

Eastman turbo oils product guide

EASTMAN

aviation solutions



Proven performance | Technical excellence | Dedicated support



With more than 150 years of combined aviation experience, our global team of aviation experts fosters strong relationships with airlines, equipment manufacturers, and other members of the industry to better understand current and future needs, enabling us to seek out innovative and flexible solutions to meet exacting requirements.

We are committed to supporting the industry with exceptional products and providing unparalleled technical services and engineering consultancy to our partners worldwide.

Eastman Aviation Solutions has a range of high quality turbine lubricants designed to suit your every need. With over a billion hours of proven performance, Eastman turbo oils are highly trusted solutions for aircraft turbine engine lubrication.

Eastman aviation lubricants

Eastman Turbo Oil 2197™

Developed to meet the needs of the most demanding turbine engines, it is the leading high performance capable (HPC) oil in service today and offers best-in-class coking resistance at high temperatures.

Eastman Turbo Oil 2380™

One of the most widely used turbo oils in commercial service, it is uniquely suited for turbo props, providing the highest load-carrying capability and advantaged low-temperature viscosity characteristics in its class.

Eastman Turbo Oil 2389™

The most widely used 3 cSt oil in aircraft APUs, it provides excellent "cold soak" reliability in aircraft accessories. It has excellent low-temperature fluidity characteristics with good thermal and oxidation stability.

Eastman Turbo Oil 25™

Formulated for the high load-carrying demands of today's helicopter transmission systems, it is a Type II oil primarily used in helicopter gearboxes and transmissions and was originally designed for use in Concorde aircraft.

Eastman HALO 157™

An advanced helicopter transmission oil with excellent load-carrying and antiwear performance, it is purpose-designed to offer maximum protection to helicopter transmission systems under extreme operating conditions.

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

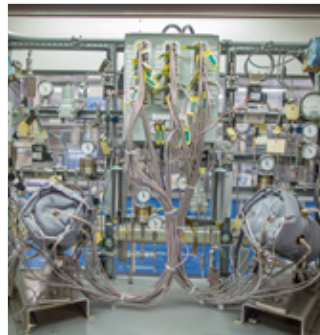
Our world-class technology team is comprised of chemists, engineers, and analytical experts respected industry-wide in the fields of lubricant formulation research, analytical chemistry, and lubricant performance testing. With more than 150 combined years of aviation lubricant experience, the team offers a winning combination of product and application expertise.

Our global research facility houses state-of-the-art analytical and performance-testing capabilities, including proprietary high-temperature dynamic deposition test equipment unique to Eastman and the aviation industry. These testing capabilities and our team of dedicated aviation scientists set Eastman apart from the competition and provide the highest level of confidence for customers using our products in the ever-demanding environments within the engine.

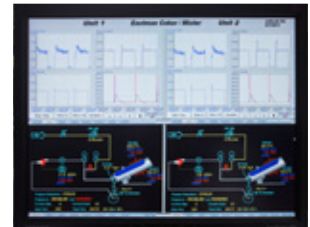
Pioneering lubricant testing beyond aviation industry requirements

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.



ALADS test apparatus



ALADS advanced control and monitoring dashboard

Aviation Lubricant Advanced Deposition Simulator (ALADS)

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 ALADS, 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 Eastman 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 ALADS 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 analyzed and weighed along with the residual oil after testing, which is filtered and sediments weighed. Very clear coking-propensity differentiation is observed between SPC and HPC lubricant classes and, more importantly, clear differentiation within classes.

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™ (ETO 2197) is designed to exceed the demands of current and future jet engines. ETO 2197 is the oil of choice for airlines choosing to operate their fleets on HPC oils, with approximately 400 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, ETO 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. It is used and trusted by engine OEMs when certifying thermally stressful engines.

ETO 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.



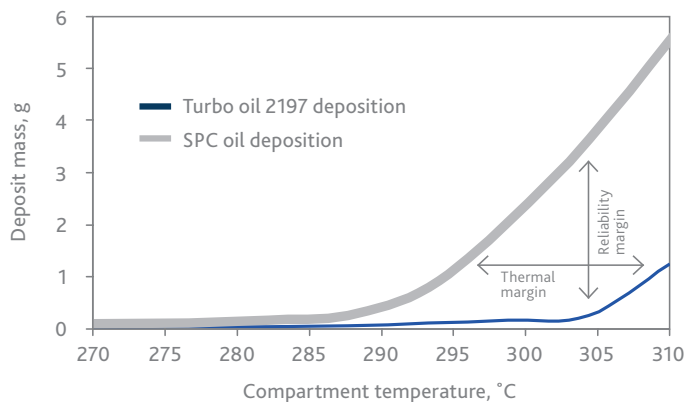
CF6-80C2, #6 bearing in D-sump

Improved reliability

Eastman Turbo Oil 2197 brings you exceptional performance, which leads to extended on-wing engine life and improved reliability. The ability of ETO 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. ETO 2197 is recognized as a problem solver for high-severity engines, i.e., PW JT8D-200, Trent 700, and V2500.

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 power plants. Benefits of this include virtually eliminating oil coking and plugged filters (and hence oil coking-related delays), fewer diverted flights, and ultimately fewer in-flight shutdowns (IFSDs).

Deposition comparison: Eastman Turbo Oil 2197 vs. SPC



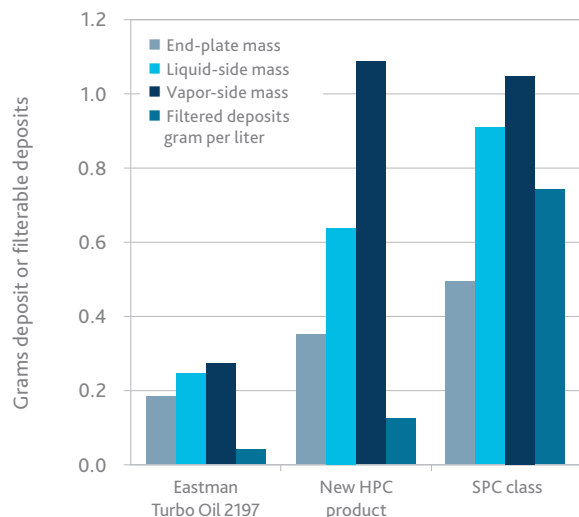
Your engines spend more time in the air and less time on the ground.
Improved reliability also means less resources are required to resolve preventable unplanned maintenance. The end result? Less disruption for you and your customers.

"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 Eastman 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 at a major U.S. airline

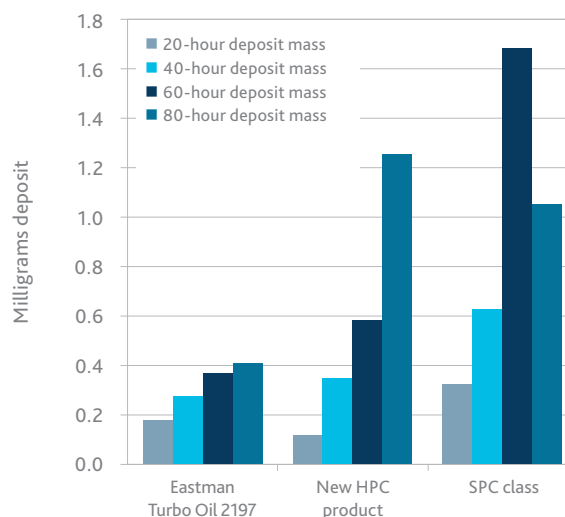
Cyclic ALADS performance

(520°/560°F soak-back simulation cycles)

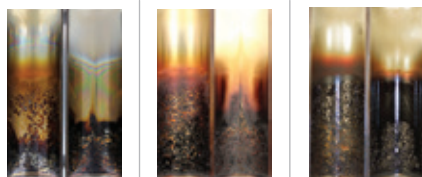


HLPS dynamic coking performance

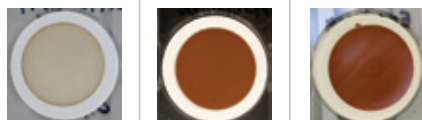
(SAE ARP 5996 at 375°C—extended duration)



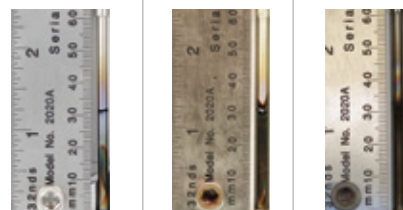
Test chambers



Filters



40 h



80 h



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 because 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.

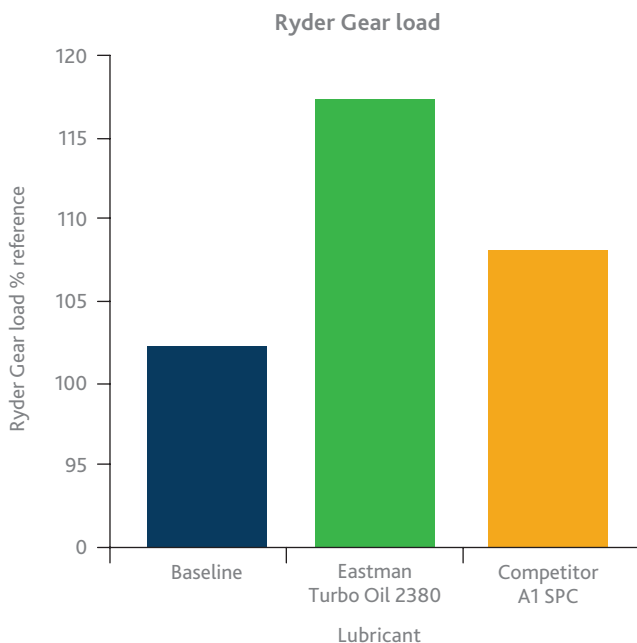
Eastman Turbo Oil 2380™

A turbine oil uniquely suited for turboprops, this product's superior low-temperature characteristics, high load-carrying capability, cleanliness, and elastomer compatibilities keep aircrafts in dangerously low temperatures running at the highest performance level possible. Eastman Turbo Oil 2380™ (ETO 2380) is one of the most widely used turbine oils in the commercial aviation industry with billions of hours of operating experience.

ETO 2380 is among the first turbine oils to be qualified and approved for MIL-PRF-23699 STD (Standard) class and subsequently SAE AS5780 Standard Performance Capability (SPC) class. A full list of commercial approvals is available on request.

ETO 2380—more than 50 years of experience with more than 230 Part 121* operators and countless Part 135* and 91* operators

**Includes non-U.S. equivalents to Parts 121, 135, and 91.*



Excellent high load-carrying capability

One of the competitive attributes of ETO 2380 is its high 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 high load-carrying test, ETO 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.

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

This means that ETO 2380 can generate savings to your fleet through better protection, potentially extending the life of your gears and bearings.

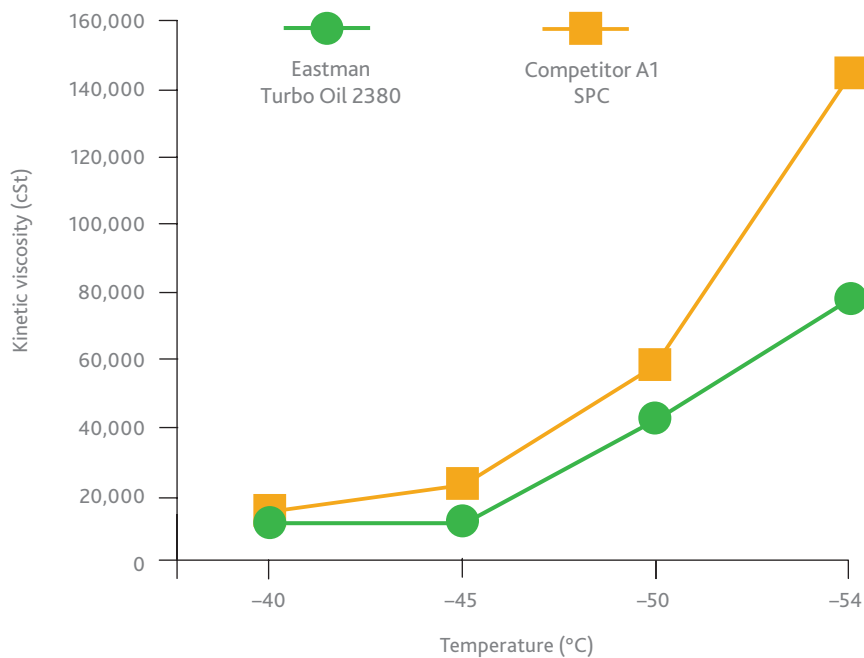
Best low-temperature viscosity

ETO 2380 has demonstrated the best low-temperature viscosity performance of 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. ETO 2380 tops the leading SPC oils today in the area of low-temperature viscosity. A test was conducted comparing a competitor's leading SPC turbine oil and ETO 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 ETO 2380 was measured at -59°C (-74°F) versus -57°C (-70°F) for the competition. The low-temperature performance of ETO 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.



The difference in performance was significant.



Eastman Turbo Oil 2389™

Especially suited for APUs

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

Product description

ETO 2389 is a low-viscosity gas turbine oil offering exceptional cold-start capability. Many large commercial airlines use ETO 2389 in their auxiliary power units (APUs) because of the reliability it affords this equipment when starting after long cold soaks at altitude. ETO 2389 is the only MIL-PRF-7808 Grade 3-qualified oil that is fully approved in all Honeywell and Hamilton Sundstrand APUs and is the factory fill of choice B787 APS 5000 APU.

ETO 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 cSt oil. It also has high load-carrying ability equal to or better than other qualified MIL-PRF-7808 Grade 3 oils.

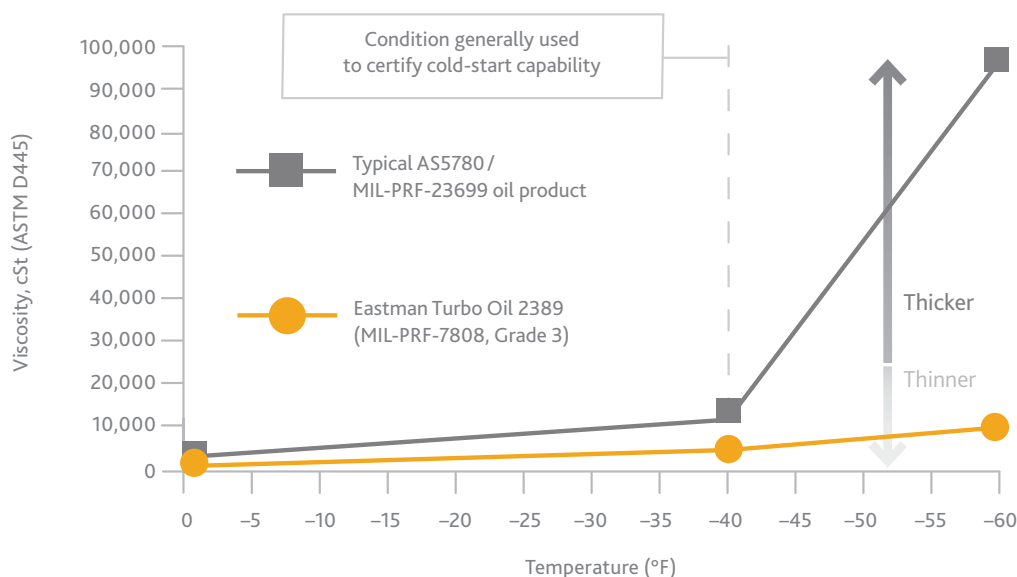
ETO 2389 is the only 3 cSt oil with significant commercial experience based on the same polyolester technology as contemporary 5 cSt oils, which provides peace of mind if inadvertently mixed with main engine oil.



Advanced APU performance oil

By using ETO 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.

Eastman Turbo Oil 2389 provides significant cold-temperature starting margin.



Exceeding operational requirements

ETO 2389 is approved for use in all APUs and is the chosen factory fill for B787 APS 5000 APU, the first APU to mandate 3 cSt oil only. This oil's performance exceeds operational requirements, giving OEMs the confidence to use ETO 2389 in testing applications for the next generation of aircraft.

Low-temperature viscosity

In low temperatures, good lubrication is critical in applications such as APUs and some aircraft accessories.

Reduced viscosity can have a dramatic impact on performance and cold-start reliability in these cases.

Exceptional cleanliness

One of the characteristic advantages of ETO 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

ETO 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 ETO 2389 around the world. We also offer a global team of aviation lubricant experts to support all of our products.

Long shelf life

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

Excellent high load-carrying ability

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

Eastman Turbo Oil 25™

Turbine engines and accessories

Eastman Turbo Oil 25™ (ETO 25) is a 5 cSt lubricant formulated for the high load-carrying demands of today's helicopter transmission systems. It offers exceptional high load-carrying ability over Type II oils in helicopter gearboxes and transmissions. ETO 25 was originally developed to meet the extreme demands of supersonic flight with the Concorde aircraft.

Product description

The high-gear, load-carrying ability of ETO 25 earned its approval against U.S. Military Specification DOD-PRF-85734 for helicopter transmission systems. The in-service experience of ETO 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.

Advantages

ETO 25 incorporates high oxidation resistance to minimize formation of carbon, coke, and sludge. It also provides best-in-class high load-carrying ability to satisfy the requirements of highly loaded gears and bearings operating in very demanding environments.



Eastman HALO 157™

Advanced helicopter transmission oil

For many years, MIL-PRF-23699 approved engine lubricants have been employed in helicopter applications where a common lubricant is required for both engines and transmission systems.

Alternatively, high load-carrying engine oils have also been found to offer advantages over conventional load-carrying MIL-PRF-23699 oils. These high load-carrying oils covered under specification DOD-PRF-85734 were, again, formulated to principally cover the performance needs of the engine more than the transmission system. The oils covered under these two specifications, therefore, are based around common 5 cSt viscometric properties.

Removing the 5 cSt constraints typical of engine oils, it is considered that optimal lubrication performance of gearboxes could be achieved by using a higher-viscosity, high load-carrying lubricant possessing other key features such as corrosion protection. HALO 157 represents many years of

research and development utilizing this unconstrained approach and represents the very first advanced helicopter transmission lubricant to meet the needs of the new MIL-PRF-32528 specification. It is dedicated for use in helicopter transmission systems and therefore is not suitable for use in the engine itself.

HALO 157 is a 9 cSt, clear amber-colored fluid with a faintly aromatic odor reminiscent of turbine engine oils. It is based on selected polyol esters, the inherent characteristics of which are enhanced by additives. It is also fully compatible and miscible with other oils approved to engine oil specifications MIL-PRF-23699 and MIL-PRF-7808.

Many thousands of hours of in-service testing have been completed across many helicopter models, culminating in approval against the NATO standard (AIR STANDARD ACS 4035) and the MIL-PRF-32538 specifications. HALO 157 also retains sole approval for use in the AgustaWestland Super Lynx and AW159 Wildcat helicopters.





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

Eastman turbo oil industry approvals

Helicopters



Manufacturer	Helicopter model	Engine	ETO 2380	ETO 2197	ETO 25
Airbus	AS355	A250-C20			
	AS550	Arrius 1 or 2			
	AS555	Arrius 1			
	BK 117B	LTS 101-750			
	BK 117C	Arriel 1			
	BO-105	A250-C18, -C20, -C28			
	H120/EC120	Arrius 2			
	H125/AS350	Arriel 1			
	H125/AS350	LTS 101-600 or -700			
	H125/AS350 B3	Arriel 2			
	H130/EC130	Arriel 2			
	H135/EC135	PW206			
	H135/EC135	Arrius 2			
	H135M/EC635	PW206			
	H145/EC145	Arriel 1, 2			
	H145M/EC645	PW206			
	H155/EC155	Arriel 2			
	H160	Arrano			
	H175/EC175	PT6C-67E			
	H215/AS332	Makila 1			
	H225/EC225	Makila 2			
	SA 330	Turmo IVC			
	SA 365/AS365	Arriel 1, 2			
	SA 366G1	LTS 101-750B-2			

Manufacturer	Helicopter model	Engine	ETO 2380	ETO 2197	ETO 25
Bell	206A	A250-C18			
	206B	A250-C20			
	206L	A250-C20, -C28, -30			
	212	PT6T-3B			
	222	LTS 101-650 or -750			
	230	A250-C30			
	407	A250-C47			
	412	PT6T-3B			
	427	PW207			
	429	PW207			
	430	A250-C40			
Leonardo	A109	A250-C20			
	A109E	PW206C			
	A109E	Arrius 2			
	A109K2	Arriel 1			
	A109S or AW109SP	PW207C			
	A119	PT6B-37A			
	Agusta-Bell 206B-1	A250-C20			
	AW139 or AB139	PT6C-67C			
MD Helicopters	MD 500C	A250-C20			
	MD 520E	A250-C20			
	MD 530F	A250-C30			
	MD 600	A250-C47			
	MD 900 or MD 902 Explorer	PW206A			
	MD 901 Explorer	Arrius			
	MD 902	PW206E or PW207E			
Mil	Mi-8 or Mi-17 (export)	TV3-117			
Robinson	R66	RR300			
Sikorsky	S-76 A	A250-C30			
	S-76 A+, A++, C	Arriel 1			
	S-76 B	PT6B-36			
	S-76 C+, C++	Arriel 2			
	S-76D	PW210			
	S-92A	CT7-8			

This list is subject to change. Refer to your Component Maintenance Manual (CMM) or the Qualified Products List (QPL) to determine which fluids are approved for your application. If you have any questions about an application, call our customer service department at 800-260-4150.

Eastman turbo oil industry approvals

Civil aircraft



		Engine oil approvals (includes engine accessories, generators, starters)			APU oil approvals			
Aircraft manufacturer	Aircraft model	Engine model	ETO 2380	ETO 2197	APU	ETO 2380	ETO 2197	ETO 2389
Airbus	A220-100, -300	PW1500G			131-9C			
	A300-600	CF6-80C2 or PW4156			331-250H			
	A310	CF6-80C2 or PW4152			331-250H			
	A318	PW6000			131-9A, 36-300, or APS 3200			
	A318, A319, A320, A321	CFM56-5A, -5B			131-9A, 36-300, or APS 3200			
	A319, A320, A321	V2500			131-9A, 36-300, or APS 3200			
	A319, A320, A321 (NEO)	LEAP-1A or PW1100G			131-9A, 36-300, or APS 3200			
	A330-200, -300	CF6-80E1 or PW4168			331-350			
	A330-200, -300	Trent 700			331-350			
	A330-800, -900 (NEO)	Trent 7000			331-350			
	A340-200, -300	CFM56-5C			331-350			
	A340-500, -600	Trent 500			331-600			
	A350-900, -1000	Trent XWB			HGT1700			
	A380	GP7200			PW980			
	A380	Trent 900			PW980			
ATR	ATR-42-200	PW120			NA			
	ATR-42-500, -600 or ATR-72-500, -600	PW127			NA			
	ATR-72-100, -200	PW124			NA			
BAE	ATP	PW126			GTCP36			
	BAe 146	ALF 502			GTCP36			
	Jetstream 41	TPE331-14GR			GTCP36			
BAE Avro	Avro RJ	LF507-1F			APS 1000			

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Eastman turbo oil industry approvals

Civil aircraft



Aircraft manufacturer	Aircraft model	Engine model	Engine oil approvals (includes engine accessories, generators, starters)		APU	APU oil approvals		
			ETO 2380	ETO 2197		ETO 2380	ETO 2197	ETO 2389
Boeing	B707	JT3C,-D or JT4A			GTCP85-98CK			
	B717-200	BR715			APS 2100			
	B727	JT8D-basic			GTCP85-98C,CK			
	B737-100/-200	JT8D-basic			GTCP85-98C,CK			
	B737-300, -400, -500	CFM56-3B/C			85-129, 36-280B, or APS 2000			
	B737-600, -700, -800, -900	CFM56-7B			131-9B			
	B737-7, -8, -9, -10 (MAX)	LEAP-1B			131-9B			
	B747-200, -300	CF6-80C2 or JT9D-7, 7R4 or RB211-524 B, D			331-660-4			
	B747-400	CF6-80C2 or PW4056			PW901A			
	B747-400	RB211-524 H			PW901A			
	B747-8	GEnx-2B			PW901C			
	B757-200, -300	PW2037 or RB211-535 C, E4			331-200ER			
	B767-200, -300	CF6-80C2 or PW4056			331-200ER			
	B767-200, -300	RB211-524H			331-200ER			
	B767-400	CF6-80C2 or PW4062			331-400			
	B777-200, -300	GE90-90B or PW4084			331-500B			
	B777-200, -300	Trent 800			331-500B			
	B777-300ER, -200LR	GE90-115B			331-500B			
	B787-800	GEnx-1B			APS 5000			
	B787-800	Trent 1000			APS 5000			
Bombardier	CRJ-200	CF34-3B		*	36-150RJ			
	CRJ-700, -900	CF34-8C			RE220 RJ			
	DHC-8-100, -200	PW121			APS 500			
	DHC-8-300	PW123			APS 500			
	DHC-8-400	PW150A			APS 1000			
Comac	ARJ21-700, -900	CF34-10A			APS 2600			
	C919	LEAP-1C			HGT 750			
de Havilland Canada	DHC-6 Series 100, -200	PT6A-20			NA			
	DHC-6 Series 300	PT6A-27			NA			

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*P10 oil pump upgrade per SB 79-0022 must be complied with prior to 2197 or M254 use.

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Eastman turbo oil industry approvals

Civil aircraft



		Engine oil approvals (includes engine accessories, generators, starters)			APU oil approvals			
Aircraft manufacturer	Aircraft model	Engine model	ETO 2380	ETO 2197	APU	ETO 2380	ETO 2197	ETO 2389
Embraer	EMB-120	PW118			36-150			
	ERJ-135, -140, -145	AE 3007A			APS 500			
	ERJ-170	CF34-8E			APS 2600			
	ERJ-190	CF34-10E			APS 2600			
	E170-E2	PW1700			APS 2600E			
	E190-E2	PW1900			APS 2600E			
Fairchild-Dornier	DO-228	TPE331-5			NA			
	DO-328	PW119B			36-150			
	Metro 23	TPE331-12			NA			
Fokker	F-50	PW127B			APS 1000			
	F-70	Tay 620			36-150RR			
	F-100	Tay 650			36-150RR			
Irkut	MC-21	PW1400G			HGT750			
Mitsubishi	SpaceJet M100, M90	PW1700			APS 2600			
Raytheon	1900D	PT6A-65B			NA			
SAAB	SAAB 340B	CT7-9B			NA			
	SAAB 2000	AE 2100A			APS 1000			
Viking	Twin Otter Series 400	PT6A-34			NA			

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

EASTMAN

The results of insight™

Eastman Corporate Headquarters

P.O. Box 431
Kingsport, TN 37662-5280 U.S.A.

U.S.A. and Canada, 800-EASTMAN (800-327-8626)
Other Locations, +(1) 423-229-2000

www.eastman.com/locations

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