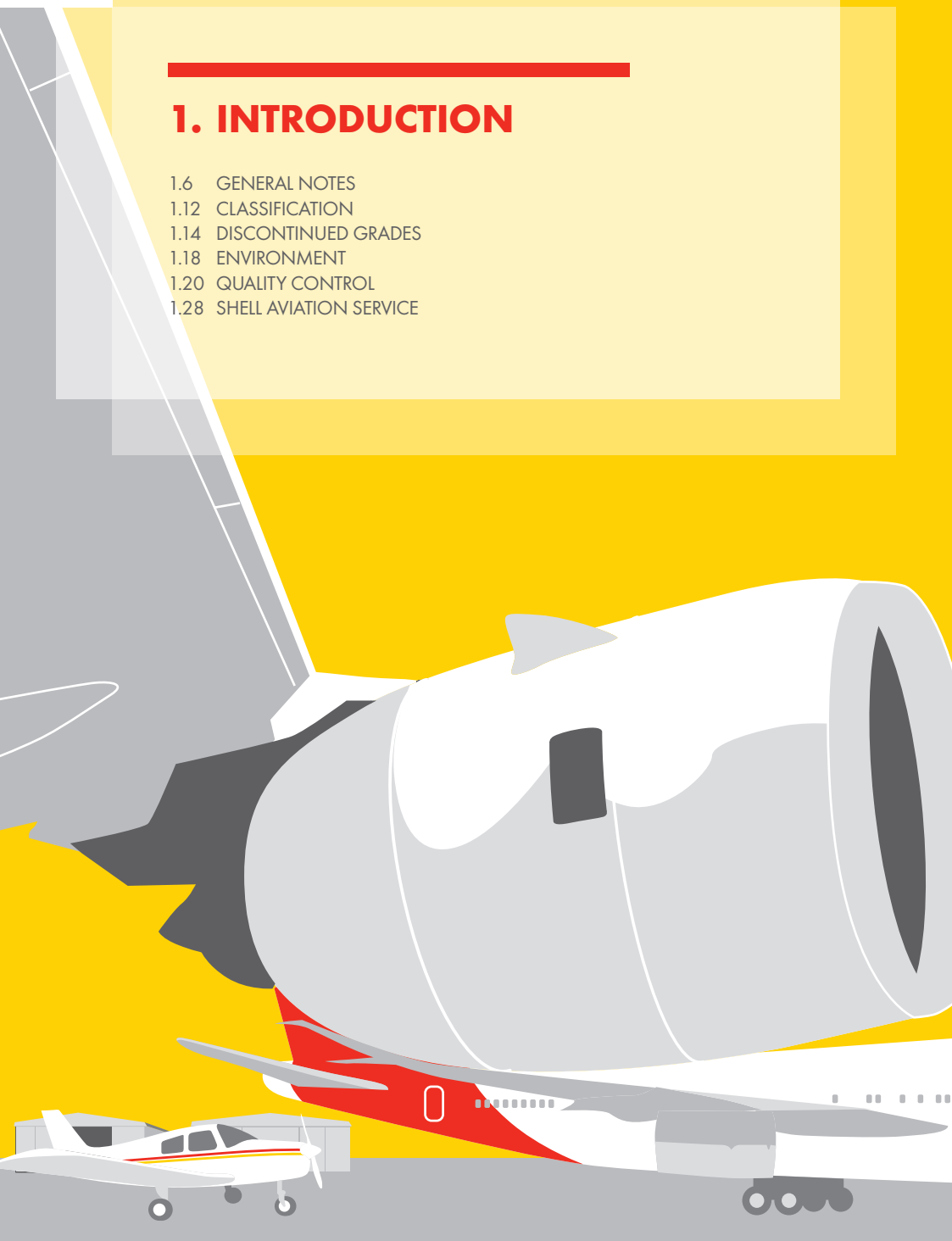
Shell Aviation

THE AEROSHELL BOOK

EDITION 19. 2012

1. INTRODUCTION



THE AEROSHELL BOOK

Nineteenth Edition 2012

Issued by:
Shell Aviation
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York Road
London
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www.shell.com/aviation

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The companies in which Royal Dutch Shell plc directly and indirectly owns investments are separate entities. In this document the expressions "Shell", "Group" and "Shell Group" are sometimes used for convenience where references are made to Group companies in general. Likewise, the words "we", "us" and "our" are also used to refer to Group companies in general or those who work for them. These expressions are also used where there is no purpose in identifying specific companies.

CONTENTS

INTRODUCTION

Shell companies manufacture, and distribute throughout the world a full range of aviation products required for the operation and maintenance of aircraft of all types. This range includes:-

Aviation Turbine Fuels
Aviation Gasolines
AeroShell Performance Additives
AeroShell Turbine Engine Oils
AeroShell Piston Engine Oils
AeroShell Greases
AeroShell Hydraulic Fluids
AeroShell Fluids
AeroShell Preservatives

This manual contains information on the characteristics and specifications of these products and offers guidance on their application.

The Specification information provided is correct as known at the time of going to press. Due to the fact that commercial and military specifications for aviation products are subject to frequent changes, it is advisable to consult the local Shell company, whose representative will also give advice on availability (not all grades are always available worldwide), prices and packaging and will be glad to answer any other queries.

All reasonable care has been taken in the preparation of this publication; however, no responsibility can be accepted for the consequences of any inaccuracy which it may contain.

GENERAL NOTES ON AEROSHELL PRODUCTS

The notes contained in this section apply to the complete range of AeroShell products. Additional notes specific to each product group are given in the notes at the front of each chapter.

Notation

The brand names chosen for the range of AeroShell products comprise three parts: the name 'AeroShell' followed by the words 'Turbine Oil', 'Fluid', 'Grease', etc. and finally a number and/or letters designating each product. The numbers do not always follow a sequence. In the case of turbine and piston engine oils the number relates to the oil viscosity; for greases, fluids and compounds the numbers merely differentiate between products and gaps occur in the sequence due to obsolescence. Consequently an up-to-date version of this book should always be used for reference purposes.

Applications

Under this heading the more important and known representative aviation uses have been named for each AeroShell Grade, and these are intended to serve as a general indicator of the type of application for which the grade is normally suitable. Further consultation with the component manufacturer is recommended in case of doubt.

Whenever an aircraft is certified, all of the oils, greases and hydraulic fluids used on that aircraft 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 grades which are qualified to be used. The U.S. Federal Aviation Administration (FAA) regulations state that only grades 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 grades should be used.

Many AeroShell products are used in non-aviation applications especially where the operating requirements or properties are at the extreme for industrial lubricants (for example, high or low temperatures). Details are not included in this publication but further information is available from local Shell companies.

In selecting an AeroShell Grade for a non-aviation application the properties of the grade 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 the 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.

Specifications

The majority of AeroShell products are manufactured to comply with British or U.S. Government Specifications because these are acceptable to most aircraft manufacturers and airline operators. In certain cases where no suitable specification exists, Shell products have been developed to meet specific performance requirements.

Many of the British and U.S. Government Specifications (as well as those of other NATO countries) are interchangeable, although the specifications are not identical. The words 'approved', 'meets', 'equivalent' and 'corresponding' have been used in the text to define the relationship between products and specifications; the precise meaning of these terms is as follows:

Approved indicates that the product has been manufactured to meet the requirements of the specification, and against which it has been approved (where type approval is required).

Meets indicates that the product complies with the requirements of the specification and, either type approval is being obtained, or because the specification is now obsolete, it is not possible to obtain type approval (where type approval is required).

Equivalent indicates that the product complies with the major requirements of the specification but has not necessarily been manufactured to the specification.

Corresponding indicates that the product has not been manufactured to meet the specification and that it is the nearest product available.

The letters 'DEF', 'DEF STAN', 'DTD', 'DED', 'D.Eng.R.D.', 'D.Eng.D', 'DERD', 'CS', 'TS' and 'BS' refer to British Specifications; 'MIL' and 'DOD' refer to American Specifications. As an aid to users, details of French and Russian Specifications are included but specifications of other countries are not included.

Currently major changes are taking place to both U.S. and British Specifications. The U.S. authorities have decided to eliminate MIL specifications as they are currently known and replace them with performance specifications. These will be labelled MIL-PRF- followed by a number. Many MIL-PRF- specifications have now been issued and others will follow until all current MIL specifications have been converted. The numeric part of the MIL-PRF- designation is the same as the numeric part of the MIL specification it replaces; however, the letter which denotes the Revision level has also changed. MIL specifications which are cancelled or obsolete will not be changed. A small number of MIL specifications have been converted to MIL-DTL- specifications, where DTL represents 'detail'.

For certain products, the U.S. authorities have decided to no longer maintain military specifications; in these cases, they have been converted to civil specifications by the SAE (Society of Automotive Engineers).

Examples of these changes include:

MIL-H-5606G became MIL-PRF-5606H
MIL-L-23699E became MIL-PRF-23699F
MIL-T-83133D became MIL-DTL-83133E
MIL-G-4343C became SAE-AMS-G-4343

British specifications are being standardised on Defence Standards (commonly referred to as DEF STAN). The changeover is virtually complete and all current DERD, DTD, CS and TS specifications have now been converted to DEF STAN specifications; in doing so, the numeric part has also been changed. Obsolete or Cancelled British Specifications will not be changed.

The British Ministry of Defence has also moved away from "qualifying" or "approving" products and no longer issues Qualified Products Lists (QPLs). Instead, the onus is put on the supplier under the new PCC (Product Conformity Certification) scheme to demonstrate that the product supplied is fit for purpose. Instead of QPLs, the Ministry of Defence now holds TAPLs (Technically Acceptable Products Lists).

Obsolete or cancelled specifications
Where specifications have been cancelled and superseded by another, the word "Obsolete" is shown after the specification. Even though the specification is obsolete, Shell may still manufacture the grade to meet the requirements of the obsolete specification and tests each batch of product against these requirements. In the majority of cases, test reports and product containers which normally include the specification number will also carry the annotation "(Obs)" or "(Obsolete)" after the specification.

Compatibility of Aeroshell grades with materials
Considerable care has to be exercised during selection of materials, including metals, paints, varnishes, insulation materials, plastics and elastomers, to ensure that they are compatible with the chosen lubricant whether it be an oil, fluid or grease. This is particularly important if the product has a synthetic oil component.

Since compatibility also depends upon the operating environment, it is impossible for lubricant suppliers to be aware of all possibilities of use. Therefore, it is most important that material or equipment manufacturers are consulted regarding compatibility of oils, fluids and greases with specific materials. Most elastomer manufacturers produce comprehensive tables of compatibility of their elastomers with a large range of products and these tables should therefore be consulted.

Where appropriate, more information on compatibility is given at the front of each product section in this book.

Rationalisation
For many years aircraft operators have been seeking to rationalise the oils and greases used on aircraft and to reduce the number of different products in their inventories.

It is possible to achieve this providing either the equipment manufacturer's approval has been obtained or the alternatives have been listed in the relevant manuals.

In some cases equipment manufacturers (e.g. Boeing) are taking steps to reduce the number of different grades required in support of their aircraft.

Use of alternative products
Apart from those products which are used for the same applications, but under different operating conditions, alternative grades should not be used as a substitute for grades which are not available.

Packages
Consumers are encouraged to obtain supplies of AeroShell products in the smallest packages commensurate with their use. Small packages which can generally be used as dispensers reduce the risk of product contamination. With larger containers it is usually necessary to decant the contents into smaller containers or jugs which may not always be perfectly clean. In addition, there is a possibility of contamination occurring through the lid or cap being left off or not being replaced properly.

Stocks
Every Shell company holds adequate stocks of those grades known to be in demand, based whenever possible on the offtake of the previous six months. For grades not in regular demand, special supply arrangements have usually to be made in advance.

Temperature and viscosity
All temperatures are quoted in Celsius. Whilst the more recent British and U.S. Specifications are now based on Celsius temperatures, the earlier specifications are still based on Fahrenheit temperatures. In such cases, whilst it is acceptable to use and quote temperatures in degrees Celsius, the Fahrenheit temperature remains the reference temperature.

All viscosities are now shown as mm^2/s, (millimetres squared per second)

This unit is related to centiStokes as follows:

1 centiStoke (cSt) = 1 mm^2/s

Substitutes for Russian aviation lubricants
A number of AeroShell substitutes for Russian Grades are available for use in aircraft of Russian origin. Full details of these are included in the Specification Section of this publication and where appropriate the Russian equivalent is shown on each grade page. Further information is available from local Shell companies.

Typical properties
Typical properties as reported in this publication are determined by averaging actual batch data provided by the manufacturing facilities over a period of time. This data is therefore typical but obviously cannot be guaranteed to be identical to the batches of products provided at any specific time. In some instances, this averaging involves more than one manufacturing facility when products are supplied from a number of facilities. It must be emphasised that the data provided in this publication is presented only as a guide for the assistance of AeroShell product users.

Technical service
Shell provides a full technical service in support of its products and their performance. Two elements of this service are firstly highly qualified technical staff and secondly laboratories and product research/development facilities. The technical staff maintain contact with customer, engine and airframe manufacturers, and accessory equipment manufacturers. The laboratories and product research/development facilities of Shell Global Solutions provide laboratory services to assist in problem analysis and product development.

Pages for notes
At various points, blank pages have been included for notes.

Further information and publications
Additional information, changes in approval status, changes in specifications, user experience and other useful data is available from local Shell companies.

In addition, brochures and leaflets on particular topics are published from time to time. Copies of any brochure/leaflet are available from local Shell companies or online at **www.shell.com/aviation**

CLASSIFICATION OF AEROSHELL PRODUCTS AND PRODUCT REFERENCE

DISCONTINUED AEROSHELL GRADES

This table lists AeroShell grades which have been discontinued since 1975.
Also included are the U.S. and British specifications that the grades were approved to, a description of the grade, plus details about a suitable alternative AeroShell Grade.

AeroShell Grade	Specification		Description/Superseded by
	U.S.	British	
AeroShell Oil W65	J-1899	-	SAE Grade 30 ashless dispersant oil. No AeroShell alternative.
AeroShell Oil Diesel 10W-40	-	-	Replaced by AeroShell Oil Diesel Ultra.
AeroShell Turbine Oil 9	-	DEF STAN 91-97	A 9mm^2/s mineral turbine oil. There is no suitable alternative AeroShell Grade.
AeroShell Turbine Oil 9B	-	DEF STAN 91-97	A 9mm^2/s mineral turbine oil with an EP agent. There is no suitable alternative AeroShell Grade.
AeroShell Turbine Oil 529	MIL-PRF-23699F Grade STD	-	Standard grade 5cSt turbine engine oil. AeroShell Turbine Oil 500 is a direct replacement.
AeroShell Turbine Oil 530	MIL-PRF-23699F Grade C/I	-	Corrosion inhibited synthetic turbine engine oil. No AeroShell alternative.
Shell Aviation Grease 7	MIL-G-23827B	DEF STAN 91-53	A general purpose synthetic grease. Acceptable alternative is AeroShell Grease 7, but the two grades should not be mixed.
AeroShell Grease 8	-	DEF STAN91-54	A grease containing graphite. No direct replacement, although AeroShell Grease 17 may be suitable for some applications.
AeroShell Grease 11MS	-	-	High load aircraft grease. No AeroShell alternative.
AeroShell Grease 15A	MIL-G-25013E	DE STAN 91-55 (Obsolete)	Replaced by AeroShell Grease 15.
AeroShell Grease 16	MIL-G-25760A (Obsolete)	DTD.5579 (Obsolete)	Depending on application, AeroShell Greases 22, 33 or 58 may be suitable.
AeroShell Grease 17	MIL-G-21164D	-	Replaced by AeroShell Grease 64, but the two grades should not be mixed.
AeroShell Grease 22A	MIL-G-81322	-	Replaced by AeroShell Grease 22C, which in turn was replaced by AeroShell Grease 22CF.
AeroShell Grease 22C	MIL-G-81322	-	Replaced by AeroShell Grease 22CF.
AeroShell Grease 22CF	MIL-PRF-81322G	-	Advanced general purpose grease. AeroShell Grease 22 is direct replacement.
AeroShell Grease 23	MIL-G-81827A	-	High load capacity grease. Alternative grade was AeroShell Grease 23C.
AeroShell Grease 23C	MIL-G-81827A	-	Synthetic grease with molybdenum disulphide. No AeroShell alternative.
AeroShell Grease 43C	SAE-AMS-G-4343	-	Pneumatic system grease. No AeroShell alternative.
AeroShell Grease 33MS	MIL-G-21164D	-	Product re-named as AeroShell Grease 64
AeroShell Grease S.4768	-	DEF STAN 80-81	Anti-seize compound. No AeroShell alternative.

DISCONTINUED AEROSHELL GRADES *continued*

AeroShell Grade	Specification		Description/Superseded by
	U.S.	**British**	
AeroShell Grease S.7108	SAE-AMS-G-6032	DEF STAN 91-6	Gasoline and oil resistant grease. No AeroShell alternative.
AeroShell Fluid 1AC	AAF.3580D	-	A special hydraulic fluid. No direct alternative although some equipment manufacturers have approved alternative grades.
AeroShell Fluid 2T	MIL-C-6529C Type III	-	Corrosion preventive for turbine engines. AeroShell Fluid 2XN is the concentrate from which AeroShell Fluid 2T was made.
AeroShell Fluid 7	MIL-H-6083	DTD.5540	A preservative mineral hydraulic fluid. Replaced by AeroShell Fluid 71.
AeroShell Fluid 9	-	DEF STAN 91-40	A piston engine storage oil. No AeroShell alternative.
AeroShell Fluid 10	-	DTD.791C	A wax thickened piston engine storage oil. No AeroShell alternative.
AeroShell Fluid 14	-	DTD.445A	A cleaning fluid. No AeroShell alternative.
AeroShell Fluid 61 Type II	MIL-H-46170B	-	Preservative synthetic hydrocarbon hydraulic fluid dyed red. Alternative is AeroShell Fluid 61 Type I which is undyed.
AeroShell Fluid 634	MIL-PRF-63460D	-	Cleaning, preserving and lubricating fluid. No AeroShell alternative.
AeroShell Compound 01	-	-	A quick drying preservative fluid. In many cases, two coats of AeroShell Compound 02 can be used in place of Compound 01.
AeroShell Compound 06	-	-	Denatured ethyl alcohol. No direct alternative, although AeroShell Compound 06A or AeroShell Compound 07 may be suitable for some applications.
AeroShell Compound 08	SAE-AMS-2518A	DEF STAN 80-80	Graphited anti-seize compound. No AeroShell alternative.
AeroShell Compound 09	MIL-M-7866C	-	Molybdenum disulphide powder. There is no suitable AeroShell alternative.
Shell Compound S.7632	MIL-A-8243D	-	De-icing fluid.
Shell Aviation Fluid S.7229	-	-	A compressor wash fluid. No AeroShell alternative.

ENVIRONMENTAL NOTES

In many countries there has been increasing interest in health, safety and environmental issues arising from the handling and use of oil products. Of late, legislation in many countries has changed, or is changing, with the result that information quickly becomes either out of date or is insufficient for a particular area.

- All AeroShell components registered in U.S. and Europe and increasingly in other countries such as Japan, China, Australia, Korea
- Safety Data Sheets are available for all grades
- Storage and handling information available to operators
- Labelling standards

Many countries now require Material Safety Data Sheets (MSDS) to be prepared for individual products and for these documents to be readily available to the users of the product.

Safety Data Sheets are available for all AeroShell grades and copies of these can be made available by local Shell companies. Where necessary, local Shell companies will ensure that any document they supply will comply with local legislation. If no local legislation exists then the data will be in accordance with the requirements of the European Community. These Safety Data Sheets contain information on:-

- Composition/information on ingredients
- Hazard identification
- First Aid measures
- Fire Fighting measures
- Accidental release measures
- Exposure control/personal protection
- Toxicological information
- Ecological information
- Disposal considerations
- Regulatory information

These Safety Data Sheets are revised and re-issued whenever there is a change in the legal requirements and thus operators should always ensure that they are in possession of the latest edition. They can be accessed via the Internet at:
www.shell.com/home/content/aviation/products/lubricants/msds/
or at: **www.epc.shell.com**

Safety Data Sheets are intended to act as a guide to users of Shell Aviation products and whilst the information is given in good faith, any remedial action must be the responsibility of the persons concerned and "Shell" cannot be responsible for any loss or damage resulting from any action taken.

QUALITY CONTROL, STORAGE, HANDLING AND RETESTING OF AEROSHELL PRODUCTS

Generally AeroShell products are very stable and do not normally deteriorate if stored and handled correctly.

Owing to the nature of aviation there is a need to adopt procedures which enhance safety requirements and ensure product quality. Thus these recommendations must be considered as minimum requirements and any local requirements (e.g. ISO 9000, governmental and/or aviation authority requirements) which are more stringent take precedence.

Quality control
All AeroShell products are blended in batches with each batch composed of the identical formulation to all previous batches. A range of tests are performed on each batch to evaluate the physical, chemical and performance characteristics of the product. Historically, the batch-to-batch variations are minor and within the limits of test repeatability.

As each batch is prepared, a small quantity of product is set aside in sealed containers. These are then kept for a period of time in order to provide a reference base.

Equally as important as good quality control during the blending and filling operation is correct storage and handling of the product prior to use. Customers can enhance the product storage by using first-in, first-out inventory procedures and maintaining the oil under normal storage conditions (i.e. indoors, protected from excessive heat, moisture and dust) and full details of the recommended storage, handling and retesting procedures are given in this section.

Product quality
In making any product which conforms to a military specification, a manufacturer can choose either to just barely meet the specification or to exceed the specification performance requirements. When a product exceeds the specification minimum requirements, the customer is provided with extra protection. The majority of AeroShell branded products exceed the specifications against which they are approved and have become acknowledged as industry standards. The products which Shell companies supply for military use are the same products supplied to commercial customers. The fact that the AeroShell products perform well in commercial operations further attests to the quality cushion which is provided to the military organisation using them.

Importance of correct storage and handling
The importance of correct storage and handling cannot be over emphasised.
Shell manufacturing plants pay particular attention to quality control throughout the entire manufacturing, blending and filling process of all aviation products. Rigorous checks take place during these operations and thorough testing before release of a product ensures that it meets the requirements of the specification and is fit to do the job for which it is intended.

It is therefore very important that operators and users of these products take equal care when handling and storing these products so that they remain in first class condition.

The most common problems
Deterioration of product quality arises mainly from contamination by water and/or dirt, and by temperature extremes during storage. In addition, deterioration can occur through the container being badly dented or damaged. Invariably, the sharp corners of dented or damaged containers are places of weakness where pinholes easily occur and rust readily forms.

Water contamination
Contamination by water can occur in two ways:

By 'breathing' of the container. In principal this happens when a container is stored in the open air. It may then be subjected to wide temperature changes (this includes, for example, the variation between daytime and night time temperature). At elevated temperatures the contents of the package will expand, and the layer of air above the oil will try to find a way out. With drums this is even possible through well sealed bungs. When cooling takes place, humid air often has the opportunity to penetrate into the drum, where the moisture then condenses out and the product becomes contaminated. Initially no more than a few droplets may be introduced, but with time the amount progressively increases and the contamination becomes significant and can lead to internal rusting of the container.

By penetration of water present on top of the container. Containers are carefully and thoroughly sealed after filling. However, if either breathing or if rusting (leading to pinholes in the container) has occurred, it is possible for water present on top of the container to penetrate the container and contaminate the product.

Preventing water contamination is simple: Store the product in a warehouse immediately after receipt. The warehouse should be dry, clean and not subject to wide temperature changes.

- Drums must be placed horizontally with the bungs at the 'quarter to three' position.
- Pails and cartons must be stored in such a way that they cannot be damaged.

Contamination by dirt
Dirt cannot normally penetrate to the contents of a container until it has been opened. The dirt present in a dusty atmosphere will settle upon the surfaces of containers. Do not remove product from such containers without first having taken the proper precautions.

■ Prevention
AeroShell products should be stored in a dry, dust-free warehouse. Before a container is opened the top should be thoroughly cleaned. In the case of drums it is recommended that the whole top, and particularly the area around the bungs, should be thoroughly cleaned.

■ Greases
Greases require special precautions. Grease containers should never be opened in a dusty atmosphere. Before removing the contents, make sure that the equipment to be used for this is clean and free from dust and dirt. A wooden scraper is generally not recommended because it leaves small particles of wood mixed in with the grease which could affect the performance of the product.

In order to prevent oil separation into the hole from which grease has been removed, the surface of the product should be flattened out. Therefore: Always leave a smooth surface, and close the container after use!

Oil separation to a greater or lesser extent occurs with all greases. Unless the separation is excessive the grease can be used providing it is stirred well before use.

■ Superclean Hydraulic Fluids
Superclean hydraulic fluids, as the name implies, are hydraulic fluids which are exceptionally clean. This is achieved by extensive filtering of the fluid, thorough cleaning of containers, and packing in a clean room.

In view of this, particular care should be taken when opening the containers since it is all too easy for the fluid to lose its superclean properties. It is recommended that for superclean fluids a dispensing device, which includes fine filtration, is used.

Storage temperatures
Aviation lubricants should not be stored in the open air. Even inside warehouses, strong sunlight entering through windows and open doors can cause prolonged high temperatures on the surfaces of containers, which may affect product quality. Accordingly, containers should be kept in a shaded location.

Certain aviation products (in most cases for ground application) are affected by extremes of cold. Such low temperatures can inhibit the performance of these products and make them either difficult to pour, or difficult to use.

Volatile component products
In general, aviation lubricating oils do not present an inherent fire risk. The main exceptions are those products containing volatile components, e.g. certain AeroShell Compounds. If a product is believed to present a fire risk, it should be stored in a separate special flameproof store room, away from other products. It is not advisable to store more than will be needed for direct use.

AeroShell products with volatile components are:

AeroShell Compounds 06A and 07

Shelf life, periodic inspection and re-testing
It is very important that no misunderstanding should ever arise over the contents of a container. Issue of an incorrect product from the warehouse should be prevented at all costs – especially for aviation applications. Great care must therefore be taken to ensure that the right product is received in the first instance. Furthermore, after products have been received, markings on containers and cartons should be kept legible; if necessary, they should be re-stencilled.

If a product is in store for a prolonged period of time, it is important to determine that it is still suitable for use. At regular intervals (exact time is for the user's decision, but it could be every quarter or every six months) a visual inspection of the outside of the cartons (for small packs) or containers (if drums or pails) should be undertaken checking for signs of leaks or damage. Those which are leaking or badly damaged should be downgraded for non-aviation use or destroyed in accordance with local environmental regulations.

If product is still in stock after a number of years, then it is necessary to take samples and test key properties to verify that the product continues to be fit for purpose. For the majority of AeroShell grades, representative samples from each batch should be re-tested after the specified time from date of manufacture or, if not known, date of order or date of receipt can be used instead.

Different products are subject to different re-test periods; similarly, the tests which need to be carried out on a product to verify its continued suitability for use depend on the type of product and field experience developed over the years. The re-test periods and the tests required for AeroShell products are based primarily on those specified in the latest issue of NATO Standardization Agreement STANAG 3149 entitled "Minimum Quality Surveillance of Petroleum Products". They are listed in the table below:

Product	Initial Retest Period (years)
All aviation piston engine oils (AeroShell Oils and W Oils)	4
AeroShell Oil Sport Plus 2	2
AeroShell Oil Sport Plus 4	4
AeroShell Oil Diesel Ultra	4
All mineral turbine engine oils	4
All synthetic turbine engine oils	6
All greases	3
AeroShell Fluids 4,41,31,51	3
AeroShell Fluids 61, 71, SSF, LGF	4
AeroShell Fluids 1, 2F, 2XN, 3, 5L-A, 5M-A, 12, 18	4
AeroShell Fluids 602, 634, S.8350	3
AeroShell Compounds 02, 05, 06A	4
AeroShell Compound 07	2
AeroShell Calibrating Fluid 2	2

Note: in some countries, the local military authorities may adhere to re-test limits more stringent than those listed above and these would need to be applied when supplying product to them.

The first re-test date shall be at the original frequency stated above. Subsequent re-tests shall follow at half that frequency. For example, the original re-test period for AeroShell Oil W100 is 4 years; thus the first re-test is due 4 years after date of manufacture with the next re-test 2 years later, with subsequent re-tests following every 2 years thereafter.

Normally there is no requirement to do a full specification test since in many specifications there are tests which are difficult/complex to do or which involve specialised hardware. Generally these can only be done by an oil products laboratory which specialises in aviation oils and greases. Instead, a reduced set of tests is specified for each product which focuses on those properties which would reveal any deterioration that has occurred in the product over the period in storage.

In some cases, the cost of re-testing can be higher than the value of the product in stock; in such situations it is doubtful that it makes economic sense to re-test the product and it should be downgraded or disposed of. Where re-testing is undertaken, then samples from each and every batch involved must be taken according to the cube root rule to determine how many containers need to be sampled.

All re-test results should be compared with the relevant specification requirements and, more importantly, with the original certificate of quality to assess if deterioration has occurred. Based on this comparison, a decision can then be made as to the suitability of the product for continued use or whether further testing is required, or if the product should be downgraded or disposed of according to local environmental regulations.

To sum up

In general, AeroShell products are inherently stable. If stored properly, their quality, properties and performance should not be affected by prolonged storage.

For greatest economic efficiency, it is recommended that products should be issued from the warehouse in the order in which they were received.

In other words: FIRST IN – FIRST OUT

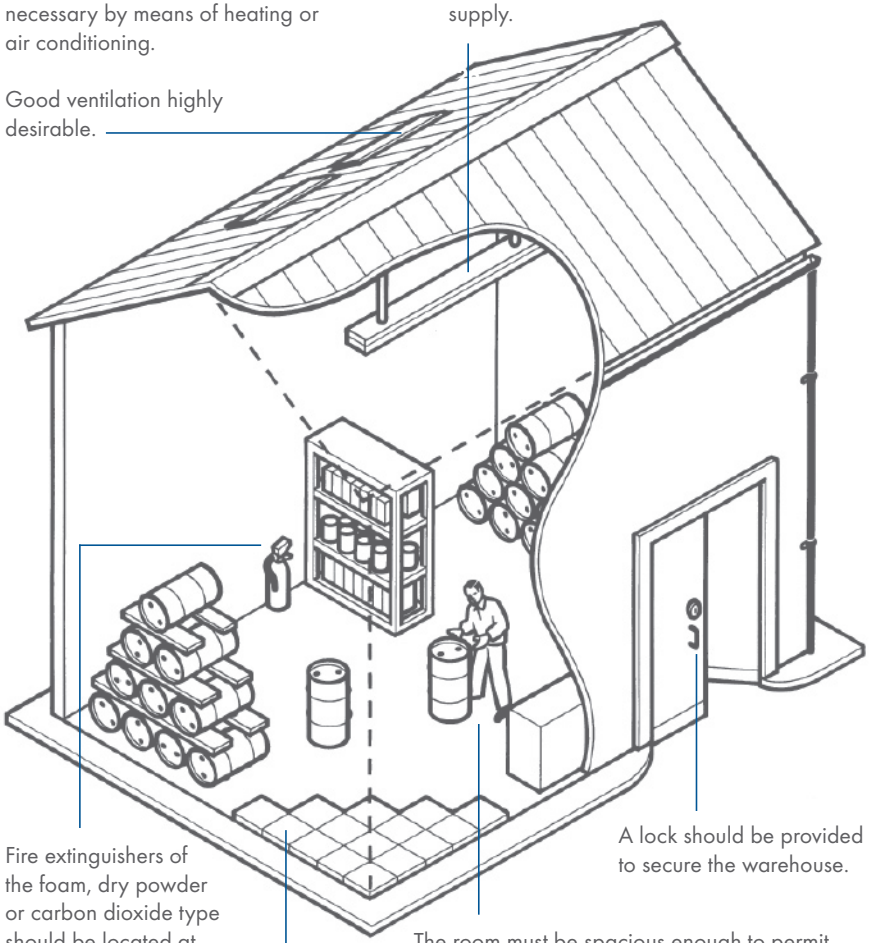
If, for some reason, a product has to be stored for longer than is economically desirable, and some doubt arises about its quality, it is recommended that Shell technical staff should be contacted for information about the product's continued suitability for aviation applications.

RECOMMENDED STORAGE

A constant temperature should be maintained throughout the year if necessary by means of heating or air conditioning.

Good lighting should be provided also an electricity connection and a water supply.

Good ventilation highly desirable.



Fire extinguishers of the foam, dry powder or carbon dioxide type should be located at accessible spots.

The room must be dust-free, accordingly it should be tiled or treated with a suitable paint.

A lock should be provided to secure the warehouse.

The room must be spacious enough to permit the handling of drums and other containers, and such tasks as tapping oil and opening tins. It should be big enough to allow easy access to the stored containers.

A pump and other useful tools should be present.

NOTES

SHELL AVIATION SERVICE

Shell Aviation is committed to meet or exceed industry standards at all locations. Aircraft operators may be assured that everyone concerned with the handling and dispensing of Shell Aviation fuels realises that the safety of each aircraft they refuel is dependent upon their skill, knowledge and ability. Fuels, fuelling methods and equipment are continually being developed and improved by Shell to meet the ever-increasing demands of modern aircraft and the aviation industry. Careful design of fuelling facilities, good operating procedures and thorough training of personnel are high on Shell's list of priorities. Included in this section are details of the care and attention paid by Shell to ensure that only clean, dry fuel to the correct specification is safely delivered into aircraft.

Types of aviation fuel

There are two categories of aviation fuel in common use today: aviation gasoline (known as Avgas) and turbine fuel or jet fuel. Details of these are given in the relevant fuels section in this handbook.

Indentification of aviation fuels

The various grades of aviation gasoline are coloured to aid recognition. These colours have been established by international agreement. Turbine fuels, however, are not dyed and are generally colourless.

In addition to fuel identification by colour, a marking and coding system has been adopted to identify the various airport fuel handling facilities and pieces of equipment according to the fuel they contain. Aviation gasolines are identified by name, using white letters on a red background; in contrast, turbine fuels are identified by white letters on a black background.

All parts of the fuelling facility and associated equipment where an error might occur, no matter how remote the possibility, are identified and labelled in the same marking and colour code. In addition, wherever possible, selective couplings are used to prevent the transfer of one grade into another.

Quality assurance

The Shell Aviation Service is designed to ensure that aviation fuels are at all times delivered into aircraft on specification and in a clean and dry condition. Shell operates throughout the world according to the standards set out in the Shell Aviation Quality System and the Shell Airport Operations Manual.

Regular audits by Shell Aviation personnel are made to ensure Shell's standards are maintained at all of Shell's locations worldwide.

SAFETY IN FUELLING OPERATIONS

Delivering the Correct Grade of Fuel

Before delivering any fuel into the aircraft, the fuelling crew need to confirm with certainty the correct grade and quantity of fuel required. This is particularly important when fuelling general aviation aircraft overwing. There is a particular problem present when refuelling types of aircraft which may exist in both turbine engine and piston engine forms. They look similar and the piston engine type may be turbo-charged, with large lettering on the cowlings saying "TURBO". To add to the problem, there are now a number of diesel-engined aircraft appearing that require jet fuel but look like conventional piston-engined aircraft that would normally require Avgas.

To prevent misfuelling aircraft during overwing fuelling, Shell Aviation requires that at least 2 out of the following criteria are satisfied for each and every fuelling:

1. A grade selective nozzle shall be fitted.

2. There shall be a decal next to the fuelling point on the aircraft specifying the grade of fuel required.

3. A Fuel Order Form has been completed and signed by an authorised member of the aircraft crew.

If the grade marking or Fuel Order Form is not available, no fuel will be delivered.

Aircraft operators should therefore make certain that all fuelling points on their aircraft are clearly marked with the correct grade of fuel.

Facilities

Shell sets high standards for the facilities used to handle aviation fuels. Storage depots are designed to store optimum quantities of fuel at the high standard required by the Shell quality assurance system. Mobile equipment used to deliver fuels to customers' aircraft is designed to ensure speedy, safe and efficient service. For both fixed and mobile equipment the emphasis is on achieving the correct balance between simplicity and sophistication. To help achieve this, Shell maintains contacts with equipment suppliers around the world and is active in international organisations responsible for equipment standards.

Good initial design and high standards of construction are complemented by regular testing and maintenance of all critical pieces of equipment.

Experience and Training
Shell has been in the aviation fuel business for more than 100 years and during that time it has built up a wealth of experience. This is communicated to all Shell locations by means of manuals, training courses and periodic publications and which is furthermore backed up by the extensive research facilities of Shell Global Solutions.

Shell staff are fully aware of all aspects of safety required for the storage, handling and dispensing of aviation fuels.

Fire
Aviation gasolines and Jet B are extremely hazardous unless handled correctly; jet fuel, although less volatile than gasoline, also requires safe handling to avoid hazard.

Shell refuelling crews are trained to handle fuels safely but, as a precaution, training in fire fighting is given, with regular fire drills held and crews made fully familiar with the operation of the fire extinguishers carried on all of Shell's fuelling vehicles.

The following points are worth remembering:

Fuel Vapour + Air + Spark or Flame = Fire

Every effort must be made therefore to prevent fuel spillage and subsequent vapour escape. Equally important are the procedures for the prevention of spark generation or naked flames near the airport apron or fuelling facilities. These are as follows:

1. No smoking or carrying of matches or lighters. This applies to all persons in the vicinity during fuelling operations.

2. Prevention of electrostatic sparks by careful bonding of fuelling equipment to aircraft.

3. Safe, well maintained equipment, e.g. motors and electrical circuits.

4. No fuelling whilst aircraft engines are running (unless special procedures are in force).

5. No fuelling whilst anti-collision strobe lights are operating (general aviation aircraft only).

6. Personnel must not wear nailed footwear or nylon clothing.

7. Care with mobile phones or any electrical equipment that could cause a spark.

Static Electricity
Matches, cigarette lighters, smoking, open flames and even backfires from vehicles or aircraft are obvious sources of ignition. Another source, not so visible or obvious, is the spark created by static electricity. Static electricity charges are generated in various degrees whenever one body passes through or against another. An aircraft in flight through the air, a fueller driving on a roadway, the rapid flow of fuel through a pipe or filter, and even the splashing of fuel into a fueller or aircraft during loading and fuelling operations, generates static electricity. A greater generation of static electricity may be expected when handling turbine fuels than when handling aviation gasoline; a basic reason for this is the higher viscosity of the fuel. Large turbine-powered aircraft demand large quantities of clean, dry fuel. The high-speed fuelling rates and the flow through ultra fine filter/separators required to meet this demand for cleanliness can create extremely high static electrical charges.

Some of the hazard from the charging of the fuel itself is reduced by the use of a static dissipator additive. However, it is worth noting that a static charge may still accumulate on the aircraft during flight or on the ground due to air friction and in this case the presence of a static dissipator additive in the fuel cannot help. To minimise this hazard, it is necessary to 'bleed off' static electrical charges before they build up to a high enough potential to create a static spark. This can be accomplished by bonding the fuelling vehicle to the aircraft with a cable and allowing sufficient time for the charge to equalise before performing any act which may draw a spark.

The bleeding-off of an electrical charge from a body of fuel or an aircraft is not always an instantaneous act as is commonly believed. It may take several seconds to bleed off all the charge from some fuels.

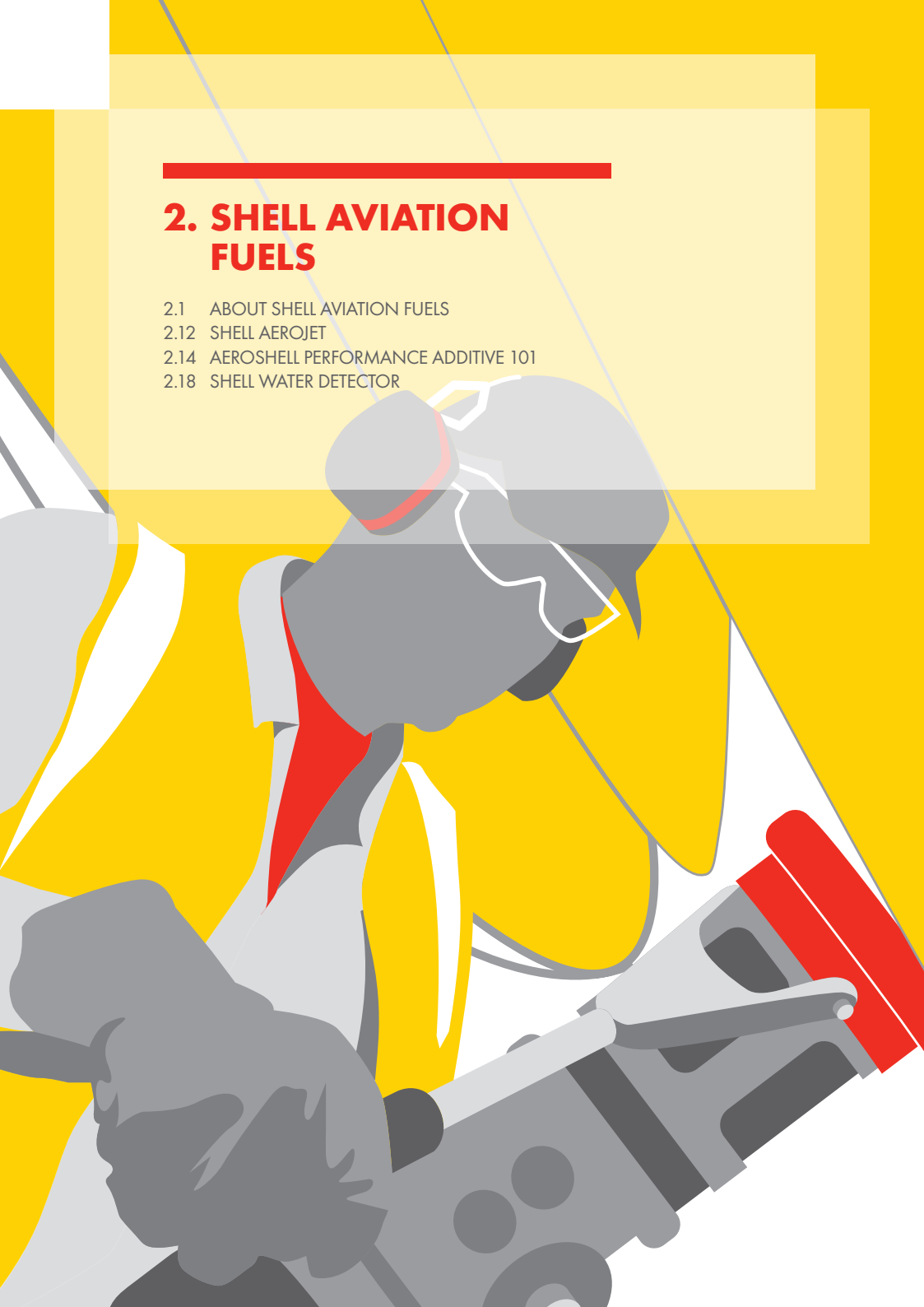
When handling all aviation fuels, the following procedures are adopted:
1. Connect the bonding wire from the fueller or cabinet to the aircraft.
2. In the case of overwing fuelling, connect the fuel nozzle bonding wire to the aircraft before the tank cover is opened (underwing couplings do not need to be individually bonded to the aircraft).
3. When disconnecting, reverse the order.

It cannot be emphasised too strongly the hazard present from static electricity when moving any hydrocarbon product. Many accidents outside airfield operations, in the home and at work, are caused by the mishandling of fuels.

Remember: If it's metal, bond it.
If it's plastic, don't use it! ! !

NOTES

2. SHELL AVIATION FUELS



SHELL AVIATION FUELS

Shell Aviation fuels may be classified into two basic groups: aviation gasoline, for use in spark ignition piston engines; aviation turbine fuels (jet fuels), for use in turbo-fan, turbo jet and turbo-prop engines. Jet fuels are also certified by Aviation Authorities for use in compression ignition piston (diesel) engines, although the jet fuel specifications do not designed for this purpose. The various grades of each type available are described in this section.

All Shell Aviation fuels are produced to meet the stringent manufacturing requirements set out in the relevant specifications. At key stages between refinery and aircraft tank, fuel quality is checked by sampling and on-site or laboratory testing, to ensure that the fuel conforms to the requirements specified for the grade when it is delivered to the aircraft. The Shell Aviation Quality Assurance System is organised on a worldwide basis, made easier because Shell Aviation Service is provided directly in many countries of the world.

Aviation Turbine Fuel (Jet Fuel)
Today's kerosine 'Jet' fuels have been developed from the illuminating kerosine used in the early gas turbine engines. These engines needed a fuel with good combustion characteristics and ahigh energy content. The kerosine type fuels used in civil aviation nowadays are mainly Jet A-1 and Jet A. The latter has a higher freezing point (minimum –40°C instead of minimum –47°C) and is available only in the U.S.A.

Major Civil Jet Fuel grades
Jet A-1
Jet A-1 is a kerosine grade of fuel suitable for most turbine engined aircraft. It has a flash point minimum of 38°C (100°F) and a freeze point minimum of –47°C. It is widely available outside the U.S.A. The main specifications for Jet A-1 grade (see below) are the UK specification DEF STAN 91-91 (Jet A-1) NATO code F-35, (formerly DERD 2494) and the ASTM specification D 1655 (Jet A-1).

Jet A
Jet A is a kerosine grade fuel, normally only available in the U.S.A. It has the same flash point as Jet A-1 but a higher freeze point minimum (–40°C). It is supplied against the ASTM D 1655 (Jet A) specification. Jet A is used within the United States by domestic and international airlines.

Jet B
Jet B is a distillate comprising naphtha and kerosine fractions. It can be used as an alternative to Jet A-1, but because it is more difficult to handle (higher flammability), there is minimal demand and availability for this grade of fuel. The only significant area of use is in very cold climates, like northern Canada, where its better cold weather performance is important. Jet B is specified by ASTM D 6615, but in Canada it is supplied against the Canadian Specification CAN/CGSB 3.23

TS-1
TS-1 is the main jet fuel grade available in Russia and the Commonwealth of Independent States. It is a kerosine type fuel with slightly higher volatility (flash point is 28°C minimum) and lower freeze point (<–50°C) compared with Jet A-1. It is supplied against the GOST 10227 specification.

No.3 Jet Fuel
No.3 Jet Fuel is the main Chinese grade which is essentially identical to Jet A-1.

American Civil Jet Fuels
The basic civil jet fuel specification used in the United States of America is ASTM Specification for Aviation Turbine Fuels D 1655, which defines the requirements for the two grades of fuel – Jet A and Jet A-1 (Note: ASTM D 1655 formerly included Jet B but this grade is now covered by a separate specification ASTM D 6615).

Alternative Fuels
A recent development for jet fuels is the approval of alternative blend components. Unconventional blend components, including those derived from Fischer-Tropsch synthesis or some renewable bio-routes, are covered by a new specification, ASTM D7566. In this specification, blend components are defined and controlled in the Annex section, along with the blending limits. Once blended, the finished fuels must meet the test requirements in the main table of ASTM D7566, which includes all of the testing requirements of ASTM D1655 plus some additional parameters. Once a finished fuel is certified to ASTM D7566 it can be recertified as ASTM D1655, thereby allowing the fuel to be handled and mixed with conventional jet fuel batches and, furthermore, not requiring any change in the certification of either aircraft or engines.

Research and testing continues to prove the suitability of new processes and source materials for use in jet fuel and, as this work progresses, the scope of ASTM D7566 will continue to be expanded to accommodate these changes.

UK Jet Fuels
Although developed originally as a military jet fuel specification by the UK Ministry of Defence, DEF STAN 91-91 (originally DERD 2494) has been adopted as the standard UK civil jet fuel specification. It defines the requirements for a kerosine type fuel (Jet A-1 grade) having a minimum freeze point of –47°C.

Jet A-1 according to the DEF STAN 91-91 specification is essentially the same as Jet A-1 defined by the ASTM D 1655.

Russian and East European Jet Fuels
Russian kerosine type jet fuels are covered by a wide range of specification grades reflecting different crude sources and processing treatments used. The grade designation is T-1 to T-8, TS-1 or RT. The grades are covered either by a State Standard (GOST) number, or a Technical Condition (TU) number. The limiting property values, detailed fuel composition and test methods differ quite considerably in some cases from the Western equivalents.

The principle grade available in Russia and other members of the Commonwealth of Independent States (CIS) is TS-1 (written as TC-1 in Russian script).

The main differences in characteristics are that Russian fuels have a low freeze point (equivalent to about –57°C by Western test methods) but also a low flash point (a minimum of 28°C compared with 38°C for western fuel). RT fuel (written as PT in Russian script) is the superior grade (a hydrotreated product) but is not produced widely. TS-1 (regular grade) is considered to be on a par with Jet A-1 and is approved by most aircraft manufacturers.

In some locations in Russia and for exports, product may be supplied against the Russian Jet A-1 specification GOST 52050-2006 which is aligned with DEF STAN 91-91.

Eastern European countries have their own national standards with their own nomenclature. Many are very similar to the Russian standards, but others reflect the requirements of visiting international airlines and are similar to Jet A-1 in properties and test methods.

Chinese Jet Fuels
Five types of jet fuel are covered by current Chinese specifications. Previously, each grade was numbered with a prefix RP; however, they are now renamed No.1 Jet Fuel, No.2 Jet Fuel, etc.. RP-1 and RP-2 are kerosines which are similar to Russian TS-1. They both have low flash points (minimum 28°C). RP-1 freeze point is –60°C and RP-2 is –50°C.

RP-3 is essentially the same as Jet A-1. RP-4 is a wide-cut type fuel similar to Jet B and Russian T-2. RP-5 is a high flash point kerosine similar to that used in the west by naval aircraft operating on aircraft carriers. Virtually all jet fuel produced in China is now RP-3 (renamed No.3 Jet Fuel).

International Specifications - AFQRJOS Check List
As jet fuel supply arrangements have become more complex in the 1970s, involving co-mingling of product in joint storage facilities, a number of fuel suppliers developed a document which became known as the Aviation Fuel Quality Requirements for Jointly Operated Systems, or AFQRJOS, Joint Fuelling System Check List. The "Check List" embodies the most stringent requirements of the DEF STAN 91-91 and ASTM D 1655 specifications for JET A-1. By definition, any product meeting Check List requirements will also meet either DEF STAN or ASTM specifications.

The Check List is recognised by eight of the major aviation fuel suppliers - BP, Chevron, ENI, ExxonMobil, Kuwait Petroleum, Shell, Statoil and Total.

Military Jet Fuel grades

JP-4
JP-4 used to be the primary jet fuel for the US Air Force but was phased out in the 1990s because of safety problems. A few airforces around the world still use it but there is very little production.

JP-4 is the military equivalent of Jet B with the addition of corrosion inhibitor and anti-icing additives; it meets the requirements of the U.S. Military Specification MIL-DTL-5624U Grade JP-4. The UK Military specification for this grade is DEF STAN 91-88 AVTAG/FSII (formerly DERD 2454), where FSII stands for Fuel System Icing Inhibitor. NATO Code F-40.

JP-5
JP-5 is a high flash point kerosine meeting the requirements of the U.S. Military Specification MIL-DTL-5624U Grade JP-5. The UK Military specification for this grade is DEF STAN 91-86 AVCAT/FSII (formerly DERD 2452). This is primarily jet fuel for use in aircraft carriers. NATO Code F-44.

JP-8
JP-8 is the military equivalent of Jet A-1 with the addition of corrosion inhibitor and anti-icing additives; it meets the requirements of the U.S. Military Specification MIL-DTL-83133G. It is the dominant military jet fuel grade for NATO airforces. The UK also has a specification for this grade namely DEF STAN 91-87 AVTUR/FSII (formerly DERD 2453). NATO Code F-34.

JP-8 +100
JP-8 +100 is JP-8 fuel to which has been added an approved thermal stability improver additive. It meets the requirements of the U.S. Military Specification MIL-DTL-83133G and is widely used by the USAF in their fighter and trainer wings. NATO Code F-37.

Aviation Gasoline (Avgas)

Aviation Gasoline (Avgas) is used in small piston engine powered aircraft within the General Aviation community, e.g. private pilots, flight training, flying clubs and crop spraying. Piston engines operate using the same basic principles as spark ignition engines in cars, but they have a much higher performance requirement. In today's General Aviation community there are only two main Avgas grades (100 and 100LL low lead) - a rationalisation that has enabled fuel companies to continue supplying a market that would otherwise have become uneconomic. Worldwide, total Avgas volumes are low, since Avgas-fuelled aircraft, although they outnumber jet-fuelled aircraft, are generally much smaller.

Avgas grades

Avgas 100
This was the standard high octane fuel for aviation piston engines and has a high lead content. There are two major specifications for Avgas 100. The ASTM D 910 and UK DEF STAN 91-90. These two specifications are essentially the same, but differ over antioxidant content, oxidation stability requirements and max lead content.

Avgas 100 is dyed green and is now only produced in a few refineries in the world.

Avgas 100LL
This grade is the lower lead version of Avgas 100. Low lead is a relative term. There is still up to 0.56 g/litre of lead in Avgas 100LL. This grade is listed in the same specifications as Avgas 100, namely ASTM D 910 and UK DEF STAN 91-90.

Avgas 100LL is dyed blue and is the main grade of Avgas used worldwide.

Avgas 100VLL
This grade is the very low lead version of Avgas 100LL, containing a maximum lead concentration of 0.45 g/litre. It is effectively a variant of Avgas 100LL with a restraint on the max lead content. It could be made available as an interim measure prior to the introduction of an unleaded high octane fuel, should it be necessary to address environmental concerns about leaded fuels. This grade is listed in ASTM D 910 and, other than the lower lead content, is constrained by the same specification requirements as Avgas 100LL. It therefore meets the same aircraft approvals and operating limitation requirements as Avgas 100LL meeting ASTM D910.

Avgas 100VLL is dyed blue.

Avgas UL82
This grade is intended to comply with the same aircraft approvals as the original motor gasoline (mogas) Supplementary Type Certificate (STC) approvals, but with better compositional and performance control. It is aimed at the low compression ratio engines which do not need the high octane of Avgas 100 and could be designed to run on unleaded fuel. Avgas UL82 is specified in ASTM D 6227. Unlike other Avgas specifications, ASTM D6227 allows the use of some non-hydrocarbon components used in mogas, such as ethers, but, unlike mogas specifications, alcohols are not permitted.

Avgas UL82 is dyed purple.

Avgas UL87
This is a relatively new grade added to ASTM D6227, driven by the need for some light sport engines to have a higher octane fuel than Avgas UL82.

Avgas UL82 is dyed yellow.

Avgas UL91
Compositionally this grade is somewhat comparable with Avgas 100LL but with a zero lead content, which results in a lower octane rating of 91MON. Avgas UL91 is specified in ASTM D7547. Avgas UL91 differs principally from both Avgas UL87 and UL82 not only in the higher octane rating, but in lower vapour pressure (49kPa max compared with 60kPa max in ASTM D6227) and that oxygenates such as ethers are not permitted. In common with all other current Avgas specifications, ASTM D7547 does not permit the use of alcohols such as ethanol.

Avgas UL91 is dyed orange.

History of Avgas Grades
Avgas is gasoline fuel for reciprocating piston engined aircraft. As with all gasolines, avgas is very volatile and is extremely flammable at normal operating temperatures. Procedures and equipment for safe handling of this product must therefore be of the highest order.

Avgas grades are defined primarily by their octane rating. Two ratings are applied to aviation gasolines (the lean mixture rating and the rich mixture rating) which results in a multiple numbering system e.g. Avgas 100/130 (in this case the lean mixture performance rating is 100 and the rich mixture rating is 130).

In the past, there were many different grades of aviation gasoline in general use e.g. 80/87, 91/96, 100/130, 108/135 and 115/145. However, with decreasing demand these were rationalised down to one principle grade, Avgas 100/130. (To avoid confusion and to minimise errors in handling aviation gasoline, it is now common practice to designate the grade by just the lean mixture performance rating; thus Avgas 100/130 becomes Avgas 100).

Some years ago, an additional grade was introduced to allow a common fuel to be used in engines originally designed for grades with lower lead contents as well as in those engines certified for higher lead contents. This grade is called Avgas 100LL, the LL standing for 'low lead'.

All equipment and facilities handling avgas are colour coded and display prominently the API markings denoting the actual grade carried. Currently, the two major grades in use internationally are Avgas 100LL and Avgas 100. To ease identification the fuels are dyed: Avgas 100LL is coloured blue, while Avgas 100 is coloured green.

In 1999 a new Avgas grade UL82 (UL standing for unleaded) was introduced as a low octane grade suitable for low compression engines. It has a higher vapour pressure than conventional Avgas and can be manufactured from motor gasoline components, but, notably, the specification does not allow alcohols such as ethanol to be used. It is particularly applicable to those aircraft which have STCs to use automotive gasoline.

An extension of this has been the grade Avgas UL87, which was created in response to the higher octane demand of some light sport engines; notably the turbocharged Rotax® engines. UL87 is otherwise similar to UL82, using similar components, but again expressly excluding alcohols.

The relatively high vapour pressure of the ASTM D6227 specification makes UL82 and UL87 somewhat unsuitable for high altitude flight as engine failure from vapour lock can be an issue. In order to meet the demands from the military for an unleaded Avgas for use in high flying, unmanned aerial vehicles (UAVs), a new low vapour pressure UL91 grade was introduced, resulting in the requirement for a new specification, ASTM D7547. At the time of writing, this specification is approved for light sport engines, such as Rotax®, and is in the process of being considered for approval in a wider range of general aviation engines of low to mid-octane demand. However, it is clear that this will not be of high enough octane rating to be used safely in all general aviation engines and work continues in trying to find a true unleaded alternative to the almost ubiquitous Avgas 100LL.

ACCESS TO AVIATION FUEL SPECIFICATIONS

Because it is important to refer only to the most recent issues of fuel specifications, their detailed requirements have not been tabulated in this AeroShell Book since they could quickly become out-of-date. Copies of the specifications cited above can be obtained from the following authorities:

DEF STAN Specifications
Ministry of Defence
Directorate of Standardisation
Kentigern House
65 Brown Street
Glasgow G2 8EX
UK

phone +44 141 224 2496
fax +44 141 224 2503

NOTE: DEF STAN specifications are freely available from their web site at:
www.dstan.mod.uk

ASTM Specifications
ASTM specifications are published annually in the ASTM Book of Standards, Section 5 (on paper and CD). Copies are available from:

ASTM
100 Barr Harbor Drive
West Conshohocken
PA 19428-2959
USA

phone +1 610 832 9585
fax +1 610 832 9555

ASTM website is: **www.astm.org**
NOTE: Specifications are available for a charge.

US Military Specifications
Department of Defense
DODSSP
Building 4/ Section D
700 Robins Avenue
PA 19111-5094
USA

phone +1 215 697 2667
fax +1 215 697 1462

NOTE: US Military specifications are freely available from their web site at:
http://assist.daps.dla.mil/quicksearch

IATA Guidance Material for Aviation Turbine Fuels Specifications
IATA issue an excellent guide covering commercial aviation fuels and additives. The latest edition can be obtained from:

Fuel Services
IATA
800 Place Victoria
PO Box 113
Montreal
Quebec
Canada H6Z 1M1

phone +1 514 874 0202
fax +1 514 874 2661

IATA website is: **www.iataonline.com**

AFQRJOS Check List for Jet A-1

The Joint Fuelling Systems Check List for Jet A-1 is maintained by the JIG Product Quality Committee on behalf of the industry. The latest edition can be accessed on the Joint Inspection Group's website: **www.jointinspectiongroup.org** under the link 'fuel quality'.

AVIATION FUEL ADDITIVES

Aviation fuel additives are compounds added to the fuel in very small quantities, usually measurable only in parts per million, to provide special or improved qualities. The quantity to be added and approval for its use in various grades of fuel is strictly controlled by the appropriate specifications.

A few additives in common use are as follows:-
1. **Anti-knock additives** reduce the tendency of gasoline to detonate. Tetra-ethyl lead (TEL) is the only approved anti-knock additive for aviation use and has been used in motor and aviation gasolines since the early 1930s.

2. **Anti-oxidants** prevent the formation of gum deposits on fuel system components caused by oxidation of the fuel in storage and also inhibit the formation of peroxide compounds in certain jet fuels.

3. **Static dissipator additives** reduce the hazardous effects of static electricity generated by movement of fuel through modern high flow-rate fuel transfer systems. Static dissipator additives do not reduce the need for 'bonding' to ensure electrical continuity between metal components (e.g. aircraft and fuelling equipment) nor do they influence hazards from lightning strikes.

4. **Corrosion inhibitors** protect ferrous metals in fuel handling systems, such as pipelines and fuel storage tanks, from corrosion. Some corrosion inhibitors also improve the lubricating properties (lubricity) of certain jet fuels.

5. **Fuel System Icing Inhibitors (Anti-icing additives)** reduce the freezing point of water precipitated from jet fuels due to cooling at high altitudes and prevent the formation of ice crystals which restrict the flow of fuel to the engine. This type of additive does not affect the freezing point of the fuel itself. Anti-icing additives can also provide some protection against microbiological growth in jet fuel.

6. **Metal de-activators** suppress the catalytic effect which some metals, particularly copper, have on fuel oxidation.

7. **Biocide additives** are sometimes used to combat microbiological growths in jet fuel, often by direct addition to aircraft tanks; as indicated above, some anti-icing additives appear to possess biocidal properties.

8. **Thermal Stability Improver additives** are sometimes used in military JP-8 fuel, to produce a grade referred to as JP-8+100, to inhibit deposit formation in the high temperature areas of the aircraft fuel system.

FUEL PROPERTIES NOT IN SPECIFICATIONS

Fuel specifications do not list all the properties of aviation fuels; it would be impractical for them to do so because by no means all of these properties could be tested for at the creation of each new fuel batch. However, many of these properties not listed in official fuel specifications may nevertheless be important to the designers of aircraft engines and airframes because they describe certain aspects of the fuel's behaviour when in aircraft tanks and fuel systems.

Examples of these properties are:

Surface tension
Specific heat
Thermal conductivity
Enthalpy
Heat of vapourisation
Lubricity
Permittivity
Flammability limits
Autoignition temperature
Spark ignition energy
Bulk Modulus
Solubility of gases in fuel
Solubility of water in fuel

Information and typical values for these properties can be obtained from a variety of publications. The most useful one for designers of aircraft and engine fuel systems is probably the Coordinating Research Council (CRC) Report entitled "Handbook of Aviation Fuel Properties" (CRC Doc. No. 635). This was published in 2004 and is available from the Society of Automotive Engineers, Inc., General Publications Department, 400 Commonwealth Drive, Warrendale, Pennsylvania PA 15096 U.S.A.
Order via **http://aerospace.sae.org/** or by calling +1 724 776 4970. Available in hard copy and CD ROM format.

SHELL AEROJET

Shell AeroJet is a premium aviation fuel service, offering major benefits to pilots, operators and owners of turbine powered aircraft. The service is available at selected airports and countries worldwide.

Shell AeroJet minimises or eliminates some of the problems associated with the use of Jet A-1 in business jets, turbo-prop aircraft and helicopters and is mandated by some airframe manufacturers such as Pilatus.

Anti-Icing
The air inside fuel tanks contains moisture which can precipitate into the fuel as free water. This water has the potential to turn to ice during flight operation or even on the ground. Shell AeroJet contains a Fuel System Icing Inhibitor (FSII) that is an approved additive which dramatically lowers the freezing point of water and eliminates this problem to give added security in case of fuel heater system breakdown. It also creates an environment that inhibits the growth of bacteria and fungi which can pose a serious danger to the plane and passengers. This feature in Shell AeroJet can be particularly valuable for aircraft operating in hot and humid conditions.

Assurance
The practice of using aerosol cans to mix anti-icing additive while overwing refuelling often results in an uneven mix and incorrect additive concentration as well as posing health hazards to the user from possible contact with the neat additive. The major advantages of Shell AeroJet over this and other systems is the assurance that the fuel has been dosed with the additive at exactly the correct rate every time without any exposure to liquid splashes or harmful vapours.

NOTES

AEROSHELL PERFORMANCE ADDITIVE 101

AeroShell Performance Additive 101, developed for the USAF JP-8 +100 programme by BetzDearborn (now GE Water & Power) for high temperature, high performance jet fuel, helps prevent the build up of carbon deposits in the engine.

AeroShell Performance Additive 101 is a unique, patented jet fuel additive designed to improve the thermal stability of military jet fuels.

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

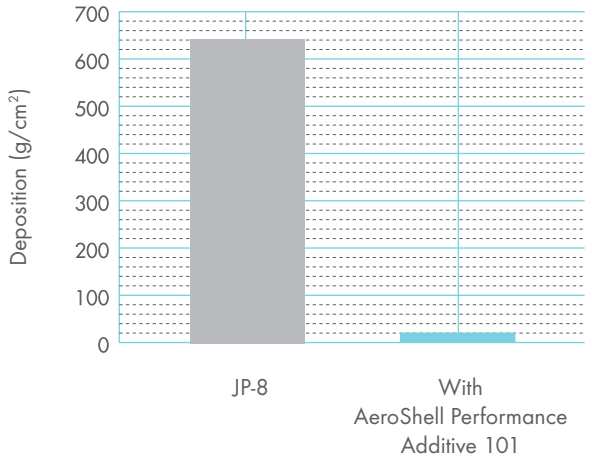
AeroShell Performance Additive 101 is designed to:

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

Improves Jet Fuel Thermal Stability

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

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



Reduces Fuel Manifold & Nozzle Coking

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

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

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

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

Reduces Operational & Maintenance Costs
Keeping the fuel system and jet engine clean from carbon deposits caused by the thermal stressing of jet fuel can reduce overall engine maintenance costs. A detailed evaluation of these impacts has been carried out with over a decade worth of field experience. Reports are available from your Shell representatives.

Combine this with improved aircraft readiness, and the full benefit of AeroShell Performance Additive 101 can prove to be a wise investment.

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

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

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

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

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

SHELL WATER DETECTOR

The Shell Water Detector is a device for determining the presence in jet fuels of finely dispersed undissolved water in concentrations lower than those normally detectable by visual examination. Water dispersions of this type can result from the emulsification of a water/fuel mixture during pumping, or from the precipitation of dissolved water due to a fall in fuel temperature.

Construction
The detector consists of two parts:

a) A standard polythene or nylon hypodermic syringe of 5 ml capacity with a Record type nozzle fitting.

b) A plastic detector capsule in which is fitted a disc of filter paper treated with water sensitive chemicals.

Use
Before use the detector capsule should be examined in order to confirm that the paper is of a uniform yellow colour. The detector capsule is fitted to the syringe, then the capsule and approximately half of the syringe is immersed in the sample under test and the plunger withdrawn until the fuel reaches the 5 ml mark. The capsule should be examined for any difference in colour between the inner wetted portion and the outer portion which is protected by the plastic moulding.

It is important to note that:

a) The screw cap should be replaced on the capsule container immediately the required capsule has been removed to prevent discolouration of the remaining capsules by atmospheric humidity. Unused capsules should not be left lying about or kept loose in the pocket.

b) A capsule should be used once only and then discarded because the sensitivity of the device is a function of the quantity of fuel passing through the paper.

Interpretation of results
The presence of undissolved water is indicated by a change in colour of the centre portion of the detector paper. The Shell Water Detector begins to react at very low levels of water contamination even below 10 ppm and the resulting colour change becomes progressively more noticeable with increasing water content until at approximately 30 ppm a distinct green colour is obtained giving a positive indication of water contamination. At lower water contamination levels a yellow/green colour is obtained which increases to blue/green and finally blue/black at very high levels of water contamination.

Application
The Shell Water Detector should be used as follows to check samples of jet fuels immediately after they are drawn:

a) Road vehicle and RTW drain samples – before discharge into airport storage.

b) Bottom samples from airport tanks – immediately before release.

c) Fueller and trailer compartment drain samples – after each replenishment.

d) Hydrant dispenser filter drain samples – after each aircraft fuelling.

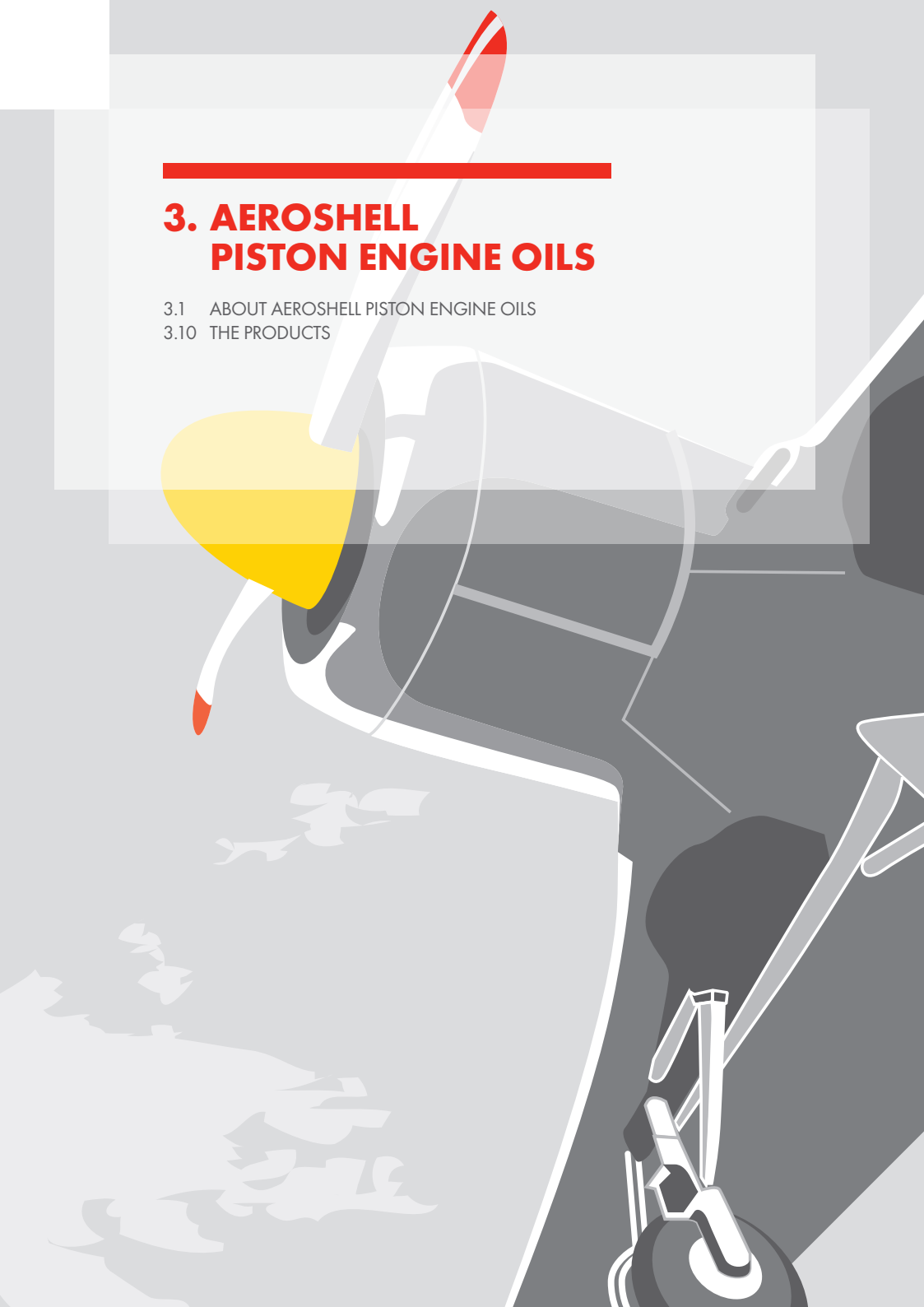
e) Fueller filter drain samples – after the first aircraft fuelling, after filling or topping up either fueller or trailer.

f) Drain samples from filtration equipment on hydrant delivery and fueller loading racks – daily.

Storage life and supply arrangements
The recommended life for Shell Water Detector capsules is nine months from time of manufacture. The life expiry date (month/year) is marked on the bottom of each tube of capsules and is also printed on one end of each box of ten tubes.

NOTES

3. AEROSHELL PISTON ENGINE OILS



AEROSHELL PISTON ENGINE OILS

For many years the performance of aircraft piston engines was such that they could be lubricated satisfactorily by means of straight mineral oils, blended from specially selected petroleum base stocks. However, demand for oils with higher degrees of thermal and oxidation stability necessitated 'fortifying' them with the addition of small quantities of non-petroleum materials. The first additives incorporated in straight mineral piston engine oils were based on the metallic salts of barium and calcium. In highly-rated engines the performance of these oils with respect to oxidation and thermal stability was excellent, but the combustion chambers of the majority of engines could not tolerate the presence of the ash deposits derived from these metal-containing additives.

To overcome the disadvantages of harmful combustion chamber deposits, a non-metallic, i.e. non-ash forming, polymeric additive was developed which was incorporated in blends of selected mineral oil base stocks, to give the range of AeroShell W Oils.

Following extensive operational success in a wide range of civil engines, military specifications based on the general characteristics of AeroShell W Oils were prepared and issued.

AeroShell W Oils were in service with the world's airlines and aircraft operators for many years when they operated big transport piston-engined aircraft, during which time these oils became virtually the standard for all aircraft piston engines. Nevertheless, supplies of straight AeroShell Oils remained available primarily for running-in the aircraft piston engine and for the few operators who required them. Today these oils (both AeroShell W Oils and AeroShell Oils) are still required for the smaller piston-engined aircraft flying in air taxi operations, flying clubs or flown by private pilots.

In the early 1980s a semi-synthetic multigrade W oil for piston engines (AeroShell Oil W 15W-50) was added to the range. This grade has become very popular amongst engine manufacturers and operators alike. In order to cater for those Lycoming engines which need improved load-carrying (i.e. those engine models which require the addition of Lycoming Additive LW 16702) AeroShell Oil W 15W-50 was upgraded in 1986 to include an anti-wear additive.

In recent years utilisation of piston engine aircraft has decreased, resulting in the aircraft spending more time on the ground. This led to an increase in corrosion being seen inside the engine. In order to combat this, AeroShell Oil W 15W-50 was further upgraded in 1993 to include a very effective anti-corrosion additive package.

For those operators who prefer a single grade but still want the anti-wear and anti-corrosion benefits of the multigrade oil, AeroShell Oil W80 Plus and AeroShell Oil W100 Plus have been added to the range of ashless dispersant oils.

To cater for the demands of operators of light sport aviation piston engines, two new grades – AeroShell Oil Sport Plus 2 (for 2-stroke engines) and AeroShell Oil Sport Plus 4 (for 4-stroke engines) have recently been introduced.

With the development of compression ignition (Diesel) piston engines specifically for the aviation market, Shell Aviation has been working closely with the OEMs to develop appropriate lubricants for this new engine type. The result of these co-operative efforts was the development of AeroShell Oil Diesel 10W-40, to be followed by the recent launch AeroShell Oil Diesel Ultra.

SPECIFICATIONS

Since the 1940s, piston engine operators have relied on two U.S. Military Specifications for defining piston engine lubrication requirements. Beginning with the non-dispersant MIL-L-6082 oils and continuing through the MIL-L-22851 Ashless Dispersant products, the U.S. Military Specifications were the standards for oil performance worldwide. In military circles Grades 1065 and 1100 as well as Type II and III were familiar grade identifications, whilst in civil use Grades 65, 80, 100 and 120 were common. However, that has all changed.

The SAE Fuels and Lubricants Technical Committee 8 – Aviation Piston Engine Fuels and Lubricant Committee worked very closely with the U.S. Navy to convert these Military Specifications into SAE Standards. Also involved were oil manufacturers, engine builders, test laboratories and the American FAA. In due course agreement was reached on a new set of performance standards for piston engine oils. These new SAE Standards are J-1966 Lubricating Oil, Aircraft Piston Engine (Non-Dispersant) and J-1899 Lubricating Oil, Aircraft Piston Engine (Ashless Dispersant), both of which have now been adopted for use. The adoption of these new SAE Standards means that the two Military Specifications (MIL-L-6082 and MIL-L-22851) are now obsolete.

These new specifications include upgraded and improved tests and have been designed to meet current technology, and include the latest test methods and precision limits.

The most obvious change for users is the move from the old Grade or Type Number system to the more common SAE viscosity classification. Thus products in both SAE specifications are defined as SAE 30, 40, 50 or 60. In addition, for the first time, multigrade aviation oils are included in the new specifications.

The U.K. has now cancelled DERD 2450 and DERD 2472 and adopted the SAE specifications.

FUNCTION OF PISTON ENGINE OIL

A piston engine oil's function inside a piston engine is to:

- reduce friction between moving parts
- provide necessary cooling to internal areas
- cushion moving parts against shock and help seal piston rings to cylinder walls
- protect highly finished internal parts of the engine from rust and corrosion
- keep interior of engine clean and free of dirt, sludge, varnish and other harmful contaminants

APPLICATION

AeroShell Oils and AeroShell W Oils are intended for use in four-stroke (four-cycle) aircraft reciprocating piston engines. They are not recommended for use in automotive engines converted for use in aircraft, and in these cases the conversion shop should be consulted for proper oil recommendations.

The term "ashless dispersant" was given to aviation oils to distinguish them from straight mineral aircraft piston engine oils. Automotive and heavy duty truck engine oils contain ashless dispersants and ash-containing detergents. They were traditionally called detergent oils (some aircraft operators incorrectly refer to ashless dispersant oils as "detergent oils").

Because of the negative effect of ash on aircraft engine performance, it is very important that ash-containing oils are NOT used in an aircraft piston engine.

Due to differences in metallurgy, operating conditions and fuel specifications, an aircraft oil will not meet all of the automobile/heavy-duty engine's requirements. In addition, the aviation oils are not qualified for this application and their use could result in voiding the warranty and/or reduction in engine life.

Thus automobile oils MUST NOT be used in aircraft engines which use or specify SAE J-1899 or J-1966 oils. Similarly aviation oils MUST NOT be used in automobile engines.

SELECTION OF RIGHT GRADE OF OIL

For the majority of aircraft piston engines the selection of the right grade is important to maximise engine performance and engine life.

Running-in	use	AeroShell Oils
Normal operation	use	AeroShell W or W Plus Oils

SELECTION OF CORRECT VISCOSITY GRADE

AeroShell Oils and AeroShell W Oils are each available in four grades. The grades differ only by viscosity and thus cover the needs of all reciprocating engines now in airline and general aviation operation. There is no general rule by which the correct grade for every engine type can be chosen, but the following table, based on recommendations from Lycoming, provides approximate guidance for selecting the most suitable grade, based on the average ambient outside air temperature at engine start-up.

AeroShell Oil	**65**	**80, W80 and W80 Plus**	**100, W100 and W100 Plus**	**120 and W120**
Outside air temperature °C	Below – 12	– 17 to 21	16 to 32	Above 26
Corresponding SAE No.	30	40	50	60

Note: This table does not apply to AeroShell Oil W 15W-50.

N.B. For large engines the choice depends greatly upon the operator's preference and past experience. Traditionally the choice seems to be associated with climatic zones: AeroShell Oil W100 or W100 Plus is preferred for temperate regions and AeroShell Oil W120 for warmer climates.

ENGINE CONVERSION

Elaborate precautions are not needed when changing from straight mineral oil to AeroShell W Oils, since both types of oil are compatible with each other.

Experience has shown that AeroShell W Oils do not loosen or affect the hard carbonaceous material already deposited in high-time engines, and may therefore be introduced at any time during the operational life of an engine.

The easiest and possibly the best way of converting a fleet of engines to an AeroShell W Oil is to 'top-up' with the oil commencing from a given date. The majority of operators use this method following procedures recommended by the engine's manufacturer.

However, other operators have drained engines and refilled them with AeroShell W Oil. If this procedure is adopted, the oil filters should be checked after a ground run and at short intervals during initial operation, because the fresh charge of AeroShell W Oil may disperse 'pockets' of partly oxidised straight mineral oil which may have bound together and retained flaky carbonaceous material during previous operation.

OIL CHANGE INTERVAL

Almost all oil change recommendations specify not only an engine hour time limit, but also a calendar time limit; typically 4 or 6 months depending upon engine manufacturer. On low usage aircraft the calendar time limit is usually more critical than the engine hour limit. The need for frequent oil changes in aircraft is not caused by the oil wearing out, but rather by the oil becoming contaminated with by-products of combustion, dirt, water (both atmospheric as well as from condensation inside an engine) and unburnt fuel. This contamination can cause corrosion in the oil wetted areas of an engine and thus changing the oil removes these contaminants and helps to minimise corrosion. In order to minimise this corrosion inside low usage engines, calendar time changes are important.

OIL CHANGE EXTENSION

Many operators are interested in extending oil change intervals. As a general rule extensions are not recommended for the following reasons:

- many engine manufacturers do not approve extended intervals
- possibility of losing engine manufacturers' warranty on the engine
- possibility that extended intervals will shorten engine life

The initial enthusiasm in the U.S. for extended intervals has declined due to problems associated with lead sludge found in engines. Many operators have now reverted back to the engine manufacturers' oil change recommendations and found that these problems disappear.

Operators are urged to follow the engine manufacturers' or rebuilders' recommendation for oil change interval.

BREAK-IN PROCEDURE

Some aircraft engine manufacturers and rebuilders/overhaul agencies suggest in their service bulletins the use of straight mineral oil in new or newly overhauled engines for break-in. These straight mineral oils are usually recommended for the first 25 to 50 or even 100 hours of operation, or until the oil consumption stabilises. Other rebuilders or manufacturers, especially for such engines as the Lycoming O-320H and O/LO360E, allow either ashless dispersant or straight mineral oil for break-in, whereas ashless dispersant oils are mandated for break-in for all turbocharged Lycoming engines. Operators should check with engine manufacturers or rebuilders for the correct recommendation for the specific engine and application.

STABILITY IN STORAGE

AeroShell W Oils are inherently stable and, providing they have been stored and handled correctly, prolonged storage does not have any effect on their quality, properties or performance.

RADIAL ENGINES

Radial engines utilise special parts and, depending upon the type of aircraft, application and climate are often subject to specific problems not seen in other types of piston engines.

In a radial engine each bank of cylinders has all of the cylinders in the same plane and transmits power through a single master rod bearing to the crankshaft. This master rod bearing is subjected to high loading and absorbs the shock and vibration from the cylinders and thus requires very good protection from the lubricant. Generally radial engines have greater piston and bearing clearances and thus require a higher viscosity oil.

As a result of all this heavy duty stress, it is recommended that for radial engines used in normal operation (all operations except agricultural spraying), an oil such as AeroShell Oil W120 is used in moderate to temperate climates and AeroShell Oil W100 in cooler climates (if breaking-in, then AeroShell Oil 120 and 100 respectively). Alternatively AeroShell Oil W 15W-50 could be used in those radial engines for which it is approved. None of these oils contain zinc additives which if used would quickly destroy the master rod bearing.

Agricultural operations represent a special problem for an oil used in radial engines. This is because of problems with high dirt and overspray ingestion into the oil. The best way to combat this is proper maintenance, good flying procedures and frequent oil changes.

VINTAGE AIRCRAFT

Vintage aircraft piston engines, including vintage radial engines, were approved on oils produced at the time the engine was originally manufactured. Many of these oils are no longer available. If the engine was approved on an aviation oil other than a MIL-L-6082 or a MIL-L-22851 oil then operators should consult with either the engine rebuilder or oil supplier. On no account assume that present oils 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 about midway through the draining of hot oil from the sump. A sample pulled off the bottom may be dirtier than normal. 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.

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

It is likely that higher wear metal levels will occur during break-in or following some maintenance procedures.

NON-AVIATION USE OF AEROSHELL PISTON ENGINE OILS

In selecting an AeroShell piston 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.

NOTES

AEROSHELL OILS 65, 80, 100 and 120

AeroShell straight mineral oils are blended from selected high viscosity index base stocks. These oils do not contain additives except for a small quantity of pourpoint depressant (which is added when improved fluidity at very low temperature is required) and an anti-oxidant.

APPLICATIONS

AeroShell Oils are available in four different viscosity grades:

AeroShell Oil 65 – AeroShell Oil 80 – AeroShell Oil 100 – AeroShell Oil 120

The suffix for each grade corresponds to the viscosity of the oil at 210°F in Saybolt Universal Seconds.

The appropriate grades of these AeroShell Oils are approved for use in four-stroke (four-cycle) certified aircraft reciprocating piston engines (except Porsche) and other aircraft radial engines which use oil to specification SAE J-1966 (MIL-L-6082) and which do not require use of an oil containing a dispersant additive. AeroShell Oils are used primarily during break-in of most new or recently overhauled four-stroke aviation piston engines. The duration and lubrication recommendations for break-in vary, so operators should refer to the original engine manufacturer and/or overhaul facility for specific recommendations.

SPECIFICATIONS

The U.S. Specification SAE J-1966 replaces MIL-L-6082E.

Although it was planned to replace the British Specification DERD 2472 with a DEF STAN specification this has now been put into suspension and instead the SAE specification has been adopted.

AeroShell Oil	65	80	100	120
U.S.	Approved J-1966 SAE Grade 30	Approved J-1966 SAE Grade 40	Approved J-1966 SAE Grade 50	Approved J-1966 SAE Grade 60
British	-	Approved J-1966 SAE Grade 40	Approved J-1966 SAE Grade 50	-

Table continued

Table continued

AeroShell Oil	65	80	100	120
French	(AIR 3560/D Grade SAE 30)	(AIR 3560/D) Grade SAE 40)	(AIR 3560/D Grade SAE 50)	-
Russian	-	MS-14	MS-20	-
NATO Code	O-113 Obsolete	-	O-117 Obsolete	-
Joint Service Designation	OM-107 Obsolete	OM-170	OM-270	OM-370 Obsolete

( ) indicates the product is equivalent to specification.

Typical Properties		65	80	100	120
SAE viscosity grade		30	40	50	60
Density @ 15°C	kg/l	0.879	0.880	0.886	0.889
Kinematic viscosity @ 100°C @ 40°C	mm^2/s	 11.8 -	 14.6 140	 19.7 230	 24.8 -
Viscosity index		94	Above 94	Above 94	94
Pourpoint	°C	–20	Below –17	Below –17	–11
Flashpoint Cleveland Open Cup	°C	250	Above 240	Above 250	Above 250
Total acidity	mgKOH/g	<0.1	<0.1	<0.1	<0.1
Sulphur	%m	0.3	0.45	0.48	0.51
Copper corrosion	@ 100°C	1	1	1	1
Ash content	%m	0.006	0.006	0.006	0.006

AEROSHELL OILS W80, W100 and W120

AeroShell W Oils were the first non-ash dispersant oils to be used in aircraft piston engines. They combine non-metallic additives with selected high viscosity index base stocks to give exceptional stability, dispersancy and anti-foaming performance. These additives leave no metallic ash residues that can lead to deposit formation in combustion chambers and on spark plugs, which can cause pre-ignition and possible engine failure.

APPLICATIONS

AeroShell W Oils are available in four different viscosity grades:

AeroShell Oil W80 – AeroShell Oil W100 – AeroShell Oil W120

The suffix for each grade corresponds to the viscosity of the oil at 210°F in Saybolt Universal Seconds.

AeroShell W Oils are intended for use in four-stroke (four-cycle) certified reciprocating piston engines, including fuel-injected and turbocharged engines. AeroShell W Oils are not recommended for use in automotive engines. For automotive engines converted for use in aircraft, the specific engine manufacturer or the conversion agency should be consulted for proper oil recommendation.

Most radial engine operators use AeroShell Oil W120 in warm weather operations with AeroShell Oil W100 or AeroShell Oil W 15W-50 being used in cooler ambient temperatures.

AeroShell Oil W100 or AeroShell Oil W 15W-50 are the common choices for most operators of Lycoming and Continental flat engines but, during colder parts of the year, use of AeroShell Oil W80 in place of AeroShell Oil W100 would be an excellent choice.

Although some aircraft engine manufacturers and rebuilders/overhaul agencies suggest in their service bulletins the use of straight mineral oil in new or newly overhauled engines, other rebuilders or manufacturers, especially for such engines as the Lycoming O-320H and O/LO360E, allow either ashless dispersant or straight mineral oil for break-in, whereas ashless dispersant oils are mandated for break-in for all turbocharged Lycoming engines. Operators should check with engine manufacturers or rebuilders for the correct recommendation for the specific engine and application.

AEROSHELL W OILS

- Promote engine cleanliness
- Help keep engines sludge free
- Help reduce oil consumption
- Help engines reach TBO (Time Between Overhaul)
- Protect highly stressed engine parts against scuffing and wear

SPECIFICATIONS

The U.S. specification SAE J-1899 replaces MIL-L-22851D.

Although it was planned to replace the British Specification DERD 2450 with a DEF STAN specification this has now been put into suspension and instead the SAE specification has been adopted.

AeroShell Oil	W80	W100	W120
U.S.	Approved J-1899 SAE Grade 40	Approved J-1899 SAE Grade 50	Approved J-1899 SAE Grade 60
British	Approved J-1899 SAE Grade 40	Approved J-1899 SAE Grade 50	Approved J-1899 SAE Grade 60
French	(AIR 3570 Grade SAE 40)	(AIR 3570 Grade SAE 50)	(AIR 3570 Grade SAE 60)
Russian	MS-14	MS-20	-
NATO Code	O-123 Obsolete	O-125 Obsolete	O-128 Obsolete
Joint Service Designation	OMD-160	OMD-250	OMD-370

( ) indicates the product is equivalent to specification.

EQUIPMENT MANUFACTURERS APPROVALS

AeroShell W Oils are approved for use by the following engine manufacturers:-

Textron Lycoming	301F
Teledyne Continental	MHS 24B
Pratt & Whitney	Service Bulletin 1183-S
Curtiss Wright	Various Service Bulletins – refer to relevant Bulletin
Franklin Engines	Various Service Bulletins – refer to relevant Bulletin

Typical Properties		**W80**	**W100**	**W120**
SAE viscosity grade		40	50	60
Colour ASTM		4.0	4.0	5.0
Density @ 15°C	kg/l	0.880	0.884	0.887
Kinematic viscosity @ 100°C @ 40°C	mm^2/s	 14.5 118	 20.2 200	 24.8 270
Viscosity index		118	118	115
Pourpoint	°C	Below –22	Below –18	Below –18
Flashpoint Cleveland Open Cup	°C	Above 240	Above 260	Above 240
Total acidity	mgKOH/g	<0.1	<0.1	<0.1
Sulphur	%m	0.3	0.38	0.51
Copper corrosion	@ 100°C	1	1	1
Ash content	%m	0.006	0.006	0.006

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

NOTES

AEROSHELL OIL W 15W-50

AeroShell Oil W 15W-50 is a unique blend of high quality mineral oil and over 50% synthetic hydrocarbon base stocks, plus the AeroShell Oil W ashless dispersant additive system. This semi-synthetic blend offers high performance in a wide variety of applications and conditions. The synthetic base stock performance provides for better cold temperature pumping and protection than single grade oils. In addition, the blend of synthetic and high quality mineral base stocks provide high temperature performance superior to that of other fully approved aircraft piston engine oils. The mineral base stocks help disperse lead by-products of combustion, thereby keeping engines free of "grey paint" or lead sludge that can be a problem with some fully synthetic oils.

The anti-wear additive system in AeroShell Oil W 15W-50 provides outstanding wear protection for critical camshafts, lifters and other high wear components.

The anti-corrosion additive package in AeroShell Oil W 15W-50 helps protect low usage engines and engines in high humidity climates against rust and corrosion of critical engine parts such as camshafts and lifters.

AeroShell Oil W 15W-50 provides superior anti-corrosion protection for all types of certified aircraft piston engines. When used with proper maintenance procedures, the product provides maximum protection and improves the likelihood that aircraft engines will reach TBO. In addition, this product provides outstanding high temperature oxidation protection for hot running engines. It is designed to keep engines cleaner with less sludge and varnish build-up in critical ring belt and other areas.

APPLICATIONS

AeroShell Oil W 15W-50 is intended for use in certified four-stroke (four-cycle) aircraft piston engines. AeroShell Oil W 15W-50 is superior to single grade oils in almost every application. It offers easier starting, better lubrication after start-up, reduced wear, reduced corrosion and rusting, and improved cleanliness, with oil pressures and temperatures equal to that of single grade SAE 50 oils at fully warmed up conditions.

The anti-corrosion additive system is designed to prevent rust or corrosion in all types of aircraft piston engines. In comparative testing of camshaft rusting under high humidity conditions, AeroShell Oil W 15W-50 was almost entirely rust free while camshafts conditioned on other oils showed heavy rusting on some cam lobes and bearing surfaces.

These results indicate that AeroShell Oil W 15W-50 can provide maximum anti-corrosion protection for aircraft piston engines, when combined with proper maintenance practices and proper operating conditions.

Because of the improved flow characteristics of AeroShell Oil W 15W-50, operators may observe slightly lower oil temperatures in some aircraft. On larger aircraft, the oil cooler flap will normally compensate for this change. However, in small aircraft, oil temperature could be reduced slightly. Operators should always check the oil temperature to ensure that they are in the range specified by the manufacturer. Most manufacturers recommend cruising oil temperatures between 82 to 93°C (180 to 200°F). Oil temperatures significantly below this range can result in excessive water and fuel contamination in the crankcase.

AEROSHELL OIL W 15W-50

- Provides excellent rust and corrosion protection for aircraft engines
- Promotes engine cleanliness, fights wear, offers excellent anti-foam properties
- Helps reduce oil consumption by up to 50% and provides superior oil flow at low temperatures
- Compatible with other approved aircraft piston engine oils
- Functions as an all season oil, no seasonal changes needed
- Reduces fuel consumption by up to 5% over single grades
- Provides superior high temperature oxidation stability

Refer to General Notes at the front of this section for information on oil change recommendations and engine break-in.

AeroShell Oil W 15W-50 is not recommended for use in automotive engines. For automotive engines converted for use in aircraft, the specific engine manufacturer or the conversion agency should be consulted for proper oil recommendation.

SPECIFICATIONS

AeroShell Oil W 15W-50 was developed in co-operation with Textron Lycoming and Continental Motors and conforms to their specifications 301F and MHS-24A respectively. This oil is also approved under Military Specification MIL-L-22851 which is now obsolete and has been replaced by the SAE J-1899 specification. AeroShell Oil W 15W-50 is also approved for use in all Pratt & Whitney radial aircraft engines. In addition AeroShell Oil W 15W-50 meets the provisions of Lycoming Service Bulletin 446C and 471, plus Service Instruction 1409A and meets the American FAA Airworthiness Directive 80-04-03 which specifies special anti-wear requirements for certain engine models.

AeroShell Oil W 15W-50 already contains, in the correct proportions, an anti-wear additive equivalent to the Lycoming additive LW 16702; operators who use AeroShell Oil W 15W-50 DO NOT need to add this Lycoming additive to the oil.

AeroShell Oil W 15W-50 is qualified for use in all Continental Motors' liquid cooled and air cooled aircraft piston engines.

U.S.	Approved SAE J-1899 Grade Multigrade
British	Approved SAE J-1899 Grade Multigrade
French	-
Russian	-
NATO Code	O-162 Obsolete
Joint Service Designation	OMD-162

EQUIPMENT MANUFACTURERS APPROVALS

AeroShell Oil W 15W-50 is approved for use by the following engine manufacturers:

Textron Lycoming	301F Service Bulletins 446E and 471B Service Instruction 1409C
Continental	MHS 24A SIL 99-2
Pratt & Whitney	Service Bulletin 1183-S
FAA	Airworthiness Directive 80-04-03 R2

Typical Properties	**SAE J-1899 Multigrade**	**Typical**
Oil type	-	Mixed synthetic hydrocarbon and mineral
SAE viscosity grade	Multigrade	Multigrade
Colour ASTM	-	4.0
Density @ 15°C kg/l	Report	0.86
Kinematic viscosity mm^2/s @ 100°C @ 40°C	 - -	 19.6 140
Viscosity index	100 min	157
Pourpoint °C	Report	–39
Flashpoint Cleveland Open Cup °C	220 min	238
Total acidity mgKOH/g	1.0 max	0.01
Sulphur %m	0.6 max	0.2
Copper corrosion 3 hrs @100°C 3 hrs @ 204°C	 1 max 3 max	 1 2
Ash content %m	0.011 max	0.006
Trace sediment	Must pass	Passes
Foaming tendency	Must pass	Passes
Elastomer compatibility AMS 3217/1 72 hrs @ 70°C swell % AMS 3217/4 72 hrs @ 150°C swell %	 Must pass Must pass	 Passes Passes
Trace metal content	Must pass	Passes
Compatibility	Must pass	Passes

A viscosity/temperature chart is shown at the end of this section.
This product is made in more than one location and the approval status and typical properties may vary between locations.

AEROSHELL OILS W80 PLUS and W100 PLUS

AeroShell Oil W80 Plus and AeroShell Oil W100 Plus are new single grade oils that combine the single grade, ashless dispersant performance found in AeroShell Oils W80 and W100 and the anti-wear/anti-corrosion additives of AeroShell Oil W15W-50 Multigrade. They are the oils for pilots who prefer a single grade but who also want the extra protection and performance from the additive package.

APPLICATIONS

The advanced additives in AeroShell Oils W80 Plus and W100 Plus provide better rust and wear protection than conventional single grades. The additives work as a protective barrier to prevent critical parts from being slowly degraded by rust or wear, especially when an aircraft sits idle. This protection helps keep the camshaft and lifters coated, reducing the likelihood of premature damage and helping operators reach TBO.

AeroShell Oils W80 Plus and W100 Plus

- Blended from selected high viscosity mineral base oils
- Contains AeroShell's proven W Oils additive package
- Additional anti-wear additives (containing Lycoming additive LW 16702)
- Additional anti-corrosion additives
- Fully compatible with other approved aircraft piston engine oils

SPECIFICATIONS

Approved SAE J-1899 SAE Grade 40 (AeroShell Oil W80 Plus)
Approved SAE J-1899 SAE Grade 50 (AeroShell Oil W100 Plus)

AeroShell Oils W80 Plus and W100 Plus already contain, in the correct proportions, an anti-wear additive equivalent to the Lycoming additive LW 16702; thus complying with FAA Airworthiness Directive 80-04-03. Operators who use AeroShell Oils W80 Plus and W100 Plus DO NOT need to add this Lycoming additive to the oil.

AeroShell Oils W80 Plus and W100 Plus are qualified for use in all Continental Motors liquid cooled and air cooled aircraft piston engines.

EQUIPMENT MANUFACTURERS' APPROVALS

AeroShell Oils W80 Plus and W100 Plus are approved for use by the following engine manufacturers:

Textron Lycoming	301F Service Bulletins 446E and 471B Service Instruction 1409C
Continental	SIL 99-2
FAA	Airworthiness Directive 80-04-03 R2

Typical Properties		**W80 Plus**	**W100 Plus**
Colour ASTM		<3.0	<3.0
Density @ 15°C	kg/l	0.883	0.887
Kinematic viscosity @ 100°C @ 40°C	mm^2/s	 14.0 113	 19.5 190
Viscosity index	100 min	124	119
Pourpoint	°C	–30	–21
Flashpoint Cleveland Open Cup	°C	260	288
Total acidity	mgKOH/g	0.02	0.02
Sulphur	%m	0.40	0.44
Copper corrosion 3 hrs @100°C		1A	1B
Ash content	%m	0.001	0.002

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

AEROSHELL OIL SPORT PLUS 2

Developed in conjunction with ROTAX®, AeroShell Oil Sport Plus 2 is the first oil specifically developed for light sport 2-stroke (2-cycle) engines such as the ROTAX® air and water-cooled series engines. These types of engines commonly encounter intense operating conditions, i.e. full power take off, cruise descent and idle conditions. Varying power outputs and higher operating temperatures demand a specific 2-stroke oil formulation which will also reduce the formation of deposits and protect the 2-stroke engine's inherent exposure to corrosion and potential ring sticking.

Provides full performance with both unleaded and leaded (AVGAS 100LL) fuel types. This oil can be used in all climates.

APPLICATIONS

AeroShell Oil Sport Plus 2 is intended for use in 2-stroke aircraft piston engines, which have previously relied on general purpose 2-stroke oils originally developed for ground/marine based applications.

- Suitable for all air-cooled and water-cooled engine types.
- Can be used in premix and separate oil injection systems.
- Can be used with unleaded and leaded (AVGAS 100LL) fuels

SPECIFICATIONS

No Aviation specifications yet defined.

Fully approved – all ROTAX® 2-stroke series engines, ROTAX® Service Instruction SI-2ST-008 Selection of suitable operating fluids for ROTAX® 2-stroke UL engines (series).

Meets the requirements of API TC

Please consult Operators Handbook/Manual to confirm the correct fuel/oil mix ratio before use.

FEATURES AND BENEFITS

- First specific oil for Light Sport and Very Light/Ultra Light 2-stroke aircraft engines
- High Film & Shear strength formulation specifically designed for strenuous operating conditions experienced by these types of aviation engines
- Promotes engine cleanliness – protects engine parts such as pistons, rings and exhaust ports from excessive (or harmful) deposits and coking
- Outstanding performance in regard to ring 'sticking'
- Excellent 'clean burn' performance
- Helps to protect engine parts from corrosion during engine shutdown and storage
- Helps engine achieve TBO (Time Between Overhauls)
- Suitable for use in oil injection and pre-mixed oil/fuel systems
- Protects highly stressed engine parts against scuffing and wear
- Can be used in any climate
- Superior performance compared to synthetic 2-stroke products when used in the aviation application
- Advanced anti-rust and anti-wear package
- Dyed green for better recognition
- Can be mixed with other mineral & synthetic 2-stroke oils previously used

DO NOT use AeroShell Oil Sport Plus 2 in engines that are designed to use Ashless Dispersant aviation piston engine oils such as AeroShell W oils. This includes aircooled Continental Motors, Textron Lycoming, Jabiru and ROTAX® 4-stroke engines.

Typical Properties		Sport Plus 2
Density @ 15°C	kg/l	0.88
Kinematic viscosity @ 100°C @ 40°C	mm^2/s	 9.0 61.1
Viscosity index		123
Pourpoint	°C	–33
Flashpoint Cleveland Open Cup	°C	65

AEROSHELL OIL SPORT PLUS 4

Developed in conjunction with ROTAX®, AeroShell Oil Sport Plus 4 is the first oil specifically developed for light sport aviation piston engines such as the ROTAX® 912 & 914 series. A combination of low cylinder head temperature (compared with air cooled engines), low oil consumption and the engine internals requires a blend of high quality hydrocarbon base stocks, incorporating synthetic technology, which allows full performance with different fuel types. This oil can be used in all climates.

APPLICATIONS

AeroShell Oil Sport Plus 4 is intended for use in four-stroke (four-cycle) aircraft piston engines that are of an original automotive design and which cannot, therefore, use traditional Ashless Dispersant aircraft engine oil types. These engines include carburetted, fuel-injected and turbocharged types such as the ROTAX® 912 & 914 series.

AeroShell Sport Plus 4 can be used in integrated gearbox and wet clutch systems.

AeroShell Oil Sport Plus 4 can be used in engines which operate on both unleaded gasoline and Avgas 100LL. The correct choice of additives and good solvent properties allow the oil to handle lead by-products that can form a semi solid sludge in the oil which can restrict oil passages and compromise lubrication. AeroShell Oil Sport Plus 4 is superior in this respect to those oil types intended for automotive/motorcycle application.

Please refer to Operators Handbook/Manual for the correct oil drain interval when operating on different fuels.

SPECIFICATIONS

No Aviation specifications yet defined.

Meets or exceeds the requirements of the highest international specifications:
API SL
JASO MA

Fully approved – all ROTAX® 912 & 914 series engines, ROTAX® Service Instruction SI-912-016/SI-914-019 Selection of suitable operating fluids for ROTAX® engine type 912 & 914 (series).

Please consult Operating Handbook/Manual to confirm the correct lubricant specification before use.

FEATURES AND BENEFITS

- First specific oil for Light Sport and Very Light/Ultra light aircraft engines
- Promotes engine cleanliness
- Helps keep engines sludge and varnish free
- Helps reduce oil consumption
- Helps engines reach TBO (Time Between Overhauls)
- Protects highly stressed engines parts against scuffing and wear
- Anti-foaming additives to maximise lubrication effectiveness – especially for those engines operating an integrated gearbox
- Better cold flow characteristics for easier starts and quicker protection
- High thermal stability for longer-lasting and safer lubrication
- Can be used in any climate
- Advanced anti-rust and anti-wear package

DO NOT use AeroShell Oil Sport Plus 4 in engines that are designed to use Ashless Dispersant aviation piston engines oils such as AeroShell W oils. This includes air-cooled Continental Motors and Textron Lycoming engines.

Typical Properties		Sport Plus 4
SAE viscosity grade		Multigrade 10W-40
Density @ 15°C	kg/l	0.871
Kinematic viscosity @ 100°C @ 40°C	mm^2/s	 14.46 94.2
Viscosity index		159
Pourpoint	°C	–33
Flashpoint Cleveland Open Cup	°C	228

AEROSHELL OIL DIESEL 10W-40

AeroShell Oil Diesel 10W-40 is a fully synthetic, multigrade engine oil designed for use in the new generation of compression ignition (Diesel) Aviation Piston Engines.

The formulation has been selected to be suitable in piston engines fuelled by Jet A or Jet A-1 and is designed for use in the latest highly rated turbocharged diesel engines under all operating conditions.

APPLICATIONS

AeroShell Oil Diesel 10W-40 is a fully synthetic engine oil containing a unique additive package to provide superior piston cleanliness, resulting in a clean, efficient and reliable engine. The package includes a powerful surface active additive that bonds to the surface of highly loaded engine parts, protecting the engine from scuffing damage.

AeroShell Oil Diesel 10W-40 has been developed to be suitable for use in engines burning Jet fuel and its performance has been optimised to cope with the demands of this type of engine. Its key performance features include the ability to sustain high bearing loads, neutralisation of acid build-up from the sulphur present in the fuel and high dispersancy to allow for the relatively high particle loading produced when burning Jet fuel.

During development, AeroShell Oil Diesel 10W-40 has amassed around 40,000 hours in engine- and flight-testing. It has been used throughout the SMA engine development program and during Thielert engine development testing: it is fully approved by both manufacturers. Further approvals are being sought as other engines are developed for this emerging market.

AeroShell Oil Diesel 10W-40 **MUST NOT** be used in spark ignition or Avgas powered aircraft engines.

ENGINE MANUFACTURERS' APPROVALS

AeroShell Oil Diesel 10W-40 is approved for use in the following engines.

SMA Engines	SR 305 (Later models yet to be produced)
Thielert Engines	1.7 and 2.0 Centurion® (Other models yet to be produced)

SPECIFICATIONS

No Aviation specifications yet defined.

U.S.	-
British	-
French	-
Russian	-
NATO Code	-
Joint Service Designation	-
ACEA	E4, E5 equivalent
API	CF equivalent

Typical Properties		**Diesel 10W-40**
Oil type		Fully synthetic hydrocarbon
SAE viscosity grade		Multigrade10W-40
Density @ 15°C	kg/l	0.859
Base oil viscosity @ 100°C @ 40°C	mm^2/s	 14.6 93.0
Viscosity index		Above 160
Pourpoint	°C	–38
Flashpoint Cleveland Open Cup	°C	220
Total base number	mgKOH/g	16.0
Sulphated ash content	%m	1.9

NOTE: At the time of writing, AeroShell Oil Diesel 10W-40 was in the process of being superseded by AeroShell Oil Diesel Ultra.

AEROSHELL OIL DIESEL ULTRA

AeroShell Oil Diesel Ultra is a fully synthetic, multigrade engine oil designed for use in the new generation of compression ignition (Diesel) Aviation Piston Engines.

The formulation has been selected to be suitable in piston engines fuelled by Jet A or Jet A-1 and is designed for use in the latest highly rated turbocharged diesel engines under all operating conditions.

APPLICATIONS

AeroShell Oil Diesel Ultra is a fully synthetic engine oil containing a unique additive package to provide superior piston cleanliness, resulting in a clean, efficient and reliable engine. This package includes a powerful surface active additive, which bonds to the surface of highly loaded engine parts, protecting the engine from scuffing damage.

This oil has been developed to provide excellent component wear protection and engine cleanliness, based on substantial engine and component endurance tests with all the major diesel aero-engine manufacturers, and flight experience with diesel aero-engines in the field over recent years.

AeroShell Oil Diesel Ultra has been developed to be suitable for use in engines burning Jet fuel and its performance has been optimised to cope with the demands of this unique type of engine/fuel combination. Its key performance features include the ability to sustain high bearing loads, neutralisation of acid build up from the sulphur present in the fuel, and high dispersancy to allow for the relatively high particle loading produced when burning Jet fuel.

AeroShell Oil Diesel Ultra **MUST NOT** be used in spark ignition or Avgas powered aircraft engines.

ENGINE MANUFACTURERS' APPROVALS

AeroShell Oil Diesel Ultra is approved to Mercedes Benz Specification 229.5, recognised and required by the leading Diesel aero engine manufacturers AeroShell Oil Diesel Ultra is approved for use in the following engines. Whilst this is correct at the time of writing, testing is ongoing to extend this approval listing as new engines are produced.

Thielert/Centurion® Engines	1.7 & 2.0 Centurion® (Other models yet to be produced)
Austro Engine	AE300

SPECIFICATIONS

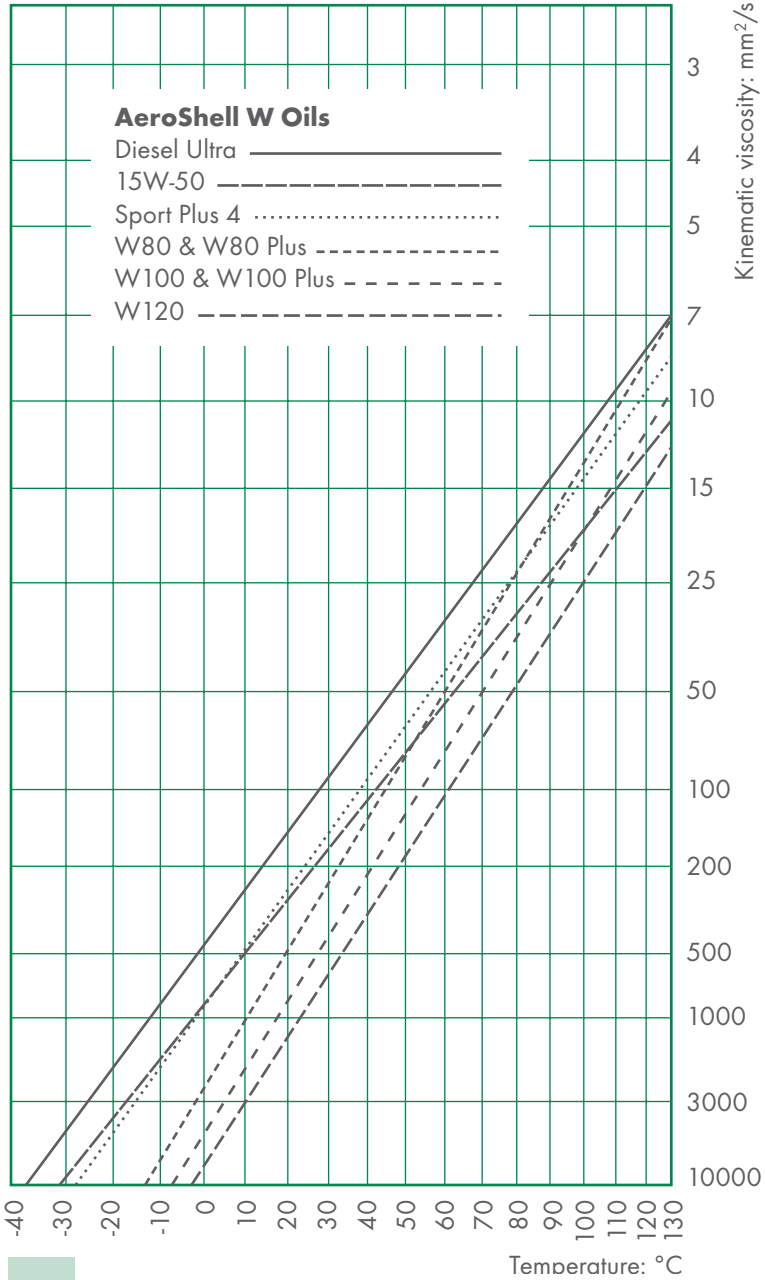
No Aviation specifications yet defined.

U.S.	-
British	-
French	-
Russian	-
NATO Code	-
Joint Service Designation	-
ACEA	Meets the requirements of A3/B4
API	Meets the requirements of SL/CF
Mercedes Benz	MB 299.5
SAE	Viscosity grade 5W-30

Typical Properties		**Diesel Ultra**
Oil type		Fully synthetic hydrocarbon
SAE viscosity grade		Multigrade 5W-30
Density @ 15°C	kg/l	0.84
Kinematic viscosity @ 100°C @ 40°C	mm^2/s	 12.2 68.2
Pourpoint	°C	–39
Flashpoint Cleveland Open Cup	°C	215
HTHS viscosity @ 150°C	mPaS	3.50

NOTE: At the time of writing, AeroShell Oil Diesel Ultra was in the process of replacing AeroShell Oil Diesel 10W-40.

TYPICAL TEMPERATURE/VISCOSITY CURVES OF AEROSHELL W OILS



4. AEROSHELL TURBINE ENGINE OILS

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

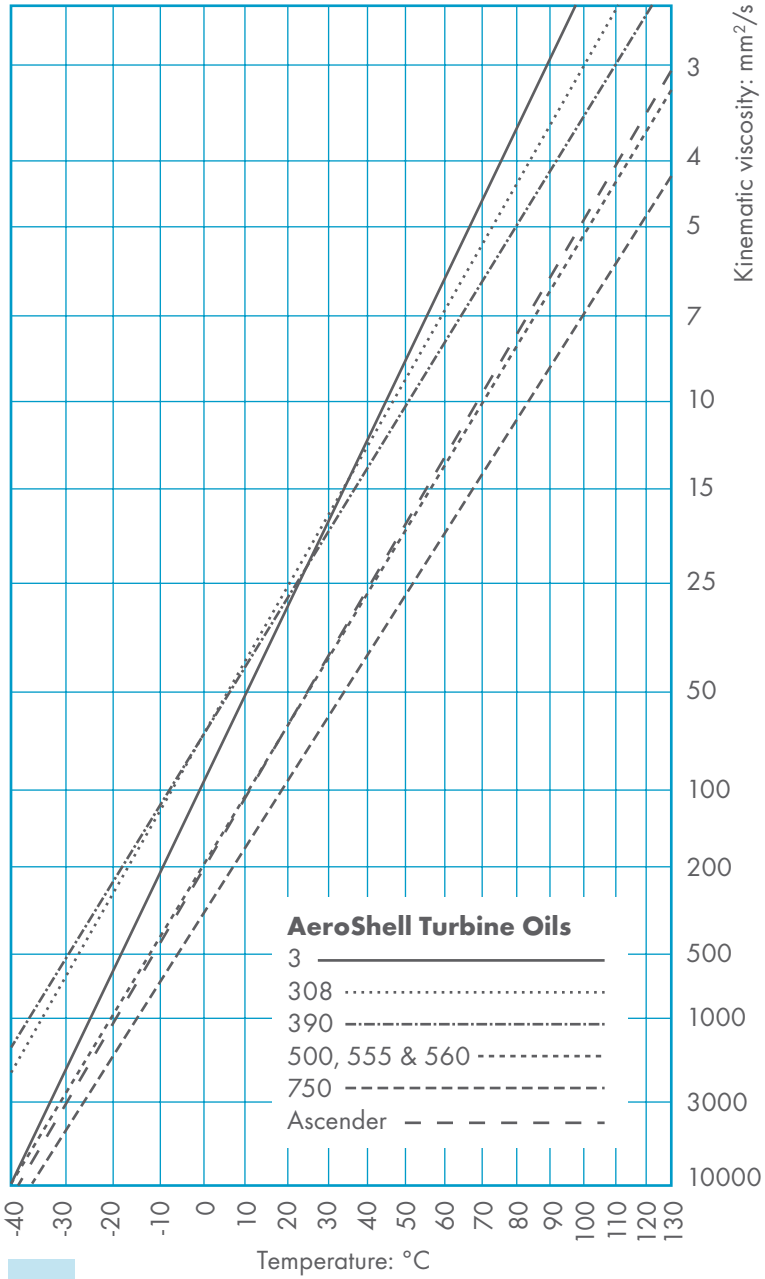
(1) AeroShell Turbine Oil 555 can be used if SB 49-59 has been incorporated

(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



5. AEROSHELL GREASES

AEROSHELL GREASES

THE DEFINITION OF A GREASE IS:

"A solid or semi-solid lubricant comprising a dispersion of a thickening agent in a liquid lubricant to which various additives have been added to improve particular properties".

Within the aviation industry, there are many grease lubricated applications covering a very wide range of performance requirements. Those requirements are being increasingly stretched through new technology developments and extended service intervals.

Many different grease formulations have been developed to meet specific requirements. One of Shell's recent objectives, as a major supplier of aviation greases, has been the development of wide performance range products where a single grease can cover a multitude of applications.

Greases, depending on the thickening agent, are broadly classified as either soap-based or non-soap-based. The soap-based greases include, for example, aluminum, calcium, sodium or lithium soaps; the non-soaps silica gel, clay and substituted urea.

The low melting points and water solubility of some soap greases limit their usefulness. As a result alternative thickening agents have been developed – soap-complex thickened greases, and non-soap greases with a much higher or no melting point. These thickening agents were developed for greases needing superior high temperature performance characteristics. Shell's search for thickeners without the limitations of the simple soap-type, led to a family of proprietary technologies including our 'Microgel®' and Lithium-Complex systems.

Microgel® greases rely on an inorganic grease thickening agent, based on hectorite clay, which has several advantages over simple soap-type thickeners. It provides the AeroShell greases in which it is used with excellent physical properties, as shown below. Those properties make them particularly suitable for multi-purpose as well as specialised applications.

1. No melting point, within any conceivable temperature range for aircraft greases.
2. Very little change in consistency with variation in temperature.
3. Extremely good load carrying ability without the need for extreme pressure additive.
4. Excellent water resistance due to the use of tenacious waterproofing agents developed by Shell.
5. Low oil separation or 'bleeding', because of the high gelling efficiency.

During recent years, the number of greases required for aircraft lubrication/maintenance has been reduced by more extensive use of multi-purpose greases. However, because of commercial and technological limitations, special greases are still required. Most aircraft grease requirements are covered by the products in the AeroShell grease range.

To minimise the number of greases required per aircraft, the most widely used specification in the aviation industry today is the general purpose grease to MIL-PRF-23827.

In the early 2000's the Boeing Company introduced a multi-purpose grease specification (BMS 3-33) to replace many of the different greases previously required in support of Boeing aircraft. This has led to the development of the accompanying specification SAE AMS 3052. The only grease to meet the most challenging set of requirements of the initial BMS 3-33A specification has been AeroShell Grease 33. This ground breaking grease, based on a Lithium-Complex thickener system, has a superior capacity to accommodate a wide range of proprietary performance additives. This thickener system now forms the basis for future grease developments in the AeroShell grease family.

Detailed information for each AeroShell grease is given in this section, but for ease of reference AeroShell greases can be split into the following application categories.

ADVANCED MULTI-PURPOSE GREASES

(Wide temperature range with good load carrying properties)

AeroShell Grease 7
AeroShell Grease 22
AeroShell Grease 33
AeroShell Grease 58
AeroShell Grease 64

AeroShell Grease 7 has a useful operating temperature range of –73°C to +149°C. This coupled with its good load carrying ability make it entirely suitable for multi-purpose applications in aircraft fleets.

AeroShell Grease 22 is recommended for most aviation anti-friction bearing applications. It is especially recommended for use wherever severe operating conditions are encountered as in high bearing loads, high speed, wide operating temperature range, and particularly where long grease retention and high resistance to water washout are required.

AeroShell Grease 33 has a useful temperature range of –73°C to +121°C and is suitable for the majority of airframe grease applications.

AeroShell Grease 64, based on AeroShell 33, contains molybdenum disulphide and is particularly effective for lubricating heavily loaded sliding steel surfaces.

LOAD CARRYING GREASES

	Typical mean Hertz load (kg)
AeroShell Grease 7	60
AeroShell Grease 22	39
AeroShell Grease 33	60
AeroShell Grease 58	79
AeroShell Grease 64	57.5

AeroShell Greases 7, 22, 33, 58 and 64 are suitable for operating under heavy load, e.g. gearboxes, retracting screws, worms, chains, and undercarriage pivot bearings, etc.

EXTREME TEMPERATURE GREASES

	Useful operating temperature range
AeroShell Grease 7	–73 to +149°C
AeroShell Grease 15	–73 to +232°C
AeroShell Grease 22	–65 to +204°C
AeroShell Grease 33	–73 to +121°C
AeroShell Grease 58	–54 to +175°C
AeroShell Grease 64	–73 to +121°C

AeroShell Grease 15 is suitable for use in lightly loaded ball and roller bearings throughout the temperature range quoted.

HIGH TEMPERATURE GREASES WHICH HAVE GOOD LOAD CARRYING ABILITY

	Useful maximum temperature
AeroShell Grease 5	+177°C
AeroShell Grease 7	+149°C
AeroShell Grease 22	+204°C
AeroShell Grease 58	+175°C
AeroShell Grease 64	+121°C

AeroShell Grease 5 is recommended for normal high temperature applications when low temperature properties are not required; it has proved to be an excellent wheel bearing grease.

GREASE WITH ENHANCED CORROSION INHIBITION

AeroShell Grease 33
AeroShell Grease 64 - (with 5% molybdenum disulphide)

AeroShell Grease 33 has enhanced corrosion resistance, and resistance to washout from water, de-icing fluids and other maintenance fluids.

AeroShell Grease 64 is not subject to any speed restrictions and is widely accepted as an advanced multi-purpose grease.

GENERAL PURPOSE GREASES WHICH HAVE A LIMITED OPERATING TEMPERATURE RANGE

AeroShell Grease 6
AeroShell Grease 14

AeroShell Grease 6 has a useful temperature range of –40°C to +121°C, good load carrying ability and is inexpensive, which makes it suitable for use as a general grease for piston engined aircraft.

AeroShell Grease 14 is now the universally accepted helicopter grease with a useful operating temperature range of –54°C to +94°C. Owing to it's excellent anti-fret properties it is especially recommended for the lubrication of helicopter main and tail rotor bearings.

SPECIAL GREASES

AeroShell Grease 14

Apart from its general purpose application for helicopters AeroShell Grease 14 is also recommended when anti-fret and anti-corrosion properties are required, e.g. splines.

GENERAL COMMENTS

TYPE OF BASE OILS

Mineral
AeroShell Grease 5
AeroShell Grease 6
AeroShell Grease 14

Synthetic Hydrocarbon
AeroShell Grease 22
AeroShell Grease 58

Synthetic Ester
AeroShell Grease 7

Silicone Oil
AeroShell Grease 15

Mixed Synthetic Hydrocarbon and Ester
AeroShell Grease 33
AeroShell Grease 64

TYPES OF THICKENER

Microgel
AeroShell Grease 5
AeroShell Grease 6
AeroShell Grease 7
AeroShell Grease 22

Lithium Complex
AeroShell Grease 33
AeroShell Grease 58
AeroShell Grease 64

Calcium Soap
AeroShell Grease 14

APPLICATIONS

Whenever an aircraft is certified, all of the greases 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 greases which are qualified to be used. The U.S. Federal Aviation Administration (FAA) regulations state that only greases 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 greases should be used.

MAIN REQUIREMENTS

The majority of aviation grease specifications call for greases to be evaluated in the following tests:

- Drop point
- Penetration at 25°C, unworked/worked
- Evaporation loss in 22 hours (temperature varies according to specification)
- Corrosion, copper strip at 100°C
- Water resistance at 40°C
- Anti-friction bearing performance (temperature varies according to specification)
- Mean Hertz load
- Oil separation in 30 hours (temperature varies according to specification)
- Bomb oxidation pressure drop (conditions vary according to specification).

In addition most aviation grease specifications call up other tests which are either specific to the type of grease or to the intended application.

TYPICAL PROPERTIES

In the following section typical properties are quoted for each grease; there may be deviations from the typical figures given but test figures will fall within the specification requirements. Due to poor repeatability of the low temperature torque test, typical test figures for this have not been included.

BASE OIL VISCOSITY

Although not normally part of the specification requirements, typical base oil viscosities have been quoted for the majority of AeroShell Greases.

USEFUL OPERATING TEMPERATURE RANGE

The useful operating temperature ranges are quoted for guidance only. Continuous operation of equipment, with bearing temperatures at or in excess of these maximum and minimum limits for the grade in use, is not recommended.

OIL SEPARATION

Oil separation to a greater or lesser extent occurs with all greases. Unless the separation is excessive the grease can be used providing it is stirred well before use.

COMPATIBILITY WITH MATERIALS

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

Greases with a silicone oil base should not be used when silicone elastomers are present.

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 can only be considered as guidelines.

Elastomer/Plastic	Mineral Oil Based Greases	Synthetic Hydrocarbon Based Greases	Synthetic Ester Based Greases
Flurocarbon (Viton)	Very Good	Very Good	Very Good
Acylonitrile	Good	Good	Poor to Good (high nitrile content is better)
Polyester	Good	Good	Poor to Fair
Silicone	Poor to Good	Poor to Good	Poor to Fair
Teflon	Very Good	Very Good	Very Good
Nylon	Poor to Good	Poor to Good	Poor
Buna-S	Poor	Poor	Poor
Perbunan	Good	Good	Fair to Good
Methacrylate	Good	Good	Poor to Fair
Neoprene	Fair to Good	Fair to Good	Poor
Natural Rubber	Poor to Fair	Poor to Fair	Poor
Polyethylene	Good	Good	Good
Butyl Rubber	Very Poor to Poor	Very Poor to Poor	Poor to Fair
Poly Vinyl Chloride	Poor to Good	Poor to Good	Poor

Compatibility Rating:
Very Good - Good - Fair - Poor - Very Poor

COMPATIBILITY AND INTERMIXING OF GREASES

What is grease incompatibility? The National Lubricating Grease Institute (NLGI) definition states that two greases show incompatibility when a mixture of the products shows physical properties or service performance which are markedly inferior to those of either of the greases before mixing. Performance or properties inferior to one of the products and superior to the other may be due to simple mixing and would not be considered as evidence of incompatibility; this is sometimes referred to as "performance dilution".

In general, mixing of greases made with different thickener types should be avoided; thus Microgel® or clay thickened greases should not be mixed with soap thickened (e.g. lithium complex) greases as this can lead to breakdown of the thickener structure. Incompatibility between greases can also arise from additive interactions. In some cases, different greases approved to the same specification may be incompatible with each other; to account for this, the MIL-PRF-23827C specification was amended to divide approved greases into Type I (soap-based) and Type II (clay-based).

GREASE SUBSTITUTION

Airframe and grease manufacturers do not recommend intermixing different types or brand names of grease, even if they are considered optional to each other, because of possible incompatibility.

When changing over from one type or brand name grease to another, the recommended practice is to remove all of the old grease from the bearing surfaces and internal cavities of the lubricated mechanism prior to application of the new grease. If this is not possible or practicable, then the "purging" technique should be employed.

Generally, "purging" is defined as "the process of injecting grease into the grease fitting until the old grease has been visibly exhausted from the mechanism and only the new grease is coming out." It is advisable to seek information from the aircraft manufacturers and their maintenance manuals for their recommendations regarding purging procedures.

Note: The definition of purging is not specific to the substitution of greases and applies equally to routine re-greasing with the same grease where the object in this case is to expel contaminants such as wear debris, dust, dirt and water which may have accumulated in the grease during service. That is, purging should always be done where the design of the lubricated component is amenable to this purging process.

Always consult the Aircraft Maintenance Manual, Maintenance Planning Document or Component Overhaul Manual, and any associated Service Bulletins for advice on the correct grade of grease to be used in a particular mechanism and on the method of application and/or replacement of that grease. In particular, the latest issues of the following publications should be consulted for the most up-to-date advice:

- Boeing Service Letter 707-SL-20-012-C/727-SL-20-022C/737-SL-20-027-C/747-SL-20-044-C/757-SL-20-022-C/767-SL-20-022-C/777-SL-20-006-C
  "Summary of Most Commonly Used Greases on Boeing Airplanes"

- Airbus Service Information Letter SIL 12-008
  "General Purpose Aviation Greases Functional Interchangeability"

- FAA Flight Standards Information Bulletin for Airworthiness FSAW 02-02C
  "The Potential Adverse Effects of Grease Substitution"

After changing from one type or brand of grease to another, operators may choose to shorten the re-greasing interval by 50% for the following period and then revert to the normal re-greasing interval specified in the Aircraft Maintenance Manual. This will help to ensure that the new type or brand of grease has fully replaced the old.

It is not good practice to randomly or intermittently alternate between grease types or brands, even though they may be approved to the same grease specification. Grease manufacturers carefully balance the components in their greases for optimum performance. Therefore even if two different greases are not incompatible, it is unlikely that all mixtures of the two greases will maintain the same optimal performance as the individual greases ("performance dilution"). Once an action has been taken to change grease types or brands, then the chosen grease should always be used for subsequent re-greasing.

Wherever possible, use of a grease gun or grease in cartridges is recommended. If grease is used directly from tins or pails, it is important that wooden scrapers are not employed and that the tin lid is replaced firmly immediately the grease has been removed in order to prevent contamination by airborne dust, dirt and atmospheric moisture.

GREASE SELECTION

In selecting a grease for a particular application the following should be considered:

- **Lubrication Requirements**
  - friction requirements
  - wear control
  - penetration
  - cooling (heat dissipation)
  - sealing
  - corrosion resistance

- **Engineering Component**
  - type of component
  - nature of contact (rolling, sliding, etc.)
  - load, speed and size
  - metallurgy/chemistry of component
  - geometrics/space constraints

- **Environment Factor**
  - temperature
  - atmosphere conditions (humidity, dirt/dust contamination)
  - ingress of water or other fluids
  - seal materials
  - health and safety

- **Endurance and Application**
  - method of application
  - re-lubrication interval
  - life expectancy of lubricant
  - life expectancy under exceptional conditions
  - life expectancy of component
  - need for protection against unexpected event
  - performance versus cost

AEROSHELL GREASES IN NON-AVIATION APPLICATIONS

In selecting an AeroShell Grease for a non-aviation application the properties of the greases 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.

AEROSHELL GREASE 5

AeroShell Grease 5 is a high temperature grease composed of a mineral oil thickened with Microgel®, possessing good load-carrying ability. It is inhibited against oxidation and corrosion and has excellent resistance to water. The useful operating temperature range is –23°C to +177°C.

APPLICATIONS

AeroShell Grease 5 is particularly effective for use as a wheel bearing grease, especially when landing speeds are high, and is suitable for the lubrication of aircraft and engine accessories operating at high speeds and at relatively high temperatures, e.g. magnetos, generators and starters. For the lubrication of rolling bearings which are required to start at temperatures as low as –23°C an adequate period should be allowed for the grease to channel.

SPECIFICATIONS

U.S.	Meets MIL-G-3545C (Obsolete)
British	Meets DTD.878A (Obsolete)
French	Equivalent DCSEA 359/A
Russian	-
NATO Code	G-359 (Obsolete)
Joint Service Designation	XG-277 (Obsolete)

PROPERTIES	**MIL-G-3545C**	**TYPICAL**
Oil type	-	Mineral
Thickener type	-	Microgel
Base oil viscosity mm²/s @ 40°C @ 100°C	 - -	 500 to 525 32
Useful operating temperature range °C	-	–23°C to +177
Drop point °C	177 min	260+
Worked penetration @ 25°C	250 to 300	284
Unworked penetration @ 25°C	-	281
Bomb oxidation pressure drop @ 99°C 100 hrs lb/in² 500 hrs lb/in²	 10 max 25 max	 6 15
Oil separation @ 100°C, in 30 hrs %m	5 max	0.5
Water resistance test loss @ 41°C %m	20 max	0.5
Evaporation loss in 22 hrs @ 149°C %m	-	1.0
Mean Hertz Load kg	-	37
Copper corrosion 24 hrs @ 100°C	Must pass	Passes
Bearing protection 2 days @ 51°C	Must pass	Passes
Anti-friction bearing performance @ 149°C hrs	-	600+
Colour	-	Amber

AEROSHELL GREASE 6

AeroShell Grease 6 is a general purpose grease composed of a mineral oil thickened with Microgel®, possessing good all-round properties within a limited range. It is inhibited against oxidation and corrosion and has good water resistance and low noise capability.

The useful operating temperature range is –40°C to +121°C.

APPLICATIONS

AeroShell Grease 6 is a general purpose airframe grease for use in anti-friction bearings, gearboxes and plain bearings within the temperature range of –40°C to +121°C.

SPECIFICATIONS

U.S.	Approved MIL-PRF-24139A Meets MIL-G-7711A (Obsolete)
British	Approved DEF STAN 91-12
French	Equivalent DCSEA 382/AA
Russian	-
NATO Code	G-382
Joint Service Designation	XG-271

PROPERTIES	MIL-PRF-24139A	TYPICAL
Oil type	Mineral	Mineral
Thickener type	-	Microgel
Base oil viscosity mm²/s @ 40°C @ 100°C	 - -	 35 5.5
Useful operating temperature range °C	-	–40°C to +121
Drop point °C	149 min	260+
Worked penetration @ 25°C	265 to 320	300
Unworked penetration @ 25°C	-	287
Bomb oxidation pressure drop @ 99°C 100 hrs lb/in² 500 hrs lb/in²	 10 max 25 max	 9 15
Oil separation @ 100°C, in 30 hrs %m	-	0.7
Water resistance test loss @ 38°C %m	5 max	2.0
Evaporation loss in 22 hrs @ 121°C %m	-	1.3
Mean Hertz Load kg	30	35
Anti-friction bearing performance @ 121°C hrs	-	2000+
Copper corrosion 24 hrs @ 100°C	Must pass	Passes
Bearing protection 2 days @ 51°C	Must pass	Passes
Colour	-	Brown

AEROSHELL GREASE 7

AeroShell Grease 7 is an advanced multi-purpose grease, composed of a synthetic oil thickened with Microgel®, possessing good load carrying ability over a wide temperature range. It is inhibited against corrosion and has excellent resistance to water.

The useful operating temperature range is –73°C to +149°C.

APPLICATIONS

AeroShell Grease 7 satisfies nearly all the airframe grease requirements of turbine engined aircraft and also those of piston engined aircraft provided that seal incompatibility does not occur. Most civil aircraft manufacturers approve AeroShell Grease 7 as a general purpose grease either by brand name or by specification. It is recommended for lubricating highly loaded gears, actuator screw mechanisms, etc., also for instrument and general airframe lubrication within the temperature range of –73°C to +149°C.

AeroShell Grease 7 contains a synthetic ester oil and should not be used in contact with incompatible seal materials. Refer to the General Notes at the front of this section.

AeroShell Grease 7 is a clay-based grease approved to MIL-PRF-23827C Type II; it should not be mixed with soap-based greases approved to MIL-PRF-23827C Type I.

SPECIFICATIONS

U.S.	Approved MIL-PRF-23827C (Type II)
British	-
French	-
Russian	-
Joint Service Designation	-

PROPERTIES	**MIL-PRF-23827C (Type II)**	**TYPICAL**
Oil type	Synthetic	Synthetic ester (Diester)
Thickener type	Clay	Microgel
Base oil viscosity mm²/s		
@ –40°C	-	1150
@ 40°C	-	10.3
@ 100°C	-	3.1
Useful operating temperature range °C	-	–73°C to +149
Drop point °C	165 min	260+
Worked penetration @ 25°C	270 to 310	296
Unworked penetration @ 25°C	200 min	283
Bomb oxidation pressure drop @ 99°C		
100 hrs kPa	70 max	62
500 hrs kPa	105 max	96.5
Oil separation @ 100°C, in 30 hrs %m	5 max	3.0
Water resistance test loss @ 38°C %m	20 max	0.80
Evaporation loss in 22 hrs @ 100°C %m	2.0 max	0.5
Mean Hertz Load kg	30 min	60
Anti-friction bearing performance @121°C hrs	-	2460
Copper corrosion 24 hrs @ 100°C	Must pass	Passes
Bearing protection 2 days @ 52°C	Must pass	Passes
Colour	-	Buff

AEROSHELL GREASE 14

AeroShell Grease 14 is a helicopter multi-purpose grease composed of a mineral oil thickened with a calcium soap, possessing outstanding anti-fret and anti-moisture corrosion properties. It is oxidation and corrosion inhibited.

The useful operating temperature range is –54°C to +93°C

APPLICATIONS

AeroShell Grease 14 is the leading helicopter multi-purpose grease and is approved by all helicopter manufacturers. Owing to its anti-fret properties, AeroShell Grease 14 is particularly suitable for the lubrication of helicopter main and tail rotor bearings, splines, etc.

SPECIFICATIONS

U.S.	Approved MIL-G-25537C
French	-
Russian	-
NATO Code	G-366
Joint Service Designation	XG-284

PROPERTIES	MIL-G-25537C	TYPICAL
Oil type	-	Mineral
Thickener type	-	Calcium Soap
Base oil viscosity mm²/s @ 40°C @ 100°C	 - -	 12.5 3.1
Useful operating temperature range °C	-	–54°C to +93
Drop point °C	140 min	148
Worked penetration @ 25°C	265 to 305	273
Unworked penetration @ 25°C	200 min	269
Bomb oxidation pressure drop @ 99°C 100 hrs MPa 400 hrs MPa	 0.0345 max 0.1378 max	 0.0207 0.0689
Oil separation @ 100°C, in 30 hrs %m	 5.0 max	 1.5
Water resistance test loss %m	-	7.2
Evaporation loss in 22 hrs @ 100°C %m	 7.0 max	 5.6
Anti-friction bearing performance @ 93°C hrs	 -	 1700+
Copper corrosion 24 hrs @ 100°C	 Must pass	 Passes
Bearing protection 2 days @ 52°C	 Must pass	 Passes
Colour	-	Tan

AEROSHELL GREASE 15

AeroShell Grease 15 is an extreme temperature range grease, composed of silicone oil with an organic thickener. AeroShell Grease 15 is inhibited against corrosion and oxidation, and possesses excellent high temperature and mechanical stability properties and low evaporation rate. It is water resistant.

The useful temperature range is –73°C to +232°C.

AeroShell Grease 15 has a tendency to bleed and should be stirred before use.

AeroShell Grease 15 has replaced AeroShell Grease 15A.

APPLICATIONS

AeroShell Grease 15 is a special grease suitable for use in lightly loaded ball and roller bearings through a temperature range of –73°C to +232°C. AeroShell Grease 15 is recommended for continuous high temperature service, e.g. for turbine engine control bearings, or where low torque properties are required at temperatures down to –73°C.

SPECIFICATIONS

U.S.	Approved MIL-G-25013E
British	Meets DEF STAN 91-55 (Obsolete)
French	-
Russian	Analogue of VNII NP 235
NATO Code	G-372
Joint Service Designation	XG-300

PROPERTIES	**MIL-G-25013E**	**TYPICAL**
Oil type	-	Silicone
Thickener type	-	Teflon
Base oil viscosity mm^2/s @ 40°C @ 100°C	 - -	 55 14.0
Useful operating temperature range °C	-	–73°C to +232
Drop point °C	230 min	260+
Worked penetration @ 25°C	260 to 320	280
Bomb oxidation pressure drop @ 100 hrs kPa	35.0	2
Low temperature torque @ –73°C Starting Nm Running Nm	 0.35 max 0.05 max	 0.32 0.035
Oil separation @ 232°C, 30 hrs %m	7.5 max	3.0
Water resistance test loss @ 40°C %m	20 max	3.1
Evaporation loss in 22 hrs @ 205°C %m	4.0 max	2.7
High temperature bearing performance @ 232°C hrs	500 min	518+
Colour	-	Off white

AEROSHELL GREASE 22

AeroShell Grease 22 is a versatile advanced general purpose grease composed of a synthetic hydrocarbon oil thickened with Microgel®, with outstanding performance characteristics. Appropriate additives are included to achieve the necessary oxidation and corrosion resistance, anti-wear properties and load carrying properties.

The useful operating temperature range is –65°C to +204°C.

APPLICATIONS

AeroShell Grease 22 is especially recommended for use wherever severe operating conditions are encountered as in high bearing loads, high speeds, wide operating temperature range, and particularly where long grease retention and high resistance to water washout are required.

The wide range of applications include aircraft wheel bearings, engine accessories, control systems, actuators, screw-jacks, servo mechanisms and electric motors, helicopter rotor bearings, instruments, airframe lubrication, hinge pins, static joints, landing gears.

AeroShell Grease 22 contains a synthetic hydrocarbon oil and should not be used in contact with incompatible seal materials. Refer to the General Notes at the front of this section for further information.

SPECIFICATIONS

U.S.	Approved MIL-PRF-81322G Approved DOD-G-24508A
British	Approved DEF STAN 91-52
French	Approved DCSEA 395/A
Russian	Analogue of CIATIM 201 and 203, VNII NP 207, ERA (VNII NP 286M) and ST (NK-50)
NATO Code	G-395
Joint Service Designation	XG-293

PROPERTIES	MIL-PRF-81322G	TYPICAL
Oil type	-	Synthetic Hydrocarbon
Thickener type	-	Microgel
Base oil viscosity mm^2/s		
@ –40°C	-	7500
@ 40°C	-	30.5
@ 100°C	-	5.7
Useful operating temperature range °C	-	–65°C to +204
Drop point °C	232 min	260+
Worked penetration @ 25°C	265 - 320	275
Unworked penetration @ 25°C	-	271
Bomb oxidation pressure drop @ 99°C		
@ 100 hrs kPa (psi)	83 (12) max	27 (4)
@ 500 hrs kPa (psi)	172 (25) max	69 (10)
Oil separation @ 177°C, in 30 hrs %m	2.0 to 8.0	4.7
Water washout Loss @ 41°C %m	20 max	0.5
Evaporation loss in 22 hrs @ 177°C %m	10 max	4.3
Anti-friction bearing performance @ 177°C hrs	400 min	400+
Load carrying capacity/ Load wear index kg	30 min	45
Copper corrosion 24 hrs @ 100°C	Must pass	Passes
Bearing protection 2 days @ 52°C	Must pass	Passes
Colour	-	Amber

AEROSHELL GREASE 33

AeroShell Grease 33 is a synthetic universal airframe grease composed of a lithium complex thickened synthetic base oil with corrosion and oxidation inhibitors and load carrying additives.

The useful operating temperature range is –73 °C to +121 °C.

APPLICATIONS

For many years aircraft operators have been seeking to rationalise the greases used on aircraft and to reduce the number of different greases in their inventories. Recently Boeing began research on a new, general purpose, corrosion-inhibiting grease. The aim was for a non-clay based grease that would provide longer life for components and mechanisms and possess improved wear and corrosion resistance. This led to the introduction of the new Boeing Specification BMS 3-33.

Owing to the wide range of operating temperatures, loads and other environmental conditions required for various aircraft components, several different types of grease with different desirable properties are used during routine lubrication of aircraft components. Boeing, in developing their BMS 3-33 specification, took account of the properties of the different grease types used on aircraft and wrote a specification for a grease which would provide improved performance and which could be used in the widest possible range of grease applications. That performance level has largely been adopted as the SAE AMS 3052 specification, which is in turn the basis for the Airbus AIMS 09-06-002 specification.

AeroShell Grease 33 is approved to BMS 3-33B and offers the improved performance properties required by this specification and the other specifications mentioned above.

AeroShell Grease 33 can be used for routine lubrication on Boeing aircraft where MIL-PRF-23827C or BMS 3-24 is specified. AeroShell Grease 33 can also be used in some applications on Boeing aircraft which require use of MIL-G-21164. Other applications on Boeing aircraft which require use of MIL-G-21164 and other greases are being reviewed and in due course Boeing will issue details of the full range of applications. For the current status, refer to the latest issue of Boeing Service Letter “BMS 3-33 General Purpose Aircraft Grease”.

AeroShell Grease 33 can be used for routine lubrication in applications where MIL-PRF-23827C is specified on aircraft manufactured by McDonnell Douglas, Airbus, BAe Regional Aircraft, Canadair, Lockheed, Embraer, Fokker and Gulfstream (except for wheel bearings, applications above 121 °C and sliding applications requiring molybdenum disulphide).

Other aircraft manufacturers are evaluating AeroShell Grease 33 with the aim of approving it for use on their aircraft. Operators should regularly check with these manufacturers for the latest status.

Use of AeroShell Grease 33 can provide operators with the following benefits:

- Reduced inventories
- Easier maintainability (one major grease for most applications)
- Reduced maintenance labour costs
- Less chance of product mis-application

AeroShell Grease 33 contains a synthetic oil and must not be used with incompatible seal materials. Refer to the General Notes at the front of this section for further information.

SPECIFICATIONS

U.S.	Approved MIL-PRF-23827C (Type I)
British	Approved DEF STAN 91-53
French	Approved DCSEA 354/A
Russian	Equivalent ERA, OKB-122-7
NATO Code	G-354
Joint Service Designation	XG-287
SAE	Exceeds AMS 3052
Boeing	Approved BMS 3-33B
Airbus	Approved AIMS 09-06-002

PROPERTIES	BMS 3-33B AIMS 09-06-002 SAE AMS 3052	TYPICAL
Oil type	Synthetic Hydrocarbon/Ester	Synthetic Hydrocarbon/Ester
Thickener type	Lithium Complex	Lithium Complex
Base oil viscosity mm²/s @ –40°C @ 40°C @ 100°C	 - - -	 1840 14.2 3.4
Useful operating temperature range °C	–73 to +121	–73°C to +121
Drop point °C	-	216
Worked penetration @ 25°C	265 to 315	297
Unworked penetration @ 25°C	-	290
Bomb oxidation pressure drop from 758 kPa (110 psi) @ 99°C @ 100 hrs kPa (psi) @ 500 hrs kPa (psi)	 70 (10) max 105 (15) max	 3.5 (0.5) 34 (5)
Oil separation @ 100°C in 30 hrs %m	-	2.0
Water resistance test loss (79°C) %m	7.5 max	< 6
Evaporation loss 500 hr @ 121°C %m	10 max	< 10
Mean Hertz Load kg	-	60
Anti-friction bearing performance @ 121°C hrs	-	1200+
Copper corrosion 24 hrs @ 100°C	Must pass	Passes
Bearing protection 2 days @ 52°C	Must pass	Passes
Colour	Blue-green	Green

NOTES

AEROSHELL GREASE 64

AeroShell Grease 64 comprises AeroShell Grease 33 fortified with 5% molybdenum disulphide. It possesses the enhanced anti-wear and anti-corrosion properties of AeroShell Grease 33 with the added EP (Extreme Pressure) properties provided by the addition of a solid lubricant.

The useful operating temperature range is –73°C to +121°C.

NOTE: *AeroShell Grease 64 was previously branded as AeroShell Grease 33MS. Responding to customer requests, to avoid confusion with AeroShell Grease 33 it was decided to rebrand AeroShell Grease 33MS as AeroShell Grease 64.*

APPLICATIONS

AeroShell Grease 33 has established itself as the answer to most of the airframe's General Purpose, airframe greasing requirements, being approved for use in Boeing, Airbus and many other aircraft types. It sets the standard with exceptional anti-corrosion and anti-wear performance while allowing aircraft operators to shrink their grease inventory and reduce the risk of misapplication. However, there remains a small number of highly loaded, sliding applications on the airframe where the additional boost of molybdenum disulphide will always be required. To address this need, Shell Aviation has developed AeroShell Grease 64. Sharing the same advanced grease technology as its parent, AeroShell Grease 64 also possesses the extreme pressure (EP) characteristics provided by molybdenum disulphide.

AeroShell Grease 64 contains a synthetic oil and must not be used with incompatible seal materials.

SPECIFICATIONS

U.S.	Approved MIL-G-21164D
British	Approved DEF STAN 91-57
French	Approved DCSEA 353/A
Russian	-
NATO Code	G-353
Joint Service Designation	XG-276

PROPERTIES	MIL-G-21164D	TYPICAL
Oil type	Synthetic Hydrocarbon/Ester	Synthetic Hydrocarbon/Ester
Thickener type	Lithium Complex	Lithium Complex
Base oil viscosity mm²/s @ –40°C @ 40°C @ 100°C	 - - -	 1840 14.2 3.4
Useful operating temperature range °C	–73 to +121	–73°C to +121
Drop point °C	165 min	234
Worked penetration @ 25°C	260 to 310	281
Unworked penetration @ 25°C	200 min	288
Worked stability (100,000 strokes)	260 to 375	309
Bomb oxidation pressure drop from 758 kPa (110 psi) @ 99°C @ 100 hrs kPa (psi) @ 500 hrs kPa (psi)	 68.9 (10) max 103.4 (15) max	 10.3 34.5
Oil separation @ 100°C in 30 hrs %m	5 max	2.29
Water resistance test loss (40°C) %m	20 max	3.39
Evaporation loss 22 hr @ 100°C %m	2 max	0.65
Low temperature torque @ –73°C Starting torque Nm 1 hr running torque Nm	 0.98 max 0.098 max	 0.50 0.060
Anti-friction bearing performance @ 121°C hrs	1000 min	Greater than 1000 (on all four runs)

Table continued

Table continued

PROPERTIES	MIL-G-21164D	TYPICAL
Extreme pressure properties load wear index	50 min	57.49
Copper corrosion 24 hrs @ 100°C	Must pass	Passes
Rust prevention/bearing protection, 2 days @ 52°C	Must pass	Passes, no corrosion
Storage stability 6 months @ 40°C		
Unworked penetration	200 min	226
Worked penetration	260 to 310	289
Change in penetration from original	30 max	8
Colour	-	Dark grey

6. AEROSHELL HYDRAULIC FLUIDS

AEROSHELL HYDRAULIC FLUIDS

AeroShell Hydraulic Fluids are used in hydraulic applications on aircraft and consist of:-

- AeroShell Fluid 4
- AeroShell Fluid 41
- AeroShell Fluid 71
- AeroShell Fluid 31
- AeroShell Fluid 51
- AeroShell Fluid 61
- AeroShell Shock Strut Fluid (SSF)
- AeroShell Landing Gear Fluid (LGF)

AeroShell Fluids 4 and 41 are mineral hydraulic fluids; the latter has superior cleanliness characteristics and is the more widely used grade.

AeroShell Fluid 71 is a preservative mineral hydraulic fluid for use in hydraulic systems and components that are in storage as well as hydraulic system test rigs.

AeroShell Fluid 31 is a synthetic hydrocarbon fire resistant hydraulic fluid. This type of fluid is increasingly replacing mineral hydraulic fluids.

AeroShell Fluid 51 is a low temperature synthetic hydrocarbon fire resistant hydraulic fluid.

AeroShell Fluid 61 is a preservative synthetic hydrocarbon fire resistant hydraulic fluid.

AeroShell SSF and LGF are hydraulic fluids specifically for landing gear shock struts of some aircraft.

For some types of aircraft, proprietary non-inflammable fluids of non-petroleum origin (phosphate ester type) are required. Shell Companies can supply Skydrol® 500B-4 and LD-4 phosphate ester fluids against a known demand.

BACKGROUND

For many years, hydraulic systems have been utilised in military and commercial aircraft. They have provided power transfer which has been proven to be reliable, efficient and lightweight compared to mechanical or electrical power transfer services. Since the 1940s, MIL-H-5606 hydraulic fluid, a mineral oil-based fluid, has been one of the most widely used types of fluid. This hydraulic fluid has provided excellent operational properties over the temperature range of –54°C to 135°C (–65°F to 275°F). A major deficiency of MIL-H-5606 fluids, which was recognised early in its use, was its high degree of flammability. The hazard generated by the flammability of the fluid was greatly increased by the high pressure required for hydraulic system operation, 2.07 x 10^7 Pascals (3000 psi), and the vulnerability of hydraulic lines widely distributed throughout the aircraft.

Recognition of fire hazards associated with MIL-H-5606 (NATO Code H-515) fluids, resulted in the commercial aircraft industry developing hydraulic systems based on phosphate ester based hydraulic fluids. However, the phosphate ester based fluids were not adopted by the military at that time because they were not compatible with MIL-H-5606 fluids nor with many of the materials (e.g. elastomers) used in MIL-H-5606 hydraulic systems in the aircraft. There was a view that the use of two incompatible hydraulic fluids could cause supply/logistic problems and could result in significant problems if the two fluids were ever inadvertently intermixed as they were not compatible or miscible. The cost of converting a MIL-H-5606 based hydraulic system to a phosphate ester based system was believed to be prohibitive owing to the requirement to change the elastomeric seals as well as many of the other materials used within and also outside the hydraulic system with which the fluid may come into contact (e.g. wiring insulation, paint, etc.). The commercial aircraft industry has found a significant reduction in the number of hydraulic fluid fires since the adoption of phosphate ester hydraulic fluids, and now all big civil transport aircraft use this type of fluid in the main hydraulic system.

Although the military did not move to phosphate ester type fluids they did identify the need for a more fire resistant fluid as a direct replacement for MIL-H-5606. As a result a synthetic hydrocarbon-based fluid, MIL-H-83282 was developed. This fluid is completely compatible with MIL-H-5606 fluids and MIL-H-5606 hydraulic system materials. All physical properties of MIL-H-83282 (now MIL-PRF-83282) were equivalent to or superior to those of MIL-H-5606 (now MIL-PRF-5606) except for low temperature viscosity. In particular all fire resistant properties of MIL-PRF-83282 are superior to those of MIL-PRF-5606.

More recently MIL-PRF-87257 was introduced in order to address the concerns over the low temperature viscosity of MIL-PRF-83282.

APPLICATIONS

Whenever an aircraft is certified, the hydraulic fluids 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 hydraulic fluids which are qualified to be used. The U.S. Federal Aviation Administration (FAA) regulations state that only hydraulic fluids 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 hydraulic fluid(s) should be used.

MAIN REQUIREMENTS

The main requirements for aircraft hydraulic fluids are:

- Low freezing point
- Minimum viscosity change with temperature
- Good corrosion and oxidation stability
- Good seal compatibility
- Shear stable
- Supercleanliness
- Fire resistant
- Good anti-foam properties
- Good low and/or high temperature stability

In addition most aviation hydraulic fluid specifications list other requirements which are either specific to the type of hydraulic fluid or to the intended application.

TYPICAL PROPERTIES

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

USEFUL OPERATING TEMPERATURE RANGE

The useful operating temperature ranges are quoted for guidance only and are based on the requirements as quoted in the relevant specification.

COMPATIBILITY

Mineral hydraulic fluids (MIL-PRF-5606, MIL-PRF-6083) are completely compatible and miscible with synthetic hydrocarbon hydraulic fluids (MIL-PRF-83282, MIL-PRF-87257 and MIL-PRF-46170) and vice versa.

Mineral hydraulic fluids (MIL-PRF-5606 and MIL-PRF-6083) and synthetic hydrocarbon hydraulic fluids (MIL-PRF-83282, MIL-PRF-87257 and MIL-PRF-46170) are not compatible with phosphate ester hydraulic fluids and on no account should they be mixed.

CHANGEOVER

Since mineral hydraulic fluids are compatible with synthetic hydrocarbon fluids changeover can be easily accomplished.

Two commonly used methods to convert existing MIL-H-5606 based hydraulic systems to MIL-PRF-83282 have been:

(1) draining the aircraft's hydraulic system or the hydraulic system reservoir of MIL-PRF-5606 and refilling with MIL-PRF-83282, thereafter servicing the aircraft's hydraulic system with MIL-PRF-83282 and

(2) merely topping off the reservoir with MIL-PRF-83282, as needed.

Both methods have been used with great success with no reported problems.

COMPATIBILITY WITH MATERIALS

When using hydraulic fluids containing a synthetic 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 can only be considered as guidelines.

Elastomer/ Plastic	Mineral Oil Based Hydraulic Fluids	Synthetic Hydro-carbon Based Hydraulic Fluids
Flurocarbon (Viton)	Very Good	Very Good
Acrylonitrile	Good	Good
Polyester	Good	Good
Silicone	Poor to Good	Poor to Good
Teflon	Very Good	Very Good
Nylon	Poor to Good	Poor to Good
Buna-S	Poor	Poor
Perbunan	Good	Good
Methacrylate	Good	Good
Neoprene	Fair to Good	Fair to Good
Natural Rubber	Poor to Fair	Poor to Fair
Polyethylene	Good	Good
Butyl Rubber	Very Poor to Poor	Very Poor to Poor
Poly Vinyl Chloride	Poor to Good	Poor to Good

Compatibility Rating:
Very Good – Good – Fair – Poor – Very Poor

TYPES OF HYDRAULIC FLUIDS

Mineral
AeroShell Fluid 4
AeroShell Fluid 41
AeroShell Fluid 71
AeroShell Fluid SSF
AeroShell Fluid LGF

Synthetic Hydrocarbon
AeroShell Fluid 31
AeroShell Fluid 51
AeroShell Fluid 61

Phosphate Ester
Skydrol® 500B4
Skydrol® LD4

HYDRAULIC FLUID CLEANLINESS - SUPERCLEAN PROPERTIES

Hydraulic fluid users should be keen to ensure optimum performance of hydraulic equipment and extend equipment life. One way of achieving this is by reducing wear of hydraulic system components. There are many ways in which wear can occur but one of the most common is due to particulates in the hydraulic fluid.

The latest issues of MIL-PRF-5606, MIL-PRF-6083, MIL-PRF-46170, MIL-PRF-83282 and MIL-PRF-87257 require hydraulic fluids to be "Superclean". By superclean it is meant that there is a very tight control on particulates in the fluid. Over the years, hydraulic systems and components have gotten smaller while operating pressures have increased. As a result, particulates in the hydraulic fluid are more likely to cause system failures through valve sticking, erosion by impingement, wear, or blockages of nozzles and tubes. Thus, these specifications include very tight limits on particulates. Typically for MIL-PRF-5606H, MIL-PRF-83282D and MIL-PRF-87257A the requirement is of the order:

Particle Size	Microscopic Count	Automatic Count
5 to 15 µm	2,500	10,000
16 to 25 µm	1,000	1,000
26 to 50 µm	250	150
51 to 100 µm	25	20
over 100 µm	10	5

MIL-PRF-5606H allows automatic method only
MIL-PRF-83282D allows both methods
MIL-PRF-87257B allows automatic method only

Shell applies special process controls including multistage filtration, container cleaning just before filling, and 'clean room' packaging conditions in order to manufacture fluids that meet these stringent limits.

However, it would be pointless for Shell manufacturing plants to go to these extreme lengths if customers/operators do not handle the fluids in a manner that ensures that the superclean properties are maintained and enhanced.

Thus it is recommended that operators take extreme care by:

- never opening containers to atmosphere
- using containers of correct size
- using a dispensing device which includes fine filtration
- ensuring hydraulic system is clean and free from metal particles, dust, dirt and other contaminants
- periodically connecting the aircraft hydraulic system to ground hydraulic trolley and circulating fluid through fine filtration.

The latest issues of specifications MIL-PRF-5606, MIL-PRF-6083, MIL-PRF-46170, MIL-PRF-83282 and MIL-PRF-87257 require approved grades to meet the above levels of particulate contamination. The ISO 4406, BS.5540, NAS 1638 or SAE 749 requirements for cleanliness are NOT required by these specifications and thus AeroShell grades approved to these specifications are not automatically tested against these other cleanliness requirements. However, it has been found that normally AeroShell Fluid 4 is typically between Classes 8 and 9 in NAS 1638, whilst AeroShell Fluid 41 is typically between Classes 4 and 5 in NAS 1638.

AEROSHELL HYDRAULIC FLUIDS IN NON-AVIATION APPLICATIONS

AeroShell Hydraulic Fluids are widely used in non-aviation applications because of their superior performance, particularly at temperature extremes, when compared with standard industrial hydraulic fluids. Many non-aviation equipment manufacturers do permit use of AeroShell Hydraulic Fluids in their equipment and in many cases list the product in the appropriate manuals. Otherwise in selecting an AeroShell Hydraulic Fluid for a non-aviation application the properties of the hydraulic fluid 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.

SUMMARY OF AEROSHELL HYDRAULIC FLUID SPECIFICATION APPROVALS

SPECIFICATION	AEROSHELL FLUID								
	4		31	41		51	61	71	SSF/LGF
	U.S. Production	European Production		U.S. Production	European Production				
MIL-PRF-5606A	Meets	Equivalent	–	–	–	–	–	–	–
MIL-PRF-5606H	–	–	–	Approved	Approved	–	–	–	–
MIL-PRF-6083F	–	–	–	–	–	–	–	Approved	–
MIL-PRF-46170D	–	–	–	–	–	–	Approved	–	–
MIL-PRF-83282D	–	–	Approved	–	–	–	–	–	–
MIL-PRF-87257B	–	–	–	–	–	Approved	–	–	–
DEF STAN 91-48 Grade Normal	Equivalent	Approved	–	–	–	–	–	–	–
DEF STAN 91-48 Grade Superclean	–	–	–	Equivalent	Approved	–	–	–	–
DEF STAN 80-142	–	–	–	–	–	–	–	Equivalent	–
H-515	–	–	–	Approved	Approved	–	–	–	–
H-520	–	Approved	–	–	–	–	–	–	–
H-537	–	–	Approved	–	–	–	–	–	–
H-538	–	–	–	–	–	Approved	–	–	–
H-544	–	–	–	–	–	–	Approved	–	–
C-635	–	–	–	–	–	–	–	Approved	–
BMS 3-32	–	–	–	–	–	–	–	–	Approved

NOTES

AEROSHELL FLUID 4

AeroShell Fluid 4 is a mineral hydraulic oil with very good low temperature characteristics and capable of operating over a wide temperature range. AeroShell Fluid 4 is composed of a mineral oil base stock and a complex additive package which results in a product with excellent low temperature flow and anti-wear properties, exceptional antifoam characteristics, and excellent oxidation stability.

AeroShell Fluid 4 is dyed red.

The useful operating temperature range unpressurised is –54°C to 90°C.
The useful operating temperature range pressurised is –54°C to 135°C.

APPLICATIONS

AeroShell Fluid 4 is intended for use as a hydraulic fluid in undercarriage retraction mechanisms, flap jacks and control mechanisms, brakes, shock absorbers, automatic pilots, oleo legs, tail wheels, servo units, etc. It is also suitable for lubricating de-icing pumps and gearboxes.

AeroShell Fluid 4 should be used in systems with synthetic rubber components and must not be used in systems incorporating natural rubber. The latter systems require castor base fluids with which AeroShell Fluid 4 is not interchangeable. Refer to the General Notes at the front of this section for more information on compatibility.

AeroShell Fluid 4 is compatible with AeroShell Fluids 31, 41, 51, 61 and 71, although it is not recommended that AeroShell Fluid 4 is used in systems which require the use of a superclean fluid nor should it be mixed with superclean fluids for operational reasons.

Chlorinated solvents should not be used for cleaning hydraulic components which use AeroShell Fluid 4. The residual solvent contaminates the hydraulic fluid and may lead to corrosion.

SPECIFICATIONS

U.S.	Meets MIL-H-5606A (Obsolete - see AeroShell Fluid 41)
British	Meets DTD.585 (Obsolete - see AeroShell Fluid 41) Approved DEF STAN 91-48 Grade Normal (European production only)
French	Approved DCSEA 415/A
Russian	Analogue to AMG-10
NATO Code	H-520 (European production only)
Joint Service Designation	OM-18 (European production only)

PROPERTIES	**DEF STAN 91-48 Grade Normal**	**TYPICAL (European Production)**
Oil type	Mineral	Mineral
Kinematic viscosity mm^2/s @ 100°C @ 40°C @ –40°C @ –54°C	 4.0 min 13 min 500 max 3000 max	 5.30 14.1 491 2300
Flashpoint Pensky Martin Closed Cup °C	81 min	105
Pourpoint °C	–60 max	< –60
Total acid number mgKOH/g	0.2 max	0.01
Relative density @ 15.6/15.6°C	-	0.87
Evaporation @ 100°C %m	20 max	10
Colour	Red	Red
Copper corrosion	2 max	Passes
Low temperature stability	Must pass	Passes
Shear stability	Must pass	Passes
Foaming characteristics	Must pass	Passes
Phosphorus content % m/m	0.035 to 0.050	Passes
Oxidation & corrosion stability (168 hrs @ 135°C) - metal weight change - change in viscosity @ 40°C % - change in acid number mgKOH/g	 Must pass –5 to +20 0.2 max	 Passes +2.0 +0.1
Anti-wear properties, scar diam mm	1.5 max	0.95
Rubber swell 168 hrs @ 70°C Vol change %	19 to 30	25

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

AEROSHELL FLUID 31

AeroShell Fluid 31 is a synthetic hydrocarbon based aircraft hydraulic fluid with greatly improved fire resistance characteristics when compared with conventional petroleum products.

AeroShell Fluid 31 has a specially designed base stock which imparts a relatively high flash point, excellent low temperature properties and good oxidation and thermal stability. In addition, AeroShell Fluid 31 is formulated with high technology additives to provide oxidation and corrosion resistance, anti-wear, and anti-foaming protection.

AeroShell Fluid 31 is superclean filtered to ensure optimum performance in particulate monitored systems.

AeroShell Fluid 31 is dyed red.

The useful operating temperature range is –40 to +205°C.

APPLICATIONS

AeroShell Fluid 31 is recommended for use in aircraft, ordnance, and missile systems operating from –40°C to +205°C. This fluid should be considered for use in auto pilots, shock absorbers, brakes, flight control systems, hydraulic servo-controlled systems and other systems using synthetic elastomer seals.

An increasing number of aircraft manufacturers now recommend use of this type of fluid in aircraft hydraulic systems in preference to mineral hydraulic oils. This move has been prompted by the need to use fluids with better fire resistant properties.

AeroShell Fluid 31 is also approved for use in the Honeywell (formerly Garrett) cooling turbine (cabin air compressors).

Increasingly this type of hydraulic fluid is being adopted for use in hydraulic systems of military aircraft in place of mineral hydraulic fluids.

AeroShell Fluid 31 is a synthetic hydrocarbon oil and should not be used in contact with incompatible seal materials. Refer to the General Notes at the front of this section for further information.

AeroShell Fluid 31 is compatible with AeroShell Fluids 4, 41, 51, 61 and 71 and can be used in systems designed to operate with MIL-PRF-5606, MIL-PRF-6083, MIL-PRF-87257 and MIL-PRF-46170 fluids.

Chlorinated solvents should not be used for cleaning hydraulic components which use AeroShell Fluid 31. The residual solvent contaminates the hydraulic fluid and may lead to corrosion.

SPECIFICATIONS

U.S.	Approved MIL-PRF-83282D
British	(MIL-PRF-83282D)
French	Approved DCSEA 437/A
Russian	-
NATO Code	H-537
Joint Service Designation	OX-19

PROPERTIES		**MIL-PRF-83282D**	**TYPICAL**
Oil type		Synthetic Hydrocarbon	Synthetic Hydrocarbon
Kinematic viscosity	mm^2/s		
@ 205°C		1.0 min	1.07
@ 100°C		3.45 min	3.53
@ 40°C		14.0 min	14.33
@ –40°C		2200 max	2098
Flashpoint Cleveland Open Cup	°C	205 min	237
Fire point	°C	245 min	251
Total acidity	mgKOH/g	0.10 max	0.01
Evaporation loss 6.5 hrs @ 150°C	%m	20 max	10
Relative density @ 15.6/15.6°C		Report	0.850

Table continued

Table continued

PROPERTIES	MIL-PRF-83282D	TYPICAL
Pourpoint °C	–55 max	Below –55
Low temperature stability 72hrs @ –40°C	Must pass	Passes
Low temperature stability 100 hrs @ 205°C	Must pass	Passes
Gravimetric filtration mg/100ml Filtration time minutes	0.3 max 15 max	0.2 Less than 15
Particle count, automatic per Lt 5 to 15 µm 16 to 25 µm 26 to 50 µm 51 to 100 µm >100 µm	 10000 max 1000 max 150 max 20 max 5 max	 1331 190 55 4 0
Water content ppm	100 max	82
Foam resistance ASTM Seq 1	Must pass	Passes
Flame propagation cm/s	Must pass	Passes
Rubber swell, NBR-L %	18 to 30	Passes
4-Ball wear, 1 hr @ 75°C scar dia mm 1 kg load/1200 rpm 10 kg load/1200 rpm 40 kg load/1200 rpm	 0.21 max 0.30 max 0.65 max	 0.18 0.24 0.50
Oxidation & corrosion stability (168 hrs @ 121°C) - metal weight change - change in viscosity @ 40°C % - change in acidity mgKOH/g	 Must pass 10 max 0.2 max	 Passes Less than 10 Less than 0.02
Flammability	Must pass	Passes

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

NOTES

AEROSHELL FLUID 41

AeroShell Fluid 41 is a mineral hydraulic oil manufactured to a very high level of cleanliness, and possesses improved fluid properties. AeroShell Fluid 41 contains additives which provide excellent low temperature fluidity as well as exceptional anti-wear, oxidation - corrosion inhibition and shear stability. In addition metal de-activators and foam inhibitors are included in this high viscosity index fluid to enhance performance in hydraulic applications. AeroShell Fluid 41 is capable of wide temperature range operation.

AeroShell Fluid 41 is dyed red.

The useful operating temperature range unpressurised is –54°C to 90°C.
The useful operating temperature range pressurised is –54°C to 135°C.

APPLICATIONS

AeroShell Fluid 41 is intended as a hydraulic fluid in all modern aircraft applications requiring a mineral hydraulic fluid. AeroShell Fluid 41 is particularly recommended where use of a "superclean" fluid can contribute to improvements in component reliability, and can be used in aircraft systems operating unpressurised between –54°C to 90°C and pressurised between –54°C to 135°C.

AeroShell Fluid 41 should be used in systems with synthetic rubber components and must not be used in systems incorporating natural rubber. Refer to the General Notes at the front of this section for further information.

AeroShell Fluid 41 is compatible with AeroShell Fluids 4, 31, 51, 61 and 71 and SSF/LGF.

Chlorinated solvents should not be used for cleaning hydraulic components which use AeroShell Fluid 41. The residual solvent contaminates the hydraulic fluid and may lead to corrosion.

SPECIFICATIONS

U.S.	Approved MIL-PRF-5606H
British	Approved DEF STAN 91-48 Grade Superclean * (European production only) Meets DEF STAN 91-48 Grade Normal (European production only) Equivalent to DEF STAN 91-48 Grades Superclean * & Normal (U.S. production only)
French	Approved DCSEA 415/A
Russian	Analogue to AMG-10
NATO Code	H-515* (equivalent H-520)
Joint Service Designation	OM15* (equivalent OM-18)

*Superclean grades

The British specification DEF STAN 91-48 covers two grades (normal and superclean) of mineral hydraulic fluid which differ only in their cleanliness limits. AeroShell Fluid 41 is manufactured to meet the superclean requirements and thus it also meets the requirements of the normal grade.

PROPERTIES	MIL-PRF-5606H	TYPICAL U.S. Production	European Production
Oil type	Mineral	Mineral	Mineral
Kinematic viscosity mm²/s @ 100°C @ 40°C @ -40°C @ -54°C	 4.90 min 13.2 min 600 max 2500 max	 6.13 15.68 384 1450	 5.30 14.1 491 2300
Viscosity index	-	214	Over 200
Flashpoint Pensky Martin Closed Cup °C	 82 min	 104	 105
Auto-ignition temperature °C	-	230	230
Pourpoint °C	-60 max	< -60	< -60
Total acid number mgKOH/g	0.20 max	0	0.01
Evaporation loss 6 hrs @ 71°C %m	 20 max	 16.5	 10
Water content ppm	100 max	55	<100
Relative density @ 15.6/15.6°C	Report	0.874	0.87
Colour	Red	Red	Red
Particle contamination, number of particles per 100ml in size range 5 to 15 microns 15 to 25 microns 25 to 50 microns 50 to 100 microns over 100 microns	 10000 max 1000 max 150 max 20 max 5 max	 1200 550 70 5 0	 808 116 44 10 1
Copper corrosion	2e max	1b	2b
Steel on steel wear scar diam mm	 1.0 max	 0.65	 0.95

PROPERTIES	MIL-PRF-5606H	TYPICAL U.S. Production	European Production
Rubber swell, L rubber %	19 to 30	22	25.4
Corrosiveness & oxidation (168 hrs @ 135°C) - metal weight change - viscosity change @ 40°C % - acid number change mgKOH/g	 Must pass -5 to +20 0.20 max	 Passes 8.08 0.02	 Passes +0.1 +0.1
Low temperature stability 72 hrs @ -54°C	 Must pass	 Passes	 Passes
Shear stability - viscosity change @ 40°C - acid number change	 Must pass 0.2 max	 Passes Less than 0.2	 Passes Less than 0.2
Gravimetric filtration mg/100ml filtration time min	0.3 max 15 max	0.1 10	Less than 0.3 Less than 15
Foaming tendency	Must pass	Passes	Passes
Barium content ppm	10 max	Nil	Nil

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

AEROSHELL FLUID 51

AeroShell Fluid 51 is a synthetic hydrocarbon and ester based fluid for use in hydraulic systems which require reliable operation in extreme low and high temperatures as well as performance outside the capability of traditional MIL-PRF-5606 mineral based fluids.

AeroShell Fluid 51 is formulated with high technology additives to provide oxidation and corrosion resistance, anti-wear, and anti-foaming protection.

AeroShell Fluid 51 is superclean filtered to ensure optimum performance in particulate monitored systems.

AeroShell Fluid 51 is dyed red.

The useful operating temperature range is –54°C to +135°C.

APPLICATIONS

AeroShell Fluid 51 is recommended for use in aircraft, ordnance and missile systems operating from –54°C to +135°C. This fluid should be considered for use in auto pilots, shock absorbers, brakes, flight control systems, hydraulic servo-control systems and other systems using synthetic elastomer seals. This fluid is especially recommended for use in high altitude aircraft that normally operate with extended loiter times and high endurance levels such as UAVs and ELINT systems.

AeroShell Fluid 51 is a synthetic hydrocarbon oil and should not be used in contact with incompatible seal materials. Refer to the General Notes at the front of this section for further information.

AeroShell Fluid 51 is compatible with AeroShell Fluids 4, 31, 41, 61 and 71 and can be used in systems designed to operate with MIL-PRF-5606, MIL-PRF-6083, MIL-PRF-83282 and MIL-PRF-46170 fluids.

Chlorinated solvents should not be used for cleaning hydraulic components which use AeroShell Fluid 51. The residual solvent contaminates the hydraulic fluid and may lead to corrosion.

SPECIFICATIONS

U.S.	Approved MIL-PRF-87257B
British	(MIL-PRF-87257B)
French	-
Russian	-
NATO Code	H-538
Joint Service Designation	OX-538

PROPERTIES	MIL-PRF-87257B	TYPICAL
Oil type	-	Synthetic Hydrocarbon
Kinematic viscosity mm²/s @ 100°C @ 40°C @ –40°C @ –54°C	 2.0 min 6.7 min 550 max -	 2.12 6.80 440 1945
Flashpoint °C	160 min	175
Fire point °C	170 min	185
Total acidity mgKOH/g	0.20 max	0.00
Evaporation loss 6.5 hrs @ 150135°C %m	 20 max	 13.5
Relative density @ 15.6/15.6°C	Report	0.838
Pourpoint °C	–60 max	–65
Low temperature stability 72 hrs @ –54°C	 Must pass	 Passes
High temperature stability - change in viscosity @ 40°C % - change in acidity - formation of precipitate or insolubles	 ±5 max 0.1 max None	 Less than 5 Less than 0.1 None
Gravimetric analysis mg/100ml	1.0 max	0.12
Particle count, automatic per Lt 5 to 15 µm 15 to 25 µm 25 to 50 µm 50 to 100 µm >100 µm	 10000 max 1000 max 150 max 20 max 5 max	 2400 250 90 5 0
Water content ppm	100 max	65
Foam resistance ASTM Seq 1	65 ml max	20
Flame propagation cm/s	0.50 max	Conforms
Rubber swell NBR-L %	19 to 30	23

PROPERTIES	MIL-PRF-87257B	TYPICAL
4-Ball Wear, 75°C scar dia mm 1 kg load 10 kg load 40 kg load	 0.21 max 0.30 max 0.65 max	 0.17 0.22 0.52
Barium content ppm	10 max	Less than 10
Flammability	Must pass	Passes
Corrosiveness & oxidation stability (168 hours @ 135 ±1°C) - metal weight change - viscosity change % - change in acidity mg/KOH/g	 Must pass ±10 max 0.2 max	 Passes Less than 10 Less than 0.02

AEROSHELL FLUID 61

AeroShell Fluid 61 is a synthetic hydrocarbon base hydraulic fluid specifically inhibited to provide excellent oxidation stability for the oil and good corrosion preventive protection to the hydraulic system.

AeroShell Fluid 61 MIL-PRF-46170D Type I is undyed.
AeroShell Fluid 61 MIL-PRF-46170D Type II is dyed red.

AeroShell Fluid 61 has an operating temperature range of –40°C to +204°C.

APPLICATIONS

AeroShell Fluid 61 is designed for use where a fire resistant preservative grade hydraulic fluid is required and is suitable for operational use from –40°C to +204°C as well as preservation of components during storage and shipment.

AeroShell Fluid 61 is compatible with AeroShell Fluids 4, 31, 41, 51 and 71.

AeroShell Fluid 61 is a synthetic oil and should not be used in contact with incompatible seal materials. Refer to the General Notes at the front of this section for further information.

Chlorinated solvents should not be used for cleaning hydraulic components which use AeroShell Fluid 61. The residual solvent contaminates the hydraulic fluid and may lead to corrosion.

SPECIFICATIONS

U.S.	Approved MIL-PRF-46170D Type I*
British	-
French	-
Russian	-
NATO Code	H-544
Joint Service Designation	-

*The US specification covers two grades, Type I and Type II. The only difference between the two grades is that Type II is dyed red for aerospace use whereas Type I is undyed.

PROPERTIES	MIL-PRF-46170D Type I	TYPICAL
Oil type	-	Synthetic Hydrocarbon
Kinematic viscosity mm^2/s		
@ 100°C	3.4 min	3.71
@ 40°C	19.5 min	15.43
@ –40°C	2600 max	2488
@ –54°C	-	15022
Flashpoint Cleveland Open Cup °C	218 min	233
Fire point Cleveland Open Cup °C	246 min	248
Acid or Base number mgKOH/g	0.2 max	0.07
Evaporation loss 22 hrs @ 149°C %m	5.0 max	2.39
Relative density @ 15.6/15.6°C	-	0.859
Pourpoint °C	–54 max	Below –54
Water content ppm	500 max	278
Auto-ignition temperature °C	343 min	354
Colour	Undyed	Undyed
Particle count, automatic per Lt		
5 to 25 microns	10000 max	1414
26 to 50 microns	250 max	390
51 to 100 microns	50 max	4
Over 100 microns	10 max	0
Trace sediment mg/l	0.005 max	0.001
Rubber swell 168 hrs @ 70°C % swell	15 to 25	21.5
4-Ball wear, 75°C - scar dia mm		
147N load/1200 rpm	0.3 max	0.23
392N load/1200 rpm	0.65 max	0.38

Table continued

Table continued

PROPERTIES	MIL-PRF-46170D Type I	TYPICAL
Galvanic corrosion	Must pass	Passes
Corrosiveness & oxidation stability (168 hrs @ 121 °C) - metal weight change - viscosity change @ 40 °C % - change in acidity mg/KOH/g	 Must pass ±10 max 0.3 max	 Passes Less than 10 Less than 0.3
Low temperature stability	Must pass	Passes
Rust prevention	Must Pass	Passes
Flammability	Must pass	Passes

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

NOTES

AEROSHELL FLUID 71

AeroShell Fluid 71 is a preservative mineral hydraulic fluid of improved cleanliness. AeroShell Fluid 71 is composed of a mineral base oil with an additive package which results in a product with excellent corrosion preventative properties as well as excellent oxidation stability, and good anti-wear characteristics.

AeroShell Fluid 71 is dyed red.

The useful operating temperature range is –54°C to +121°C.

APPLICATIONS

AeroShell Fluid 71 is intended for preserving hydraulic equipment in storage from –54°C to +121°C, and also for use in rig testing of hydraulic components.

AeroShell Fluid 71 should only be used in hydraulic systems employing synthetic rubber seals suitable for MIL-PRF-5606/DEF STAN 91-48 (AeroShell Fluids 4 or 41) type of fluids. Refer to General Notes at the front of this section for further information.

AeroShell Fluid 71 is compatible with AeroShell Fluids 4, 31, 41, 51 and 61.

Chlorinated solvents should not be used for cleaning hydraulic components which use AeroShell Fluid 71. The residual solvent contaminates the hydraulic fluid and may lead to corrosion.

SPECIFICATIONS

U.S.	Approved MIL-PRF-6083F
British	Equivalent DEF STAN 80-142
French	Equivalent to DCSEA 535/A
Russian	-
NATO Code	C-635
Joint Service Designation	Equivalent PX-26

PROPERTIES	MIL-PRF-6083F	TYPICAL
Oil type	Mineral	Mineral
Kinematic viscosity mm^2/s @ –40°C @ –54°C @ 40°C	 800 max 3500 max 13 min	 525 2400 14.3
Flashpoint Pensky Martin Closed Cup °C	 82 min	 88
Total acidity mgKOH/g	0.2 max	0.12
Pourpoint °C	–59 max	Below –59
Relative density @ 15.6/15.6°C	-	0.879
Water content ppm	500	200
Colour	Red	Red
Trace sediment mg/l	0.005 max	0.002
Corrosiveness & oxidation stability (168 hrs @ 121°C) - metal weight change - viscosity change @ 40°C - acid number change mg/KOH/g	 Must pass –5 to +20 0.2 max	 Passes Passes Less than 0.2
Copper corrosion	3a max	Passes
Corrosion inhibition	Must pass	Passes
Particle size per 100ml 5 to 25 microns 26 to 50 microns 51 to 100 microns Over 100	 10000 max 250 max 50 max 10 max	 1170 90 10 1
Low temperature stability 72 hrs @ –54°C	 Must pass	 Passes
Shear stability change in viscosity @ 40°C %	 2.0 max	 0.06

Table continued

Table continued

PROPERTIES		MIL-PRF-6083F	TYPICAL
Rubber swell L rubber	%	19 - 28	23
Evaporation loss 22 hrs @ 100°C	%m	75 max	62
Foaming tendency		Must pass	Passes
Steel on steel wear, scar diam	mm	1.0 max	Passes
Gravimetric filtration Filtration time	mg/100ml mins	0.5 max 15 max	Less than 0.5 12

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

NOTES

AEROSHELL SSF AND LGF

AeroShell Shock Strut Fluid (SSF) and AeroShell Landing Gear Fluid (LGF) are mineral hydraulic fluids (MIL-PRF-6083 and MIL-PRF-5606 respectively) to which additional additives have been added to improve the extreme pressure characteristics and the fluid's natural lubricity. The lubricity agent provides a stable thin film layer to the metal surfaces at mild operating conditions. When severe conditions exist (landing/touchdown), the extreme pressure additive supplies the load carrying needed at the metal-to-metal surfaces to prevent the occurrence of such phenomena as "ladder cracking" and "slip stiction" of the piston component of the landing gear.

AeroShell SSF is AeroShell Fluid 71 plus additives.

AeroShell LGF is AeroShell Fluid 41 plus additives.

AeroShell SSF and LGF are straw yellow in colour.

APPLICATIONS

AeroShell SSF is recommended for all normal applications whilst the better low temperature properties of AeroShell LGF make it particularly suitable in areas of low temperature operations.

AeroShell SSF and AeroShell LGF are compatible with each other as well as with AeroShell Fluids 4, 41 and 71.

SPECIFICATIONS

U.S.	-
British	-
French	-
Russian	-
NATO Code	-
Joint Service Designation	-
Boeing	Approved BMS 3-32A (AeroShell SSF is approved to Type I and AeroShell LGF is approved to Type II)
McDonnell Douglas	Approved DPM-6177

AeroShell SSF and LGF are not covered by any military specification.

EQUIPMENT MANUFACTURERS APPROVALS

AeroShell SSF and LGF are approved for use in the shock struts of the following aircraft:

Boeing	707/720, 727, 737, 747 (except those using BMS 3-11 fluids), 757, 767 and 777
Lockheed	L1011 Tristar
McDonnell Douglas	DC-8, DC-9, DC-10, MD-80, MD-11
Airbus	CML Code 02-004A (SSF)

For use in the landing gear shock struts of other aircraft, operators must check with the respective manufacturer first.

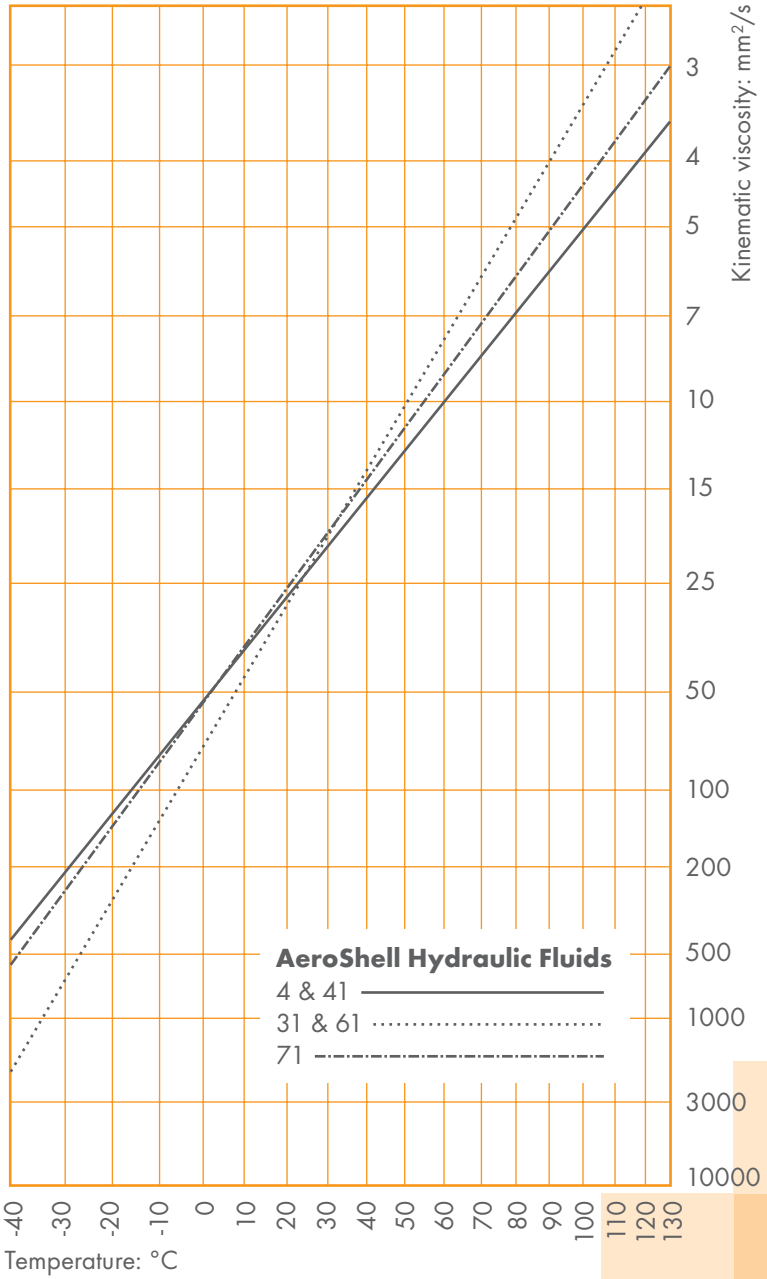
PROPERTIES	SSF TYPICAL	LGF TYPICAL
Base hydraulic fluid specification	MIL-PRF-6083F	MIL-PRF-5606H
Kinematic viscosity mm^2/s		
@ 40°C	14.5	14.5
@ -40°C	560	423
@ -54°C	2640	1780
Flashpoint °C	108	110
Neutralisation number mgKOH/g	2.6	2.4
Evaporation %		
SSF 22 hrs @ 99°C	65	-
LGF 6 hrs @ 71°C	-	18.0
Relative density @ 15.6/15.6°C	0.882	0.874
Pourpoint °C	-62	Below -68
Foaming		
Seq I Foam/collapse time sec	30/30	45
Seq II Foam/collapse time sec	20/10	-
Seq III Foam/collapse time sec	30/30	-

Table continued

Table continued

PROPERTIES		SSF TYPICAL	LGF TYPICAL
Corrosiveness & oxidation stability (168 hrs @ 121 °C)			
Metal weight change	mg/cm²		
Copper		+0.002	–0.06
Aluminium		0	–0.005
Steel		0	–0.02
Magnesium		+0.002	+0.01
Cadmium		0	+0.01
Fluid properties			
Change in viscosity	%	+15	+10.5
Change in acid number	mgKOH/g	+0.5	+0.05
Insolubles		1.0 mg/100ml	Clear
4-ball wear, scar diam	mm	0.43	0.43
Colour		Yellow	Yellow

TYPICAL TEMPERATURE/VISCOSITY CURVE OF AEROSHELL HYDRAULIC FLUIDS



NOTES

7. AEROSHELL PRESERVATIVES

AEROSHELL PRESERVATIVES

AeroShell Preservatives are used for the preservation and protection of aircraft, aircraft engines and aircraft components.

Two classes of corrosion preservatives are used on aircraft, those for protecting engine interiors and those for exterior application.

Corrosion protectives (internal-engines)

AeroShell Fluid 2F
AeroShell Fluid 2XN

Piston engine corrosion protective fluids

Corrosion protection fluids are used for preventing cold corrosion which would occur during the storage or shipment of engines, principally because of the action of fuel combustion products trapped in piston engine cylinders after shut-down. In addition to the protection given by the compound they contain, these fluids neutralise the acid products of combustion resulting from the use of leaded fuel, e.g. hydrobromic acid.

British and American methods for inhibiting engines differ as is shown by the following specifications prescribing the official procedures:

	American	**British**
Piston engine practice:	MIL-E-6058B (Obsolete)	D.Eng.R.D. 2027 (Obsolete)
Turbine engine practice:	MIL-E-5607F (Obsolete)	D.Eng.R.D. 2028 (Obsolete)

For inhibited engine oils in piston engines the British procedure was to motor the engines cold using a ‘storage’ oil (DEF STAN 91-40) in the engine oil system, followed by spraying of various parts internally with a wax thickened oil/petrol mixture (DTD.791C).

The U.S. procedure differs according to whether the storage period is short term or for an extended period. For short term protection only one type of product is required and this is a ‘flyaway’ oil (AeroShell Fluid 2F, MIL-C-6529C Type II), which is added to the engine oil system while the engine is run-up under its own power. Immediately before shutdown it is sprayed into various parts of the engine as in the British procedure.
AeroShell Fluid 2XN is the concentrate for AeroShell Fluid 2F.

Turbine Engine Corrosion Protective Fluids

Corrosion protective fluids to MIL-C-6529C Type III are suitable for the internal protection during storage of turbine engines which normally use mineral lubricating oil to MIL-PRF-6081D.

Corrosion protective fluids to MIL-PRF-8188D are suitable for the internal protection during storage of turbine engines which normally use synthetic lubricating oils to MIL-PRF-7808L.

More recently there has been increasing concern regarding corrosion inside turbine engines which use synthetic oils to MIL-PRF-23699 (formerly MIL-L-23699). In order to address these concerns the specification MIL-PRF-23699G has been revised to include a corrosion inhibited (C/I) grade alongside the standard (STD) grade and high temperature grade (HTS).

Corrosion Protectives - external

AeroShell Compound 05

A variety of exterior corrosion preventatives are in current use to provide the many kinds of protection needed. The choice of protective depends upon the degree of protection necessary and ease of removal required.

Corrosion protection is a big subject and whilst it is not within the scope of this handbook (there being many other publications available) the following key elements may be helpful in deciding what corrosion preventative to specify or use in any particular application. The key elements are:-

- period of protection required, i.e. short, medium or long term
- whether component or assembly is stored indoor, outdoors or undercover
- climatic conditions at point of storage if outside
- whether preservative is to be applied hot or cold
- method of application, i.e. spray, brush, dipping
- whether preservative includes a solvent as a carrier which then volatilises off
- film thickness of the preservative
- film strength i.e. hard, soft
- whether preservative is to be removed or is permanent
- whether component is to be handled (fingerprints are corrosive and some protective films cannot withstand handling)
- what other methods are used to aid or enhance preservation, for example, wrapping in grease proof paper, silica gel moisture absorbing crystals, cacooning assemblies etc.

Protectives for a wide range of applications are provided by Shell Ensis products, and Shell Vapour Phase Inhibitors, but these products are outside the scope of this publication.

NOTES

AEROSHELL FLUID 2F

AeroShell Fluid 2F is an inhibited "flyaway" lubricating oil for the internal protection of piston engines during storage.

AeroShell Fluid 2F consists of three parts AeroShell Oil 100 (SAE J-1966 Grade SAE 50) with one part AeroShell Fluid 2XN (MIL-C-6529C Type I) – a corrosion preventative.

APPLICATIONS

AeroShell Fluid 2F is used as a piston engine preservative oil, also as a "flyaway" oil, in place of the normal engine oil. A period of 15 minutes engine running under idling conditions is required to ensure adequate distribution throughout the engine. It can also be applied to other parts of the engine and its accessories by spraying. The ashless anti-corrosion additive package and highly refined mineral base oils protect the engine by minimising the effects of humidity and neutralising the acidic components of engine oil oxidation and combustion by-products.

After storage and before operating the engine, rotate the crankshaft by hand and drain off the preservative oil. An additional optional precaution is to flush the engine with the correct grade of AeroShell oil before draining and re-filling with fresh oil.

Operation of engines containing "flyaway" oils is limited to 50 hours maximum. Detailed instructions for inhibiting piston engines are given in specifications MIL-E-6058B and MIL-E-6059A and in relevant engine manufacturer's publications.

AeroShell Fluid 2F may be used in conjunction with Shell VPI 260 or VPI 280 if protection for extended periods is required.

SPECIFICATIONS

U.S.	Approved MIL-C-6529C Type II
British	-
French	Equivalent to AIR 1503/B Type B
Russian	-
NATO Code	C-609
Joint Service Designation	OX-270 (Obsolete)

PROPERTIES		MIL-C-6529C Type II	TYPICAL
Oil type		-	Mineral
Kinematic viscosity @ 98.9°C @ 37.8°C	mm^2/s	 22.5 max -	 20.0 265
Flashpoint Cleveland Open Cup	°C	 204 min	 257
Pourpoint	°C	–12 max	Below –12
Relative density @ 15.6/15.6	°C	-	0.89
Carbon residue	%m	2 max	0.45
Ash	%m	0.015 max	0.01
Lead corrosion 4 hrs @ 149°C	mg/in^2	 70 max	 14.3
Copper corrosion 3 hrs @ 100°C		 -	 Passes
Rust protection (humidity cabinet)		-	Passes

AEROSHELL FLUID 2XN

AeroShell Fluid 2XN is a corrosion preventative concentrate from which AeroShell Fluid 2F is blended; the blending proportions are one part AeroShell Fluid 2XN to three parts Aeroshell Oil 100.

In general, operators should obtain supplies blended ready for use in engines, unless the use of the concentrate is specified.

APPLICATIONS

AeroShell Fluid 2XN is primarily used as an ingredient of AeroShell Fluid 2F, but can be used undiluted to provide additional protection for piston engines after run-out on AeroShell Fluid 2F, by spraying exhaust ports, rocker arms, accessories.

For aircraft gas turbine engines a mixture of one part of AeroShell Fluid 2XN to three parts of AeroShell Turbine Oil 2 is required. Detailed instructions for inhibiting turbines are given in specification MIL-E-5607F.

The ashless anti-corrosion additive package together with the highly refined mineral base oil protects the engine by minimising the effects of humidity and neutralising the acidic components of engine oil oxidation and, in piston engines, the combustion byproducts as well.

SPECIFICATIONS

U.S.	Approved MIL-C-6529C Type I
British	(Has adopted MIL-C-6529C Type I) Approved DTD900/4913A (Obsolete)
French	Equivalent to AIR 1503/B Type B Concentrate
Russian	-
NATO Code	C-608
Joint Service Designation	ZX-21

Properties are controlled only for the finished blends using AeroShell Fluid 2XN.

PROPERTIES	**MIL-C-6529C Type I**	**TYPICAL**
Oil type	-	Mineral
Kinematic viscosity mm^2/s @ 37.8°C @ 98.9°C	 - -	 254 20.0
Flashpoint Cleveland Open Cup °C	-	254
Pourpoint °C	-	–17
Relative density @ 15.6/15.6 °C	-	0.9
Carbon residue %m	-	0.5
Ash %m	-	0.01
Lead corrosion 4 hrs @ 149°C mg/in^2	-	35
Copper corrosion 3 hrs @ 100°C	-	Passes
Rust protection (humidity cabinet)	-	Passes

AEROSHELL COMPOUND 05

AeroShell Compound 05 is a petroleum jelly/beeswax mixture for protecting metal parts against corrosion under temperate and tropical conditions. Specification DEF STAN 80-85 requires the product to have the following approximate composition:

- High melting point mineral jelly (DEF STAN 91-38) 90% mass
- Beeswax (CS.2177) 10% mass.

APPLICATIONS

AeroShell Compound 05 is used for protecting piston assemblies, anti-friction bearings, chains and other small parts under temperate and tropical conditions. AeroShell Compound 05 is applied by hot dipping in melted material to give a film about 0.5 mm thick, the thickness can be controlled by the temperature and period of immersion. This gives a fairly firm, greasy film, with a slightly higher melting point, better texture and better protective qualities than plain mineral jelly. Grease resistant wrapping is necessary to protect the film from damage, but parts should be wrapped only after the film has set. The coating should be cleaned off before use, particularly to ensure freedom from grit and dirt, but meticulous cleaning is not necessary as any residual material will normally disperse harmlessly in the lubricant.

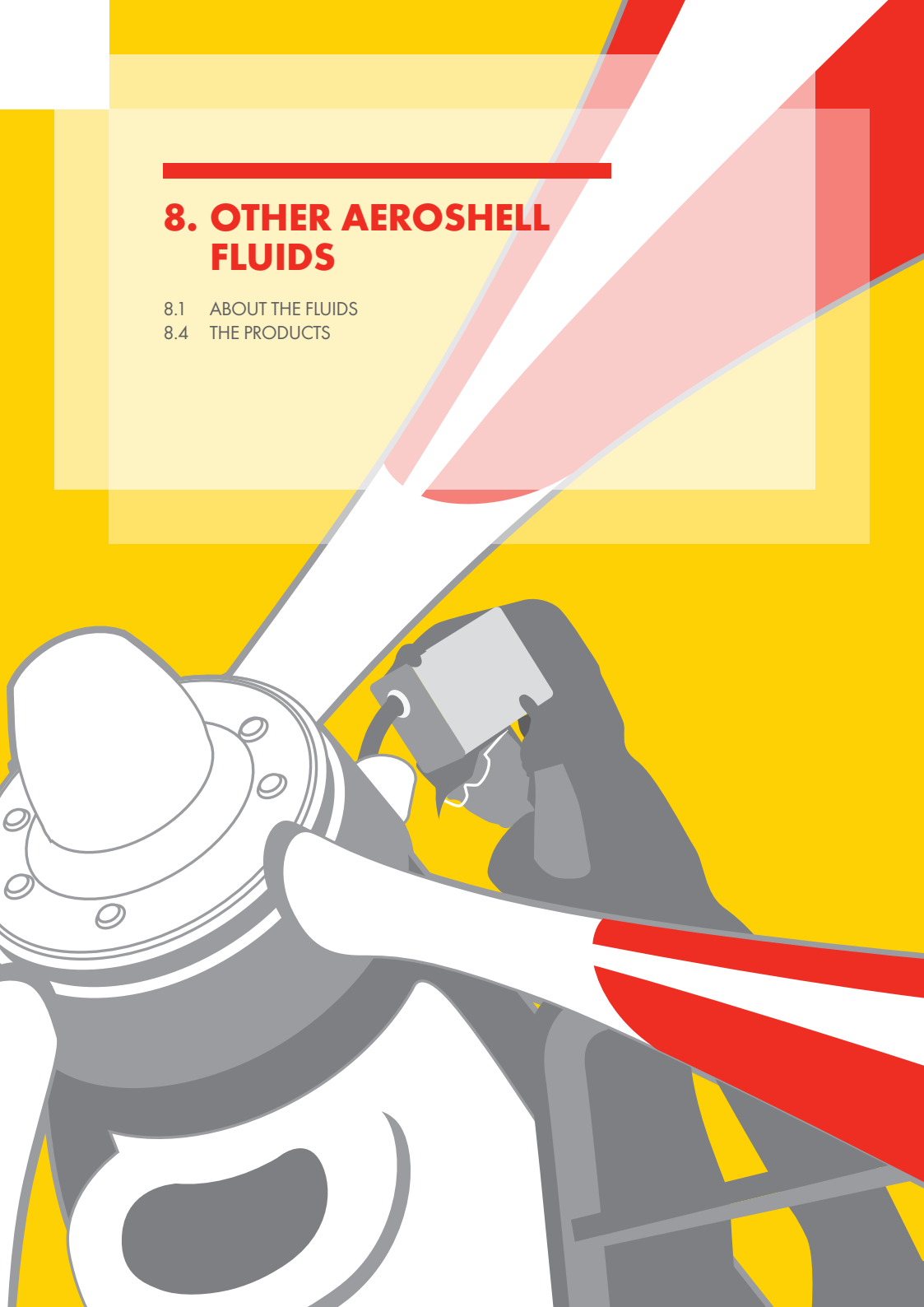
SPECIFICATIONS

U.S.	Corresponding MIL-C-11796C Class 3
British	Approved DEF STAN 80-85
French	Equivalent to AIR 8136
Russian	-
NATO Code	C-628 (obsolete)
Joint Service Designation	PX-11

PROPERTIES		DEF STAN 80-85	TYPICAL
Melting point	°C	65 min	70
Saponification value	mgKOH/g	8.5 min	9.4
Ash	%m	0.05 max	0.02
Inorganic acidity		Nil	Nil
Total acidity	mgKOH/g	1.7 to 2.2	1.9

NOTES

8. OTHER AEROSHELL FLUIDS



OTHER AEROSHELL FLUIDS

Other AeroShell Fluids are used for special applications on aircraft, aircraft engines and auxiliary equipment, and can be subdivided under the following headings:

Lubricating oils
Gearbox oils
Calibrating fluids
De-icing fluids
Avionic cooling fluids

Lubricating Oils

AeroShell Fluid 1
AeroShell Fluid 3
AeroShell Fluid 12
AeroShell Fluid 18

AeroShell Fluid 1 is an aircraft instrument and light mineral lubricating oil. AeroShell Fluid 3 and AeroShell Fluid 12 cover the two types of aircraft general purpose and instrument oils in use today i.e. mineral oil (MIL-PRF-7870) and synthetic oil (MIL-PRF-6085) respectively. They are recommended for the lubrication of delicate instruments and general aircraft lubrication by oil can application, etc.

AeroShell Fluid 18 is a low temperature, water displacing general purpose oil.

Gearbox Oils

AeroShell Fluid 5L-A
AeroShell Fluid 5M-A
AeroShell Fluid S.8350

AeroShell Fluid 5L-A and 5M-A are recommended for the lubrication of gears where high tooth loadings exist e.g. helicopter gearboxes and constant speed alternator drives. AeroShell Fluid 5L-A is of low viscosity, AeroShell Fluid 5M-A of medium viscosity.

AeroShell Fluid S.8350 is an extreme pressure gear oil and recommended for lubrication of gears where the use of a 90 EP gear oil is required.

Calibrating Fluid

AeroShell Calibrating Fluid 2

This fluid is used for calibrating the aircraft fuel system components of turbine engines.

De-icing Fluids

AeroShell Compound 06A
AeroShell Compound 07

Various alcohols, or mixtures of these with other materials, are used for de-icing windscreens, propellers, carburettors and wing surfaces. The most common requirement, for de-icers for windscreens and propellers, is met by AeroShell Compounds 06A and 07. A mixture of equal volumes of AeroShell Compounds 07 and 06A, is suitable as a defrosting spray for aircraft parked in the open. AeroShell Compound 07 is also an approved wing de-icing fluid.

Avionic Cooling Fluids

AeroShell Fluid 602

AeroShell Fluid 602 is a cooling fluid for aircraft avionic systems.

NOTES

AEROSHELL FLUID 1

AeroShell Fluid 1 is a light lubricating mineral oil containing, by specification, less than 0.10% mass stearic acid.

APPLICATIONS

For use as a lubricant where a light anti-freezing oil is required, e.g. on aircraft instruments, gun mounting buffers, hydraulic couplings, controls, door hinges, etc. Also used as a preservative oil for Stromberg carburettors and some fuel systems.

AeroShell Turbine Oil 3 can be used as an alternative to AeroShell Fluid 1, but AeroShell Fluid 1 must never be used as an alternative to AeroShell Turbine Oil 3.

SPECIFICATIONS

U.S.	-
British	Approved DEF STAN 91-44
French	Equivalent to AIR 3515/B
Russian	-
NATO Code	O-134
Joint Service Designation	OM-13

PROPERTIES	**DEF STAN 91-44**	**TYPICAL**
Oil type	Mineral	Mineral
Kinematic viscosity mm^2/s @ –25°C @ 40°C	 1250 max 12 min	 1140 12.15
Flashpoint Pensky Martin Closed Cup °C	144 min	150
Pourpoint °C	–45 min	Below –45
Aniline point °C	85 min	87
Aniline point change after extraction with sulphuric acid °C	5.5 max	2.2
Total acidity mgKOH/g	0.3 max	0.15
Ash %m	0.01 max	Less than 0.01
Density @ 15°C kg/l	-	0.873
Trace element content	Must pass	Passes
Copper corrosion 3 hrs @ 100°C	Must pass	Passes

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

AEROSHELL FLUID 3

AeroShell Fluid 3 is a general purpose mineral lubricating oil recommended for general lubrication of aircraft parts that require a light oil with good low temperature characteristics and a low freezing point. It is inhibited against oxidation and corrosion. AeroShell Fluid 3 is a relatively low viscosity product with good resistance to evaporation.

APPLICATIONS

AeroShell Fluid 3 is recommended for general lubrication of aircraft parts that require a light oil, e.g. hinges, pivot joints, shaft joints, linkage pins and bearings, pulleys, cables, camera mechanisms, radio and radar gear and instruments. AeroShell Fluid 3 is normally applied by means of an oil can or brush. For this reason it is also described as 'an oilcan lubricant'.

Operating temperature range of AeroShell Fluid 3 is –54°C to +121°C.

For high temperature applications where no provision is made for frequent re-lubrication the synthetic oil, AeroShell Fluid 12, should be used in place of the mineral oil, AeroShell Fluid 3; however in this case care should be taken to ensure that there is no incompatibility between AeroShell Fluid 12 and seals, paints etc.

SPECIFICATIONS

U.S.	Approved MIL-PRF-7870D
British	Approved DEF STAN 91-47
French	-
Russian	-
NATO Code	O-142
Joint Service Designation	OM-12

PROPERTIES	MIL-PRF-7870D	TYPICAL
Oil type	-	Mineral
Kinematic viscosity mm²/s @ 38°C @ –40°C	 10 min 4000 max	 10.0 Less than 4000
Flashpoint Cleveland Open Cup °C	 130 min	 155
Pourpoint °C	–57 max	Below –57
Evaporation @ 99°C, 22 hrs %m	25 max	13
Total acid number mgKOH/g	Report	0.3
Relative density @ 15.6/15.6°C	-	0.89
Low temperature stability 72 hrs @ –54°C	 Must pass	 Passes
Corrosion & oxidation stability (168 hrs @ 121°C) - metal weight change - viscosity change % - acid number change mgKOH/g	 Must pass –5 to +20 0.2 max	 Passes 10 0.02
Corrosivity	Must pass	Passes
ASTM colour	-	< 0.5

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

AEROSHELL FLUID 5L-A

AeroShell Fluid 5L-A is a highly refined, low viscosity mineral oil containing an extreme pressure additive as well as additives to provide good oxidation and corrosion protection.

AeroShell Fluid 5L-A has good low temperature characteristics.

APPLICATIONS

AeroShell Fluid 5L-A is used for the lubrication of gears where high tooth loadings exist, particularly when operating at low temperature. AeroShell Fluid 5L-A is particularly suitable for the lubrication of radar gearboxes, constant speed alternator drives. AeroShell Fluid 5L-A is also used in those helicopter transmissions (gearboxes) which require use of this type of MIL-PRF-6086 oil.

AeroShell Fluid 5L-A must not be used in engines.

SPECIFICATIONS

U.S.	Approved MIL-PRF-6086F Light Grade
British	Approved DEF STAN 91-112 Grade L
French	-
Russian	-
NATO Code	O-153
Joint Service Designation	Equivalent OEP-30

PROPERTIES		**MIL-PRF-6086F Light Grade**	**TYPICAL**
Oil type		-	Mineral
Kinematic viscosity @ 37.8 °C @ 98.9 °C	mm^2/s	 23 to 34 -	 27.8 4.90
Flashpoint Cleveland Open Cup	°C	 137.8 min	 190
Viscosity index		80 min	100
Pourpoint	°C	–40 max	Below –40
Total acid number	mgKOH/g	1.0 max	0.1
Relative density @ 15.6/15.6 °C		-	0.89
Load wear index	kg	40 min	45.5
Colour ASTM		8 max	1.0
Foaming, sequence I, II, III		Must pass	Passes
Copper corrosion 3 hrs @ 100 °C		Must pass	Passes

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

AEROSHELL FLUID 5M-A

AeroShell Fluid 5M-A is a highly refined, medium viscosity mineral oil containing an extreme pressure additive as well as additives to provide good oxidation and corrosion protection.

APPLICATIONS

Aeroshell Fluid 5M-A is used for the lubrication of gears where high tooth loadings exist. AeroShell Fluid 5M-A is particularly recommended for the lubrication of translation units of contra-rotating propellers, radar gearboxes, constant speed alternator drives. AeroShell Fluid 5M-A is also used in those helicopter transmissions (gearboxes) which require use of a MIL-PRF-6086 oil.

AeroShell Fluid 5M-A is also suitable as an extreme pressure lubricant for heavily loaded pins, bushes and gear mechanisms.

AeroShell Fluid 5M-A must not be used in engines.

SPECIFICATIONS

U.S.	Approved MIL-PRF-6086F Medium Grade
British	Approved DEF STAN 91-112 Grade M
French	-
Russian	-
NATO Code	O-155
Joint Service Designation	OEP-70

PROPERTIES	**MIL-PRF-6086F Medium Grade**	**TYPICAL**
Oil type	-	Mineral
Kinematic viscosity mm^2/s @ 37.8 °C @ 98.9 °C	 60 to 82 -	 68 8.3
Flashpoint Cleveland Open Cup °C	154.5 min	204
Viscosity index	80 min	100
Pourpoint °C	–28.9max	Below –29
Total acid number mgKOH/g	1.0 max	0.1
Relative density @ 15.6/15.6 °C -	0.92	
Load wear index kg	40 min	50
Colour ASTM	8 max	< 3
Foaming, sequence I, II, III	Must pass	Passes
Copper corrosion 3 hrs @ 100 °C	Must pass	Passes

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

AEROSHELL FLUID 12

AeroShell Fluid 12 is a low volatility synthetic ester oil used in aircraft instruments and also for the general lubrication of aircraft. It is oxidation and corrosion inhibited, and possesses good high and low temperature characteristics.

APPLICATIONS

AeroShell Fluid 12 is used for general aircraft lubrication as well as for aircraft gyro instrument gimbal bearings, separately lubricated high speed turbines and compressors, aircraft air cycle equipment and electronic equipment. AeroShell Fluid 12 is particularly suitable for use when an oil with a low evaporation rate is required at high and low temperatures.

AeroShell Fluid 12 is a synthetic oil and it should not be used in contact with incompatible seal materials such as neoprene or natural rubber. Suitable seal material include Fluorocarbon (Viton). AeroShell Fluid 12 may also affect certain paints and plastics. It is recommended that components are evaluated for compatibility if there is any question.

SPECIFICATIONS

U.S.	Approved MIL-PRF-6085D
British	Equivalent DEF STAN 91-49
French	Approved AIR 3511/A
Russian	-
NATO Code	O-147
Joint Service Designation	Equivalent OX-14

PROPERTIES	**MIL-PRF-6085D**	**TYPICAL**
Oil type	-	Synthetic ester
Kinematic viscosity mm^2/s @ 54.4°C @ –53.9°C	 8 min 12000 max	 8.2 11000
Flashpoint Cleveland Open Cup °C	 185 min	 220
Pourpoint °C	–57 max	Below –60
Total acid number mgKOH/g	-	0.20
Relative density @ 15.6/15.6°C	-	0.925
Evaporation loss in 22 hrs @ –120°C %m	 1.80 max	 1.50
Colour ASTM	-	<0.5
Corrosion & oxidation stability (168 hrs @ 135°C) - metal weight change - viscosity change @ 54.5°C - total acid number change mgKOH/g - insolubles mg/100ml	 Must pass ± 5 0.5 max -	 Passes 0.5 0.1 1.0
Low temperature stability	Must pass	Passes
Corrosivity	Must pass	Passes

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

AEROSHELL FLUID 18

AeroShell Fluid 18 is a highly refined petroleum lubricating oil and contains additives to inhibit corrosion and rusting and improve water displacing characteristics.

APPLICATIONS

AeroShell Fluid 18 is for use in the lubrication and corrosion protection of small arms and automatic weapons and as a general purpose lubricant for all applications where water displacing, corrosion protection, and low temperature lubrication is required.

AeroShell Fluid 18 is also intended for locks, hinges, electric motors, fans, small bearings, control rods and cables and can be used in numerous non-aviation applications.

AeroShell Fluid 18 is not recommended as a lubricant at temperatures below –57°C.

SPECIFICATIONS

U.S.	Approved MIL-PRF-32033
British	Equivalent DEF STAN 91-79 (Obsolete)
French	-
Russian	-
NATO Code	O-190 (Obsolete)
Joint Service Designation	OX-14 (Obsolete)

PROPERTIES	**MIL-PRF-32033**	**TYPICAL**
Oil type	Mineral	Mineral
Kinematic viscosity mm^2/s @ 40°C @ –40°C @ –54°C	 11 min 7000 max 60000 max	 11.3 4500 55700
Flashpoint Cleveland Open Cup °C	 135 min	 150
Pourpoint °C	–57 max	–61
Total acid number mgKOH/g	-	0.44
Relative density @ 15.6/15.6°C	-	0.890
Evaporation 22 hrs @ 100°C %	25 max	23
Precipitation number ml	0.005 max	0.00
Corrosion & oxidation stability (168 hrs @ 121°C) - viscosity change % - change in acidity mgKOH/g - metal weight change	 –5 to +20 0.2 max Must pass	 10.25 0.01 Passes
Water displacing properties	Must pass	Passes
Copper corrosion 3 hrs @ 100°C	Must pass	Passes
Galvanic corrosion	None	Passes
Rust protection 168 hrs @ 43°C	No rust	Passes

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

AEROSHELL FLUID 602

AeroShell Fluid 602 synthetic base fluid is composed of highly branched, compact and very stable molecules known as polyalphaolefins (PAO), blended with additives to provide long term storage stability.

AeroShell Fluid 602 offers exceptional performance over a wide temperature range and does not react with water, resulting in clean systems and long fluid and component life.

APPLICATIONS

AeroShell Fluid 602 is most widely used as a cooling fluid for aircraft avionic systems, whose benefits include lower initial cost, longer fluid life, lower weight and lower toxicity when compared with other types of avionic system coolants. Since AeroShell Fluid 602 does not react with water, no reclamation equipment is required, adding further to the cost advantage.

SPECIFICATIONS

U.S.	Approved MIL-PRF-87252C
British	-
French	-
Russian	-
NATO Code	S-1748
Joint Service Designation	-

PROPERTIES	MIL-PRF-87252C	TYPICAL
Relative density @ 15.6/15.6 °C	-	0.799
Viscosity mm²/s		
@ 100 °C	1.65 min	1.77
@ 40 °C	5.0 min	5.29
@ –40 °C	300 max	280
@ –54 °C	1300 max	1094
Viscosity index	-	145
Pourpoint °C	-	–73
Flash point °C	150 min	160
Fire point °C	160 min	171
Evaporation loss		
@ 204 °C, 6.5 hr %m	-	17
Total acid number mgKOH/g	0.2 max	< 0.01
Water content, Karl Fischer ppm	50 max	35
Density g/cc dilatometer		
@ 0 °C	-	0.8058
@ 100 °C	-	0.7392
@ 190 °C	-	0.6768
Specific heat cal/g °C		
@ –17.8 °C	-	0.49
@ 37.8 °C	-	0.54
@ 149 °C	-	0.63
@ 260 °C	-	0.72
Thermal conductivity, heat probe method cal/hr cm² (°C/cm)		
@ –17.8 °C	-	1.26
@ 37.8 °C	-	1.21
@ 149 °C	-	1.12
@ 260 °C	-	1.02

Table continued

Table continued

PROPERTIES	MIL-PRF-87252C	TYPICAL
Coefficient of thermal expansion dilatometer 1/°C		
0 to 50°C	-	0.00083
50 to 100°C	-	0.00092
100 to 150°C	-	0.00103
150 to 190°C	-	0.00117
Dielectric constant 400 Hz	-	2.10
Power factor 400 Hz	-	< 0.0001
Dielectric breakdown Voltage kv	35 min	47
Volume resistivity @ 25°C ohm-cm	1.0 x 10^{10} min	2.9 x 10^{15}
Particle count, automatic		
5 to 15 µm	10000 max	2664
16 to 25 µm	1000 max	345
26 to 50 µm	150 max	86
51 to 100 µm	20 max	10
< 100 µm	5 max	0
Elastomer compatibility		
Recommended (Swell <5%)	-	Nitrile (N674-70) Fluorosilicone Fluorocarbon Polyacrylate
Marginal (Swell <15%)	-	Nitrile (N497-70)
Not recommended (Swell >15%)	-	Ethylene Propylene Buna N SBR

NOTES

AEROSHELL FLUID S.8350

AeroShell Fluid S.8350 is an SAE 90 extreme pressure gearbox oil.

APPLICATIONS

AeroShell Fluid S.8350 is used for helicopter rotor gears, drive-shafts and pitch control mechanisms and wherever high loads and slow speeds in gears require the use of a 90 EP gear oil. AeroShell Fluid S.8350 is approved for use in various Westland helicopter gearboxes.

AeroShell Fluid S.8350 must not be used in engines.

SPECIFICATIONS

U.S.	-
British	Approved DTD.900/4981A
French	-
Russian	-
NATO Code	-
Joint Service Designation	OEP-215

PROPERTIES		**DTD.900/4981A**	**TYPICAL**
Oil type		-	Mineral
Kinematic viscosity @ 40°C @ 100°C	mm^2/s	 - 16.26 to 17.42	 182 17.0
Viscosity index		85 min	97
Flashpoint Cleveland Open Cup	°C	177 min	228
Pourpoint	°C	–18 max	–21
Total acid number	mgKOH/g	0.2	0.15
Density @ 15°C	kg/l	-	0.895
Evaporation loss @ 150°C		5 max	3.0
Precipitation loss	ml	0.05 max	0.01
Copper corrosion		Must pass	Passes
Foaming, sequence I, II, III		Must pass	Passes

AEROSHELL CALIBRATING FLUID 2

AeroShell Calibrating Fluid 2 is composed of Specially Run Stoddard Solvent and is used for calibrating aircraft fuel system components.

APPLICATIONS

AeroShell Calibrating Fluid 2 is intended for the calibration of fuel system components of aircraft turbine engines.

SPECIFICATIONS

U.S.	Approved MIL-PRF-7024E Type II
British	-
French	-
Russian	-
NATO Code	-
Joint Service Designation	-

PROPERTIES	**MIL-PRF-7024E Type II**	**TYPICAL**
Oil type	-	Mineral
Relative density @ 15.6/15.6°C	0.77 ± 0.005	0.77
Temperature – density variation		
@ 15°C	-	0.7705
@ 30°C	-	0.759
@ 40°C	-	0.752
@ 80°C	-	0.7225
Kinematic viscosity mm^2/s		
@ 10°C	-	1.46
@ 25°C	1.17 ± 0.05	1.15
@ 40°C	-	0.95
Flashpoint by TAG method °C	38 min	43
Distillation:		
IBP °C	149 min	158
End point °C	210 max	196
Recovery %	98.5 min	98.5
Total acid number mgKOH/g	0.015 max	0.007
Colour, saybolt	-	30
Copper corrosion 3 hrs @ 100°C	Must pass	Passes
Aromatics % vol	20 max	< 1.0

AEROSHELL COMPOUND 06A

AeroShell Compound 06A is used as a de-icing fluid for windscreens, carburettors and propellers.

APPLICATIONS

AeroShell Compound 06A and ethyl alcohol (obsolete grade AeroShell Compound 06) are equally effective for de-icing and are miscible in all proportions. However, operators should follow the aircraft manufacturer's recommendations regarding the type of fluid to be used, because of possible side effects.

SPECIFICATIONS

U.S.	Equivalent TT-I-735a Grade B Equivalent ASTM D770
British	Approved BS.1595
French	Equivalent AIR 3660/B
Russian	-
NATO Code	S-737
Joint Service Designation	AL-11

PROPERTIES		**BS.1595**	**TYPICAL**
Flashpoint (Abel)	°C	-	10.0
Distillation range: IBP Dry	°C	 81.5 83.0	 82 83
Water content	%m	0.5 max	0.085
Density @ 20°C	kg/l	0.785 to 0.787	0.786
Miscibility with water		Must pass	Passes
Colour	Hazen units	15 max	5
Residue on evaporation	%	0.002 max	0.002
Aldehydes & ketones % mass as acetone		0.01 max	0.007
Alkalinity or acidity % mass as acetic acid		0.002 max	0.0002

AEROSHELL COMPOUND 07

AeroShell Compound 07 is a de-icing fluid composed of ethylene glycol, isopropyl alcohol and distilled water.

Specification DTD.406B requires the product to have the following approximate composition:

Ethanediol (BS.2537) 85% volume

Isopropanol (BS.1595) 5% volume

Distilled water 10% volume

APPLICATIONS

AeroShell Compound 07 is used for in-flight de-icing of windscreens, propellers, wings, tailplanes, etc. on suitably equipped aircraft.

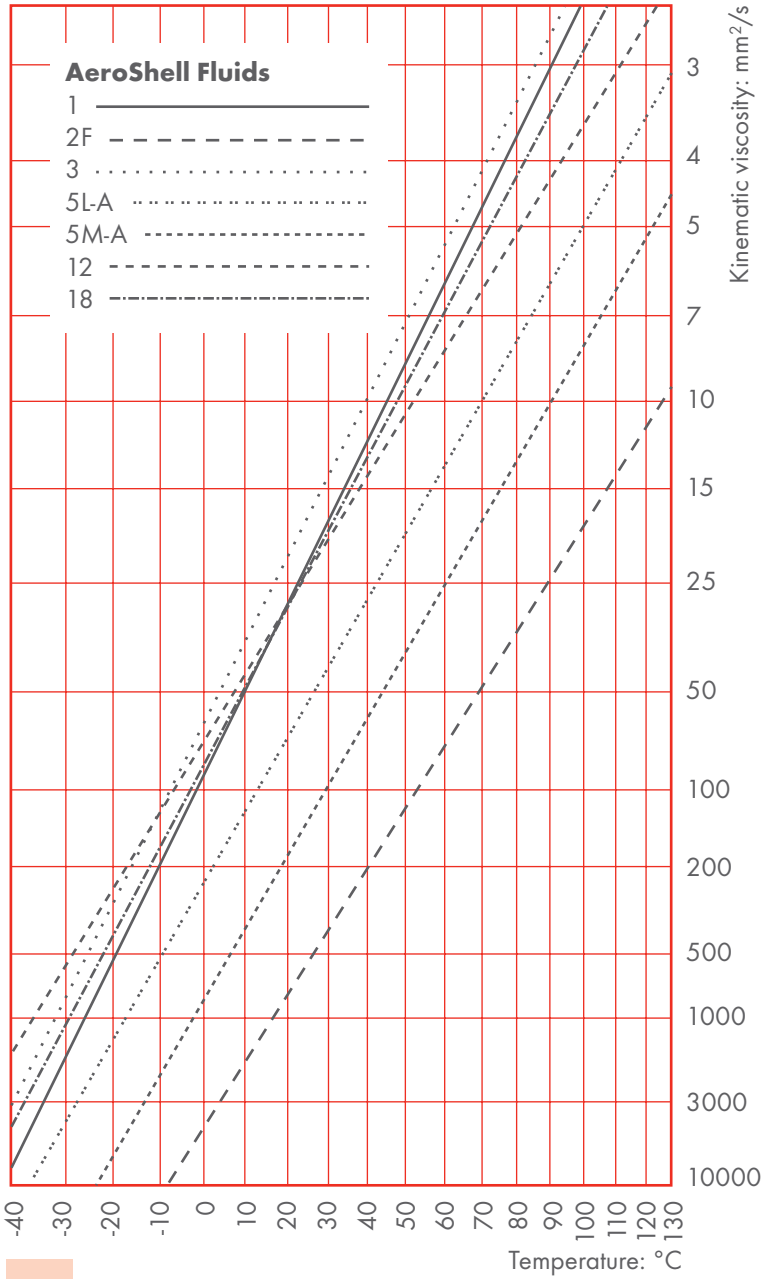
AeroShell Compound 07 is also recommended for removing hoar frost and light snow/ice from parked aircraft. AeroShell Compound 07 can be sprayed undiluted or mixed with up to 50% volume of water, depending upon the severity of the icing conditions, the efficiency of the spraying technique and whether it is applied hot or cold.

SPECIFICATIONS

U.S.	-
British	Approved DTD.406B
French	-
Russian	-
NATO Code	S-745
Joint Service Designation	AL-5

PROPERTIES		**DTD.406B**	**TYPICAL**
Flashpoint Cleveland Open Cup	°C	-	54.4
Kinematic viscosity @ 20°C	mm^2/s	11.0 to 13.0	11.4
Cold test @ –40°C		No deposition	Complies
pH value		6.0 to 7.5	6.9
Conductivity, micromho/cm		5.0 max	0.5
Density @ 15°C	kg/l	1.092 to 1.097	1.094
Miscibility with water @ 15°C		Must pass	Passes

TYPICAL TEMPERATURE/VISCOSITY CURVE OF OTHER AEROSHELL FLUIDS



9. CONVERSION TABLES

TEMPERATURE CONVERSION CHART

The central figure in each column is the temperature in degrees Celsius or Fahrenheit which require conversion. If this is in terms of degrees Celsius, the corresponding Fahrenheit temperature will be found to the right of it; if the given temperature is in terms of Fahrenheit, the corresponding Celsius temperature is to the left.

°C		°F	°C		°F	°C		°F
-73.3	**-100**	-148.0	-6.7	**20**	68.0	10.0	**50**	122.0
-68.7	**-90**	-130.0	-6.1	**21**	69.8	10.6	**51**	123.8
-62.2	**-80**	-112.0	-5.6	**22**	71.6	11.1	**52**	125.6
-56.7	**-70**	-94.0	-5.0	**23**	73.4	11.7	**53**	127.4
-51.0	**-60**	-76.0	-4.4	**24**	75.2	12.2	**54**	129.2
-45.6	**-50**	-58.0	-3.9	**25**	77.0	12.8	**55**	131.0
-40.0	**-40**	-40.0	-3.3	**26**	78.8	13.3	**56**	132.8
-34.4	**-30**	-22.0	-2.8	**27**	80.6	13.9	**57**	134.6
-28.9	**-20**	-4.0	-2.2	**28**	82.4	14.4	**58**	136.4
-23.3	**-10**	14.0	-1.7	**29**	84.2	15.0	**59**	138.2
-17.8	**0**	32.0	-1.1	**30**	86.0	15.6	**60**	140.0
-17.2	**1**	33.8	-0.6	**31**	87.8	16.1	**61**	141.8
-16.7	**2**	35.6	0.0	**32**	89.6	16.7	**62**	143.6
-16.1	**3**	37.4	0.6	**33**	91.4	17.2	**63**	145.4
-15.6	**4**	39.2	1.1	**34**	93.2	17.8	**64**	147.2
-15.0	**5**	41.0	1.7	**35**	95.0	18.3	**65**	149.0
-14.4	**6**	42.8	2.2	**36**	96.8	18.9	**66**	150.8
-13.9	**7**	44.6	2.8	**37**	98.6	19.4	**67**	152.6
-13.3	**8**	46.4	3.3	**38**	100.4	20.0	**68**	154.4
-12.8	**9**	48.2	3.9	**39**	102.2	20.6	**69**	156.2
-12.2	**10**	50.0	4.4	**40**	104.0	21.2	**70**	158.0
-11.7	**11**	51.8	5.0	**41**	105.8	21.7	**71**	159.8
-11.1	**12**	53.6	5.6	**42**	107.6	22.2	**72**	161.6
-10.6	**13**	55.4	6.1	**43**	109.4	22.8	**73**	163.4
-10.0	**14**	57.2	6.7	**44**	111.2	23.3	**74**	165.2
-9.4	**15**	59.0	7.2	**45**	113.0	23.9	**75**	167.0
-8.9	**16**	60.8	7.8	**46**	114.8	24.4	**76**	168.8
-8.3	**17**	62.6	8.3	**47**	116.6	25.0	**77**	170.6
-7.8	**18**	64.4	8.9	**48**	118.4	25.6	**78**	172.4
-7.2	**19**	66.2	9.4	**49**	120.2	26.1	**79**	174.2

°C		°F	°C		°F	°C		°F
26.7	**80**	176.0	48.9	**120**	248.0	71.1	**160**	320.0
27.2	**81**	177.8	49.4	**121**	249.8	71.7	**161**	321.8
27.8	**82**	179.6	50.0	**122**	251.6	72.2	**162**	323.6
28.3	**83**	181.4	50.6	**123**	253.4	72.8	**163**	325.4
28.9	**84**	183.2	51.1	**124**	255.2	73.3	**164**	327.2
29.4	**85**	185.0	51.7	**125**	257.0	73.9	**165**	329.0
30.0	**86**	186.8	52.2	**126**	258.8	74.4	**166**	330.8
30.6	**87**	188.6	52.8	**127**	260.6	75.0	**167**	332.6
31.1	**88**	190.4	53.3	**128**	262.4	75.6	**168**	334.4
31.7	**89**	192.2	53.9	**129**	264.2	76.1	**169**	336.2
32.2	**90**	194.0	54.4	**130**	266.0	76.7	**170**	338.0
32.8	**91**	195.8	55.0	**131**	267.8	77.2	**171**	339.8
33.3	**92**	197.6	55.6	**132**	269.6	77.8	**172**	341.6
33.9	**93**	199.4	56.1	**133**	271.4	78.3	**173**	343.4
34.4	**94**	201.2	56.7	**134**	273.2	78.9	**174**	345.2
35.0	**95**	203.0	57.2	**135**	275.0	79.4	**175**	347.0
35.6	**96**	204.8	57.8	**136**	276.8	80.0	**176**	348.8
36.1	**97**	206.6	58.3	**137**	278.6	80.6	**177**	350.6
36.7	**98**	208.4	58.9	**138**	280.4	81.1	**178**	352.4
37.2	**99**	210.2	59.4	**139**	282.2	81.7	**179**	354.2
37.8	**100**	212.0	60.0	**140**	284.0	82.2	**180**	356.0
38.3	**101**	213.8	60.6	**141**	285.8	82.8	**181**	357.8
38.8	**102**	215.6	61.1	**142**	287.6	83.3	**182**	359.6
39.4	**103**	217.4	61.7	**143**	289.4	83.9	**183**	361.4
40.0	**104**	219.2	62.2	**144**	291.2	84.4	**184**	363.2
40.6	**105**	221.0	62.8	**145**	293.0	85.0	**185**	365.0
41.1	**106**	222.8	63.3	**146**	294.8	85.6	**186**	366.8
41.7	**107**	224.6	63.9	**147**	296.6	86.1	**187**	368.6
42.2	**108**	226.4	64.4	**148**	298.4	86.7	**188**	370.4
42.8	**109**	228.2	65.0	**149**	300.2	87.2	**189**	372.2
43.3	**110**	230.0	65.6	**150**	302.0	87.8	**190**	374.0
43.9	**111**	231.8	66.1	**151**	303.8	88.3	**191**	375.8
44.4	**112**	233.6	66.7	**152**	305.6	88.9	**192**	377.6
45.0	**113**	235.4	67.2	**153**	307.4	89.4	**193**	379.4
45.6	**114**	237.2	67.8	**154**	309.2	90.0	**194**	381.2
46.1	**115**	239.0	68.3	**155**	311.0	90.6	**195**	383.0
46.7	**116**	240.8	68.9	**156**	312.8	91.1	**196**	384.8
47.2	**117**	242.6	69.4	**157**	314.6	91.7	**197**	386.6
47.8	**118**	244.4	70.0	**158**	316.4	92.2	**198**	388.4
48.3	**119**	246.2	70.6	**159**	318.2	92.8	**199**	390.2

°C		°F	°C		°F	°C		°F
93.3	**200**	392.0	204.4	**400**	752.0	315.6	**600**	1112.0
98.9	**210**	410.0	210.0	**410**	770.0	343.3	**650**	1202.0
104.4	**220**	428.0	215.6	**420**	788.0	371.1	**700**	1292.0
110.0	**230**	446.0	221.1	**430**	806.0	398.9	**750**	1382.0
115.6	**240**	464.0	226.7	**440**	824.0	426.7	**800**	1472.0
121.1	**250**	482.0	232.2	**450**	842.0	454.4	**850**	1562.0
126.7	**260**	500.0	237.8	**460**	860.0	482.2	**900**	1652.0
132.2	**270**	518.0	243.3	**470**	878.0	510.0	**950**	1742.0
137.8	**280**	536.0	248.9	**480**	896.0	537.8	**1000**	1832.0
143.3	**290**	554.0	254.4	**490**	914.0			
148.9	**300**	572.0	260.0	**500**	932.0			
154.4	**310**	590.0	265.6	**510**	950.0			
160.0	**320**	608.0	271.1	**520**	968.0			
165.6	**330**	626.0	276.7	**530**	986.0			
171.1	**340**	644.0	282.2	**540**	1004.0			
176.7	**350**	662.0	287.8	**550**	1022.0			
182.2	**360**	680.0	293.3	**560**	1040.0			
187.8	**370**	698.0	298.9	**570**	1058.0			
193.3	**380**	716.0	304.4	**580**	1076.0			
198.9	**390**	734.0	310.0	**590**	1094.0			

°C = $^5/_9$ (°F – 32)

°F = ($^5/_9$ x °C) + 32

MISCELLANEOUS CONVERSION CHART

Some useful conversion factors are listed below. For a full range, consult **www.onlineconversion.com**

TO CONVERT FROM:	TO:	MULTIPLY BY:
Calorific Value. SI units - mass basis-Joule/kilogramme (J/kg); volume basis-Joule/cubic metre (J/m^3)		
MJ/kg	**Btu/lb**	**4.299×10^2**
Btu/lb	**kWh/kg**	**6.461×10^{-4}**
cal/g(kcal/kg)	**Btu/lb**	**1.8**
Concentration (mass/volume) and **Density**. SI unit - kilogramme/cubic metre (kg/m^3)		
kg/m^3(g/litre)	**kg/litre**	**10^{-3}**
lb/1000 UK gal	**mg/litre**	**99.78**
lb/1000 US gal	**mg/litre**	**1.198×10^2**
g/US gal	**g/litre**	**0.264**
kg/litre	**lb/UK gal**	**10.02**
kg/litre	**lb/ft^3**	**62.43**
Concentration (volume/volume). SI unit - cubic metre/cubic metre (m^3/m^3)		
ml/UK gal	**ml/litre or litre/m^3**	**0.22**
ml/US gal	**ml/litre or litre/m^3**	**0.264**
ppm	**% vol**	**10^{-4}**
Energy/Heat/Work. SI unit - Joule (J)		
Btu	**kJ**	**1.055**
Btu	**kWh**	**2.9307×10^{-4}**
therm	**MJ**	**1.055×10^2**
cal	**J**	**4.1868**
kWh	**MJ**	**3.6**
Force. SI unit - Newton (N)		
lbf	**N**	**4.448**
pdl	**N**	**1.38255×10^{-1}**
dyne	**mN**	**0.01**
Length. SI unit - metre (m)		
in	**mm**	**25.4**
ft	**m**	**0.3048**

TO CONVERT FROM:	TO:	MULTIPLY BY:
Mass. SI unit - kilogram (kg)		
kg	**lb**	**2.2046**
lb	**g**	**4.536×10^2**
UK ton (2240 lb) long	**tonne(t)**	**1.016**
UK ton (2000 lb) short	**tonne(t)**	**0.907**
Power/Heat Flow. SI unit - Watt (W)		
h.p.	**kW**	**0.7457**
ft.lbf/s	**W**	**1.3558**
Btu/hr	**W**	**0.2931**
Pressure. SI unit - Newton/square metre (N/m^2)		
N/m^2 (Pascal)	**Bar**	**10^{-5}**
lbf/in^2(psi)	**N/m^2 (Pa)**	**6.895×10^3**
lbf/in^2	**mbar**	**68.948**
kgf/cm	**$2N/m^2$**	**9.807×10^4**
kgf/cm^2	**lbf/in^2**	**14.223**
in Hg	**mbar**	**33.864**
atmosphere	**mbar**	**1013.25**
lbf/in^2(psi)	**Pa**	**6.894757×10^3**
lbf/in^2(psi)	**Bar**	**0.06894**
Bar	**Pa (N/m^2)**	**10^5**
Volume. SI units - cubic metre (m^3)		
m^3	**ft^3**	**35.315**
in^3	**cm^3**	**16.387**
UK gal	**m^3**	**4.546×10^{-3}**
US gal	**m^3**	**3.785×10^{-3}**
UK gal	**litre**	**4.546**
US gal	**litre**	**3.785**

Relative Density) Specific Gravity/API conversion

$$\text{(Relative Density) Specific Gravity 15.6/15.6°C} = \frac{141.5}{°\text{API} + 131.5}$$

Kinematic viscosity

mm^2/s = 1cSt

NOTES

10. AVIATION SPECIFICATIONS

AVIATION SPECIFICATIONS GUIDE

British, U.S., French and Russian Military Specifications for aviation fuels, engine oils, hydraulic fluids, greases and other aviation products used on aircraft.

Foreword

This part of the AeroShell Book contains five lists relating to British and U.S. Military Aviation specifications, NATO Code Numbers, Joint Service Designations and Shell Aviation Products. The lists are inter-related in that they contain the same data arranged in different forms for easy reference. In each list or table, the title data is given in the first column in numerical order.

Further lists provide details of French and Russian Military Aviation Specifications and Shell Aviation Products. Specifications of other countries have not been included for reasons of space and their more limited application.

Details of the precise relationship between the various items on each line are given in the introductions preceding each list.

The significance of the letters incorporated in the various specification numbers and reference symbols are given in the key in the following page.

In the column headed “Product and Application” only the most important and representative known uses have been named, and these are intended to serve as an indication of the type of application for which each grade is suitable.

A range of substitutes to Russian grades have been developed for use in aircraft manufactured in Russia, some of which have been approved by the Russian Authorities and full details of these approvals are given in the list of Russian Specifications.

Some AeroShell products are manufactured at more than one location. It is possible that the approval status will vary according to the source of material.

The specification information provided is believed correct at time of going to press. However, commercial and military specifications for aviation products are subject to frequent changes, and where applications require compliance of AeroShell grades to new or revised specifications, consultation with the local Shell company is advised.

In many cases where an AeroShell grade is not listed an unbranded, specification grade may be available; for further details please consult your local AeroShell supplier.

BRITISH SPECIFICATIONS

DTD DEF	Procurement Executive Ministry of Defence (Director of Materials Research)
D.Eng.R.D. DERD D.Eng.D	Procurement Executive Ministry of Defence (Director General Engine Development)
DEF STAN	Directorate of Standardisation, Ministry of Defence
CS	Procurement Executive Ministry of Defence (Materials Quality Assurance Directorate)
BS	British Standards Institution
TS	Technical Specification

U.S. SPECIFICATIONS

AAF	U.S. Army Air Force
AN	U.S. Air Force Navy Aeronautical
JAN	Joint Army/Navy
MIL	U.S. Military Specification
DOD	Department of Defense
PRF	Performance Standard
DTL	Detail Standard
VV	U.S. Federal Specification
JJJ	U.S. Federal Specification
TT	U.S. Federal Specification
SS	U.S. Federal Specification
O	U.S. Federal Specification
P	U.S. Federal Specification

BRITISH JOINT SERVICE DESIGNATIONS

Oils

OM	Oil mineral
OEP	Oil extreme pressure
OMD	Oil mineral detergent
OF	Oil fatty
OC	Oil compound
OX	Oil miscellaneous

The number following represents the approximate viscosity at 40°C

Greases

LG	Lime base grease
XG	Miscellaneous greases

This covers greases made from less common soaps, e.g. aluminium, lithium, etc., unspecified soaps or mixture of soaps. The group also includes greases containing fatty oils, synthetic oils, graphite or other non-soap additives.

The number following represents the approximate worked penetration

Miscellaneous Products

PX	Protective, miscellaneous. Materials for temporary protection against corrosion of metal equipment in storage
ZX	Speciality, miscellaneous
AL	Coolants, anti-freezing and de-icing agents The number following is merely an arbitrary serial number

Miscellaneous Products

PX	Protective, miscellaneous. Materials for temporary protection against corrosion of metal equipment in storage
ZX	Speciality, miscellaneous
AL	Coolants, anti-freezing and de-icing agents The number following is merely an arbitrary serial number

NATO Symbols

F	All fuels
O	All oils except those developed for some other primary function other than lubrication
H	All oils where the hydraulic properties are the main consideration
G	All greases except those developed for a special function
C	All products possessing anti-corrosion properties
S	All products which were developed for special functions, i.e. speciality products
P	All products for use as propellants

BRITISH AVIATION SPECIFICATIONS

Scope of list

This list is comprised of British Specifications in the DTD, DTD.900, DED, DEF, DEF STAN, D.Eng.R.D., D.Eng.D., DERD, BS, CS and TS series which cover aviation fuels, lubricants and allied products.

It should be noted that the original title "Director General Engine Research and Development" was modified to exclude "Research" and this resulted in a general change from D.Eng.R.D. to D.Eng.D. More recently both D.Eng.R.D. and D.Eng.D. were changed to DERD as the specifications were amended, or new specifications were issued by the department concerned.

In the 1980s many British Ministry of Defence DTD specifications were rewritten as DEF STAN specifications.

Recently it was decided to standardise British Specifications as Defence Standards (commonly referred to as DEF STAN), and many of the DERD specifications have been changed over. The changeover is virtually complete and all current DERD, DTD, CS and TS specifications have now been converted to DEF STAN specifications; in doing so the numeric part has also been changed. Obsolete or Cancelled British Specifications will not be changed.

The British Ministry of Defence has also adopted certain U.S. Military Specifications, these include MIL-DTL-5020, MIL-PRF-46010, MIL-S-81087, MIL-L-46000, MIL-PRF-83282, DOD-L-25681 and SAE J-1899 and J-1966. Details of these specifications are included in the section on U.S. Aviation Specifications.

British Defence Standards can be downloaded as Acrobat documents from the UK MoD website **www.dstan.mod.uk**

Interpretation of list

In the column headed "Alternative U.S. Specification", only those specifications which are equivalent, or acceptable alternatives, to the British Specification are shown.

Where an asterisk * appears in the last column of the list, the AeroShell grade recommended does not necessarily meet all the clauses of the British Specification, but is the nearest product marketed by Shell.

For easy reference, obsolete specifications are shown in both the current and superseded specification columns. In the former case, a suitable comment is made, namely, "OBSOLETE – superseded by ..."

Specification	Superseded Specification	NATO Code	Joint Service Designation	Product and Application	Alternative U.S. Specification	AeroShell Grade
DTD.72A	DTD.72	-	OF-300 (Obsolete)	Treated castor oil, specification now OBSOLETE	-	-
DTD.279C	-	-	-	CANCELLED - superseded by DEF STAN 80-83	-	-
DTD.392B	-	-	-	OBSOLETE - superseded by DEF STAN 80-80	-	-
DTD.406B	DTD.406A	S-745	AL-5	De-icing fluid ethylene glycol/alcohol/water mixture	-	AeroShell Compound 07
DTD.417B	DTD.4127A DTD.201	O-140 (Obsolete)	OM-150	Low temperature oil for aircraft controls. OBSOLETE - superseded by DEF STAN 91-114	-	-
DTD.445A	-	-	-	OBSOLETE	-	-
DTD.581C	-	-	-	OBSOLETE - superseded by DEF STAN 91-112	-	-
DTD.585 Obsolete	-	-	-	Hydraulic oil - petroleum base	MIL-H-5606A Obsolete	AeroShell Fluid 4*
DTD.585B Obsolete	-	-	-	OBSOLETE - superseded by DEF STAN 91-48 Grade Superclean	-	-
DTD.791C	-	C-613	PX-13	OBSOLETE - superseded by DEF STAN 81-205	-	-
DTD.804	-	-	-	OBSOLETE - superseded by DEF STAN 80-34	-	-
DTD.806B	-	-	-	OBSOLETE - superseded by DEF STAN 91-54	-	-
DTD.822B	-	-	-	OBSOLETE - superseded by DEF STAN 91-49	-	-

Specification	Superseded Specification	NATO Code	Joint Service Designation	Product and Application	Alternative U.S. Specification	AeroShell Grade
DTD.878A	-	-	-	OBSOLETE - superseded by DTD.5601. AeroShell Grease 5 still available for civil market meeting DTD.878A	-	AeroShell Grease 5
DTD.897B	-	-	-	OBSOLETE - superseded by DEF STAN 91-56	-	-
DTD.900AA Series	DTD.900Z	-	-	Approval procedure for proprietary materials and processes. See later in this section for details of selected individual approvals.	-	-
DTD.5527A	-	-	-	OBSOLETE - superseded by DEF STAN 91-57	-	-
DTD.5530	-	-	-	OBSOLETE - superseded by DTD.5617	-	-
DTD.5540B	-	C-635	PX-26	OBSOLETE - superseded by DEF STAN 80-142	-	-
DTD.5578	-	-	-	OBSOLETE - superseded by DEF STAN 91-47	-	-
DTD.5579	-	-	-	OBSOLETE - superseded by DTD.5601	-	-
DTD.5581	-	-	-	OBSOLETE - superseded by DEF STAN 91-46	-	-
DTD.5585A	-	-	-	OBSOLETE - superseded by DEF STAN 91-55	-	-
DTD.5586	-	-	-	OBSOLETE - superseded by DEF STAN 68-61	-	-
DTD.5598	-	-	-	OBSOLETE - superseded by DEF STAN 91-53	-	-
DTD.5601A	-	-	-	OBSOLETE - superseded by DEF STAN 91-52	-	-
DTD.5609	-	-	-	OBSOLETE - superseded by DEF STAN 91-51	-	-
DTD.5610	-	-	-	OBSOLETE - superseded by MIL-G-4343C	-	-
DTD.5617	-	-	-	OBSOLETE - superseded by DEF STAN 80-81	-	-
DTD.900/4042A	-	S-718	ZX-24	Anti-seize compound, aircraft oxygen system	-	-
DTD.900/4081C	-	-	-	OBSOLETE - superseded by DTD.900/6103A	-	-
DTD.900/4386A	DTD.900/4386	-	OX-16	Dowty liquid fluid for aircraft	-	-
DTD.900/4630A	-	-	-	Molybdenum disulphide grease for certain precision ball bearings and actuator gearboxes	-	-
DTD.900/4639	-	-	ZX-30	Lubricant, solid film, unbonded, graphite dispersion	-	-
DTD.900/4802B	-	-	-	Lubrication of gearbox drive, shaft universal joints	-	-
DTD.900/4872A	DTD.900/4309 DTD.900/4872	-	XG-344 (Obsolete)	Lubricant for certain turbine, engine starters. OBSOLETE	-	-
DTD.900/4877A	-	-	ZX-36	Lubricant for fitting electrical cables in aircraft	-	-
DTD.900/4881D	DTD.900/4881C	-	OX-20	Phosphate ester hydraulic fluid	-	-
DTD.900/4907	-	S-1746	AL-34	Anti-icing protection fluid for parked aircraft. Not suitable for use in aircraft de-icing systems.	-	-
DTD.900/4910A	DTD.900/4910	-	-	Grease for actuator screw jack and flap transmission system of certain aircraft	-	-

Specification	Superseded Specification	NATO Code	Joint Service Designation	Product and Application	Alternative U.S. Specification	AeroShell Grade
DTD.900/4913A	-	-	-	OBSOLETE - superseded by MIL-C-6529C Type I	-	AeroShell Fluid 2XN
DTD.900/4914A	-	-	-	OBSOLETE - superseded by DEF STAN 91-85	-	-
DTD.900/4939A	DTD.900/4939	-	AL-36	Windscreen washing fluid for certain aircraft	-	-
DTD.900/4981A	-	-	OEP-215	Helicopter gearbox oil	-	AeroShell Fluid S.8350
DTD.900/4990	-	-	-	Molybdenum disulphide grease for special applications	-	-
DTD.900/6103A	DTD.900/4081	-	OX-87	Hydraulic fluid for certain aircraft	-	-
DEF.2001A	-	-	-	OBSOLETE - superseded by DEF STAN 91-44	-	-
DEF.2004A	-	-	-	OBSOLETE - superseded by DEF STAN 91-42	-	-
DEF.2007A	-	-	-	OBSOLETE - superseded by DEF STAN 91-39	-	-
DEF.2181A	-	-	-	OBSOLETE - superseded by DEF STAN 91-40	-	-
DEF.2261A	-	-	-	OBSOLETE - superseded by DEF STAN 91-12	-	-
DEF.2304	-	-	-	OBSOLETE - superseded by DEF STAN 68-62	-	-
DEF.2331A (Obsolete)	DEF.2331 DTD.121D	C-614 -	PX-1 dyed PX-1 undyed	Temporary rust preventive - dyed Temporary rust preventive – undyed OBSOLETE – superseded by DEF STAN 80-217	MIL-C-16173E Grade 2 -	- -
DEF.2332A	-	-	-	OBSOLETE - superseded by DEF STAN 80-34	-	-
DEF.2333	-	-	-	OBSOLETE - superseded by DEF STAN 91-38	-	-
DEF.2334	-	-	-	OBSOLETE - superseded by DEF STAN 80-85 (formerly DEF STAN 91-50)	-	-
DEF STAN 01-5	-	-	-	Fuels, lubricants and associated products	-	-
DEF STAN 05-50	-	-	-	Series of test methods for testing fuels, lubricants and associated products	-	-
DEF STAN 59-10	-	-	-	Silicone compound for insulating and sealing electrical equipment. Specification now superseded by DEF STAN 68-69	-	-
DEF STAN 68-7	-	-	ZX-33 (Obsolete)	CANCELLED	-	-
DEF STAN 68-10	DTD.900/4916 CS.3122	C-634	PX-24	Water displacing and protective fluid	-	-
DEF STAN 68-11	-	-	PX-10 (Obsolete)	CANCELLED - superseded by DEF STAN 68-10	-	-
DEF STAN 68-61 (Obsolete)	DTD.5586	-	AL-26	Inhibited coolant fluid	-	-
DEF STAN 68-62	DEF.2304	S-740	ZX-35	Molybdenum disulphide powder	SAE-AMS-M-7866	-
DEF STAN 68-69	DEF STAN 59-10	S-736	XG-250	Electrical insulating silicone compound	SAE AS8660	-
DEF STAN 68-108 (Obsolete)	-	-	AL-20	Technical ethanediol	-	-
DEF STAN 68-118 (Obsolete)	DEF STAN 68-217	-	-	De-icing/anti-icing fluid for runways. Specification superseded by Dual National Standard VG9700	-	-

Specification	Superseded Specification	NATO Code	Joint Service Designation	Product and Application	Alternative U.S. Specification	AeroShell Grade
DEF STAN 68-127	TS10177	S-757	AL-39	Inhibited ethanediol antifreeze	-	-
DEF STAN 68-128	TS10067E	-	-	OBSOLETE - superseded by DEF STAN 68-150	-	-
DEF STAN 68-129	TS10188	-	AL-40	Methanol/water mixture for hydrogen generation	-	-
DEF STAN 68-150	DEF STAN 68-128	-	AL-48	Mixture of AL-41 and AL-61	-	-
DEF STAN 68-217	-	-	-	CANCELLED - see DEF STAN 68-118	-	-
DEF STAN 68-251	DERD 2461	S-1747	AL-61	Fuel soluble pipeline corrosion inhibitor/lubricity improving additive for aviation turbine fuels	MIL-PRF-25017H	-
DEF STAN 68-252	DERD 2451	S-1745	AL-41	Fuel system icing inhibitor, high flash type	MIL-DTL-85470B	-
DEF STAN 68-253	DERD 2491	-	AL-24 (Obsolete)	Methanol/water mixtures	-	-
DEF STAN 68-253	DERD 2491	S-1744	AL-28	Methanol/water mixtures	-	-
DEF STAN 68-253	DERD 2491	S-1739	WTA	Demineralised water	-	-
DEF STAN 80-34	DEF.2332A DTD.804	-	PX-4	Corrosion preventive compound	-	-
DEF STAN 80-80	DTD.392B	S-720	ZX-13	Anti-seize compound for aircraft, graphite and petroleum mixture	SAE-AMS-2518A	-
DEF STAN 80-81 (Obsolete)	DTD.5617	S-722	ZX-38	Anti-seize compound, molybdenum disulphide	-	-
DEF STAN 80-83	DTD.279A	-	PX-32	Corrosion preventive compound for aircraft structures	-	-
DEF STAN 80-85	DEF.2334 DEF STAN 91-50	C-628 (Obsolete)	PX-11	Corrosion preventive compound	-	AeroShell Compound 05
DEF STAN 80-142 (Obsolete)	DTD.5540B	C-635	PX-26	Preservative mineral hydraulic fluid of improved cleanliness	MIL-PRF-6083F	AeroShell Fluid 71*
DEF STAN 80-143	TS.10131	-	PX-28	Preservative for internal airframe surfaces	-	-
DEF STAN 80-145	-	-	PX-15	Corrosion preventive. CANCELLED	-	-
DEF STAN 80-186 (Obsolete)	TS.10164	-	PX-31	Corrosion preventive	-	-
DEF STAN 81-205	DTD.791C	C-613	PX-13	Aircraft piston engine corrosion preventive oil	-	-
DEF STAN 80-217	DEF.2331A	C-614	PX-1	Corrosion preventive, Soft film, Cold application	-	-
DEF STAN 91-4	-	F-76	DIESO F-76	Alternative turbine/diesel engine fuel for use in certain Naval helicopters. This specification is primarily for F-76 (DIESO F-76, Fuel, Naval Distillate)	MIL-DTL-16884L	-
DEF STAN 91-6	-	G-363	XG-235	Gasoline and oil resistant grease	SAE-AMS-G-6032	-
DEF STAN 91-12	DEF.2261A	G-382	XG-271	General purpose aircraft grease. CANCELLED	MIL-G-7711A (Obsolete)	AeroShell Grease 6
DEF STAN 91-19	-	-	-	CANCELLED - superseded by U.S. Specification MIL-L-8937D which in turn has been superseded by MIL-PRF-46010G (NATO S-1738, Joint Service ZX-34)	-	-
DEF STAN 91-27	-	G-403	XG-279	Grease	MIL-PRF-10924H	-
DEF STAN 91-28 (Obsolete)	-	G-450 (Obsolete)	XG-274 (Obsolete)	Multipurpose quiet service grease superseded by DEF STAN 91-105	MIL-PRF-24139A	AeroShell Grease 6*
DEF STAN 91-30	-	-	-	CANCELLED	-	-
DEF STAN 91-35	-	-	OX-30	Emulsifying petroleum hydraulic fluid for use in certain types of radar equipment	-	-

Specification	Superseded Specification	NATO Code	Joint Service Designation	Product and Application	Alternative U.S. Specification	AeroShell Grade
DEF STAN 91-38	DEF.2333	-	PX-6	Technical petrolatum Stiff, tacky petrolatum	-	-
		S-743	PX-7	Soft petrolatum	VV-P-236A	-
DEF STAN 91-39	DEF.2007A	H-576	OM-33	Hydraulic oil for certain radar equipment	-	-
DEF STAN 91-40 (Obsolete)	DEF.2181A	C-615	PX-27	Corrosion preventive oil for aircraft piston engines	-	-
DEF STAN 91-44 (Obsolete)	DEF.2001A DTD.44D	O-134	OM-13	General purpose lubricating oil	-	AeroShell Fluid 1 (AeroShell Turbine Oil 3)
DEF STAN 91-46	DTD.5581	-	-	Damping fluid, dimethyl silicone, various grades. CANCELLED	W-D-1078B	-
Grade 3	-	S-1712	ZX-41			-
Grade 10	-	S-1714	ZX-42			-
Grade 20	-	S-1716	ZX-43			-
Grade 50	-	S-1718	ZX-44			-
Grade 100	-	S-1720	ZX-45			-
Grade 500	-	-	ZX-46			-
Grade 1000	-	-	ZX-47			-
Grade 7500	-	S-1724	ZX-48			-
Grade 12500	-	-	ZX-49			-
Grade 20000	-	S-1726	ZX-50			-
Grade 60000	-	-	ZX-51			-
Grade 100000	-	S-1728	ZX-52			-
Grade 200000	-	S-1732	ZX-53			-
DEF STAN 91-47 (Obsolete)	DTD.5578	O-142	OM-12	General purpose lubricating oil of low freezing point	MIL-PRF-7870D	AeroShell Fluid 3
DEF STAN 91-48 Grade Superclean	DTD.585B	H-515	OM-15	Hydraulic fluid of improved cleanliness and performance	MIL-PRF-5606H	AeroShell Fluid 41 (European production approved, U.S. production is equivalent
DEF STAN 91-48 Grade Normal	TS.10165	H-520	OM-18	Hydraulic fluid of improved performance	-	AeroShell Fluid 41* AeroShell Fluid 4 (European production only is approved)
DEF STAN 91-49	DTD.822B	O-147	OX-14	Low temperature synthetic lubricating oil	MIL-PRF-6085D	AeroShell Fluid 12
DEF STAN 91-50	-	-	-	Replaced by DEF STAN 80-85	-	-
DEF STAN 91-51	DTD.5609	G-366	XG-284	Helicopter general purpose and anti-fretting grease	MIL-G-25537C	AeroShell Grease 14
DEF STAN 91-52 (Obsolete)	DTD.5601A	G-395	XG-293	Multi-purpose aircraft grease	MIL-PRF-81322G	AeroShell Grease 22
DEF STAN 91-53	DTD.5598	G-354	XG-287	Grease, multi-purpose, low temperature	MIL-PRF-23827C	AeroShell Grease 33
DEF STAN 91-54 (Obsolete)	DTD.806B	G-355	XG-285	Graphited grease	MIL-G-7187 (Obsolete)	-
DEF STAN 91-55 (Obsolete)	DTD.5585A	G-372	XG-300	Extreme high temperature ball and roller bearing grease. UK MoD has adopted MIL-G-25013E	MIL-G-25013E	AeroShell Grease 15
DEF STAN 91-56	DTD.897A	G-394	XG-315	Silicone grease for pneumatic systems	-	-
DEF STAN 91-57	DTD.5527A	G-353	XG-276	Molybdenum disulphide grease for use in heavily loaded applications at high and low temperatures	MIL-G-21164D	AeroShell Grease 64*
DEF STAN 91-64 (Obsolete)	-	-	XG-305	Molybdenum disulphide grease	-	-
DEF STAN 91-66	-	-	-	The segregation, handling and quality assurance of petroleum fuels, lubricants and associated products	-	-
DEF STAN 91-69 (Provisional)	-	-	OX-125	Helicopter transmission fluid 9 mm^2/s	-	-
DEF STAN 91-71 (Obsolete)	TS.10134	-	OX-165	Synthetic lubricating fluid for gears and transmissions	-	-

Specification	Superseded Specification	NATO Code	Joint Service Designation	Product and Application	Alternative U.S. Specification	AeroShell Grade
DEF STAN 91-78	-	-	PX-19	Soft film corrosion preventive. CANCELLED	-	-
DEF STAN 91-79 (Obsolete)	-	O-190 (Obsolete)	OX-18 (Obsolete)	CANCELLED. Preservative general purpose lubricating oil. Requirements now contained in DEF STAN 91-102	MIL-PRF-32033	AeroShell Fluid 18*
DEF STAN 91-85	DTD.900/4914A	G-357 (Obsolete)	XG-273	Synthetic grease with graphite	-	-
DEF STAN 91-86	DERD 2452	F-44	AVCAT/FSII	Aviation turbine fuel, high flash type with FSII	MIL-DTL-5624U Grade JP-5	Shell JP-5 Special arrangements necessary
DEF STAN 91-87	DERD 2453	F-34	AVTUR/FSII	Aviation turbine fuel, kerosine type with FSII	MIL-DTL-83133G Grade JP-8	Shell JP-8 Special arrangements necessary
DEF STAN 91-88	DERD 2454	F-40	AVTAG/FSII	Aviation turbine fuel, wide cut type with FSII	MIL-DTL-5624U Grade JP-4	- -
DEF STAN 91-89	DERD 2492	S-746	AVPIN	Isopropyl nitrate for certain engine starters	-	-
DEF STAN 91-90	DERD 2485	F-12 (Obsolete)	AVGAS 80	Aviation gasoline Grade 80/87	ASTM D910	-
DEF STAN 91-90	DERD 2485	-	AVGAS 100	Aviation gasoline Grade 100/130	ASTM D910	Shell Avgas 100
DEF STAN 91-90	DERD 2485	F-18	AVGAS 100LL	Aviation gasoline 100/130 Low Lead	ASTM D910	Shell Avgas 100LL
DEF STAN 91-91	DERD 2494	F-35	AVTUR	Aviation turbine fuel, kerosine type	MIL-DTL-83133G ASTM D1655	Shell Jet A-1 Shell AeroJet*
DEF STAN 91-92	-	-	-	Intended to replace DERD 2450 but will not now be issued	-	-
DEF STAN 91-93	DERD 2458	-	OX-22	Synthetic lubricating oil for marine gas turbines	-	-
DEF STAN 91-94	DERD 2468	-	OX-7	Synthetic lubricating oil for aircraft turbine engines 3 mm^2/s viscosity	-	AeroShell Turbine Oil 390
DEF STAN 91-96	-	-	-	Intended to replace DERD 2472 but will not now be issued	-	-
DEF STAN 91-97	DERD 2479/0	O-138	OM-71	Mineral lubricating oil 9 mm^2/s viscosity. CANCELLED	-	-
DEF STAN 91-97	DERD 2479/1	O-136	OEP-71	Mineral lubricating oil with EP additive 9 mm^2/s viscosity. CANCELLED	-	-
DEF STAN 91-98	DERD 2487	O-149	OX-38	Synthetic lubricating oil for aircraft gas turbine engines 7.5 mm^2/s viscosity	-	AeroShell Turbine Oil 750
DEF STAN 91-99	DERD 2490	O-135	OM-11	Mineral aviation turbine oil, 3 mm^2/s viscosity	-	Meets specification. AeroShell Turbine Oil 3
DEF STAN 91-100	DERD 2497	O-160	OX-26	Synthetic lubricating oil for aircraft gas turbines 5 mm^2/s viscosity	-	Equivalent to specification. AeroShell Turbine Oil 555
DEF STAN 91-101 Grade-OX-27	DERD 2499 Grade-OX-27	O-156	OX-27	Synthetic lubricating oil for aircraft gas turbines 5 mm^2/s viscosity	MIL-PRF-23699G Grade STD Grade HTS	AeroShell Turbine Oil 500 AeroShell Turbine Oil 560*
DEF STAN 91-101 Grade OX-28	DERD 2499 Grade OX-28	-	OX-28	Synthetic lubricating oil for certain gas turbines 5 mm^2/s viscosity (marine use)	-	-
DEF STAN 91-102	DEF STAN 91-79	O-157	OX-24	Low temperature lubricating oil for weapons	MIL-PRF-14107D	AeroShell Fluid 18*
DEF STAN 91-103	-	-	PX-36	Corrosion preventive, cleaner and lubricant for weapons	-	-
DEF STAN 91-105	DEF STAN 91-28	G-421	XG-291	Grease, multi-purpose, heavy duty	-	-
DEF STAN 91-106	-	-	XG-294	Grease, multi-purpose, elevated temperature range	-	-
DEF STAN 91-112	DTD.581C	O-153 O-153	OEP-30 OEP-70	Extreme pressure gear oil Grade Light Grade Medium	MIL-PRF-6086F Grade Light MIL-PRF-6086F Grade Medium	AeroShell Fluid 5L-A AeroShell Fluid 5M-A

Specification	Superseded Specification	NATO Code	Joint Service Designation	Product and Application	Alternative U.S. Specification	AeroShell Grade
DEF STAN 91-114	DTD.417B	-	OM-150	Low temperature oil for aircraft controls	-	-
DEF STAN 96-1 (Obsolete)	DTD.77	S-732	ZX-20 (Obsolete)	Graphite powder - lubricating grade. Specification now obsolete	SS-G-659a	-
DED.2472	-	-	-	OBSOLETE - superseded by D.Eng.R.D. 2472	-	-
DED.2480	-	-	-	OBSOLETE	-	-
DERD 2450 Grade D-65 (Obsolete)	-	O-123 (Obsolete)	OMD-160	Lubricating oil for aircraft piston engines - ashless dispersant type, SAE 40 Grade	SAE J-1899 Grade SAE 40	AeroShell Oil W80
DERD 2450 Grade D-80 (Obsolete)	-	O-125 (Obsolete)	OMD-250	Lubricating oil for aircraft piston engines - ashless dispersant type, SAE 50 Grade	SAE J-1899 Grade SAE 50	AeroShell Oil W100
DERD 2450 Grade D-100 (Obsolete)	-	O-128 (Obsolete)	OMD-370	Lubricating oil for aircraft piston engines - ashless dispersant type, SAE 60 Grade	SAE J-1899 Grade SAE 60	AeroShell Oil W120
DERD 2451	-	-	-	OBSOLETE - superseded by DEF STAN 68-252	-	-
DERD 2452	-	-	-	OBSOLETE - superseded by DEF STAN 91-86	-	-
DERD 2453	-	-	-	OBSOLETE - superseded by DEF STAN 91-87	-	-
DERD 2454	-	-	-	OBSOLETE - superseded by DEF STAN 91-88	-	-
DERD 2458	-	-	-	OBSOLETE - superseded by DEF STAN 91-93	-	-
DERD 2461	-	-	-	OBSOLETE - superseded by DEF STAN 68-251	-	-
DERD 2468	-	-	-	OBSOLETE - superseded by DEF STAN 91-94	-	-
DERD 2469	-	-	-	OBSOLETE	-	-
D.Eng.R.D. 2470	-	-	-	OBSOLETE	-	-
DERD 2472 A/O (Obsolete)	DED 2472	O-115 (Obsolete)	OM-170	Lubricating oil for aircraft piston engines, SAE 40 Grade	SAE J-1966 Grade 40	AeroShell Oil 80
DERD 2472 B/O (Obsolete)	DED 2472	O-117 (Obsolete)	OM-270	Lubricating oil for aircraft piston engines, SAE 50 Grade	SAE J-1966 Grade 50	AeroShell Oil 100
DERD 2472 A/2	-	-	-	OBSOLETE	-	-
DERD 2472 B/2	-	-	-	OBSOLETE	-	-
DERD 2475	-	-	-	OBSOLETE - superseded by DERD 2485	-	-
DERD 2479/0	-	-	-	OBSOLETE - superseded by DEF STAN 91-97	-	-
DERD 2479/1	-	-	-	OBSOLETE - superseded by DEF STAN 91-97	-	-
D.Eng.R.D. 2481	-	-	-	OBSOLETE - superseded by DERD 2491	-	-
D.Eng.R.D. 2482	-	-	-	OBSOLETE - superseded by DERD 2494	-	-
DERD 2485	-	-	-	OBSOLETE - superseded by DEF STAN 91-90	-	-
DERD 2486	-	-	-	OBSOLETE	-	-
DERD 2487	-	-	-	OBSOLETE - superseded by DEF STAN 91-98	-	-
D.Eng.R.D. 2488	-	-	-	OBSOLETE - superseded by DERD 2498	-	-

Specification	Superseded Specification	NATO Code	Joint Service Designation	Product and Application	Alternative U.S. Specification	AeroShell Grade
DERD 2490	-	-	-	OBSOLETE - superseded by DEF STAN 91-99	-	-
DERD 2491	-	-	-	OBSOLETE - superseded by DEF STAN 68-253	-	-
DERD 2492	-	-	-	OBSOLETE - superseded by DEF STAN 91-89	-	-
DERD 2493	-	-	-	OBSOLETE	-	-
DERD 2494	-	-	-	OBSOLETE - superseded by DEF STAN 91-91	-	-
D.Eng.R.D. 2495	-	-	-	OBSOLETE	-	-
DERD 2497	-	-	-	OBSOLETE - superseded by DEF STAN 91-100	-	-
DERD 2498	-	-	-	OBSOLETE - superseded by DEF STAN 91-86	-	-
DERD 2499	-	-	-	OBSOLETE - superseded by DEF STAN 91-101	-	-
BS.245:76 Type 1	-	S-752	White Spirit	White Spirit	MIL-PRF-680C Type 1	Shell White Spirit
BS.290	-	-	-	Turpentine (included in BS.244)	-	-
BS.506:87	-	S-747	AL-14	Methanol	O-M-232K Grade A	-
BS.1595:86	-	S-737	AL-11	Isopropyl alcohol (anti-icing fluid)	TT-I-735A Grade B	AeroShell Compound 06A
BS.3591:85	DEF.58 CS.606F	-	-	Denatured ethyl alcohol, for windscreens and carburettor de-icing	MIL-A-6091C (Obsolete)	-
CS.3118	-	-	-	OBSOLETE - superseded by DEF STAN 91-79	-	-
CS.3120	-	-	-	OBSOLETE - superseded by DEF STAN 91-78	-	-
TS.10035A	-	-	-	OBSOLETE	-	-
TS.10067E	-	-	-	OBSOLETE - superseded by DEF STAN 68-128	-	-
TS.10131	-	-	-	OBSOLETE - superseded by DEF STAN 80-143	-	-
TS.10134A	-	-	-	OBSOLETE - superseded by DEF STAN 91-71	-	-
TS.10164	-	-	-	OBSOLETE - superseded by DEF STAN 80-186	-	-
TS.10165	-	-	-	OBSOLETE - superseded by DEF STAN 91-48 Grade Normal	-	-
TS.10177	-	-	-	OBSOLETE - superseded by DEF STAN 68-127	-	-
TS.10180	-	-	-	OBSOLETE	-	-
TS.10188	-	-	-	OBSOLETE - superseded by DEF STAN 68-129	-	-
TS.10228	-	-	-	Ice control agent for aircraft runways	-	-
TS.10266A	TS.10266	-	-	Cleaning fluid for compressors of gas turbine engines	-	-
TS.10281	-	-	-	Cleaning compound for aircraft surfaces	-	-
TS.10151	-	-	-	OBSOLETE - superseded by DEF STAN 68-10	-	-

U.S. AVIATION SPECIFICATIONS

Scope of list

This list is comprised of U.S. Military Specifications which cover aviation fuels, engine oils, hydraulic fluids, greases and allied products.

Currently major changes are taking place to U.S. Specifications. The U.S. authorities have decided to eliminate MIL specifications as they are currently known and replace them by Performance specifications. These will be labelled MIL-PRF- followed by a number. Many MIL-PRF- specifications have now been issued and others will follow until all current MIL specifications have been converted. The numeric part of the MIL-PRF- designation is the same as the numeric part of the MIL specification it replaces; however, the letter which denotes the Revision level has also changed. Some other MIL specifications have been converted to Detail specifications denoted by MIL-DTL- followed by a number. MIL specifications which are cancelled or obsolete will not be changed.

For certain products, the US authorities have decided to no longer maintain military specifications; in these cases, they have been converted to civil specifications by the SAE (Society of Automotive Engineers).

Recent examples of this change include:

MIL-L-7808K has become MIL-PRF-7808L
MIL-L-23699F has become MIL-PRF-23699G
MIL-T-83188D has become MIL-DTL-83188E
MIL-G-4343C has become SAE-AMS-G-4343

U.S. Military specifications can be downloaded free of charge as Acrobat documents from U.S. Department of Defense ASSIST database site:
http://assist.daps.dla.mil/quicksearch

Qualified Products Lists (QPLs) are now held electronically in the Qualified Products Database (PQD) and can be downloaded from there on the ASSIST website.

Specification	Superseded Specification	NATO Code	Product and Application	Alternative British Specification	AeroShell Grade
MIL-P-116J (Obsolete)	MIL-P-116H	-	Refer to MIL-STD-2073-1D Standard Practice for Military Packaging	-	-
MIL-PRF-372D	MIL-C-372C	-	Solvent cleaning compound for automatic weapons	-	-
MIL-PRF-680C	MIL-PRF-680B	-	Degreasing solvent	-	-
MIL-PRF-907F	MIL-PRF-907E	-	High temperature anti-seize thread compound	-	-
MIL-S-3136B	-	-	OBSOLETE - superseded by TT-S-735	-	-
MIL-PRF-3150E	MIL-PRF-3150D	O-192	Preservative Lubricating Oil - Medium	-	-
MIL-G-3278A	-	-	OBSOLETE - superseded by MIL-G-23827A	-	-
MIL-G-3545C (Obsolete)	-	-	OBSOLETE - superseded by MIL-G-81322 (AeroShell Grease 5 is still available meeting MIL-G-3545C and NATO Code G-359)	-	AeroShell Grease 5
MIL-PRF-3572B	MIL-L-3572A	-	Lubricant, colloidal graphite in oil	-	-
MIL-DTL-3918B	MIL-L-3918A	-	Jewel bearing instrument oil - INACTIVE	-	-
MIL-DTL-4339E	MIL-C-4339D	C-630	Soluble corrosion preventive oil - INACTIVE	-	-
MIL-G-4343C (Obsolete)	MIL-G-4343B	G-392	Grease for pneumatic systems - superseded by SAE-AMS-G-4343	SAE-AMS-G-4343	-
MIL-DTL-5020E	MIL-L-5020D	S-712	Aircraft compass liquid	-	-
MIL-T-5542E	-	-	Specification cancelled. Use MIL-PRF-27617	-	-
MIL-T-5544C (Obsolete)	MIL-T-5544B	S-720	Graphite-petrolatum anti-seize thread compound - superseded by SAE-AMS-2518A	DEF STAN 80-80	-
MIL-C-5545C (Obsolete)	AN-C-178 MIL-C-5545B	C-612 (Obsolete)	Corrosion preventive compound for aircraft engines, heavy oil type	-	-
MIL-G-5572F	-	-	Specification cancelled. Use ASTM D910	-	-

Specification	Superseded Specification	NATO Code	Product and Application	Alternative British Specification	AeroShell Grade
MIL-H-5606A (Obsolete)	MIL-O-5606	-	Hydraulic aircraft oil, petroleum base. Remains available for civil use.	DTD.585 (Obsolete)	AeroShell Fluid 4*
MIL-PRF-5606H	MIL-H-5606G	H-515	Hydraulic aircraft oil, petroleum base, of improved cleanliness and performance	DEF STAN 91-48 Grade Superclean	AeroShell Fluid 41
MIL-E-5607F (Obsolete)	MIL-E-5607E	-	Process for preparation for storage and shipment of gas turbine engines	-	-
MIL-DTL-5624U Grade JP-4 Grade JP-5	MIL-DTL-5624T	- F-40 F-44	Aircraft turbine engine fuel Wide cut, gasoline type with FSII High flash point, kerosine type with FSII	- DEF STAN 91-86 DEF STAN 91-88	- - Shell JP-5
MIL-G-6032D (Obsolete)	AN-G-14a MIL-L-6032C	G-363	Gasoline and oil resistant grease - superseded by SAE-AMS-G-6032	DEF STAN 91-6	-
MIL-E-6058B (Obsolete)	AN-R-11a MIL-P-5894 MIL-E-6058A	-	Procedure for preparation of aircraft reciprocating engines for storage and shipment	D.Eng.R.D. 2027 (Obsolete)	-
MIL-E-6059A (Inactive)	AN-E-50	-	Processes for corrosion protection, pre-oiling and ground operation of aircraft reciprocating engines	D.Eng.R.D. 2027 (Obsolete)	-
MIL-PRF-6081D Grade 1005 Grade 1010	MIL-L-6081C	 O-132 (Obsolete) O-133	Aircraft mineral turbine oil Grade 1005 Grade 1010	-	- AeroShell Turbine Oil 2
MIL-L-6082E (Obsolete)	-	-	OBSOLETE - superseded by SAE J-1966. See later in this section.	-	-
MIL-PRF-6083F	MIL-H-6083E	C-635	Preservative oil of improved cleanliness for hydraulic equipment	DEF STAN 80-142	AeroShell Fluid 71
MIL-PRF-6085D	MIL-L-6085C AN-O-11	O-147	Low volatility aircraft instrument lubricating oil	DEF STAN 91-49	AeroShell Fluid 12
MIL-PRF-6086F Grade L - Light Grade M - Medium	MIL-PRF-6086E	 O-153 O-155	Lubricating gear oil, petroleum base Low viscosity Medium viscosity	DEF STAN 91-112 Grade OEP-30 Grade OEP-70	- AeroShell Fluid 5L-A AeroShell Fluid 5M-A
MIL-A-6091C (Obsolete)	-	-	Denatured ethyl alcohol for aircraft use	BS.3591:85	-
MIL-C-6529C (Inactive for new design)	MIL-C-7853 MIL-C-6529B	 C-608 C-609 C-610	Non metallic aircraft engine corrosion preventive compounds Type I - concentrate Type II - ready mixed material for aircraft piston engines Type III - ready mixed material for jet aircraft engines	 (MIL-C-6529C) - -	 AeroShell Fluid 2XN AeroShell Fluid 2F -
MIL-S-6625A (Obsolete)	MIL-S-6625	-	Anti-icing spray equipment for aircraft windshield	-	-
MIL-C-6708	-	-	OBSOLETE - superseded by MIL-C-16173E, Grade 1 and MIL-C-11796C	-	-
MIL-G-6711	-	-	OBSOLETE - superseded by SS-G-659a	-	-
MIL-L-6880B (Obsolete)	-	-	General Specification for lubrication of aircraft. OBSOLETE – superseded by MIL-STD-838	-	-
MIL-PRF-7024E	MIL-C-7024D	-	Calibrating fluid for aircraft fuel systems and components Type I - normal heptane Type II - special run Stoddard solvent Type III - high flashpoint fluid	-	 - AeroShell Calibrating Fluid 2 -
MIL-G-7118A	-	-	OBSOLETE - superseded by MIL-PRF-23827C	-	-
MIL-G-7187	-	-	OBSOLETE - superseded by MIL-G-21164D and MIL-G-23549	-	-
MIL-G-7421B	-	-	OBSOLETE - superseded by MIL-PRF-23827C	-	-
MIL-G-7711A (Obsolete)	-	-	OBSOLETE - superseded by MIL-G-81322 AeroShell Grease 6 still available for civil market meeting MIL-G-7711A and NATO Code G-382	-	AeroShell Grease 6*
MIL-PRF-7808L Grade 3 Grade 4	MIL-L-7808K	 O-148 O-163	Synthetic lubricating oil for military gas turbines Normal grade Higher viscosity/greater thermal stability grade	 (MIL-PRF-7808L Grade 3) -	 AeroShell Turbine Oil 308 -

Specification	Superseded Specification	NATO Code	Product and Application	Alternative British Specification	AeroShell Grade
MIL-M-7866C (Obsolete)	MIL-M-7866B	S-740	Molybdenum disulphide powder - superseded by SAE-AMS-M-7866	DEF STAN 68-62	-
MIL-PRF-7870D	MIL-PRF-7870C	O-142	General purpose low temperature lubricating oil	DEF STAN 91-47	AeroShell Fluid 3
MIL-PRF-8188D	MIL-C-8188C	C-638	Synthetic corrosion protective oil for aircraft gas turbines	-	-
MIL-A-8243D (Obsolete)	MIL-A-8243C	-	De-icing and defrosting fluids. Superseded by SAE-AMS 1424	-	-
MIL-H-8446B (Obsolete)	MIL-H-8446A	-	Aircraft non-petroleum hydraulic fluid	-	-
MIL-S-8660C (Obsolete)	MIL-I-8660B	S-736	Silicone compound - superseded by SAE AS8660	DEF STAN 68-69	-
MIL-L-8937D	-	S-1738	OBSOLETE - superseded by MIL-L-46010B	-	-
MIL-T-9188C (Obsolete)	MIL-T-9188B	-	Tricresyl phosphate for use as an aviation gasoline additive	-	-
MIL-L-9236B	-	-	OBSOLETE - superseded by MIL-L-27502	-	-
MIL-PRF-10924H	MIL-PRF-10924G	G-403	Multi-purpose grease	DEF STAN 91-27	-
MIL-L-11734C	MIL-L-11734B	-	Synthetic lubricating oil (mechanical time fuses)	-	-
MIL-C-11796C	MIL-C-11796B MIL-C-15167 MIL-C-6708 in part	 C-633 - - C-627 (Obsolete)	Corrosion preventive, petrolatum, hot application Class 1 - hard film Class 1A - hard film, non-stick Class 2 - medium film Class 3 - soft film	-	 - - - AeroShell Compound 05*
MIL-A-13881C (Obsolete)	MIL-A-13881B	-	Mica based anti-seize compound	-	-
MIL-H-13919B	-	-	OBSOLETE - superseded by MIL-H-46170	-	-
MIL-PRF-14107D	-	O-157	Low temperature oil for aircraft weapons	DEF STAN 91-102	AeroShell Fluid 18*
MIL-PRF-15074E	MIL-C-15074D	-	Corrosion preventive - fingerprint remover	-	-
MIL-L-15719A	MIL-L-15719	-	Lubricating grease (high temperature, electric motor, ball and roller bearings)	-	-
MIL-PRF-16173E	MIL-C-16173D MIL-C-972 MIL-C-19471	 C-632 C-620 - - -	Corrosion preventive, solvent cut back cold application Grade 1 - hard film Grade 2 - soft film Grade 3 - soft film, water displacing Grade 4 - transparent film, non-tacky Grade 5 – low pressure steam removable	-	 - AeroShell Compound 02* - - -
MIL-DTL-16884L	MIL-PRF-16884K	F-76	Alternative turbine/diesel engine fuel for use in certain Naval helicopters	DEF STAN 91-4	-
MIL-DTL-17111D	MIL-DTL-17111C	H-575	Power transmission fluid	-	-
MIL-PRF-17672E	MIL-PRF-17672D	H-573	Hydraulic fluid, petroleum, inhibited	-	-
MIL-G-18709A	-	-	Ball and roller bearing grease. This specification cancelled - use DOD-G-24508 (see later in this section).	-	-
MIL-W-18723D (Obsolete)	-	-	Waterproof solvent type aircraft wax. Specification now cancelled.	-	-
MIL-H-19457D	MIL-H-19457C	H-580	Fire resistant phosphate ester hydraulic fluid	-	-
MIL-L-19701B	MIL-L-19701A	-	Semi-fluid lubricant for aircraft ordnance	-	-
MIL-O-19838	-	-	Installation and test of aircraft oil system - INACTIVE	-	-
MIL-G-21164D	MIL-G-21164C MIL-G-7187	G-353	Molybdenum disulphide grease, for low and high temperature	DEF STAN 91-57	AeroShell Grease 64*
MIL-PRF-21260E	MIL-L-21260D	-	Internal lubricating oil - combustion engine preservation. This specification covers a range of grades.	-	-
MIL-H-22072C	MIL-H-22072B	H-579	Catapult hydraulic fluid	-	-

Specification	Superseded Specification	NATO Code	Product and Application	Alternative British Specification	AeroShell Grade
MIL-L-22851D	-	-	OBSOLETE - superseded by SAE J-1899 (see later in this section)	-	-
MIL-C-23112 (Obsolete)	-	-	Fire resistant corrosion preventive - superseded by MIL-H-19457	-	-
MIL-L-23398D	MIL-L-23398C	S-749	Lubricant, solid film air drying	(MIL-L-23398D)	-
MIL-C-23411A	-	-	CANCELLED - superseded by MIL-C-81309	-	-
MIL-DTL-23549D	MIL-G-23549C	-	General purpose grease	-	-
MIL-PRF-23699G Grade STD Grade C/I Grade HTS	MIL-L-23699E	 O-156 O-152 O-154	Synthetic lubricating oil for aircraft gas turbines, 5 mm^2/s viscosity Grade STD (Standard) Grade C/I (Corrosion Inhibited grade) Grade HTS - (High Thermal Stability)	 DEF STAN 91-101 Grade OX-27 - -	 AeroShell Turbine Oil 500 - AeroShell Turbine Oil 560
MIL-PRF-23827C (Type I & Type II)	MIL-G-23827B MIL-G-7118A MIL-G-3278A MIL-G-7421B MIL-G-15793	G-354	Grease for aircraft instruments, gears and actuator screws	DEF STAN 91-53	AeroShell Grease 7 (Type II) AeroShell Grease 33 (Type I)
MIL-L-24131C	MIL-L-24131B	-	Colloidal graphite in isopropanol	-	-
MIL-PRF-24139A	MIL-G-24139A	G-450	Multi-purpose quiet service grease	DEF STAN 91-28 (Obsolete)	AeroShell Grease 6
MIL-H-24459	-	-	OBSOLETE - superseded by MIL-L-17672	-	-
MIL-L-24478C	MIL-L-24478B	-	Lubricant, molybdenum disulphide in isopropanol	-	-
MIL-G-25013E	MIL-G-25013D MIL-G-27343A	G-372	Extreme high temperature ball and roller bearing grease	DEF STAN 91-55 (Obsolete)	AeroShell Grease 15
MIL-PRF-25017F	MIL-I-25017E	S-1747	Fuel soluble corrosion inhibitors for aviation turbine fuels	-	-
MIL-DTL-25524E	MIL-F-25524D	-	Thermally stable aviation turbine fuel	-	-
MIL-G-25537C	MIL-G-25537B	G-366	Helicopter oscillating bearing grease	DEF STAN 91-51	AeroShell Grease 14
MIL-F-25558C (Obsolete)	MIL-F-25558B	-	Fuel, ramjet - Grade RJ-1	-	-
MIL-DTL-25576E	MIL-DTL-25576D	-	Propellant - kerosine, Grade RP-1	-	-
MIL-L-25681C	-	-	OBSOLETE - superseded by DOD-L-25681D (see entry later in this section)	-	-
MIL-G-25760A (Obsolete)	-	-	OBSOLETE - superseded by MIL-G-81322A	-	-
MIL-C-25769J	-	-	Specification cancelled, use MIL-C-87936	-	-
MIL-C-27251A (Obsolete)	-	-	Low temperature aircraft surface cleaning compound. Specification now cancelled.	-	-
MIL-F-27351	-	-	Specification now cancelled. Use MIL-PRF-7024E	-	-
MIL-L-25702 (Obsolete)	MIL-L-9236B	-	High temperature synthetic lubricating oil for aircraft gas turbines	-	-
MIL-G-27549 (Obsolete)	-	-	Heavy load-carrying aircraft grease	-	-
MIL-PRF-27601C	MIL-H-27601B	-	High temperature, petroleum base, hydraulic fluid for flight vehicles	-	-
MIL-PRF-27617F	MIL-G-27617E	 G-397 G-398 G-399 G-1350	Grease, fuel and oxidiser resistant Type I Type II Type III Type IV	-	-
MIL-DTL-27686G (Obsolete)	MIL-I-27686F	S-748 (Obsolete)	Fuel system icing inhibitor (ethylene glycol monomethyl ether) – superseded by MIL-DTL-85470	DERD 2451 Grade AL-31 (Obsolete)	-
MIL-L-27694A (Obsolete)	MIL-L-27694	-	Lubricating oil, instrument	-	-
MIL-PRF-32033	VV-L-800C	O-190 (Obsolete)	General purpose oil and preservative (water displacing, low temperature)	DEF STAN 91-79 (Obsolete)	AeroShell Fluid 18

Specification	Superseded Specification	NATO Code	Product and Application	Alternative British Specification	AeroShell Grade
MIL-DTL-38219D	MIL-PRF-38219D	-	Low volatility turbine fuel Grade JP-7	-	-
MIL-G-38220	-	-	OBSOLETE - superseded by MIL-G-27617	-	-
MIL-G-38277	-	-	OBSOLETE	-	-
MIL-PRF-38299D	MIL-PRF-38299C	-	Purging fluid for preserving fuel tanks of jet aircraft	-	-
MIL-C-43616C	MIL-C-43616B	-	Aircraft surface cleaning compound	-	-
MIL-L-45983	-	-	Solid film heat cured lubricant	-	-
MIL-L-46000C	MIL-L-46000B	O-158 (Obsolete)	Semi-fluid lubricating oil for automatic weapons	-	-
MIL-PRF-46002D	MIL-PRF-46002C	-	Contact and volatile corrosion inhibited preservative oil	-	-
MIL-G-46003A (Obsolete)	MIL-G-46003	-	Grease, rifle	-	-
MIL-H-46004 (Obsolete)	-	H-535 (Obsolete)	Hydraulic fluid petroleum base for missiles. Superseded by MIL-PRF-5606	-	-
MIL-PRF-46010G	MIL-PRF-46010F	S-1738 (Type 1)	Corrosion inhibiting heat cured solid film lubricant	-	-
MIL-PRF-46147D	MIL-PRF-46147C	-	Corrosion inhibiting air cured solid film lubricant	-	-
MIL-L-46150	-	-	Semi-fluid lubricant for weapons	-	-
MIL-L-46156A (Obsolete)	MIL-L-46156	-	Corrosion removing compound for sodium hydroxide base - superseded by A-A-59261	-	-
MIL-PRF-46167D	MIL-PRF-46167C	O-184	Lubricating oil, IC Engine, Arctic	-	-
MIL-PRF-46170D	MIL-PRF-46170C H-544 -		Fire resistant preservative synthetic hydrocarbon hydraulic fluid Type I - undyed Type II - dyed red for aerospace	-	 AeroShell Fluid 61 -
-MIL-G-46178 (Obsolete)	-	-	Helicopter drive shaft coupling grease. Specification now cancelled.	-	-
MIL-G-46886B (Obsolete)	MIL-G-46886A	-	Silicone grease - superseded by A-A-59173	-	-
MIL-F-47174A	-	-	Hydraulic fluid, petro base, intermediate viscosity. Specification now cancelled.	-	-
MIL-G-47219A	MIL-G-47219	-	Halofluorocarbon lubricating grease. Specification now cancelled.	-	-
MIL-C-47220B (Obsolete)	MIL-C-47220A	-	Dielectric coolant fluid - superseded by MIL-C-87252	-	-
MIL-L-60326 (Obsolete)	-	-	Lubricant, fluorocarbon telomer dispersion	-	-
MIL-PRF-63460E	MIL-PRF-63460D	S-758	Lubricant, cleaner and preservative for weapons and weapon systems	-	-
MIL-H-81019D	MIL-H-81019C	-	Hydraulic fluid, petroleum base (ultra low temperature)	-	-
MIL-S-81087C (Type I)	MIL-S-81087B	H-536	Hydraulic fluid, chlorinated silicone - INACTIVE	(MIL-S-81087C)	-
MIL-R-81261A	MIL-R-81261	-	Rain repellent glass window shield for in-flight application. Specification now cancelled.	-	-
MIL-PRF-81309F	MIL-C-81309E MIL-C-23411A	-	Ultra thin film water displacing corrosion preventive compound	-	-
MIL-PRF-81322G	MIL-PRF-81322F MIL-G-7711A MIL-G-3545C MIL-G-25760A	G-395	General purpose grease, wide temperature range	DEF STAN 91-52	AeroShell Grease 22
MIL-PRF-81329D	MIL-L-81329C	S-1737	Lubricant, solid film, extreme environment	-	-
MIL-B-81744A	-	-	Lubricant migration deterring barrier coating solution	-	-
MIL-G-81827A	MIL-G-81827	-	Molybdenum disulphide grease with high load capacity, wide temperature range	-	-

Specification	Superseded Specification	NATO Code	Product and Application	Alternative British Specification	AeroShell Grade
MIL-L-81846A	-	-	OBSOLETE superseded by DOD-L-81846B (see entry later in this section)	-	-
MIL-F-81912	-	-	Fuel for expendable turbine engine - INACTIVE	-	-
MIL-G-81937A	MIL-G-81937	-	Ultra clean instrument grease	-	-
MIL-P-82522C	MIL-P-82522B	-	Propellant, jet engine, T-H dimer Grade RJ-4	-	-
MIL-R-83055	-	-	General specification for aircraft windshield rain repellent dispensing systems. Specification now cancelled, use MIL-E-87145	-	-
MIL-R-83056	-	-	Rain repellent applied in flight, aircraft windshield. Specification now cancelled, use MIL-R-81261.	-	-
MIL-DTL-83133G	MIL-DTL-83133F	F-34 F-37 F-35	Aviation turbine fuel kerosine type JP-8 (freeze point -47°C) JP-8 +100 Jet A-1	DEF STAN 91-87 - DEF STAN 91-91	Shell JP-8 Shell JP-8 +100 Shell Jet A-1 Shell AeroJet*
MIL-L-83176A	MIL-L-83176	-	Instrument bearing lubricant. Specification now cancelled.	-	-
MIL-PRF-83261C	MIL-PRF-83261B	-	Grease, aircraft, EP/anti-wear	-	-
MIL-PRF-83282D	MIL-H-83282C	H-537	Fire resistant hydraulic fluid, synthetic hydrocarbon base	(MIL-PRF-83282D)	AeroShell Fluid 31
MIL-H-83306 (Obsolete)	-	-	Fire resistant hydraulic fluid, phosphate ester based. Specification now cancelled.	-	-
MIL-PRF-83363D	MIL-PRF-83363C	G-396	Helicopter transmission grease PTFE	(MIL-G-83363B)	-
MIL-D-83411A (Obsolete)	-	-	De-icer/anti-icer fluid for runways and taxiways. Specification now cancelled, use AMS 1432.	-	-
MIL-G-83414 (Obsolete)	-	-	Grease, aircraft gunmount. Specification now cancelled	-	-
MIL-PRF-83483D	MIL-PRF-83483C	-	Anti-seize thread compound, molybdenum disulphide and petrolatum	-	-
MIL-DTL-85054D	MIL-DTL-85054C	-	A clear water displacing corrosion preventive compound	-	-
MIL-DTL-85470B	MIL-I-85470A	S-1745	High flash type fuel system icing inhibitor (di-ethylene glycol monomethyl ether)	DEF STAN 68-252 Grade AL-41	-
MIL-PRF-85570D	MIL-PRF-85570C	-	Aircraft exterior cleaning compound	-	-
MIL-PRF-85704C	MIL-C-85704B	-	Turbine engine gas path cleaning compound	-	-
MIL-PRF-87100A	MIL-L-87100	-	Aircraft turbine engine oil, polyphenyl ether base	-	-
MIL-DTL-87107D	MIL-P-87107C	-	Propellant, high density synthetic hydrocarbon type Grade JP-10	-	-
MIL-C-87159A (Obsolete)	-	-	Water dilutable cleaning compound. Specification now cancelled, use MIL-C-87936.	-	-
MIL-DTL-87173B	MIL-P-87173A	-	Propellant, priming fuel ALCM engine Grade PF-1 - INACTIVE	-	-
MIL-L-87177A	MIL-L-87177	-	Synthetic water displacing corrosion preventive compound	-	-
MIL-PRF-87252C	MIL-C-87252B	S-1748	Coolant fluid, hydrolytically stable, dielectric	-	AeroShell Fluid 602
MIL-PRF-87257B	MIL-PRF-87257A	H-538	Low temperature synthetic hydrocarbon fire resistant hydraulic fluid	(MIL-PRF-87257A)	AeroShell Fluid 51
MIL-C-87936A (Obsolete)	-	-	Water dilutable aircraft exterior surface cleaning ompound - superseded by MIL-C- 87937	-	-
MIL-PRF-87937D	MIL-PRF-87937C	-	Cleaning compound, Aerospace equipment	-	-
DOD-G-24508A	DOD-G-24508	-	High performance ball and roller bearing grease	-	AeroShell Grease 22
DOD-PRF-24574	-	-	Lubricating fluid for low and high pressure oxidising gas mixtures	-	-

Specification	Superseded Specification	NATO Code	Product and Application	Alternative British Specification	AeroShell Grade
DOD-L-25681D	MIL-L-25681C	S-1735	Molybdenum disulphide lubricating oil, silicone base	(DOD-L-25681D)	-
DOD-L-81846B	MIL-L-81846A	-	High flash point lubricating oil for instrument ball bearing	-	-
DOD-PRF-85336B	DOD-L-85336A	-	Lubricant, all weather (automatic weapons)	-	-
DOD-G-85733	-	-	High temperature grease for catapult systems	-	-
DOD-PRF-85734A	DOD-L-85734	-	Synthetic ester oil for helicopter transmissions	-	AeroShell Turbine Oil 555
VV-P-216C	VV-P-216B	-	Penetrating oil - superseded by A-A-50493	-	-
O-M-232L	O-M-232K	S-747	Methanol	BS.506:87	-
VV-P-236A	VV-P-236	S-743	Technical petrolatum INACTIVE	DEF STAN 91-38 Grade PX-7	-
SS-G-659A	MIL-G-6711 SS-G-659	S-732	Graphite powder - lubricating grade	DEF STAN 96-1	-
TT-T-656C	TT-T-656B	-	Tricresyl phosphate	-	-
VV-G-671F	VV-G-671E	G-408	Graphite grease	-	-
P-D-680B (Obsolete) Type I Type II	P-D-680A	 S-752 S-753	White spirit - superseded by MIL-PRF-680 Type I - Flashpoint 38 °C Type II - Flashpoint 65 °C	BS.245	 - -
TT-S-735A (Obsolete)	MIL-S-3136B	-	Standard hydrocarbon test fluid - superseded by ASTM D471	-	-
TT-I-735A Grade B	TT-I-735 MIL-F-5566	S-737	Isopropyl alcohol (anti-icing fluid)	BS.1595:86	AeroShell Compound 06A
O-E-760D (Obsolete)	O-E-760C	S-738	Eythl alcohol, denatured alcohol - superseded by A-A-59282, 51693, 53880	-	-

VV-L-800C (Obsolete)	VV-L-800B	O-190 (Obsolete)	General purpose oil and preservative (water displacing low temperature) - superseded by MIL-PRF-32033	-	AeroShell Fluid 18
VV-L-820C (Obsolete)	VV-L-820B	0-196 (Obsolete)	General purpose light oil. Cancelled, superseded by VV-L-800	-	Shell Vitrea Oil 22*
VV-D-1078B	MIL-S-21568A VV-D-1078C	 S-1714 S-1716 S-1718 S-1720 S-1724 S-1726 S-1728 S-1732	Damping fluids silicone base Grade 10 Grade 20 Grade 50 Grade 100 Grade 7500 Grade 20000 Grade 100000 Grade 200000	DEF STAN 91-46 (Obsolete)	-
ASTM D770	TT-I-735B Grade B	S-737	Isopropyl alcohol	BS.1595:86	AeroShell Compound 06A*
ASTM D910	-	F-12 (Obsolete) - F-18 (Obsolete)	Aviation gasoline, various grades	DEF STAN 91-90	- Shell Avgas 100 Shell Avgas 100LL
ASTM D1655	-	F-35	Aviation turbine fuel, kerosine type	DEF STAN 91-91	Shell Jet A-1 Shell AeroJet*
SAE AS1241	-	-	Fire resistant phosphate ester hydraulic fluid for aircraft	-	-
SAE-AMS-1424	MIL-A-8243D	-	De-icing/anti-icing fluid, SAE Type I	-	-
SAE-AMS-2518A	MIL-T-5544C	S-720	Graphite-petrolatum anti-seize thread compound	DEF STAN 80-80	-
SAE-AMS-3057	-	-	Lubricant, semi-fluid for aircraft gearboxes	-	-
SAE AMS-3151	-	-	Aircraft compass fluid	-	-
SAE-AMS-G-4343	MIL-G-4343C	G-392	Grease for pneumatic systems	-	-

Specification	Superseded Specification	NATO Code	Product and Application	Alternative British Specification	AeroShell Grade
SAE AS5780B	SAE AS5780A	-	Aero and Aero-Derived Gas Turbine Engine Lubricants Grade SPC Grade SPC Grade HPC	-	 AeroShell Turbine Oil 500 AeroShell Turbine Oil 560 AeroShell Ascender
SAE-AMS-G-6032	MIL-G-6032D	G-363	Gasoline and oil resistant grease	DEF STAN 91-6	-
SAE AS6625	MIL-S-6625A	-	Anti-icing spray equipment for aircraft windshield	-	-
SAE-AMS-M-7866	MIL-M-7866C	S-740	Molybdenum disulphide powder	DEF STAN 68-62	-
SAE AS8660	MIL-S-8660C	S-736	Silicone compound	DEF STAN 68-69	-
SAE J-1899	MIL-L-22851D	 O-123 (Obsolete) O-125 (Obsolete) O-128 (Obsolete) O-162 (Obsolete)	Ashless dispersant aircraft piston engine oil SAE Grade 40 SAE Grade 40 SAE Grade 50 SAE Grade 50 SAE Grade 60 SAE Grade Multigrade	SAE J-1899	 AeroShell Oil W80 AeroShell Oil W80 Plus AeroShell Oil W100 AeroShell Oil W100 Plus AeroShell Oil W120 AeroShell Oil W 15W-50
SAE J-1966	MIL-L-6082E	 O-113 (Obsolete) O-115 (Obsolete) O-117 (Obsolete) -	Aircraft piston engine lubricating oil SAE Grade 30 SAE Grade 40 SAE Grade 50 SAE Grade 60	SAE J-1966	 - AeroShell Oil 80 AeroShell Oil 100 AeroShell Oil 120
FMS-1071	-	-	Grease for aircraft sweep wing pivot hinge	-	-
BMS 3-11	-	-	Boeing material specification for phosphate ester hydraulic fluid	-	Skydrol 500 B4 or LD4
BMS 3-24A	BMS 3-24	-	Boeing material specification for general purpose grease	-	-
BMS 3-32	-	-	Boeing material specification for specially fortified hydraulic fluids for aircraft landing gear shock struts Type I - preservative version Type II - low temperature version	 - -	 AeroShell SSF AeroShell LGF
BMS 3-33B	BMS 3-33A	-	Boeing material specification for general purpose airframe grease	-	AeroShell Grease 33
BMS 3-34	-	-	Boeing material specification for grease for sealed-for-life bearings	-	-

NATO CODE NUMBERS

Scope of list

These symbols are used to denote the products in current use by the NATO countries. This is not intended to be a comprehensive list of all NATO products, but is a selection comprising all aviation fuels, engine oils, hydraulic fluids, greases and allied products.

Interpretation of list

In the columns headed "British Specification" and "U.S. Specification" the specifications listed are the official specifications for the NATO Code Number. Where both the British and U.S. Specifications are listed for the same NATO Code Number this means that these specifications are officially equivalent and completely interchangeable for NATO applications.

Where an asterisk* appears in the last column of the list, the AeroShell grade recommended does not necessarily meet all the clauses of the official specifications, but is the nearest product marketed by Shell.

For easy reference, obsolete specifications are shown in both the current and superseded specification columns. In the former case, a suitable comment is made, namely, "OBSOLETE - superseded by..."

NATO Code	Product and Application	U.S. Specification	British Specification	Joint Service Designation	AeroShell Grade
C-608	Aircraft engine corrosion preventive oil - concentrate	MIL-C-6529C Type I	(MIL-C-6529C Type I)	ZX-21	AeroShell Fluid 2XN
C-609	Piston engine corrosion preventive oil	MIL-C-6529C Type II	-	OX-270 (Obsolete)	AeroShell Fluid 2F
C-610	Turbine engine corrosion preventive oil	MIL-C-6529C Type III	-	ZX-17 (Obsolete)	-
C-612 (Obsolete)	OBSOLETE	-	-	-	-
C-613	Temporary protective for aircraft engine cylinders	-	DEF STAN 81-205	PX-13 (Obsolete)	-
C-614	Short term protective at medium ambient temperatures - mixture of lanolin/white spirit	-	DEF STAN 80-217	PX-1	-
C-615	Corrosion preventive oils for aircraft engines during storage	-	DEF STAN 91-40	PX-27	-
C-618 (Obsolete)	Long term protective at medium and high ambient temperatures, superseded by PX-32 or PX-28	-	-	PX-3 (Obsolete)	-
C-620	Corrosion preventive solvent cut-back, cold application - soft film	MIL-PRF-16173E Grade 2	-	-	-
C-627 (Obsolete)	Corrosion preventive, petrolatum, hot application - soft film	MIL-C-11796C Class 3	-	-	AeroShell Compound 05*
C-628 (Obsolete)	Corrosion preventive, petrolatum, hot application - soft film	-	DEF STAN 80-85	PX-11	AeroShell Compound 05
C-629	Temporary protective for preservation of aircraft spare parts	-	-	-	-
C-630	Soluble corrosion preventive oil	MIL-C-4339E	-	-	-
C-632	Corrosion preventive, solvent cut-back, cold application - hard film	MIL-PRF-16173E Grade 1	-	-	-

NATO Code	Product and Application	U.S. Specification	British Specification	Joint Service Designation	AeroShell Grade
C-633	Corrosion preventive, petrolatum, hot application - hard film	MIL-C-11796C Class 1	-	-	-
C-634	Water displacing corrosion preventive	-	DEF STAN 68-10	PX-24	-
C-635	Preservative oil of improved cleanliness for hydraulic equipment	MIL-PRF-6083F	DEF STAN 80-142	PX-26	AeroShell Fluid 71
C-638	High temperature synthetic corrosion protective oil for turbine engines	MIL-PRF-8188D	-	-	-
C-639	OBSOLETE	-	-	-	-
C-654 (Obsolete)	Corrosion preventive, soft film hot application	-	-	-	-
F-12 (Obsolete)	Aviation gasoline Grade 80/87	MIL-G-5572F (Obsolete) ASTM D910	DEF STAN 91-90	-	-
F-18 (Obsolete)	Aviation gasoline Grade 100/130 Low Lead	ASTM D910	DEF STAN 91-90	AVGAS 100LL	Shell Avgas 100LL
F-34	Aviation turbine fuel - kerosine type with fuel system icing inhibitor (-47°C freeze point)	MIL-DTL-83133G Grade JP-8	DEF STAN 91-87	AVTUR/FSII	Shell JP-8 Special arrangements necessary
F-35	Aviation turbine fuel - kerosine type (-47°C freeze point)	MIL-DTL-83133G ASTM D1655	DEF STAN 91-91	AVTUR	Shell JET A-1 Shell AeroJet*
F-37	Aviation turbine fuel F-34 plus thermal stability additive S-1749	MIL-DTL-83133G	-	-	Shell JP-8 +100
F-40	Aviation turbine fuel - wide cut type with fuel system icing inhibitor	MIL-DTL-5624U Grade JP-4	DEF STAN 91-88	AVTAG/FSII	-
F-43 (Obsolete)	Aviation turbine fuel - high flash type (-46°C freeze point) replaced by F-44	-	DERD 2498 (Obsolete)	AVCAT	-
F-44	Aviation turbine fuel - high flash type (-46°C freeze point) with fuel system icing inhibitor	MIL-DTL-5624U Grade JP-5	DEF STAN 91-86	AVCAT/FSII	Shell JP-5 Special arrangements necessary
F-76	Alternative turbine/diesel engine fuel for use in certain Naval helicopters	MIL-F-16884L	DEF STAN 91-4	DIESO F-76	-
G-350 (Obsolete)	OBSOLETE - superseded by G-354	-	-	-	-
G-352	OBSOLETE - superseded by G-354	-	-	-	-
G-353	Synthetic molybdenum disulphide aircraft grease	MIL-G-21164D	DEF STAN 91-57	XG-276	AeroShell Grease 64*
G-354	Synthetic aircraft grease for aircraft and instruments	MIL-PRF-23827C	DEF STAN 91-53	XG-287	AeroShell Grease 33
G-355	Graphited aircraft grease	MIL-G-7187 (Obsolete)	DEF STAN 91-54	XG-285	-
G-357 (Obsolete)	Graphited synthetic grease for flexible cables	-	DEF STAN 91-85	XG-273	-
G-359	High temperature aircraft grease	MIL-G-3545C (Obsolete)	DTD.878A (Obsolete)	XG-277 (Obsolete)	AeroShell Grease 5
G-361	Wide temperature range synthetic aircraft grease	MIL-G-25760A (Obsolete)	DTD.5579 (Obsolete)	XG-292 (Obsolete)	-
G-363	Hydrocarbon resistant plug grease	SAE-AMS-G-6032	DEF STAN 91-6	XG-235	-
G-366	Helicopter oscillating bearing grease	MIL-G-25537C	DEF STAN 91-51	XG-284	AeroShell Grease 14
G-372	High temperature synthetic grease	MIL-G-25013E	DEF STAN 91-55 (Obsolete)	XG-300	AeroShell Grease 15
G-382	Aircraft general purpose grease	MIL-G-7711A (Obsolete)	DEF STAN 91-12	XG-271 (Obsolete)	AeroShell Grease 6
G-392	Synthetic grease for pneumatic systems	SAE-AMS-G-4343	(SAE-AMS-G-4343)	XG-269	-
G-394	Silicone based grease for pneumatic systems	-	DEF STAN 91-56	XG-315	-
G-395	Multi-purpose aircraft grease	MIL-PRF-81322G	DEF STAN 91-52	XG-293	AeroShell Grease 22
G-396	Aircraft grease PTFE	MIL-PRF-83363D	-	-	-

NATO Code	Product and Application	U.S. Specification	British Specification	Joint Service Designation	AeroShell Grade
G-397	Grease fuel and oil resistant, liquid oxygen compatible	MIL-PRF-27617F Type I	-	-	-
G-398	Grease liquid oxygen compatible	MIL-PRF-27617F Type II	-	-	-
G-399	Grease liquid oxygen compatible	MIL-PRF-27617F Type III	-	-	-
G-403	All purpose grease	MIL-PRF-10924H	DEF STAN 91-27	XG-279	-
G-408	Graphite grease	VV-G-671F Grade 1	-	-	-
G-421	Grease, general use	-	DEF STAN 91-105	XG-291	-
G-450 (Obsolete)	Multi-purpose quiet service grease Superseded by G-421	MIL-PRF-24139A	DEF STAN 91-28 (Obsolete)	XG-274 (Obsolete)	AeroShell Grease 6
G-1350	Grease liquid oxygen compatible	MIL-PRF-27617F Type IV	-	-	-
H-515	Hydraulic fluid, petroleum base, improved cleanliness and performance	MIL-PRF-5606H	DEF STAN 91-48 Grade Superclean	OM-15	AeroShell Fluid 41
H-520	Hydraulic fluid, petroleum base, improved performance	-	DEF STAN 91-48 Grade Normal	OM-18	AeroShell Fluid 41* AeroShell Fluid 4 (European production only)
H-535	OBSOLETE	-	-	-	-
H-536	Hydraulic fluid, chlorinated silicone	MIL-S-81087C (Type 1)	(MIL-S-81087C)	OX-50	-
H-537	Hydraulic fluid, fire resistant synthetic hydrocarbon	MIL-PRF-83282D	(MIL-PRF-83282D)	OX-19	AeroShell Fluid 31
H-538	Low temperature synthetic hydrocarbon hydraulic fluid	MIL-PRF-87257B	(MIL-PRF-87257B)	OX-538	AeroShell Fluid 51
H-540	Petroleum hydraulic fluid	-	-	-	-
H-544	Preservative grade fire resistant synthetic hydrocarbon hydraulic fluid	MIL-PRF-46170D Type I	-	-	AeroShell Fluid 61
H-575	Inhibited petroleum hydraulic oil	MIL-DTL-17111D	-	-	-
H-576	General purpose hydraulic fluid	-	DEF STAN 91-39	OM-33	-
H-579	Fire resistant hydraulic fluid, water glycol	MIL-H-22072C	-	-	-
H-580	Hydraulic fluid, phosphate ester fire resistant	MIL-H-19457D	-	-	-
O-113 (Obsolete)	Lubricating oil for aircraft piston engines - SAE 30	SAE J-1966 Grade SAE 30	-	OM-107 (Obsolete)	AeroShell Oil 65
O-115 (Obsolete)	Lubricating oil for aircraft piston engines - SAE 40	SAE J-1966 Grade SAE 40	SAE J-1966 Grade SAE 40	OM-170	AeroShell Oil 80
O-117 (Obsolete)	Lubricating oil for aircraft piston engines - SAE 50	SAE J-1966 Grade SAE 50	SAE J-1966 Grade SAE 50	OM-270	AeroShell Oil 100
O-123 (Obsolete)	Lubricating oil for aircraft piston engines - dispersant Grade SAE 40	SAE J-1899 Grade SAE 40	SAE J-1899 Grade SAE 40	OMD-160	AeroShell Oil W80 AeroShell Oil W80 Plus
O-125 (Obsolete)	Lubricating oil for aircraft piston engines - dispersant Grade SAE 50	SAE J-1899 Grade SAE 50	SAE J-1899 Grade SAE 50	OMD-250	AeroShell Oil W100 AeroShell Oil W100 Plus
O-128 (Obsolete)	Lubricating oil of aircraft piston engines - dispersant Grade SAE 60	SAE J-1899 Grade SAE 60	SAE J-1899 Grade SAE 60	OMD-370	AeroShell Oil W120
O-132 (Obsolete)	Mineral lubricating oil for aircraft turbine engines - petroleum Grade 1005	MIL-PRF-6081D Grade 1005	-	-	-
O-133	Mineral lubricating oil for aircraft turbine engines - petroleum Grade 1010	MIL-PRF-6081D Grade 1010	-	OM-10 (Obsolete)	AeroShell Turbine Oil 2
O-134	General purpose lubricating oil	-	DEF STAN 91-44	OM-13 (Obsolete)	AeroShell Fluid 1 (AeroShell Turbine Oil 3)
O-135	Mineral lubricating oil for aircraft turbine engines - 3 mm^2/s viscosity	-	DEF STAN 91-99	OM-11	AeroShell Turbine Oil 3
O-136	Mineral lubricating oil for aircraft turbine engines – EP – 9 mm^2/s viscosity	-	DEF STAN 91-97	OEP-71	-
O-138	Mineral lubricating oil for aircraft turbine engines - 9 mm^2/s viscosity	-	DEF STAN 91-97	OM-71	-

NATO Code	Product and Application	U.S. Specification	British Specification	Joint Service Designation	AeroShell Grade
O-140 (Obsolete)	Low temperature oil for aircraft controls	-	DTD.417B	OM-150	-
O-142	General purpose low temperature lubricating oil	MIL-PRF-7870D	DEF STAN 91-47	OM-12	AeroShell Fluid 3
O-147	Lubricating oil for aircraft instruments	MIL-PRF-6085D	DEF STAN 91-49	OX-14	AeroShell Fluid 12
O-148	Synthetic ester lubricating oil for aircraft turbine engines - 3 mm^2/s viscosity	MIL-PRF-7808L Grade 3	(MIL-PRF-7808L Grade 3)	OX-9	AeroShell Turbine Oil 308
O-149	Synthetic ester lubricating oil for aircraft turbine engines - 7.5 mm^2/s viscosity	-	DEF STAN 91-98	OX-38	AeroShell Turbine Oil 750
O-150	Synthetic ester lubricating oil for aircraft turbine engines - 3 mm^2/s viscosity	-	-	-	-
O-152	Synthetic ester lubricating oil for aircraft turbine engines - corrosion inhibited 5 mm^2/s	MIL-PRF-23699G Grade C/I	-	-	-
O-153	Extreme pressure gear oil - light grade	MIL-PRF-6086F Grade L	DEF STAN 91-112 Grade Light	OEP-30	AeroShell Fluid 5L-A
O-154	Synthetic ester lubricating oil for aircraft turbine engines - high thermal stability 5 mm^2/s	MIL-PRF-23699G Grade HTS	-	-	AeroShell Turbine Oil 560
O-155	Extreme pressure gear oil - medium grade	MIL-PRF-6086F Grade M	DEF STAN 91-112 Grade Medium	OEP-70	AeroShell Fluid 5M-A
O-156	Synthetic ester lubricating oil for aircraft turbine engines - 5 mm^2/s viscosity standard grade	MIL-PRF-23699G Grade STD	DEF STAN 91-101 Grade OX-27	OX-27	AeroShell Turbine Oil 500
O-157	Low temperature oil for aircraft weapons	MIL-PRF-14107D	DEF STAN 91-102	OX-24	AeroShell Fluid 18*
O-158 (Obsolete)	Low temperature lubrication of automatic weapons	MIL-L-46000C	(MIL-L-46000C)	XG-485 (Obsolete)	-
O-159	Synthetic ester lubricating oil for aircraft turbine engines - 7.5 mm^2/s viscosity	-	-	-	AeroShell Turbine Oil 750*
O-160	Synthetic ester lubricating oil for aircraft turbine engines - 5 mm^2/s viscosity	-	DEF STAN 91-100	OX-26	AeroShell Turbine Oil 555
O-162 (Obsolete)	Lubricating oil for aircraft piston engines, ashless dispersant SAE 15W-50	SAE J-1899 SAE Multigrade	-	OMD-162	AeroShell Oil W 15W-50
O-163	Synthetic engine oil for military gas turbines	MIL-PRF-7808L Grade 4	-	-	-
O-184 (Obsolete)	OBSOLETE - superseded by O-266	-	-	OEP-220	-
O-190 (Obsolete)	General purpose oil and preservative, water displacing low temperature	MIL-PRF-32033	DEF STAN 91-79 (Obsolete)	OX-18 (Obsolete)	AeroShell Fluid 18
O-192	Preservative lubricating oil - medium	MIL-PRF-3150E	-	-	-
O-196 (Obsolete)	General purpose light oil	VV-L-820C (Cancelled)	-	-	-
O-218 (Obsolete)	Lubricating oil, colloidal graphite	-	DEF STAN 91-30 (Cancelled)	OX-320 (Cancelled)	-
S-712 (Obsolete)	Aircraft compass liquid (mineral type)	MIL-L-5020E	-	OM-1	-
S-716	Anti-seize compound (lead free)	TT-S-1732 (Cancelled)	-	-	-
S-717	Anti-seize compound for aircraft oxygen	MIL-T-5542E (Cancelled)	-	ZX-32 (Obsolete)	-
S-718	Aqueous colloidal graphite for screw threads of low pressure oxygen cylinders	-	DTD.900/4042A	ZX-24	-
S-720	Aircraft grease for sparking plugs and other threads	SAE-AMS-2518A	DEF STAN 80-80	ZX-13	-
S-722	Molybdenum disulphide anti-seize compound for heavily loaded surfaces	-	DEF STAN 80-81	ZX-38	-
S-725	OBSOLETE - superseded by S-716	-	-	-	-
S-732	Lubricating graphite	SS-G-659A	DEF STAN 91-6	ZX-20 (Obsolete)	-
S-736	Insulating compound for use in assembly of ignition harness	SAE AS8660	DEF STAN 68-69	XG-250	-

NATO Code	Product and Application	U.S. Specification	British Specification	Joint Service Designation	AeroShell Grade
S-737	Isopropyl alcohol (anti-icing fluid)	TT-I-735A Grade B	BS.1595.86	AL-11	AeroShell Compound 06A
S-738	Denatured ethyl alcohol (de-icing fluid) for aircraft windscreens and carburettors	O-E-760D Type III	-	-	-
S-740	Molybdenum disulphide powder	SAE-AMS-M-7866	DEF STAN 68-62	ZX-35	-
S-742	De-icing and defrosting fluid	MIL-A-8243D Type II (Obsolete)	-	-	-
S-743	Technical petroleum	VV-P-236A	DEF STAN 91-38 Grade PX-7	PX-7	-
S-745	De-icing/defrosting fluid	-	DTD.406B	AL-5	AeroShell Compound 07
S-746	Isopropyl nitrate	-	DEF STAN 91-89	AVPIN	-
S-747	Methanol for use in methanol water mixtures and anti-freeze solutions	O-M-232L Grade A	BS.506:87	AL-14	-
S-748 (Obsolete)	Fuel system icing inhibitor (ethylene glycol monomethyl ether). Superseded by S-1745	MIL-DTL-27686G (Obsolete)	DERD 2451 Grade AL-31 (Obsolete)	AL-31 (Obsolete)	-
S-749	Lubricant, solid film, air drying	MIL-L-23398D	(MIL-L-23398D)	ZX-55	-
S-752	White spirit, flashpoint 38°C	MIL-PRF-680C Type I	BS.245:76 Type I	White spirit	-
S-753	White spirit - high flash	MIL-PRF-680C Type II	-	-	-
S-756	Transformer oil	-	BS.148.84	OM-16	-
S-757	Inhibited ethanediol	-	DEF STAN 68-127	AL-39	-
S-758	Lubricant, cleaner and preservative for weapons	MIL-PRF-63460E	-	-	-
S-761	Multifunctional synthetic lubricant for weapons	-	-	-	-
S-1712	Damping fluid, dimethyl silicone Grade 3	-	DEF STAN 91-46	ZX-41	-
S-1714	Damping fluid, dimethyl silicone Grade 10	VV-D-1078B	DEF STAN 91-46	ZX-42	-
S-1716	Damping fluid, dimethyl silicone Grade 20	VV-D-1078B	DEF STAN 91-46	ZX-43	-
S-1718	Damping fluid, dimethyl silicone Grade 50	VV-D-1078B	DEF STAN 91-46	ZX-44	-
S-1720	Damping fluid, dimethyl silicone Grade 100	VV-D-1078B	DEF STAN 91-46	ZX-45	-
S-1722 (Obsolete)	OBSOLETE (Damping fluid, dimethyl silicone)	-	-	-	-
S-1724	Damping fluid, dimethyl silicone Grade 7500	VV-D-1078B	DEF STAN 91-46	ZX-48 (Obsolete)	-
S-1726	Damping fluid, dimethyl silicone Grade 20000	VV-D-1078B	DEF STAN 91-46	ZX-50 (Obsolete)	-
S-1728	Damping fluid, dimethyl silicone Grade 100000	VV-D-1078B	DEF STAN 91-46	ZX-52 (Obsolete)	-
S-1730 (Obsolete)	OBSOLETE (Damping fluid, dimethyl silicone)	-	-	-	-
S-1732	Damping fluid, dimethyl silicone Grade 200000	VV-D-1078B	DEF STAN 91-46	ZX-53 (Obsolete)	-
S-1734 (Obsolete)	OBSOLETE (Damping fluid, dimethyl silicone)	-	-	-	-
S-1735	Molybdenum disulphide lubricant, silicone base	DOD-L-25681D	(DOD-L-25681D)	OX-70	-
S-1737	Lubricant solid film, extreme environment	MIL-PRF-81329D	-	-	-
S-1738	Heat cured solid film lubricant	MIL-PRF-46010G Type 1	SAE AS 5272 Type 1	ZX-34	-
S-1739	Demineralised water	-	DEF STAN 68-253	WTA	-
S-1740 (Obsolete)	OBSOLETE	-	-	AL-24 (Obsolete)	-
S-1744	Thrust augmentation fluid for aircraft turbine engines (Methanol/Water 44/56 grade)	-	DEF STAN 68-253	AL-28	-

NATO Code	Product and Application	U.S. Specification	British Specification	Joint Service Designation	AeroShell Grade
S-1745	High flash type fuel system icing inhibitor for aviation turbine fuel (di-ethylene glycol monomethyl ether)	MIL-DTL-85470B	DEF STAN 68-252 Grade AL-41	AL-41	-
S-1746	De-icing/Defrosting fluid	-	DTD.900/4907	AL-34	-
S-1747	Corrosion inhibitor/lubricity additive for jet fuel	MIL-PRF-25017H	DEF STAN 68-251	AL-61	-
S-1748	Coolant fluid, hydrolytically stable, dielectric	MIL-PRF-87252C	-	-	AeroShell Fluid 602
S-1749	Jet fuel thermal stability improver additive	MIL-DTL-83133G	-	-	AeroShell Performance Additive 101

NOTES

BRITISH JOINT SERVICE DESIGNATIONS

Scope of list

This list comprises the British Joint Service Designations which cover aviation fuels, engine oils, hydraulic fluids, greases and allied products.

Interpretation of list

The Joint Service Designations are allocated to grades which meet British Specifications (or those U.S. Specifications which have been adopted by the U.K.) and are supplied to the British Services. Hence only British Specifications are shown. However, in some cases the British Ministry of Defence uses U.S. Specifications and these are included for completeness.

Where an asterisk* appears in the last column of the list, the AeroShell grade recommended does not necessarily meet all the clauses of the official specification, but is the nearest product marketed by Shell.

For easy reference, obsolete specifications are shown in both the current and superseded specification columns. In the former case, a suitable comment is made, namely, "OBSOLETE - superseded by..."

Joint Service Designation	British Specification	NATO Code	Product and Application	AeroShell Grade
DIESO F-76	DEF STAN 91-4	F-76	Alternative turbine/diesel engine fuel for use in certain Naval helicopters	-
73 AVGAS	-	-	OBSOLETE	-
80 NL AVGAS	-	-	OBSOLETE	-
91/96 AVGAS	-	-	OBSOLETE	-
AVGAS 80 (Obsolete)	DEF STAN 91-90	F-12 (Obsolete)	Aviation gasoline, Grade 80	-
AVGAS 100 (Obsolete)	DEF STAN 91-90	-	Aviation gasoline, Grade 100/130	Shell Avgas 100
AVGAS 100LL	DEF STAN 91-90	F-18 (Obsolete)	Aviation gasoline, Grade 100/130 (low lead)	Shell Avgas 100LL
AVTAG/FSII	DEF STAN 91-88	F-40	Wide cut gasoline type fuel, with fuel system icing inhibitor	-
AVTUR/FSII	DEF STAN 91-87	F-34	Kerosine type fuel (-47° C freeze point) with fuel system icing inhibitor	Shell JP-8 Special arrangements necessary
AVCAT (Obsolete)	DERD 2498 (Obsolete)	F-43 (Obsolete)	High flash kerosine type fuel (-46° C freeze point). Replaced by AVCAT/FSII	-
AVCAT/FSII	DEF STAN 91-86	F-44	High flash kerosine type fuel (-46° C freeze point) with fuel system icing inhibitor	Shell JP-5 Special arrangements necessary
AVPIN	DEF STAN 91-89	S-746	Turbine engine starter fuel (isopropyl nitrate)	-
AVTUR	DEF STAN 91-91	F-35	Aviation turbine fuel - kerosine type (-47° C freeze point)	Shell Jet A-1 Shell AeroJet*
WTA	DEF STAN 62-253	S-1739	Pure water for thrust augmentation	-
White Spirit	BS.245:76 Type 1	S-752	White spirit	Shell White Spirit
AL-3 (Obsolete)	-	-	Inhibited aircraft engine coolant and general purpose anti-freeze fluid	-
AL-5	DTD.406B	S-745	De-icing fluid	AeroShell Compound 07
AL-7	-	-	OBSOLETE	-

Joint Service Designation	British Specification	NATO Code	Product and Application	AeroShell Grade
AL-8	-	-	OBSOLETE - superseded by AL-11	-
AL-9	-	-	OBSOLETE - superseded by AL-14	-
AL-11	BS.1595.86	S-737	Isopropyl alcohol anti-icing fluid	AeroShell Compound 06A
AL-14	BS.506:87	S-747	Methanol	-
AL-20	DEF STAN 68-108	-	Ethanediol (used in DTD.406B)	-
AL-24 (Obsolete)	DEF STAN 68-253	-	Methanol/water mixture of certain aircraft piston engines	-
AL-26	DEF STAN 68-61	-	Coolant fluid - inhibited	-
AL-28	DEF STAN 68-253	S-1744	43.8% vol. Methanol/56.2% vol.	-
AL-29	-	-	OBSOLETE	-
AL-31 (Obsolete)	DERD 2451 (Obsolete)	S-748 (Obsolete)	Fuel system icing inhibitor (ethylene gylcol monomethyl ether). Superseded by AL-41	-
AL-32	-	-	OBSOLETE	-
AL-33	-	-	OBSOLETE	-
AL-34	DTD.900/4907	S-1746	Fluid for anti-icing and de-icing parked aircraft	-
AL-36	DTD.900/4939A	-	Windscreen washing fluid for certain aircraft	-
AL-38 (Obsolete)	-	-	OBSOLETE - superseded by AL-48	-
AL-39	DEF STAN 68-127	S-757	Anti-freeze, inhibited ethanediol	-
AL-40	DEF STAN 68-129	-	Methanol/water mixture for hydrogen generation	-
AL-41	DEF STAN 68-252	S-1745	High flash fuel system icing inhibitor (di-ethylene gylcol monomethyl ether)	-
AL-48	DEF STAN 68-150	-	Mixture of AL-41 and AL-61	-
AL-61	DEF STAN 68-251	S-1747	Corrosion inhibitor/lubricity additive for jet fuel	-

OEP-30	DEF STAN 91-112 Grade L	O-153	EP gear lubricant of light viscosity	AeroShell Fluid 5L-A
OEP-38	DEF STAN 91-59	O-186	Gear lubricant for very cold ambient temperatures	-
OEP-70	DEF STAN 91-112 Grade M	O-155	EP gear lubricant of medium viscosity	AeroShell Fluid 5M-A
OEP-71	DEF STAN 91-97	O-136	Mineral lubrication oil for aircraft, 9 mm^2/s viscosity	-
OEP-215	DTD.900/4981A	-	Helicopter gearbox oil for certain Westland helicopters	AeroShell Fluid S.8350
OF-4 (Obsolete)	DTD.900/4081A (Obsolete)	-	Proprietary aircraft hydraulic fluid (castor oil base). Specification now cancelled; replaced by OX-87).	-
OM-1	(MIL-L-5020C)	S-712 (Obsolete)	Aircraft compass fluid, U.K. has adopted U.S. specification	-
OM-3	-	-	OBSOLETE	-
OM-10 (Obsolete)	-	O-133	Mineral lubricating oil for turbine engines, 2 mm^2/s viscosity	AeroShell Turbine Oil 2*
OM-11	DEF STAN 91-99	O-135	Mineral aviation turbine oil, 3 mm^2/s viscosity	Meets specification. AeroShell Turbine Oil 3
OM-12	DEF STAN 91-47	O-142	General purpose low temperature lubricating oil	AeroShell Fluid 3
OM-13 (Obsolete)	DEF STAN 91-44	O-134	Light lubricating oil. Replaced by OM-11	AeroShell Fluid 1 (AeroShell Turbine Oil 3)
OM-15	DEF STAN 91-48 Grade Superclean	H-515	Extreme low temperature mineral hydraulic fluid of improved cleanliness and performance	AeroShell Fluid 41 (European production only, U.S. production is equivalent)
OM-16	BS.148:84	S-756	Oil for electrical purposes	Shell Diala Oil B*
OM-18	DEF STAN 91-48 Grade Normal	H-520	Hydraulic fluid - petroleum base of improved performance	AeroShell Fluid 41* AeroShell Fluid 4 (European production only)
OM-21 (Obsolete)	BS.4475:75	-	Flushing oil. Specification now obsolete.	-
OM-22	BS.148:84	-	Transformer oil for aircraft electrical equipment (pourpoint -45° C max)	Shell Diala Oil B* or D*
OM-33	DEF STAN 91-39	H-576	General purpose hydraulic oil	-

Joint Service Designation	British Specification	NATO Code	Product and Application	AeroShell Grade
OM-71	DEF STAN 91-97	O-138	Mineral lubricating oil for miscellaneous applications	-
OM-107 (Obsolete)	-	O-113 (Obsolete)	Lubricating oil for aircraft piston engines. SAE 30 Grade.	AeroShell Oil 65
OM-150	DTD.417B (DEF STAN 91-114 in preparation)	O-140 (Obsolete)	Lubricating oil for aircraft controls	-
OM-170	SAE J-1966 Grade SAE 40	O-115 (Obsolete)	Lubricating oil for aircraft piston engines. SAE 40 Grade.	AeroShell Oil 80 AeroShell Oil W80 Plus
OM-270	SAE J-1966 Grade SAE 50	O-117 (Obsolete)	Lubricating oil for aircraft piston engines. SAE 50 Grade.	AeroShell Oil 100
OM-370 (Obsolete)	SAE J-1966 Grade SAE 60	-	Lubricating oil for aircraft piston engines. SAE 60 Grade.	AeroShell Oil 120
OMD-160	SAE J-1899 Grade SAE 40	O-123 (Obsolete)	Lubricating oil for aircraft piston engines - ashless dispersant type. SAE 40 Grade.	AeroShell Oil W80
OMD-162	SAE J-1899 Grade Multigrade	O-162 (Obsolete)	Lubricating oil for aircraft piston engines - ashless dispersant type SAE 15W-50.	AeroShell Oil W 15W-50
OMD-250	SAE J-1899 Grade SAE 50	O-125 (Obsolete)	Lubricating oil for aircraft piston engines - ashless dispersant type. SAE 50 Grade.	AeroShell Oil W100 AeroShell Oil W100 Plus
OMD-270 (Obsolete)	DERD 2472B/2	O-127 (Obsolete)	OBSOLETE - Lubricating oil for aircraft piston engines	-
OMD-370	SAE J-1899 Grade SAE 60	O-128 (Obsolete)	Lubricating oil for aircraft piston engines - ashless dispersant type SAE 60 Grade.	AeroShell Oil W120
OX-7	DEF STAN 91-94	-	Synthetic turbine oil 3 mm^2/s viscosity	AeroShell Turbine Oil 390
OX-9	(MIL-PRF-7808L Grade 3)	O-148	Synthetic turbine oil 3 mm^2/s viscosity	AeroShell Turbine Oil 308
OX-14	DEF STAN 91-49	O-147	Synthetic oil with additives - low volatility aircraft instrument oil	AeroShell Fluid 12*
OX-15	-	-	OBSOLETE - superseded by PX-26	-
OX-16	DTD.900/4386A	-	Silicone damping fluid	-
OX-18 (Obsolete)	DEF STAN 91-79	O-190 (Obsolete)	General purpose oil and preservative, water displacing low temperature	AeroShell Fluid 18
OX-19	(MIL-H-83282D)	H-537	Fire resistant synthetic hydrocarbon hydraulic fluid. U.K. has adopted U.S. Specification MIL-PRF-83282D.	AeroShell Fluid 31
OX-20	DTD.900/4881D	-	Phosphate ester hydraulic fluid	-
OX-22	DEF STAN 91-93	O-291	Synthetic turbine oil for marine gas turbine engines	-
OX-23	-	-	OBSOLETE - superseded by OX-27	-
OX-24	DEF STAN 91-102	O-157	Low temperature oil for aircraft weapons	AeroShell Fluid 18*
OX-26	DEF STAN 91-100	O-160	Synthetic turbine oil 5 mm^2/s viscosity	Equivalent to specification. AeroShell Turbine Oil 555
OX-27	DEF STAN 91-101 Grade OX-27	O-156	Synthetic turbine oil 5 mm^2/s viscosity	AeroShell Turbine Oil 500 AeroShell Turbine Oil 560*
OX-28	DEF STAN 91-101 Grade OX-28	-	Synthetic turbine oil 5 mm^2/s viscosity for certain turbines	-
OX-30	DEF STAN 91-35	H-584	Emulsifying petroleum hydraulic fluid for use in certain types of radar equipment	-
OX-38	DEF STAN 91-98	O-149	Synthetic turbine oil 7.5 mm^2/s viscosity	AeroShell Turbine Oil 750
OX-50	(MIL-S-81087C)	H-536	U.K. has adopted U.S. Specification MIL-S-81087C	-
OX-70	(DOD-L-25681D)	S-1735	Molybdenum disulphide lubricating oil, silicone base, U.K. has adopted U.S. Specification DOD-L-25681D.	-
OX-87	DTD.900/6103A	-	Hydraulic fluid for certain aircraft	-
OX-125	DEF STAN 91-69 (Provisional)	-	Helicopter Transmission Lubricant (9 mm^2/s)	-
OX-165	DEF STAN 91-71	-	Synthetic gear lubricating oil	-
OX-270 (Obsolete)	-	C-609	Corrosion preventive oil. Meets U.S. Specification MIL-C-6529C Type II.	AeroShell Fluid 2F
OX-275 (Obsolete)	-	-	OBSOLETE - superseded by PX-27	-
OX-320 (Obsolete)	DEF STAN 91-30	O-218 (Obsolete)	CANCELLED - lubricating oil, colloidal graphite	-
OX-538	(MIL-PRF-87257A)	H-538	Low temperature synthetic hydrocarbon hydraulic fluid	AeroShell Fluid 51

Joint Service Designation	British Specification	NATO Code	Product and Application	AeroShell Grade
PX-1	DEF STAN 80-217	C-614	Lanolin/white spirit corrosion protective	-
PX-2 (Obsolete)	-	-	OBSOLETE - superseded by PX-31	-
PX-3 (Obsolete)	-	-	OBSOLETE - superseded by PX-32 or PX-28	-
PX-4	DEF STAN 80-34	C-642	Corrosion preventive compound	-
PX-6	DEF STAN 91-38 Grade PX-6	-	Stiff tacky petrolatum. Used mainly as an ingredient of PX-11	-
PX-7	DEF STAN 91-38 Grade PX-7	S-743	Mineral petrolatum	-
PX-9 (Obsolete)	-	-	OBSOLETE - superseded by PX-28	-
PX-10 (Obsolete)	-	-	OBSOLETE - superseded by PX-24	-
PX-11	DEF STAN 80-85	C-628 (Obsolete)	Long term mineral jelly/beeswax protective	AeroShell Compound 05
PX-12 (Obsolete)	-	-	OBSOLETE - superseded by XG-250 for certain special applications	-
PX-13 (Obsolete)	DEF STAN 81-205	C-613	Wax thickened engine protective	-
PX-14 (Obsolete)	-	-	OBSOLETE - superseded by PX-4	-
PX-15	DEF STAN 80-145	-	Corrosion preventive	-
PX-19 (Obsolete)	DEF STAN 91-78	-	Soft film temporary protective. OBSOLETE – superseded by XG-380	-
PX-24	DEF STAN 68-10	C-634	Water displacing and protective fluid. Also replaces PX-10 and PX-29	-
PX-25 (Obsolete)	-	-	OBSOLETE	-
PX-26	DEF STAN 80-142	C-635	Preservative mineral hydraulic fluid	AeroShell Fluid 71*
PX-27	DEF STAN 91-40	C-615	Storage oil for piston engine preservation	-
PX-28	DEF STAN 80-143	-	Preservative for internal airframe surfaces	-
PX-29 (Obsolete)	-	-	OBSOLETE - superseded by PX-24	-
PX-30 (Obsolete)	-	-	OBSOLETE	-
PX-31	DEF STAN 80-186	-	Corrosion preventive compound	-
PX-32	DEF STAN 80-83	-	Corrosion preventive compound for aircraft structures	-
PX-36	DEF STAN 91-103	-	Corrosion preventive, weapon cleaner, lubricant	-
XG-235	DEF STAN 91-6	G-363	Fuel and oil resistant grease	-
XG-250	DEF STAN 68-69	S-736	Compound for use in assembly of ignition harness	-
XG-261	-	-	Silicone grease	-
XG-265 (Obsolete)	-	-	OBSOLETE - superseded by XG-293	-
XG-269	SAE-AMS-G-4343	G-392	Synthetic grease for pneumatic systems. U.K. has adopted SAE-AMS-G-4343.	-
XG-271 (Obsolete)	DEF STAN 91-12	G-382	Aircraft general purpose grease. OBSOLETE – superseded by XG-291	AeroShell Grade 6
XG-273	DEF STAN 91-85	G-357 (Obsolete)	Graphite grease for lubrication of Bowden cables	-
XG-274 (Obsolete)	DEF STAN 91-28 (Obsolete)	G-450 (Obsolete)	Multi-purpose quiet service grease. OBSOLETE – superseded by XG-291	AeroShell Grease 6*
XG-275 (Obsolete)	-	-	OBSOLETE - superseded by XG-287	-
XG-276	DEF STAN 91-57	G-353	Synthetic grease containing molybdenum disulphide	AeroShell Grease 64
XG-277 (Obsolete)	DTD.878A (Obsolete)	G-359	OBSOLETE - superseded by XG-293. AeroShell Grease 5 is still available meeting the obsolete British Specification.	AeroShell Grease 5
XG-278 (Obsolete)	-	-	OBSOLETE - superseded by XG-287	-
XG-279	DEF STAN 91-27	G-403	All purpose grease	-
XG-284	DEF STAN 91-51	G-366	Aircraft anti-fret grease and helicopter general purpose grease	AeroShell Grease 14
XG-285	DEF STAN 91-54	G-355	Graphited grease for aircraft general use	-

Joint Service Designation	British Specification	NATO Code	Product and Application	AeroShell Grade
XG-287	DEF STAN 91-53	G-354	Load carrying synthetic grease for aircraft gears	AeroShell Grease 33
XG-291	DEF STAN 91-105	G-421	Grease, general use	-
XG-292 (Obsolete)	DTD.5579 (Obsolete)	G-361	OBSOLETE - superseded by XG-293	-
XG-293	DEF STAN 91-52	G-395	Synthetic general purpose grease, wide temperature range	AeroShell Grease 22
XG-294	DEF STAN 91-106	G-1352	Grease, multi-purpose, elevated temperature range	-
XG-295 (Obsolete)	-	-	OBSOLETE - superseded by XG-287	-
XG-300	DEF STAN 91-55 (Obsolete)	G-372	Extreme high temperature ball and roller bearing grease. UK has adopted MIL-G-25013E	AeroShell Grease 15
XG-305	DEF STAN 91-64 (Obsolete)	-	Molybdenum disulphide grease	-
XG-315	DEF STAN 91-56	G-394	Silicone grease for metal to metal rubber lubrication	-
XG-329 (Obsolete)	-	-	OBSOLETE - superseded by XG-293	-
XG-344 (Obsolete)	DTD.900/4872A	-	Grease for certain turbine engine starters - OBSOLETE	-
XG-350 (Obsolete)	-	-	OBSOLETE - superseded by XG-271	-
XG-410 (Obsolete)	-	-	OBSOLETE - superseded by XG-235	-
XG-480 (Obsolete)	-	-	OBSOLETE	-
XG-485 (Obsolete)	(MIL-L-46000C)	O-158 (Obsolete)	Low temperature lubrication of automatic weapons. U.K. has adopted U.S. Specification MIL-L-46000C.	-
ZX-13	DEF STAN 80-80	S-720	Graphited anti-seize compound	AeroShell Compound 08
ZX-14 (Obsolete)	-	-	OBSOLETE - superseded by XG-235	-
ZX-17 (Obsolete)	-	C-610	Corrosion preventive oil for aircraft gas turbines	-
ZX-20 (Obsolete)	DEF STAN 96-1 (Obsolete)	S-732	Graphite powder - lubricating grade	-
ZX-21 (Obsolete)	(MIL-C-6529C Type I)	C-608	Inhibited lubricating oil concentrate for engine protection. U.K. has adopted U.S. Specification.	AeroShell Fluid 2XN
ZX-24	DTD.900/4042A	S-718	Proprietary brand of aqueous colloidal graphite	-
ZX-28 G & P (Obsolete)	-	-	OBSOLETE	-
ZX-29 (Obsolete)	-	-	OBSOLETE - superseded by PX-24	-
ZX-30	DTD.900/4639	-	Dry lubricating coating for certain metal parts	-
ZX-31 (Obsolete)	-	-	OBSOLETE	-
ZX-32 (Obsolete)	-	S-717	Anti-seize and sealing thread compound for oxygen systems. Meets U.S. Specification MIL-T-5542E.	-
ZX-33 (Obsolete)	DEF STAN 68-7	-	CANCELLED. Cleaning and lubricating compound	-
ZX-34	SAE AS5272 Type 1	S-1738	Bonded dry film lubricant	-
ZX-35	DEF STAN 68-62	S-740	Molybdenum disulphide powder	-
ZX-36	DTD.900/4877A	-	Lubrication for fitting electrical cables in aircraft	-
ZX-38	DEF STAN 80-81	S-722	Anti-seize compound, molybdenum disulphide type	-
ZX-41(Obsolete)	DEF STAN 91-46	S-1712	Damping fluid dimethyl silicone Grade 3	-
ZX-42 (Obsolete)	DEF STAN 91-46 (Obsolete)	S-1714	Damping fluid dimethyl silicone Grade 10	-
ZX-43	DEF STAN 91-46	S-1716	Damping fluid dimethyl silicone Grade 20	-
ZX-44	DEF STAN 91-46	S-1718	Damping fluid dimethyl silicone Grade 50	-
ZX-45	DEF STAN 91-46	S-1720	Damping fluid dimethyl silicone Grade 100	-
ZX-46	DEF STAN 91-46	-	Damping fluid dimethyl silicone Grade 500	-
ZX-47	DEF STAN 91-46	-	Damping fluid dimethyl silicone Grade 1000	-
ZX-48 (Obsolete)	DEF STAN 91-46	S-1724	Damping fluid dimethyl silicone Grade 7500	-
ZX-49 (Obsolete)	DEF STAN 91-46	-	Damping fluid dimethyl silicone Grade 12500	-
ZX-50 (Obsolete)	DEF STAN 91-46	S-1726	Damping fluid dimethyl silicone Grade 20000	-

Joint Service Designation	British Specification	NATO Code	Product and Application	AeroShell Grade
ZX-51	DEF STAN 91-46	-	Damping fluid dimethyl silicone Grade 60000	-
ZX-52 (Obsolete)	DEF STAN 91-46	S-1728	Damping fluid dimethyl silicone Grade 100000	-
ZX-53 (Obsolete)	DEF STAN 91-46 (Obsolete)	S-1732	Damping fluid dimethyl silicone Grade 200000	-
ZX-55	(MIL-L-23398D)	S-749	Lubricant, solid film air drying corrosion inhibiting. U.K. has adopted the U.S. Specification.	-

NOTES

FRENCH AVIATION SPECIFICATIONS

Scope of list

This list covers French aviation specifications for aviation fuels, lubricants and allied products. The equivalent British and American specifications can be found elsewhere in this guide.

French specifications are being converted from Normes AIR (issued formerly by Delegation Generale pour l'Armement) to DCSEA (issued by Service des Essences des Armées). Since 1997, SEA has been responsible for writing these specifications.

Norme AIR have all been downgraded as non-suitable for new design. Nevertheless, they can still be used if there is no replacement specification.

According to SEA policy, it is no longer essential for a product to be manufactured in France to be approved to the French specification, either Norme AIR or DCSEA.

French Specification	NATO Code	Product and Application	AeroShell Grade
AIR 1501 (Inactive)	C-614	Corrosion protective	AeroShell Compound 02
AIR 1502	C-629	Corrosion protective	-
AIR 1503/B Type A	C-615	Piston engine storage oil	-
AIR 1503/B Type B Concentrate (Inactive)	C-608	Piston engine storage oil	AeroShell Fluid 2XN
AIR 1503/B Type B (Inactive)	C-609	Piston engine storage oil	AeroShell Fluid 2F
AIR 1504/B	C-610	Turbine engine corrosion preventive – superseded by DCSEA 510/A	-
AIR 1506/B (Obsolete)	C-635	Preservative mineral hydraulic fluid of improved cleanliness - superseded by DCSEA 535/A	AeroShell Fluid 71
AIR 3401/1 Grade 80/87 (Obsolete)	F-12 (Obsolete)	Aviation gasoline - Grade 80/87 (Obsolete)	-
AIR 3401/1 Grade 100/130 (Obsolete)	F-18	Aviation gasoline - Grade 100/130 Low Lead - superseded by DCSEA 118/B	Shell AVGAS 100LL
AIR 3401/1 Grade 115/145 (Obsolete)	F-22 (Obsolete)	Aviation gasoline - Grade 115/145 (Obsolete)	-
AIR 3404/C Grade F-43 (Obsolete)	F-43 (Obsolete)	Aviation turbine fuel - high flash type - superseded by DCSEA 144/A	-
AIR 3404/C Grade F-44 (Obsolete)	F-44	Aviation turbine fuel - high flash type with fuel system icing inhibitor - superseded by DCSEA 144/C	Shell JP-5
AIR 3405/D Grade F-34 (Obsolete)	F-34	Aviation turbine fuel - kerosine type with fuel system icing inhibitor - superseded by DCSEA 134/C	Shell JP-8
AIR 3405/D Grade F-35 (Obsolete)	F-35	Aviation turbine fuel - kerosine type - superseded by DCSEA 134/C	Shell Jet A-1 Shell AeroJet*
AIR 3407/B (Inactive)	F-40	Aviation turbine fuel - wide cut type with fuel system icing inhibitor	-
AIR 3511/A	O-147	Low volatility aircraft instrument and general purpose oil	AeroShell Fluid 12
AIR 3512/A	O-138	Mineral turbine engine oil	-

French Specification	NATO Code	Product and Application	AeroShell Grade
AIR 3513 (Inactive) AIR 3514	- O-150	Both AIR 3513 and AIR 3514 are very specialised. French Specifications required for a limited number of domestic applications. AIR 3513 specified a 3 mm^2/s synthetic oil and was originally covered by NATO Code O-148. By 1970 AIR 3513 was superseded by AIR 3514. Various AeroShell synthetic turbine oils are approved by brand name for the majority of engines for which AIR 3514 is specified.	- -
AIR 3515/B	O-135	3 mm^2/s mineral turbine engine oil	AeroShell Turbine Oil 3
AIR 3516/A	O-133	2 mm^2/s mineral turbine engine oil	AeroShell Turbine Oil 2
AIR 3517/A	O-159	7.5 mm^2/s synthetic turbine engine oil	AeroShell Turbine Oil 750
AIR 3520/B Grade H-515 (Obsolete)	H-515	Mineral hydraulic fluid of improved cleanliness - superseded by DCSEA 415/A	AeroShell Fluid 41
AIR 3520/B Grade H-520 (Obsolete)	H-520	Mineral hydraulic fluid - superseded by DCSEA 415/A	AeroShell Fluid 41 AeroShell Fluid 4
AIR 3525/B (Obsolete)	O-155	Extreme pressure oil for gearboxes - superseded by DCSEA 255/A	AeroShell Fluid 5M-A
AIR 3560/D Grade SAE 30 (Inactive)	O-113 (Obsolete)	Piston engine oil	AeroShell Oil 65
AIR 3560/D Grade SAE 40 (Inactive)	O-115 (Obsolete)	Piston engine oil	AeroShell Oil 80
AIR 3560/D Grade SAE 50 (Inactive)	O-117 (Obsolete)	Piston engine oil	AeroShell Oil 100
AIR 3565/A	S-743	Soft film protective	-
AIR 3570 Grade SAE 40 (Inactive)	O-123 (Obsolete)	Ashless dispersant piston engine oil	AeroShell Oil W80 AeroShell Oil W80 Plus*
AIR 3570 Grade SAE 50 (Inactive)	O-125 (Obsolete)	Ashless dispersant piston engine oil	AeroShell Oil W100 AeroShell W100 Plus*
AIR 3570 Grade SAE 60 (Inactive)	O-128 (Obsolete)	Ashless dispersant piston engine oil	AeroShell Oil W120
AIR 3634	C-634	Corrosion preventive compound, water displacing – superseded by DCSEA 534/A	-
AIR 3651/A (Methanol) (Inactive)	S-747	Methanol for use in methanol/water mixtures	-
AIR 3651/A (Water) (Inactive)	S-1739	Demineralised water	-
AIR 3651/A (60/40) (Inactive)	S-1741 (Obsolete)	Methanol/water mixture	-
AIR 3651/A (50/50) (Inactive)	S-1742 (Obsolete)	Methanol/water mixture	-
AIR 3651/A (44/56)	S-1744	Methanol/water mixture	-
AIR 3652/B Grade S-748 (Obsolete)	S-748 (Obsolete)	Fuel system icing inhibitor	-
AIR 3652/B Grade S-1745 (Obsolete)	S-1745	High flash fuel system icing inhibitor for aviation turbine fuel (di-ethylene glycol monomethyl ether) - superseded by DCSEA 745/A	-
AIR 3655/A	S-738	De-icing fluid – superseded by DCSEA 638/A	-
AIR 3660/A	S-737	De-icing fluid – superseded by DCSEA 637A	AeroShell Compound 06A
AIR 4205/B	G-359	High temperature aircraft grease - superseded by DCSEA 359/A	AeroShell Grease 5
AIR 4206/B	G-355	Graphite grease - superseded by DCSEA 355/A	-
AIR 4207/A	G-361	Synthetic wide temperature range grease - superseded by DCSEA 361/B	-
AIR 4210/B	G-354	Synthetic grease - superseded by DCSEA 354/A	AeroShell Grease 7 AeroShell Grease 33
AIR 4214/B (Obsolete)	G-363	Gasoline and oil resistant grease - superseded by DCSEA 363/B	-
AIR 4215/B (Obsolete)	G-382	Aircraft general purpose grease - superseded by DCSEA 382/A	AeroShell Grease 6
AIR 4217/A	G-353	Molybdenum disulphide grease - superseded by DCSEA 353/A	-
AIR 4222	G-395	Synthetic general purpose grease - superseded by DCSEA 395/A	AeroShell Grease 22
AIR 4223	S-740	Molybdenum disulphide powder – superseded by DCSEA 640/B	-
AIR 4224	S-732	Graphite powder, lubricating – superseded by DCSEA 632/B	-
AIR 4225/B (Inactive)	G-350 (Obsolete)	Extreme pressure grease	-

French Specification	NATO Code	Product and Application	AeroShell Grade
AIR 4226	G-352 (Obsolete)	Aircraft grease. Specification obsolete, replaced by AIR 4210/B	-
AIR 4246 (Inactive)	O-158	Lubricating oil, semi-fluid (-54°C to +130°C)	-
AIR 4247/A	S-720	Graphited anti-seize compound	-
AIR 8130 (Inactive)	C-630	Corrosion preventive soluble oil	-
AIR 8132	C-620	Corrosion preventive	-
AIR 8136 (Inactive)	C-627	Petroleum jelly/beeswax mixture for general preservation	AeroShell Compound 05
DCEA 202/B (Obsolete)	-	White spirit	-
DCEA 300 (Obsolete)	G-403	All purpose grease	-
DCSEA 501/A	S-758	Lubricant, cleaner and preservative	-
DCSEA 118/A (Obsolete)	F-18	Aviation gasoline, grade 100/130	Shell Avgas 100LL
DCSEA 134/C	F-34	Aviation turbine fuel with fuel system icing inhibitor	Shell JP-8
DCSEA 134C	F-35	Aviation turbine fuel - kerosine type	Shell Jet A-1 Shell AeroJet*
DCSEA 144/C	F-44	Aviation turbine fuel, high flash point type, with fuel system icing inhibitor	Shell JP-5 (special arrangements necessary)
DCSEA 255/A	O-155	Extreme pressure oil for transmissions	AeroShell Fluid 5MA
DCSEA 299/A	O-156	5mm²/s synthetic turbine engine oil	AeroShell Turbine Oils 500, 560
DCSEA 353/A	G-353	Synthetic molybdenum disulphide grease	AeroShell Grease 64
DCSEA 354/A	G-354	Synthetic grease for airframe and instruments	AeroShell Grease 33
DCSEA 355/A	G-355	Graphited aircraft grease	-
DCSEA 359/A	G-359	Mineral Grease	AeroShell Grease 5
DCSEA 361/A (Obsolete)	G-361	Wide temperature range synthetic aircraft grease	-
DCSEA 363/A (Obsolete)	G-363	Gasoline and oil resistant grease	-
DCSEA 382/A	G-382	Aircraft general purpose mineral grease	AeroShell Grease 6
DCSEA 392/A	G-392	Synthetic grease for pneumatic systems – superseded by SAE AMS-G-4343	-
DCSEA 395/A	G-395	Multipurpose synthetic aircraft grease	AeroShell Grease 22
DCSEA 415/A	H-520	Mineral hydraulic fluid	AeroShell Fluid 4
DCSEA 415/A	H-515	Mineral hydraulic fluid	AeroShell Fluid 41
DCSEA 437/B	H-537	Synthetic hydrocarbon hydraulic fluid	AeroShell Fluid 31
DCSEA 502/A (Inactive)	S-761	Multifunctional synthetic lubricant for weapons	-
DCSEA 510/A	C-610	Turbine engine corrosion preventive	-
DCSEA 534/A	C-634	Corrosion preventive compound, water displacing	-
DCSEA 535/A	C-635	Preservative mineral hydraulic fluid	AeroShell Fluid 71
DCSEA 637/A	S-737	De-icing fluid	AeroShell Compound 06A
DCSEA 638/A	S-738	De-icing fluid	-
DCSEA 632/B	S-732	Graphite powder, lubricating	-
DCSEA 640/B	S-740	Molybdenum disulphide powder	-
DCSEA 745/A	S-1745	Fuel system icing inhibitor, high flash point type	-
DCSEA 745/A	XS-1745 (SEA code)	Mixture of S-1745 with anti-corrosion additive	-

RUSSIAN AVIATION SPECIFICATIONS

SCOPE OF LIST

This list is comprised of Russian Aviation Specifications which cover aviation engine oils, hydraulic fluids, greases and allied products. The list is composed of two parts, firstly a listing of specifications and then secondly a listing of grade names.

In Russia lubricants are governed by State Standards and are designated under a series of specifications including:

GOST: Gozudarstuyeny Standart
VTU-(BTY): Temporary Technical Conditions
TU-(TY): Technical Conditions
MRTU: Inter Republic Technical Conditions

INTERPRETATION OF LIST

In this list where a grade is shown in brackets it indicates that the grade is an industrial grade. Where an asterisk* appears in the last column of the list, the AeroShell grade recommended does not necessarily meet all the clauses/requirements of the Russian Specifications, but is the nearest product marketed by Shell.

Any grade marked with brackets or an asterisk has not necessarily been tested for suitability as a replacement. Shell Companies have not been able to test samples of Russian aviation lubricants using U.S. or British test methods nor have Shell Companies been able to test AeroShell grades in full scale hardware tests prescribed by the Russian Authorities.

For this reason Shell Companies make no representation as to the fitness or suitability of any AeroShell lubricant listed in this List. Responsibility for evaluation of an AeroShell Grade as a suitable alternative is that of the customer or operator. Although the information set forth herein is presented in good faith and believed to be correct at time publication Shell Companies make no representation as to the completeness or accuracy thereof.

This information is included in this publication upon the condition that the customer/operator using this information will make their own determination as to suitability for their purpose prior to use. In no event will Shell Companies be responsible for damages of any nature whatsoever resulting from the use or reliance upon the information. Nothing contained in this section is to be construed as a recommendation to use any product.

Specification GOST	Grade Name	AeroShell Grade	Remarks
782-59	Grease UN	AeroShell Compound 05*	Technical vaseline for protection of metal surfaces against corrosion
982-68	TK TKP	AeroShell Turbine Oil 3* AeroShell Turbine Oil 3*	Transformer oil Transformer oil with anti-oxidant additive
1012-72	Avgas 95/130	Shell Avgas 100 Shell Avgas 100LL	-
1013-49 (Superseded by 21743-76)	MS-14 MS-20 MK-22	AeroShell Oil 80 AeroShell Oil W80 AeroShell Oil 100 AeroShell Oil W100 AeroShell Oil 100 AeroShell Oil W100	Aircraft piston engine oils
1033-73	US-1 US-2	-	Medium melting point multi-purpose grease
1631-61 (Obsolete)	1-13	-	High temperature grease for roller bearings
1642-50	Spindle Oil AV	-	Highly refined spindle oil
1805-76	MVP	-	Instrument oil
1957-72	UT (Constalin-1)	-	Calcium based multi-purpose grease
20734-75	7-50S-3	-	-
2712-75	AMS-1 AMS-3	-	Lubrication of mechanisms
2967-52	Grease AF-70	-	Instrument grease
3005-51	Gun grease	-	Corrosion protection of mechanisms
3276-74 (Obsolete)	GOI-54p	AeroShell Grease 6*	Lubricant and protective
3333-80	USsA	-	Graphite grease

Specification GOST	Grade Name	AeroShell Grade	Remarks
4003-53	Hypoid Gear oil	-	Hypoid gear oil
4216-55 (Obsolete, superseded by 18375-73)	OKB-122-3 OKB-122-4 OKB-122-5 OKB-122-14 OKB-122-16	- - - - -	A series of instrument oils
4366-76	Press Solidol S Solidol S	-	Multi-purpose, high melting point
5020-75	Steol-M	-	Synthetic hydraulic fluid
5546-66	HF-12-18	-	Refrigerator oil for Fron system in Mi-8 helicopter
5573-67 (Obsolete)	NK 50 (HK-50)	AeroShell Grade 5* AeroShell Grade 22	High temperature wheel bearing grease
6267-74	CIATIM 201	AeroShell Grade 22 AeroShell Grade 6*	Multi-purpose grease
6457-66	MK-8 MK-8P	AeroShell Turbine Oil 3 AeroShell Turbine Oil 3SP AeroShell Turbine Oil 2* AeroShell Turbine Oil 3SP	3 mm^2/s mineral turbine
6794-78	AMG-10	AeroShell Fluid 41	Mineral hydraulic fluid
7171-78	BU	-	Gasoline and oil resistant grease
7903-74	BM-4 (VM-4)	-	-
8313-88	-	-	Fuel anti-icing additive
8551-74	CIATIM 205	-	Anti-seize grease/compound
8773-73	CIATIM 203	AeroShell Grade 22 AeroShell Grade 6*	Grease for high load mechanisms
9320-60 (Superseded by 21743-76)	MS-20S	AeroShell Oil 100 AeroShell Oil W100	Aircraft piston engine oils
9433-80	CIATIM 221	AeroShell Grade 15* AeroShell Grade 22	Multi-purpose engine grease
9762-61	Grease MS-70	-	-
10227-86	TS-1	Shell TS-1	Jet fuel
10328-63	MK-6	AeroShell Turbine Oil 2*	Mineral turbine oil
10568-63	PVK Grease	-	Grease lubrication and corrosion protection
10817-64	VNII NP-44-2 VNII NP-44-2C	- -	Petroleum oils for turbo-prop applications
10877-64	K-17	-	Preservative grease
10957-64	Lubricant No. 6	-	-
11110-75	CIATIM 202	AeroShell Grade 22 AeroShell Grade 6*	Instrument and roller bearing grease
11122-66	VNII NP-25	-	Bearing and pivot lubricant
11552-65	MS-6	AeroShell Turbine Oil 2*	Mineral turbine oil
12030-66	VNII NP-223	-	Lubrication of roller bearings
12031-66	VNII NP-262	-	Lubrication of bearings of electric spindles
12245-66	VNII NP-7	AeroShell Turbine Oil 750*	Synthetic turbine oil
12308	T-8V, T-6	-	Military jet fuels
13076-86	VNII NP 50-1-4F	AeroShell Turbine Oil 390* AeroShell Turbine Oil 560*	Synthetic turbine oil
14068-79	VNII NP-232	-	Anti-seize compound
15171-70	AKOR-1	AeroShell Fluid 2XN*	Preservative additive
15866-70	PFMS-4	-	Organosilicone fluid

Specification GOST	Grade Name	AeroShell Grade	Remarks
16422-70	CIATIM 208	-	Transmission grease
16564-71	RT	Shell Jet A-1	Jet aircraft fuel
16728-71	VNII NP-403	-	Hydraulic oil
18179-72	OKB-122-7	AeroShell Grease 33 AeroShell Grease 6*	General purpose grease
18375-74 (Replaces 4216-55)	OKB-122-3 (132-19) OKB-122-5 (132-08) OKB-122-14 (132-20) OKB-122-16 (132-21) OKB-122-4 (132-07)	- - - - -	Series of oils
18852-73	VNII NP-246	AeroShell Grease 15*	High temperature grease
19537-74	PVK	AeroShell Compound 05*	Soft film protective
19774-74	VNII NP-207	AeroShell Grease 22	Multi-purpose grease
19782-74	VNII NP-225	-	Molybdenum disulphide grease
20734-75	7-50C-3	-	Silicone hydraulic fluid
21743-96	MS-14 MS-20 MS-20S MK-22 MS-20P	AeroShell Oil 80 AeroShell Oil W80 AeroShell Oil 100 AeroShell Oil W100 AeroShell Oil W 15W-50 AeroShell Oil 100 AeroShell Oil W100 AeroShell Oil 100 AeroShell Oil W100 -	Aircraft piston engine oils
21791-76	MAS-8N MAS-14N MAS-30NK	- - -	Synthetic oils
23907-79	-	-	De-icing fluids
24300-80	LZ-31	-	Grease
24926-81	VNII NP-282	-	Grease

Specification TU	Grade Name	AeroShell Grade	Remarks
6-020-531-69	PFMS-4S	-	Specialised grease
6-02-917-79	PFMS-4S	-	Specialised grease
11-100-69	MD-BF	-	-
38-00180-75	IPM-10	AeroShell Turbine Oil 390*	Synthetic turbine oil. See also TU 38.1011299-90
38-001116-73	Grease No. 9	-	-
38-1-158-68	VNII NP-225	-	-
38-1-230-66 (Obsolete)	Grease OKB-122-7 Grease OKB-122-7-5 Grease OKB-122-8	AeroShell Grease 6* AeroShell Grease 22 AeroShell Grease 6*	Believed to be superseded by GOST 18179-72
38-101-295-75 (Obsolete) Supersedes 38-1-164-65 and 38-1-157-65)	36/1 36/1K B3-V	AeroShell Turbine Oil 390 AeroShell Turbine Oil 390 AeroShell Turbine Oil 500*	Synthetic turbine oils (see also TU 38.101384-78)
38-101-295-85	B3-V	AeroShell Turbine Oil 560 AeroShell Turbine Oil 500*	Synthetic turbine oils
38-101-297-78	VNII NP 235	AeroShell Grease 15*	High temperature grease
38-101-384-78	36/1Ku-A	AeroShell Turbine Oil 390 AeroShell Turbine Oil 560* AeroShell Turbine Oil 500*	Synthetic turbine oils
38-101-419-79 (Obsolete)	CIATIM 221S	-	Grease
38-101-722-85	MN-7.5U	AeroShell Turbine Oil 750	Synthetic turbine oil
38-101-740-80	NGJ-4	Skydrol® 500B4 or LD4	Phosphate ester hydraulic fluid
38-101-741-78	-	-	Fuel static dissipater additive
38-101-950-00	ERA (VNII NP 286M)	AeroShell Grease 33 AeroShell Grease 22* AeroShell Grease 6*	Multi-purpose grease
38-101-1181-88	MS-8RK	AeroShell Turbine Oil 3SP	Mineral preservation oil for engines
38-101-1219-89	ST (NK-50)	AeroShell Grease 22	Grease
38-101-1243-89	CIATIM 221S	AeroShell Grease 22*	Grease
38-101-1299-06	IPM-10	AeroShell Turbine Oil 390*	Synthetic turbine engine oil
38-101-1332-90	TSgip	-	Heavily loaded gear oil
38-401-58-12-91	VNII NP 50-1-4U	AeroShell Turbine Oil 390 AeroShell Turbine Oil 560	Synthetic turbine engine oil
38-401-58-57-93	NGJ-5u	Sykdrol® 500B4 or LD4	Phosphate ester hydraulic fluid
38-401-121-75 (Obsolete)	VNII NP 286M	AeroShell Grease 22 AeroShell Grease 6*	Grease
38-401-286-82	VNII-NP 50-1-4U	AeroShell Turbine Oil 390 AeroShell Turbine Oil 560	Synthetic turbine engine oil
38-401-337	PTS-225	-	Synthetic turbine engine oil
301-04-010-92	LZ-240	AeroShell Turbine Oil 560	Synthetic turbine engine oil

Specification OCT/CTY/VT	Grade Name	AeroShell Grade	Remarks
OCT 6-08-431-75	Grade C-1	-	Graphite powder
OCT 38-01145-80	I-13	-	Obsolete
OCT 38-01163-78	MS-8P	AeroShell Turbine Oil 3SP	Mineral turbine engine oil
OCT 38-01180-80	CIATIM 221S CIATIM 221C	AeroShell Grease 22	Grease
OCT 38-01294-83	IPM-10	AeroShell Turbine Oil 390*	Synthetic turbine engine oil
OCT 38-1355-84	CT (HK-50) ST	AeroShell Grease 5* AeroShell Grease 22	Wheel bearing grease
OCT 95-510-77	Grease No.8	-	Anti-seize grease
CTY 36-13-719-61	PFMS-4S	-	-
VT UNP-18-58	CIATIM 221S	AeroShell Grease 22	Grease

Grade Name	Specification	AeroShell Grade
AF-70	Refer to "Grease AF-70"	-
AKOR-1	GOST 15171-70	AeroShell Fluid 2XN*
AMG-10	GOST 6794-78	AeroShell Fluid 41
AMS-1	GOST 2712-75	-
AMS-3	GOST 2712-75	-
AV	Refer to "Spindle Oil AV"	-
B3-V	TU 38-101-295-75 TU 38-101-295-85	AeroShell Turbine Oil 500* AeroShell Turbine Oil 560
BM-4 (VM-4)	GOST 7903-74	-
BU	Refer to 'Gasoline Proof Grease'	-
C-1	OCT 6-08-431-75	-
CIATIM 201	GOST 6267-74	AeroShell Grease 22 AeroShell Grease 6*
CIATIM 202	GOST 11110-75	AeroShell Grease 22* AeroShell Grease 6*
CIATIM 203	GOST 8773-73	AeroShell Grease 22 AeroShell Grease 6*
CIATIM 205	GOST 8551-74	-
CIATIM 208	GOST 16422-70	-
CIATIM 221	GOST 9433-80	AeroShell Grease 22
CIATIM 221S (221C)	TU 38-101-419-79 VT UNP-18-58 OCT 38-01180-80	-

Grade Name	Specification	AeroShell Grade
CT (HK-50) or ST	OCT 38-1355-84	AeroShell Grease 5* AeroShell Grease 22
ERA (VNII NP 286M)	TU 38-101-950-83	AeroShell Grease 22 AeroShell Grease 6*
Gasoline Proof Grease	GOST 7171-78	-
GOI-54p	GOST 3276-74	AeroShell Grease 6*
Grease No. 8	OCT 95-510-77	-
Grease No. 9	TU 38-001116-73	-
Grease AF-70	GOST 2967-52	-
Grease MS-70	GOST 9762-61	-
Grease UN	GOST 782-59	AeroShell Compound 05*
Gun Grease	GOST 3005-51	-
HF-12-18	GOST 5546-66	-
HK-50 (NK-50)	GOST 5573-67	AeroShell Grease 5* AeroShell Grease 22
Hypoid Gear Oil	GOST 4003-53	-
I-13	GOST 1631-61 OCT 38-01145-80	-
IPM-10	TU 38-00180-75 OCT-38-01294-83 TU 38-101-1299-90	AeroShell Turbine Oil 390* AeroShell Turbine Oil 390* AeroShell Turbine Oil 390*
K-17	GOST 10877-64	-
Lubricant No. 6	GOST 10957-64	-
LZ-31	GOST 24300-80	-
LZ-240	TU 38-401-579-86 301-04-010-92 301-04-015-91	AeroShell Turbine Oil 500* AeroShell Turbine Oil 560 AeroShell Turbine Oil 560
CT (HK-50)	OCT 38-1355-84	AeroShell Grease 5* AeroShell Grease 22
MD-BD	TU 11-100-69	-
MAS-8N	GOST 21791-76	-
MAS-14N	GOST 21791-76	-
MAS-30NK	GOST 21791-76	-
MN 7.5U-(or MH 7.5u)	TU 38-101-722-85	AeroShell Turbine Oil 750
MK-6	GOST 10328-63	AeroShell Turbine Oil 2*
MK-8	GOST 6457-66	AeroShell Turbine Oil 3 AeroShell Turbine Oil 2*
MK-8P	GOST 6457-66	AeroShell Turbine Oil 3SP
MK-22	GOST 1013-49 GOST 21743-76	AeroShell Oil 100 AeroShell Oil W100 AeroShell Oil 100 AeroShell Oil W100
MS-6	GOST 11552-65	AeroShell Turbine Oil 2*
MS-8	-	AeroShell Turbine Oil 3
MS-8P	OCT 38-01163-78	AeroShell Turbine Oil 3SP
MS-8RK	TU 38-101-1181-88	AeroShell Turbine Oil 3SP
MS-14	GOST 1013-49 GOST 21743-76	AeroShell Oil 80 AeroShell Oil W80 AeroShell Oil 80 AeroShell Oil W80

Grade Name	Specification	AeroShell Grade
MS-20	GOST 1013-49 GOST 21743-76	AeroShell Oil 100 AeroShell Oil W100 AeroShell Oil 100 AeroShell Oil W100 AeroShell Oil W 15W-50
MS-20P	-	-
MS-20S	GOST 9320-60 GOST 21743-76	AeroShell Oil 100 AeroShell Oil W100 AeroShell Oil 100 AeroShell Oil W100
MS-70	Refer to 'Grease MS-70'	-
MVP	GOST 1805-76	-
NGJ-4	TU 38-101-740-80	Sykdrol® 500B4 or LD4
NGJ-5U	TU-38-401-811-90	Skydrol® 500B4 or LD4
OKB-122-3	GOST 4216-55 GOST 18375-73	-
OKB-122-4	GOST 4216-55 GOST 18375-73	-
OKB-122-5	GOST 4216-55 GOST 18375-73	-
OKB-122-7	GOST 18179-72 TU 38-1-230-66	AeroShell Grease 6*
OKB-122-7-5	TU 38-1-230-66	AeroShell Grease 22
OKB-122-8	TU 38-1-230-66	AeroShell Grease 6*
OKB-122-14	GOST 4216-55 GOST 18375-73	-
OKB-122-16	GOST 4216-55 GOST 18375-73	-
PFMS-4	GOST 15866-70	-
PFMS-4S	TU 6-020-531-69 TU 6-02-917-79 CTY 36-13-719-61	-
Press Solidol S	GOST 4366-76	-
PTS-225	TU 38-401337	-
PVK	GOST 10586-63 GOST 19537-74	AeroShell Compound 05
RT	GOST 16564-71	Shell Jet A-1*
Solidol S	GOST 4366-76	-
Spindle Oil AV	GOST 1642-50	-
T-6	GOST 12308	-
T-8V	GOST 12308	-
TK	GOST 982-68	AeroShell Turbine Oil 3*
TKP	GOST 982-68	AeroShell Turbine Oil 3*
TS-1	GOST 10277-86	Shell TS-1
UN	Refer to 'Grease UN'	-
US-1	GOST 1033-73	-
US-2	GOST 1033-73	-
USsA	GOST 3333-80	-
UT	GOST 1957-72	-
VM-4	Refer to 'BM-4'	-

Grade Name	Specification	AeroShell Grade
VNII NP 7	GOST 12246-66	-
VNII NP 25	GOST 11122-65	-
VNII NP 44-2	GOST 10817-64	-
VNII NP 44-2-C	GOST 10817-64	-
VNII NP 50-1-4F	GOST 13076-67	AeroShell Turbine Oil 390 AeroShell Turbine Oil 560
VNII NP 50-1-4U	TU 38-401-286-82	AeroShell Turbine Oil 390 AeroShell Turbine Oil 560
VNII NP 207	GOST 19774-74	AeroShell Grease 22
VNII NP 223	GOST 12030-66	-
VNII NP 225	GOST 19782-74 TU 38-1-158-68	-
VNII NP 232	GOST 14068-79	-
VNII NP 235	TU 38-101-297-78	AeroShell Grease 15*
VNII NP 246	GOST 18852-73	AeroShell Grease 15*
VNII NP 262	GOST 12031-66	-
VNII NP 282	GOST 24926-81	-
VNII NP 286M (ERA)	TU 38-401-121-75 TU 38-101-950-83	AeroShell Grease 22 AeroShell Grease 6* AeroShell Grease 22 AeroShell Grease 6*
VNII NP 403	GOST 16728-71	-
7-50C-3	GOST 20734-75	-
36/1	TU 38-101-295-75	AeroShell Turbine Oil 390
36/1K	TU 38-101-295-75	AeroShell Turbine Oil 390
36/1 KUA	TU-38-101-384-78	AeroShell Turbine Oil 390 AeroShell Turbine Oil 500* AeroShell Turbine Oil 560
132-07	GOST 18375-73	-
132-08	GOST 18375-73	-
132-19	GOST 18375-73	-
132-20	GOST 18375-73	-
132-21	GOST 18375-73	-

AEROSHELL PRODUCT SPECIFICATIONS

Scope of list

This list is comprised of all current AeroShell Grades, namely: aviation oils, fluids, greases and other Shell products used in aircraft, i.e. aviation fuels and specialised products.

Interpretation of list

For each AeroShell Grade listed the relevant U.S. and U.K. Specifications, NATO Code Number and Joint Service Designation are listed. Details of the product and application are also given and where appropriate comments are included.

Where an asterisk* appears alongside either the U.S. or U.K. Specification in the list, it means that the AeroShell Grade is not necessarily fully approved to that specification but that it meets the requirements of that specification.

AeroShell Grade	U.S. Specification	British Specification	NATO Code	Joint Service Designation	Product and Application	Remarks
AVIATION FUEL						
Shell Avgas 100	ASTM D910	DEF STAN 91-90	-	AVGAS 100	Fuel for aircraft piston engines Grade 100/130	-
Shell Avgas 100LL	ASTM D910	DEF STAN 91-90	F-18	AVGAS 100LL	Fuel for aircraft piston engines Grade 100/130 Low Lead	-
Shell JP-8	MIL-DTL-83133G Grade JP-8	DEF STAN 91-87	F-34	AVTUR/FSII	Aviation turbine fuel, kerosine type with FSII	Special arrangements necessary
Shell JP-8 +100	MIL-DTL-83133G Grade JP-8 +100	-	F-37	-	Aviation turbine fuel. JP-8 + thermal stability additive S-1749	Special arrangements necessary
Shell Jet A-1	MIL-DTL-83133G ASTM D1655	DEF STAN 91-91	F-35	AVTUR	Aviation turbine fuel kerosine type	-
Shell JP-5	MIL-DTL-5624U Grade JP-5	DEF STAN 91-86	F-44	AVCAT/FSII	Aviation turbine fuel, high flash kerosine type with FSII	Special arrangements necessary
Shell Jet A	ASTM D1655	-	-	-	Aviation turbine fuel, freeze point -40°C	Normally only available in the U.S.A.
Shell Jet B	ASTM D6615	-	-	-	Aviation turbine fuel, wide cut	Normally only available in Canada meeting CAN/CGSB 3.23
Shell Aerojet	ASTM D1655*	DEF STAN 91-91*	F-35*	-	Aviation turbine fuel, kerosene type with FSII	Special arrangements necessary
AEROSHELL ADDITIVES						
AeroShell Performance Additive 101	(MIL-DTL-83133G)	-	S-1749	-	Fuel additive to improve thermal stability of aviation turbine fuel	This additive when added to JP-8 makes grade JP-8 +100

AeroShell Grade	U.S. Specification	British Specification	NATO Code	Joint Service Designation	Product and Application	Remarks
PISTON ENGINE OILS						
AeroShell Oil 65	SAE J-1966 Grade SAE 30	-	O-113 (Obsolete)	OM-107 (Obsolete)	Aircraft piston engine oil	-
AeroShell Oil 80	SAE J-1966 Grade SAE 40	SAE J-1966 Grade SAE 40	O-115 (Obsolete)	OM-170	Aircraft piston engine oil	-
AeroShell Oil 100	SAE J-1966 Grade SAE 50	SAE J-1966 Grade SAE 50	O-117 (Obsolete)	OM-270 (Obsolete)	Aircraft piston engine oil	-
AeroShell Oil 120	SAE J-1966 Grade SAE 60	-	-	OM-370	Aircraft piston engine oil	-
AeroShell Oil W80	SAE J-1899 Grade SAE 40	SAE J-1899 Grade SAE 40	O-123 (Obsolete)	OMD-160	Ashless dispersant aircraft piston engine oil	-
AeroShell Oil W80 Plus	SAE J-1899 Grade SAE 40	-	-	-	Ashless dispersant aircraft piston engine oil	-
AeroShell Oil W100	SAE J-1899 Grade SAE 50	SAE J-1899 Grade SAE 50	O-125 (Obsolete)	OMD-250	Ashless dispersant aircraft piston engine oil	-
AeroShell Oil W100 Plus	SAE J-1899 Grade SAE 50	-	-	-	Ashless dispersant aircraft piston engine oil	-
AeroShell Oil W120	SAE J-1899 Grade SAE 60	SAE J-1899 Grade SAE 60	O-128 (Obsolete)	OMD-370	Ashless dispersant aircraft piston engine oil	-
AeroShell Oil W 15W-50	SAE J-1899 Grade Multigrade	SAE J-1899 Grade Multigrade	O-162 (Obsolete)	OMD-162	Ashless dispersant aircraft piston engine oil	-
AeroShell Oil Sport Plus 2	API TC	-	-	-	Specific oil for Light Sport and Very Light/Ultra Light 2-stroke aircraft engines	Approved by Rotax® Service Instruction SI-2ST-008
AeroShell Oil Sport Plus 4	API SL	-	-	-	Specific oil for Light Sport and Very Light/Ultra Light 4-stroke aircraft engines	-
AeroShell Oil Diesel Ultra	API SM/CF	-	-	-	Specific oil for aircraft diesel engines	Approved to Mercedes Benz MB229.5
TURBINE ENGINE OILS						
AeroShell Turbine Oil 2	MIL-PRF-6081D Grade 1010	-	O-133	OM-10 (Obsolete)	Mineral aviation turbine oil 2 mm^2/s viscosity	-
AeroShell Turbine Oil 3	-	DEF STAN 91-99	O-135	OM-11	Mineral aviation turbine oil 3 mm^2/s viscosity	Acceptable substitute for AeroShell Fluid 1
AeroShell Turbine Oil 3SP	-	-	-	-	Mineral aviation turbine oil 3 mm^2/s viscosity	Analogue to Russian Grade MS-8P
AeroShell Turbine Oil 308	MIL-PRF-7808L Grade 3	(MIL-PRF-7808L Grade 3)	O-148	OX-9	Synthetic ester aviation turbine oil 3 mm^2/s viscosity	-
AeroShell Turbine Oil 390	-	DEF STAN 91-94	-	OX-7	Synthetic ester aviation turbine oil 3 mm^2/s viscosity	-
AeroShell Turbine Oil 500	MIL-PRF-23699G Grade STD SAE AS5780B Grade SPC	DEF STAN 91-101 Grade OX-27	O-156	OX-27	Standard Grade, synthetic ester aviation turbine oil 5 mm^2/s viscosity	-
AeroShell Turbine Oil 555	DOD-L-85734A	DEF STAN 91-100	O-160	OX-26	Synthetic ester oil for helicopter transmissions. High load synthetic ester aviation turbine oil 5 mm^2/s viscosity	-
AeroShell Turbine Oil 560	MIL-PRF-23699G Grade HTS SAE AS5780B Grade SPC	-	O-154		High thermal stability synthetic ester aviation turbine oil 5 mm^2/s viscosity	-

AeroShell Grade	U.S. Specification	British Specification	NATO Code	Joint Service Designation	Product and Application	Remarks
AeroShell Ascender	SAE AS5780B Grade HPC	-	-	-	High performance capability synthetic ester aviation turbine oil 5 mm^2/s viscosity	-
AeroShell Turbine Oil 750	-	DEF STAN 91-98	O-149	OX-38	Synthetic ester aviation turbine oil 7.5 mm^2/s viscosity	-
AEROSHELL GREASES						
AeroShell Grease 5	MIL-G-3545C* (Obsolete)	DTD.878A*	G-359	XG-277 (Obsolete)	High temperature aircraft grease	Still available for civil market meeting obsolete U.S. and U.K. Specifications
AeroShell Grease 6	MIL-G-7711A* (Obsolete) MIL-PRF-24139A	DEF STAN 91-12 DEF STAN 91-28*	G-382 G-450	XG-271 -	Aircraft general purpose grease Multi-purpose quiet service grease	Still available for civil market meeting obsolete U.S. and U.K. Specifications Approved to U.S. Specification. Equivalent to U.K. Specification
AeroShell Grease 7	MIL-PRF-23827C (Type II)	-	-	-	Synthetic grease for aircraft	-
AeroShell Grease 14	MIL-G-25537C	DEF STAN 91-51	G-366	XG-284	Helicopter general purpose grease	-
AeroShell Grease 15	MIL-G-25013E	DEF STAN 91-55 (Obsolete)	G-372	XG-300	Extreme high temperature grease	-
AeroShell Grease 22	MIL-PRF-81322G DOD-G-24508A	DEF STAN 91-52	G-395	XG-293	Synthetic general purpose aircraft grease	-
AeroShell Grease 33	MIL-PRF-23827C (Type I)	DEF STAN 91-53	G-354	XG-287	General purpose airframe grease	Approved to Boeing Specification BMS 3-33B
AeroShell Grease 58	SAE AMS3058	-	-	-	Wide temperature range grease for aircraft wheel bearings	-
AeroShell Grease 64	MIL-G-21164D	DEF STAN 91-57	G-353	-	Synthetic ester aircraft grease with molybdenum disulphide	Formerly branded as AeroShell Grease 33MS
AeroShell Compound 08	SAE-AMS-2518A	DEF STAN 80-80	S-720	ZX-13	Graphited anti-seize compound 7.5 mm^2/s viscosity	-
HYDRAULIC FLUIDS						
AeroShell Fluid 4	MIL-H-5606A* (Obsolete) -	DTD.585* (Obsolete) DEF STAN 91-48 Grade Normal	- H-520	- OM-18	Mineral hydraulic fluid Mineral hydraulic fluid	Still available meeting obsolete U.S. and U.K. Specifications European production only
AeroShell Fluid 31	MIL-PRF-83282D	(MIL-PRF-83282D)	H-537	OX-19	Synthetic hydrocarbon fire resistant hydraulic fluid	-
AeroShell Fluid 41	MIL-PRF-5606H	DEF STAN 91-48 Grade Superclean	H-515	OM-15	Mineral hydraulic fluid of improved cleanliness	-
AeroShell Fluid 51	MIL-PRF-87257B	(MIL-PRF-87257B)	H-538	OX-538	Low temperature synthetic hydrocarbon fire resistant hydraulic fluid	-
AeroShell Fluid 61	MIL-PRF-46170D Type I	-	H-544	-	Preservative synthetic hydrocarbon fire resistant hydraulic fluid	-
AeroShell Fluid 71	MIL-PRF-6083F	DEF STAN 80-142*	C-635	PX-26*	Preservative mineral hydraulic fluid of improved cleanliness	Approved to U.S. Specification Equivalent to U.K. Specification
AeroShell SSF	-	-	-	-	Fluid based on MIL-PRF-6083 for use in landing gear shock struts	Approved to Boeing Specification BMS 3-32 Type I
AeroShell LGF	-	-	-	-	Fluid based on MIL-PRF-5606 for use in landing gear shock struts	Approved to Boeing Specification BMS 3-32 Type II

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OTHER FLUIDS						
AeroShell Fluid 1	-	DEF STAN 91-44	O-134	OM-13 (Obsolete)	Light lubricating oil	-
AeroShell Fluid 3	MIL-PRF-7870D	DEF STAN 91-47	O-142	OM-12	General purpose lubricating oil	-
AeroShell Fluid 5L-A	MIL-PRF-6086F Grade Light	DEF STAN 91-112 Grade Light*	O-153	OEP-30*	Extreme pressure gear oil of low viscosity	Approved to U.S. Specification Equivalent to U.K. Specification
AeroShell Fluid 5M-A	MIL-PRF-6086F Grade Medium	DEF STAN 91-112 Grade Medium	O-155	OEP-70	Extreme pressure gear oil of medium viscosity	-
AeroShell Fluid 12	MIL-PRF-6085D	DEF STAN 91-49*	O-147	OX-14*	Low volatility aircraft instrument oil	Approved to U.S. Specification Equivalent to U.K. Specification
AeroShell Fluid 18	MIL-PRF-32033	DEF STAN 91-97* (Obsolete)	O-190 (Obsolete)	OX-18* (Obsolete)	Light lubricating oil	-
AeroShell Fluid 602	MIL-PRF-87252C	-	S-1748	-	Avionic cooling fluid	-
AeroShell Fluid S.8350	-	DTD.900/4981A	-	OEP-215	Helicopter gearbox oil	-
AeroShell Calibrating Fluid 2	MIL-PRF-7024E Type II	-	-	-	Special run Stoddard Solvent	-
AeroShell Compound 06A	TT-I-735A Grade B	BS.1595.86	S-737	AL-11	Isopropyl alcohol de-icing fluid	Equivalent to ASTM D770
AeroShell Compound 07	-	DTD.406B	S-745	AL-5	Glycol/alcohol mixture	-
PRESERVATIVES						
AeroShell Fluid 2F	MIL-C-6529C Type II	-	C-609	OX-270 (Obsolete)	Inhibited lubricating oil for internal protection of piston engines during storage	-
AeroShell Fluid 2XN	MIL-C-6529C Type I	(MIL-C-6529C Type I)	C-608	ZX-21 (Obsolete)	Concentrate for AeroShell Fluid 2F and 2T	-
AeroShell Compound 05	MIL-C-11796C Class 3*	DEF STAN 80-85	C-628 (Obsolete)	PX-11	Petroleum jelly/beeswax mixture for general preservation	U.S. Specification acceptable substitute. NATO symbol of substitute C-627
OTHER PRODUCTS						
Shell Water Detector	-	-	-	-	Method for detecting water in jet fuel	-

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