AEROSHELL TURBINE ENGINE OILS

The earliest gas turbine engines were developed using straight mineral oils but the operational requirements for low temperature starting, either on the ground or at high altitude (re-lights) led to the development of a range of straight mineral oils with viscosities far lower than those of conventional aircraft engine oil of that time. For example, oils with viscosities between 2 mm^2/s and 9 mm^2/s at 100°C became standard for gas turbine engines, compared with viscosities of 20 mm^2/s to 25 mm^2/s at 100°C for piston engine oils.

Although demand for the low viscosity straight mineral turbine oils is diminishing, the following list tabulates the range of specifications covered.

MIL-PRF-6081D Grade 1010 - AeroShell Turbine Oil 2

DEF STAN 91-99 (DERD 2490) - AeroShell Turbine Oil 3

DEF STAN 91-97 (DERD 2479/0) - (AeroShell Turbine Oil 9 – grade now withdrawn)

DEF STAN 91-97 (DERD 2479/1) - (AeroShell Turbine Oil 9B – grade now withdrawn)

The higher viscosity 9 mm^2/s oils in the foregoing range were required for the highly loaded propeller reduction gears of turboprop engines. In some of these engines the natural load carrying characteristics derived from the viscosity of the oil alone was not enough and required improvement by an EP (Extreme Pressure) additive. The resultant blend, AeroShell Turbine Oil 9B (grade now withdrawn), was used by aircraft and helicopter operators.

With the progressive development of the gas turbine engine to provide a higher thrust and compression ratio, etc., the mineral oils were found to lack stability and to suffer from excessive volatility and thermal degradation at the higher temperatures to which they were subjected.

At this stage, a revolutionary rather than evolutionary oil development took place concurrently with engine development and lubricating oils derived by synthesis from naturally occurring organic products found an application in gas turbine engines. The first generation of synthetic oils were all based on the esters of sebacic acid, principally dioctyl sebacate. As a class, these materials exhibited outstanding properties which made them very suitable as the basis for gas turbine lubricants.

However, these materials yielded a product with a viscosity of about 3 mm^2/s at 100°C and alone had insufficient load carrying ability to support and transmit high gear loads. Therefore, to these materials were added thickeners (complex esters), which gave the required degree of load carrying ability and raised the final viscosity to about 7.5 mm^2/s at 100°C.

Unlike straight mineral oils, the synthetic oils had to rely on additives, and in later formulations on multi-component additive packages, to raise their performance. This was particularly necessary to improve resistance to oxidation and thermal degradation; important properties which govern long term engine cleanliness.

The two different basic grades of synthetic oil found favour on opposite sides of the Atlantic; in the U.S.A. 3 mm^2/s oils became standard while, in the U.K., 7.5 mm^2/s oils were used. AeroShell Turbine Oil 300 and AeroShell Turbine Oil 750 respectively were developed to meet these two separate requirements.

The situation persisted for some years until 3 mm^2/s oils were required for use in British pure jet engines. For many years AeroShell Turbine Oil 300 was the standard Shell 3 mm^2/s oil and rendered satisfactory airline service in many different types of British and American engines. However, to provide a more than adequate margin of performance and to allow for further increase of operational life, principally in Rolls-Royce engines, AeroShell Turbine Oil 390 was developed.

Although the use of 3 mm^2/s oils in aero-engines has declined, the use in auxiliary power units is increasing where, because of the low temperature viscometric properties, use of 3 mm^2/s oils gives improved cold starting reliability after prolonged cold soak.

Soon after the introduction of AeroShell Turbine Oil 390, American practice changed. With the almost continuous increases in engine size and power output, a demand developed in the U.S.A. for oils possessing improved thermal stability and high load carrying ability, with some sacrifice in low temperature performance, and the idea of introducing a "Type II", 5 mm^2/s oil was formed.

These 5 mm^2/s 'second generation', oils were usually based on 'hindered' esters and have since found wide application in American engines and subsequently in British, Canadian and French engines. AeroShell Turbine Oil 500 was developed to meet these requirements.

To meet the requirements to lubricate the engines of supersonic aircraft AeroShell Turbine Oil 555 was developed as an advanced 5 mm^2/s synthetic oil with high temperature and load carrying performance.

Changes which have taken place over the last two decades in engine performance (in terms of improved fuel consumption, higher operating temperatures and pressures) and in maintenance practices have resulted in increased severity in lubricant operating conditions. These types of changes stress the engine oil and thus the original Type II oils are becoming less suitable for use in modern aircraft engines. This has resulted in the need for engine oils with very good (and improved) thermal stability such as AeroShell Turbine Oil 560. This type of oil with better thermal stability is now generally known as "third generation" or "HTS".

In military aviation, the British Military initially standardised on the 7.5 mm^2/s oils as defined by DERD 2487 (now renumbered as DEF STAN 91-98), but then, in the mid 1980s switched and decided that future requirements will be met by the specification DERD 2497 (now renumbered as DEF STAN 91-100) covering high temperature performance oils.

In the U.S.A., the U.S. Air Force continues to prefer 3 mm^2/s oils, and, more recently, 4 mm^2/s oils, and maintains their performance requirements by revisions to specification MIL-PRF-7808 (formerly MIL-L-7808). The U.S. Navy, with interest in turbo-prop engines and helicopter gearboxes, etc., has tended to use 5 mm^2/s oils and after a series of specifications have finalised their requirements in the MIL-PRF-23699 specification (formerly MIL-L-23699). The latest issue of this specification, MIL-PRF-23699G, now caters for three classes of 5 mm^2/s oils; these are Standard Class (STD), Corrosion Inhibited class (C/I) and High Thermal Stability Class (HTS). Various AeroShell Turbine Oils are approved for each Class and the Summary Table at the end of these notes should be consulted for further information.

More recently with the need to transmit more power and higher loads through helicopter gearboxes it has become apparent that MIL-PRF-23699 oils may not be completely satisfactory. With this in mind, many helicopter manufacturers (as well as the U.S. Navy) have now turned to the advanced high load carrying 5 mm^2/s oil AeroShell Turbine Oil 555. This in turn has led to the development of a U.S. military specification DOD-PRF-85734A (formerly DOD-L-85734) which covers a helicopter transmission oil against which AeroShell Turbine Oil 555 is fully approved.

Historically, the aircraft engine original equipment manufacturers (OEMs) have used the above military specifications to control the performance and quality of turbine oils used in their commercial engines. In recent years, as engine developments resulted in hotter-running engines, the OEMs decided that they needed a more comprehensive, civil specification with which to define oil properties and performance and, against which, they could approve oils. This led to the development of the SAE specification AS5780, which defines two grades of 5mm^2/s turbine

engine oils – SPC (Standard Performance Capability) and HPC (High Performance Capability). Shell's newest turbine engine oil, AeroShell Ascender, was the first newly developed HPC oil to be approved against the SAE AS5780 specification.

VINTAGE AIRCRAFT

Vintage aircraft turbine engines were approved on oils available when the engine was originally manufactured and in many cases these oils were specific blends of mineral oils, such oils being no longer available. If the engine was approved on a mineral turbine oil other than MIL-L-6081 or DEF STAN 91-99 (formerly DERD 2490) oils then operators should consult with either the engine manufacturer/rebuilder or oil supplier. In some cases it is possible to switch to a synthetic turbine oil but such a move can only be considered on a case by case basis. On no account assume that present turbine oils (both mineral and synthetic) are direct replacements for old vintage aircraft applications.

OIL ANALYSIS

Routine oil analysis is now seen as a valuable part of a good maintenance programme. Increasingly operators are adopting oil analysis programmes in order to help discover problems before they turn into major failures. Typically these programmes consist of spectrometric wear metal check, together with a few simple oil tests such as viscosity and acidity. Shell Companies can offer this service to operators.

It is important to note that the information gained is only as good as the sampling procedure. A single test is not enough to reveal trends and significant changes, it can only tell an operator if there is already a serious problem. Operators should therefore:

- **Take samples properly**
For best results, take the sample immediately after engine shutdown. The sample should be taken the same way every time. An improperly taken sample can lead to mistaken conclusions about engine problems.

- **Rely on a series of consistent tests over time**
Operators should look for significant changes or trends over time, not just absolute values.

- **Be consistent**
Always take the sample the same way at the same time interval. Always properly label the sample so that its identity is known.

APPLICATIONS

Whenever an aircraft is certified, all of the engine oils are specified for each application point on the Type Certificate. The Type Certificate will specify, either by specification number or by specific brand names, those engine oils which are qualified to be used. The U.S. Federal Aviation Administration (FAA) regulations state that only engine oils qualified for specific applications can be used in certified aircraft. Therefore, it is the responsibility of the aircraft owner or designated representative to determine which engine oil should be used.

OIL APPROVALS

The oil approvals listed in this section are believed to be current at time of printing, however, the respective engine manufacturer's manuals and service bulletins should be consulted to ensure that the oil conforms with the engine manufacturer's latest lubricant approval listing.

TYPICAL PROPERTIES

In the following section typical properties are quoted for each turbine oil; there may be deviations from the typical figures given but test figures will fall within the specification requirement.

COMPRESSOR WASHING

Some turbine engine manufacturers permit or even recommend regular compressor washing. In this, water and/or special wash fluid is sprayed into the compressor during either ground idle running or during the final stages of engine shut down. The purpose of this washing is to restore the performance of the compressor by washing off any salt/sand/dirt/dust which may have collected on the compressor blade thereby causing deterioration in the performance of the compressor.

Operators should strictly follow the engine manufacturers' requirements for performing the compressor wash and in particular any requirement for a drying run since incorrect application of the wash/drying cycle could lead to contamination of the oil system by water and/or special wash fluid.

OIL CHANGE INTERVAL

For many gas turbine engines there is no set oil change interval, this is because the oil in the system changes over through normal consumption in a reasonable number of hours. For some engines, particularly smaller engines, the engine manufacturer recommends regular oil changes. Operators should therefore adhere to the recommendations for the specific model of engine they operate. Depending upon the condition of the oil and the oil wetted areas of the engine, the engine manufacturer may be prepared to authorise oil change extensions.

For gas turbines used in coastal operations (e.g. off-shore helicopter operations) where there is salt in the atmosphere, in high temperature/high humidity areas or in sandy/dusty areas regular oil changes can be beneficial because it allows removal of any salt/sand/dust/dirt/water contamination from the oil.

OIL CHANGEOVER

Generally synthetic turbine oils in one viscosity group are compatible and miscible with all other synthetic oils in the same viscosity group (and in many cases other viscosity groups as well). However, in changing from one synthetic turbine oil to another, an operator must follow the engine manufacturers' recommendations.

Change by top-off (mixing) allows the change over to take place slowly and there is increasing evidence that this is less of a shock to the engine and engine oil system. Whilst most engine manufacturers e.g. Rolls Royce, GE, P&W, CFMI, etc., allow change by top-off (mixing), other engine manufacturers e.g. Honeywell, do not and only allow changeover by either drain and refill or drain, flush and refill.

It is Shell's policy to always recommend that the engine manufacturer's recommendations are followed. In addition it is recommended that for the initial period during and after change over the oil filters are inspected more frequently.

COMPATIBILITY WITH MATERIALS

The advent of synthetic oil for gas turbine engine lubrication permitted greater extremes of temperature to be safely encountered (far in excess of those possible with mineral oils), and brought with it the problem of compatibility, not only of elastomers, but of metals, paints, varnishes, insulation materials and plastics. In fact all materials associated with lubricants in aircraft have had to be reviewed and new materials evolved, in some cases, to enable maximum benefit to be obtained from the use of synthetic turbine oils.

Much of this evaluation has been undertaken by the manufacturers in the industries concerned, and may be summarised under the general heading of the materials groups.

ELASTOMER COMPATIBILITY

When using a synthetic ester turbine oil the compatibility with sealing materials, plastics or paints has to be examined.

As a general rule, Shell Companies do not make recommendations regarding compatibility, since aviation applications are critical and the degree of compatibility depends on the operating conditions, performance requirements, and the exact composition of materials. In many cases the equipment manufacturers perform their own compatibility testing or have their elastomer supplier do it for them. Many elastomer suppliers do produce tables showing the compatibility of their products with a range of other materials. Therefore, the information provided here can only be considered as a guideline.

Elastomer/Plastic	Mineral Turbine Oils	Synthetic Ester Turbine Oils
Fluorocarbon (Viton)	Very good	Very good
Acrylonitrile	Good	Poor to Good (high nitrile content is better)
Polyester	Good	Poor to Fair
Silicone	Poor to Good	Poor to Fair
Teflon	Very Good	Very Good
Nylon	Poor to Good	Poor
Buna -S	Poor	Poor
Perbunan	Good	Fair to Good
Methacrylate	Good	Poor to Fair
Neoprene	Fair to Good	Poor
Natural Rubber	Poor to Fair	Poor
Polyethylene	Good	Good
Butyl Rubber	Very Poor to Poor	Poor to Fair
Poly Vinyl Chloride	Poor to Good	Poor

Compatibility Rating:

Very Good – Good – Fair – Poor – Very Poor

PAINTS

Epoxy resin paints have been found to be practically the only paints entirely compatible giving no breakdown or softening or staining in use, except for the very light colour shades, which are susceptible to staining due to the actual colour of the anti-oxidant inhibitor contained in practically all ester based lubricants.

PLASTICS

Only the more common plastics can be considered for evaluation of compatibility.

The best from chemical and physical aspects is polytetrafluoroethylene, as might be expected from its generally inert properties. This is closely followed by higher molecular weight nylon. Polyvinyl chloride is rapidly softened by the hot oil and is not recommended. Currently, polythene and terylene are also suspect in this respect, but have not been extensively evaluated.

VARNISHES

Many commonly used phenolic impregnated varnishes are softened by contact with the hot oil, but a few of the harder grades show moderate to good resistance. Silicone varnishes and TS 188 are considerably softened.

Modified alkyd type varnishes, when baked, possess good resistance to oil but have poor resistance to water. When good resistance to water is also required, it is recommended that the varnish be coated with a water resistant finish.

MINERAL AND VEGETABLE OILS

Ester based synthetic oils are incompatible with mineral and vegetable oils. In no circumstances should these products be used together and, if changing from one type to another, then particular care is needed to ensure that all traces of the previous product are removed prior to ester lubricant application.

METALS

Copper and alloys containing copper

As in mineral oil applications, pure copper has a marked catalytic effect at sustained high oil temperatures on the break down of the esters to acid derivatives, and its use in engines or other equipment is thus most undesirable. Copper alloys such as brass and bronze do not possess this property to any great degree and can be used with safety.

Aluminium and steel and their alloys

These materials are not affected.

Cadmium

Cadmium, in the form of plating as a protective treatment for storage of parts destined to be in contact with oil in service, experiences a tendency at the higher temperatures to be taken into solution by synthetic oils. This solvent action does not harm the lubricant, but the slow removal of cadmium plating after many hours of service will detract from its efficiency as a subsequent protective.

Lead and alloys containing lead

Lead and all alloys containing lead are attacked by synthetic lubricants. The way the lubricant reacts with the lead differs according to the type of lubricant, but in general, all lead compounds should be avoided. The most common forms of lead are lead abradable seals and lead solder used particularly in filters and mesh screens. In these cases the mesh screen should be brazed.

OTHER METALS

Magnesium is not affected except where hydrolysis occurs. Thus magnesium should not be used if there is any likelihood of hydrolysis occurring or alternatively the magnesium could be coated with epoxy to protect it.

Monel and Inconel are not affected.

Tungsten accumulates a very thin soft black film after prolonged immersion in synthetic oils under static conditions. It is readily removed by wiping, leaving no sign of corrosion. Under the scrubbing conditions normally associated with circulatory oil systems this film does not materialise and its effect may be ignored.

Zinc, as galvanised protective, is attacked by synthetic lubricants leading to the formation of zinc soaps and thus should not be used. Storage of synthetic oils is best achieved in tinned mild steel cans or failing this, bright mild steel.

Titanium is not affected.

Silver and silver plating is generally not affected. However, in some synthetic ester oils, the additive pack, especially high load additives, react with the silver and blacken or even de-plate the silver.

Chromium plating is not affected.

Nickel and alloys are generally satisfactory.

Tin plating is generally satisfactory.

For aircraft oil tanks the recommended material is light alloy or stainless steel.

NON-AVIATION USE OF AEROSHELL TURBINE ENGINE OILS

In selecting an AeroShell turbine engine oil for a non-aviation application, the properties of the oil must be examined. This will only give an approximate indication as to the expected performance in the specific application. However, such data must be regarded as guidance only. There is no laboratory test that can give a complete prediction of performance in actual use, and the final stage in any decision must involve performance tests in either the actual equipment or in the laboratory/test house under conditions expected in service.

The main use of AeroShell turbine engine oils in non-aviation applications is in aero-derived industrial and marine gas turbine applications. Such engines have found application in:

- electrical power generation
- large pumps and compressors, especially in pipeline applications and in petrochemical process industry
- marine propulsion

In an aero-engine, essential design features are it's size and weight, which results in compact units. Such designs place heavy demands on the engine components and lubricants to ensure total reliability in the high temperatures within the engine.

The land and sea based derivatives of the aero-engines retain the essential design elements of their aviation versions and thus have similar lubrication requirements. Engine manufacturers therefore approve the use of aircraft synthetic turbine oils in these engines. Only these lubricants have the characteristics required to provide the unit lubrication and cooling within the severe operating environment.

There is a full range of AeroShell turbine oils approved by the major engine manufacturers for use in their industrial and marine derivatives of aero-engines and a quick reference table is included at the end of this section.

SUMMARY OF AEROSHELL TURBINE OIL SPECIFICATION APPROVALS

Specification Number	AEROSHELL TURBINE OIL 308	390	500	555	560	750	Ascender	Comments
MIL-PRF-7808L Grade 3	Approved	–	–	–	–	–	–	U.S. Air Force 3 mm^2/s oil specification
Grade 4	–	–	–	–	–	–	–	4 mm^2/s oil specification
MIL-PRF-23699G STD	–	–	Approved	–	–	–	–	U.S. Navy 5 mm^2/s oil specification
HTS	–	–	–	–	Approved	–	Approved	
DOD-PRF-85734A	–	–	–	Approved	–	–	–	U.S. helicopter transmission specification
SAE AS5780B Grade SPC	–	–	Approved	–	Approved	–	–	Aero and aero-derived Gas Turbine oil specification
Grade HPC	–	–	–	–	–	–	Approved	
DEF STAN 91-93 (DERD 2458)	–	–	–	–	–	–	–	U.K. 5 mm^2/s Marine Gas Turbine oil specification
DEF STAN 91-94 (DERD 2468)	–	Approved	–	–	–	–	–	U.K. 3 mm^2/s oil specification
DEF STAN 91-98 (DERD 2487)	–	–	–	–	–	Approved	–	U.K. 7.5 mm^2/s oil specification
DEF STAN 91-100 (DERD 2497)	–	–	–	Equivalent	–	–	–	U.K. Advanced 5 mm^2/s oil specification
DEF STAN 91-101 (DERD 2499)								U.K. 5 mm^2/s oil specification
Grade OX-27	–	–	Approved	–	–	–	–	
Grade OX-28	–	–	–	–	–	–	–	

AEROSHELL TURBINE OIL 2

AeroShell Turbine Oil 2 is a 2 mm^2/s mineral turbine oil blended from mineral base stocks to which a pour-point depressant and an anti-oxidant have been added.

APPLICATIONS

AeroShell Turbine Oil 2 is widely used for inhibiting fuel systems and fuel system components during storage.

AeroShell Turbine Oil 2 is an analogue to the Russian Grade MK-8 and can therefore be used in engines which require the use of MK-8.

SPECIFICATIONS

U.S.	Approved MIL-PRF-6081D Grade 1010
British	-
French	Equivalent to AIR 3516/A
Russian	Analogue to MK-8
NATO Code	O-133
Joint Service Designation	OM-10 (Obsolete)

PROPERTIES		**MIL-PRF-6081D Grade 1010**	**TYPICAL**
Oil type		Mineral	Mineral
Density @ 15 °C	kg/l	-	0.875
Kinematic viscosity @ 37.8 °C @ –40 °C	mm^2/s	 10.0 min 3000 max	 10.5 2700
Viscosity stability 3hrs @ –40 °C		 2 max	 0.2
Pourpoint	°C	–57 max	Below –57
Flashpoint Cleveland Open Cup	°C	132 min	154
Total acidity	mgKOH/g	0.10 max	0.02
Colour	ASTM	5.5 max	<0.5
Copper corrosion 3 hrs @ 121 °C	ASTM	 1 max	 Passes
Trace sediment	ml/200ml	0.005 max	0.001
Corrosion & oxidation stability 168 hrs @ 121 °C - metal weight change - change in viscosity @ 37.8 °C - acid number change	 % mgKOH/g	 Must pass –5 to +20 0.2 max	 Passes Passes Less than 0.2

AEROSHELL TURBINE OIL 3

AeroShell Turbine Oil 3 is a 3 mm^2/s mineral turbine oil blended from mineral base stocks to which a anti-corrosion additive has been added.

APPLICATIONS

AeroShell Turbine Oil 3 was developed for early pure jet engines and is still approved for some versions of these engines plus the Turbomeca Artouste, Marbore 2 and Marbore 6.

AeroShell Turbine Oil 3 is widely used for inhibiting fuel systems and fuel system components during storage.

AeroShell Turbine Oil 3 is an analogue to the Russian Grade MK-8 and can therefore be used in engines which require the use of MK-8. It is also used as the mineral turbine oil component in the mixture of mineral turbine oil and piston engine oil used in Russian turbo-prop engines.

SPECIFICATIONS

U.S.	-
British	Meets DEF STAN 91-99
French	Equivalent to AIR 3515/B
Russian	Analogue to MK-8
NATO Code	O-135
Joint Service Designation	OM-11

PROPERTIES		**DEF STAN 91-99**	**TYPICAL**
Oil type		Mineral	Mineral
Density @ 15°C	kg/l	-	0.875
Kinematic viscosity @ 40°C @ –25°C	mm^2/s	 12.0 min 1250 max	 12.28 1112
Pourpoint	°C	–45 max	Below –45
Flashpoint Pensky Martin Closed Cup	°C	144 min	146
Total acidity	mgKOH/g	0.30 max	0.15
Strong acid number	mgKOH/g	NIL	NIL
Copper corrosion 3 hrs @100°C		1 max	Passes
Saponification matter	mgKOH/g	1 max	0.25
Ash	% m/m	0.01 max	0.001
Aromatic content	%	10 max	6.0
Oxidation - total acid number increase - asphaltenes	 mgKOH/g % m/m	 0.7 max 0.35 max	 0.24 0.09

AEROSHELL TURBINE OIL 3SP

AeroShell Turbine Oil 3SP is a 3 mm^2/s mineral turbine oil incorporating additives to improve anti-wear and anti-oxidant properties as well as low temperature properties.

APPLICATIONS

AeroShell Turbine Oil 3SP has excellent low temperature properties and is approved for use in Russian engines which use the Russian grades MS-8P, MK-8P and MS-8RK. Typical civil applications include various models of the Il-62, Il-76, Il-86, Il-114, Tu-134, Tu-154, YAK-40, AN-12, AN-26, AN-30, and M-15 aircraft as well as the Mi-6 and Mi-10 helicopters. Typical military applications include the MiG-9, MiG-11, MiG-15, MiG-17, MiG-21, Su-7, Su-9, Su-11 and Su-15 aircraft.

AeroShell Turbine Oil 3SP is approved for use in the preservation of oil and fuel systems where Russian grades MK-8, MS-8P and MS-8RK are used.

AeroShell Turbine Oil 3SP can also be used in oil mixtures where this oil is mixed with piston engine oil. Typical mixtures are:

SM-4.5 = 75% MS-8P + 25% MS-20
= 75% AeroShell Turbine Oil 3SP + 25% AeroShell Oil 100

SM-8.0 = 50% MS-8P + 50% MS-20
= 50% AeroShell Turbine Oil 3SP + 50% AeroShell Oil 100

SM-11.5 = 25% MS-8P + 75% MS-20
= 25% AeroShell Turbine Oil 3SP + 75% AeroShell Oil 100

Typical applications for these mixtures include the Il-8, AN-12, AN-24, AN-26, AN-28 and AN-30 aircraft as well as various military aircraft and some helicopter transmissions.

SPECIFICATIONS

U.S.	-
British	-
French	-
Russian	(see table below)
NATO Code	-
Joint Service Designation	-

AeroShell Turbine Oil 3SP has been tested and approved by the Central Institute of Aviation Motors (CIAM) in Moscow as follows:

Engine oils	MS-8P	(OST 38.01163-78)
	MS-8RK	(TU 38-1011181-88)
Preservative oil	MK-8	(GOST 6457-66)
	MS-8P	
	MS-8R	

AeroShell Turbine Oil 3SP is also approved and ratified in Decision No DB - 6.8 - 21 by:

GUAP Goscomoboronprom (Chief Department of Aviation Industry of Defence Industry State Committee of Russian Federation)

DVT MT (Aviation Transport Department of Ministry of Transport of Russian Federation).

PROPERTIES		OST 38.01163-78	TYPICAL
Oil type		Mineral	Mineral
Density @ 20°C	kg/l	0.875 max	0.875
Kinematic viscosity @ 50°C @ -40°C	mm^2/s	 8.0 min 4000 max	 8.15 3367
Pourpoint	°C	-55 max	Below -55
Total acid number	mgKOH/g	0.30 max	0.02
Lubricating properties		Must pass	Passes
Thermal oxidation		Must Pass	Passes
Water content		NIL	NIL
Sediment content		NIL	NIL
Sulphur content	%m	0.55 max	0.13
Ash content	%m	0.008 max	0.002
Flashpoint	°C	150 min*	Above 140*
Foaming tendency		Must pass	Passes
Corrosivity		Must Pass	Passes
Elastomer compatibility		Must Pass	Passes

* CIAM ACCEPTS LIMIT OF 140°C. REFER TO LETTER OF APPROVAL FOR DETAILS OF WAIVER.

SPECIFICATIONS

COMPARISON OF AEROSHELL TURBINE OIL 3SP and RUSSIAN GRADE MS-8P

In their qualification approval testing programme, CIAM tested AeroShell Turbine Oil 3SP against the requirements of the OST 38.01163-78 Specification and in comparison with a sample of Russian-produced MS-8P. When comparing results, it is important to realise that the OST 38.01163-78 specification was written specifically to cover MS-8P which was made from a particular mineral base oil; a direct analogue of this base oil is not available outside of Russia and so it is to be expected that not all the properties of AeroShell Turbine Oil 3SP would necessarily be identical to those of MS-8P, nor even fully conform to the OST 38.01163-78 specification. This was, indeed, found to be the case by CIAM. Nevertheless, CIAM still approved AeroShell Turbine Oil 3SP as being a suitable alternative to MS-8P.

In terms of volatility - flash point and evaporation loss - AeroShell Turbine Oil 3SP does not conform to the requirements of OST 38.01163-78. However, CIAM proceeded to approve AeroShell Turbine Oil 3SP on the basis that aircraft which use it would formerly have used MK-8P, which was more volatile than the MS-8P which replaced it. CIAM confirmed its acceptance of a lower flash point in their letter dated 24th February, 1994.

With regard to load carrying/anti-wear properties, when assessed by the 4-ball machine, AeroShell Turbine Oil 3SP was found to give marginally inferior results to MS-8P. However, when subjected by CIAM to more realistic, high temperature, SH-3 gearbox bench testing, the results were good and CIAM concluded in their report that all aspects of pinion teeth wear did not exceed the accepted norms and that operation of the gearbox was "normal". Furthermore, deterioration of the oil after test was minimal. Although each batch of AeroShell Turbine Oil 3SP manufactured by Shell is tested on a 4-ball machine, the test methods used are ASTM D2596 and/or D4172 which would not necessarily produce identical results to the Russian GOST 9490-75 method.

GUAP Goscomoboronprom (Chief Department of Aviation Industry of Defence Industry State Committee of Russian Federation)

DVT MT (Aviation Transport Department of Ministry of Transport of Russian Federation).

AEROSHELL TURBINE OIL 308

AeroShell Turbine Oil 308 is a 3 mm^2/s synthetic ester oil incorporating additives to improve resistance to oxidation and corrosion and to minimise wear.

APPLICATIONS

AeroShell Turbine Oil 308 was developed specifically for use in particular models of aircraft turbo-prop and turbo-jet engines for which a MIL-PRF-7808 (formerly MIL-L-7808) oil is required.

AeroShell Turbine Oil 308 contains a synthetic ester oil and should not be used in contact with incompatible seal materials and it also affects some paints and plastics. Refer to the General Notes at the front of this section for further information.

SPECIFICATIONS

U.S.	Approved MIL-PRF-7808L Grade 3
British	-
French	-
Russian	-
NATO Code	O-148
Joint Service Designation	OX-9

PROPERTIES	**MIL-PRF-7808L Grade 3**	**TYPICAL**
Oil type	Synthetic ester	Synthetic ester
Density @ 15°C kg/l	-	0.956
Kinematic viscosity mm^2/s		
@ 100°C	3.0 min	3.1
@ 40°C	11.5 min	12.0
@ –40°C	-	2400
@ –51°C	17000 max	12000
Viscosity stability	Must pass	Passes
Pourpoint °C	-	Below –62
Flashpoint Cleveland Open Cup °C	210 min	235
Total acidity mgKOH/g	0.3 max	0.15
Trace metal content	Must pass	Passes
Evaporation 6.5 hrs @ 205°C %m	30 max	20
Silver - bronze corrosion @ 232°C		
- silver gm/m^2	± 4.5 max	0.01
- bronze gm/m^2	± 4.5 max	0.05
Deposit test		
- deposit rating	1.5 max	0.8
- neutralisation number change %	20 max	2.0
- viscosity change @ 40°C %	100 max	12.0
Storage stability	Must pass	Passes
Compatibility	Must pass	Passes

Table continued

Table continued

PROPERTIES		MIL-PRF-7808L Grade 3	TYPICAL
Elastomer compatibility			
SAE-AMS 3217/1, 168 hrs @ 70°C			
	% swell	12 to 35	27
SAE-AMS 3217/4, 72 hrs @ 175°C			
	% swell	2 to 25	16
- tensile strength change	%	50 max	30
- elongation change	%	50 max	3.5
- hardness change	%	20 max	9.0
SAE-AMS 3217/5, 72 hrs @ 150°C			
	% swell	2 to 25	Passes
- tensile strength change	%	50 max	Less than 50
- elongation change	%	50 max	Less than 50
- hardness change	%	20 max	Less than 20
Static foam test			
- foam volume	ml	100 max	30
- foam collapse time	secs	60 max	15
Dynamic foam test		Must pass	Passes
Corrosion and oxidation stability		Must pass	Passes
Bearing deposition stability			
- deposit rating		60 max	<60
- filter deposit weight	g	2.0 max	<2
- viscosity change @ 40°C		–5 to +25	Passes
- acid number change	mg/KOH/g	1.0 max	<1
- metal weight change	mg/cm^2	±0.2 max	Passes
Gear load carrying capacity		Must pass	Passes

A viscosity/temperature chart is shown at the end of this section.

NOTES

AEROSHELL TURBINE OIL 390

AeroShell Turbine Oil 390 is a 3 mm^2/s synthetic diester oil incorporating a carefully selected and balanced combination of additives to improve thermal and oxidation stability and to increase the load carrying ability of the base oil.

APPLICATIONS

AeroShell Turbine Oil 390 was developed primarily as an improved 3 mm^2/s oil for British turbo-jet engines. AeroShell Turbine Oil 390 is fully approved for a wide range of turbine engines.

More recently, because of the low temperature characteristics of AeroShell Turbine Oil 390, there is interest in using this oil in auxiliary power units (APU) in order to overcome the effects of cold soak. Normal practice is to shut down the APU during cruise, the APU then experiences cold soak, often prolonged, and when the unit is started there is considerable difficulty resulting in the unit not coming up to speed in the given time, thus causing a hung start.

In such cases where the APU is subject to a long cold soak the viscosity of standard 5 mm^2/s oils used in the APU will increase from 5 mm^2/s at 100°C to typically 10,000 mm^2/s at –40°C. At this much higher viscosity the oil cannot flow easily leading to a large viscous drag within the APU, thereby contributing to the difficulty in starting. AeroShell Turbine Oil 390 on the other hand experiences a much smaller viscosity increase (typically 2000 mm^2/s at –40°C) with a reduction in viscous drag which is often sufficient to overcome hung start problems.

All experience to date shows a considerable improvement in cold reliability of the APU when AeroShell Turbine Oil 390 is used.

SPECIFICATIONS

U.S.	-
British	Approved DEF STAN 91-94
French	-
Russian	Analogue to IPM-10, VNII NP 50-1 4f and 4u, and 36Ku-A
NATO Code	-
Joint Service Designation	OX-7

EQUIPMENT MANUFACTURER'S APPROVALS

AeroShell Turbine Oil 390 is approved for use in all models of the following engines:

Honeywell	GTCP 30, 36, 70, 85, 331 and 660 APUs Starters, Turbo compressors
Pratt & Whitney Canada	PW901A APU
Rolls Royce	Conway, Spey, Tay, M45H
Turbomeca	Artouste III, Bastan, Turmo, AST 950. Approved with restrictions*: Ardiden, Arriel, Arrius, Artouste, TM333, AST 600, Astazou, Makila, Marbore 6
Hamilton-Sundstrand	APS 500, 1000, 2000, 3000

*Please refer to Turbomeca manual for details.

PROPERTIES		DEF STAN 91-94	TYPICAL
Oil type		-	Synthetic ester
Density @ 15°C	kg/l	-	0.924
Kinematic viscosity	mm^2/s		
@ 40°C		16.0 max	12.9
@ 100°C		4.0 min	3.4
@ –54°C		13000 max	<13000
Pourpoint	°C	–60 max	–68
Flashpoint Cleveland Open Cup	°C	225 min	225
Foam characteristics		Must pass	Passes
Trace element content		Must pass	Passes
Elastomer compatibility, swell tests			
- nitrile	%	14 to 26	Within range
- viton	%	15 to 25	Within range
- silicone	%	16 to 24	Within range
Solid particle contamination			
- sediment	mg/l	10 max	<10
- total ash of sediment	mg/l	1 max	<1
Corrosivity		Must pass	Passes
High temperature oxidative stability		Must pass	Passes
Load carrying ability		Report	Passes

A viscosity/temperature chart is shown at the end of this section.

NOTES

AEROSHELL TURBINE OIL 500

AeroShell Turbine Oil 500 is a 5 mm^2/s synthetic hindered ester oil incorporating a carefully selected and balanced combination of additives to improve thermal and oxidation stability and metal passivation.

APPLICATIONS

AeroShell Turbine Oil 500 was developed essentially to meet the requirements of Pratt & Whitney 521 Type II and MIL-L-23699 specifications and is entirely suitable for most civil and military engines requiring this class of lubricant. AeroShell Turbine Oil 500 is approved for use in a wide range of turbine engines as well as the majority of accessories.

With the advent of the new civil turbine oil specification, SAE AS5780, which has more stringent requirements than the military specification MIL-PRF-23699, AeroShell Turbine Oil 500 was approved as a SPC (Standard Performance Capability) oil.

AeroShell Turbine Oil 500 contains a synthetic ester oil and should not be used in contact with incompatible seal materials and it also affects some paints and plastics. Refer to the General Notes at the front of this section for further information.

SPECIFICATIONS

U.S.	Approved MIL-PRF-23699G Grade STD Approved SAE AS5780B Grade SPC
British	Approved DEF STAN 91-101 Grade OX-27
French	Equivalent DCSEA 299/A
Russian	-
NATO Code	O-156
Joint Service Designation	OX-27
Pratt & Whitney	Approved 521C Type II
General Electric	Approved D-50 TF 1
Allison	Approved EMS-53 (Obsolete)

EQUIPMENT MANUFACTURER'S APPROVALS

AeroShell Turbine Oil 500 is approved for use in all models of the following engines:

Honeywell	TPE 331, GTCP 30, 36, 85, 331, 660 and 700 series APUs. ALF 502, LF507, LTS101, LTP101, T53, T55, AL5512, RE100, TCSP700, RE200
Allison (Rolls-Royce)	250 Series, 501, D13, T56, GMA 2100, GMA 3007
BMW-Rolls-Royce	BR710, BR715
Engine Alliance	GP7200
Eurojet	EJ200
GE	CF6, CT58, CF700, CJ610, CJ805, CF34, CT7, CT64
Hamilton Sundstrand	APS 500, 100, 2000, 3000
IAE	-
Motorlet	M601D, E and Z
Pratt & Whitney	JT3, JT4, JT8, JT9, JT12, PW4000, PW6000
Pratt & Whitney Canada	JT15, PT6A, PT6T, ST6, PW100, PW200, PW300, PW500
Rolls-Royce	RB211, -524, -535, Tay, Gnome, Spey, RB183, Adour, M45H, Viper (Series MK 301, 521, 522, 526, 535, 540, 601, 623 and 632)
Turbomeca	Adour, Ardiden, Arriel, Arrius, Arrius 1D, AST 600, Astazou XVI, Larzac, Makila, MTR390, RTM322, TM333, 526, 535, 540, 601, 623 and 632. Approved with restrictions*: Artouste, AST 950, Astazou, Turmo, Bastan

Full details of the approval status of AeroShell Turbine Oil 500 in APUs and other engines/accessories is available.
*Please refer to Turbomeca manual for details.

PROPERTIES	MIL-PRF-23699G Grade STD SAE AS5780B Grade SPC	TYPICAL
Oil type	Synthetic ester	Synthetic ester
Kinematic viscosity mm²/s		
@ 100°C	4.90 to 5.40	5.17
@ 40°C	23.0 min	25.26
@ –40°C	13000 max	8996
Flashpoint Cleveland Open Cup °C	246 min	256
Pourpoint °C	–54 max	<–54
Total acidity mgKOH/g	1 max	0.11
Evaporation loss 6.5 hrs @ 204°C %m	10.0 max	3.6
Foaming	Must pass	Passes
Swelling of standard synthetic rubber SAE-AMS 3217/4		
72 hrs @ 204°C swell %	5 to 25	Within limits 15%
Elastomer compatibility, % weight change after 24/120 hours:		
Fluorocarbon @ 200°C	10/15 max.	Within limits
LCS Fluorocarbon @ 200°C	10/20 max.	Within limits
Nitrile @ 130°C	Report	Within limits
Silicone @ 175°C	Report	Within limits
Perfluoroelastomer @ 200°C	N/A	
Thermal stability/corrosivity 96 hrs @ 274°C		
- metal weight change mg/cm	4 max	0.5
- viscosity change %	5 max	2.69
- Total acid number change mgKOH/g	6 max	2.03

PROPERTIES	MIL-PRF-23699G Grade STD SAE AS5780B Grade SPC	TYPICAL
Corrosion & oxidation stability		
72 hrs @ 175°C	Must pass	Passes
72 hrs @ 204°C	Must pass	Passes
72 hrs @ 218°C	Must pass	Passes
HLPS dynamic coking @ 375°C		
@ 20hrs Deposit mg	Report	1.34 average
Ryder gear test, relative rating %		
Hercolube A	102	117
Bearing Test Rig Type 1 1/2 conditions (100hrs)		
- Overall deposit demerit rating	80.0 max	51
- Viscosity change @ 40°C %	–5 to +30	18.25
- Total acid number change mgKOH/g	2 max	0.63
- filter deposits g	3 max	0.70
Sonic shear stability		
viscosity change at 40°C %	4 max	0.19
Trace metal content	Must pass	Passes
Sediment mg/l	10 max	0.77
Ash mg/l	1 max	0.4

AeroShell Turbine Oil 500 is also approved for use in the industrial and marine versions of the Rolls Royce Trent, Avon, Allison 501K and 570K, Honeywell TF35, Pratt & Whitney GG3/FT3, GG4/FT4, GG12/FT12, all General Electric LM Series of units, Turbomeca industrial engines and certain Solar gas turbine engines.

A viscosity/temperature chart is shown at the end of this section.

AEROSHELL TURBINE OIL 555

AeroShell Turbine Oil 555 is an advanced 5 mm^2/s synthetic hindered ester oil incorporating a finely balanced blend of additives to improve thermal and oxidation stability and to increase the load carrying ability of the base oil.

APPLICATIONS

AeroShell Turbine Oil 555 was specifically developed to meet the high temperatures and load carrying requirements of SST engines and the DEF STAN 91-100 (formerly DERD 2497) and XAS-2354 specifications. AeroShell Turbine Oil 555 was also designed to give enhanced performance in current engines.

More recently with the need to transmit more power and higher loads through helicopter transmission and gearbox systems (many helicopters use a synthetic turbine engine oil in the transmission/gearbox system) it has become apparent that the use of a very good load carrying oil, such as AeroShell Turbine Oil 555 is necessary. This in turn has led to the development of a U.S. Military Specification, DOD-L-85734 (now DOD-PRF-85734A), which covers a helicopter transmission oil against which AeroShell Turbine Oil 555 is fully approved.

AeroShell Turbine Oil 555 contains a synthetic ester oil and should not be used in contact with incompatible seal materials and it also affects some paints and plastics. Refer to the General Notes at the front of this section for further information.

SPECIFICATIONS

U.S.	Approved DOD-PRF-85734A
British	Equivalent DEF STAN 91-100 Note: both UK and US production are manufactured to the same formulation.
French	-
Russian	-
NATO Code	O-160
Joint Service Designation	OX-26
Pratt & Whitney	Approved 521C Type II
General Electric	Approved D-50 TF 1
Allison	Approved EMS-53 (Obsolete)

EQUIPMENT MANUFACTURER'S APPROVALS

AeroShell Turbine Oil 555 is approved for use in all models of the following engines:

Honeywell	Auxiliary Power Units GTCP 30, 36, 85, 331, 660 and 700 series
General Electric	CT58, CT64, CF700, CJ610
Motorlet	M601D, E and Z
Pratt & Whitney	JT3, JT4, JT8, JT9, JT12, PW4000
Pratt & Whitney Canada	ST6, PW200
Rolls-Royce	Gem, Gnome, M45H, Olympus 593, RB199
Turbomeca	Adour, MTR390. Approved with restrictions*: Artouste (some models) Astazou, AST 950, Bastan

*Please refer to Turbomeca manual for details.

EQUIPMENT MANUFACTURER'S APPROVALS – HELICOPTER TRANSMISSIONS

AeroShell Turbine Oil 555 is approved for an increasing number of helicopter transmissions, whilst details are listed below, it is important that operators check latest status with the helicopter manufacturer. In all cases it is important to check compatibility with seals used in the transmission/gearbox.

U.S. Military	Approved for helicopter transmission specification DOD-PRF-85734A
Eurocopter	Approved for Super Puma, for other helicopters check with Eurocopter
Agusta	Approved for A109 and A129 models, for other models check with Agusta
Bell Helicopter Textron	Approved for all Bell turbine engine powered helicopters
Boeing Vertol	Approved for Chinook
McDonnell Douglas	Approved
MBB	Approved
Sikorsky	Approved for S-61N (note other types such as the S-70 and S-76 do not use synthetic turbine oils in the transmission)
Westland Helicopters	Approved for some models

PROPERTIES	DOD-PRF-85734A	TYPICAL
Oil type	Synthetic ester	Synthetic ester
Kinematic viscosity mm²/s @ 98.9°C @ 37.8°C @ –40°C	 5.0 to 5.5 25.0 min 13000 max	 5.4 29.0 11000
Flashpoint Cleveland Open Cup °C	246 min	>246
Pourpoint °C	–54 max	Below –54
Total acidity mgKOH/g	0.5 max	0.3
Evaporation loss 6.5 hrs @ 204°C %m	10.0 max	2.6
Foaming	Must pass	Passes
Swelling of standard synthetic rubber SAE-AMS 3217/1 72 hrs @ 70°C swell % SAE-AMS 3217/4 72 hrs @ 204°C swell %	 0 to 25 0 to 25	 14 14
Thermal stability/corrosivity 96 hrs @ 274°C - metal weight change mg/cm² - viscosity change @ 37.8°C % - Total acid number change mgKOH/g	 4 max 5 max 6 max	 –0.97 –1.2 2

Table continued

Table continued

PROPERTIES	DOD-PRF-85734A	TYPICAL
Corrosion & oxidation stability		
72 hrs @ 175°C	Must pass	Passes
72 hrs @ 204°C	Must pass	Passes
72 hrs @ 218°C	Must pass	Passes
Ryder gear test, relative rating %		
Hercolube A	145	>145
Bearing test rig type 1½ conditions		
- Overall deposit demerit rating	80.0 max	22
- Viscosity change @ 37.8°C %	–5 to +30	21
- Total acid number change mgKOH/g	2 max	0.83
- filter deposits g	3 max	0.5
Sonic shear stability		
- viscosity change at 40°C %	4 max	NIL
Trace metal content	Must pass	Passes
Sediment mg/l	10 max	Passes
Ash mg/l	1 max	Passes

AeroShell Turbine Oil 555 is also approved for use in the industrial and marine versions of the Rolls - Royce RB211-22 and Olympus engines, General Electric LM 100, 250, 350, 1500 and 2500 engines.

A viscosity/temperature chart is shown at the end of this section.

NOTES

AEROSHELL TURBINE OIL 560

AeroShell Turbine Oil 560 is a third generation, high performance, low coking 5 mm^2/s synthetic hindered ester oil incorporating a carefully selected and finely balanced combination of additives to improve thermal and oxidation stability.

APPLICATIONS

Changes which have taken place over the last twenty years in engine performance (in terms of improved fuel consumption, higher operating temperatures and pressures) and maintenance practices have resulted in increased severity in lubricant operating conditions.

AeroShell Turbine Oil 560 was developed to withstand the hostile environments of today's high powered, high compression engines in which the older generation of oils can be stressed up to and beyond their thermal limits, as evidenced by oil coking in the high temperature bearing areas.

By overcoming the problems associated with using old technology oils in new technology engines, AeroShell Turbine Oil 560:

- maintains a cleaner engine
- provides improved load carrying capacity
- reduces maintenance costs
- prolongs bearing life

in both new and existing engines.

In order for military authorities to take advantage of this better performance in military engines the specification MIL-PRF-23699 was re-written to include a "High Thermal Stability" (HTS) grade as well as the Standard (STD) and Corrosion Inhibited (C/I) grades. AeroShell Turbine Oil 560 is fully approved as an HTS oil. With the advent of the new civil turbine oil specification, SAE AS5780, which has more stringent requirements than the military specification, AeroShell Turbine Oil 560 was approved as a SPC (Standard Performance Capability) oil.

With effect from January 1st 2002, AeroShell Turbine Oil 560 has been manufactured with an improved formulation to further enhance its anti-coking performance.

AeroShell Turbine Oil 560 contains a synthetic ester oil and should not be used in contact with incompatible seal materials and it also affects some paints and plastics. Refer to the General Notes at the front of this section for further information.

SPECIFICATIONS

U.S.	Approved MIL-PRF-23699G Grade HTS Approved SAE AS5780B Grade SPC
British	Equivalent DEF STAN 91-101
French	Equivalent DCSEA 299/A
Russian	Analogue to VNII NP 50-1-4F, B3V, LZ-240, VNII NP 50-1-4U and 36/Ku-A
NATO Code	O-154
Joint Service Designation	Equivalent OX-27
Pratt & Whitney	Approved 521C Type II
General Electric	Approved D-50 TF 1
Allison	Approved EMS-53 (Obsolete)

EQUIPMENT MANUFACTURER'S APPROVALS

AeroShell Turbine Oil 560 is approved for use in all models of the following engines:

Honeywell	TPE 331, APUs (majority of models), LTS 101, LTP 101, ALF 502, LF 507, AS907, AS977, GTCP 30, 36, 85, 331, 660, RE220
Allison (Rolls-Royce)	250 Series
BMW-Rolls-Royce	BR710, BR715
CFM International	CFM 56 (all models)
CFE	CFE 738
Engine Alliance	GP7200
GE	GE 90, CF6 (all models) CJ610, CF700, CT34, GEnX
IAE	V2500 Series
IHI	FJR 710
Hamilton Sundstrand	APS 500, 1000, 2000, 3000
Pratt & Whitney	JT3D, JT8D, JT9D, PW4000 Series (cleared for flight evaluation in PW2000 engines)
Pratt & Whitney Canada	PT6T, PT6A (some models only), PW120,121 Series, JT15D, PW200 Series, PW300 Series, PW500 Series, PW901A APU
Rolls-Royce	Spey, Tay RB183, Adour, RB199
Turbomeca	Ardiden, Arriel, Arrius, Arrius 1D, AST 600, Astazou XVI, Makila, TM333. Approved with restrictions*: Artouste, AST 950, Bastan, Turmo

*Please refer to Turbomeca manual for details

PROPERTIES	MIL-PRF-23699G Grade HTS SAE AS5780B Grade SPC	TYPICAL
Oil type	Synthetic ester	Synthetic ester
Kinematic viscosity mm^2/s		
@ 100°C	4.90 to 5.40	5.24
@ 40°C	23.0 min	26.71
@ –40°C	13000 max	9351
Flashpoint Cleveland Open Cup °C	246 min	268
Pourpoint °C	–54 max	–60
Total acidity mgKOH/g	1 max	0.20
Evaporation loss 6.5 hrs @ 204°C %m	10.0 max	2.0
Foaming	Must pass	Passes
Swelling of standard synthetic Rubber SAE-AMS 3217/4 72 hrs @ 204°C swell %	5 to 25	12.9
Elastomer compatibility, % weight change after 24/120 hours:		
Fluorocarbon @ 200°C	10/15 max.	7.5/9.0
LCS Fluorocarbon @ 200°C	10/20 max.	6.5/8.5
Nitrile @ 130°C	Report	6.5/6.0
Silicone @ 175°C	Report	14.5/13.5
Perfluoroelastomer @ 200°C	N/A	0.5/0.5

Table continued

Table continued

PROPERTIES	MIL-PRF-23699G Grade HTS SAE AS5780B Grade SPC	TYPICAL
Thermal stability/corrosivity 96 hrs @ 274°C		
- metal weight change mg/cm	4 max	0.23
- viscosity change @ 37.8°C %	5 max	0.3
- Total acid number change mgKOH/g	6 max	1.5
Corrosion & oxidation stability		
72 hrs @ 175°C	Must pass	Passes
72 hrs @ 204°C	Must pass	Passes
72 hrs @ 218°C	Must pass	Passes
HLPS dynamic coking @ 375°C		
@ 20hrs Deposit mg	Report	0.21
Ryder gear test, relative rating %		
Hercolube A	102	112
Bearing test rig (100hr test)		
Type 1½ conditions		
- Overall deposit demerit rating	80 max	21
- Viscosity change @ 40°C %	–5 to +30max	24
- Total acid number change mgKOH/g	2.0 max	0.81
- filter deposits g	3 max	0.55 (200hr test)
Sonic shear stability		
- viscosity change at 40°C %	4 max	0.3
Trace metal content	Must pass	Passes

AeroShell Turbine Oil 560 is also approved for use in the industrial and marine versions of the Rolls-Royce RB211-22, Avon, Spey, Olympus and Tyne engines, Pratt & Whitney GG3/FT3, GG4/FT4, GG12/FT12, GG8/FT8 engines, all General Electric LM Series of units, some Honeywell and Turbomeca industrial engines and certain Solar gas turbine engines.

A viscosity/temperature chart is shown at the end of this section.

NOTES

AEROSHELL TURBINE OIL 750

AeroShell Turbine Oil 750 is a 7½ mm^2/s synthetic mixed ester oil containing a thickener and additives which provide excellent load carrying, thermal and oxidation stability.

APPLICATIONS

AeroShell Turbine Oil 750 was developed to meet the requirements of DERD 2487 (now DEF STAN 91-98) and to provide a high standard of lubrication in British civil gas turbines, particularly turbo-prop engines where a good load carrying oil was required for the propeller reduction gearbox.

AeroShell Turbine Oil 750 is also approved by the Russian authorities as an analogue to MN-7.5u and for those Russian turbo-prop applications which require the use of mixtures of mineral turbine oil and aircraft piston engine oil.

AeroShell Turbine Oil 750 contains a synthetic ester oil and should not be used in contact with incompatible seal materials and it also affects some paints and plastics. Refer to the General Notes at the front of this section for further information.

SPECIFICATIONS

U.S.	-
British	Approved DEF STAN 91-98 (replaces DERD 2487)
French	Equivalent to AIR 3517A
Russian	Analogue to TU 38.1011722-85 Grade MN-7.5u
NATO Code	O-149 (equivalent O-159)
Joint Service Designation	OX-38

EQUIPMENT MANUFACTURER'S APPROVALS

AeroShell Turbine Oil 750 is approved for use in all models of the following engines:

Honeywell	Auxiliary Power Units (some models)
Allison (Rolls-Royce)	PT6 (some models)
BMW-Rolls-Royce	Dart, Tyne, Avon (some early models only), Gnome, Pegasus, Palouste, Nimbus, Proteus, Orpheus, Olympus 200 and 300
Sikorsky	S-61N transmissions
Soloviev	D30 engine
Turbomeca	Turmo. Approved with restrictions*: Artouste, Astazou, Bastan

*Please refer to Turbomeca manual for details

PROPERTIES		DEF-STAN 91-98	TYPICAL
Oil type		Synthetic ester	Synthetic ester
Density @ 15°C	kg/l	Report	0.947
Kinematic viscosity	mm^2/s		
@ 40°C		36.0 max	32
@ 100°C		7.35 min	7.47
@ –40°C		13000 max	10140
@ –40°C after storage @ –54°C for 12 hr		-	10800
Flashpoint Cleveland Open Cup	°C	216 min	242
Pourpoint	°C	–54 max	Below –54
Total acidity	mgKOH/g	Report	0.03
Foaming characteristics		Must pass	Passes
Sediment	mg/l	10 max	Less than 10
Total ash of sediment	mg/l	1 max	Less than 1
Trace element content		Must pass	Passes
Elastomer swell tests		Must pass	Passes
Corrosivity, metal weight change		Must pass	Passes
Gear machine rating		Must pass	Passes
Shear stability			
- viscosity change @ 40°C	%	2 max	Less than 2
- condition of oil		Must pass	Passes
Compatibility and miscibility		Must pass	Passes
Homogeneity			
@ 210°C		Must pass	Passes
@ –40°C		Must pass	Passes

A viscosity/temperature chart is shown at the end of this section.

NOTES

AEROSHELL ASCENDER

AeroShell Ascender is a "fourth generation" turbine engine oil developed with a high performance, low coking, 5 mm^2/s synthetic hindered ester basestock combined with a state of the art additive system, to both improve thermal and oxidation stability and provide superior elastomer compatibility.

APPLICATIONS

AeroShell Ascender was developed for the latest generation of gas turbine engines as a low-coking, high compatibility product. Its improved thermal and oxidative stability will ensure negligible coke formation in engines, so any traditional engine problems associated with coke should never occur. It has also been tested extensively for elastomer compatibility, which is a known service problem. AeroShell Ascender therefore offers the customer the balance of low coking performance with excellent elastomer compatibility.

AeroShell Ascender will also deliver performance benefits in today's existing high powered, high compression engines in which the older generation of oils can be stressed up to and beyond their thermal limits, as evidenced by oil coking in the high temperature bearing areas.

FEATURES & BENEFITS

The value of AeroShell Ascender lies in its ability to deliver both low coking and elastomer compatibility/seal integrity. Until recently, it had been commonly accepted that the two are mutually exclusive, so that improving the oil's properties in one regard meant compromising the other.

For airline operators, this problem can be expensive in terms of prematurely degraded seals. With AeroShell Ascender, Shell Aviation has developed a product that now deals with this problem so operators no longer have to choose between coking performance and elastomer compatibility.

FEATURES	BENEFITS
Excellent elastomer seal compatibility	Reduced chance of seal swell or degradation leading to high oil consumption and cost of changing the seals
Low coking performance	Less chance of oil coke build-up in bearing chambers and service pipes resulting in lower maintenance and cleaning costs
Improved oxidation and thermal stability	Extended oil life during arduous engine conditions
Excellent compatibility with other approved oils	No issues or concerns when changing from one approved oil to AeroShell Ascender
A ' High Performance Capability' grade oil	Improved performance over traditional 'standard' grade oils can help reduce maintenance costs and extend engine life

SPECIFICATIONS

U.S.	Approved SAE AS5780B HPC Grade Approved MIL-PRF-23699G HTS Grade
British	Equivalent DEF STAN 91-101
French	Equivalent DCSEA 299/A
Russian	-
NATO Code	O-154
Joint Service Designation	Equivalent OX-27
Pratt & Whitney	Approved 521C Type II
General Electric	Approved D-50 TF 1

EQUIPMENT MANUFACTURER'S APPROVALS

AeroShell Ascender is approved for use in all models of the following engines:

IAE	V2500 Series

*Approval is currently in progress for all engine models. For latest engine approval status, please contact your Shell Aviation representative.

PROPERTIES	**SAE AS5780B Grade HPC**	**TYPICAL**
Oil Type	Synthetic ester	Synthetic ester
Kinematic viscosity mm^2/s		
@ 100°C	4.90 to 5.40	5.02
@ 40°C	23.0 min	25.47
@ –40°C	13000 max	11724
Flashpoint Cleveland Open Cup °C	246 min	266
Pourpoint °C	–54 max	<–54
Total acidity mgKOH/g	1 max	0.24
Evaporation loss 6.5 hrs @ 204°C %m	10.0 max	2.0
Swelling of standard synthetic rubber SAE-AMS 3217/4 72 hrs @ 204°C swell %	5 to 25	16.24
Foaming	Must pass	Passes
Elastomer compatibility, % weight change after 24/120 hours:		
Fluorocarbon @ 200°C	11/15 max.	9/10
LCS Fluorocarbon @ 200°C	12/20 max.	6.5/8
Nitrile @ 130°C	Report	8/8
Silicone @ 175°C	Report	12.5/12.5
Perfluoroelastomer @ 200°C	Report	0.5/0.5

PROPERTIES	**SAE AS5780B Grade HPC**	**TYPICAL**
Thermal stability/corrosivity 96 hrs @ 274°C		
- metal weight change mg/cm	4 max	0.23
- viscosity change @ 37.8°C %	5 max	0.3
- Total acid number change mgKOH/g	6 max	1.5
Corrosion & oxidation stability		
72 hrs @ 175°C	Must pass	Passes
72 hrs @ 204°C	Must pass	Passes
72 hrs @ 218°C	Must pass	Passes
Ryder gear test, relative rating % Hercolube A	102	103
Bearing test rig (200hr test) Type 1½ conditions		
- Overall deposit demerit rating	40 max	33
- Viscosity change @ 40°C %	0 to +35	16.7
- Total acid number change mgKOH/g	2.0 max	0.60
- filter deposits g	1.5 max	0.80
HLPS dynamic coking @ 375°C		
@ 20 hours, Deposit mg	0.4 max	0.23
@ 40 hours, Deposit mg	0.6 max	0.32
Shear stability		
- viscosity change at 40°C %	4 max	NIL
Trace metal content	Must pass	Passes

A viscosity/temperature chart is shown at the end of this section.

Engine Manufacturer	Engine	AEROSHELL TURBINE OIL 390	500	555	560	750
Allison	501K, 570K and 571K Series		Approved			
General Electric	LM 100, 250, 350 and 150		Approved	Approved	Approved	
	LM 2500		Approved	Approved	Approved	
	LM 5000		Approved		Approved	
	LM 6000		Approved		Approved	
Pratt & Whitney Canada (PWAC)	ST6-75, -76		Approved		Approved	
	ST6-73		Approved	Approved (1)	Approved	
	ST6A, ST6B, ST6J, ST6K, ST6L		Approved		Approved	
Rolls-Royce	Trent		Approved			
	Avon	Approved	Approved		Approved	
	Gnome					Approved
	Olympus			Approved	Approved	Approved
	Proteus					Approved
	RB211-22			Approved (2)	Approved (3)	
	RB211-24				Approved (3)	
	Spey Industrial	Approved			Approved	
	Spey Marine				Approved	Approved
	Tyne				Approved	Approved
Solar	Centaur		Approved (4)		Approved (4)	
	Mars		Approved (4)		Approved (4)	
	Saturn		Approved (4)		Approved (4)	
Honeywell	TF-25, -35, -40		?		?	
Turbomeca	Astagaz XII & XIV	Approved	Approved			Approved
	Astazou IV	Approved				Approved
	Bastangaz IV, VI & VII	Approved	Approved			Approved
	Oredon IV		Approved			
	Turmagaz III	Approved				Approved
Turbo Power & Marine (Pratt & Whitney)	GG3/FT3		Approved		Approved	
	GG4/FT4		Approved		Approved	
	GG12/FT12		Approved		Approved	
	GG8/FT8				Approved	

NOTES:

? Consult the engine manufacturer for details on latest approvals

(1) AeroShell Turbine Oil 555 can be used if SB 49-59 has been incorporated

(2) -22/Mk1 lube system combination only

(3) 10,000 hours max. on Viton "O" seals

(4) Oils approved on a unit by unit basis, not all units can use synthetic oils thus the manual for specific unit must be consulted or the unit manufacturer contacted.

TYPICAL TEMPERATURE/VISCOSITY CURVES OF AEROSHELL TURBINE OILS