e., PW JT8D-200, Trent 700, and V2500.

Deposition Comparison : Eastman Turbo Oil 2197 vs. STD



CF6-80C2, #6 bearing in D-sump

This demonstrated increased cleanliness can be seen in exacting laboratory testing and is reflected in significantly improved engine bearing compartment cleanliness, particularly in modern high-temperature, high-bypass turbofan powerplants. Benefits of this are virtually eliminating oil coking and plugged filters, and hence oil coking-related delays, fewer diverted flights, and ultimately fewer in-flight shutdowns (IFSDs).

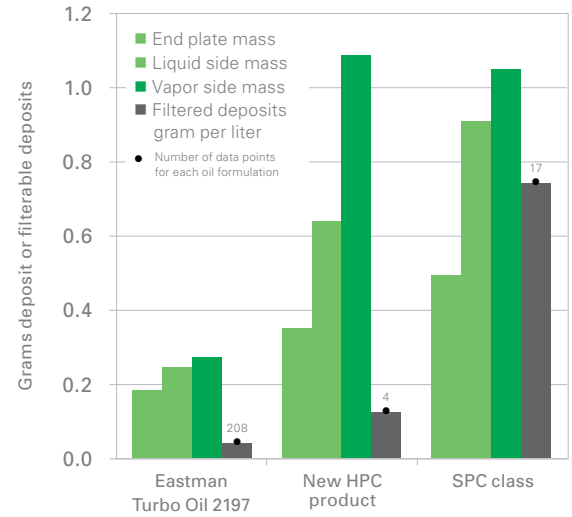
Your engines spend more time in the air and less time on the ground. Improved reliability also means less resources are required to resolve preventable unplanned maintenance. The end result? Less disruption for you and your customers.

"With standard oil, our CF6-80C2 engines on the B767 were on a routine 1500-cycle interval for turbine rear frame D-sump oil supply and scavenge tube removal and cleaning due to coke formation. After switching to Turbo Oil 2197, coke formation was no longer an issue and we stopped this routine cleaning. This took away a significant impact to our 767 maintenance burden with reduced labor hours and also one less item requiring downtime for a busy ETOPS aircraft."

Senior CF6-80C2 Propulsion Engineer, major U.S. airline

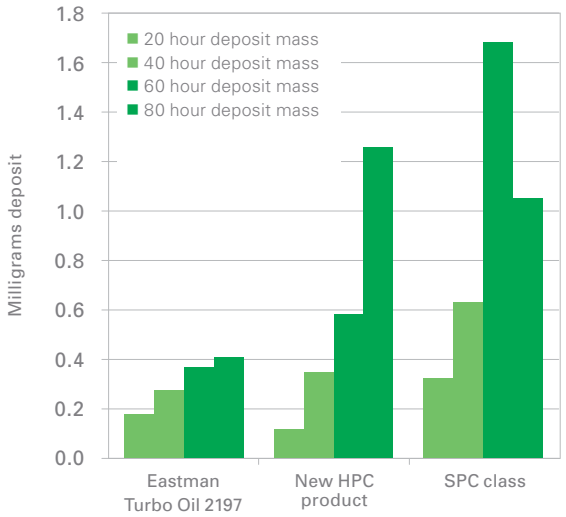
Cyclic Coker Mister performance

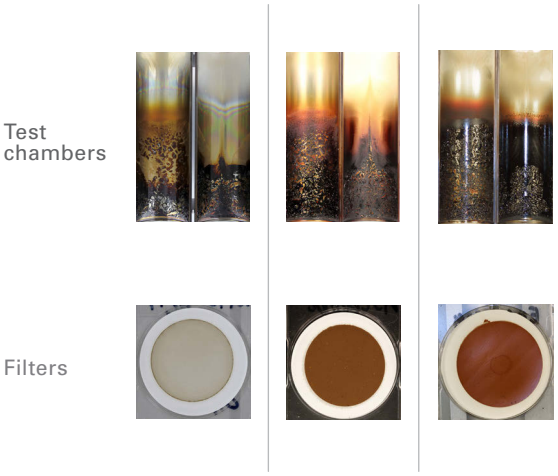
(520˚/ 560˚F soak back simulation cycles)

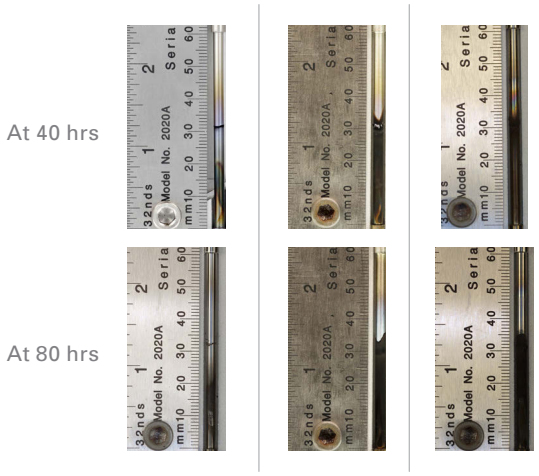


HLPS dynamic coking performance

(SAE ARP 5996 at 375˚C - Extended Duration)







HLPS

One of a large number of industry standard tests we have to undertake as part of the development and approval process is the Hot Liquid Process Simulator (HLPS) test which again measures deposition characteristics of an oil. Typical test duration is 40 hours but experience has shown that by extending the test to 80 hours, a much more significant performance differentiation is observed characterized by increased deposits on the tube. This extension of test duration is important as the results provide great insight into likely performance of the lubricant either in a higher-severity turbine engine (more heat stress on the oil) or after prolonged use in a less-severe turbine engine.

The HLPS chart clearly shows that performance differentiation can easily be observed between lubricant classes (HPC vs. SPC) after 40 hours but comparing within the same class (i.e., HPC), the extended test duration provides a much better comparison of performance.

Eastman Turbo Oil 2380

A turbo oil designed for the commercial needs of established turbine engines

The product was carefully designed to achieve an optimum balance of properties. The balance of cold ambient temperature viscosity, load-carrying capability, cleanliness, and elastomer compatibility was at the forefront of the considerations in designing Eastman Turbo Oil 2380. Today, it is still one of the most widely used turbine oils in the commercial aviation industry. Turbo Oil 2380 is among the first turbine oils to be qualified and approved for MIL-PRF-23699 STD (Standard) class and subsequently SAE AS5780 SPC (Standard Performance Capability) class. A full list of commercial approvals is available on request.

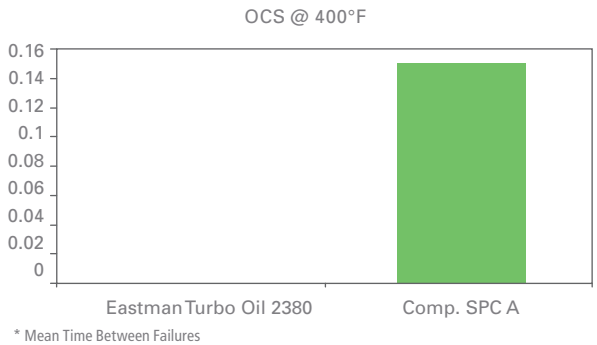
Premier accessory performance/excellent load-carrying capability/best low-temperature viscosity/typical STD grade cleanliness.

Turbo Oil 2380 — More than 50 years of experience with more than 230 operators.

Premier accessory performance

Turbo Oil 2380 brings you exceptional accessory performance which leads to extended on-wing accessories' lifespan and improved reliability. Also, the ability of 2380 to neutralize the effects of copper (Cu) through superior metal passivation results in reduction of oxidation and sludge formation.

Cu weight change (mg/cm²)



* Mean Time Between Failures

	Eastman Turbo Oil 2380	Comp. SPC A
No. of IDG samples	48	35
Avg. used oil Cu level, ppm	0.6	7.7
Overall IDG reliability consistently higher when using Eastman Turbo Oil 2380		

	Oil Type	Filter Chg. (hrs)	MTBF** (hrs)
US Operator A	Eastman Turbo Oil 2380	200	4000
US Operator B	Comp. SPC A	900	2000

* Mean Time Between Failures

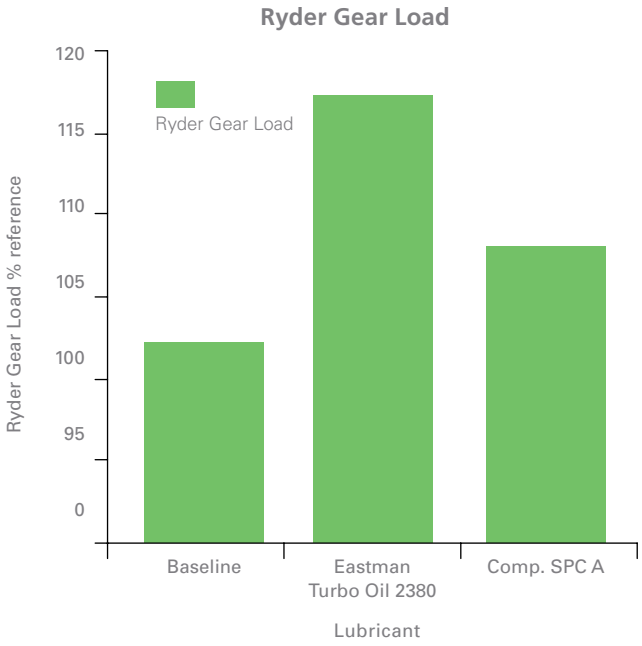
In service, the metal passivation effects of Turbo Oil 2380 allow proper filtration of Cu particles resulting in diminished metal wear effects and extend on-wing life of IDGs and CSDs.

Excellent load-carrying capability

One of the competitive attributes of Turbo Oil 2380 is its load-carrying capability. This parameter is calculated via the Ryder Gear Test, that is used to determine the antiscuffing property of a lubricant. The baseline measurement of this test is 102% of the reference oil. In the load-carrying test, Turbo Oil 2380 yielded results of 117% or 14.7% above the baseline versus the leading SPC competitive oil with a value of 108% or 5.9% above baseline. Clearly Turbo Oil 2380 offers a greater margin of performance.

Turbo Oil 2380 has demonstrated superior competitive performance in many different types of engines, but specifically in the highly demanding environment of the turbo prop engines. In particular, more than 70% of the PT6 engines are lubricated by Turbo Oil 2380.

This means that Turbo Oil 2380 can generate savings to your fleet through potentially extending the life of your gears and bearings.

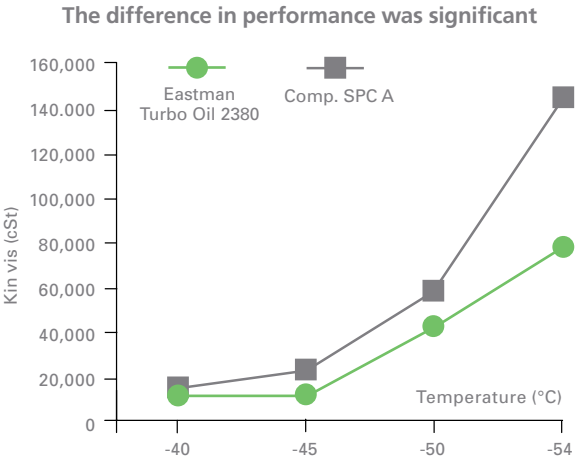


Best low-temperature viscosity

Turbo Oil 2380 has demonstrated the best low-temperature viscosity performance for all 5 cSt turbine oils commercially available today. The low-temperature viscosity performance of turbine oils is determined by measuring the kinematic viscosity of the oil at colder ambient temperatures. Higher viscosities at colder temperatures can result in more difficult engine starts on cold winter days. This attribute improves the cold-soak start reliability.

Turbo Oil 2380 tops the leading STD and SPC oils today in the area of low-temperature viscosity. A test was conducted comparing a competitor's leading STD/SPC turbine oil and Turbo Oil 2380. The following chart shows the results of this comparison test.

The competition was 40% more viscous at -40°C (-40°F) and 71% at -53.4°C (65°F). Pour point for Turbo Oil 2380 was measured at -59°C (-74°F) versus -57°C (-70°F) for the competition. The low-temperature performance of Turbo Oil 2380 translates into improved gear and bearing reliability in cold soak condition due to better lubrication at start-up. In addition, high oil pressure events during start-up on cold days may be reduced significantly.



Eastman Turbo Oil 2389

Advanced APU oil

Eastman Turbo Oil 2389 is an advanced gas turbine lubricant that has a viscosity of 3 centistokes at 99°C (210°F) which meets or exceeds the requirements of U.S. Military Specification MIL-PRF-7808 grade 3 and incorporates a level of technology from Type II (5cSt) commercial turbine lubricants.

Product description

Turbo Oil 2389 is a low viscosity gas turbine oil offering exceptional cold-start capability.

Many large commercial airlines use Turbo Oil 2389 in their auxiliary power units (APUs) because of the reliability it affords this equipment when starting after long, cold soaks at altitude. Turbo Oil 2389 is the only MIL-PRF-7808 grade 3 qualified oil that is fully approved in all Honeywell and Hamilton Sundstrand APUs.

Turbo Oil 2389 is formulated from synthetic base stocks and advanced technology additives to provide the combined thermal and oxidation stability properties of commercial Type II lubricants with the low-temperature fluidity characteristics of a 3-centistoke oil. It also has load-carrying ability equal to or better than other qualified MIL-PRF-7808 grade 3 oils.

Advanced APU performance oil

By using Turbo Oil 2389, your airline can meet the requirements from regulatory agencies for ETOPS operations. As an advanced APU performance oil, it improves performance during cold starts and creates a more reliable operation.

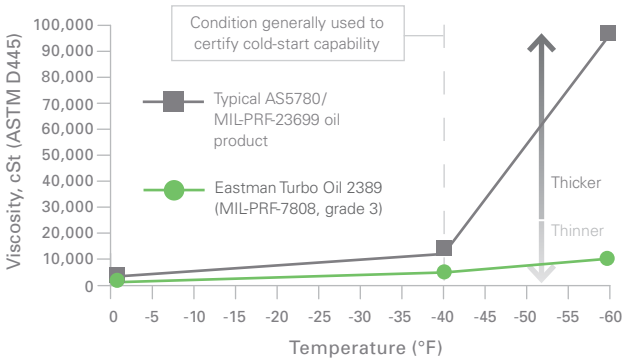
Exceeding operational requirements

Turbo Oil 2389 is approved for use in all APUs. However, its performance exceeds operational requirements, giving OEMs the confidence to use Turbo Oil 2389 in testing applications for the next generation of aircraft.

Low-temperature viscosity

In low temperatures, good lubrication is critical in applications such APUs and some aircraft accessories. Reduced viscosity can have a dramatic impact on performance and cold-start reliability in these cases.

Eastman Turbo Oil 2389 provides significant cold-temperature starting margin



Excellent load carrying

Turbo Oil 2389 provides load-carrying ability well in excess of requirements established by the engine and equipment manufacturers — as measured in the Ryder Gear test.

Exceptional cleanliness

One of the characteristic advantages of Turbo Oil 2389 is the minimum formation of varnish or sludge deposits. Long periods of severe operation are possible without the danger of scavenge pump screen plugging or the corrosion that often accompanies excessive deposits.

High-bulk stability

Turbo Oil 2389 has a high resistance to physical or chemical change resulting from oxidation. This permits long periods of severe operation without significant increase in viscosity or total acidity, the two principal indicators of product oxidation.

Available worldwide

Eastman Aviation Solutions uses a robust global distribution network, which allows us to ship Turbo Oil 2389 around the world. We also offer a global team of aviation lubricant experts to support all Eastman Aviation Solutions.

Long shelf life

The shelf life of Turbo Oil 2389 is 10 years or more when stored in original, unopened quart cans under recommended conditions, such as away from extreme heat and moisture.

Eastman Turbo Oil 25

Turbine engine and accessory

Eastman Turbo Oil 25 is designed to meet the severe requirements of helicopters and offers exceptional load-carrying ability over Type II oils in helicopter gearboxes and transmissions.

Product description

The high-gear, load-carrying ability of Turbo Oil 25 earned its approval against U.S. Military specification, DOD-PRF-85734, for helicopter transmission systems. The in-service experience of Turbo Oil 25, in this application, has been proven over many years.

It is also approved against DEF STAN 91-100 (formerly DERD 2497) and was approved against the first and all subsequent issues of the Approved Products List.

Eastman Turbo Oil 274

Turbine engine and accessory

Eastman Turbo Oil 274 is the most widely used 7.5 cSt turbo oil lubricant in commercial use. This fact attests to the outstanding performance of this product in the engines and accessories now in service.

Product description

Turbo Oil 274 is a synthetic oil having a viscosity of 7.5 centistokes at 210°F and meets DEF STAN 91-98/2. It is formulated with special synthetic base stocks into which are incorporated additives to inhibit wear, oxidation, and foaming. The popularity of Turbo Oil 274 is largely due to its good high-temperature performance and load-carrying ability. These provide long, trouble-free performance under severe conditions.

Synthetic oils of this type are not all identical. The advantages of Turbo Oil 274 are achieved only by careful selection and balance of base stocks and additives to provide the desired performance.

Helicopter oil guide

Why switch for more proven helicopter performance?

Eastman Aviation Solutions creates innovative solutions for high-severity engines providing industry-leading products and services.

High-performing products

Whatever your turbine oil requirements, we have the lubrication products designed to meet your needs.

1. **Main transmission**
2. **Turbine engine**
3. **Tail Rotor gearbox**
4. **Intermediate gearbox**

Turbine engines

Agusta/Westland

Helicopter model	Engine	Approved engine lubricant
A109	A250-C20	EMNTO 2380 EMNTO 2197
A109A or A109A II	A250-C20B or -C20 R/1	EMNTO 2380 EMNTO 2197
A109E	PW206C	EMNTO 2380 EMNTO 25
A109E	Arrius 2K1	EMNTO 2380 EMNTO 2197
A109K2	Arriel 1K1	EMNTO 2380 EMNTO 2197
A109S or AW109SP	PW207C	EMNTO 2380 EMNTO 25
A119 or AW119 MK2	PT6B-37A	EMNTO 2380
Agusta-Bell 206B-1	A250-C20	EMNTO 2380 EMNTO 2197
AW139 or AB139	PT6C-67C	EMNTO 2380

Bell

Helicopter model	Engine	Approved engine lubricant
Bell 206A	A250-C18	EMNTO 2380 EMNTO 2197
Bell 206B/B3 JetRanger	A250-C20	EMNTO 2380 EMNTO 2197
Bell 206L LongRanger	A250-C20B or -20J	EMNTO 2380 EMNTO 2197
Bell 206L-1, L-3, L-4 LongRanger	A250-28B or -C30P	EMNTO 2380 EMNTO 2197
Bell 212 Twin Huey	PT6T-3B	EMNTO 2380 EMNTO 25
Bell 222	LTS 101-650C-2, -650C-3	EMNTO 2197
Bell 222B, 222U	LTS 101-750C-1	EMNTO 2197
Bell 230	A250-C30G/2	EMNTO 2380 EMNTO 2197
Bell 407	A250-C47B	EMNTO 2380 EMNTO 2197
Bell 412, 412EP, 412CF	PT6T-3B or -3D	EMNTO 2380 EMNTO 25
Bell 427	PW207D	EMNTO 2380 EMNTO 25
Bell 429	PW207D	EMNTO 2380 EMNTO 25
Bell 430	A250-C40B	EMNTO 2380 EMNTO 2197

Eurocopter

Helicopter model	Engine	Approved engine lubricant
AS332C, L, L1 Super Puma	Makila 1A, 1A1	EMNTO 2380 EMNTO 2197 EMNTO 25
AS332L2 Super Puma	Makila 1A2	EMNTO 2380 EMNTO 2197 EMNTO 25
AS350 B3 Ecureuil	Arriel 2B, 2B1, 2B2	EMNTO 2380 EMNTO 2197
AS350B, B1, B2 Ecureuil	Arriel 1B, 1D, 1D2	EMNTO 2380 EMNTO 2197
AS350C, D ASTAR	LTS 101-600 or -700	EMNTO 2197
AS355E, F, F1 Twinstar	A250-C20F	EMNTO 2380 EMNTO 2197
AS355N, NP Twinstar	Arrius 1A, 1A1	EMNTO 2380 EMNTO 2197
BK 117A-1, A-3, A-4	LTS 101-650B-1	EMNTO 2197
BK 117B-1, B-2	LTS 101-750B-1	EMNTO 2197
BK 117C1	Arriel 1E	EMNTO 2380 EMNTO 2197
BK 117C2 (aka EC145)	Arriel 1E2	EMNTO 2380 EMNTO 2197
BO-105 A	A250-C18	EMNTO 2380 EMNTO 2197
BO-105 C, S, LS-A1	A250-C20, -C20B, -C28C	EMNTO 2380 EMNTO 2197
BO-105 LS-A1, LS-A3	A250-C28C	EMNTO 2380 EMNTO 2197
EC120B	Arrius 2F	EMNTO 2380 EMNTO 2197
EC130 B4, T2	Arriel 2B1, 2D	EMNTO 2380 EMNTO 2197
EC135 P1, P2, P2+	PW206B, B2	EMNTO 2380 EMNTO 25
EC135 T1, T2, T2+	Arrius 2B, 2B1, 2B2	EMNTO 2380 EMNTO 2197
EC155B, B1	Arriel 2C1, 2C2	EMNTO 2380 EMNTO 2197
EC225 Super Puma	Makila 2A, 2A1	EMNTO 2380 EMNTO 2197
SA330	Turmo IVC	EMNTO 2380 EMNTO 2197
SA-365C, C1, C2, N, N1, N2 Dauphin	Arriel 1A, 1A1, 1A2, 1C, 1C1, 1C2	EMNTO 2380 EMNTO 2197
SA-366G1 Dauphin	LTS 101-750B-2	EMNTO 2197

Mil

Helicopter model	Engine	Approved engine lubricant
Mi-8 or Mi-17 (export)	TV3-117	EMNTO 2380

Sikorsky

Helicopter model	Engine	Approved engine lubricant
S-76 A	A250-C30	EMNTO 2380 EMNTO 2197
S-76 A+, A++, C	Arriel 1S or 1S1	EMNTO 2380 EMNTO 2197
S-76 B	PT6B-36A or 36B	EMNTO 2380
S-76 C+, C++	Arriel 2S1 or 2S2	EMNTO 2380 EMNTO 2197

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The results of insight™

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